

What shapes genome-wide diversity?

A case study in *Drosophila melanogaster*

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1 Drosophila-like neutral simulations of chr 2L (True Landscapes)

Second batch of 10 replicate datasets simulated using parameters as inferred from real Drosophila data.

Here we present results using true (simulated) genomic landscapes.

1.1 50 kb scale

```
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.rho.50000.txt", header = T)
sim.theta.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.theta.50000.txt", header = T)

1.1.1 Replicate 1

rep_1.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/rep_1.pi.50kb.bedgraph", header = F)
rep_1.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/sim.tmrca.50k.map", header = F)

sim.lands.50kb <- as.data.frame(cbind(rep_1.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_1.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 36665911, p-value = 0.6511
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.01850036

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 35649572, p-value = 0.8119
## alternative hypothesis: true rho is not equal to 0
```

```

## sample estimates:
##      rho
## 0.00973136

# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep1 <- sim.lands.50kb
sim.lands.50kb.rep1$Replicate <- 1

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = sim.lands.50kb)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS) ^ 2, data = sim.lands.50kb)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##             df      AIC
## m.div.50kb    6 -7492.648
## m.div.50kb.2   7 -7491.365
## m.div.50kb.3   8 -7491.767

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))



```

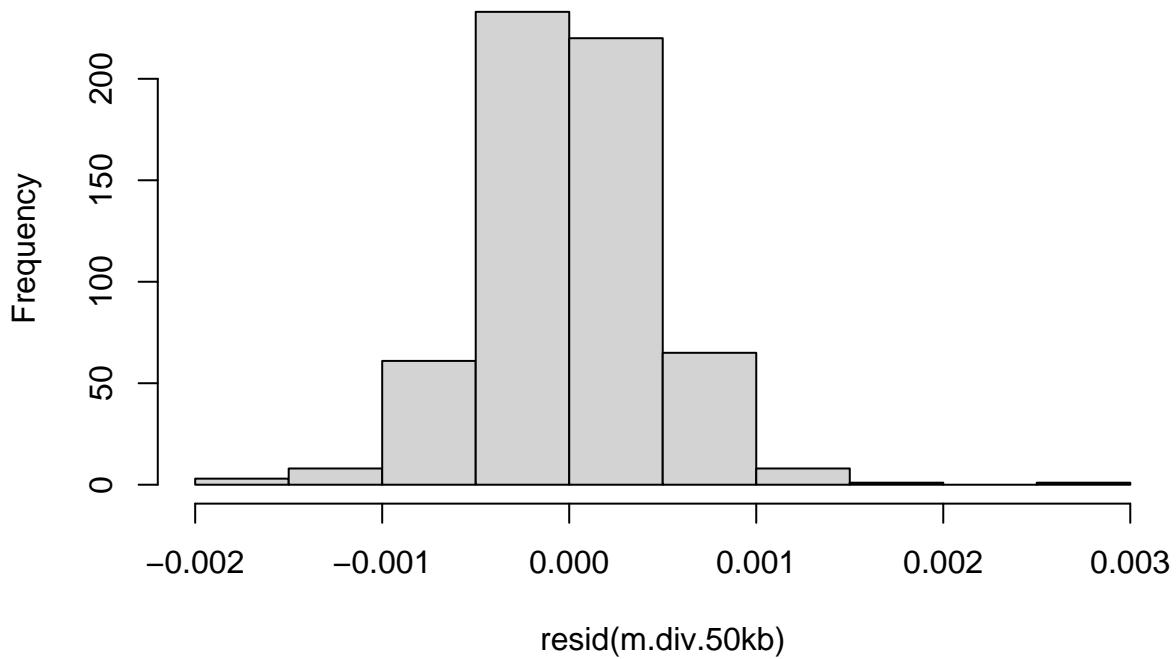
```

## DW = 2.1111, p-value = 0.9056
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.39214, p-value < 2.2e-16
hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = sim.lands.50kb)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -1.839e-03 -2.676e-04 -1.006e-05  2.647e-04  2.976e-03 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.069e-02 1.908e-05 1084.381 <2e-16 ***
## thetaS      1.100e-02 1.919e-05  573.279 <2e-16 ***
## rhoS        4.258e-05 1.915e-05   2.223  0.0266 *  
## tmrcaS      1.665e-03 1.910e-05   87.195 <2e-16 *** 
## thetaS:tmrcaS 8.867e-04 1.810e-05   48.983 <2e-16 *** 
## 
```

```

## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0004673 on 595 degrees of freedom
## Multiple R-squared: 0.9982, Adjusted R-squared: 0.9982
## F-statistic: 8.37e+04 on 4 and 595 DF, p-value: < 2.2e-16
vif(m.div.50kb)

##          thetaS         rhoS        tmrcaS thetaS:tmrcaS
## 1.010273    1.006427    1.000652    1.011132

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.50kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.50kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.50kb, weights = varPower(0, ~theta), method = "ML")
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.50kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##          df      AIC
## g.div.50kb.1 8 -7490.623
## g.div.50kb.2 8 -7570.956
## g.div.50kb.3 7 -7572.341
## g.div.50kb.4 7 -7490.654

summary(g.div.50kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.50kb
##          AIC      BIC logLik
## -7572.341 -7541.562 3793.17
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.4774622

```

```

## 
## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020690112 1.904598e-05 1086.3241 0.0000
## thetaS       0.011057434 1.990949e-05   555.3850 0.0000
## rhoS        0.000025866 1.646000e-05      1.5715 0.1166
## tmrcaS      0.001666932 1.902968e-05     87.5965 0.0000
## thetaS:tmrcaS 0.000875737 1.979066e-05    44.2500 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.497
## rhoS        0.001  0.052
## tmrcaS     0.013  0.026 -0.004
## thetaS:tmrcaS 0.026  0.025  0.036  0.494
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.955335882 -0.608690299  0.006577071  0.610719662  4.719725049
##
## Residual standard error: 0.003393872
## Degrees of freedom: 600 total; 595 residual
vif(g.div.50kb.3)

```

```

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.003575 1.004633 1.323896 1.325415

```

1.1.2 Replicate 2

```

rep_2.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/rep_2.pi.50kb.bedgraph", header = FALSE)
rep_2.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_2.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_2.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 36499595, p-value = 0.7344
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## -0.01388046

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592

```

```

## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.04613476
cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 33177308, p-value = 0.05494
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## 0.07840555

# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

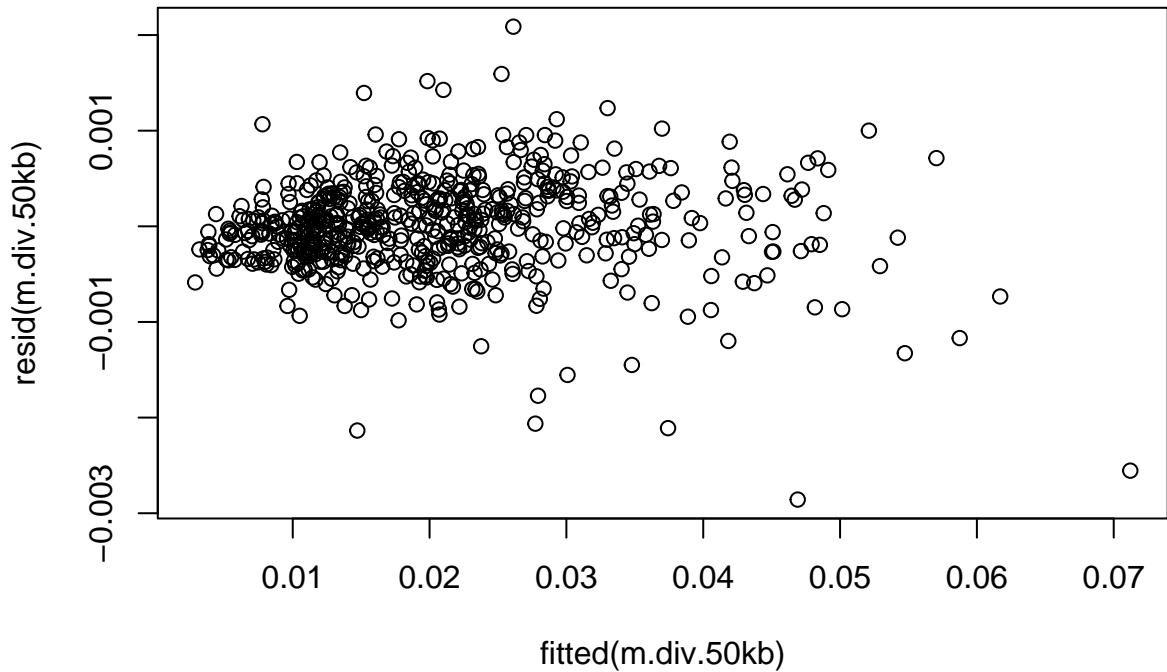
sim.lands.50kb.rep2 <- sim.lands.50kb
sim.lands.50kb.rep2$Replicate <- 2

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = sim.lands.50kb)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS) ^ 2, data = sim.lands.50kb)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##           df      AIC
## m.div.50kb    6 -7408.739
## m.div.50kb.2  7 -7409.225
## m.div.50kb.3  8 -7407.388
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```

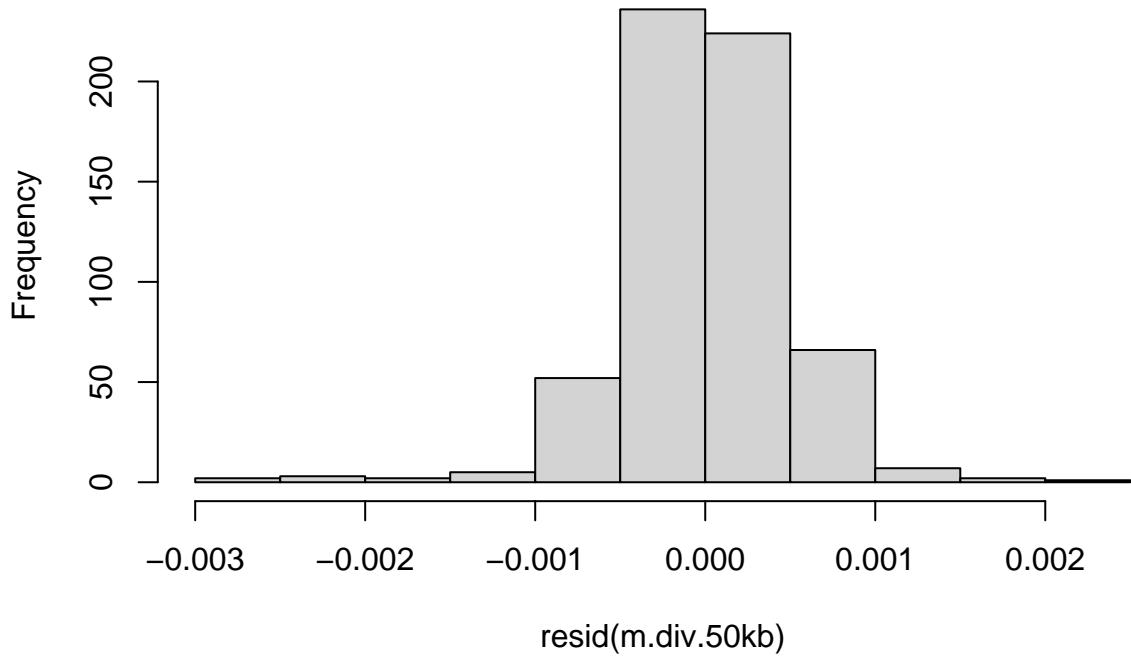


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.9715, p-value = 0.3445
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.51438, p-value = 0.682
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.50kb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -2.857e-03 -2.640e-04  1.830e-06  2.990e-04  2.087e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.057e-02 2.047e-05 1005.301 <2e-16 ***
## thetaS      1.092e-02 2.058e-05  530.815 <2e-16 ***
## rhoS       -2.995e-05 2.053e-05   -1.459  0.145
## tmrcaS     1.738e-03 2.063e-05   84.273 <2e-16 ***
## thetaS:tmrcaS 9.278e-04 1.973e-05   47.015 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0005011 on 595 degrees of freedom
## Multiple R-squared:  0.9979, Adjusted R-squared:  0.9979
## F-statistic: 7.16e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.009894 1.005565 1.015137 1.018886
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 2] <- anova.diversity$VarExp[4] * 100

```

1.1.3 Replicate 3

```

rep_3.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/rep_3.pi.50kb.bedgraph", header = FALSE)
rep_3.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_3.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_3.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and tmrca
## S = 37873663, p-value = 0.203
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.05204912
cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.04613476
cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: rho and tmrca
## S = 35383984, p-value = 0.6757
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01710883

```

```

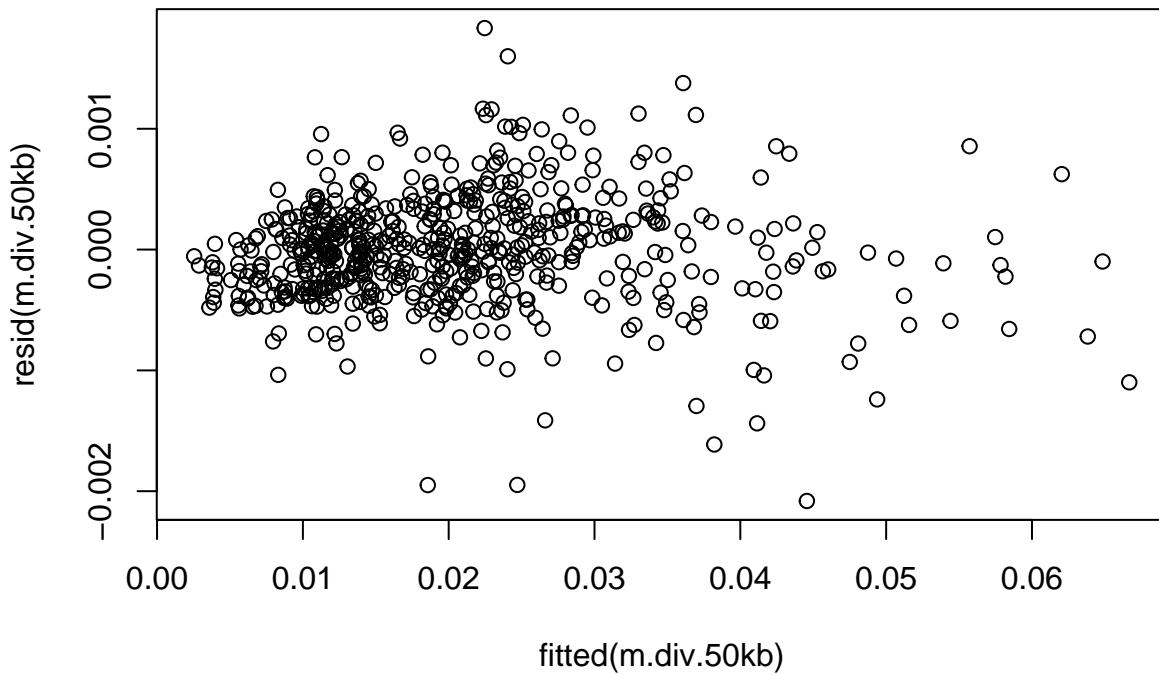
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep3 <- sim.lands.50kb
sim.lands.50kb.rep3$Replicate <- 3

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

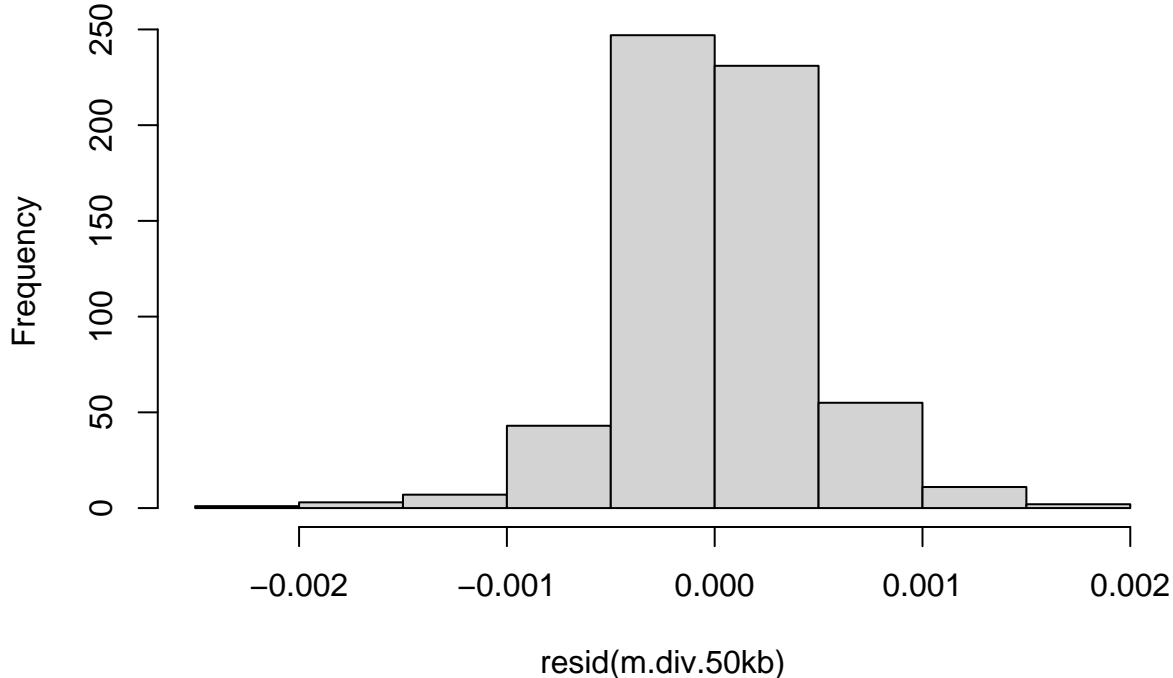
##
## Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.9214, p-value = 0.1563
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
## Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.50434, p-value = 0.555

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##      Min       1Q     Median       3Q      Max  
## -2.081e-03 -2.636e-04 -7.680e-06  2.600e-04  1.833e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.067e-02 1.870e-05 1105.47 <2e-16 ***  
## thetaS       1.101e-02 1.875e-05  587.29 <2e-16 ***  
## rhoS        1.911e-05 1.874e-05   1.02  0.308  
## tmrcaS      1.935e-03 1.882e-05  102.80 <2e-16 ***  
## thetaS:tmrcaS 1.034e-03 1.754e-05   58.97 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004578 on 595 degrees of freedom  
## Multiple R-squared:  0.9983, Adjusted R-squared:  0.9983  
## F-statistic: 8.857e+04 on 4 and 595 DF,  p-value: < 2.2e-16  
anova.diversity <- Anova(m.div.50kb)  
apiss <- anova.diversity$"Sum Sq"  
anova.diversity$VarExp <- apiss / sum(apiss)
```

```

r2.sim.50kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 3] <- anova.diversity$VarExp[4] * 100

```

1.1.4 Replicate 4

```

rep_4.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/rep_4.pi.50kb.bedgraph", header = TRUE)
rep_4.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/sim.tmrca.50k.map", header = TRUE)

sim.lands.50kb <- as.data.frame(cbind(rep_4.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_4.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 36135074, p-value = 0.9269
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.003754843

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 37039432, p-value = 0.4801
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.02887597

# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

```

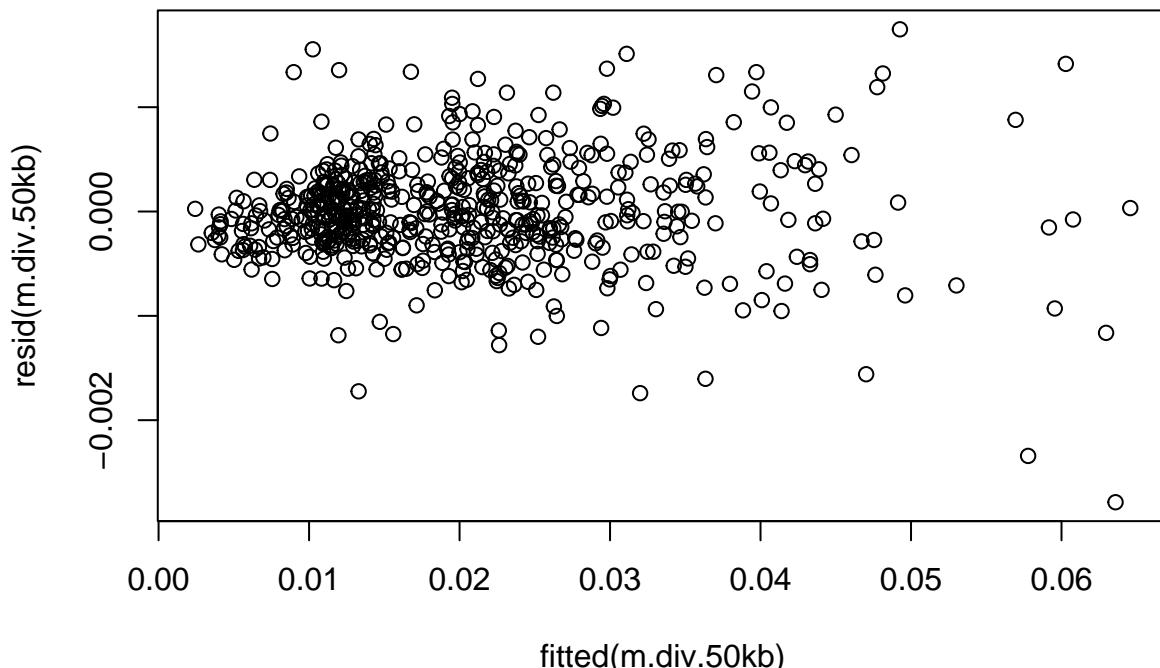
```

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep4 <- sim.lands.50kb
sim.lands.50kb.rep4$Replicate <- 4

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

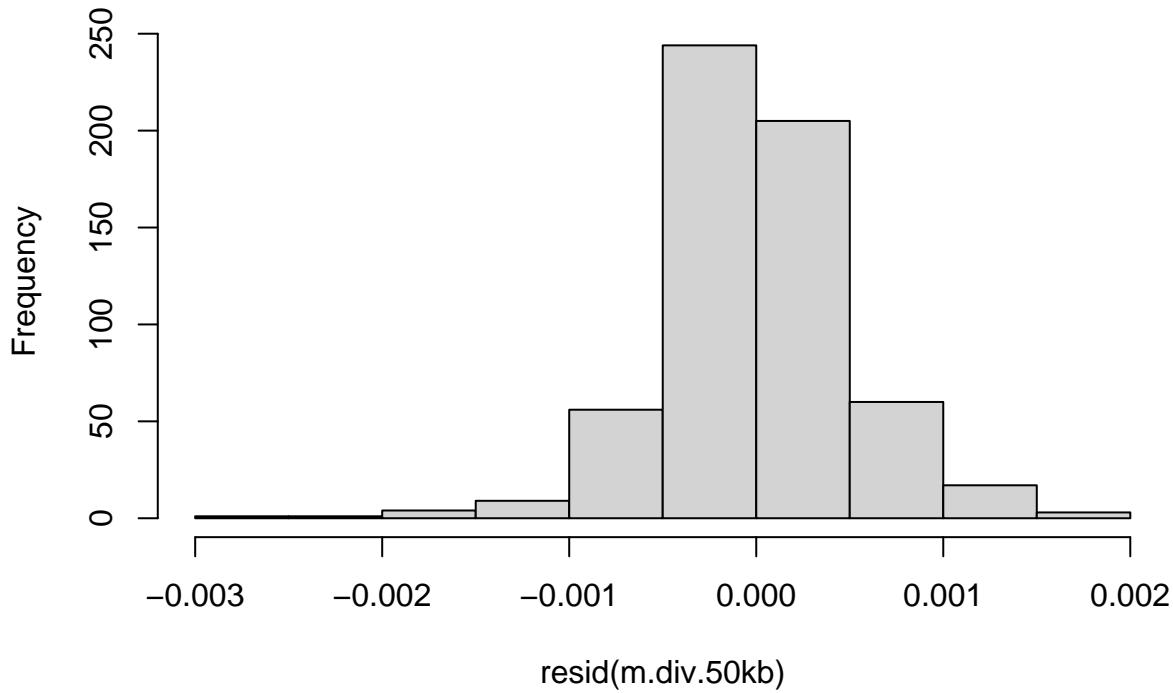
dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
##  data:  m.div.50kb
##  DW = 2.0985, p-value = 0.8779
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
##  data:  m.div.50kb
##  HMC = 0.53836, p-value = 0.89
hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.50kb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -2.787e-03 -2.851e-04 -3.163e-05  2.685e-04  1.746e-03
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.050e-02 2.077e-05 987.094 <2e-16 ***
## thetaS       1.093e-02 2.081e-05 525.118 <2e-16 ***
## rhoS        4.114e-05 2.082e-05  1.976  0.0486 *  
## tmrcaS      1.849e-03 2.081e-05  88.857 <2e-16 ***
## thetaS:tmrcaS 9.878e-04 2.074e-05  47.634 <2e-16 ***
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0005088 on 595 degrees of freedom
## Multiple R-squared:  0.9979, Adjusted R-squared:  0.9979 
## F-statistic: 7.205e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.002369 1.002792 1.001952 1.001253
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 4] <- anova.diversity$VarExp[4] * 100

```

1.1.5 Replicate 5

```

rep_5.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/rep_5.pi.50kb.bedgraph", header = FALSE)
rep_5.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_5.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_5.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and tmrca
## S = 35425520, p-value = 0.6965
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01595505

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: rho and tmrca
## S = 37018948, p-value = 0.4888
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.02830697

```

```

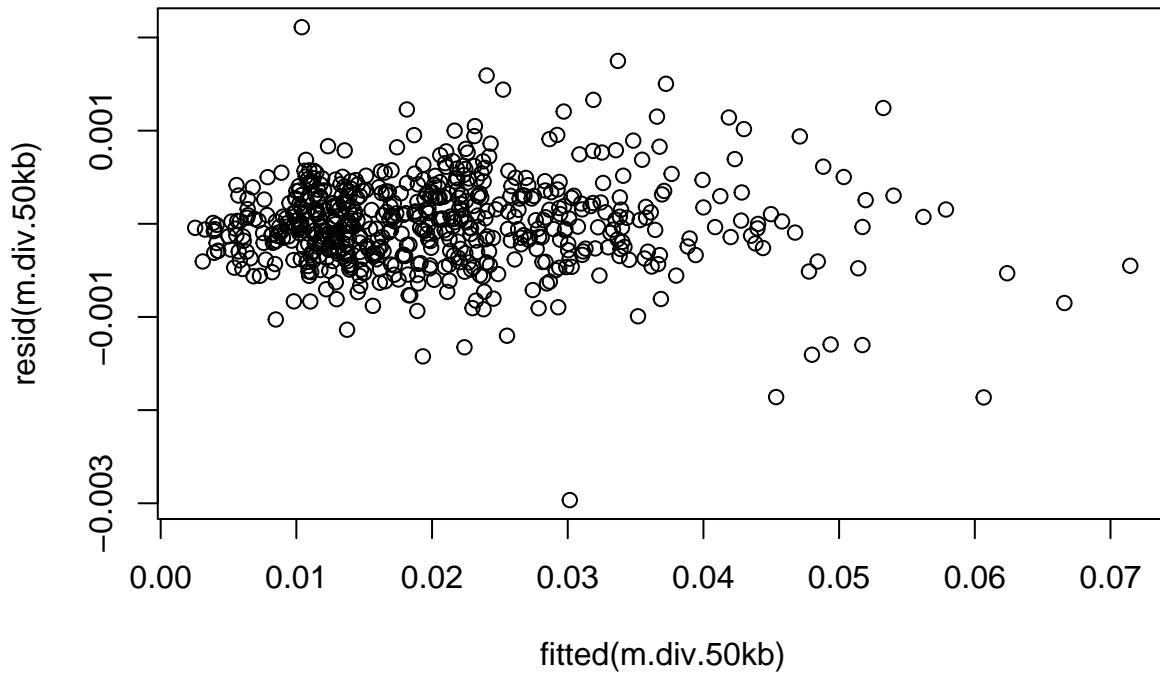
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep5 <- sim.lands.50kb
sim.lands.50kb.rep5$Replicate <- 5

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
## Durbin-Watson test
##
## data: m.div.50kb
## DW = 2.0931, p-value = 0.864
## alternative hypothesis: true autocorrelation is greater than 0

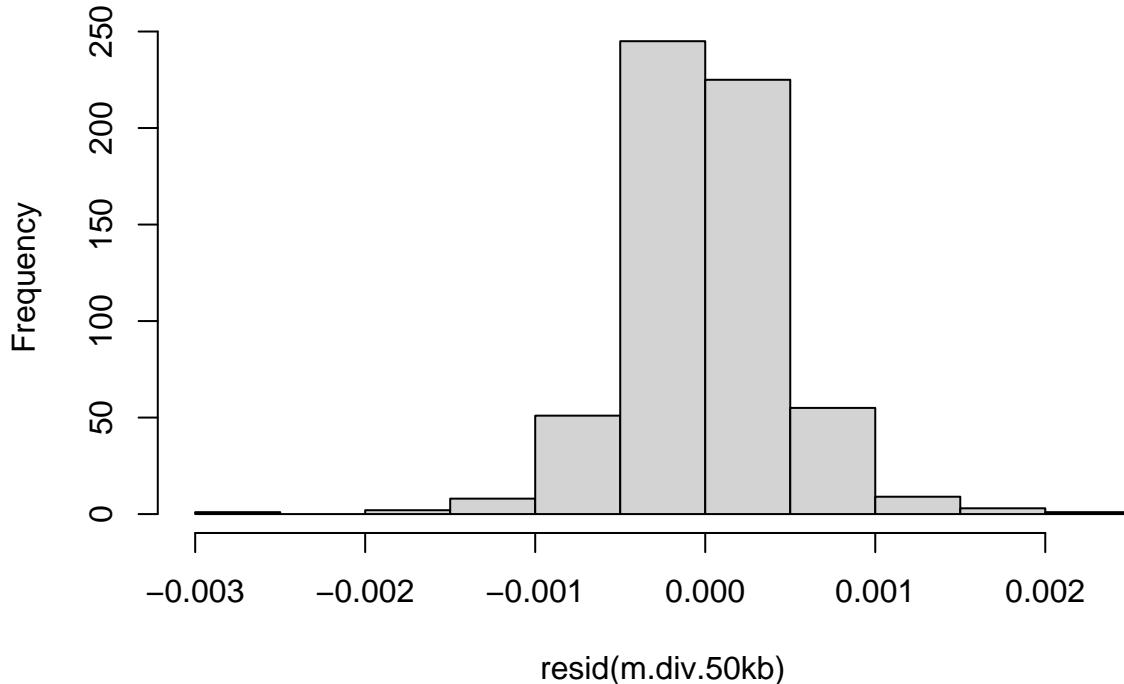
hmctest(m.div.50kb)

##
## Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.45962, p-value = 0.073

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -2.966e-03 -2.902e-04 -1.674e-05  2.879e-04  2.110e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.062e-02 1.967e-05 1048.31 <2e-16 ***  
## thetaS       1.099e-02 1.973e-05  557.06 <2e-16 ***  
## rhoS        4.533e-06 1.972e-05    0.23   0.818  
## tmrcaS      1.750e-03 1.971e-05   88.80 <2e-16 ***  
## thetaS:tmrcaS 9.113e-04 1.937e-05   47.05 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004816 on 595 degrees of freedom  
## Multiple R-squared:  0.9981, Adjusted R-squared:  0.9981  
## F-statistic: 7.932e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb)
```

```
##          thetaS          rhoS         tmrcaS thetaS:tmrcaS
```

```

##      1.005626      1.004046      1.003205      1.005141
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 5] <- anova.diversity$VarExp[4] * 100

```

1.1.6 Replicate 6

```

rep_6.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/rep_6.pi.50kb.bedgraph", header = FALSE)
rep_6.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_6.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_6.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 36901608, p-value = 0.5403
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## -0.0250475

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 37734896, p-value = 0.2384
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## -0.04819447

```

```

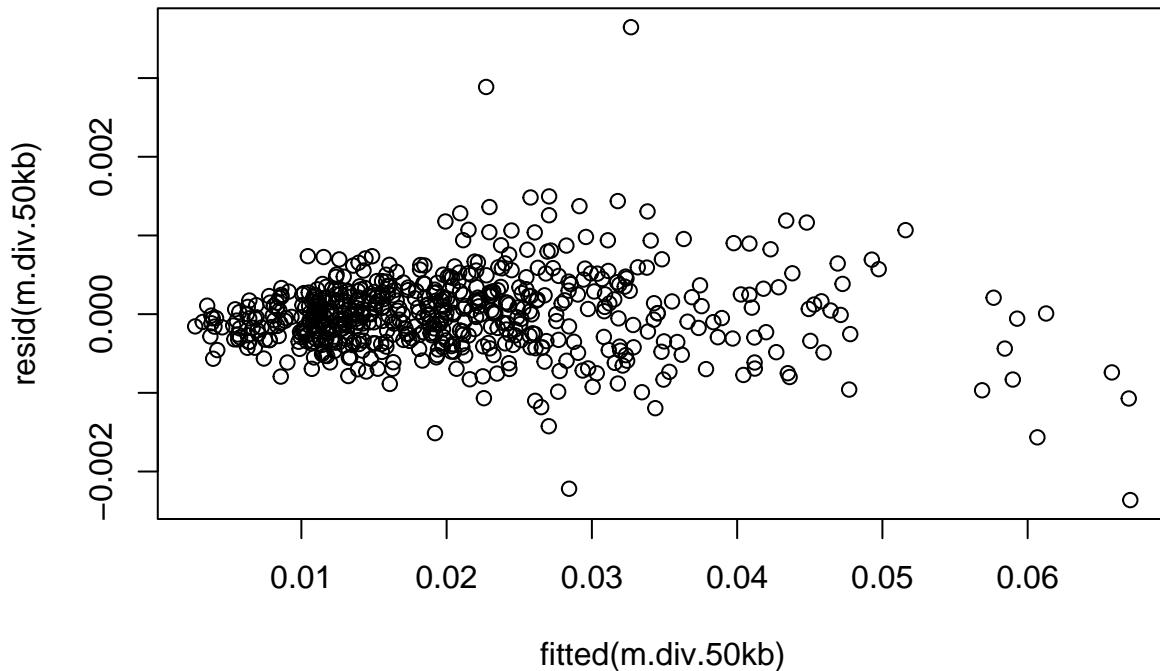
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep6 <- sim.lands.50kb
sim.lands.50kb.rep6$Replicate <- 6

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
##  data:  m.div.50kb
##  DW = 2.1478, p-value = 0.9618
##  alternative hypothesis: true autocorrelation is greater than 0

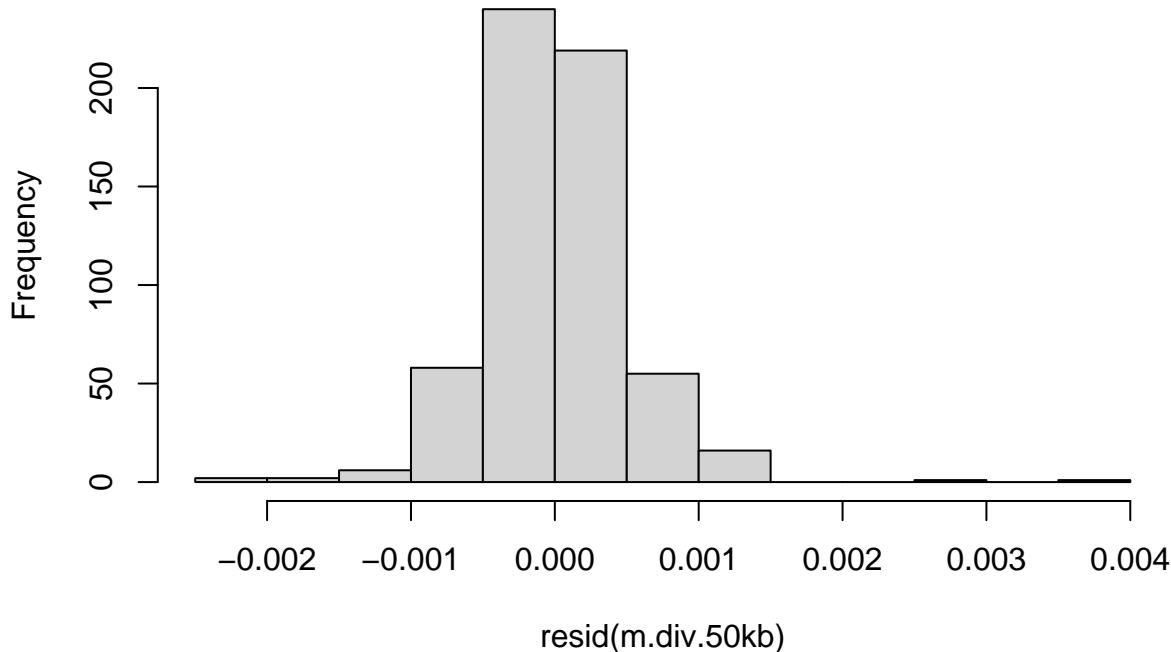
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
##  data:  m.div.50kb
##  HMC = 0.46094, p-value = 0.091

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##       Min        1Q     Median        3Q       Max  
## -0.0023630 -0.0002937 -0.0000107  0.0002498  0.0036466  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.058e-02 2.073e-05 993.114 <2e-16 ***  
## thetaS       1.096e-02 2.083e-05 526.030 <2e-16 ***  
## rhoS        -3.498e-05 2.078e-05 -1.683  0.0929 .  
## tmrcaS       1.783e-03 2.077e-05  85.861 <2e-16 ***  
## thetaS:tmrcaS 9.128e-04 2.013e-05  45.345 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005077 on 595 degrees of freedom  
## Multiple R-squared:  0.998, Adjusted R-squared:  0.9979  
## F-statistic: 7.29e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb)
```

```
##          thetaS          rhoS         tmrcaS thetaS:tmrcaS
```

```

##      1.008799      1.004015      1.002153      1.008954
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 6] <- anova.diversity$VarExp[4] * 100

```

1.1.7 Replicate 7

```

rep_7.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/rep_7.pi.50kb.bedgraph", header = FALSE)
rep_7.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_7.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_7.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 38638560, p-value = 0.0728
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0732963

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 36196758, p-value = 0.8936
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.005468293

```

```

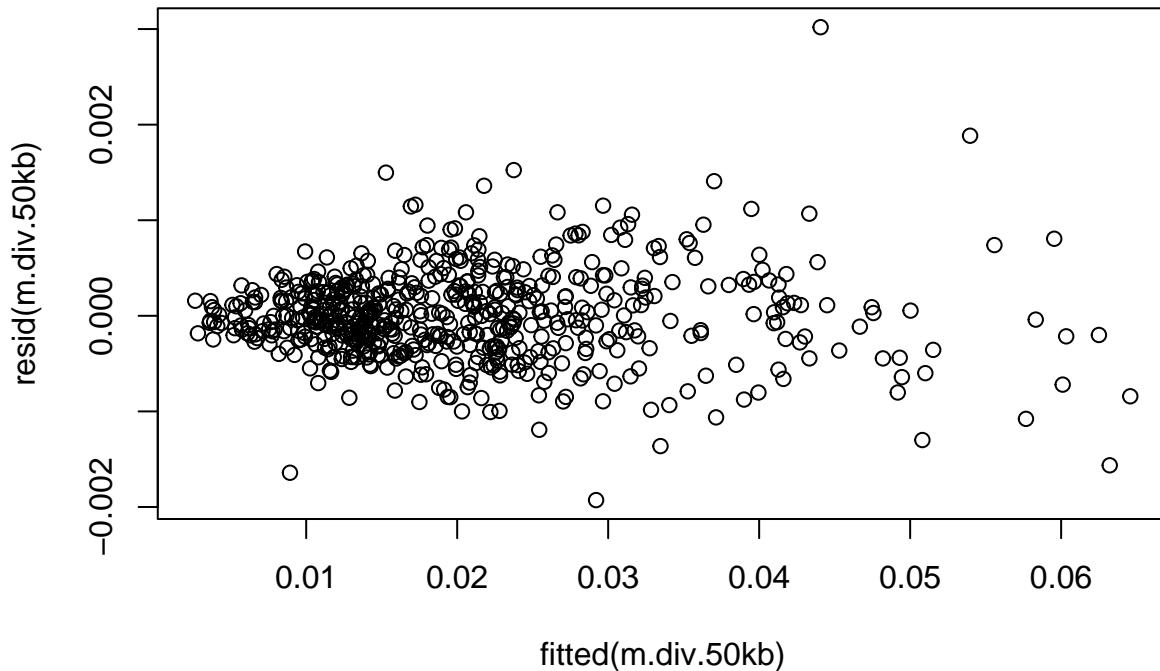
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep7 <- sim.lands.50kb
sim.lands.50kb.rep7$Replicate <- 7

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
##  data:  m.div.50kb
##  DW = 1.959, p-value = 0.2918
##  alternative hypothesis: true autocorrelation is greater than 0

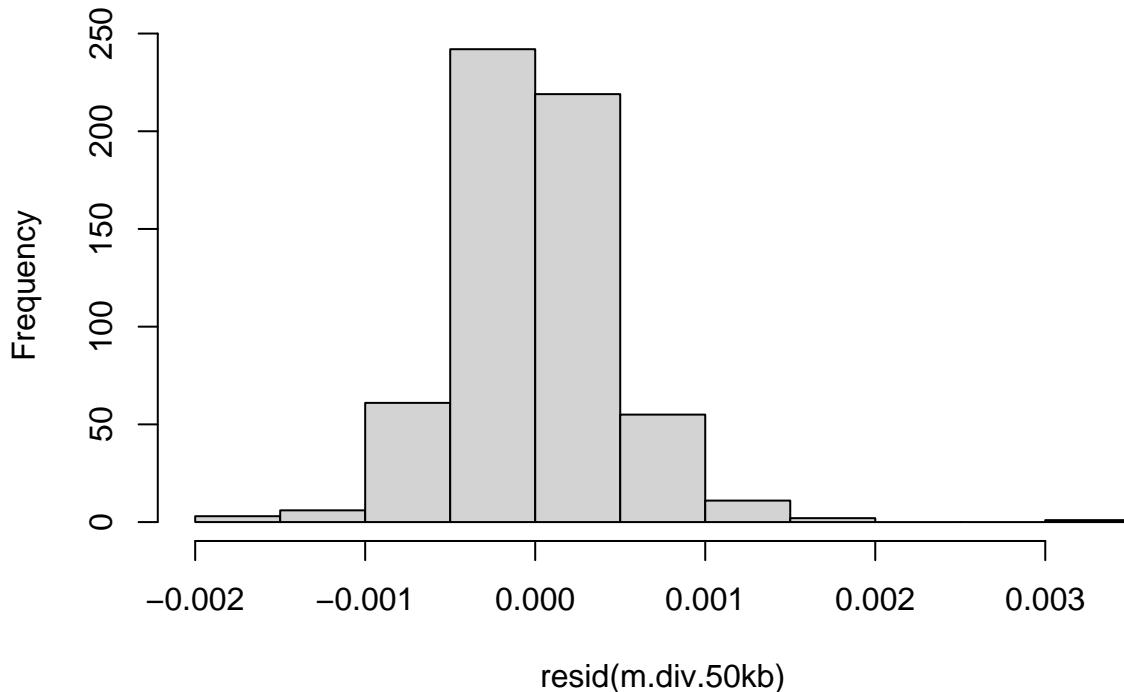
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
##  data:  m.div.50kb
##  HMC = 0.47957, p-value = 0.241

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -1.928e-03 -2.610e-04 -1.731e-05  2.569e-04  3.020e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.061e-02 1.945e-05 1059.614 <2e-16 ***  
## thetaS       1.104e-02 1.950e-05  565.892 <2e-16 ***  
## rhoS        -1.707e-05 1.947e-05   -0.877  0.381  
## tmrcaS       1.829e-03 1.950e-05   93.801 <2e-16 ***  
## thetaS:tmrcaS 9.594e-04 1.942e-05   49.398 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004759 on 595 degrees of freedom  
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9982  
## F-statistic: 8.263e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
```

```

##      1.005903      1.002241      1.005336      1.003949
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 7] <- anova.diversity$VarExp[4] * 100

```

1.1.8 Replicate 8

```

rep_8.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/rep_8.pi.50kb.bedgraph", header = FALSE)
rep_8.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_8.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_8.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

## Warning in cor.test.default(x = mf[[1L]], y = mf[[2L]], ...): Cannot compute
## exact p-value with ties

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 37183069, p-value = 0.4216
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.03286589

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

## Warning in cor.test.default(x = mf[[1L]], y = mf[[2L]], ...): Cannot compute
## exact p-value with ties

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 37073930, p-value = 0.4656

```

```

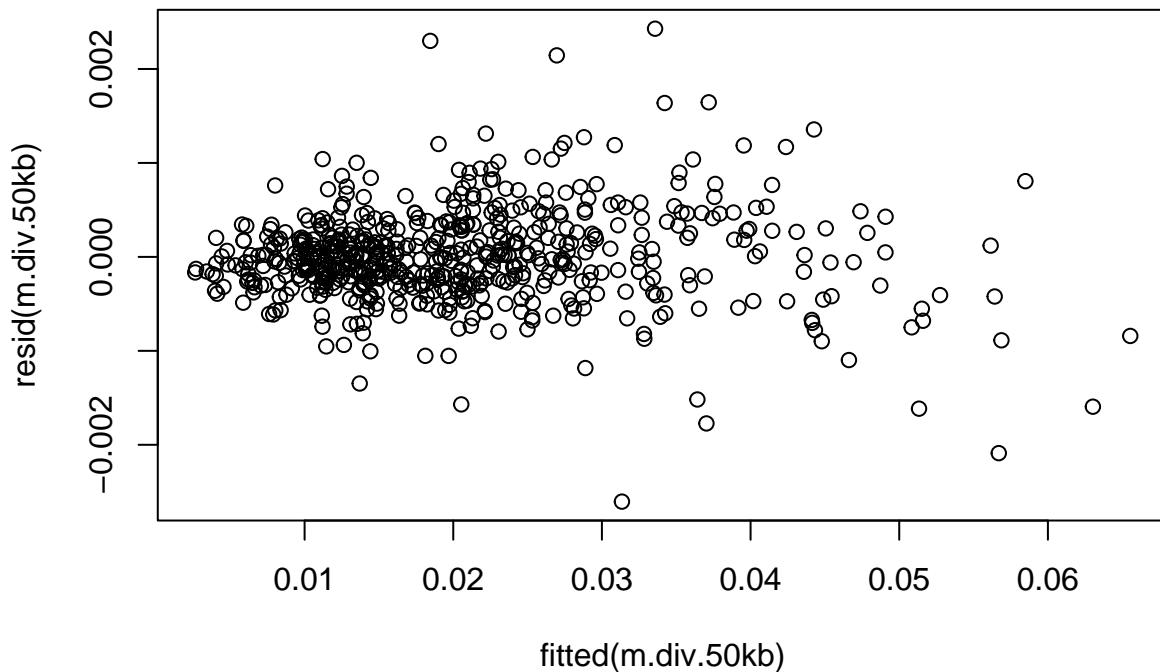
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.02983425
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep8 <- sim.lands.50kb
sim.lands.50kb.rep8$Replicate <- 8

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

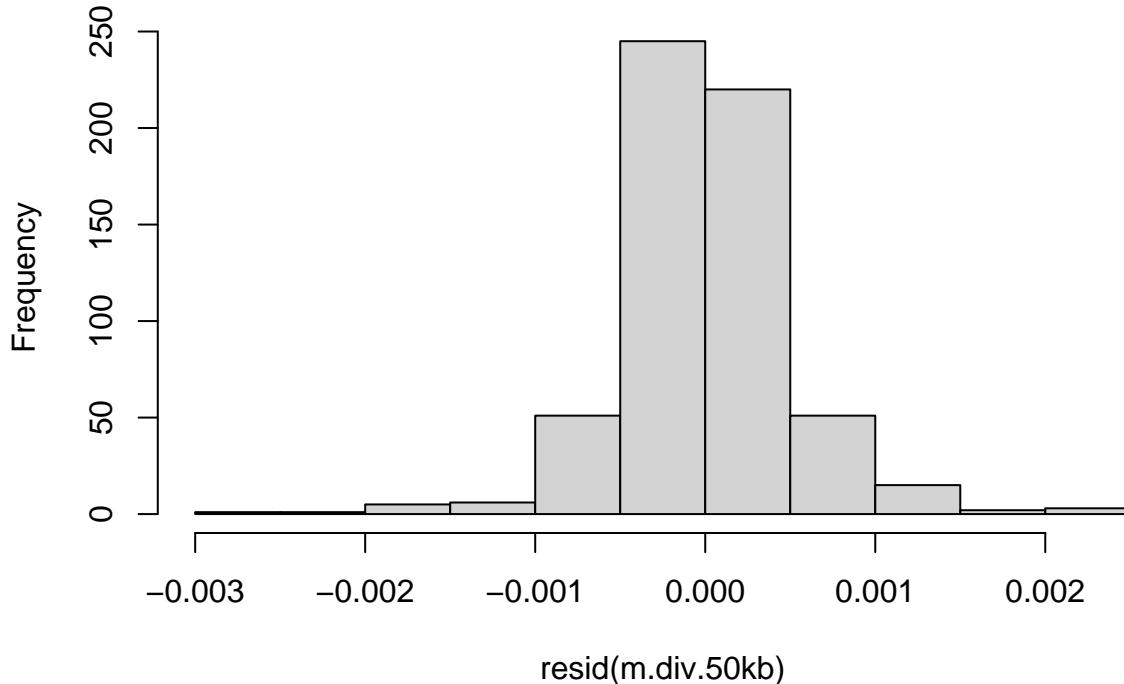
##
##  Durbin-Watson test
##
##  data: m.div.50kb
##  DW = 2.0323, p-value = 0.6384
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
##  data: m.div.50kb
##  HMC = 0.48525, p-value = 0.311

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -2.605e-03 -2.691e-04 -1.686e-05  2.620e-04  2.428e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.057e-02 2.065e-05 996.284 <2e-16 ***  
## thetaS       1.095e-02 2.074e-05 527.803 <2e-16 ***  
## rhoS        -2.590e-06 2.068e-05 -0.125     0.9  
## tmrcaS       1.744e-03 2.086e-05  83.583 <2e-16 ***  
## thetaS:tmrcaS 8.513e-04 1.947e-05  43.722 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005051 on 595 degrees of freedom  
## Multiple R-squared:  0.9979, Adjusted R-squared:  0.9979  
## F-statistic: 7.078e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb)
```

```
## there are higher-order terms (interactions) in this model
```

```

## consider setting type = 'predictor'; see ?vif
##      thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.010112     1.003974     1.021487     1.023819

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 8] <- anova.diversity$VarExp[4] * 100

```

1.1.9 Replicate 9

```

rep_9.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/rep_9.pi.50kb.bedgraph", header = FALSE)
rep_9.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/sim.tmrca.50k.map", header = FALSE)

sim.lands.50kb <- as.data.frame(cbind(rep_9.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_9.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 35536739, p-value = 0.7531
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01286561
cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.04613476
cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 37091756, p-value = 0.4583
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01286561

```

```

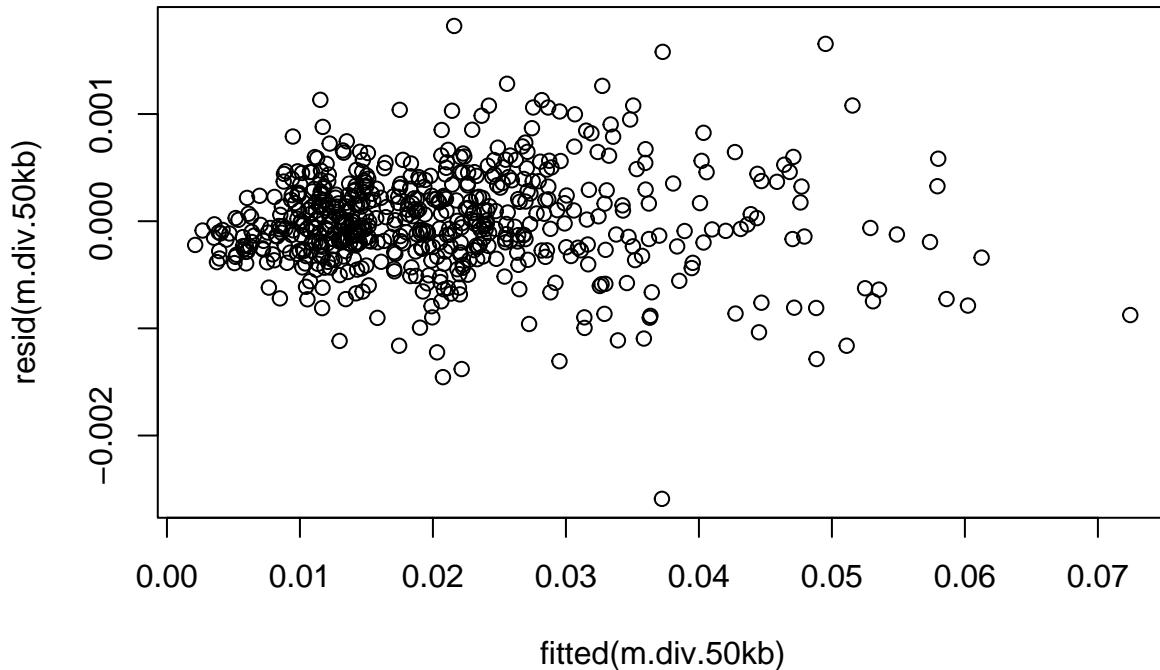
##          rho
## -0.03032942
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep9 <- sim.lands.50kb
sim.lands.50kb.rep9 $Replicate <- 9

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```



```

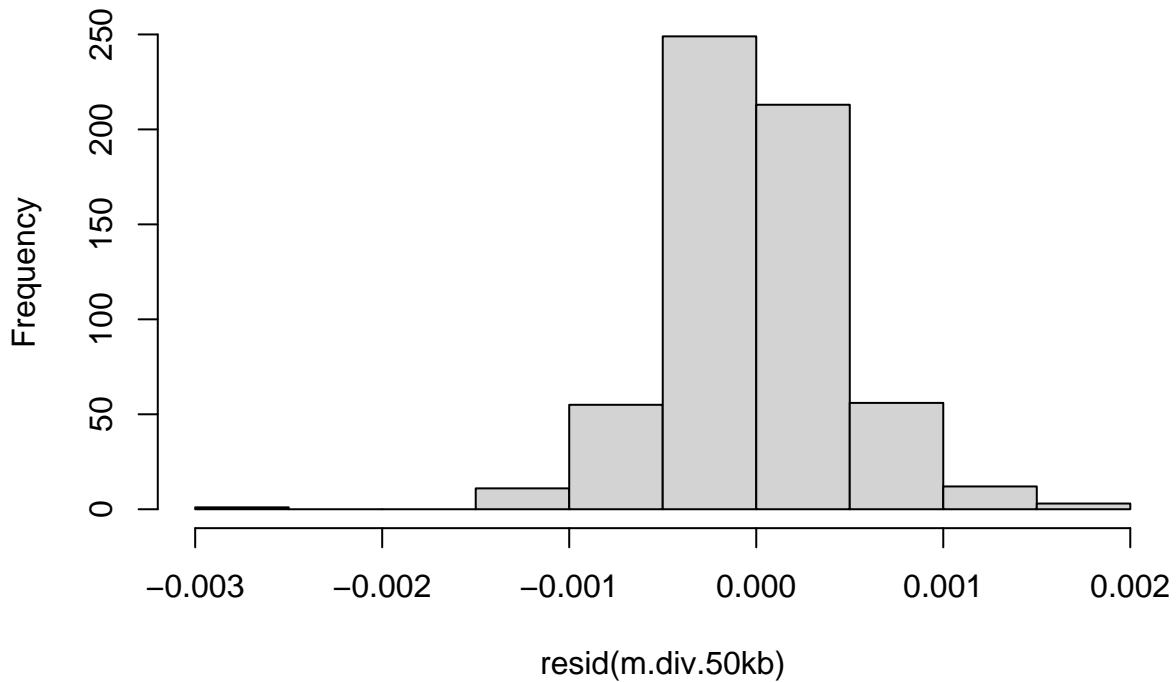
dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
##  data: m.div.50kb
##  DW = 1.9547, p-value = 0.2758
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
##  data: m.div.50kb
##  HMC = 0.55455, p-value = 0.973
hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.50kb)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -2.591e-03 -2.409e-04 -2.982e-05  2.668e-04  1.822e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.065e-02 1.899e-05 1087.271 <2e-16 ***
## thetaS       1.099e-02 1.903e-05  577.567 <2e-16 ***
## rhoS        -2.305e-05 1.902e-05   -1.212  0.226
## tmrcaS       1.783e-03 1.902e-05   93.731 <2e-16 ***
## thetaS:tmrcaS 9.400e-04 1.800e-05   52.235 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000465 on 595 degrees of freedom
## Multiple R-squared:  0.9983, Adjusted R-squared:  0.9983
## F-statistic: 8.777e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.003519    1.002537    1.001713    1.001897
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 9] <- anova.diversity$VarExp[4] * 100

```

1.1.10 Replicate 10

```

rep_10.pi.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/rep_10.pi.50kb.bedgraph", header = TRUE)
rep_10.tmrca.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/sim.tmrca.50k.map", header = TRUE)

sim.lands.50kb <- as.data.frame(cbind(rep_10.pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_10.tmrca.50kb))
names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and tmrca
## S = 37655834, p-value = 0.2606
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## -0.0459983

cor.test(~theta+rho, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: theta and rho
## S = 37660747, p-value = 0.2592
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## -0.04613476

cor.test(~rho+tmrca, data = sim.lands.50kb, method = "spearman")

## Spearman's rank correlation rho
## data: rho and tmrca
## S = 36687846, p-value = 0.6403
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## -0.01910966

```

```

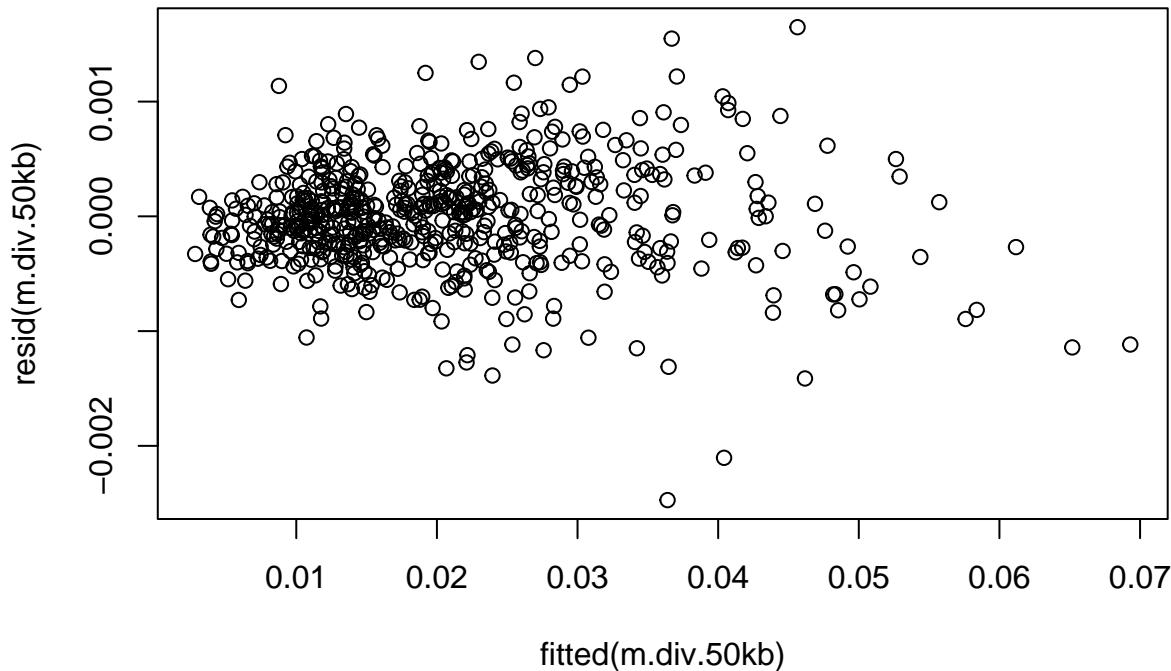
# standardizing
sim.lands.50kb$thetaS <- (sim.lands.50kb$theta - mean(sim.lands.50kb$theta)) / sd(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaS <- (sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)) / sd(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoS <- (sim.lands.50kb$rho - mean(sim.lands.50kb$rho)) / sd(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

sim.lands.50kb.rep10 <- sim.lands.50kb
sim.lands.50kb.rep10$Replicate <- 10

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.50kb)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
## Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.9775, p-value = 0.3738
## alternative hypothesis: true autocorrelation is greater than 0

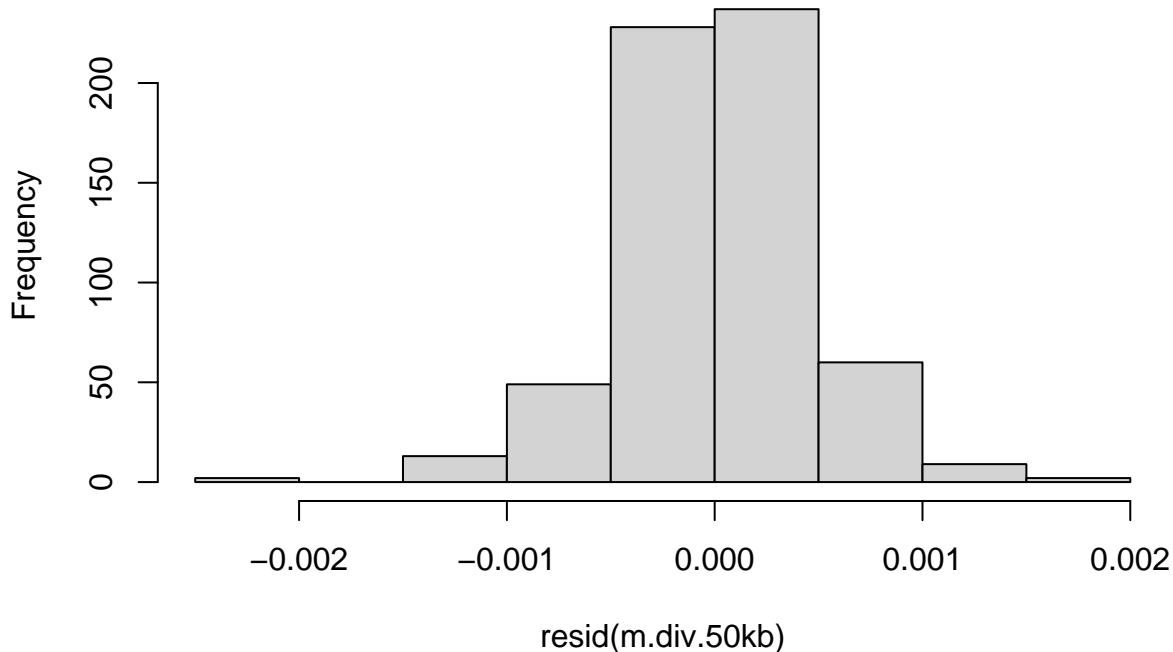
hmctest(m.div.50kb)

##
## Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.43153, p-value = 0.011

```

```
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.50kb)  
##  
## Residuals:  
##      Min       1Q     Median       3Q      Max  
## -2.473e-03 -2.632e-04  1.203e-05  2.861e-04  1.648e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.070e-02 1.924e-05 1075.884 <2e-16 ***  
## thetaS       1.102e-02 1.937e-05  568.969 <2e-16 ***  
## rhoS        2.243e-05 1.927e-05   1.164   0.245  
## tmrcaS      1.929e-03 1.929e-05  100.018 <2e-16 ***  
## thetaS:tmrcaS 1.060e-03 1.803e-05   58.816 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004703 on 595 degrees of freedom  
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9982  
## F-statistic: 8.211e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
```

```

##      1.015483     1.005221     1.007259     1.011948
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.50kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.sim.50kb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

```

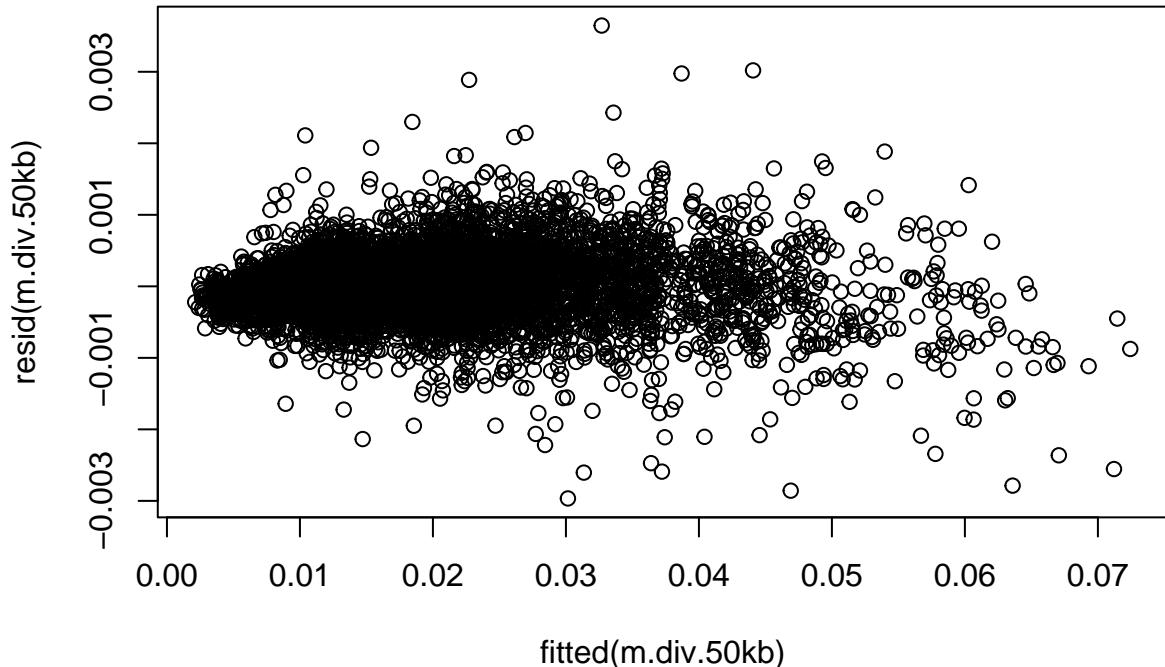
1.1.11 all replicates:

```

sim.lands.50kb.all <- rbind(sim.lands.50kb.rep1, sim.lands.50kb.rep2, sim.lands.50kb.rep3, sim.lands.50kb.rep4)

m.div.50kb <- lm(diversity ~ (thetaS + rhoS + tmrcas + thetaS:tmrcas)*as.factor(Replicate), data = sim.lands.50kb.all)
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
##  data:  m.div.50kb
##  DW = 2.0321, p-value = 0.8384
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

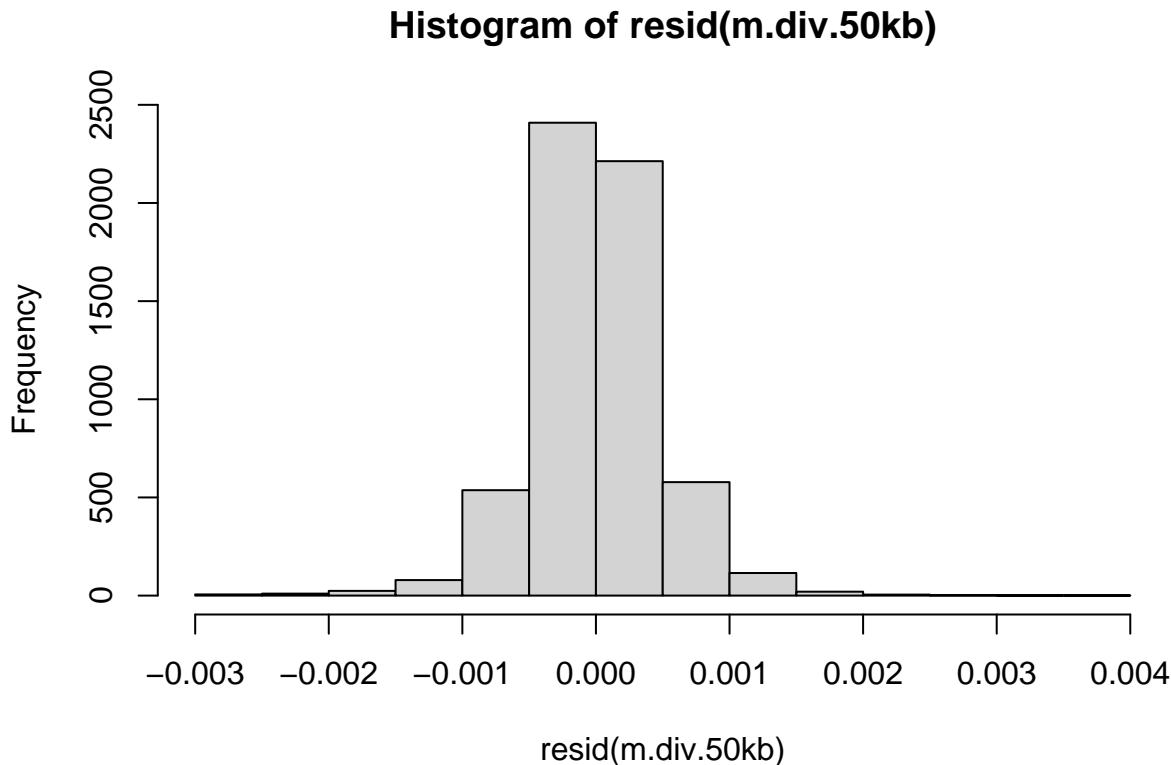
##
##  Durbin-Mt. test
##  data:  m.div.50kb
##  D = 2.0321, p-value = 0.8384
##  alternative hypothesis: true autocorrelation is greater than 0

```

```

##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.4985, p-value = 0.424
hist(resid(m.div.50kb))

```



```

m.div.50kb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replica)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as.factor(Replica)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

```

```

##           df      AIC
## m.div.50kb 51 -74511.74
## m.div.50kb.2 61 -74500.95
## m.div.50kb.3 71 -74492.20

```

```
summary(m.div.50kb)
```

```

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##     as.factor(Replicate), data = sim.lands.50kb.all)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.0029659 -0.0002709 -0.0000132  0.0002735  0.0036466
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.069e-02  1.978e-05 1045.973 < 2e-16

```

```

## thetaS          1.100e-02  1.989e-05  552.973 < 2e-16
## rhoS           4.258e-05  1.986e-05   2.145 0.032024
## tmrcaS         1.665e-03  1.980e-05   84.107 < 2e-16
## as.factor(Replicate)2 -1.161e-04  2.798e-05  -4.151 3.36e-05
## as.factor(Replicate)3 -1.905e-05  2.798e-05  -0.681 0.495974
## as.factor(Replicate)4 -1.861e-04  2.797e-05  -6.653 3.12e-11
## as.factor(Replicate)5 -7.501e-05  2.797e-05  -2.681 0.007352
## as.factor(Replicate)6 -1.078e-04  2.797e-05  -3.855 0.000117
## as.factor(Replicate)7 -7.993e-05  2.799e-05  -2.856 0.004310
## as.factor(Replicate)8 -1.182e-04  2.799e-05  -4.224 2.43e-05
## as.factor(Replicate)9 -4.323e-05  2.798e-05  -1.545 0.122345
## as.factor(Replicate)10  9.218e-06  2.800e-05   0.329 0.741996
## thetaS:tmrcaS    8.867e-04  1.877e-05   47.248 < 2e-16
## thetaS:as.factor(Replicate)2 -7.915e-05  2.813e-05  -2.813 0.004917
## thetaS:as.factor(Replicate)3  1.252e-05  2.810e-05   0.445 0.656053
## thetaS:as.factor(Replicate)4 -7.144e-05  2.808e-05  -2.544 0.010981
## thetaS:as.factor(Replicate)5 -8.828e-06  2.810e-05  -0.314 0.753425
## thetaS:as.factor(Replicate)6 -4.167e-05  2.812e-05  -1.482 0.138453
## thetaS:as.factor(Replicate)7  3.481e-05  2.810e-05   1.239 0.215471
## thetaS:as.factor(Replicate)8 -5.259e-05  2.813e-05  -1.869 0.061650
## thetaS:as.factor(Replicate)9 -7.340e-06  2.809e-05  -0.261 0.793848
## thetaS:as.factor(Replicate)10  1.748e-05  2.817e-05   0.620 0.535070
## rhoS:as.factor(Replicate)2 -7.253e-05  2.808e-05  -2.584 0.009801
## rhoS:as.factor(Replicate)3 -2.347e-05  2.806e-05  -0.836 0.403040
## rhoS:as.factor(Replicate)4 -1.445e-06  2.806e-05  -0.052 0.958925
## rhoS:as.factor(Replicate)5 -3.805e-05  2.806e-05  -1.356 0.175200
## rhoS:as.factor(Replicate)6 -7.757e-05  2.806e-05  -2.764 0.005730
## rhoS:as.factor(Replicate)7 -5.965e-05  2.805e-05  -2.127 0.033499
## rhoS:as.factor(Replicate)8 -4.517e-05  2.806e-05  -1.610 0.107517
## rhoS:as.factor(Replicate)9 -6.564e-05  2.805e-05  -2.340 0.019335
## rhoS:as.factor(Replicate)10 -2.016e-05  2.807e-05  -0.718 0.472726
## tmrcaS:as.factor(Replicate)2  7.321e-05  2.810e-05   2.605 0.009200
## tmrcaS:as.factor(Replicate)3  2.696e-04  2.808e-05   9.600 < 2e-16
## tmrcaS:as.factor(Replicate)4  1.838e-04  2.801e-05   6.562 5.75e-11
## tmrcaS:as.factor(Replicate)5  8.493e-05  2.802e-05   3.031 0.002446
## tmrcaS:as.factor(Replicate)6  1.177e-04  2.801e-05   4.201 2.70e-05
## tmrcaS:as.factor(Replicate)7  1.635e-04  2.803e-05   5.833 5.74e-09
## tmrcaS:as.factor(Replicate)8  7.827e-05  2.815e-05   2.781 0.005436
## tmrcaS:as.factor(Replicate)9  1.173e-04  2.801e-05   4.187 2.87e-05
## tmrcaS:as.factor(Replicate)10 2.638e-04  2.805e-05   9.406 < 2e-16
## thetaS:tmrcaS:as.factor(Replicate)2  4.118e-05  2.676e-05   1.539 0.123935
## thetaS:tmrcaS:as.factor(Replicate)3  1.474e-04  2.639e-05   5.585 2.44e-08
## thetaS:tmrcaS:as.factor(Replicate)4  1.012e-04  2.724e-05   3.714 0.000206
## thetaS:tmrcaS:as.factor(Replicate)5  2.465e-05  2.705e-05   0.911 0.362273
## thetaS:tmrcaS:as.factor(Replicate)6  2.610e-05  2.685e-05   0.972 0.331125
## thetaS:tmrcaS:as.factor(Replicate)7  7.274e-05  2.726e-05   2.669 0.007639
## thetaS:tmrcaS:as.factor(Replicate)8 -3.541e-05  2.647e-05  -1.337 0.181114
## thetaS:tmrcaS:as.factor(Replicate)9  5.338e-05  2.653e-05   2.013 0.044203
## thetaS:tmrcaS:as.factor(Replicate)10 1.738e-04  2.640e-05   6.582 5.05e-11
##
## (Intercept)      ***
## thetaS          ***
## rhoS            *
## tmrcaS          ***

```

```

## as.factor(Replicate)2      ***
## as.factor(Replicate)3      ***
## as.factor(Replicate)4      ***
## as.factor(Replicate)5      **
## as.factor(Replicate)6      ***
## as.factor(Replicate)7      **
## as.factor(Replicate)8      ***
## as.factor(Replicate)9      ***
## as.factor(Replicate)10     ***
## thetaS:tmrcaS              ***
## thetaS:as.factor(Replicate)2  **
## thetaS:as.factor(Replicate)3  **
## thetaS:as.factor(Replicate)4  *
## thetaS:as.factor(Replicate)5
## thetaS:as.factor(Replicate)6
## thetaS:as.factor(Replicate)7
## thetaS:as.factor(Replicate)8  .
## thetaS:as.factor(Replicate)9
## thetaS:as.factor(Replicate)10
## rhoS:as.factor(Replicate)2   **
## rhoS:as.factor(Replicate)3
## rhoS:as.factor(Replicate)4
## rhoS:as.factor(Replicate)5
## rhoS:as.factor(Replicate)6   **
## rhoS:as.factor(Replicate)7   *
## rhoS:as.factor(Replicate)8
## rhoS:as.factor(Replicate)9   *
## rhoS:as.factor(Replicate)10
## tmrcaS:as.factor(Replicate)2  **
## tmrcaS:as.factor(Replicate)3  ***
## tmrcaS:as.factor(Replicate)4  ***
## tmrcaS:as.factor(Replicate)5  **
## tmrcaS:as.factor(Replicate)6  ***
## tmrcaS:as.factor(Replicate)7  ***
## tmrcaS:as.factor(Replicate)8  **
## tmrcaS:as.factor(Replicate)9  ***
## tmrcaS:as.factor(Replicate)10
## thetaS:tmrcaS:as.factor(Replicate)2
## thetaS:tmrcaS:as.factor(Replicate)3  ***
## thetaS:tmrcaS:as.factor(Replicate)4  ***
## thetaS:tmrcaS:as.factor(Replicate)5
## thetaS:tmrcaS:as.factor(Replicate)6
## thetaS:tmrcaS:as.factor(Replicate)7  **
## thetaS:tmrcaS:as.factor(Replicate)8
## thetaS:tmrcaS:as.factor(Replicate)9  *
## thetaS:tmrcaS:as.factor(Replicate)10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0004844 on 5950 degrees of freedom
## Multiple R-squared:  0.9981, Adjusted R-squared:  0.9981
## F-statistic: 6.421e+04 on 49 and 5950 DF,  p-value: < 2.2e-16

```

1.2 200 kb scale

```
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.rho.2e+05.txt", header = T)
sim.theta.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.theta.2e+05.txt", header = T)

1.2.1 Replicate 1

rep_1.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/rep_1.pi.200kb.bedgraph", header = F)
rep_1.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/sim.tmrca.200k.map", header = F)

sim.lands.200kb <- as.data.frame(cbind(rep_1.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_1.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 569023, p-value = 0.8876
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.01164184

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712

cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 570624, p-value = 0.8602
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.01448776

# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
```

```

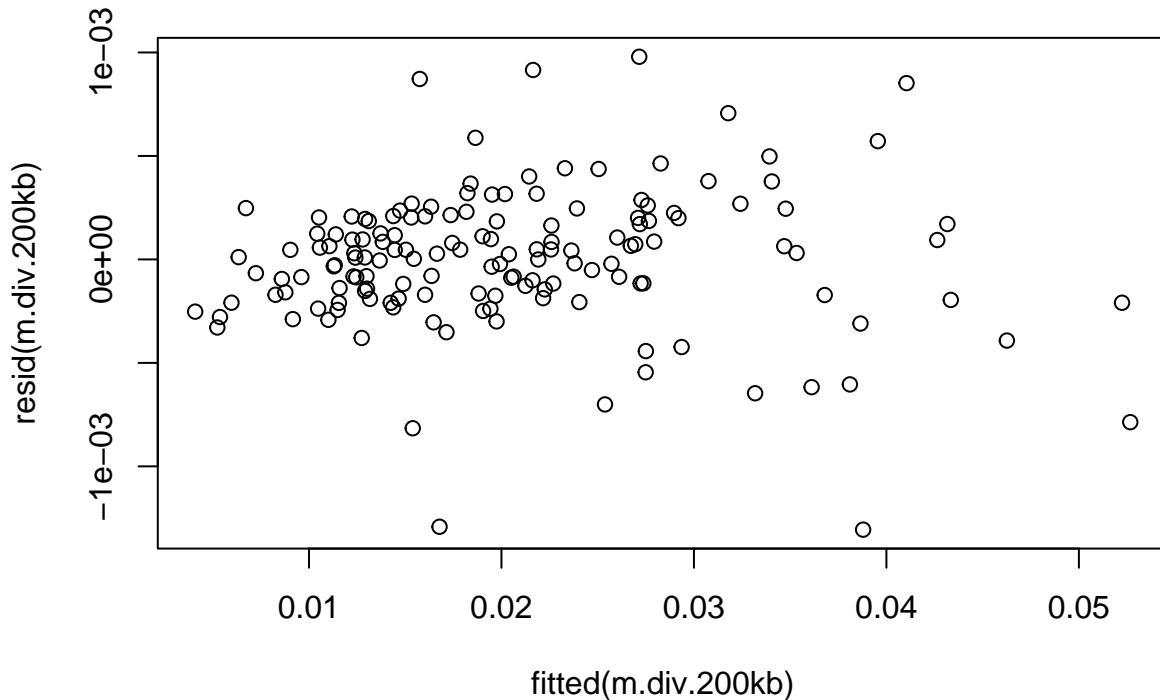
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep1 <- sim.lands.200kb
sim.lands.200kb.rep1$Replicate <- 1

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

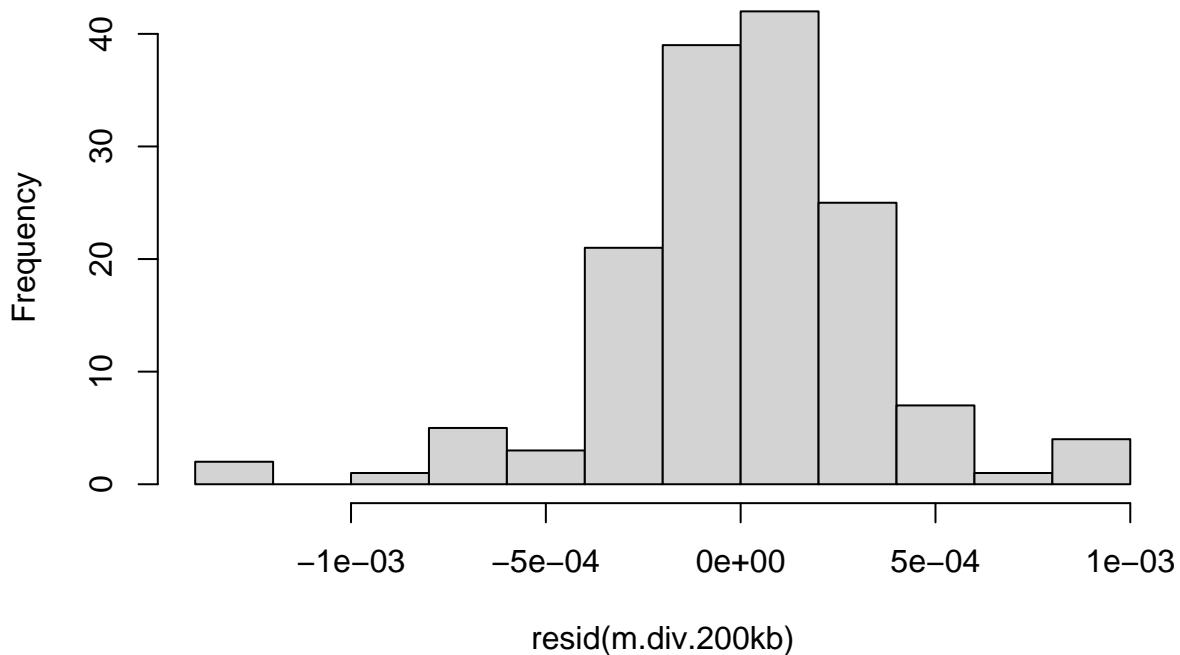
dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
##  data: m.div.200kb
##  DW = 1.9751, p-value = 0.4234
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
##  data: m.div.200kb
##  HMC = 0.49982, p-value = 0.516
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -1.306e-03 -1.718e-04  1.801e-05  1.985e-04  9.793e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.067e-02 2.788e-05 741.370 <2e-16 ***
## thetaS      9.726e-03 2.807e-05 346.532 <2e-16 ***
## rhoS        4.827e-05 2.819e-05  1.712   0.089 .  
## tmrcaS     9.232e-04 2.798e-05  32.997 <2e-16 ***
## thetaS:tmrcaS 4.181e-04 2.919e-05 14.325 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003415 on 145 degrees of freedom
## Multiple R-squared:  0.9988, Adjusted R-squared:  0.9988 
## F-statistic: 3.049e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.006587    1.015701    1.000386    1.009284
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1960.653
## g.div.200kb.2 8 -1989.342
## g.div.200kb.3 7 -1990.156
## g.div.200kb.4 7 -1962.629
summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.200kb
##       AIC      BIC logLik
## -1960.653 -1936.568 988.3264
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##     Phi
## 0.0128653
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##     power
## 0.09806138
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020677719 2.755567e-05 750.3981 0.0000
## thetaS       0.009739030 2.761295e-05 352.6979 0.0000

```

```

## rhoS          0.000044975 2.782599e-05   1.6163  0.1082
## tmrcaS       0.000920051 3.116980e-05  29.5174  0.0000
## thetaS:tmrcaS 0.000412158 3.220875e-05 12.7965  0.0000
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS      0.019
## rhoS        -0.008  0.071
## tmrcaS     -0.004  0.004  0.012
## thetaS:tmrcaS 0.002  0.015  0.080  0.010
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.98450410 -0.50677837  0.05287617  0.53024118  3.17436318
##
## Residual standard error: 0.0003592932
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##      thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.005172      1.011520      1.000229      1.006587

```

1.2.2 Replicate 2

```

rep_2.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/rep_2.pi.200kb.bedgraph", header=TRUE)
rep_2.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/sim.tmrca.200k.map", header=TRUE)

sim.lands.200kb <- as.data.frame(cbind(rep_2.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_2.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 551432, p-value = 0.8115
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01963361

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712

```

```

cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 533372, p-value = 0.529
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.05174097

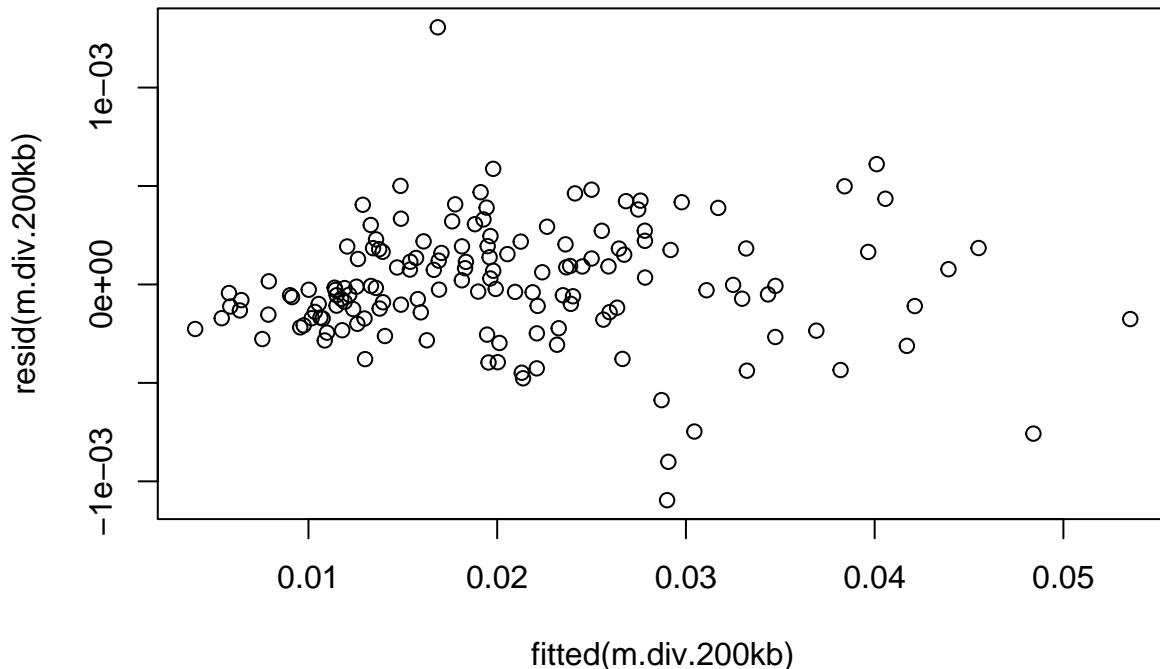
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep2 <- sim.lands.200kb
sim.lands.200kb.rep2$Replicate <- 2

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.5928, p-value = 0.005174
## alternative hypothesis: true autocorrelation is greater than 0

```

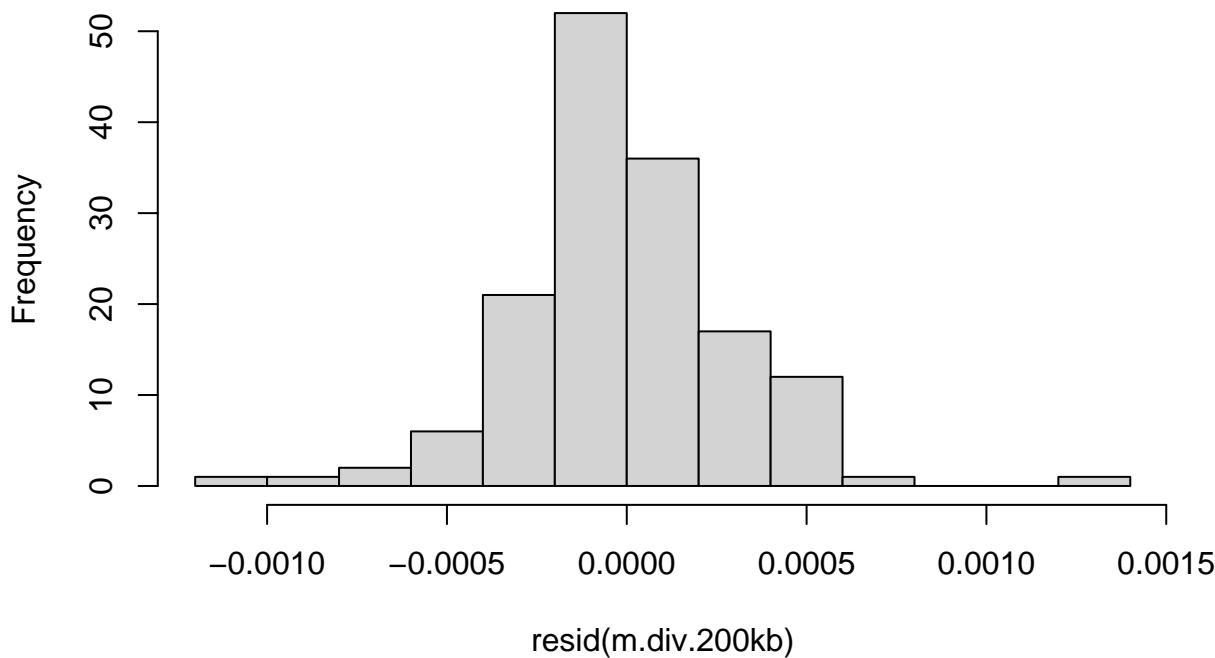
```

hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.59119, p-value = 0.947
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -1.096e-03 -1.706e-04 -2.456e-05  1.813e-04  1.306e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.056e-02 2.494e-05 824.14 <2e-16 ***
## thetaS       9.659e-03 2.528e-05 382.15 <2e-16 ***
## rhoS        -4.702e-05 2.514e-05 -1.87  0.0635 .
## tmrcaS      1.008e-03 2.527e-05  39.88 <2e-16 ***
## thetaS:tmrcaS 5.023e-04 2.506e-05  20.04 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## 
## Residual standard error: 0.0003054 on 145 degrees of freedom
## Multiple R-squared:  0.999, Adjusted R-squared:  0.999
## F-statistic: 3.71e+04 on 4 and 145 DF, p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.020463   1.009539   1.020098   1.034557

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 2] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1999.170
## g.div.200kb.2 8 -2026.605
## g.div.200kb.3 7 -2024.385
## g.div.200kb.4 7 -1994.587

summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##          AIC      BIC    logLik
## -1994.587 -1973.512 1004.293
##
## 
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.05610177
##
## 
## Coefficients:
```

```

##                  Value    Std.Error t-value p-value
## (Intercept) 0.020558086 2.471890e-05 831.6749 0.0000
## thetaS       0.009659617 2.494911e-05 387.1727 0.0000
## rhoS        -0.000049950 2.524138e-05 -1.9789 0.0497
## tmrcaS       0.001007236 2.671400e-05  37.7044 0.0000
## thetaS:tmrcaS 0.000503151 2.647930e-05 19.0017 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.008
## rhoS       -0.024  0.078
## tmrcaS      0.005  0.032 -0.034
## thetaS:tmrcaS 0.023  0.106 -0.049  0.130
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.47043641 -0.55553802 -0.07563554  0.56949546  4.25940187
##
## Residual standard error: 0.0003111301
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.4)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.019001     1.010456     1.018469     1.031144

```

1.2.3 Replicate 3

```

rep_3.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/rep_3.pi.200kb.bedgraph", header=FALSE)
rep_3.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_3.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_3.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 592174, p-value = 0.5211
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.05280076

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.05280076

```

```

##          rho
## -0.0554712
cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 594376, p-value = 0.4902
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.05671541

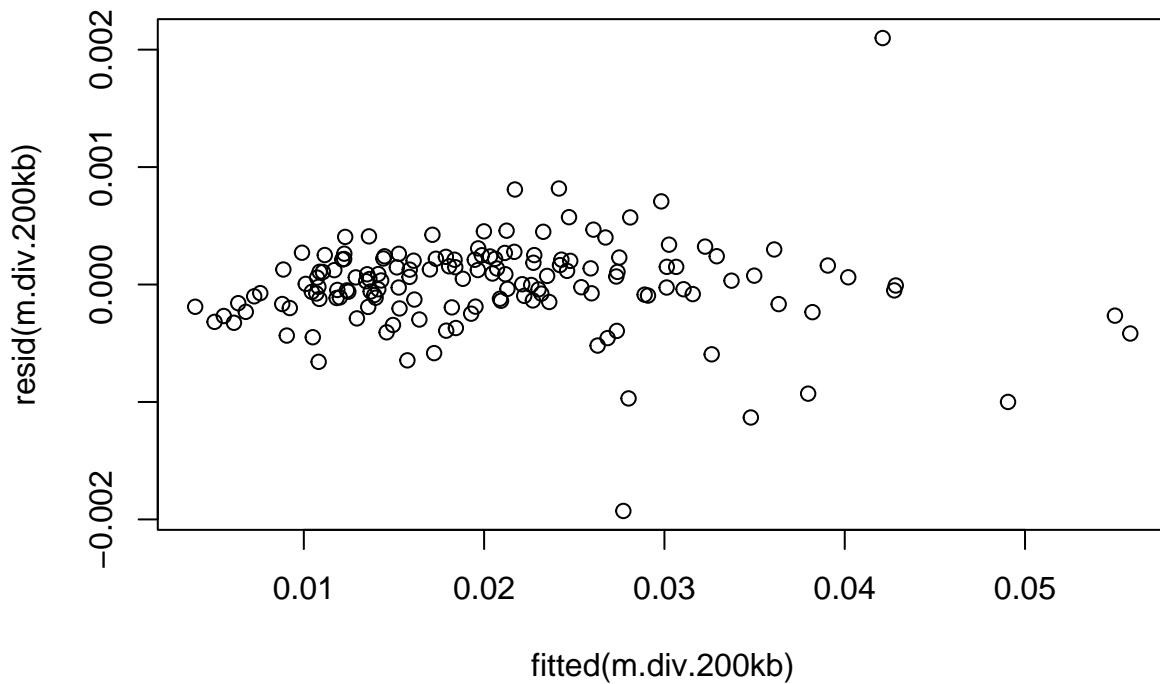
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep3 <- sim.lands.200kb
sim.lands.200kb.rep3$Replicate <- 3

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
## Durbin-Watson test
##
## data: m.div.200kb

```

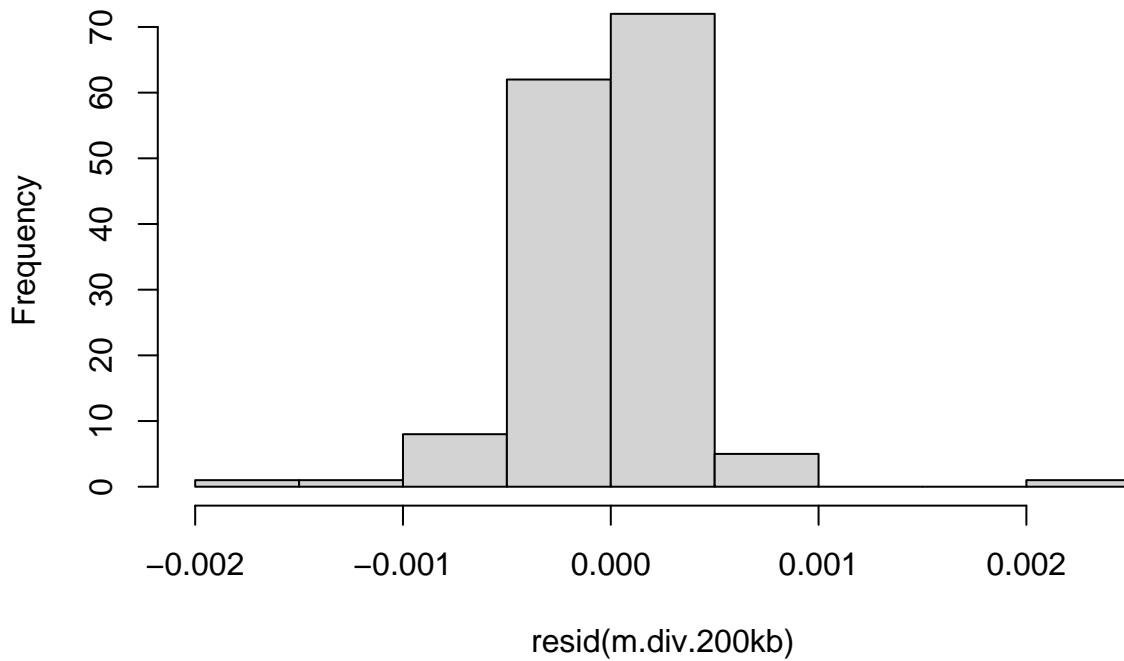
```

## DW = 1.9205, p-value = 0.2965
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.45845, p-value = 0.228
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -1.928e-03 -1.460e-04  3.044e-05  2.110e-04  2.099e-03 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.064e-02 3.245e-05 636.263   <2e-16 ***
## thetaS      9.746e-03 3.273e-05 297.825   <2e-16 ***
## rhoS       4.776e-05 3.277e-05   1.458     0.147    
## tmrcaS     1.034e-03 3.267e-05  31.662   <2e-16 ***
## thetaS:tmrcaS 4.558e-04 3.396e-05 13.422   <2e-16 ***
## 
```

```

## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003972 on 145 degrees of freedom
## Multiple R-squared: 0.9984, Adjusted R-squared: 0.9984
## F-statistic: 2.269e+04 on 4 and 145 DF, p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS         rhoS        tmrcaS thetaS:tmrcaS
## 1.011267    1.013794    1.007777    1.007048

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.200kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 3] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1920.026
## g.div.200kb.2 8 -1971.651
## g.div.200kb.3 7 -1973.033
## g.div.200kb.4 7 -1921.265

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##          AIC      BIC   logLik
## -1920.026 -1895.941 968.0132
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## 0.07225046
## Variance function:
```

```

## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##      power
## 0.1097379
##
## Coefficients:
##              Value    Std.Error t-value p-value
## (Intercept) 0.020641496 3.339579e-05 618.0867 0.0000
## thetaS       0.009743827 3.189089e-05 305.5364 0.0000
## rhoS        0.000047243 3.171627e-05   1.4896 0.1385
## tmrcaS      0.001028885 3.564754e-05   28.8627 0.0000
## thetaS:tmrcaS 0.000453599 3.676813e-05  12.3367 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     -0.016
## rhoS      -0.056  0.057
## tmrcaS    -0.004  0.015  0.069
## thetaS:tmrcaS 0.033 -0.067 -0.025  0.028
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.56582153 -0.35771148  0.08674676  0.50528266  5.33836283
##
## Residual standard error: 0.0004103673
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.007830    1.008485    1.005803    1.005937

```

1.2.4 Replicate 4

```

rep_4.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/rep_4.pi.200kb.bedgraph", head=FALSE)
rep_4.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/sim.tmrca.200k.map", head=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_4.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_4.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 554491, p-value = 0.8631
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01419494
cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

```

```

## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712
cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 559798, p-value = 0.9539
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.004759323

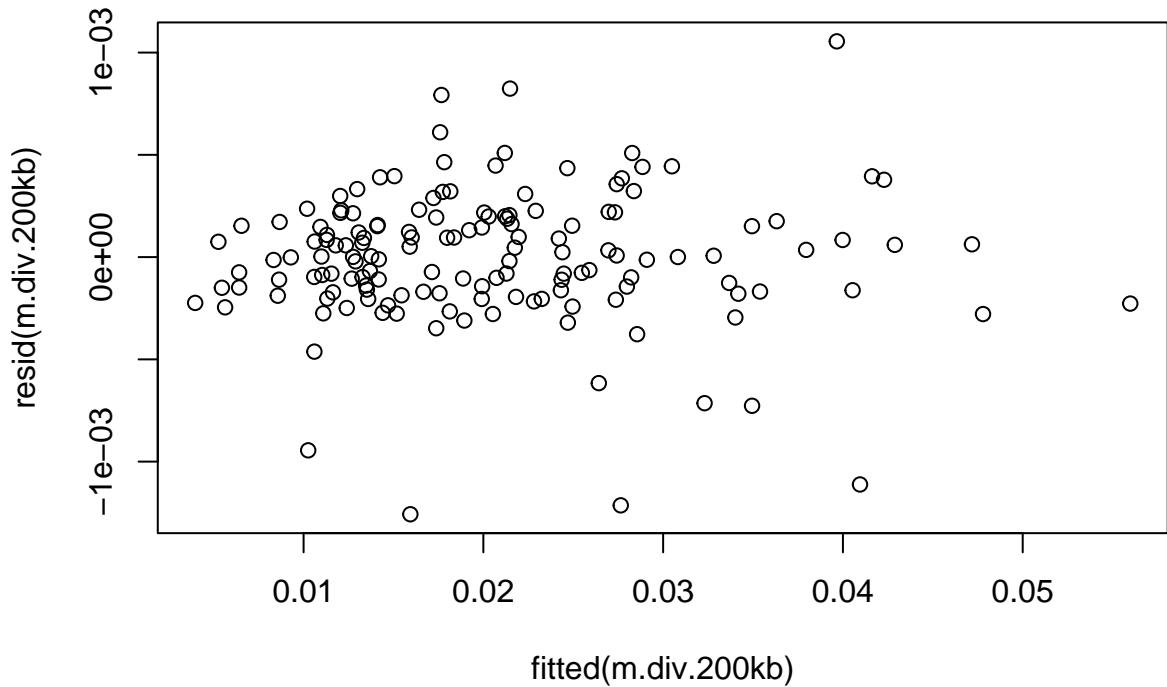
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep4 <- sim.lands.200kb
sim.lands.200kb.rep4$Replicate <- 4

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```



```

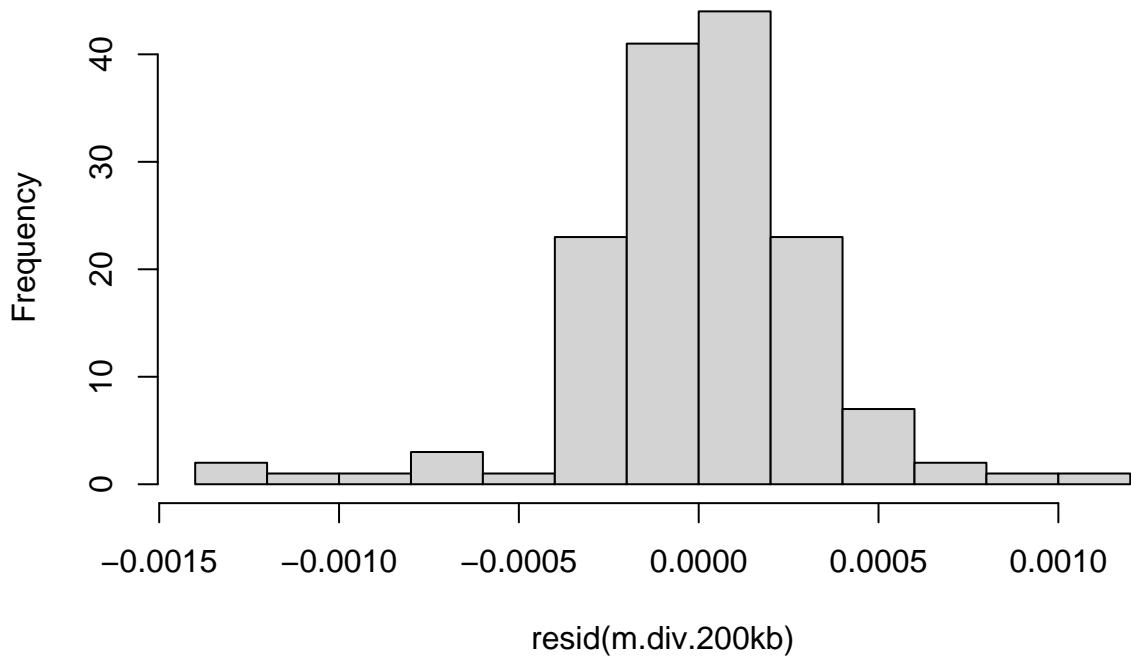
dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
##  data: m.div.200kb
##  DW = 1.9887, p-value = 0.4477
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
##  data: m.div.200kb
##  HMC = 0.4058, p-value = 0.056
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -1.257e-03 -1.693e-04  3.530e-06  1.847e-04  1.055e-03 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.050e-02 2.710e-05 756.559 <2e-16 ***
## thetaS       9.689e-03 2.728e-05 355.236 <2e-16 ***
## rhoS        1.325e-05 2.730e-05  0.485   0.628    
## tmrcaS      9.844e-04 2.744e-05  35.873 <2e-16 ***
## thetaS:tmrcaS 4.405e-04 2.620e-05 16.813 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003317 on 145 degrees of freedom
## Multiple R-squared:  0.9989, Adjusted R-squared:  0.9989 
## F-statistic: 3.248e+04 on 4 and 145 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.007460 1.009198 1.019677 1.019709
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 4] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1966.927
## g.div.200kb.2 8 -1985.011
## g.div.200kb.3 7 -1986.948
## g.div.200kb.4 7 -1968.927
summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.200kb
##       AIC      BIC    logLik
##   -1966.927 -1942.842 991.4637
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## -0.001705347
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.01367428
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020501695 2.703165e-05 758.4329 0.0000
## thetaS       0.009688793 2.720782e-05 356.1032 0.0000

```

```

## rhoS          0.000014802 2.731263e-05   0.5419  0.5887
## tmrcaS       0.000983547 2.781924e-05   35.3549  0.0000
## thetaS:tmrcaS 0.000440949 2.660553e-05   16.5736  0.0000
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS      -0.001
## rhoS        -0.003  0.078
## tmrcaS       0.003 -0.029  0.025
## thetaS:tmrcaS -0.032 -0.008  0.043 -0.128
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.79532032 -0.50959420  0.01098014  0.56741335  3.26282302
##
## Residual standard error: 0.0003289786
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##      thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.007307    1.009094    1.018826    1.019171

```

1.2.5 Replicate 5

```

rep_5.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/rep_5.pi.200kb.bedgraph", header=FALSE)
rep_5.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_5.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_5.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 570758, p-value = 0.858
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.01472654

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.0554712

```

```

cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 582370, p-value = 0.6671
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.03537046

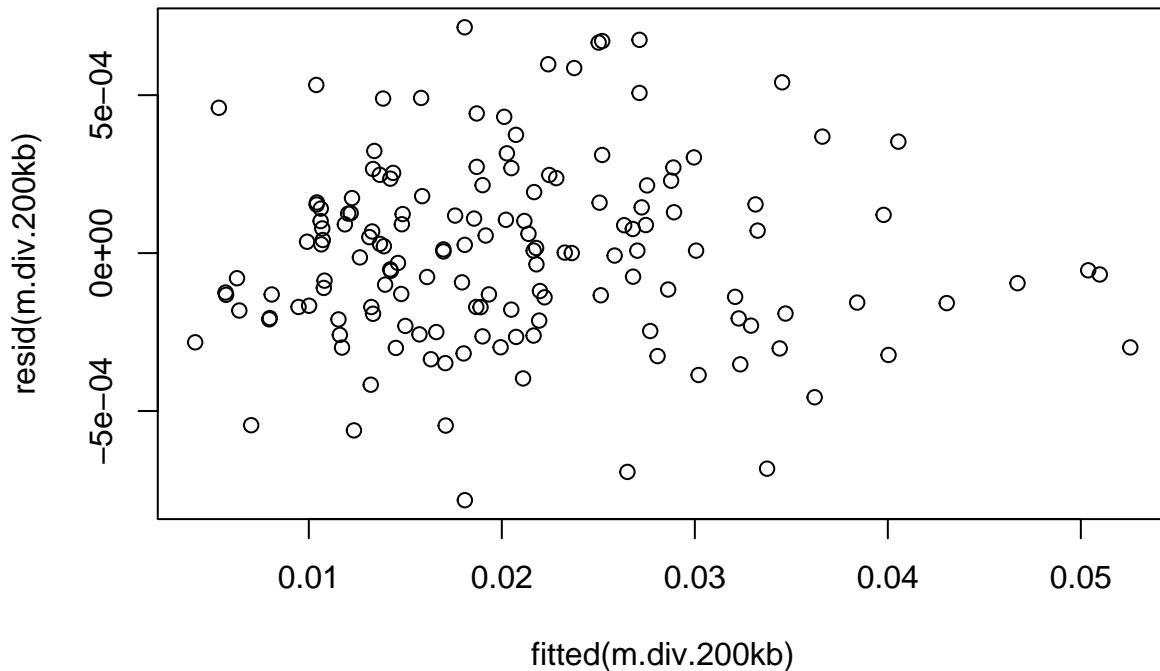
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep5 <- sim.lands.200kb
sim.lands.200kb.rep5$Replicate <- 5

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.9065, p-value = 0.2691
## alternative hypothesis: true autocorrelation is greater than 0

```

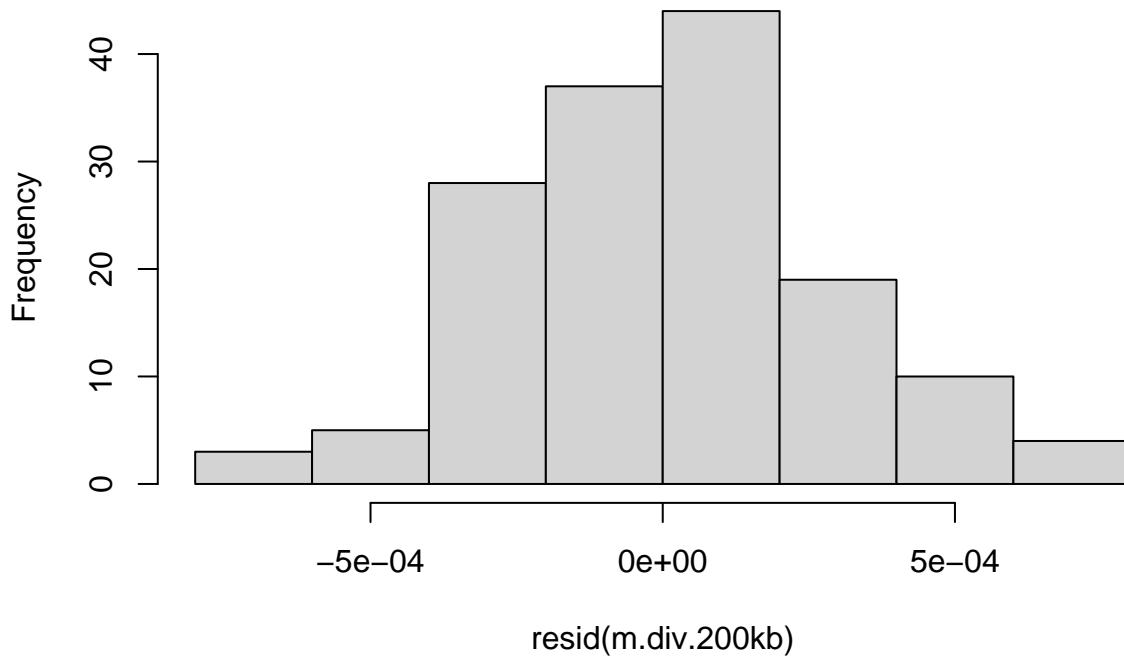
```

hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.42468, p-value = 0.101
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -7.823e-04 -1.890e-04  3.370e-06  1.582e-04  7.148e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.061e-02  2.367e-05 870.811 <2e-16 ***
## thetaS       9.728e-03  2.387e-05 407.532 <2e-16 ***
## rhoS        1.346e-05  2.392e-05   0.563   0.575
## tmrcaS      9.268e-04  2.442e-05  37.957 <2e-16 ***
## thetaS:tmrcaS 3.965e-04  2.117e-05  18.728 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## 
## Residual standard error: 0.0002897 on 145 degrees of freedom
## Multiple R-squared:  0.9991, Adjusted R-squared:  0.9991
## F-statistic: 4.197e+04 on 4 and 145 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##          thetaS            rhoS           tmrcaS   thetaS:tmrcaS
## 1.011705    1.015517    1.058659    1.054433

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 5] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -2008.926
## g.div.200kb.2 8 -2009.860
## g.div.200kb.3 7 -2011.824
## g.div.200kb.4 7 -2010.568

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##          AIC      BIC   logLik
## -2008.926 -1984.841 1012.463
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## 0.05014693
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
```

```

## Parameter estimates:
##      power
## -0.05198583
##
## Coefficients:
##              Value    Std.Error t-value p-value
## (Intercept) 0.020608118 2.470174e-05 834.2779 0.0000
## thetaS       0.009727627 2.384667e-05 407.9239 0.0000
## rhoS        0.000016319 2.366747e-05   0.6895 0.4916
## tmrcaS      0.000927260 2.305850e-05  40.2134 0.0000
## thetaS:tmrcaS 0.000394120 1.982990e-05 19.8750 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     -0.011
## rhoS       0.008  0.076
## tmrcaS    -0.010  0.038  0.093
## thetaS:tmrcaS 0.037  0.051 -0.034 -0.228
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.899512306 -0.658571018  0.005253288  0.553979370  2.525474719
##
## Residual standard error: 0.0002737013
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.010709 1.014431 1.064843 1.058914

```

1.2.6 Replicate 6

```

rep_6.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/rep_6.pi.200kb.bedgraph", head=TRUE)
rep_6.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/sim.tmrca.200k.map", head=TRUE)

sim.lands.200kb <- as.data.frame(cbind(rep_6.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_6.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 577585, p-value = 0.7442
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.02686264

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho

```

```

## 
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712
cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

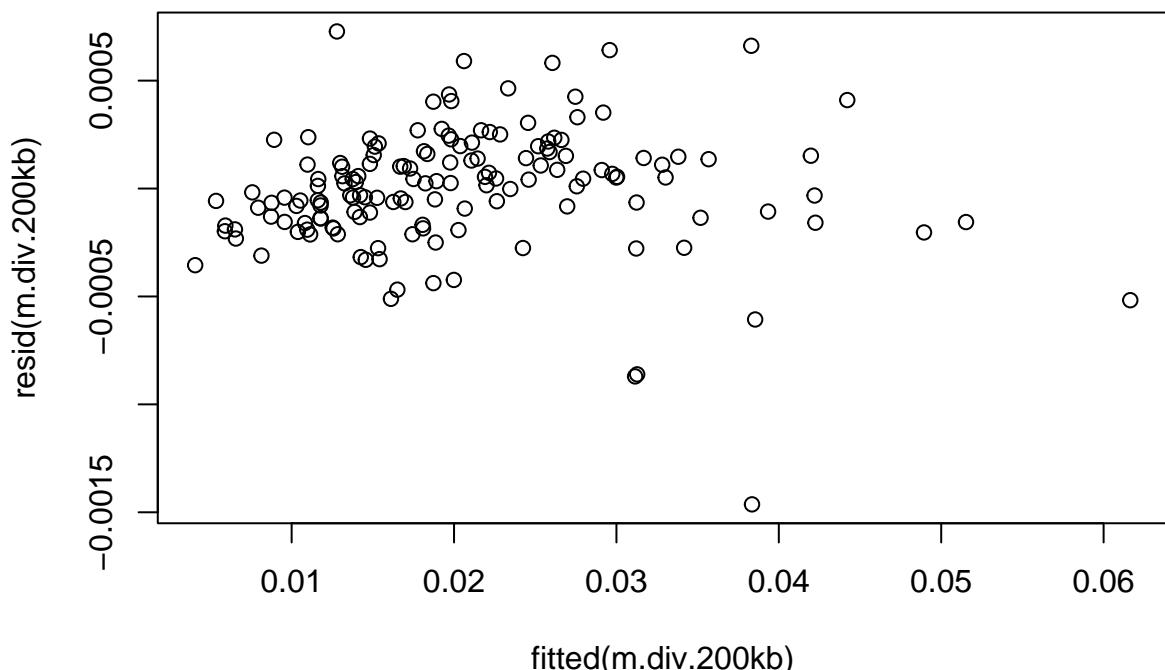
## 
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 606554, p-value = 0.3401
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.07836615
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep6 <- sim.lands.200kb
sim.lands.200kb.rep6$Replicate <- 6

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 2.0877, p-value = 0.6996
## alternative hypothesis: true autocorrelation is greater than 0

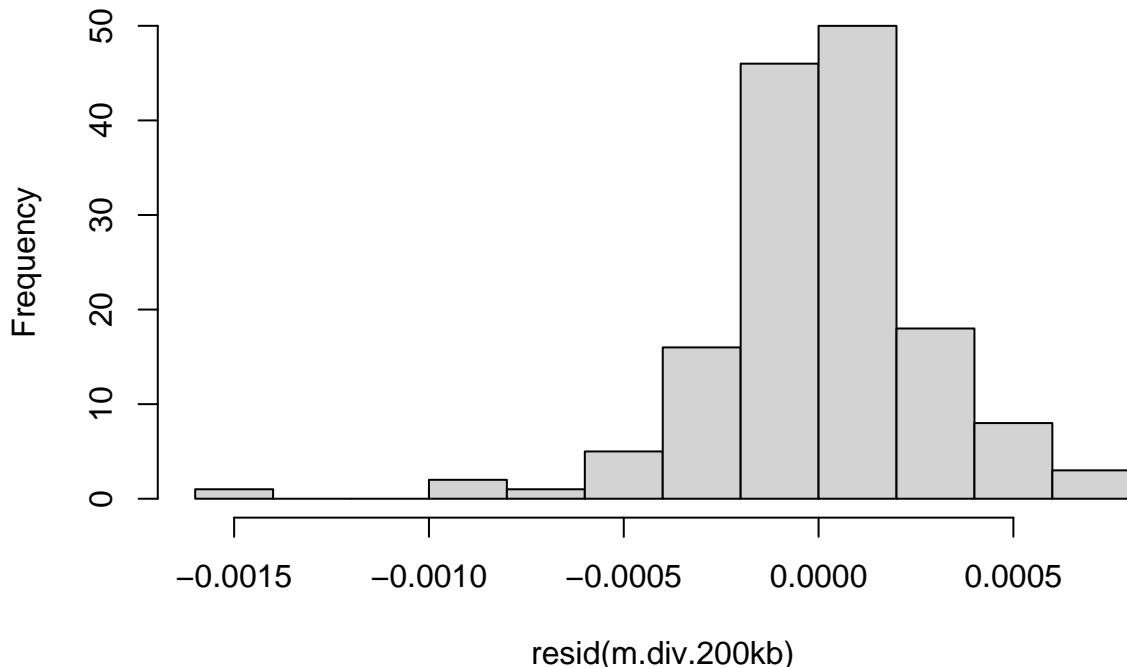
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.59616, p-value = 0.956

hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -1.463e-03 -1.507e-04  2.405e-05  1.519e-04  7.279e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  1.000e+00  1.000e-01  1.000e+00  1.000e+00  1.000e+00
## thetaS      -1.463e-03  1.507e-04 -1.463e-03  1.519e-04  7.279e-04
## rhoS        2.405e-05  1.519e-04  2.405e-05  1.519e-04  7.279e-04
## tmrcaS     -1.519e-04  1.519e-04 -1.519e-04  1.519e-04  7.279e-04
## thetaS:tmrcaS 1.519e-04  1.519e-04  1.519e-04  1.519e-04  7.279e-04
## 
```

```

##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.055e-02 2.337e-05 879.460 <2e-16 ***
## thetaS      9.676e-03 2.449e-05 395.145 <2e-16 ***
## rhoS       5.383e-06 2.351e-05   0.229    0.819
## tmrcaS     8.934e-04 2.365e-05  37.771 <2e-16 ***
## thetaS:tmrcaS 4.264e-04 1.890e-05  22.563 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000286 on 145 degrees of freedom
## Multiple R-squared:  0.9992, Adjusted R-squared:  0.9992
## F-statistic: 4.499e+04 on 4 and 145 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.092293     1.006542     1.019078     1.103193

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.200kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 6] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -2012.029
## g.div.200kb.2 8 -2049.648
## g.div.200kb.3 7 -2048.426
## g.div.200kb.4 7 -2013.285

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##          AIC      BIC logLik
## -2012.029 -1987.944 1014.015
##
```

```

## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## -0.08059735
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.007550391
##
## Coefficients:
##             Value    Std.Error t-value p-value
## (Intercept) 0.020554949 2.158530e-05 952.2660 0.0000
## thetaS       0.009681470 2.359319e-05 410.3502 0.0000
## rhoS        0.000009467 2.345327e-05   0.4036 0.6871
## tmrcaS      0.000893121 2.397363e-05  37.2543 0.0000
## thetaS:tmrcaS 0.000418922 1.912005e-05 21.9101 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.013
## rhoS        -0.004  0.081
## tmrcaS      0.005 -0.021  0.019
## thetaS:tmrcaS -0.045 -0.279  0.000 -0.128
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -5.2355776 -0.4872758  0.0956625  0.5329192  2.5314430
##
## Residual standard error: 0.0002829799
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.096600     1.007789     1.020862     1.106927

```

1.2.7 Replicate 7

```

rep_7.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/rep_7.pi.200kb.bedgraph", header=FALSE)
rep_7.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_7.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_7.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 647408, p-value = 0.06511
## alternative hypothesis: true rho is not equal to 0

```

```

## sample estimates:
##      rho
## -0.150999
cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712
cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

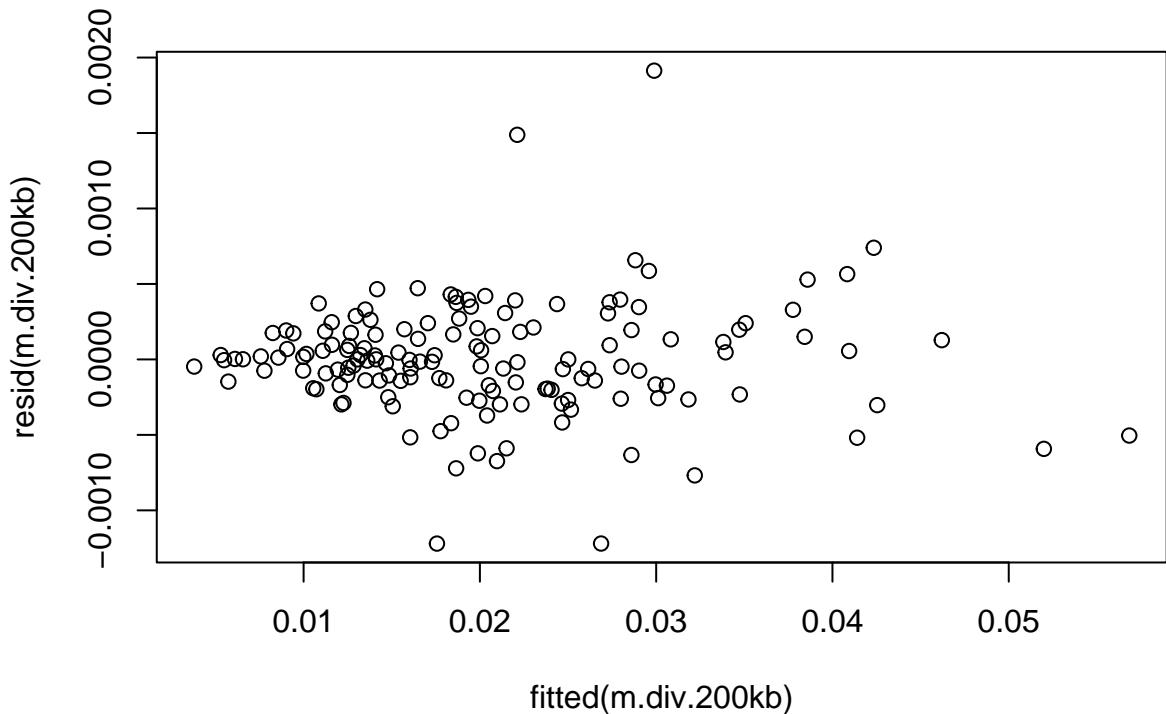
##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 523746, p-value = 0.402
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.06885462
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep7 <- sim.lands.200kb
sim.lands.200kb.rep7$Replicate <- 7

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
##  data:  m.div.200kb
##  DW = 1.9801, p-value = 0.4361
##  alternative hypothesis: true autocorrelation is greater than 0

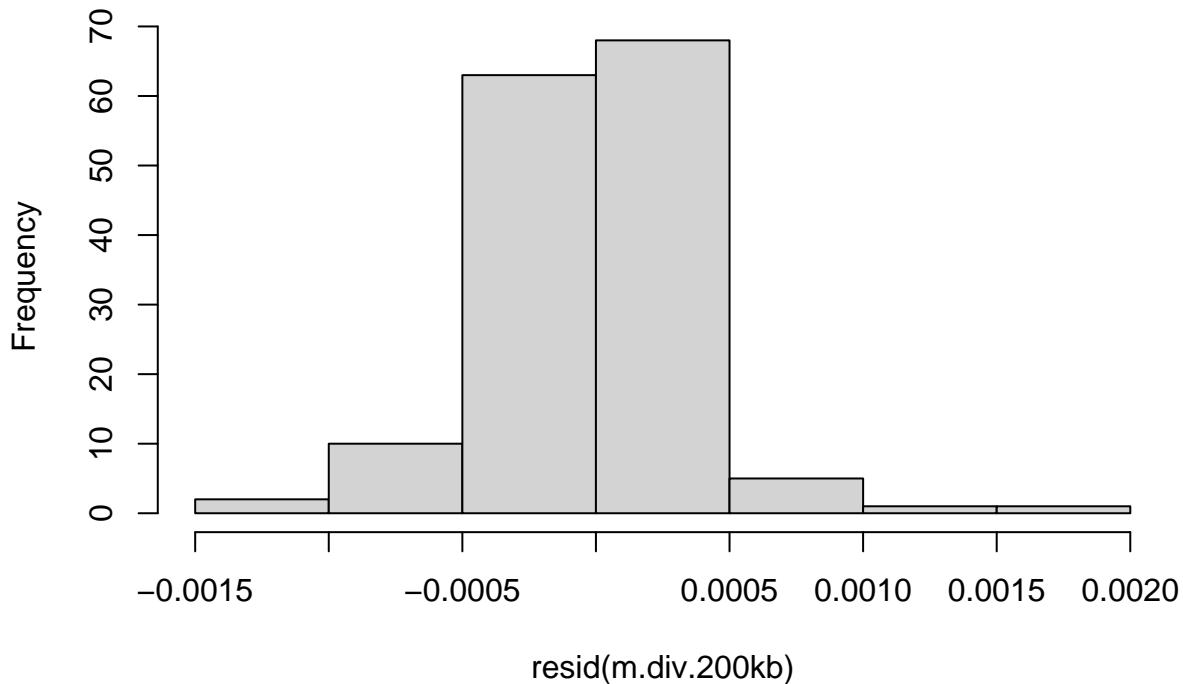
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
##  data:  m.div.200kb
##  HMC = 0.40495, p-value = 0.046

hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.200kb)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.220e-03 -1.868e-04 -1.610e-06  1.848e-04  1.913e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.062e-02 3.141e-05 656.642 <2e-16 ***  
## thetaS       9.795e-03 3.154e-05 310.525 <2e-16 ***  
## rhoS        -2.443e-05 3.130e-05 -0.781  0.436  
## tmrcaS       8.987e-04 3.155e-05  28.486 <2e-16 ***  
## thetaS:tmrcaS 4.019e-04 3.399e-05 11.823 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0003796 on 145 degrees of freedom  
## Multiple R-squared:  0.9985, Adjusted R-squared:  0.9985  
## F-statistic: 2.432e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.028877 1.013152 1.029367 1.003227
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 7] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1931.091
## g.div.200kb.2 8 -1977.037
## g.div.200kb.3 7 -1977.854
## g.div.200kb.4 7 -1933.088
summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.200kb
##       AIC      BIC logLik
## -1931.091 -1907.006 973.5455
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##     Phi
## 0.004603866
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##     power
## 0.1007805
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020622943 3.052795e-05 675.5431 0.0000
## thetaS      0.009799415 3.072126e-05 318.9783 0.0000

```

```

## rhoS          -0.000025469 3.074521e-05 -0.8284  0.4088
## tmrcaS        0.000904702 3.471121e-05 26.0637  0.0000
## thetaS:tmrcaS 0.000401667 3.693070e-05 10.8762  0.0000
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS          0.007
## rhoS          -0.012  0.098
## tmrcaS         -0.011  0.122 -0.057
## thetaS:tmrcaS  0.136  0.017  0.054 -0.035
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.84856559 -0.51901042  0.00912862  0.48503262 4.45105106
##
## Residual standard error: 0.0003952929
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##      thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.026768     1.017196     1.021227     1.004215

```

1.2.8 Replicate 8

```

rep_8.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/rep_8.pi.200kb.bedgraph", header=FALSE)
rep_8.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_8.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_8.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 588671, p-value = 0.5714
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0465727

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712

```

```

cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 624456, p-value = 0.1793
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.1101933

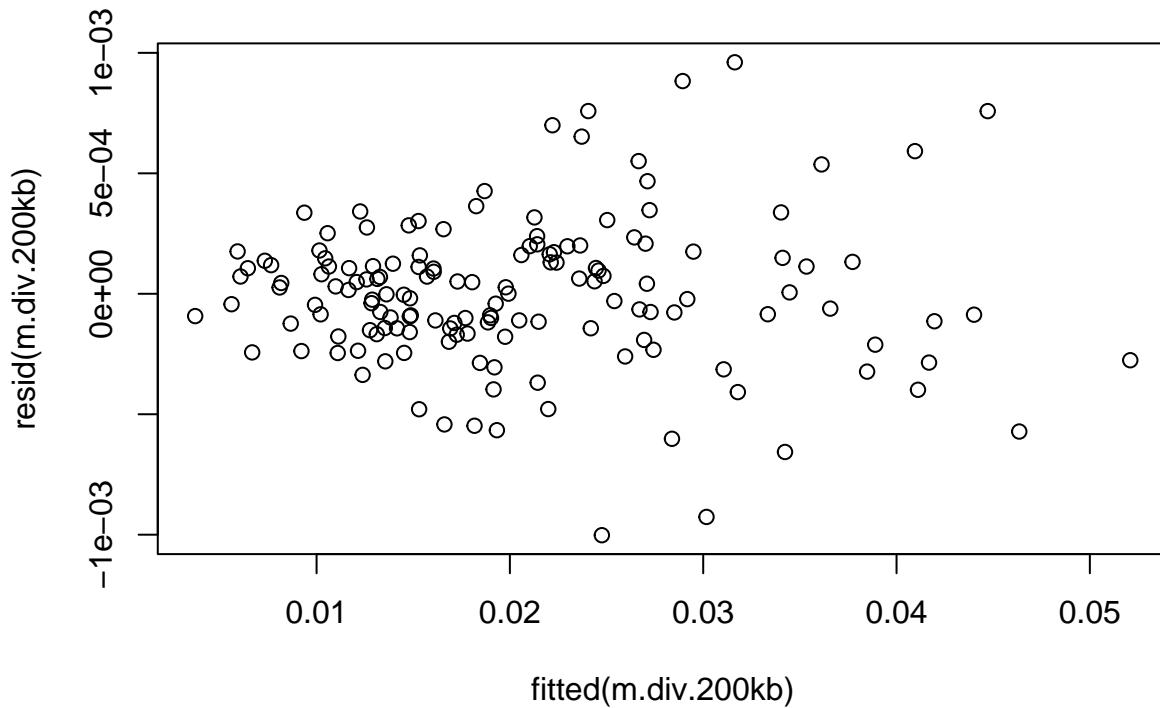
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep8 <- sim.lands.200kb
sim.lands.200kb.rep8$Replicate <- 8

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
## Durbin-Watson test
##
## data: m.div.200kb
## DW = 2.036, p-value = 0.577

```

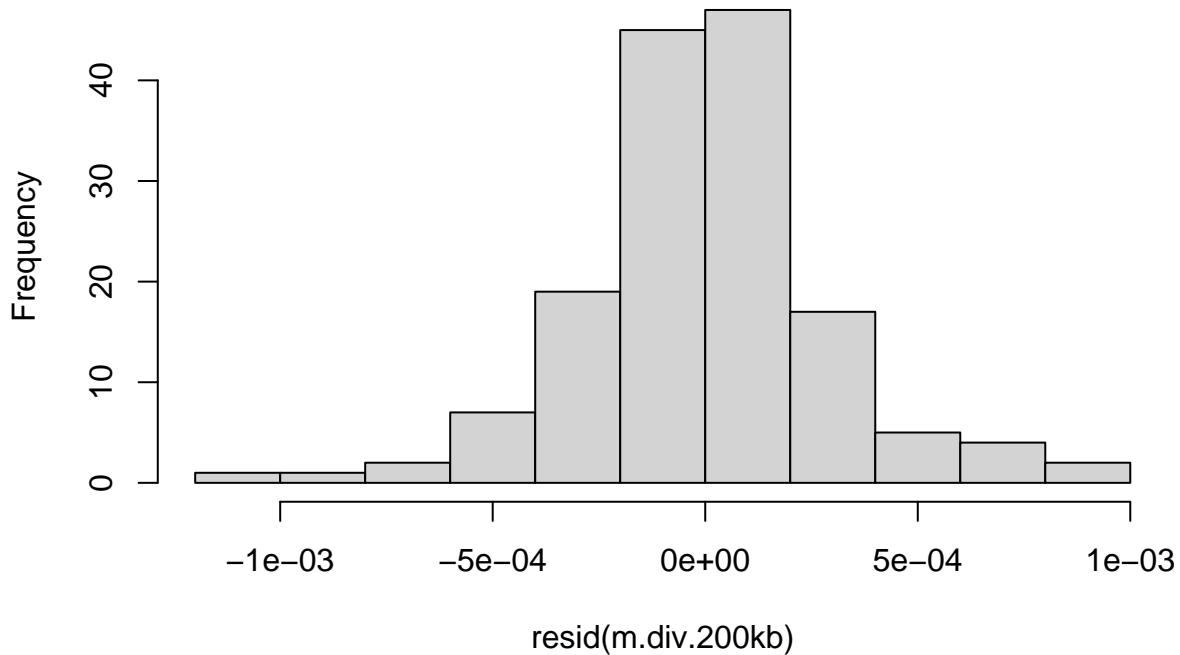
```

## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.54355, p-value = 0.766
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -0.0010021 -0.0001570 -0.0000008  0.0001486  0.0009608 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.057e-02  2.534e-05 811.819 <2e-16 ***
## thetaS       9.750e-03  2.590e-05 376.496 <2e-16 ***
## rhoS        -1.386e-05 2.578e-05 -0.538   0.592    
## tmrcaS       9.878e-04  2.621e-05 37.681 <2e-16 ***  
## thetaS:tmrcaS 4.413e-04  2.304e-05 19.154 <2e-16 ***  
## --- 
##
```

```

## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000309 on 145 degrees of freedom
## Multiple R-squared:  0.999, Adjusted R-squared:  0.999
## F-statistic: 3.616e+04 on 4 and 145 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.046676   1.036894   1.072450   1.089271

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.200kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 8] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1998.796
## g.div.200kb.2 8 -2028.564
## g.div.200kb.3 7 -2028.634
## g.div.200kb.4 7 -2000.568

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##      AIC      BIC logLik
## -1998.796 -1974.711 1007.398
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## -0.04046889
## Variance function:
## Structure: Power of variance covariate

```

```

## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.1593249
##
## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020574766 2.278747e-05 902.8983 0.0000
## thetaS       0.009738641 2.450951e-05 397.3414 0.0000
## rhoS        -0.000005761 2.327901e-05 -0.2475 0.8049
## tmrcaS      0.000977363 3.019243e-05 32.3711 0.0000
## thetaS:tmrcaS 0.000441257 2.704373e-05 16.3164 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.083
## rhoS        -0.127  0.055
## tmrcaS      -0.025  0.054  0.132
## thetaS:tmrcaS 0.099  0.142 -0.099 -0.182
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.173589627 -0.516409994 -0.006007084  0.532209522  2.942624379
##
## Residual standard error: 0.000332443
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.031232      1.027537      1.054570      1.067353

```

1.2.9 Replicate 9

```

rep_9.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/rep_9.pi.200kb.bedgraph", header=FALSE)
rep_9.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_9.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_9.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 493800, p-value = 0.1366
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##     rho
## 0.1220935

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##

```

```

##  Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0554712
cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 597682, p-value = 0.4463
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.062593

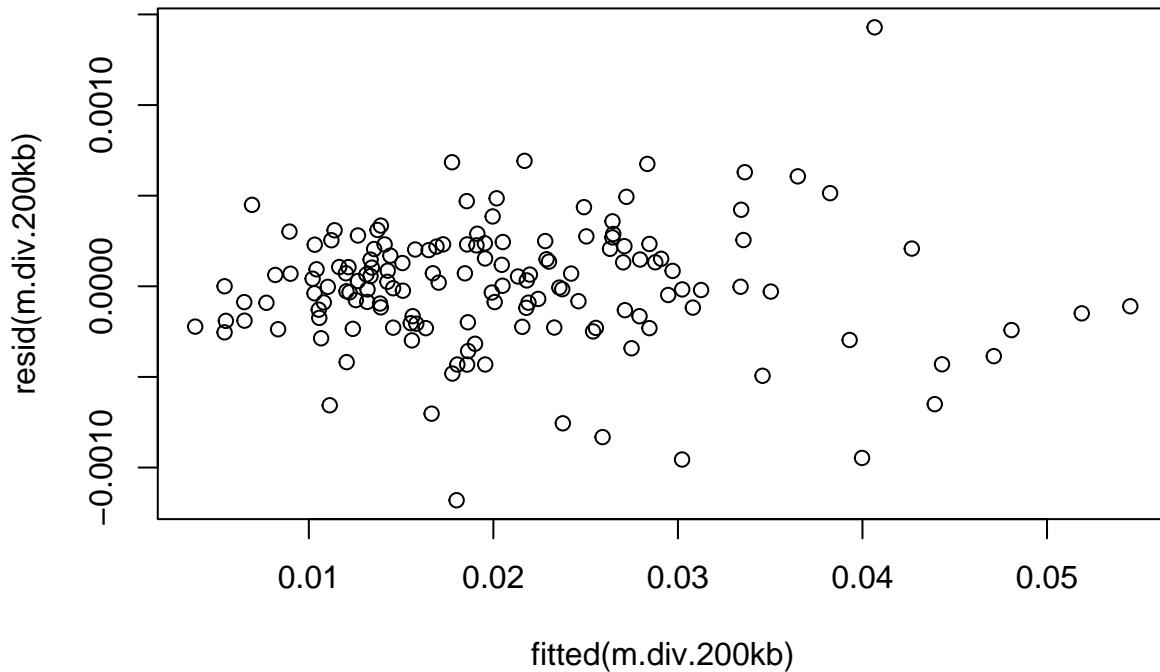
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep9 <- sim.lands.200kb
sim.lands.200kb.rep9$Replicate <- 9

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.6818, p-value = 0.022
## alternative hypothesis: true autocorrelation is greater than 0

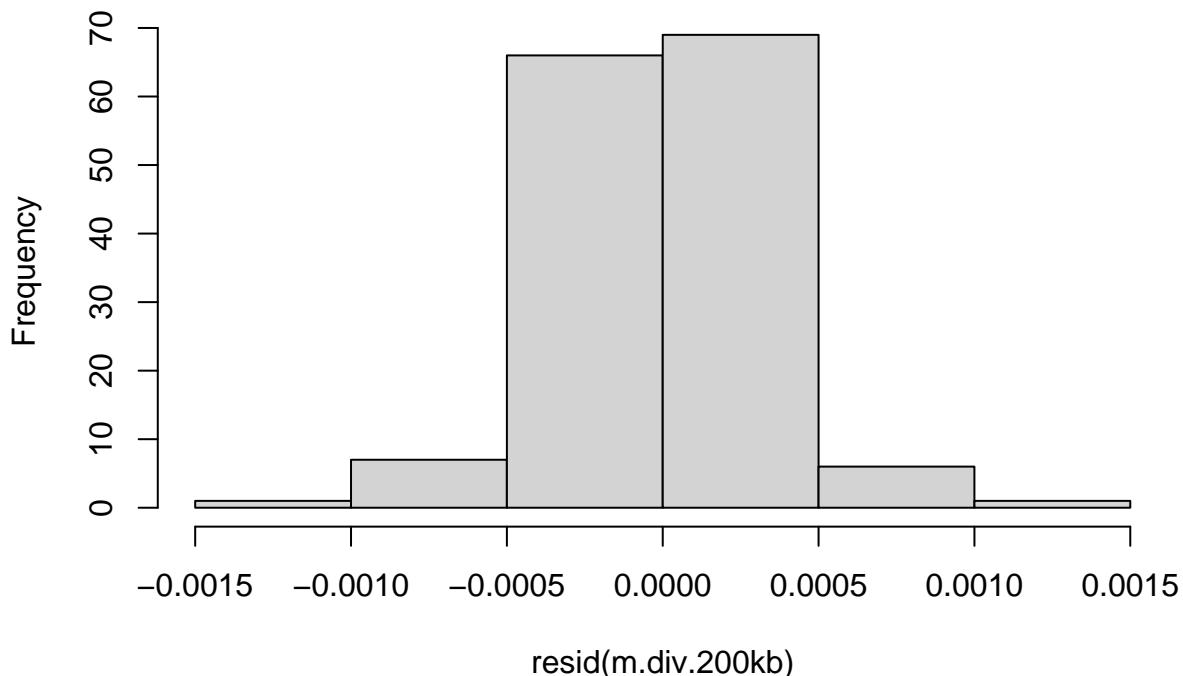
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.42403, p-value = 0.101

hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



resid(m.div.200kb)

```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.200kb)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -1.180e-03 -1.904e-04  1.650e-06  2.078e-04  1.429e-03
##
## Coefficients:

```

```

##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.061e-02 2.834e-05 727.360 <2e-16 ***
## thetaS      9.742e-03 2.870e-05 339.390 <2e-16 ***
## rhoS       9.161e-06 2.834e-05   0.323   0.747
## tmrcaS     9.056e-04 2.854e-05  31.733 <2e-16 ***
## thetaS:tmrcaS 4.515e-04 2.912e-05  15.505 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003441 on 145 degrees of freedom
## Multiple R-squared:  0.9988, Adjusted R-squared:  0.9988
## F-statistic: 3.126e+04 on 4 and 145 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.036853     1.010843     1.024970     1.022137

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.200kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 9] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1964.586
## g.div.200kb.2 8 -1986.087
## g.div.200kb.3 7 -1982.085
## g.div.200kb.4 7 -1961.894
summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: sim.lands.200kb
##          AIC      BIC logLik
## -1964.586 -1940.501 990.2932
##
```

```

## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## 0.1900801
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.1278244
##
## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020612285 3.283653e-05 627.7242 0.0000
## thetaS       0.009767871 2.787922e-05 350.3639 0.0000
## rhoS        -0.000011518 2.618022e-05 -0.4400 0.6606
## tmrcaS       0.000889847 3.185860e-05  27.9312 0.0000
## thetaS:tmrcaS 0.000448255 3.190872e-05 14.0480 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      -0.021
## rhoS        -0.047  0.023
## tmrcaS      0.000 -0.082  0.056
## thetaS:tmrcaS -0.085 -0.067  0.022 -0.014
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.37227108 -0.54078511  0.07832413  0.59703964  4.03528098
##
## Residual standard error: 0.0003641912
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.012295     1.004485     1.010579     1.005499

```

1.2.10 Replicate 10

```

rep_10.pi.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/rep_10.pi.200kb.bedgraph", header=FALSE)
rep_10.tmrca.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/sim.tmrca.200k.map", header=FALSE)

sim.lands.200kb <- as.data.frame(cbind(rep_10.pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_10.tmrca.200kb))
names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 605678, p-value = 0.3502
## alternative hypothesis: true rho is not equal to 0

```

```

## sample estimates:
##           rho
## -0.07680806

cor.test(~theta+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 593676, p-value = 0.5002
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.0554712

cor.test(~rho+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 612862, p-value = 0.2753
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##           rho
## -0.08958087

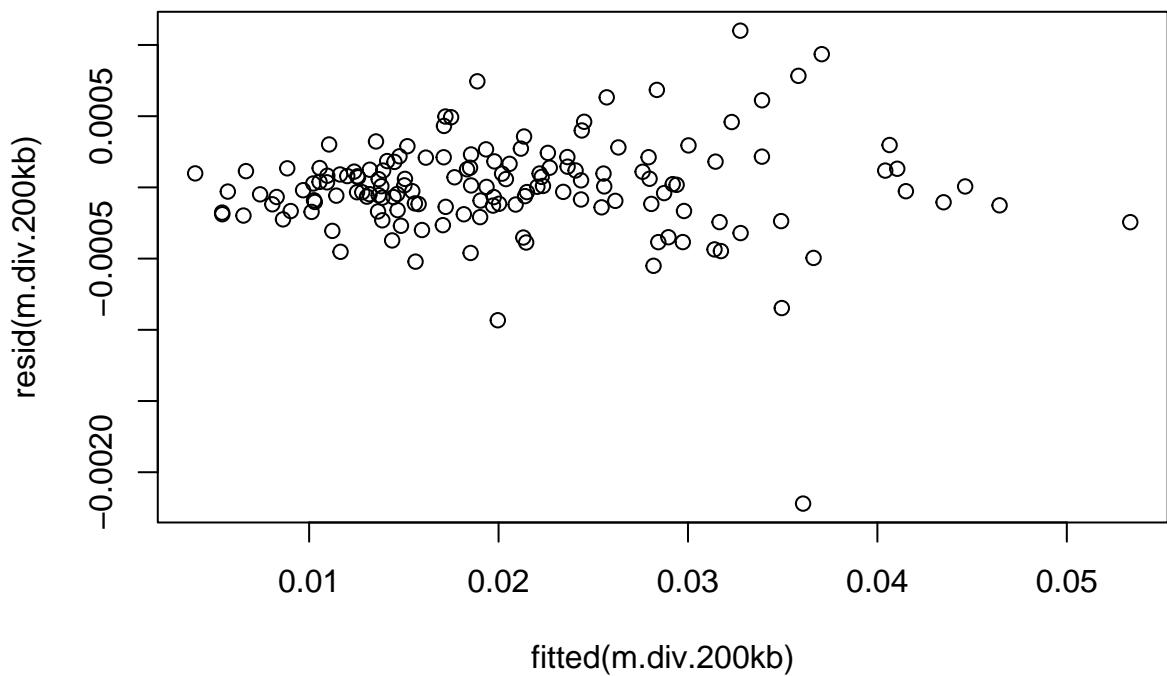
# standardizing
sim.lands.200kb$thetaS <- (sim.lands.200kb$theta - mean(sim.lands.200kb$theta)) / sd(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaS <- (sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)) / sd(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoS <- (sim.lands.200kb$rho - mean(sim.lands.200kb$rho)) / sd(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

sim.lands.200kb.rep10 <- sim.lands.200kb
sim.lands.200kb.rep10$Replicate <- 10

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.200kb)
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```

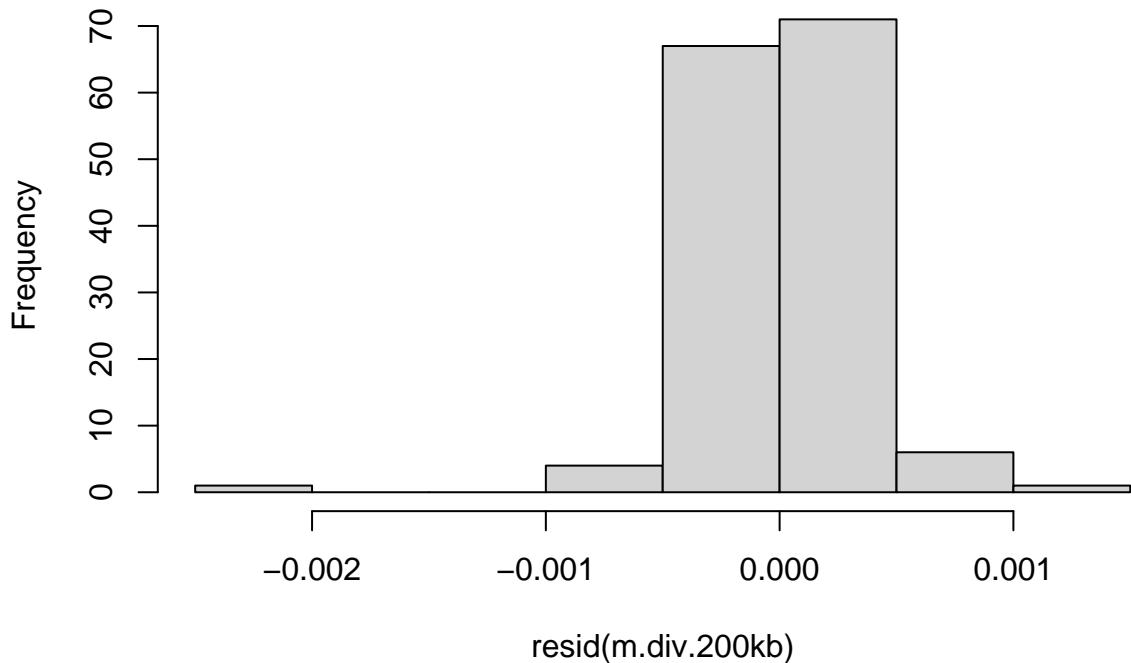


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 2.1646, p-value = 0.8354
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.41358, p-value = 0.083
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = sim.lands.200kb)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -2.220e-03 -1.345e-04  6.710e-06  1.375e-04  1.100e-03
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.071e-02 2.877e-05 720.015 <2e-16 ***
## thetaS       9.806e-03 3.006e-05 326.195 <2e-16 ***
## rhoS        7.183e-06 2.907e-05  0.247   0.805    
## tmrcaS      1.083e-03 2.914e-05  37.182 <2e-16 ***
## thetaS:tmrcaS 5.833e-04 2.572e-05 22.681 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0003493 on 145 degrees of freedom
## Multiple R-squared:  0.9987, Adjusted R-squared:  0.9987 
## F-statistic: 2.783e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.103525    1.032220    1.036739    1.088489
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.sim.200kb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~theta), method = "ML")
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                        data = sim.lands.200kb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

```

```

##           df      AIC
## g.div.200kb.1 8 -1973.113
## g.div.200kb.2 8 -2021.337
## g.div.200kb.3 7 -2019.213
## g.div.200kb.4 7 -1974.043

```

```
summary(g.div.200kb.3)
```

```

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.200kb
##          AIC      BIC    logLik
## -2019.213 -1998.138 1016.606
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
## Parameter estimates:
##   power
## 0.976478
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020715499 2.732285e-05 758.1749 0.0000
## thetaS       0.009841843 2.481773e-05 396.5650 0.0000
## rhoS        0.000022860 1.902481e-05   1.2016 0.2315
## tmrcaS      0.001078377 2.783631e-05  38.7400 0.0000

```

```

## thetaS:tmrcaS 0.000537840 2.813065e-05 19.1194 0.0000
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS       0.750
## rhoS        0.022  0.128
## tmrcaS      0.050  0.052  0.108
## thetaS:tmrcaS 0.054 -0.063  0.003  0.724
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.206595037 -0.523054985  0.009968671  0.618901511  2.625659426
##
## Residual standard error: 0.01791136
## Degrees of freedom: 150 total; 145 residual
vif(g.div.200kb.3)

```

```

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.036857    1.036652    2.189197    2.169248

```

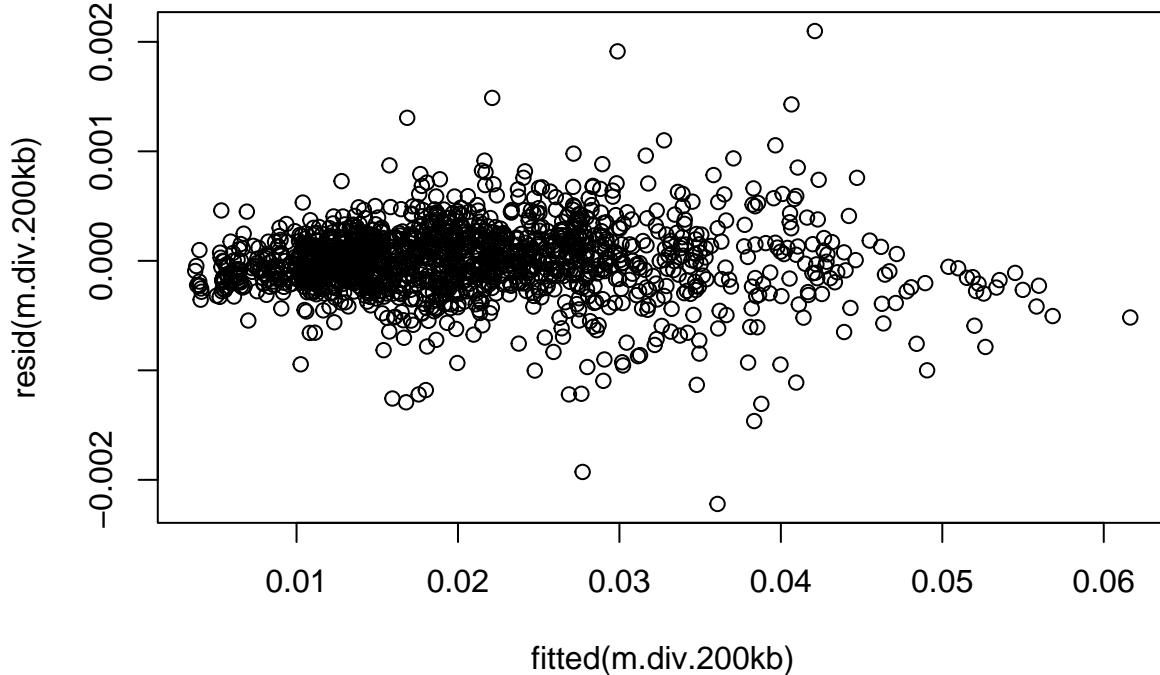
1.2.11 all replicates:

```

sim.lands.200kb.all <- rbind(sim.lands.200kb.rep1, sim.lands.200kb.rep2, sim.lands.200kb.rep3, sim.lands.200kb.rep4)

m.div.200kb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)*as.factor(Replicate), data = sim.lands.200kb.all)
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

```

```

##
## Durbin-Watson test
##

```

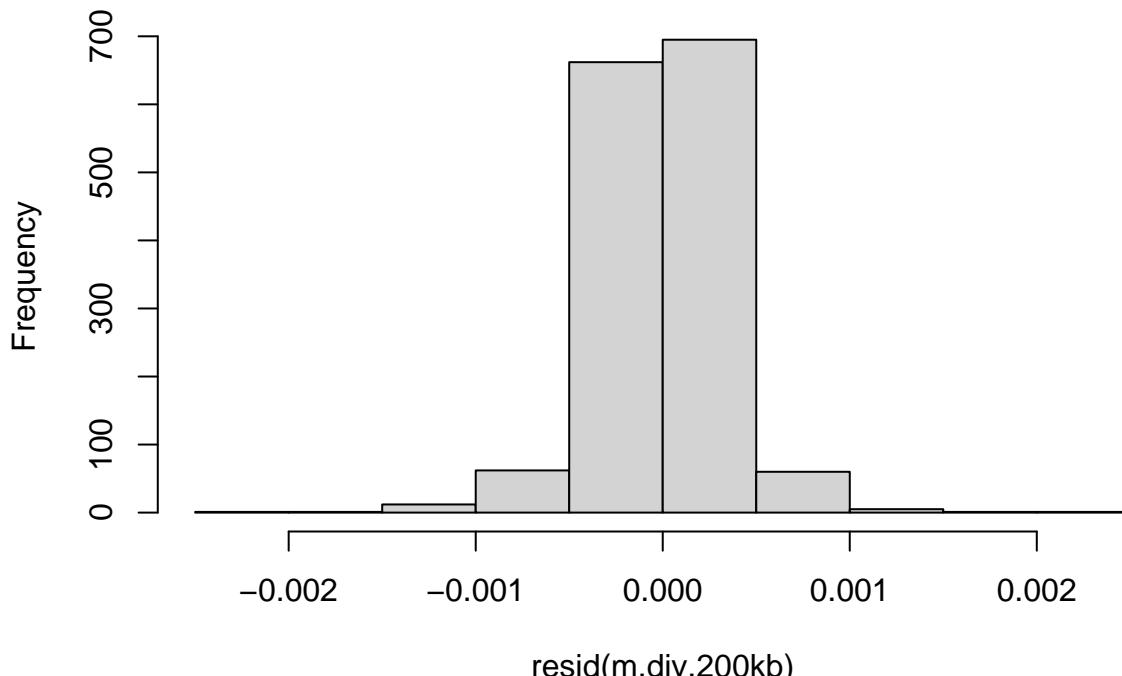
```

## data: m.div.200kb
## DW = 1.9429, p-value = 0.07075
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.49993, p-value = 0.481
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

m.div.200kb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replicate)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as.factor(Replicate)

```

```
AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)
```

```

##          df      AIC
## m.div.200kb   51 -19694.66
## m.div.200kb.2 61 -19684.61
## m.div.200kb.3 71 -19669.64

```

```
summary(m.div.200kb)
```

```

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##     as.factor(Replicate), data = sim.lands.200kb.all)
##
## Residuals:

```

```

##      Min       1Q    Median      3Q     Max
## -0.0022201 -0.0001690  0.0000028  0.0001766  0.0020986
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2.067e-02  2.737e-05 755.296 < 2e-16 ***
## thetaS                     9.726e-03  2.755e-05 353.041 < 2e-16 ***
## rhoS                      4.827e-05  2.767e-05  1.744  0.08129 .
## tmrcaS                    9.232e-04  2.746e-05 33.616 < 2e-16 ***
## as.factor(Replicate)2     -1.119e-04 3.871e-05 -2.891  0.00390 **
## as.factor(Replicate)3     -2.543e-05 3.871e-05 -0.657  0.51140
## as.factor(Replicate)4     -1.680e-04 3.871e-05 -4.340  1.52e-05 ***
## as.factor(Replicate)5     -6.032e-05 3.871e-05 -1.558  0.11943
## as.factor(Replicate)6     -1.150e-04 3.872e-05 -2.971  0.00302 **
## as.factor(Replicate)7     -4.595e-05 3.896e-05 -1.179  0.23850
## as.factor(Replicate)8     -9.870e-05 3.879e-05 -2.545  0.01104 *
## as.factor(Replicate)9     -5.618e-05 3.887e-05 -1.445  0.14858
## as.factor(Replicate)10    4.349e-05 3.887e-05  1.119  0.26340
## thetaS:tmrcaS             4.181e-04 2.865e-05 14.594 < 2e-16 ***
## thetaS:as.factor(Replicate)2 -6.651e-05 3.909e-05 -1.701  0.08911 .
## thetaS:as.factor(Replicate)3  2.060e-05 3.900e-05  0.528  0.59755
## thetaS:as.factor(Replicate)4 -3.649e-05 3.897e-05 -0.936  0.34924
## thetaS:as.factor(Replicate)5  2.141e-06 3.901e-05  0.055  0.95623
## thetaS:as.factor(Replicate)6 -4.982e-05 3.978e-05 -1.252  0.21063
## thetaS:as.factor(Replicate)7  6.889e-05 3.917e-05  1.759  0.07887 .
## thetaS:as.factor(Replicate)8  2.471e-05 3.935e-05  0.628  0.53009
## thetaS:as.factor(Replicate)9  1.606e-05 3.925e-05  0.409  0.68256
## thetaS:as.factor(Replicate)10 8.024e-05 3.989e-05  2.012  0.04443 *
## rhoS:as.factor(Replicate)2  -9.529e-05 3.908e-05 -2.439  0.01486 *
## rhoS:as.factor(Replicate)3  -5.114e-07 3.912e-05 -0.013  0.98957
## rhoS:as.factor(Replicate)4  -3.503e-05 3.907e-05 -0.896  0.37014
## rhoS:as.factor(Replicate)5  -3.482e-05 3.913e-05 -0.890  0.37376
## rhoS:as.factor(Replicate)6  -4.289e-05 3.905e-05 -1.098  0.27218
## rhoS:as.factor(Replicate)7  -7.271e-05 3.911e-05 -1.859  0.06323 .
## rhoS:as.factor(Replicate)8  -6.213e-05 3.934e-05 -1.579  0.11446
## rhoS:as.factor(Replicate)9  -3.911e-05 3.909e-05 -1.001  0.31717
## rhoS:as.factor(Replicate)10 -4.109e-05 3.929e-05 -1.046  0.29585
## tmrcaS:as.factor(Replicate)2  8.449e-05 3.903e-05  2.165  0.03056 *
## tmrcaS:as.factor(Replicate)3  1.111e-04 3.891e-05  2.856  0.00435 **
## tmrcaS:as.factor(Replicate)4  6.116e-05 3.903e-05  1.567  0.11730
## tmrcaS:as.factor(Replicate)5  3.620e-06 3.940e-05  0.092  0.92682
## tmrcaS:as.factor(Replicate)6  -2.987e-05 3.902e-05 -0.765  0.44414
## tmrcaS:as.factor(Replicate)7  -2.448e-05 3.912e-05 -0.626  0.53152
## tmrcaS:as.factor(Replicate)8  6.459e-05 3.953e-05  1.634  0.10251
## tmrcaS:as.factor(Replicate)9  -1.761e-05 3.908e-05 -0.451  0.65236
## tmrcaS:as.factor(Replicate)10 1.602e-04 3.919e-05  4.087  4.61e-05 ***
## thetaS:tmrcaS:as.factor(Replicate)2  8.419e-05 3.971e-05  2.120  0.03418 *
## thetaS:tmrcaS:as.factor(Replicate)3  3.768e-05 4.052e-05  0.930  0.35254
## thetaS:tmrcaS:as.factor(Replicate)4  2.244e-05 3.901e-05  0.575  0.56523
## thetaS:tmrcaS:as.factor(Replicate)5  -2.157e-05 3.769e-05 -0.572  0.56721
## thetaS:tmrcaS:as.factor(Replicate)6  8.308e-06 3.621e-05  0.229  0.81856
## thetaS:tmrcaS:as.factor(Replicate)7  -1.622e-05 4.149e-05 -0.391  0.69582
## thetaS:tmrcaS:as.factor(Replicate)8  2.322e-05 3.802e-05  0.611  0.54147
## thetaS:tmrcaS:as.factor(Replicate)9  3.342e-05 4.031e-05  0.829  0.40724

```

```

## thetaS:tmrcaS:as.factor(Replicate)10 1.652e-04 3.781e-05 4.370 1.33e-05 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003352 on 1450 degrees of freedom
## Multiple R-squared: 0.9989, Adjusted R-squared: 0.9988
## F-statistic: 2.574e+04 on 49 and 1450 DF, p-value: < 2.2e-16

```

1.3 1 Mb scale

```

r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.rho.1e+06.txt", header = T)
sim.theta.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/dm.sim.theta.1e+06.txt", header = T)

```

1.3.1 Replicate 1

```

rep_1.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/rep_1.pi.1Mb.bedgraph", header = T)
rep_1.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_1/sim.tmrca.1M.map", header = T)

sim.lands.1Mb <- as.data.frame(cbind(rep_1.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_1.tmrca.1Mb$sim))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 5134, p-value = 0.452
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.142158
cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842
cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca

```

```

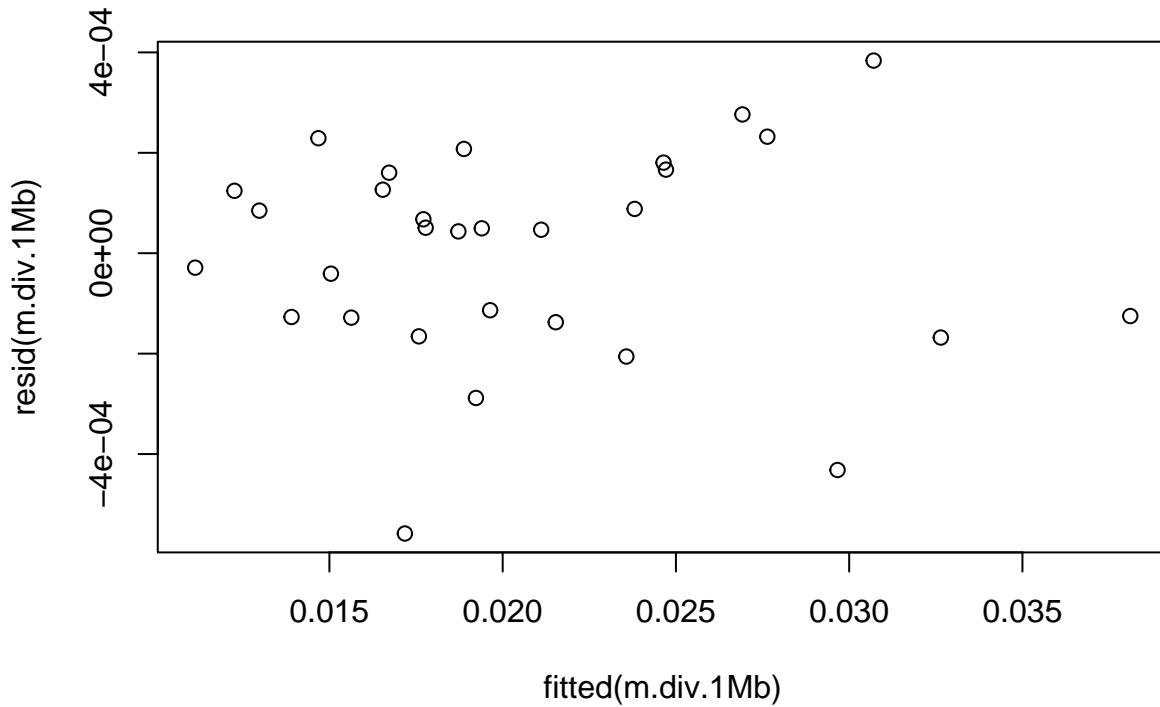
## S = 4576, p-value = 0.9251
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.01802002
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep1 <- sim.lands.1Mb
sim.lands.1Mb.rep1$Replicate <- 1

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
## Durbin-Watson test
##
## data: m.div.1Mb
## DW = 1.5295, p-value = 0.09374
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)

##
## Harrison-McCabe test
##

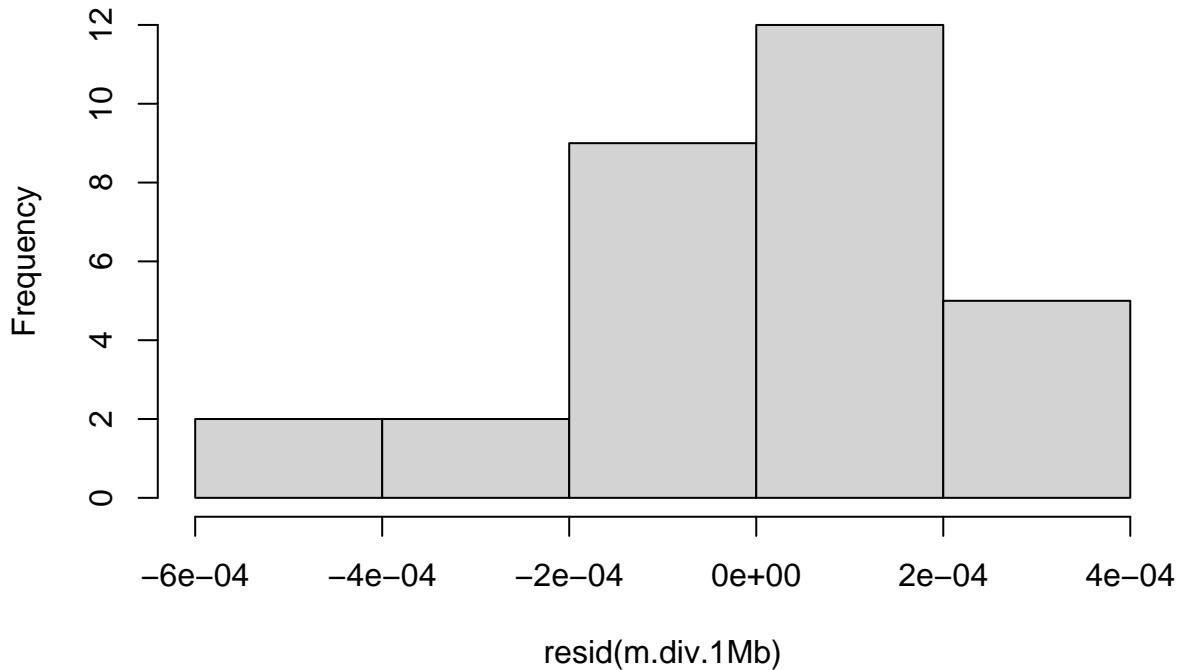
```

```

## data: m.div.1Mb
## HMC = 0.59412, p-value = 0.766
hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -0.0005582 -0.0001279  0.0000482  0.0001519  0.0003836
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.067e-02 4.132e-05 500.181 < 2e-16 ***
## thetaS       6.406e-03 4.696e-05 136.418 < 2e-16 ***
## rhoS        -1.598e-06 4.452e-05 -0.036   0.9717
## tmrcaS       3.863e-04 4.278e-05  9.031 2.41e-09 ***
## thetaS:tmrcaS 8.560e-05 4.532e-05   1.889   0.0706 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002263 on 25 degrees of freedom
## Multiple R-squared:  0.9989, Adjusted R-squared:  0.9988
## F-statistic: 5910 on 4 and 25 DF,  p-value: < 2.2e-16

```

```

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.248566     1.121845     1.036015     1.370034

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df          AIC
## g.div.1Mb.1 8 -412.2997
## g.div.1Mb.2 8 -411.1435
## g.div.1Mb.3 7 -412.3258
## g.div.1Mb.4 7 -411.2879
summary(g.div.1Mb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##           AIC      BIC    logLik
##       -411.1435 -399.9339 213.5717
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##           Phi
##       0.2056274
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
## Parameter estimates:
##           power
##       0.5923266
##

```

```

## Coefficients:
##              Value    Std.Error t-value p-value
## (Intercept) 0.020671313 5.014612e-05 412.2216 0.0000
## thetaS       0.006394417 4.762910e-05 134.2544 0.0000
## rhoS        0.000000461 4.147260e-05   0.0111 0.9912
## tmrcaS      0.000374106 3.841620e-05   9.7382 0.0000
## thetaS:tmrcaS 0.000110598 4.390571e-05   2.5190 0.0185
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.320
## rhoS      -0.003  0.147
## tmrcaS    -0.013 -0.023 -0.002
## thetaS:tmrcaS 0.001 -0.306  0.105  0.162
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.0952982 -0.6387240  0.2093559  0.7518412  1.4518942
##
## Residual standard error: 0.002413704
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.2)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.145680     1.049549     1.028481     1.163739

```

1.3.2 Replicate 2

```

rep_2.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/rep_2.pi.1Mb.bedgraph", header = FALSE)
rep_2.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_2/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_2.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_2.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 3982, p-value = 0.5467
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.1141268

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0

```

```

## sample estimates:
##      rho
## -0.257842
cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  rho and tmrca
## S = 3726, p-value = 0.3645
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.171079

cor.test(~diversity+theta, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and theta
## S = 4053.2, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9927941

cor.test(~diversity+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and tmrca
## S = 552924, p-value = 0.8364
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01698031

cor.test(~diversity+rho, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and rho
## S = 596694, p-value = 0.4591
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.06083648

# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

```

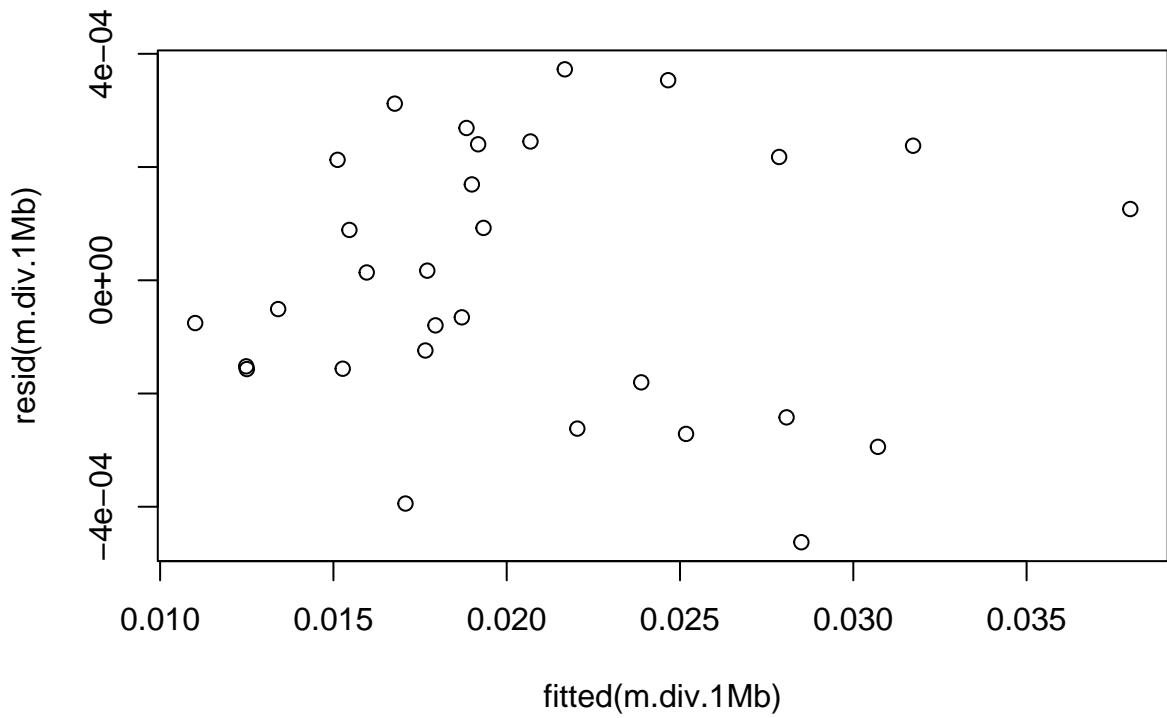
```

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep2 <- sim.lands.1Mb
sim.lands.1Mb.rep2$Replicate <- 2

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
## Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.6531, p-value = 0.9631
## alternative hypothesis: true autocorrelation is greater than 0

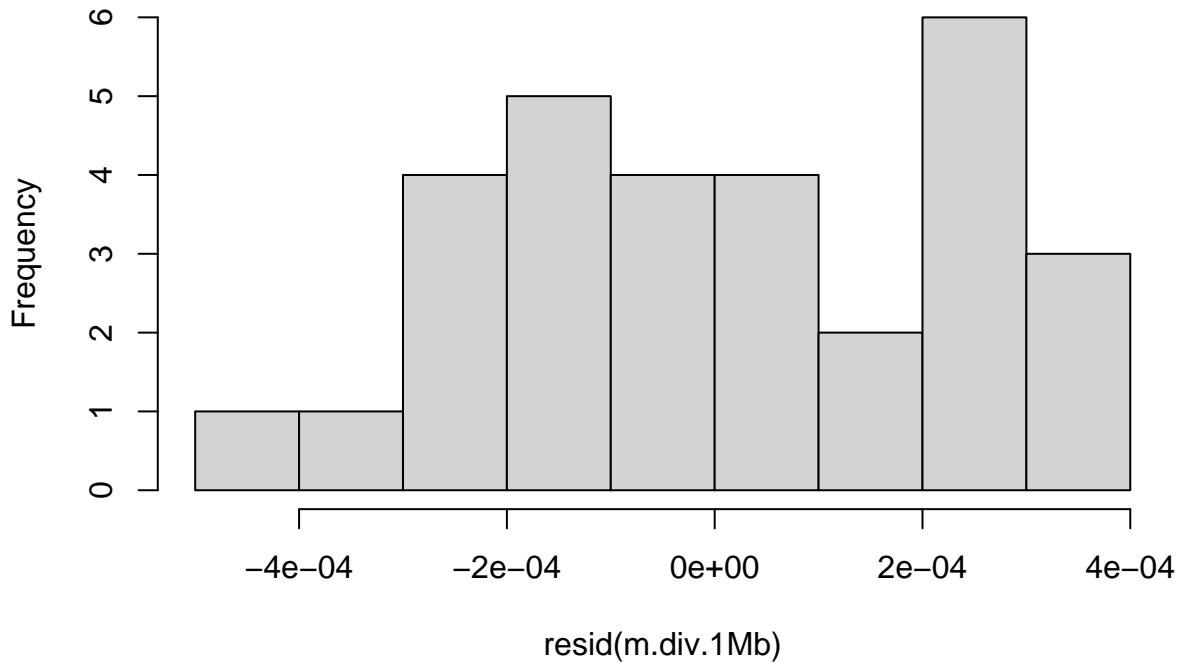
hmctest(m.div.1Mb)

##
## Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.51119, p-value = 0.562

hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -4.627e-04 -1.567e-04 -1.856e-05  2.165e-04  3.726e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.052e-02 4.606e-05 445.437 < 2e-16 ***
## thetaS       6.270e-03 4.942e-05 126.882 < 2e-16 ***
## rhoS        -2.992e-05 4.850e-05 -0.617 0.542900
## tmrcaS       4.395e-04 4.996e-05   8.796 3.99e-09 ***
## thetaS:tmrcaS 2.033e-04 4.644e-05   4.376 0.000188 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002496 on 25 degrees of freedom
## Multiple R-squared:  0.9987, Adjusted R-squared:  0.9985
## F-statistic: 4800 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.136589 1.094711 1.161898 1.176801
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.1Mb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 2] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

```

```

##          df      AIC
## g.div.1Mb.1 8 -410.7217
## g.div.1Mb.2 8 -411.7182
## g.div.1Mb.3 7 -410.7340
## g.div.1Mb.4 7 -406.9645
summary(g.div.1Mb.4)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##       AIC      BIC    logLik
##   -406.9645 -397.1561 210.4822
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.2519622
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020515042 4.227073e-05 485.3250 0.0000
## thetaS       0.006322847 4.121629e-05 153.4065 0.0000
## rhoS        -0.000031075 4.650607e-05 -0.6682 0.5101
## tmrcaS       0.000424067 5.980589e-05   7.0907 0.0000
## thetaS:tmrcaS 0.000193007 5.563157e-05   3.4694 0.0019
##
## Correlation:
```

```

##          (Intr) thetaS rhoS   tmrcaS
## thetaS      0.295
## rhoS      -0.086  0.199
## tmrcaS      0.051 -0.119 -0.225
## thetaS:tmrcaS -0.205 -0.172  0.101 -0.279
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.5678391 -0.5590589  0.1193498  0.9131596  1.4343392
##
## Residual standard error: 0.0002559004
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.4)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.103963    1.094913    1.154303    1.144962

```

1.3.3 Replicate 3

```

rep_3.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/rep_3.pi.1Mb.bedgraph", header = FALSE)
rep_3.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_3/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_3.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_3.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 6456, p-value = 0.01674
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.4362625

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca

```

```

## S = 4500, p-value = 0.9963
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.001112347
cor.test(~diversity+theta, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: diversity and theta
## S = 4053.2, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## 0.9927941
cor.test(~diversity+tmrca, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: diversity and tmrca
## S = 552924, p-value = 0.8364
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## 0.01698031
cor.test(~diversity+rho, data = sim.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: diversity and rho
## S = 596694, p-value = 0.4591
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.06083648

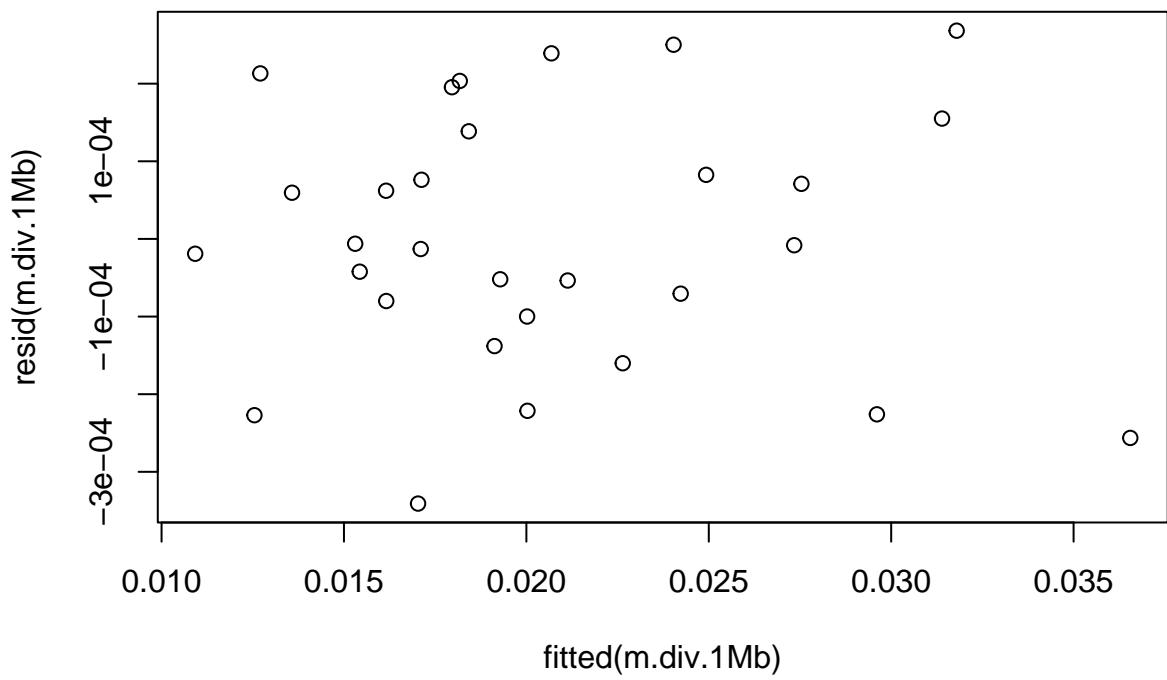
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep3 <- sim.lands.1Mb
sim.lands.1Mb.rep3$Replicate <- 3

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```
dwtest(m.div.1Mb)
```

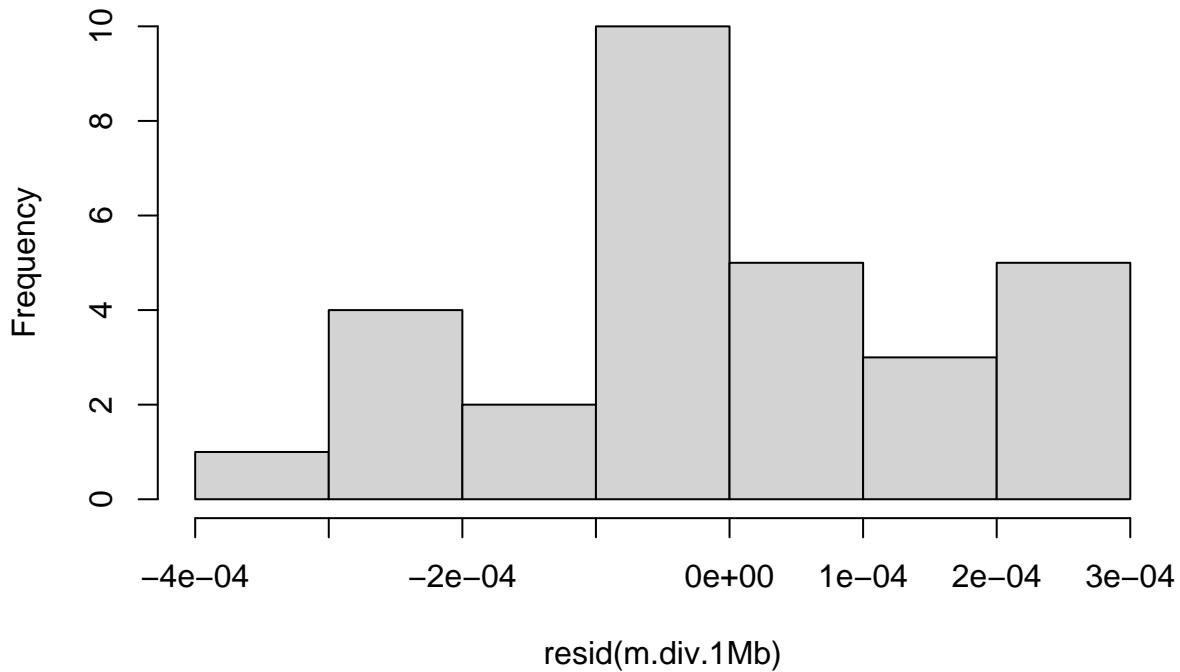
```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.3611, p-value = 0.8304
## alternative hypothesis: true autocorrelation is greater than 0
```

```
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.69982, p-value = 0.953
```

```
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -3.409e-04 -9.496e-05 -1.057e-05  1.246e-04  2.682e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.070e-02 3.559e-05 581.752 < 2e-16 ***
## thetaS       6.469e-03 3.722e-05 173.822 < 2e-16 ***
## rhoS        4.023e-05 3.455e-05   1.164   0.255
## tmrcaS      5.563e-04 3.721e-05  14.949 5.67e-14 ***
## thetaS:tmrcaS 2.292e-04 4.592e-05    4.990 3.83e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001781 on 25 degrees of freedom
## Multiple R-squared:  0.9993, Adjusted R-squared:  0.9992
## F-statistic: 9011 on 4 and 25 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS            rhoS           tmrcaS      thetaS:tmrcaS
## 1.266893     1.091885     1.266548     1.131259
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.1Mb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 3] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -428.0729
## g.div.1Mb.2 8 -425.3487
## g.div.1Mb.3 7 -425.9315
## g.div.1Mb.4 7 -429.7431
summary(g.div.1Mb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC    logLik
## -425.3487 -414.1391 220.6743
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##     Phi
## -0.2182964
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
##   Parameter estimates:
##     power
## 0.7538286
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020689422 3.172528e-05 652.1431 0.0000
## thetaS       0.006478817 3.593374e-05 180.2990 0.0000

```

```

## rhoS          0.000046941 3.032585e-05   1.5479  0.1342
## tmrcaS       0.000548083 3.706028e-05  14.7890  0.0000
## thetaS:tmrcaS 0.000175860 5.260023e-05   3.3433  0.0026
##
## Correlation:
##              (Intr) thetaS rhoS  tmrcaS
## thetaS      0.468
## rhoS        0.067  0.266
## tmrcaS     0.285  0.368  0.161
## thetaS:tmrcaS 0.522  0.265  0.121  0.574
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.20817237 -0.75616795  0.02860389  0.78792168  1.65546162
##
## Residual standard error: 0.003766649
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.2)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.223239      1.081786      1.615396      1.498599

```

1.3.4 Replicate 4

```

rep_4.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/rep_4.pi.1Mb.bedgraph", header = FALSE)
rep_4.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_4/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_4.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_4.tmrca.1Mb$sim))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 4678, p-value = 0.8307
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.0407119

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

```

```

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  rho and tmrca
## S = 3482, p-value = 0.2302
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.2253615

cor.test(~diversity+theta, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and theta
## S = 4053.2, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9927941

cor.test(~diversity+tmrca, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and tmrca
## S = 552924, p-value = 0.8364
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01698031

cor.test(~diversity+rho, data = sim.lands.200kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  diversity and rho
## S = 596694, p-value = 0.4591
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.06083648

# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep4 <- sim.lands.1Mb

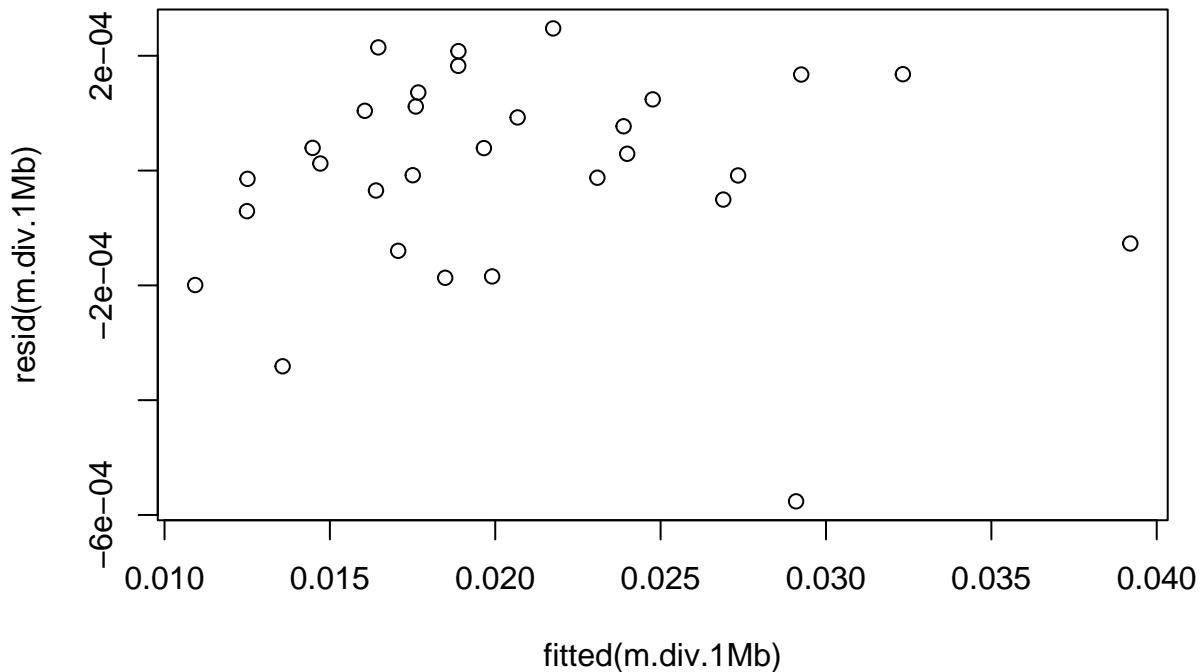
```

```

sim.lands.1Mb.rep4$Replicate <- 4

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
## Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.4044, p-value = 0.8773
## alternative hypothesis: true autocorrelation is greater than 0

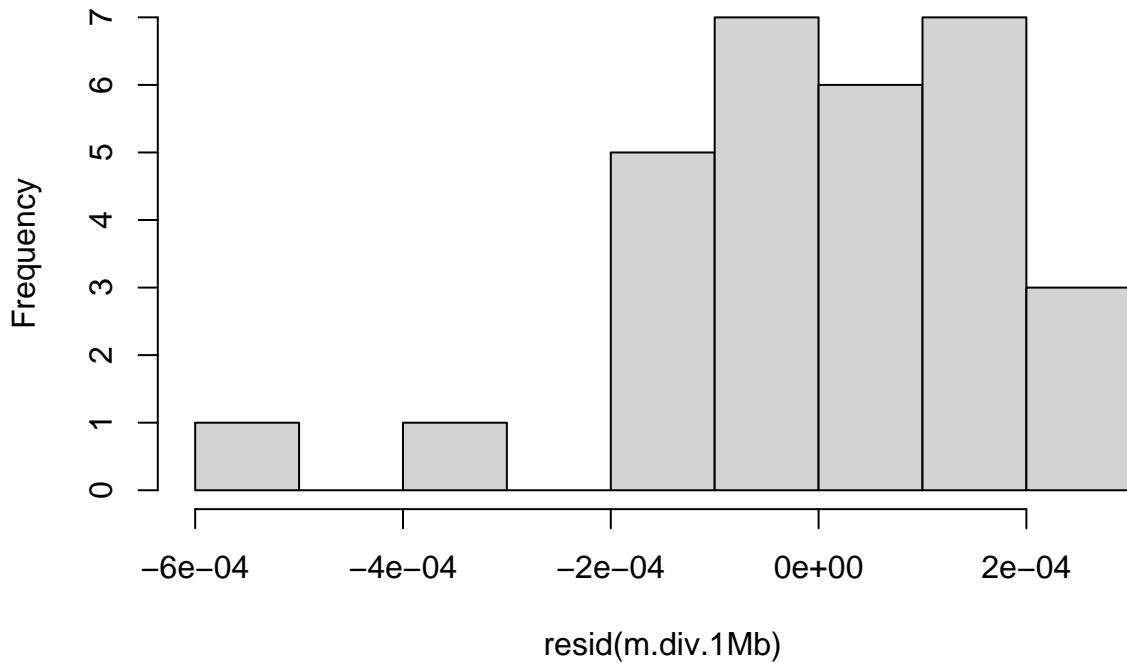
hmctest(m.div.1Mb)

##
## Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.39065, p-value = 0.202

hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.1Mb)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -5.763e-04 -6.567e-05  2.077e-05  1.210e-04  2.477e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.049e-02 3.521e-05 582.000 < 2e-16 ***  
## thetaS       6.295e-03 3.811e-05 165.192 < 2e-16 ***  
## rhoS        6.522e-06 3.753e-05   0.174   0.863  
## tmrcaS      4.575e-04 3.850e-05  11.884 8.84e-12 ***  
## thetaS:tmrcaS 1.915e-04 2.839e-05    6.744 4.55e-07 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001916 on 25 degrees of freedom  
## Multiple R-squared:  0.9992, Adjusted R-squared:  0.9991  
## F-statistic:  8277 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.146913  1.112350  1.170471   1.295650
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 4] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

```

```

##          df      AIC
## g.div.1Mb.1 8 -420.0970
## g.div.1Mb.2 8 -430.0628
## g.div.1Mb.3 7 -422.3985
## g.div.1Mb.4 7 -419.9326
summary(g.div.1Mb.4)

```

```

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC    logLik
## -419.9326 -410.1242 216.9663
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## -0.002887823
##
## Coefficients:
##             Value     Std.Error  t-value p-value
## (Intercept) 0.020490280 3.520910e-05 581.9597 0.0000
## thetaS       0.006294848 3.811164e-05 165.1687 0.0000
## rhoS        0.000006509 3.751282e-05   0.1735 0.8636
## tmrcaS      0.000457503 3.841775e-05  11.9086 0.0000
## thetaS:tmrcaS 0.000191433 2.831182e-05    6.7616 0.0000
##
## Correlation:

```

```

##          (Intr) thetaS rhoS   tmrcaS
## thetaS      0.027
## rhoS      -0.024  0.158
## tmrcaS      0.038 -0.068 -0.186
## thetaS:tmrcaS -0.113 -0.252  0.215 -0.338
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.2965105 -0.3740540  0.1192442  0.6937372  1.4084158
##
## Residual standard error: 0.0001746699
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.4)

##      thetaS        rhoS        tmrcaS thetaS:tmrcaS
## 1.148594     1.112871     1.171324     1.297814

```

1.3.5 Replicate 5

```

rep_5.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/rep_5.pi.1Mb.bedgraph", header = FALSE)
rep_5.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_5/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_5.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_5.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 4438, p-value = 0.9476
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.01268076

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca

```

```

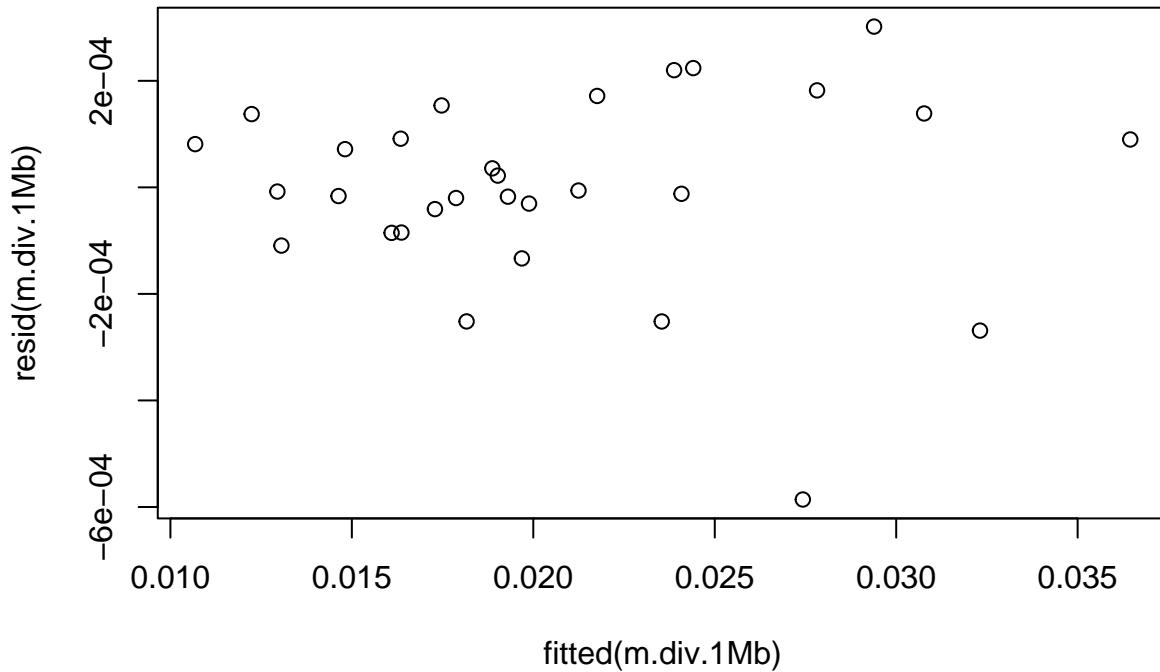
## S = 4306, p-value = 0.8252
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.04204672
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep5 <- sim.lands.1Mb
sim.lands.1Mb.rep5$Replicate <- 5

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

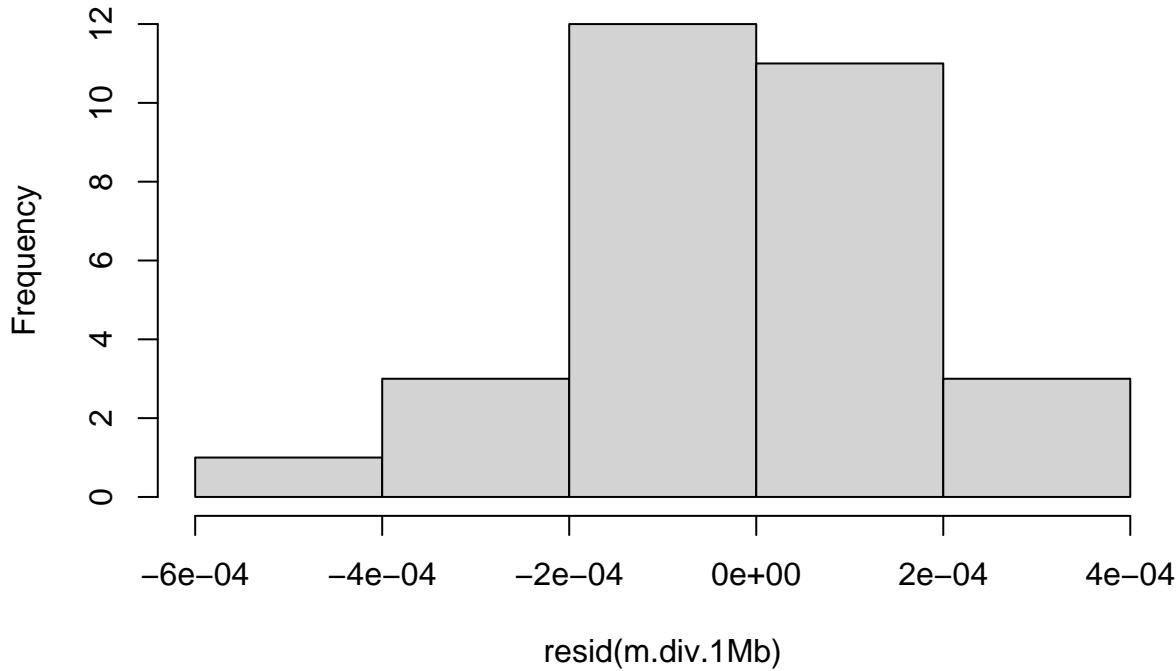
##
## Durbin-Watson test
##
## data: m.div.1Mb
## DW = 1.9571, p-value = 0.43
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)

##
## Harrison-McCabe test
##
## data: m.div.1Mb

```

```
## HMC = 0.35533, p-value = 0.123
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -5.859e-04 -7.379e-05 -6.890e-06  1.260e-04  3.018e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.060e-02 3.534e-05 582.791 < 2e-16 ***
## thetaS       6.371e-03 3.829e-05 166.389 < 2e-16 ***
## rhoS        -2.259e-05 3.696e-05 -0.611   0.5467
## tmrcaS      4.195e-04 3.599e-05 11.655 1.34e-11 ***
## thetaS:tmrcaS 9.237e-05 4.113e-05  2.246   0.0338 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001933 on 25 degrees of freedom
## Multiple R-squared:  0.9992, Adjusted R-squared:  0.9991
## F-statistic: 7809 on 4 and 25 DF,  p-value: < 2.2e-16
```

```

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.137681      1.060240      1.005247      1.119618

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 5] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df          AIC
## g.div.1Mb.1 8 -426.5967
## g.div.1Mb.2 8 -432.5907
## g.div.1Mb.3 7 -432.4836
## g.div.1Mb.4 7 -428.1764
summary(g.div.1Mb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##           AIC      BIC    logLik
##     -426.5967 -415.3871 221.2984
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##           Phi
##     -0.1465999
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##           power
##     -0.4495461
##

```

```

## Coefficients:
##                               Value    Std.Error  t-value p-value
## (Intercept)      0.020626470 2.301799e-05 896.1022  0.000
## thetaS          0.006396805 2.714055e-05 235.6918  0.000
## rhoS           -0.000077352 2.814571e-05 -2.7483  0.011
## tmrcaS          0.000444662 1.983989e-05 22.4125  0.000
## thetaS:tmrcaS  0.000124837 2.423357e-05  5.1514  0.000
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS     -0.028
## rhoS      -0.129  0.307
## tmrcaS    -0.075  0.078  0.057
## thetaS:tmrcaS 0.105  0.321  0.059 -0.116
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.0184063 -0.5124464 -0.1590768  0.6853181  2.8726107
##
## Residual standard error: 0.0001141051
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.1)

##          thetaS         rhoS        tmrcaS thetaS:tmrcaS
##          1.244059      1.107252      1.029882      1.142506

```

1.3.6 Replicate 6

```

rep_6.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/rep_6.pi.1Mb.bedgraph", header = FALSE)
rep_6.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_6/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_6.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_6.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 3592, p-value = 0.2858
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## 0.2008899

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0

```

```

## sample estimates:
##      rho
## -0.257842
cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 4268, p-value = 0.7906
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.05050056

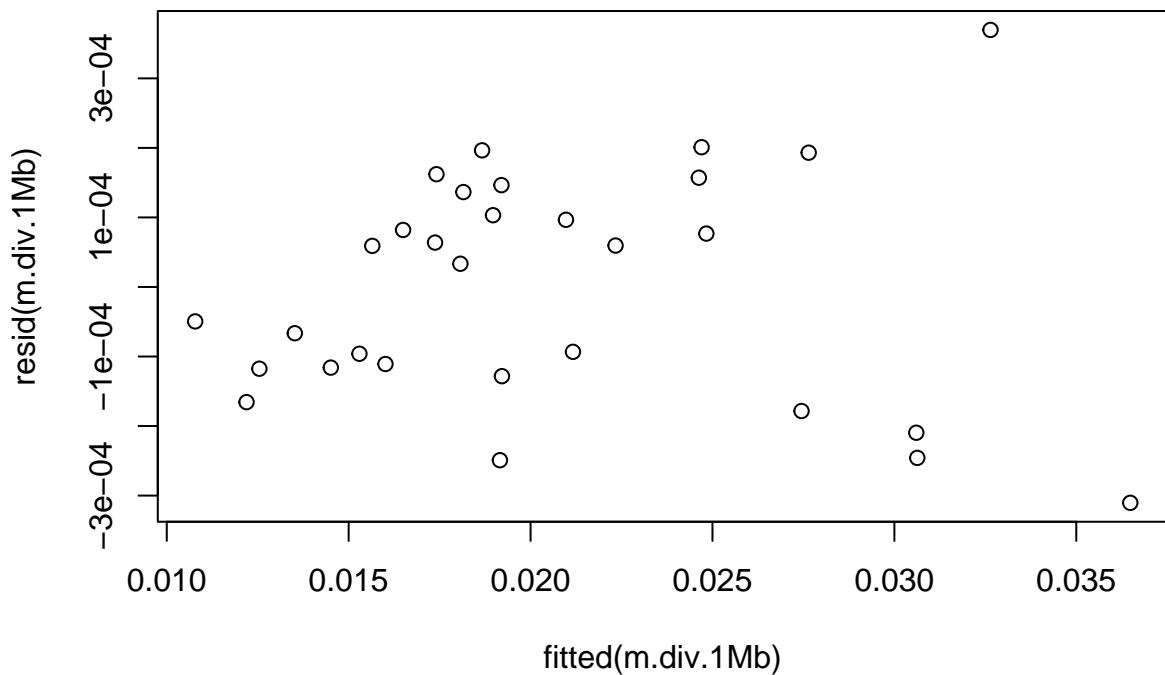
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep6 <- sim.lands.1Mb
sim.lands.1Mb.rep6$Replicate <- 6

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```
dwtest(m.div.1Mb)
```

```

##
## Durbin-Watson test
##
```

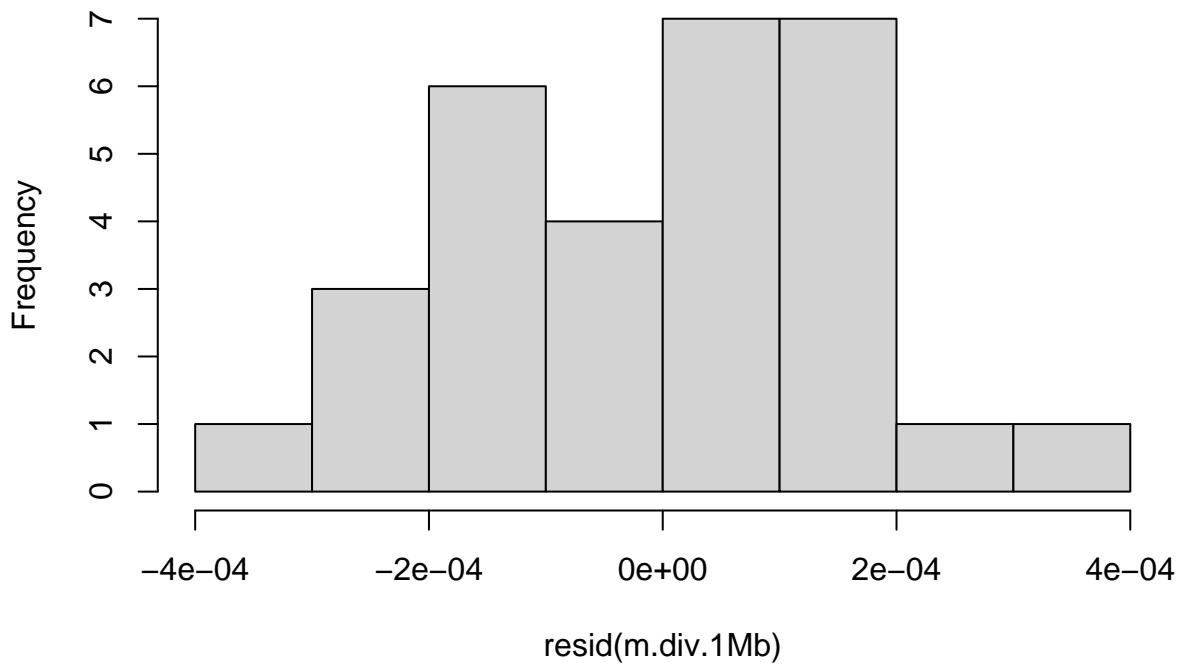
```

## data: m.div.1Mb
## DW = 1.956, p-value = 0.4515
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)

##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.62113, p-value = 0.821
hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = sim.lands.1Mb)
##
## Residuals:
##      Min        1Q        Median         3Q        Max 
## -3.104e-04 -1.172e-04  4.625e-05  1.282e-04  3.696e-04 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.055e-02 3.357e-05 612.052 < 2e-16 ***
## thetaS       6.365e-03 3.492e-05 182.260 < 2e-16 ***
## rhoS        4.494e-05 3.462e-05   1.298  0.20607  
## tmrcaS      3.544e-04 3.476e-05  10.193 2.18e-10 ***
## 
```

```

## thetaS:tmrcaS 1.391e-04  4.149e-05   3.353  0.00255 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000178 on 25 degrees of freedom
## Multiple R-squared:  0.9993, Adjusted R-squared:  0.9992
## F-statistic:  9504 on 4 and 25 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS            rhoS            tmrcaS    thetaS:tmrcaS
##        1.116973       1.097630       1.106634       1.052297

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 6] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
                      "ML")

g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
                      "ML")

g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")

g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -422.3762
## g.div.1Mb.2 8 -435.8602
## g.div.1Mb.3 7 -437.7991
## g.div.1Mb.4 7 -424.3752

summary(g.div.1Mb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC logLik
##     -422.3762 -411.1666 219.1881
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##           Phi
## -0.006382886

```

```

## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##      power
## 0.006258492
##
## Coefficients:
##              Value    Std.Error t-value p-value
## (Intercept) 0.020549063 3.337128e-05 615.7709 0.0000
## thetaS       0.006366035 3.491831e-05 182.3122 0.0000
## rhoS        0.000045112 3.464354e-05   1.3022 0.2047
## tmrcaS      0.000354487 3.500544e-05 10.1266 0.0000
## thetaS:tmrcaS 0.000139191 4.163166e-05   3.3434 0.0026
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.021
## rhoS      0.041  0.246
## tmrcaS    -0.045 -0.250 -0.174
## thetaS:tmrcaS -0.253 -0.088 -0.161  0.177
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -1.9233069 -0.7194018  0.2808678  0.7874012  2.2552045
##
## Residual standard error: 0.0001630107
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.117112     1.097722     1.105424     1.051631

```

1.3.7 Replicate 7

```

rep_7.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/rep_7.pi.1Mb.bedgraph", header = FALSE)
rep_7.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_7/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_7.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_7.tmrca.1Mb$tmrca))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 5750, p-value = 0.135
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.2791991

```

```

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 3620, p-value = 0.3013
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.1946607

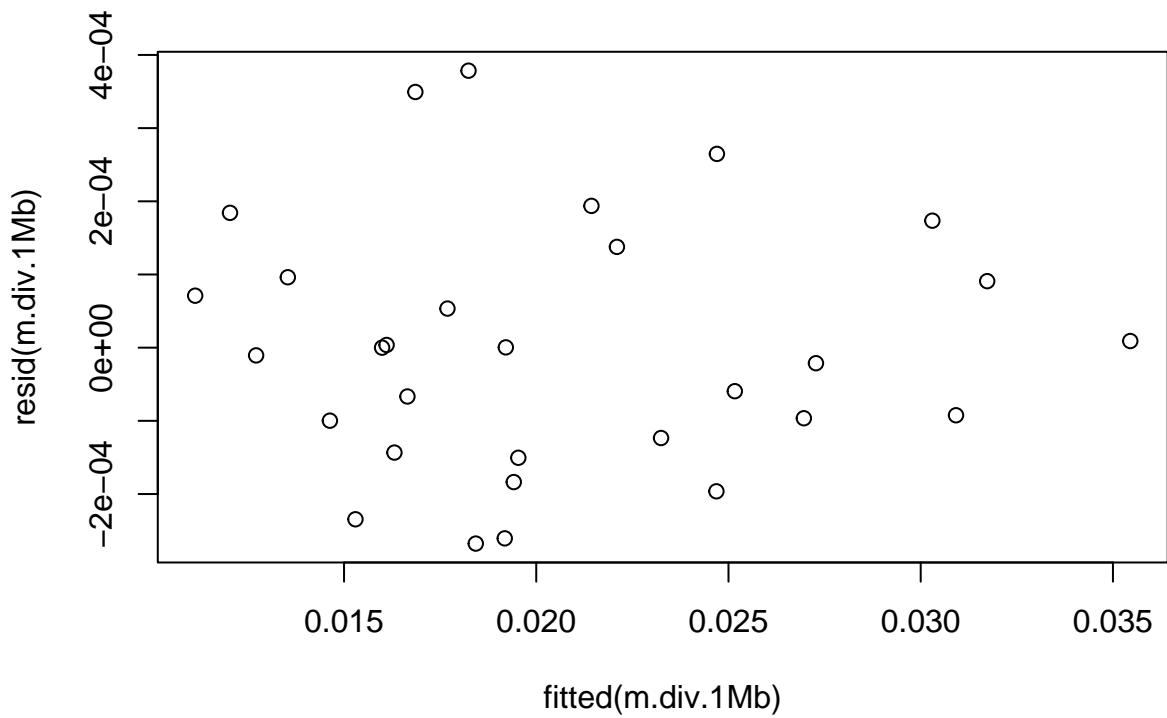
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep7 <- sim.lands.1Mb
sim.lands.1Mb.rep7$Replicate <- 7

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb)~fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
##  Durbin-Watson test
##
##  data:  m.div.1Mb
##  DW = 1.9852, p-value = 0.4718
##  alternative hypothesis: true autocorrelation is greater than 0

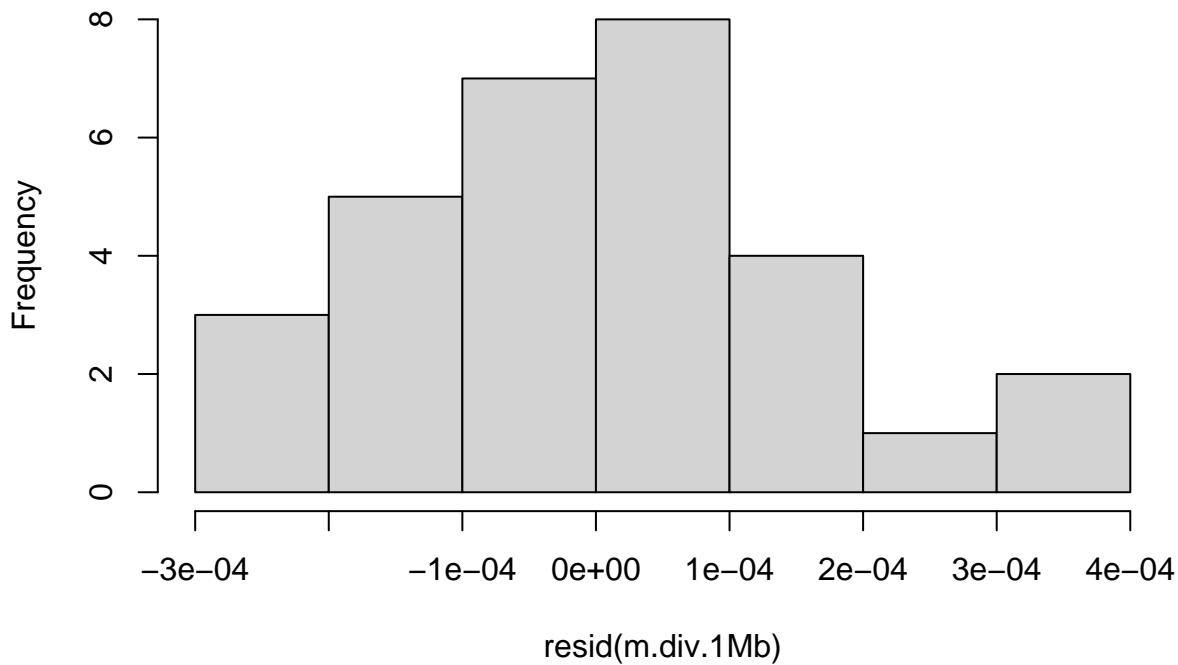
hmctest(m.div.1Mb)

##
##  Harrison-McCabe test
##
##  data:  m.div.1Mb
##  HMC = 0.65923, p-value = 0.878

hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = sim.lands.1Mb)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -2.677e-04 -1.175e-04 -5.270e-06  9.488e-05  3.785e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.060e-02 3.433e-05 599.990 < 2e-16 ***  
## thetaS       6.450e-03 3.767e-05 171.218 < 2e-16 ***  
## rhoS        -3.255e-05 3.520e-05 -0.925 0.363900  
## tmrcaS       5.480e-04 3.534e-05 15.507 2.47e-14 ***  
## thetaS:tmrcaS 1.411e-04 3.091e-05  4.565 0.000115 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001836 on 25 degrees of freedom  
## Multiple R-squared:  0.9993, Adjusted R-squared:  0.9991  
## F-statistic:  8510 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.220441    1.065300    1.073803    1.143527
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 7] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

```

```

##          df      AIC
## g.div.1Mb.1 8 -421.4162
## g.div.1Mb.2 8 -421.5957
## g.div.1Mb.3 7 -423.2877
## g.div.1Mb.4 7 -423.1728
summary(g.div.1Mb.4)

```

```

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC    logLik
## -423.1728 -413.3644 218.5864
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## -0.1283284
##
## Coefficients:
##              Value Std.Error t-value p-value
## (Intercept) 0.020601141 3.394087e-05 606.9716 0.0000
## thetaS       0.006444551 3.678745e-05 175.1834 0.0000
## rhoS        -0.000041269 3.464264e-05 -1.1913 0.2447
## tmrcaS       0.000546095 3.150710e-05 17.3324 0.0000
## thetaS:tmrcaS 0.000141443 2.805616e-05  5.0414 0.0000
##
## Correlation:

```

```

##          (Intr) thetaS rhoS   tmrcaS
## thetaS      0.117
## rhoS      -0.088  0.131
## tmrcaS     0.104  0.266 -0.039
## thetaS:tmrcaS  0.251  0.377 -0.177  0.117
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.86277907 -0.73676036 -0.06923575  0.58720299  2.24678713
##
## Residual standard error: 0.0001548854
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.4)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.305424    1.089254    1.082814    1.240657

```

1.3.8 Replicate 8

```

rep_8.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/rep_8.pi.1Mb.bedgraph", header = FALSE)
rep_8.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_8/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_8.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_8.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 4082, p-value = 0.628
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.09187987

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca

```

```

## S = 4888, p-value = 0.6448
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##          rho
## -0.08743048

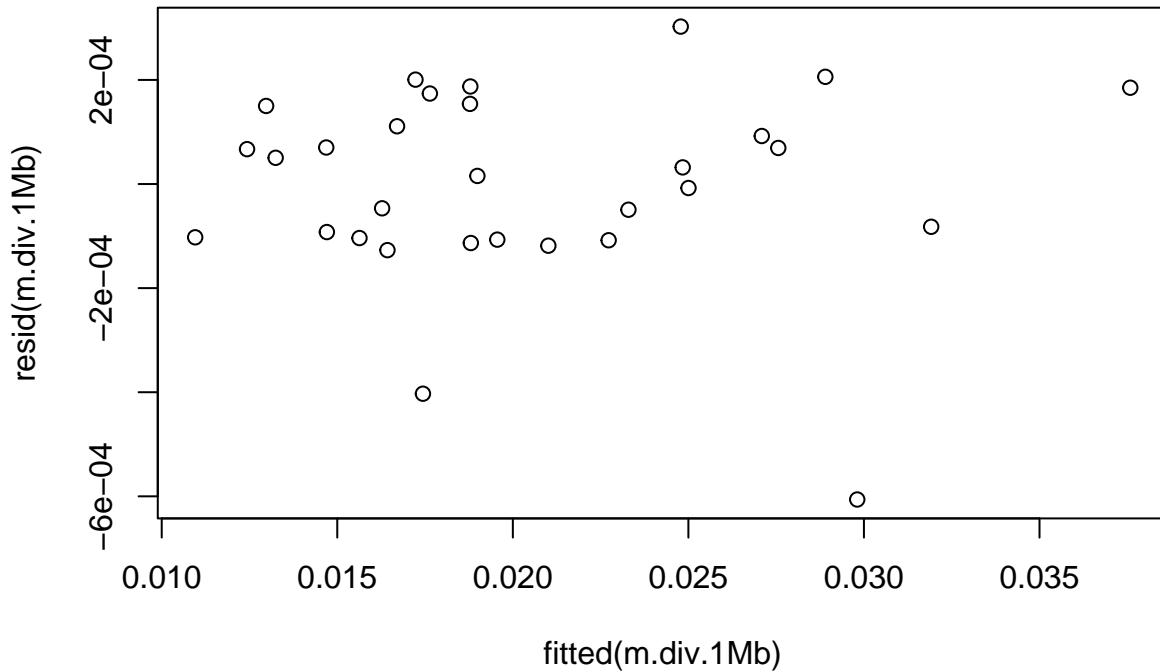
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep8 <- sim.lands.1Mb
sim.lands.1Mb.rep8$Replicate <- 8

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
## Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.4886, p-value = 0.9089
## alternative hypothesis: true autocorrelation is greater than 0

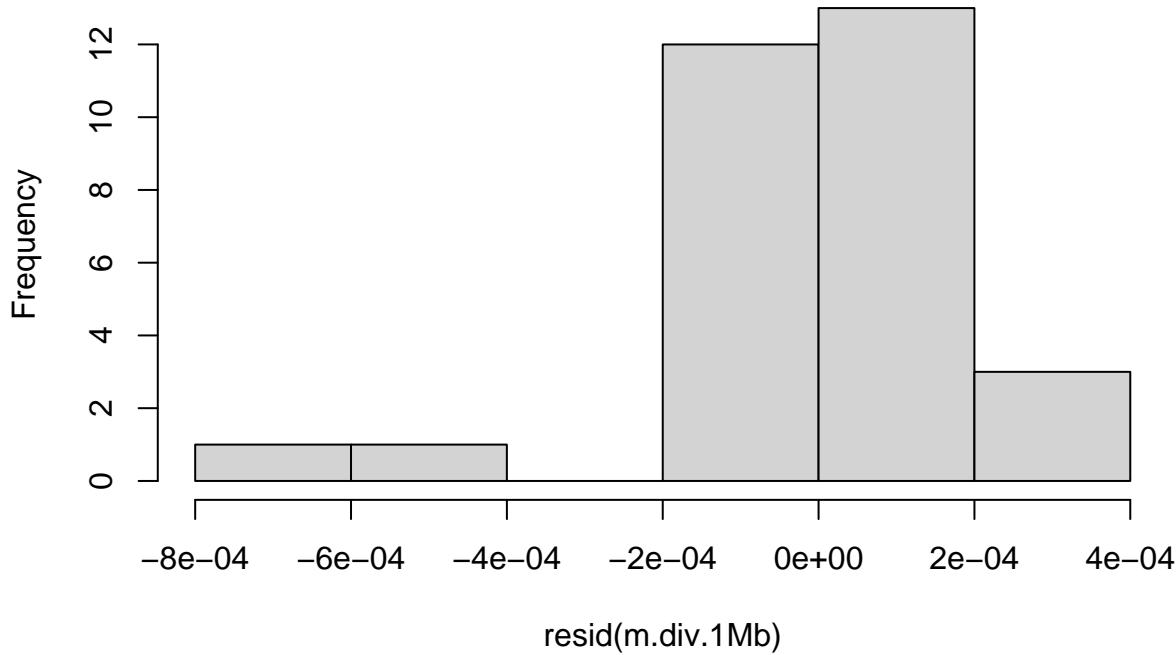
hmctest(m.div.1Mb)

##
## Harrison-McCabe test
##
## data: m.div.1Mb

```

```
## HMC = 0.6984, p-value = 0.955
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -6.061e-04 -1.034e-04  2.376e-05  1.402e-04  3.024e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.051e-02  3.685e-05 556.403 < 2e-16 ***
## thetaS       6.314e-03  3.861e-05 163.527 < 2e-16 ***
## rhoS        1.492e-05  3.797e-05   0.393  0.69767  
## tmrcaS       4.378e-04  3.748e-05 11.682 1.27e-11 ***
## thetaS:tmrcaS 1.607e-04  4.505e-05   3.567  0.00149 ** 
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0001996 on 25 degrees of freedom
## Multiple R-squared:  0.9992, Adjusted R-squared:  0.999 
## F-statistic: 7462 on 4 and 25 DF,  p-value: < 2.2e-16
```

```

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.085610     1.049827     1.022656     1.032819

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 8] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df          AIC
## g.div.1Mb.1 8 -419.3307
## g.div.1Mb.2 8 -425.0311
## g.div.1Mb.3 7 -423.7775
## g.div.1Mb.4 7 -418.2265
summary(g.div.1Mb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##           AIC      BIC    logLik
##       -425.0311 -413.8215 220.5155
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##           Phi
##       -0.3439154
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
## Parameter estimates:
##           power
##       1.019458
##

```

```

## Coefficients:
##                               Value    Std.Error  t-value p-value
## (Intercept)      0.020508031 2.684285e-05 764.0036 0.0000
## thetaS          0.006319064 3.395083e-05 186.1240 0.0000
## rhoS            0.000052279 2.824670e-05   1.8508 0.0760
## tmrcaS          0.000415615 3.643822e-05 11.4060 0.0000
## thetaS:tmrcaS  0.000115780 4.705211e-05   2.4607 0.0211
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS      0.579
## rhoS        0.016  0.225
## tmrcaS     -0.120 -0.191 -0.049
## thetaS:tmrcaS -0.265 -0.314 -0.026  0.579
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.5674791 -0.6450544  0.1946231  0.7321428  1.6314185
##
## Residual standard error: 0.01200832
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.2)

##           thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.170489      1.057535      1.506884      1.614438

```

1.3.9 Replicate 9

```

rep_9.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/rep_9.pi.1Mb.bedgraph", header = FALSE)
rep_9.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_9/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_9.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_9.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 3806, p-value = 0.4171
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.1532814

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0

```

```

## sample estimates:
##      rho
## -0.257842
cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  rho and tmrca
## S = 4996, p-value = 0.5562
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.1114572

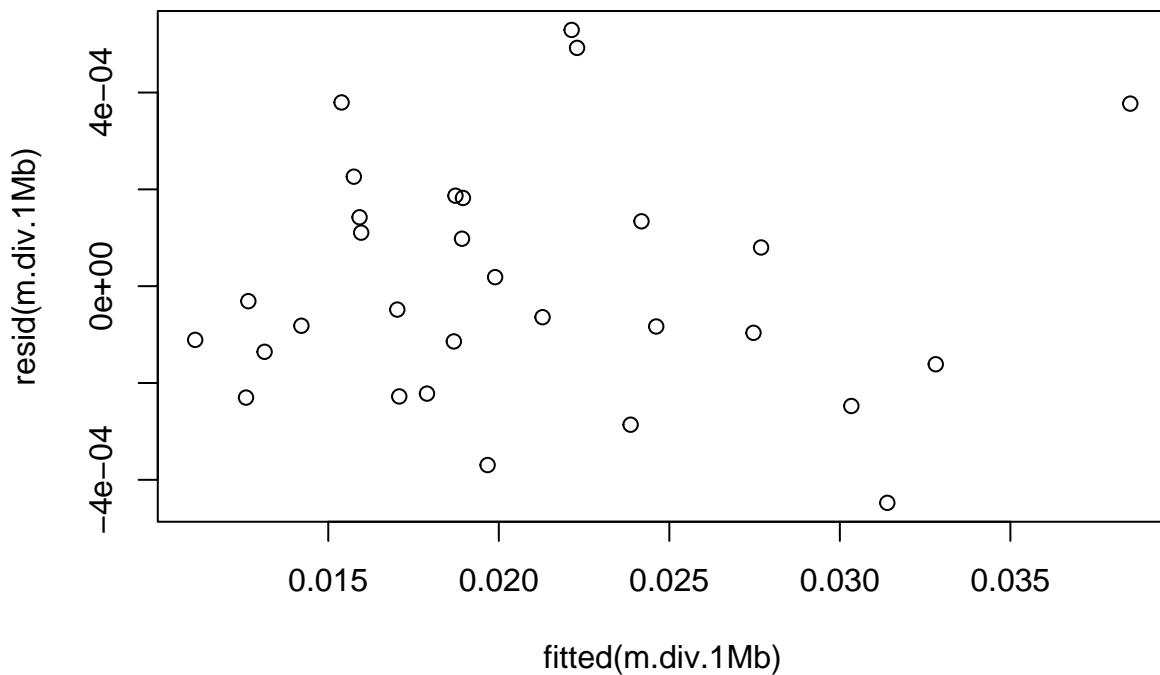
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep9 <- sim.lands.1Mb
sim.lands.1Mb.rep9$Replicate <- 9

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```
dwtest(m.div.1Mb)
```

```

##
##  Durbin-Watson test
##

```

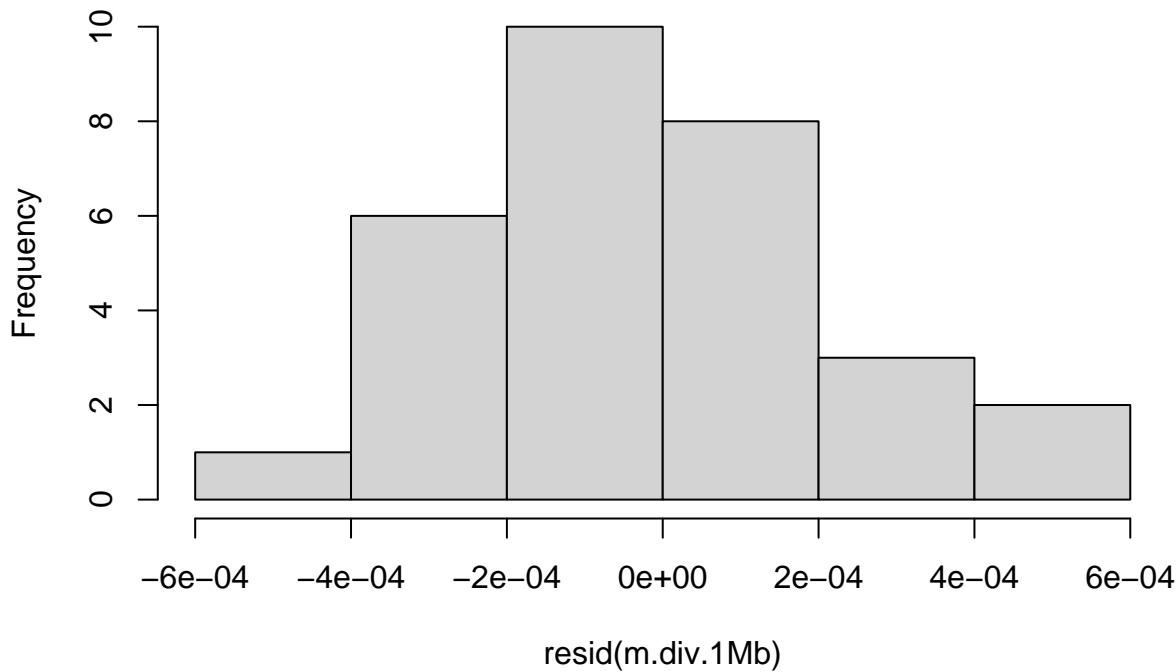
```

## data: m.div.1Mb
## DW = 2.2409, p-value = 0.7322
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)

##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.5612, p-value = 0.693
hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -0.0004475 -0.0001548 -0.0000562  0.0001403  0.0005293 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.064e-02 5.033e-05 410.041 < 2e-16 ***
## thetaS       6.419e-03 6.079e-05 105.593 < 2e-16 ***
## rhoS        2.282e-05 5.237e-05   0.436   0.6667  
## tmrcaS      4.840e-04 5.292e-05   9.145 1.89e-09 ***
## 
```

```

## thetaS:tmrcaS 1.178e-04  5.427e-05   2.171   0.0396 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000263 on 25 degrees of freedom
## Multiple R-squared:  0.9986, Adjusted R-squared:  0.9984
## F-statistic:  4623 on 4 and 25 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.549740     1.150241     1.174437     1.464009

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.sim.1Mb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 9] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method =
                      "ML")

g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method =
                      "ML")

g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")

g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -403.8020
## g.div.1Mb.2 8 -402.6954
## g.div.1Mb.3 7 -403.8074
## g.div.1Mb.4 7 -405.0982

summary(g.div.1Mb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC    logLik
##      -402.6954 -391.4858 209.3477
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##          Phi
## -0.1794151

```

```

## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##     power
## 0.9121804
##
## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020649482 4.435945e-05 465.5036 0.0000
## thetaS       0.006463656 5.531067e-05 116.8609 0.0000
## rhoS        0.000025176 4.658229e-05   0.5405 0.5937
## tmrcaS      0.000478715 5.132101e-05   9.3279 0.0000
## thetaS:tmrcaS 0.000091199 6.138883e-05   1.4856 0.1499
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.566
## rhoS        0.036  0.211
## tmrcaS     -0.101 -0.164  0.287
## thetaS:tmrcaS -0.343 -0.432 -0.072  0.335
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.6206636 -0.5774847 -0.1606134  0.7977722  2.1960400
##
## Residual standard error: 0.0106097
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.2)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.292757    1.186137    1.275994    1.357943

```

1.3.10 Replicate 10

```

rep_10.pi.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/rep_10.pi.1Mb.bedgraph", header = FALSE)
rep_10.tmrca.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims_2/rep_10/sim.tmrca.1M.map", header = FALSE)

sim.lands.1Mb <- as.data.frame(cbind(rep_10.pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_10.tmrca.1Mb))
names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

cor.test(~theta+tmrca, data = sim.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 4496, p-value = 1
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##     rho
## -0.0002224694

```

```

cor.test(~theta+rho, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: theta and rho
## S = 5654, p-value = 0.1684
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.257842

cor.test(~rho+tmrca, data = sim.lands.1Mb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 5530, p-value = 0.22
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## -0.2302558

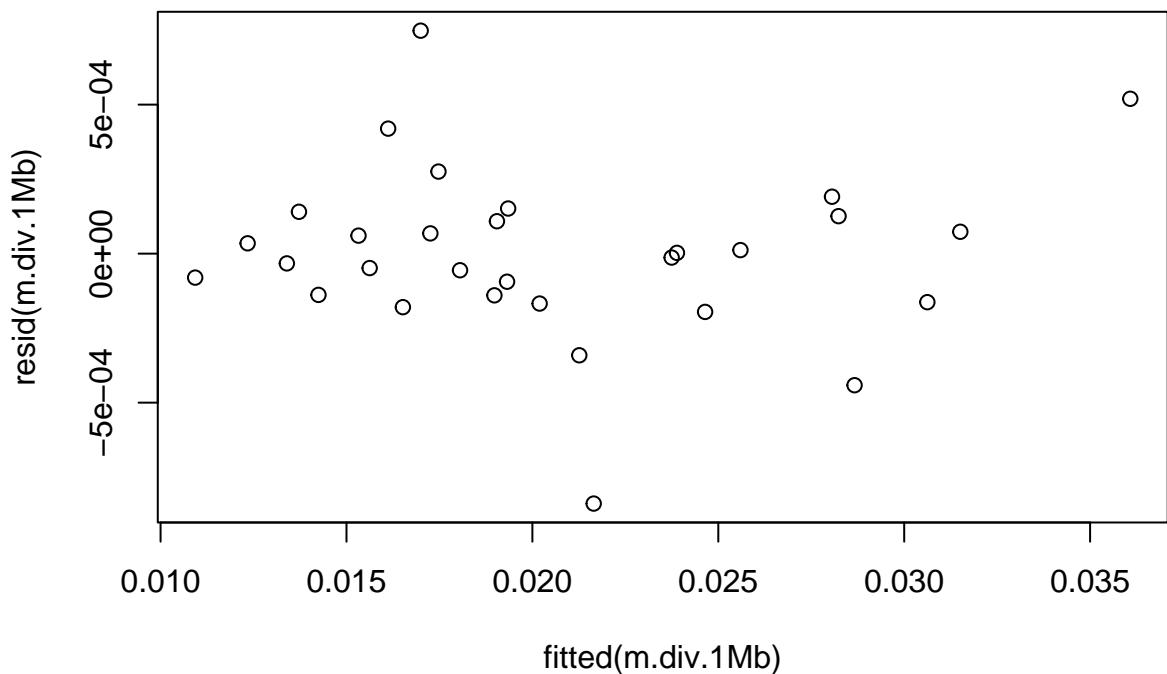
# standardizing
sim.lands.1Mb$thetaS <- (sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)) / sd(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaS <- (sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)) / sd(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoS <- (sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)) / sd(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

sim.lands.1Mb.rep10 <- sim.lands.1Mb
sim.lands.1Mb.rep10$Replicate <- 10

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = sim.lands.1Mb)
plot(resid(m.div.1Mb)~fitted(m.div.1Mb))

```

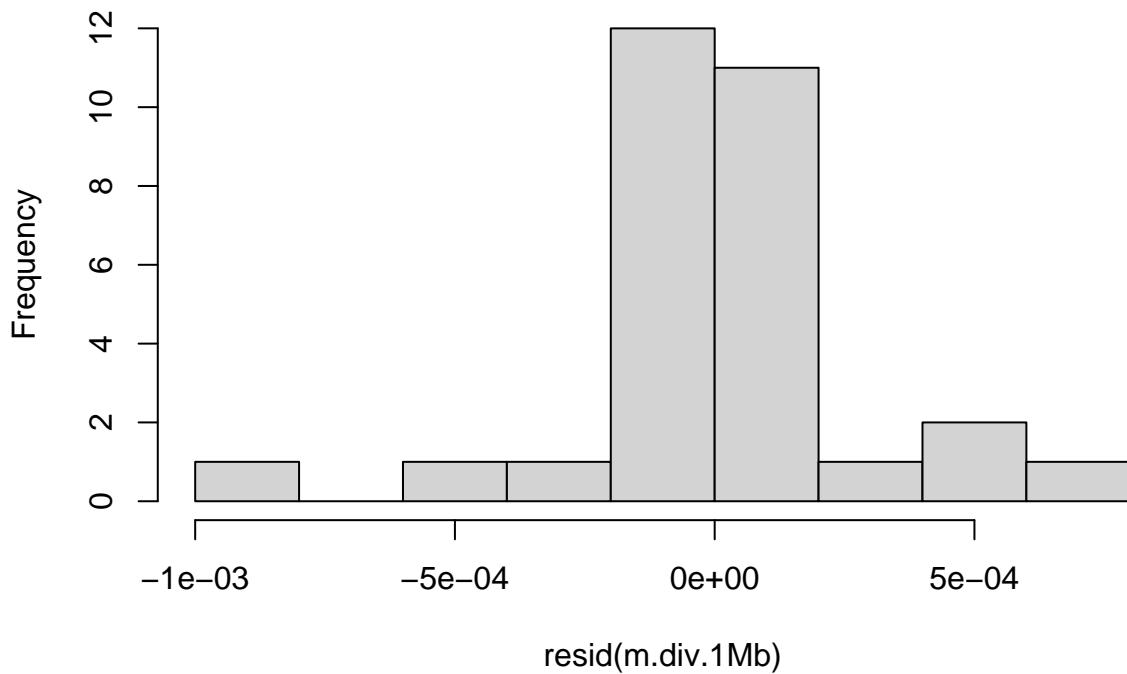


```
dwtest(m.div.1Mb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.2351, p-value = 0.7114
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.50343, p-value = 0.496
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = sim.lands.1Mb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -8.386e-04 -1.396e-04 -5.280e-06  1.214e-04  7.480e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.066e-02 5.729e-05 360.639 < 2e-16 ***
## thetaS       6.380e-03 6.210e-05 102.725 < 2e-16 ***
## rhoS        -5.882e-05 6.055e-05 -0.971  0.34066  
## tmrcaS       4.478e-04 5.987e-05  7.479  7.84e-08 ***
## thetaS:tmrcaS 1.834e-04 5.024e-05  3.651  0.00121 ** 
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003101 on 25 degrees of freedom
## Multiple R-squared:  0.9979, Adjusted R-squared:  0.9976 
## F-statistic: 2967 on 4 and 25 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.163460 1.106027 1.081379 1.089123
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.1Mb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.sim.1Mb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), method = "ML")

g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), cor = corAR1(0, ~bin), method = "ML")

g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~theta), method = "ML")

g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
                      data = sim.lands.1Mb, weights = varPower(0, ~tmrcaS), method = "ML")

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

```

```

##          df      AIC
## g.div.1Mb.1 8 -389.6526
## g.div.1Mb.2 8 -391.6273
## g.div.1Mb.3 7 -393.4571
## g.div.1Mb.4 7 -391.0588

summary(g.div.1Mb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: sim.lands.1Mb
##          AIC      BIC  logLik
## -389.6526 -378.443 202.8263
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##           Phi
## -0.1465639
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##           power
## -0.03572166
##

```

```

## Coefficients:
##                               Value    Std.Error  t-value p-value
## (Intercept)      0.020660956 4.989094e-05 414.1224 0.0000
## thetaS          0.006389856 5.920453e-05 107.9285 0.0000
## rhoS           -0.000060441 5.764661e-05 -1.0485 0.3045
## tmrcaS          0.000455826 5.641932e-05   8.0793 0.0000
## thetaS:tmrcaS  0.000182560 4.733635e-05   3.8567 0.0007
##
## Correlation:
##              (Intr) thetaS rhoS   tmrcaS
## thetaS      0.026
## rhoS       -0.010  0.233
## tmrcaS     0.004  0.269  0.196
## thetaS:tmrcaS 0.185  0.193 -0.107 0.028
##
## Standardized residuals:
##      Min        Q1        Med        Q3        Max
## -2.92030770 -0.46161928 -0.06569144  0.37557798  2.67951305
##
## Residual standard error: 0.0002767048
## Degrees of freedom: 30 total; 25 residual
vif(g.div.1Mb.1)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.175442     1.106886     1.100012     1.065755

```

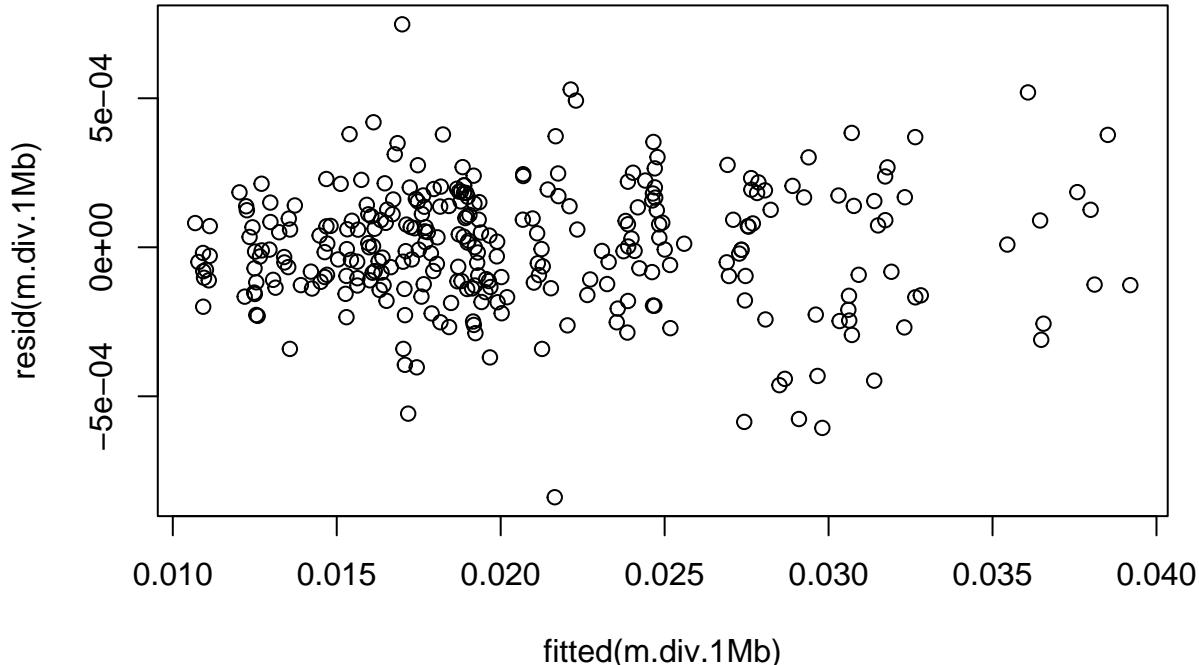
1.3.11 all replicates:

```

sim.lands.1Mb.all <- rbind(sim.lands.1Mb.rep1, sim.lands.1Mb.rep2, sim.lands.1Mb.rep3, sim.lands.1Mb.rep4)

m.div.1Mb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)*as.factor(Replicate), data = sim.lands.1Mb.all)
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.2218, p-value = 0.8988
## alternative hypothesis: true autocorrelation is greater than 0

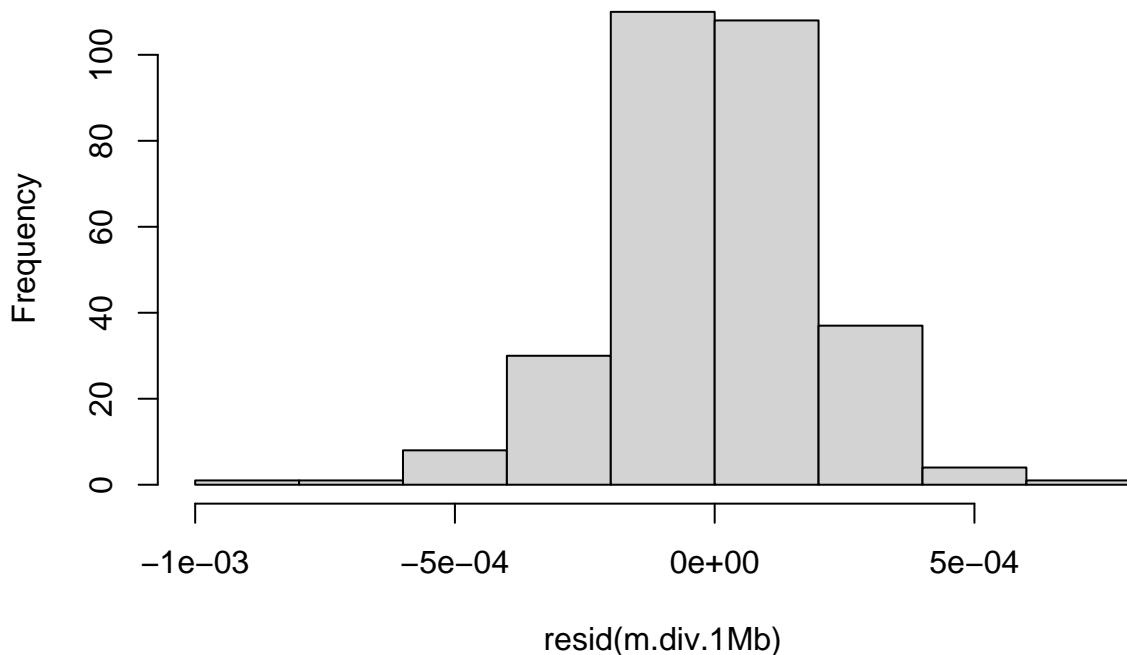
hmctest(m.div.1Mb)

##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.44776, p-value = 0.097

hist(resid(m.div.1Mb))

```

Histogram of resid(m.div.1Mb)



```

m.div.1Mb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replicate)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as.f

```

```

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

```

```

##          df      AIC
## m.div.1Mb 51 -4150.862
## m.div.1Mb.2 61 -4156.386
## m.div.1Mb.3 71 -4142.940

```

```

summary(m.div.1Mb)

```

```

##

```

```

## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##      as.factor(Replicate), data = sim.lands.1Mb.all)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -8.386e-04 -1.236e-04 -2.970e-06  1.379e-04  7.480e-04
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)    
## (Intercept)                2.067e-02  4.041e-05 511.490 < 2e-16 ***
## thetaS                     6.406e-03  4.592e-05 139.502 < 2e-16 ***
## rhoS                      -1.598e-06 4.353e-05 -0.037  0.97075  
## tmrcaS                     3.863e-04  4.183e-05  9.235 < 2e-16 ***
## as.factor(Replicate)2      -1.518e-04 5.745e-05 -2.642  0.00877 ** 
## as.factor(Replicate)3      3.579e-05  5.991e-05  0.597  0.55082  
## as.factor(Replicate)4      -1.782e-04 5.733e-05 -3.108  0.00210 ** 
## as.factor(Replicate)5      -7.055e-05 5.719e-05 -1.234  0.21845  
## as.factor(Replicate)6      -1.201e-04 5.811e-05 -2.066  0.03981 *  
## as.factor(Replicate)7      -7.130e-05 5.783e-05 -1.233  0.21877  
## as.factor(Replicate)8      -1.625e-04 5.748e-05 -2.827  0.00507 ** 
## as.factor(Replicate)9      -3.009e-05 5.854e-05 -0.514  0.60771  
## as.factor(Replicate)10     -8.475e-06 5.749e-05 -0.147  0.88293  
## thetaS:tmrcaS              8.560e-05  4.432e-05  1.931  0.05458 .  
## thetaS:as.factor(Replicate)2 -1.363e-04 6.347e-05 -2.148  0.03269 *  
## thetaS:as.factor(Replicate)3 6.285e-05  6.518e-05  0.964  0.33591  
## thetaS:as.factor(Replicate)4 -1.114e-04 6.361e-05 -1.751  0.08119 .  
## thetaS:as.factor(Replicate)5 -3.527e-05 6.349e-05 -0.556  0.57902  
## thetaS:as.factor(Replicate)6 -4.112e-05 6.321e-05 -0.651  0.51596  
## thetaS:as.factor(Replicate)7 4.372e-05  6.458e-05  0.677  0.49902  
## thetaS:as.factor(Replicate)8 -9.221e-05 6.279e-05 -1.469  0.14321  
## thetaS:as.factor(Replicate)9 1.277e-05  6.875e-05  0.186  0.85283  
## thetaS:as.factor(Replicate)10 -2.675e-05 6.383e-05 -0.419  0.67554  
## rhoS:as.factor(Replicate)2  -2.832e-05 6.119e-05 -0.463  0.64390  
## rhoS:as.factor(Replicate)3  4.183e-05  6.115e-05  0.684  0.49461  
## rhoS:as.factor(Replicate)4  8.119e-06  6.143e-05  0.132  0.89496  
## rhoS:as.factor(Replicate)5  -2.099e-05 6.071e-05 -0.346  0.72985  
## rhoS:as.factor(Replicate)6  4.654e-05  6.123e-05  0.760  0.44789  
## rhoS:as.factor(Replicate)7  -3.095e-05 6.078e-05 -0.509  0.61103  
## rhoS:as.factor(Replicate)8  1.652e-05  6.057e-05  0.273  0.78527  
## rhoS:as.factor(Replicate)9  2.442e-05  6.195e-05  0.394  0.69378  
## rhoS:as.factor(Replicate)10 -5.722e-05 6.134e-05 -0.933  0.35182  
## tmrcaS:as.factor(Replicate)2 5.318e-05  6.093e-05  0.873  0.38365  
## tmrcaS:as.factor(Replicate)3 1.700e-04  6.236e-05  2.725  0.00688 ** 
## tmrcaS:as.factor(Replicate)4 7.119e-05  6.105e-05  1.166  0.24469  
## tmrcaS:as.factor(Replicate)5 3.317e-05  5.872e-05  0.565  0.57267  
## tmrcaS:as.factor(Replicate)6 -3.197e-05 6.016e-05 -0.531  0.59558  
## tmrcaS:as.factor(Replicate)7 1.617e-04  5.970e-05  2.708  0.00724 ** 
## tmrcaS:as.factor(Replicate)8 5.150e-05  5.897e-05  0.873  0.38337  
## tmrcaS:as.factor(Replicate)9 9.763e-05  6.110e-05  1.598  0.11137  
## tmrcaS:as.factor(Replicate)10 6.147e-05  5.980e-05  1.028  0.30498  
## thetaS:tmrcaS:as.factor(Replicate)2 1.176e-04  6.050e-05  1.945  0.05294 .  
## thetaS:tmrcaS:as.factor(Replicate)3 1.435e-04  7.227e-05  1.986  0.04809 *  
## thetaS:tmrcaS:as.factor(Replicate)4 1.059e-04  5.513e-05  1.920  0.05597 .

```

```

## thetaS:tmrcaS:as.factor(Replicate)5  6.767e-06  6.467e-05  0.105  0.91675
## thetaS:tmrcaS:as.factor(Replicate)6  5.354e-05  6.803e-05  0.787  0.43203
## thetaS:tmrcaS:as.factor(Replicate)7  5.548e-05  5.790e-05  0.958  0.33889
## thetaS:tmrcaS:as.factor(Replicate)8  7.509e-05  6.679e-05  1.124  0.26196
## thetaS:tmrcaS:as.factor(Replicate)9  3.221e-05  6.365e-05  0.506  0.61325
## thetaS:tmrcaS:as.factor(Replicate)10 9.784e-05  5.702e-05  1.716  0.08738 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002213 on 250 degrees of freedom
## Multiple R-squared:  0.999, Adjusted R-squared:  0.9988
## F-statistic:  4956 on 49 and 250 DF,  p-value: < 2.2e-16

```

2 Drosophila-like neutral simulations of chr 2L (Inferred Landscapes)

First batch of 10 replicate datasets simulated using parameters as inferred from real Drosophila data.

Here we present results using genomic landscapes are inferred by iSMC

2.1 50 kb scale

```

r2.inf.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.inf.50kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.inf.50kb) <- reps

# sim landscapes
sim.rho.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.rho.50000.txt")
sim.theta.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.theta.50000.txt")
sim.lands.50kb <- as.data.frame(cbind(sim.theta.50kb$sim, sim.rho.50kb$sim))
names(sim.lands.50kb ) <- c("theta", "rho")

```

2.1.1 Replicate 1

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_1/rs.pair_1.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

inf.lands.50kb.rep_1 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_1) <- c("diversity", "theta", "rho", "tmrca")

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 781576, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0

```

```

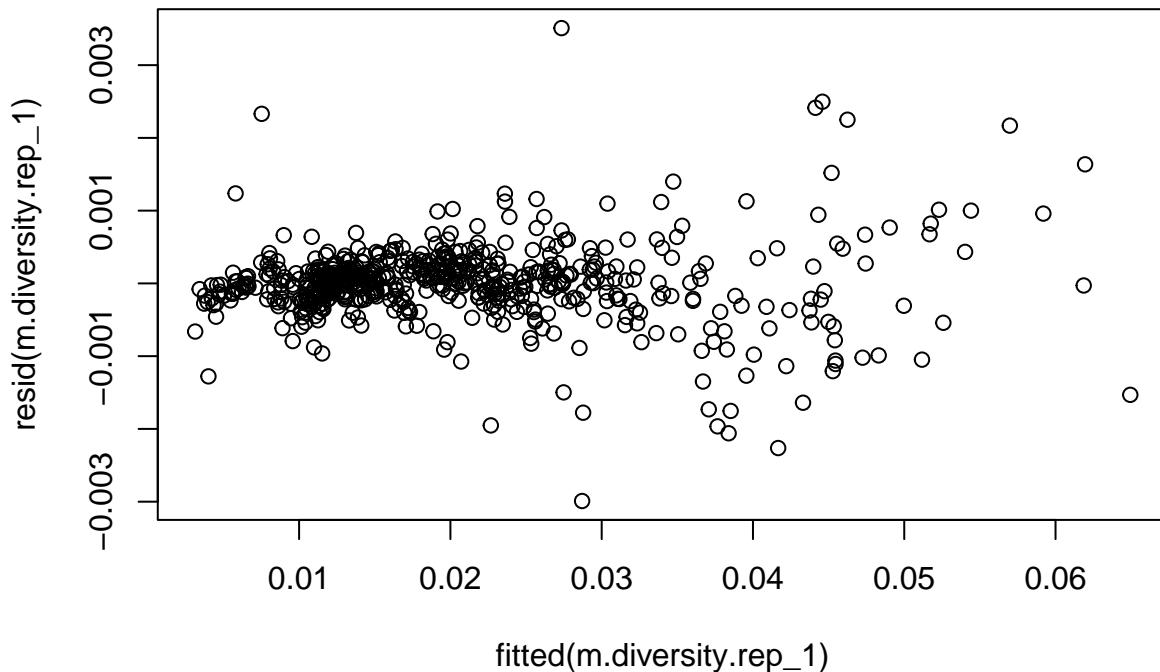
## sample estimates:
##      rho
## 0.9782895
# standardizing
inf.lands.50kb.rep_1$thetaS <- (inf.lands.50kb.rep_1$theta - mean(inf.lands.50kb.rep_1$theta)) / sd(inf.lands.50kb.rep_1$theta)
inf.lands.50kb.rep_1$tmrcaS <- (inf.lands.50kb.rep_1$tmrca - mean(inf.lands.50kb.rep_1$tmrca)) / sd(inf.lands.50kb.rep_1$tmrca)
inf.lands.50kb.rep_1$rhoS <- (inf.lands.50kb.rep_1$rho - mean(inf.lands.50kb.rep_1$rho)) / sd(inf.lands.50kb.rep_1$rho)

inf.lands.50kb.rep_1$bin <- 1:nrow(inf.lands.50kb.rep_1)
inf.lands.50kb.rep_1$Replicate <- 1

m.diversity.rep_1 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_1)

plot(resid(m.diversity.rep_1) ~ fitted(m.diversity.rep_1))

```



```

dwtest(m.diversity.rep_1)

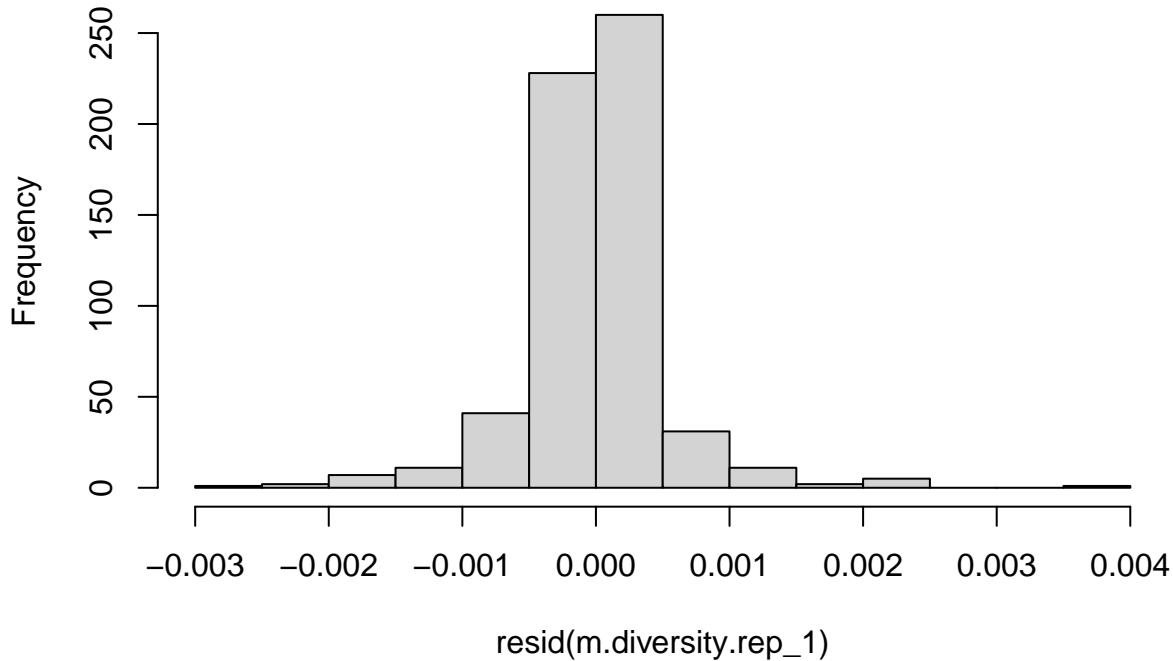
##
## Durbin-Watson test
##
## data: m.diversity.rep_1
## DW = 1.4157, p-value = 2.024e-13
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_1)

##
## Harrison-McCabe test
##
## data: m.diversity.rep_1
## HMC = 0.61568, p-value = 1

```

```
hist(resid(m.diversity.rep_1))
```

Histogram of resid(m.diversity.rep_1)



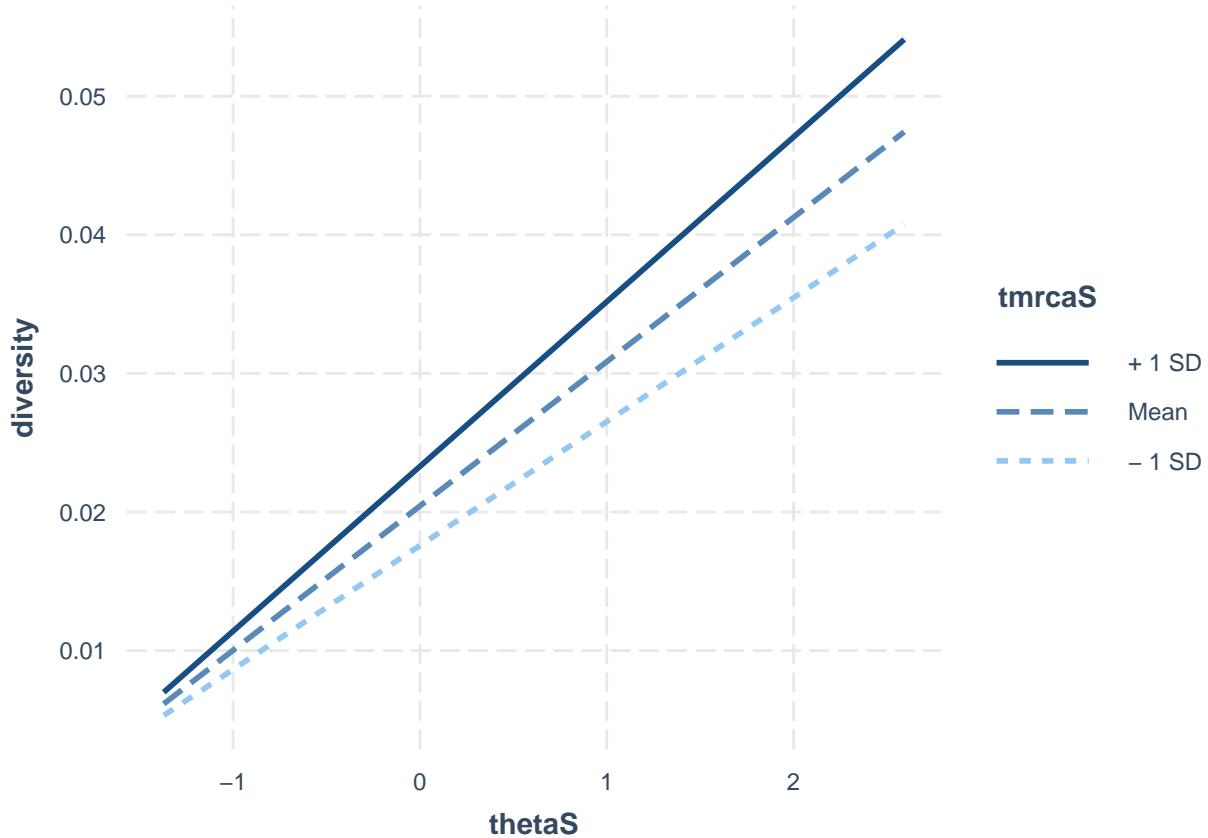
```
summary(m.diversity.rep_1)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_1)  
##  
## Residuals:  
##       Min         1Q     Median         3Q        Max  
## -0.0029908 -0.0002117  0.0000130  0.0001979  0.0035089  
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.043e-02 2.236e-05 913.668 <2e-16 ***  
## thetaS       1.041e-02 2.246e-05 463.564 <2e-16 ***  
## rhoS        -5.658e-06 2.228e-05 -0.254    0.8  
## tmrcaS       2.854e-03 2.312e-05 123.483 <2e-16 ***  
## thetaS:tmrcaS 1.473e-03 2.126e-05 69.290 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005436 on 595 degrees of freedom  
## Multiple R-squared:  0.9977, Adjusted R-squared:  0.9977  
## F-statistic: 6.386e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_1)
```

```
##          thetaS          rhoS          tmrcaS  thetaS:tmrcaS
```

```
##      1.022723      1.005959      1.082987      1.064617
interact_plot(m.diversity.rep_1, pred = thetaS, modx= tmrcaS)
```



```
g.rep_1 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_1, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_1)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_1
##          AIC      BIC    logLik
##     -7367.645 -7336.866 3690.822
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.3212747
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020438810 3.125509e-05 653.9355 0.0000
## thetaS       0.010435258 2.837609e-05 367.7482 0.0000
## tmrcaS       0.002817637 2.481844e-05 113.5300 0.0000
## rhoS         0.0000004491 2.161341e-05   0.2078 0.8355
## thetaS:tmrcaS 0.001426645 2.293513e-05  62.2035 0.0000
```

```

## Correlation:
##          (Intr) thetaS tmrcaS rhoS
## thetaS      0.010
## tmrcaS     -0.018 -0.155
## rhoS       -0.003  0.009  0.012
## thetaS:tmrcaS -0.096 -0.101  0.181  0.042
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -5.45341396 -0.37367657  0.05022105  0.36056906  6.43069153
##
## Residual standard error: 0.000544344
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_1)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.030576     1.054551    1.001941     1.041465

g.rep_1.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_1, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_1.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_1
##      AIC      BIC      logLik
## -5449.253 -5427.268 2729.626
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.5079669
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020632135 0.0002124018 97.13730 0.0000
## thetaS       0.011230411 0.0001619026 69.36522 0.0000
## rhoS        0.000007276 0.0001032089  0.07050 0.9438
##
## Correlation:
##          (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.003
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.88116216 -0.45332037  0.04478515  0.48762545  4.98107994
##
## Residual standard error: 0.002969561
## Degrees of freedom: 600 total; 597 residual

```

```

anova.diversity <- Anova(m.diversity.rep_1)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 1] <- anova.diversity$VarExp[4] * 100

```

2.1.2 Replicate 2

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_2/rs.pair_2.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 557174, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9845229

inf.lands.50kb.rep_2 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_2) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_2$thetaS <- (inf.lands.50kb.rep_2$theta - mean(inf.lands.50kb.rep_2$theta)) / sd(inf.lands.50kb.rep_2$theta)
inf.lands.50kb.rep_2$tmrcaS <- (inf.lands.50kb.rep_2$tmrca - mean(inf.lands.50kb.rep_2$tmrca)) / sd(inf.lands.50kb.rep_2$tmrca)
inf.lands.50kb.rep_2$rhoS <- (inf.lands.50kb.rep_2$rho - mean(inf.lands.50kb.rep_2$rho)) / sd(inf.lands.50kb.rep_2$rho)

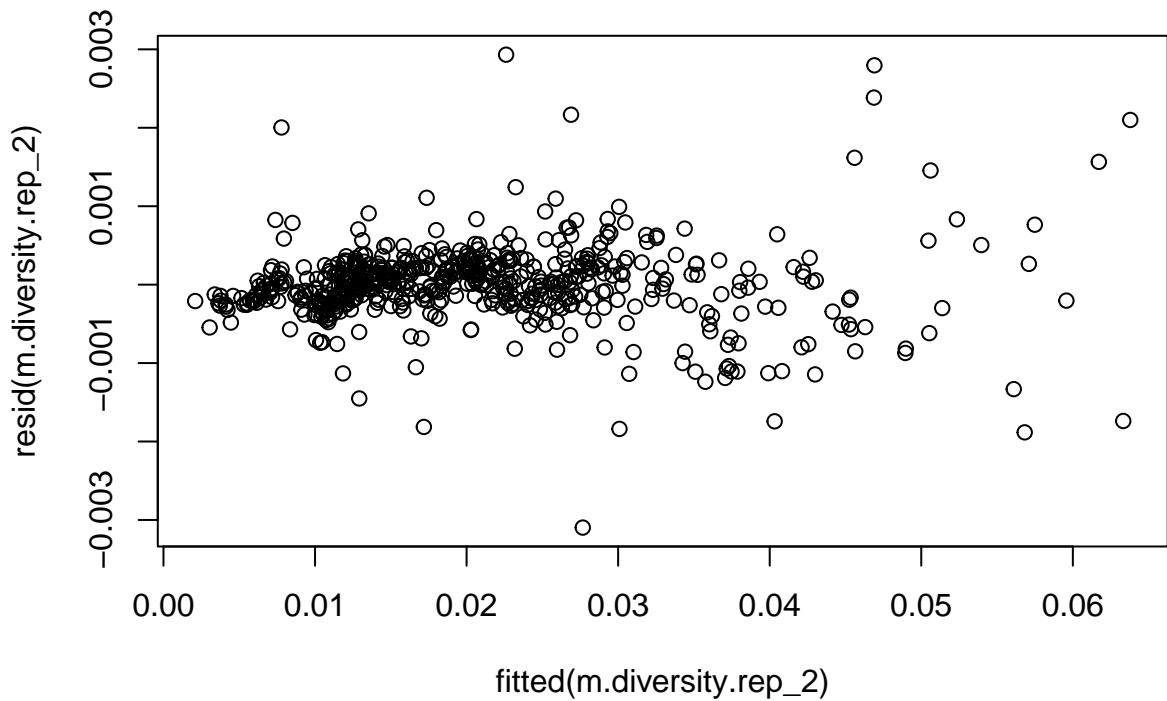
inf.lands.50kb.rep_2$bin <- 1:nrow(inf.lands.50kb.rep_2)

inf.lands.50kb.rep_2$Replicate <- 2

m.diversity.rep_2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_2)

plot(resid(m.diversity.rep_2) ~ fitted(m.diversity.rep_2))

```

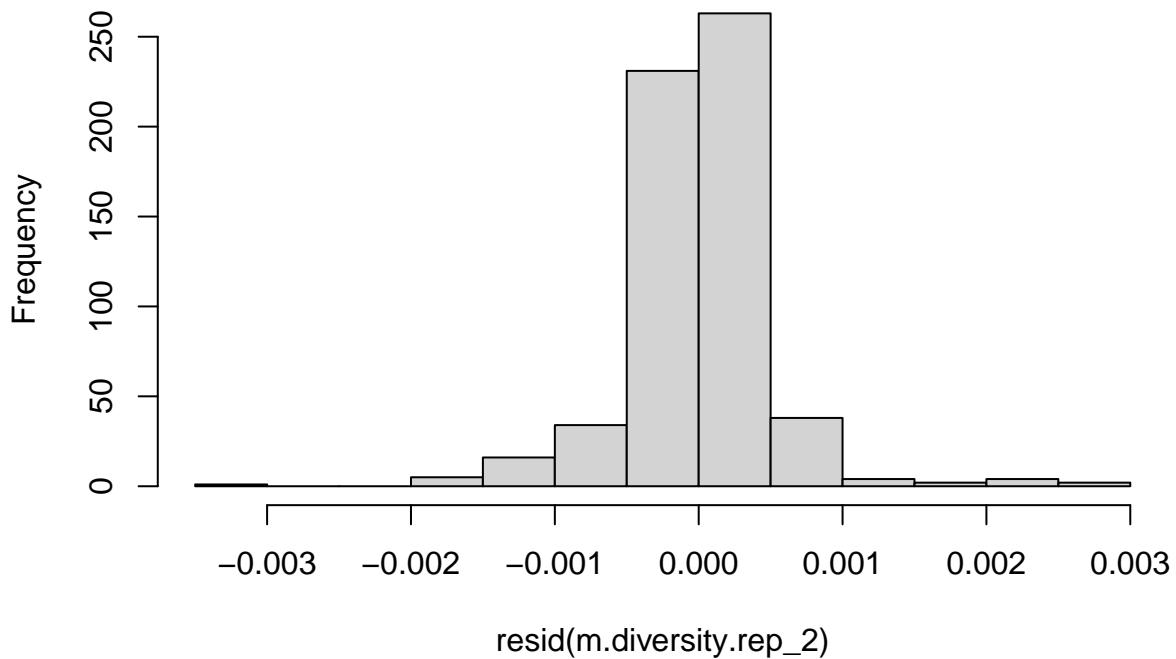


```
dwtest(m.diversity.rep_2)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_2
## DW = 1.3609, p-value = 1.173e-15
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_2)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_2
## HMC = 0.61478, p-value = 1
hist(resid(m.diversity.rep_2))
```

Histogram of resid(m.diversity.rep_2)



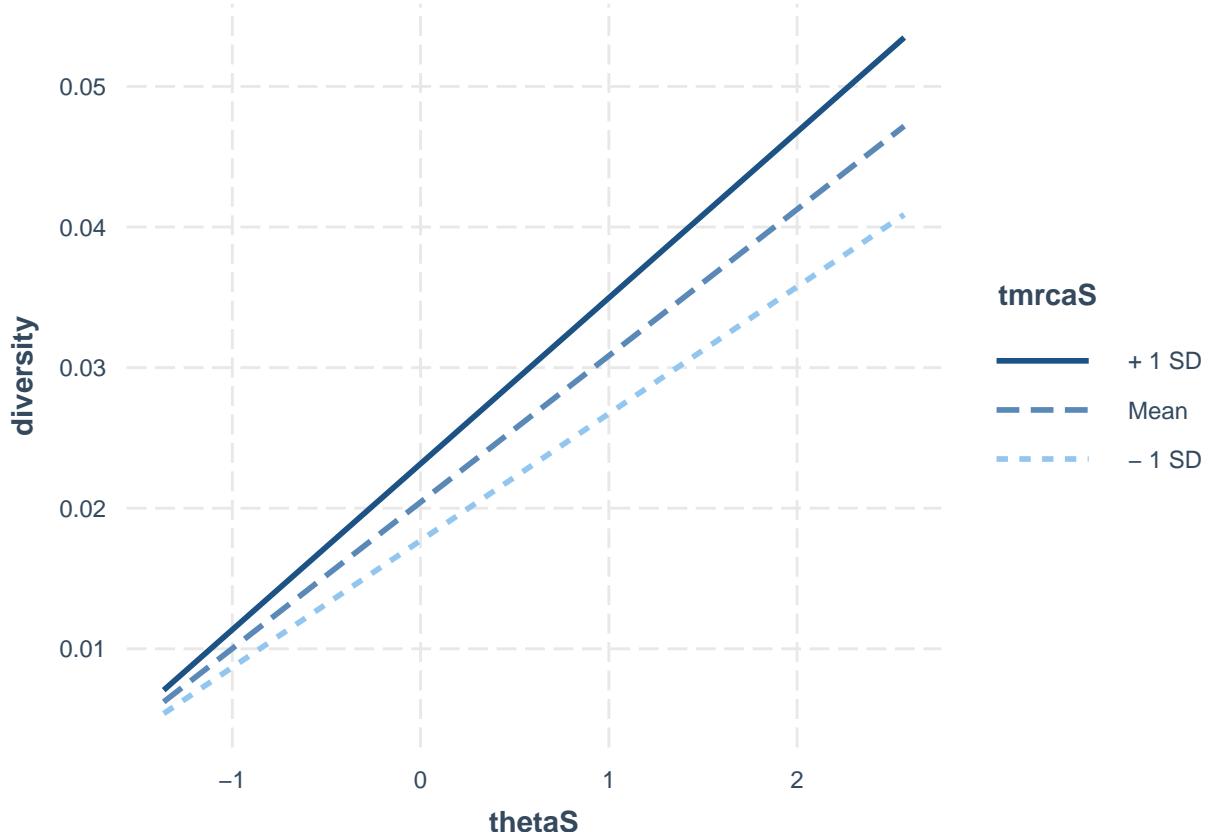
```
summary(m.diversity.rep_2)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.50kb.rep_2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -3.097e-03 -2.018e-04  1.307e-05  2.192e-04  2.932e-03
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.043e-02 2.069e-05 987.265 <2e-16 ***
## thetaS       1.041e-02 2.075e-05 501.668 <2e-16 ***
## rhoS        -1.464e-05 2.069e-05 -0.708  0.479    
## tmrcaS       2.728e-03 2.141e-05 127.438 <2e-16 ***
## thetaS:tmrcaS 1.389e-03 1.785e-05 77.841 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0005043 on 595 degrees of freedom
## Multiple R-squared:  0.998, Adjusted R-squared:  0.9979 
## F-statistic: 7.242e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_2)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.014673  1.008197  1.079382  1.064171
```

```
interact_plot(m.diversity.rep_2, pred = thetaS, modx= tmrcaS)
```



```
g.rep_2 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_2, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_2)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_2
##          AIC      BIC    logLik
##     -7474.789 -7444.011 3744.395
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.3693417
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020437731 3.069727e-05 665.7833 0.0000
## thetaS       0.010425586 2.682830e-05 388.6041 0.0000
## tmrcaS      0.002686625 2.228409e-05 120.5625 0.0000
## rhoS        -0.000021005 1.943549e-05  -1.0807 0.2802
## thetaS:tmrcaS 0.001330244 1.868961e-05  71.1756 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.001
## tmrcaS     -0.004 -0.116
## rhoS       -0.002  0.001  0.001
## thetaS:tmrcaS -0.073 -0.014  0.052  0.045
##
## Standardized residuals:
##      Min        Q1        Med        Q3        Max
## -5.967387960 -0.392529054  0.008556582  0.424116285  5.938323518
##
## Residual standard error: 0.0005073101
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_2)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.013673    1.016230    1.002036    1.004808

g.rep_2.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_2, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_2.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_2
##      AIC      BIC logLik
## -5390.022 -5368.037 2700.011
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3415288
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020597993 0.0001669114 123.40674 0.0000
## thetaS      0.010803037 0.0001480341  72.97670 0.0000
## rhoS      -0.000092475 0.0001110053  -0.83307 0.4051
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.003
##
## Standardized residuals:
##      Min        Q1        Med        Q3        Max
## -3.532949546 -0.502347038  0.001576082  0.522732374  6.220744946
##
## Residual standard error: 0.002859674
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_2)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 2] <- anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.50kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 2] <- anova.diversity$VarExp[4] * 100

```

2.1.3 Replicate 3

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_3/rs.pair_3.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 789617, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9780661

inf.lands.50kb.rep_3 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_3) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_3$thetaS <- (inf.lands.50kb.rep_3$theta - mean(inf.lands.50kb.rep_3$theta)) / sd(inf.lands.50kb.rep_3$theta)
inf.lands.50kb.rep_3$tmrcaS <- (inf.lands.50kb.rep_3$tmrca - mean(inf.lands.50kb.rep_3$tmrca)) / sd(inf.lands.50kb.rep_3$tmrca)
inf.lands.50kb.rep_3$rhoS <- (inf.lands.50kb.rep_3$rho - mean(inf.lands.50kb.rep_3$rho)) / sd(inf.lands.50kb.rep_3$rho)

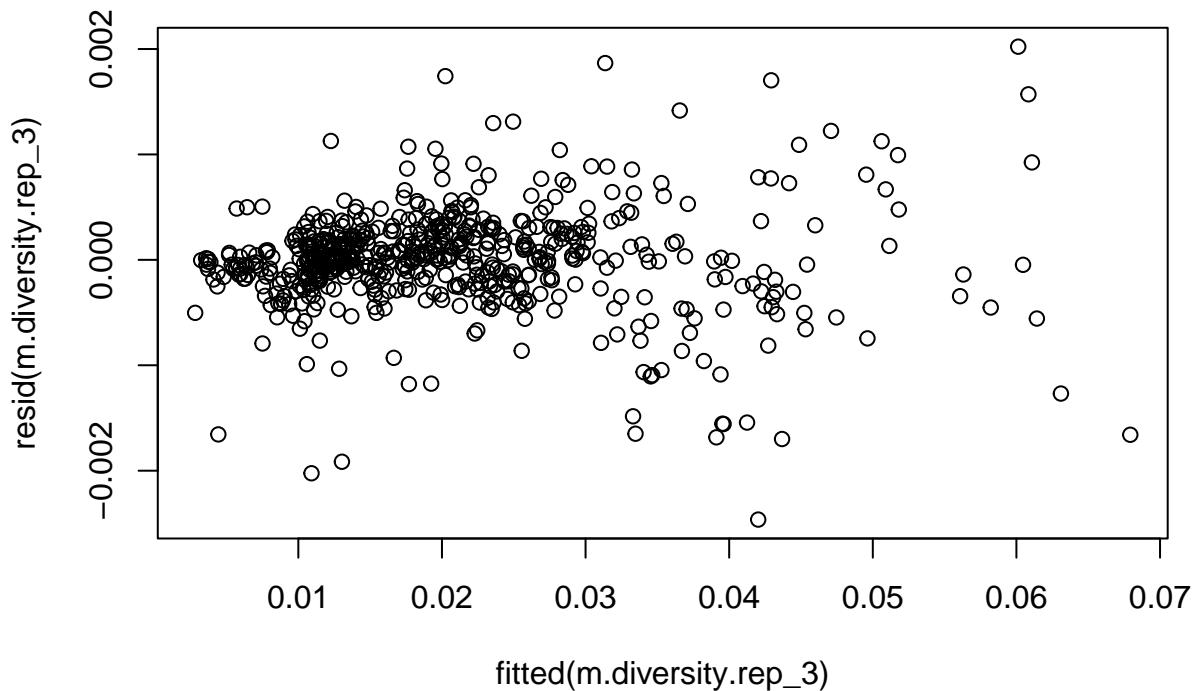
inf.lands.50kb.rep_3$bin <- 1:nrow(inf.lands.50kb.rep_3)

inf.lands.50kb.rep_3$Replicate <- 3

m.diversity.rep_3 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_3)

plot(resid(m.diversity.rep_3)~fitted(m.diversity.rep_3))

```

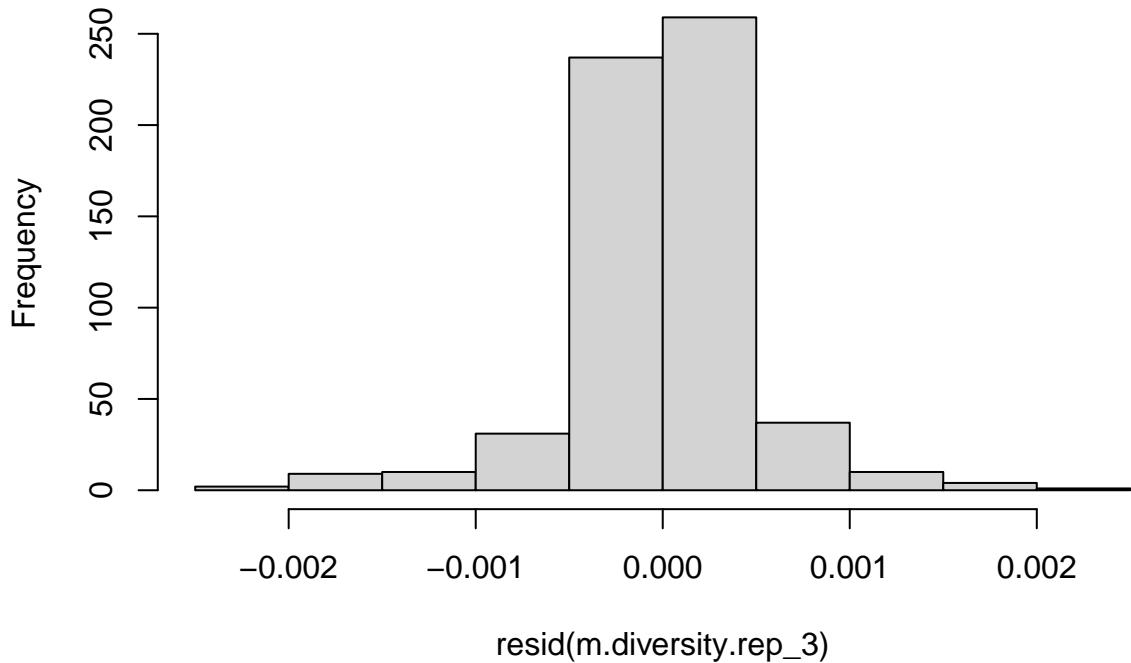


```
dwtest(m.diversity.rep_3)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_3
## DW = 1.4619, p-value = 1.133e-11
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_3)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_3
## HMC = 0.52153, p-value = 0.754
hist(resid(m.diversity.rep_3))
```

Histogram of resid(m.diversity.rep_3)



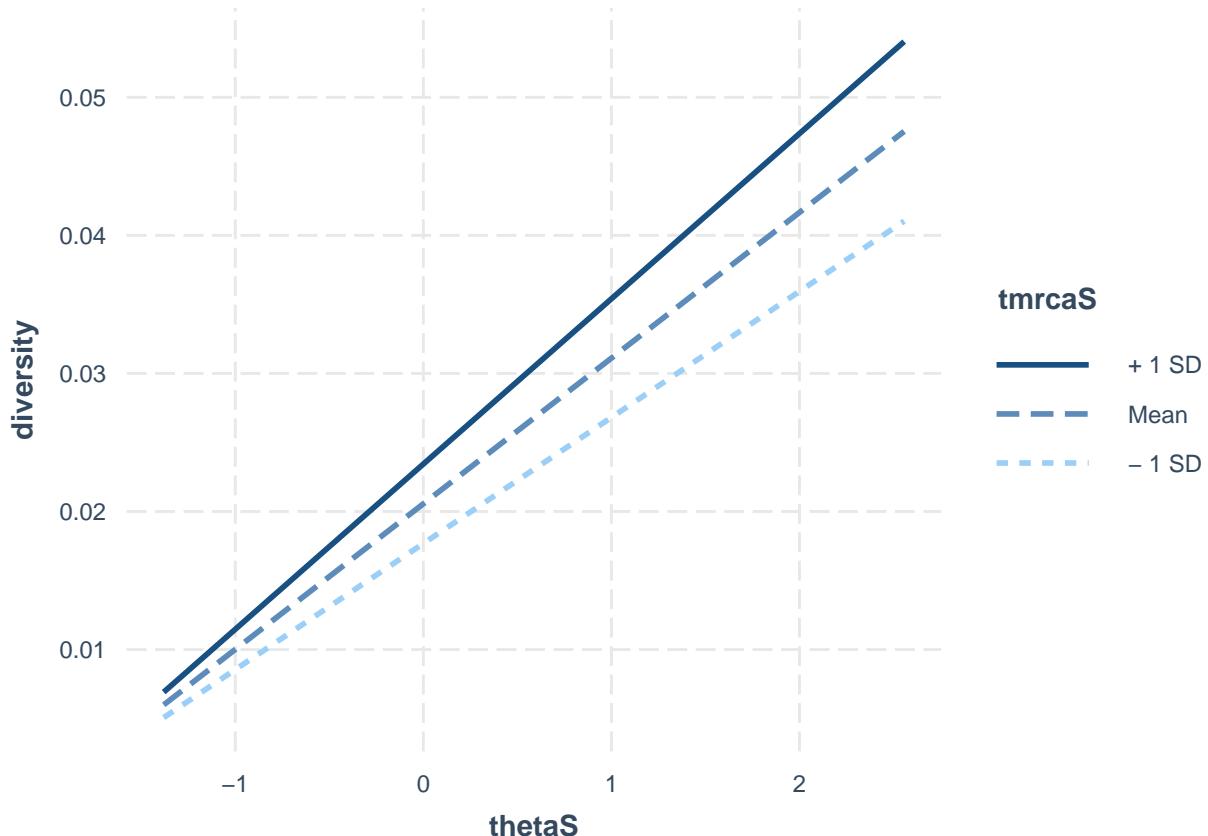
```
summary(m.diversity.rep_3)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_3)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -2.464e-03 -1.891e-04  1.021e-05  2.163e-04  2.022e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.056e-02 1.980e-05 1038.471 <2e-16 ***  
## thetaS       1.055e-02 1.991e-05  529.902 <2e-16 ***  
## rhoS        -1.745e-05 1.976e-05  -0.883  0.378  
## tmrcaS       2.878e-03 2.002e-05  143.768 <2e-16 ***  
## thetaS:tmrcaS 1.417e-03 1.685e-05   84.092 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004822 on 595 degrees of freedom  
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9982  
## F-statistic: 8.432e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_3)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.021037  1.006372  1.032585  1.019421
```

```
interact_plot(m.diversity.rep_3, pred = thetaS, modx= tmrcaS)
```



```
g.rep_3 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_3, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_3)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_3
##          AIC      BIC    logLik
##     -7500.229 -7469.45 3757.114
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.2838818
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020562880 2.650697e-05 775.7537 0.0000
## thetaS       0.010560835 2.454950e-05 430.1853 0.0000
## tmrcaS       0.002861485 2.145250e-05 133.3870 0.0000
## rhoS        -0.000022393 1.925540e-05  -1.1629 0.2453
## thetaS:tmrcaS 0.001390888 1.848554e-05  75.2419 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.007
## tmrcaS     -0.006 -0.122
## rhoS       -0.004  0.009  0.029
## thetaS:tmrcaS -0.087 -0.075  0.058  0.056
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -5.02048902 -0.38805559  0.03745702  0.44738982  4.48985459
##
## Residual standard error: 0.0004813794
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_3)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.020199    1.018281    1.004142    1.011269

g.rep_3.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_3, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_3.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_3
##      AIC      BIC logLik
## -5335.691 -5313.707 2672.846
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4625776
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020741983 0.0002138359 96.99954 0.0000
## thetaS      0.011165930 0.0001731923 64.47130 0.0000
## rhoS      -0.000127852 0.0001131819 -1.12962 0.2591
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.011
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.53093269 -0.44179911 -0.01021147  0.44918244  5.33441211
##
## Residual standard error: 0.003171671
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_3)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 3] <- anova.diversity$VarExp[4] * 100

```

2.1.4 Replicate 4

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_4/rs.pair_4.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 807402, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9775721

inf.lands.50kb.rep_4 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_4) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_4$thetaS <- (inf.lands.50kb.rep_4$theta - mean(inf.lands.50kb.rep_4$theta)) / sd(inf.lands.50kb.rep_4$theta)
inf.lands.50kb.rep_4$tmrcaS <- (inf.lands.50kb.rep_4$tmrca - mean(inf.lands.50kb.rep_4$tmrca)) / sd(inf.lands.50kb.rep_4$tmrca)
inf.lands.50kb.rep_4$rhoS <- (inf.lands.50kb.rep_4$rho - mean(inf.lands.50kb.rep_4$rho)) / sd(inf.lands.50kb.rep_4$rho)

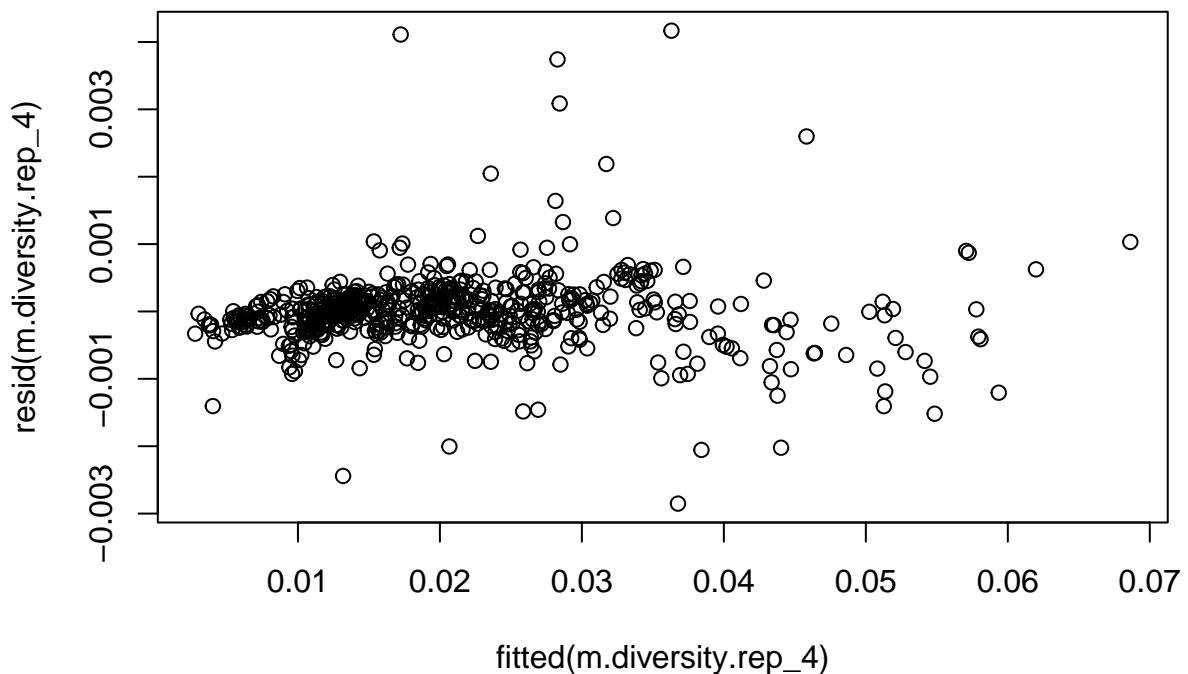
inf.lands.50kb.rep_4$bin <- 1:nrow(inf.lands.50kb.rep_4)

inf.lands.50kb.rep_4$Replicate <- 4

m.diversity.rep_4 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_4)

plot(resid(m.diversity.rep_4) ~ fitted(m.diversity.rep_4))

```



```

dwtest(m.diversity.rep_4)

##
##  Durbin-Watson test
##
##  data: m.diversity.rep_4
##  DW = 0.96213, p-value < 2.2e-16
##  alternative hypothesis: true autocorrelation is greater than 0

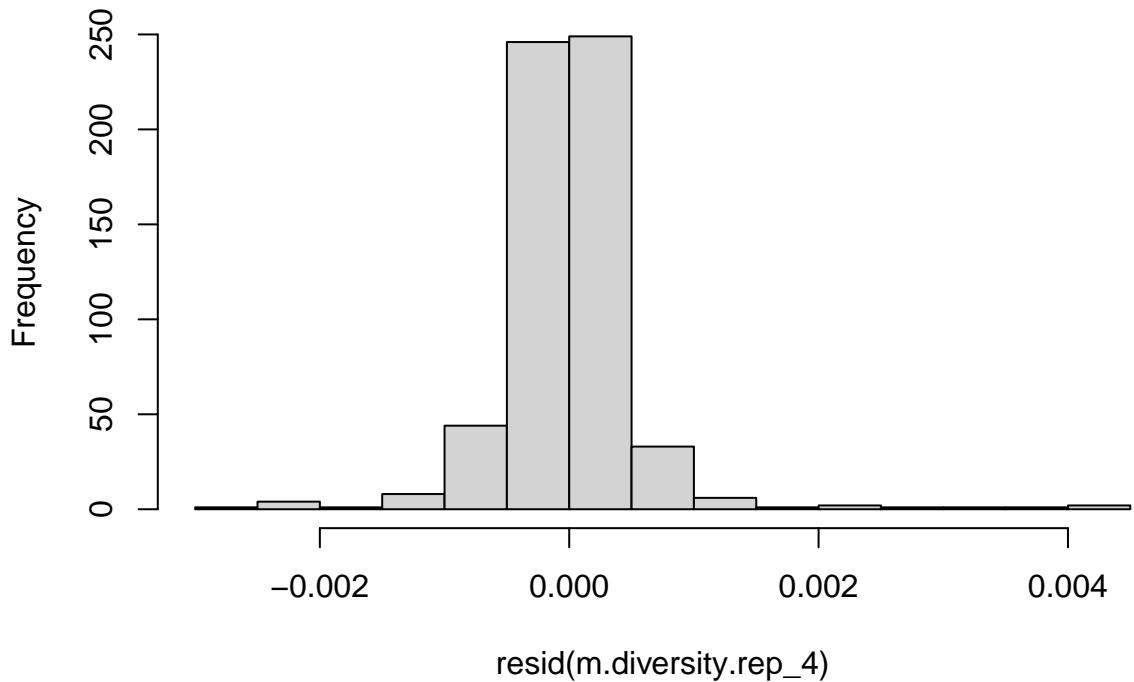
hmctest(m.diversity.rep_4)

##
##  Harrison-McCabe test
##
##  data: m.diversity.rep_4
##  HMC = 0.70321, p-value = 1

hist(resid(m.diversity.rep_4))

```

Histogram of resid(m.diversity.rep_4)



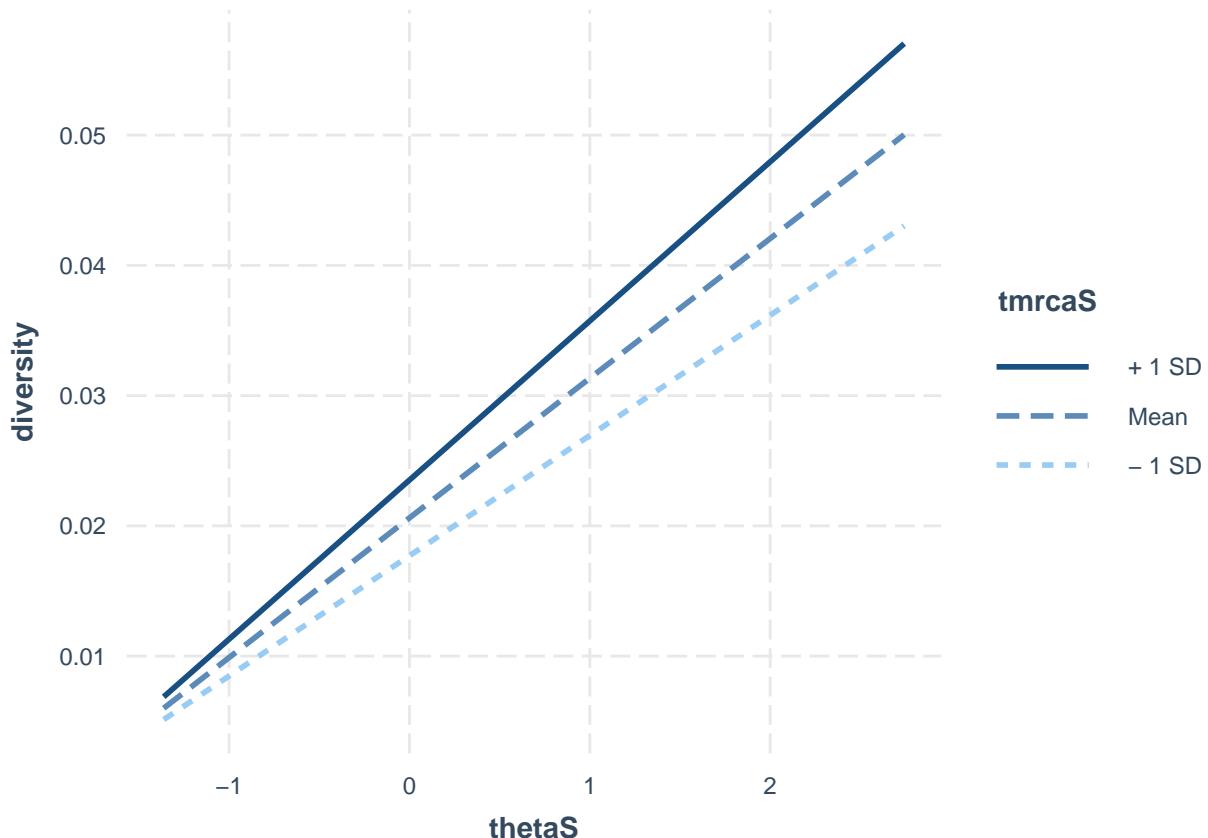
```
summary(m.diversity.rep_4)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_4)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -0.0028517 -0.0002016 -0.0000049  0.0001933  0.0041675  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.061e-02 2.304e-05 894.744 <2e-16 ***  
## thetaS       1.072e-02 2.308e-05 464.707 <2e-16 ***  
## rhoS        -1.398e-05 2.319e-05 -0.603  0.547  
## tmrcaS       2.905e-03 2.336e-05 124.378 <2e-16 ***  
## thetaS:tmrcaS 1.492e-03 2.120e-05 70.356 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005637 on 595 degrees of freedom  
## Multiple R-squared:  0.9975, Adjusted R-squared:  0.9975  
## F-statistic: 5.993e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_4)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.003879 1.013809 1.028409 1.014679
```

```
interact_plot(m.diversity.rep_4, pred = thetaS, modx= tmrcaS)
```



```
g.rep_4 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_4, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_4)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_4
##          AIC      BIC    logLik
##     -7464.493 -7433.715 3739.247
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.5423451
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020615250 4.251583e-05 484.8841 0.0000
## thetaS       0.010711538 3.118823e-05 343.4480 0.0000
## tmrcaS      0.002895620 2.330073e-05 124.2717 0.0000
## rhoS        -0.000009215 1.893368e-05  -0.4867 0.6266
## thetaS:tmrcaS 0.001424462 2.028301e-05  70.2293 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.001
## tmrcaS     -0.001 -0.069
## rhoS        0.000 -0.009  0.081
## thetaS:tmrcaS -0.024 -0.065 -0.008  0.006
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -5.20520627 -0.37375535 -0.02131367  0.35668752  7.22457564
##
## Residual standard error: 0.0005658744
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_4)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.009184    1.011566    1.006630    1.004416

g.rep_4.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_4, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_4.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_4
##      AIC      BIC logLik
## -5330.615 -5308.631 2670.308
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4710929
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.02068915 0.0002181869 94.82308 0.0000
## thetaS       0.01105774 0.0001742197 63.47010 0.0000
## rhoS        -0.00021567 0.0001141970 -1.88857 0.0594
##
## Correlation:
##           (Intr) thetaS
## thetaS 0.000
## rhoS   0.000  0.003
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -5.45522216 -0.42729625  0.05682276  0.47857205  5.82296892
##
## Residual standard error: 0.00320132
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_4)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 4] <- anova.diversity$VarExp[4] * 100

```

2.1.5 Replicate 5

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_5/rs.pair_5.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 655949, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9817791

inf.lands.50kb.rep_5 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_5) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_5$thetaS <- (inf.lands.50kb.rep_5$theta - mean(inf.lands.50kb.rep_5$theta)) / sd(inf.lands.50kb.rep_5$theta)
inf.lands.50kb.rep_5$tmrcaS <- (inf.lands.50kb.rep_5$tmrca - mean(inf.lands.50kb.rep_5$tmrca)) / sd(inf.lands.50kb.rep_5$tmrca)
inf.lands.50kb.rep_5$rhoS <- (inf.lands.50kb.rep_5$rho - mean(inf.lands.50kb.rep_5$rho)) / sd(inf.lands.50kb.rep_5$rho)

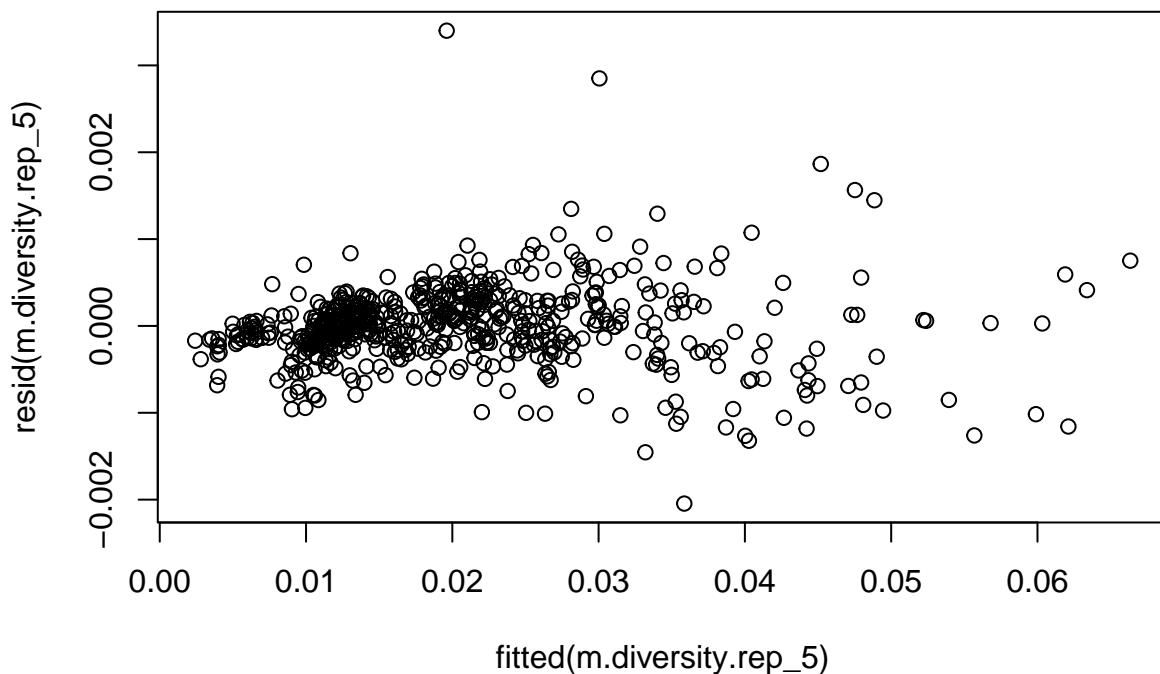
inf.lands.50kb.rep_5$bin <- 1:nrow(inf.lands.50kb.rep_5)

inf.lands.50kb.rep_5$Replicate <- 5

m.diversity.rep_5 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_5)

plot(resid(m.diversity.rep_5)~fitted(m.diversity.rep_5))

```

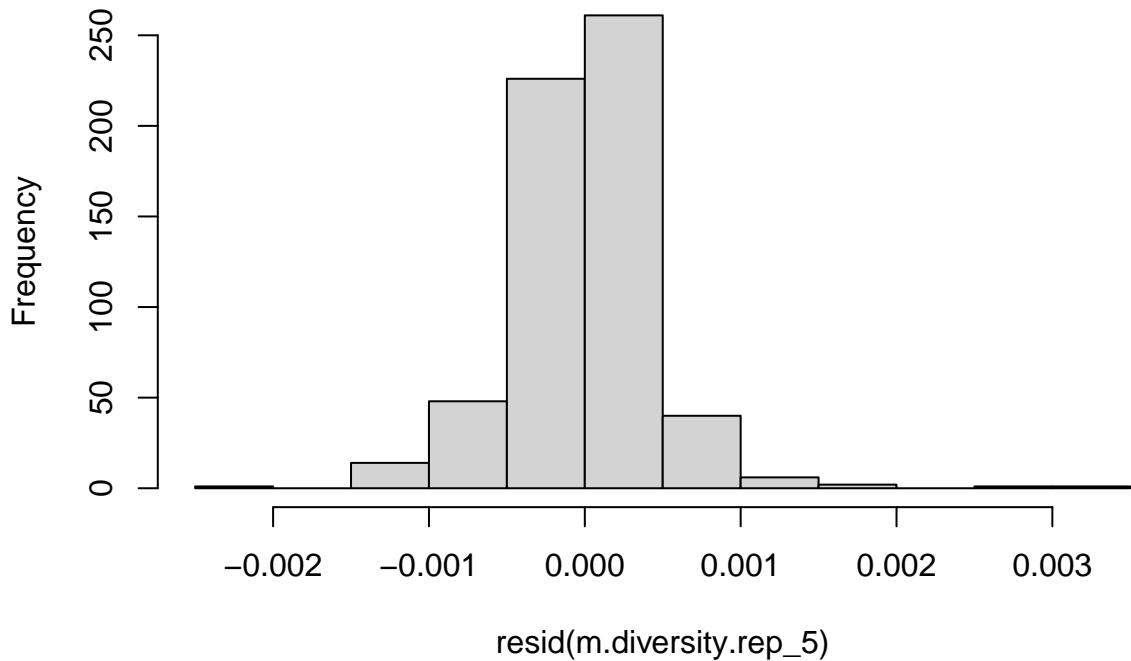


```
dwtest(m.diversity.rep_5)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_5
## DW = 1.4275, p-value = 5.886e-13
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_5)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_5
## HMC = 0.55418, p-value = 0.955
hist(resid(m.diversity.rep_5))
```

Histogram of resid(m.diversity.rep_5)



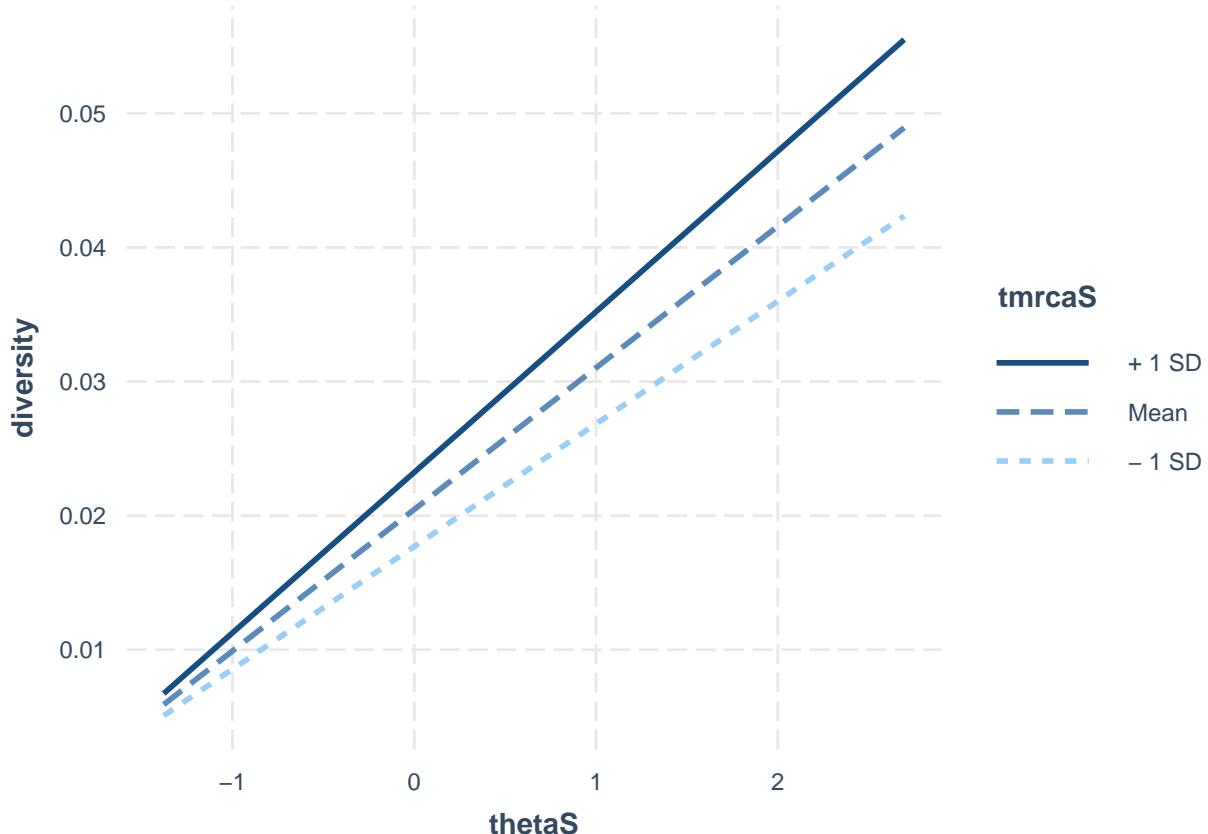
```
summary(m.diversity.rep_5)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.50kb.rep_5)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -0.0020455 -0.0002004  0.0000140  0.0002247  0.0033998
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.047e-02 1.890e-05 1082.787 <2e-16 ***
## thetaS      1.056e-02 1.896e-05  556.934 <2e-16 ***
## rhoS       -8.403e-06 1.900e-05   -0.442  0.658    
## tmrcaS      2.768e-03 1.918e-05  144.318 <2e-16 ***
## thetaS:tmrcaS 1.413e-03 1.579e-05   89.459 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0004621 on 595 degrees of freedom
## Multiple R-squared:  0.9983, Adjusted R-squared:  0.9983 
## F-statistic: 8.634e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_5)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.008094 1.012755 1.031798 1.020175
```

```
interact_plot(m.diversity.rep_5, pred = thetaS, modx= tmrcaS)
```



```
g.rep_5 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_5, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_5)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_5
##          AIC      BIC    logLik
##     -7570.892 -7540.114 3792.446
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.3687999
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020473277 2.826402e-05 724.3584 0.0000
## thetaS       0.010548590 2.480950e-05 425.1835 0.0000
## tmrcaS       0.002725546 2.067692e-05 131.8159 0.0000
## rhoS        -0.000014228 1.810647e-05  -0.7858 0.4323
## thetaS:tmrcaS 0.001345803 1.696976e-05  79.3060 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.002
## tmrcaS      0.002 -0.094
## rhoS        -0.001  0.002  0.058
## thetaS:tmrcaS -0.045  0.037 -0.040  0.028
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.3488500216 -0.4439991681  0.0002670608  0.4775851244  7.1344633217
##
## Residual standard error: 0.0004681579
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_5)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.010139    1.013921    1.004356    1.003709

g.rep_5.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_5, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_5.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_5
##      AIC      BIC logLik
## -5329.279 -5307.294 2669.64
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4006009
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020570880 0.0001928251 106.68153 0.0000
## thetaS      0.010803776 0.0001646389  65.62102 0.0000
## rhoS       -0.000188361 0.0001165489  -1.61615 0.1066
##
## Correlation:
##           (Intr) thetaS
## thetaS 0.000
## rhoS   0.001  0.007
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.31295794 -0.44285975  0.05270967  0.47530087  5.66926609
##
## Residual standard error: 0.003085565
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_5)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 5] <- anova.diversity$VarExp[4] * 100

```

2.1.6 Replicate 6

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_6/rs.pair_6.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 576502, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.983986

inf.lands.50kb.rep_6 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_6) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_6$thetaS <- (inf.lands.50kb.rep_6$theta - mean(inf.lands.50kb.rep_6$theta)) / sd(inf.lands.50kb.rep_6$theta)
inf.lands.50kb.rep_6$tmrcaS <- (inf.lands.50kb.rep_6$tmrca - mean(inf.lands.50kb.rep_6$tmrca)) / sd(inf.lands.50kb.rep_6$tmrca)
inf.lands.50kb.rep_6$rhoS <- (inf.lands.50kb.rep_6$rho - mean(inf.lands.50kb.rep_6$rho)) / sd(inf.lands.50kb.rep_6$rho)

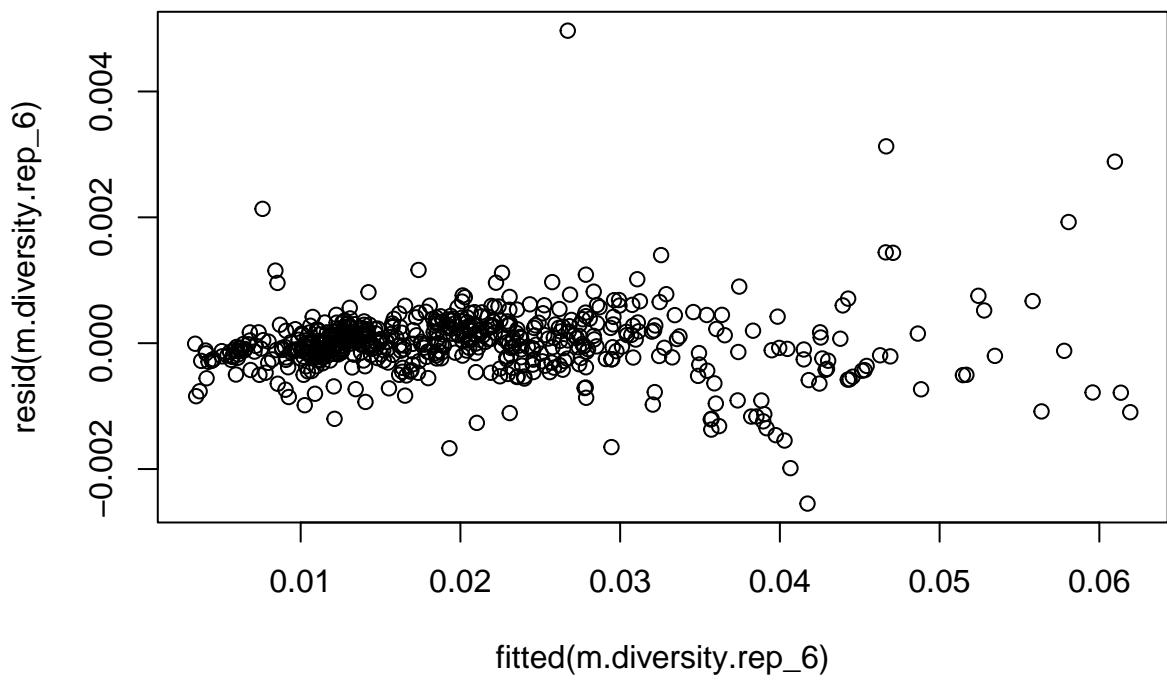
inf.lands.50kb.rep_6$bin <- 1:nrow(inf.lands.50kb.rep_6)

inf.lands.50kb.rep_6$Replicate <- 6

m.diversity.rep_6 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_6)

plot(resid(m.diversity.rep_6) ~ fitted(m.diversity.rep_6))

```

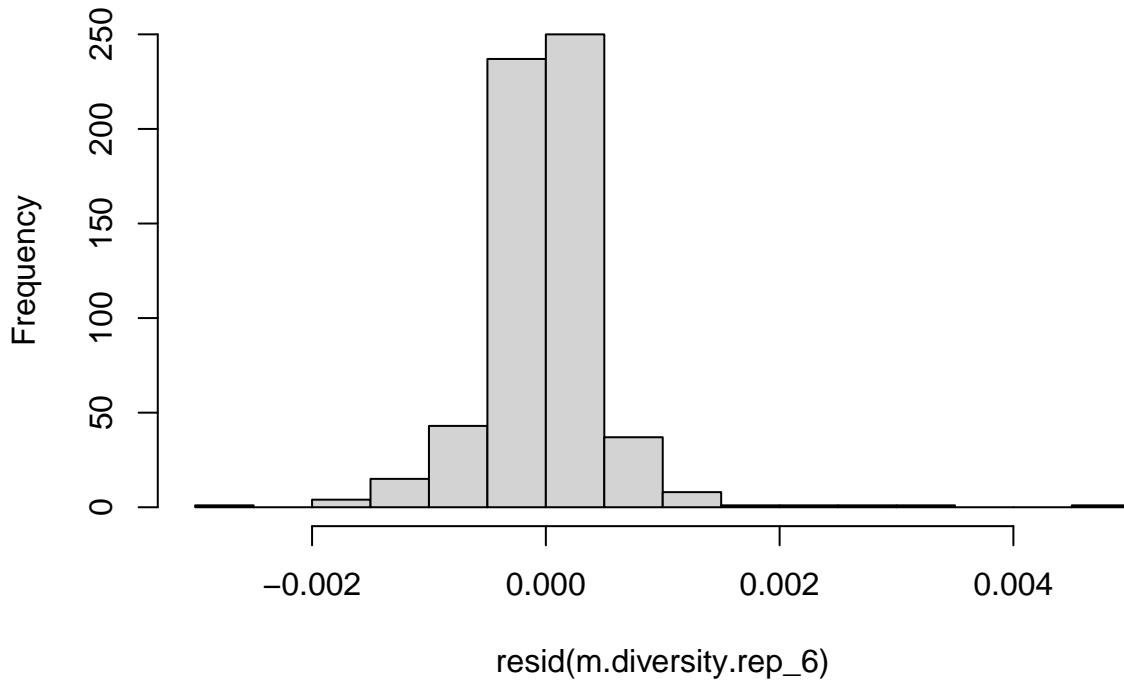


```
dwtest(m.diversity.rep_6)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_6
## DW = 1.4152, p-value = 1.956e-13
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_6)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_6
## HMC = 0.5501, p-value = 0.952
hist(resid(m.diversity.rep_6))
```

Histogram of resid(m.diversity.rep_6)



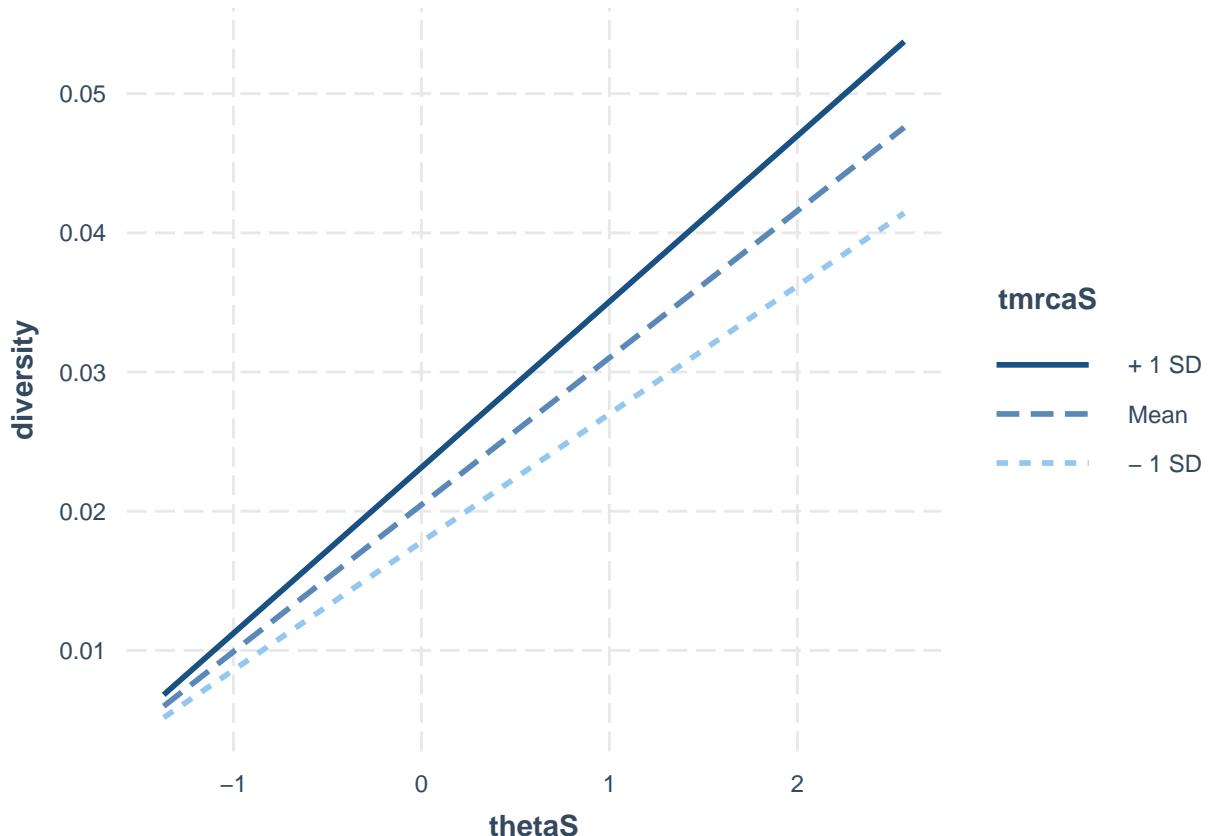
```
summary(m.diversity.rep_6)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_6)  
##  
## Residuals:  
##       Min        1Q     Median        3Q       Max  
## -0.0025487 -0.0002073 -0.0000008  0.0002258  0.0049661  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.046e-02 2.183e-05 937.468 <2e-16 ***  
## thetaS      1.056e-02 2.187e-05 482.709 <2e-16 ***  
## rhoS       1.225e-05 2.206e-05   0.555   0.579  
## tmrcaS     2.678e-03 2.246e-05 119.259 <2e-16 ***  
## thetaS:tmrcaS 1.356e-03 1.899e-05  71.423 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005333 on 595 degrees of freedom  
## Multiple R-squared:  0.9977, Adjusted R-squared:  0.9977  
## F-statistic: 6.529e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_6)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.007732 1.024681 1.062283 1.032167
```

```
interact_plot(m.diversity.rep_6, pred = thetaS, modx= tmrcaS)
```



```
g.rep_6 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_6, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_6)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_6
##          AIC      BIC  logLik
##     -7391.16 -7360.382 3702.58
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.3219522
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020468098 3.058636e-05 669.1903 0.0000
## thetaS       0.010559959 2.754228e-05 383.4091 0.0000
## tmrcaS       0.002648334 2.350889e-05 112.6524 0.0000
## rhoS         0.0000000301 2.134923e-05    0.0141 0.9888
## thetaS:tmrcaS 0.001311352 2.055231e-05   63.8056 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.000
## tmrcaS     -0.006 -0.082
## rhoS        0.000  0.014  0.075
## thetaS:tmrcaS -0.056  0.002  0.082  0.013
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.664990405 -0.377078774 -0.001461415  0.411936942  9.302435019
##
## Residual standard error: 0.0005339103
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_6)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.007216    1.019473    1.006158    1.006869

g.rep_6.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_6, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_6.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_6
##      AIC      BIC logLik
## -5414.912 -5392.927 2712.456
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4107098
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020584561 0.0001826143 112.72154 0.0000
## thetaS      0.010823438 0.0001541657  70.20654 0.0000
## rhoS      -0.000139262 0.0001093776  -1.27322 0.2034
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.014
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.246615324 -0.484784795 -0.004012755  0.502253353  5.520109928
##
## Residual standard error: 0.002887164
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_6)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 6] <- anova.diversity$VarExp[4] * 100

```

2.1.7 Replicate 7

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_7/rs.pair_7.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 715696, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9801195

inf.lands.50kb.rep_7 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_7) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_7$thetaS <- (inf.lands.50kb.rep_7$theta - mean(inf.lands.50kb.rep_7$theta)) / sd(inf.lands.50kb.rep_7$theta)
inf.lands.50kb.rep_7$tmrcaS <- (inf.lands.50kb.rep_7$tmrca - mean(inf.lands.50kb.rep_7$tmrca)) / sd(inf.lands.50kb.rep_7$tmrca)
inf.lands.50kb.rep_7$rhoS <- (inf.lands.50kb.rep_7$rho - mean(inf.lands.50kb.rep_7$rho)) / sd(inf.lands.50kb.rep_7$rho)

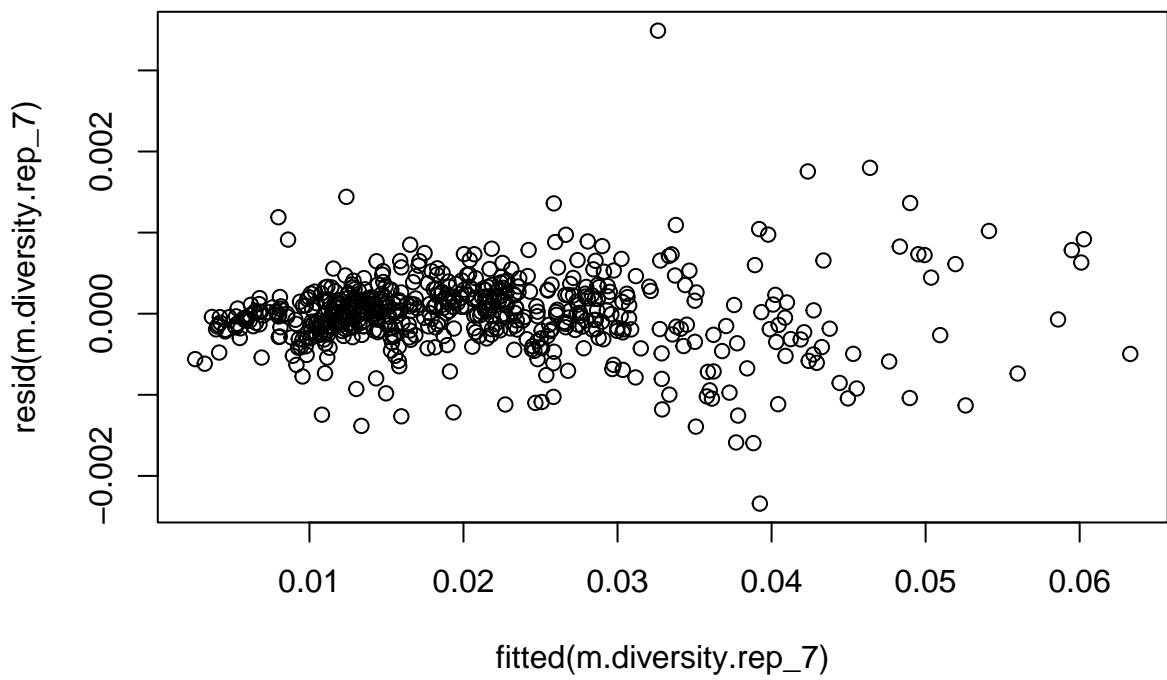
inf.lands.50kb.rep_7$bin <- 1:nrow(inf.lands.50kb.rep_7)

inf.lands.50kb.rep_7$Replicate <- 7

m.diversity.rep_7 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_7)

plot(resid(m.diversity.rep_7) ~ fitted(m.diversity.rep_7))

```

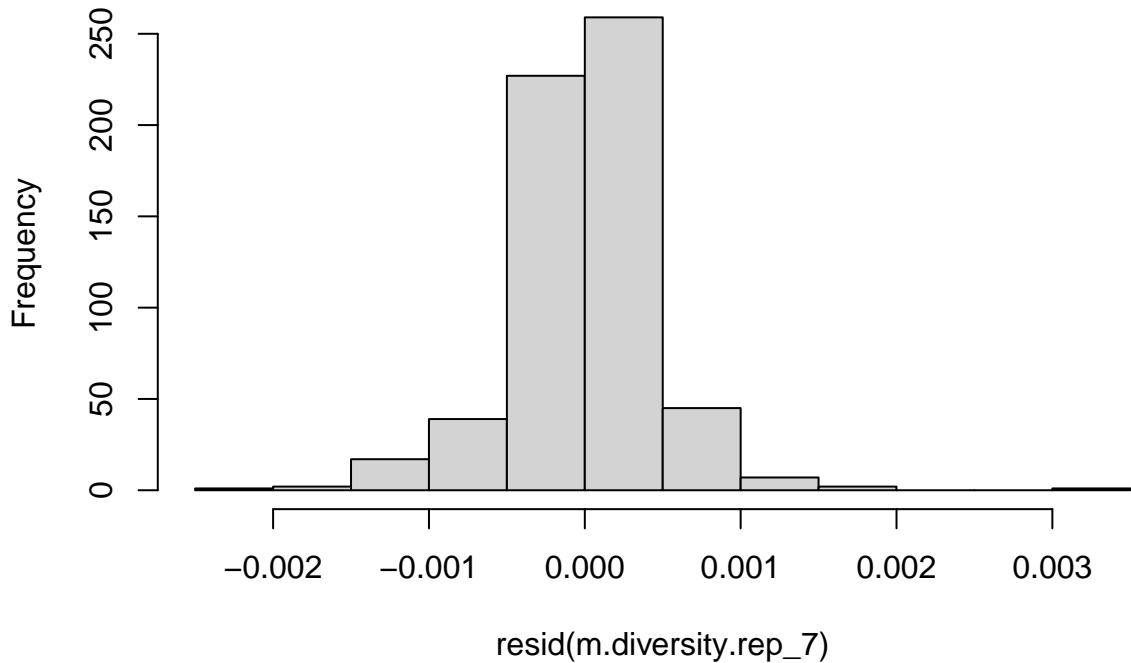


```
dwttest(m.diversity.rep_7)
```

```
##  
## Durbin-Watson test  
##  
## data: m.diversity.rep_7  
## DW = 1.2084, p-value < 2.2e-16  
## alternative hypothesis: true autocorrelation is greater than 0  
hmctest(m.diversity.rep_7)
```

```
##  
## Harrison-McCabe test  
##  
## data: m.diversity.rep_7  
## HMC = 0.58586, p-value = 0.998  
hist(resid(m.diversity.rep_7))
```

Histogram of resid(m.diversity.rep_7)



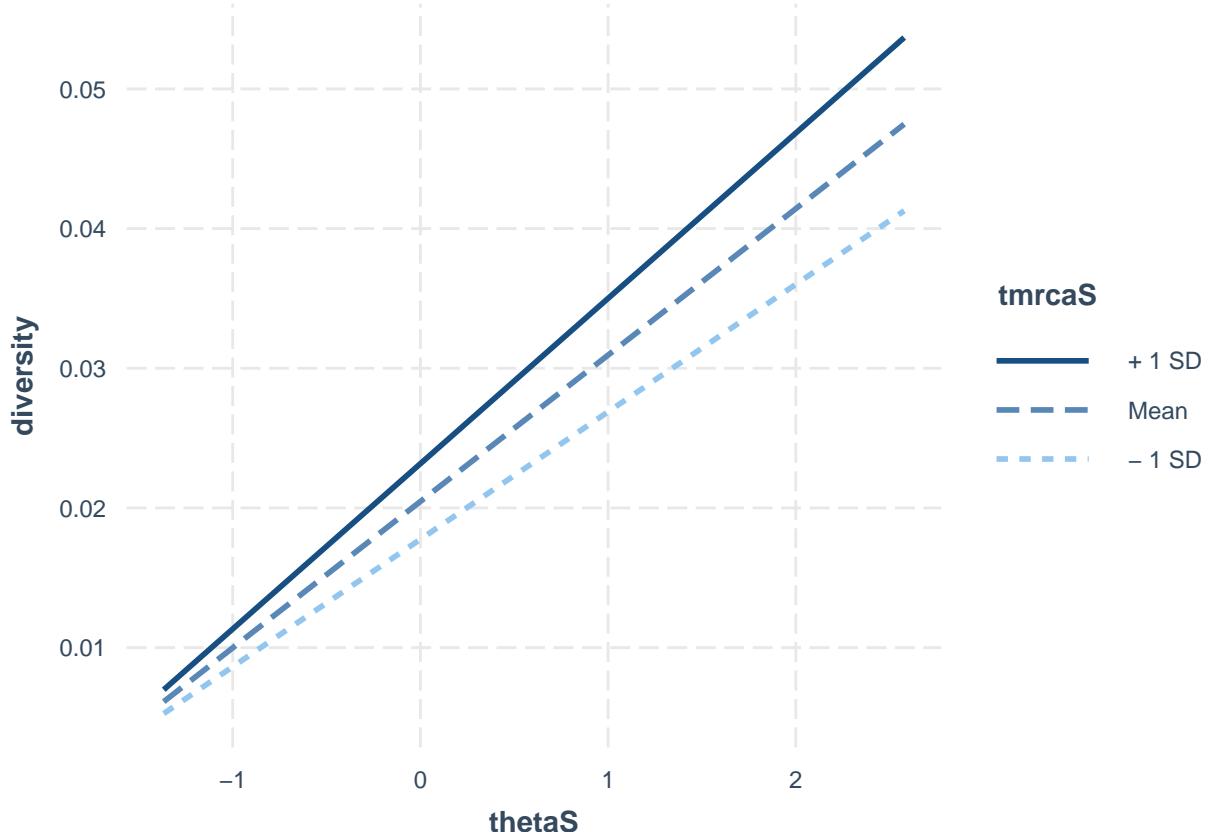
```
summary(m.diversity.rep_7)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_7)  
##  
## Residuals:  
##       Min        1Q     Median        3Q       Max  
## -0.0023413 -0.0001931  0.0000183  0.0002113  0.0034898  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.046e-02 1.906e-05 1073.378 < 2e-16 ***  
## thetaS       1.048e-02 1.911e-05  548.323 < 2e-16 ***  
## rhoS        -5.001e-05 1.904e-05   -2.627 0.00885 **  
## tmrcaS       2.706e-03 1.957e-05   138.265 < 2e-16 ***  
## thetaS:tmrcaS 1.355e-03 1.725e-05    78.551 < 2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0004657 on 595 degrees of freedom  
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9982  
## F-statistic: 8.313e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_7)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.009141 1.001458 1.058334 1.053888
```

```
interact_plot(m.diversity.rep_7, pred = thetaS, modx= tmrcaS)
```



```
g.rep_7 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_7, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_7)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_7
##          AIC      BIC    logLik
##     -7617.29 -7586.512 3815.645
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.4690905
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020470105 3.231288e-05 633.4967 0.0000
## thetaS       0.010509441 2.607289e-05 403.0793 0.0000
## tmrcaS       0.002648119 1.999976e-05 132.4076 0.0000
## rhoS        -0.000038977 1.690711e-05  -2.3054 0.0215
## thetaS:tmrcaS 0.001278210 1.826157e-05  69.9946 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS     -0.006 -0.099
## rhoS        0.002  0.005 -0.022
## thetaS:tmrcaS -0.047  0.014  0.100 -0.014
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.79375372 -0.41801231  0.05547631  0.45600292  7.65648236
##
## Residual standard error: 0.0004740043
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_7)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.010511    1.020984    1.000614    1.010927

g.rep_7.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_7, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_7.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_7
##      AIC      BIC logLik
## -5472.449 -5450.464 2741.224
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.469828
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020580105 0.0001934033 106.41030 0.0000
## thetaS       0.010815427 0.0001552921  69.64571 0.0000
## rhoS        0.000020888 0.0001011154   0.20658  0.8364
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.003
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.47464746 -0.42695326  0.04565358  0.50179301  5.14163869
##
## Residual standard error: 0.002842278
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_7)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 7] <- anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.50kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 7] <- anova.diversity$VarExp[4] * 100

```

2.1.8 Replicate 8

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_8/rs.pair_8.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 682855, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9810318

inf.lands.50kb.rep_8 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_8) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_8$thetaS <- (inf.lands.50kb.rep_8$theta - mean(inf.lands.50kb.rep_8$theta)) / sd(inf.lands.50kb.rep_8$theta)
inf.lands.50kb.rep_8$tmrcaS <- (inf.lands.50kb.rep_8$tmrca - mean(inf.lands.50kb.rep_8$tmrca)) / sd(inf.lands.50kb.rep_8$tmrca)
inf.lands.50kb.rep_8$rhoS <- (inf.lands.50kb.rep_8$rho - mean(inf.lands.50kb.rep_8$rho)) / sd(inf.lands.50kb.rep_8$rho)

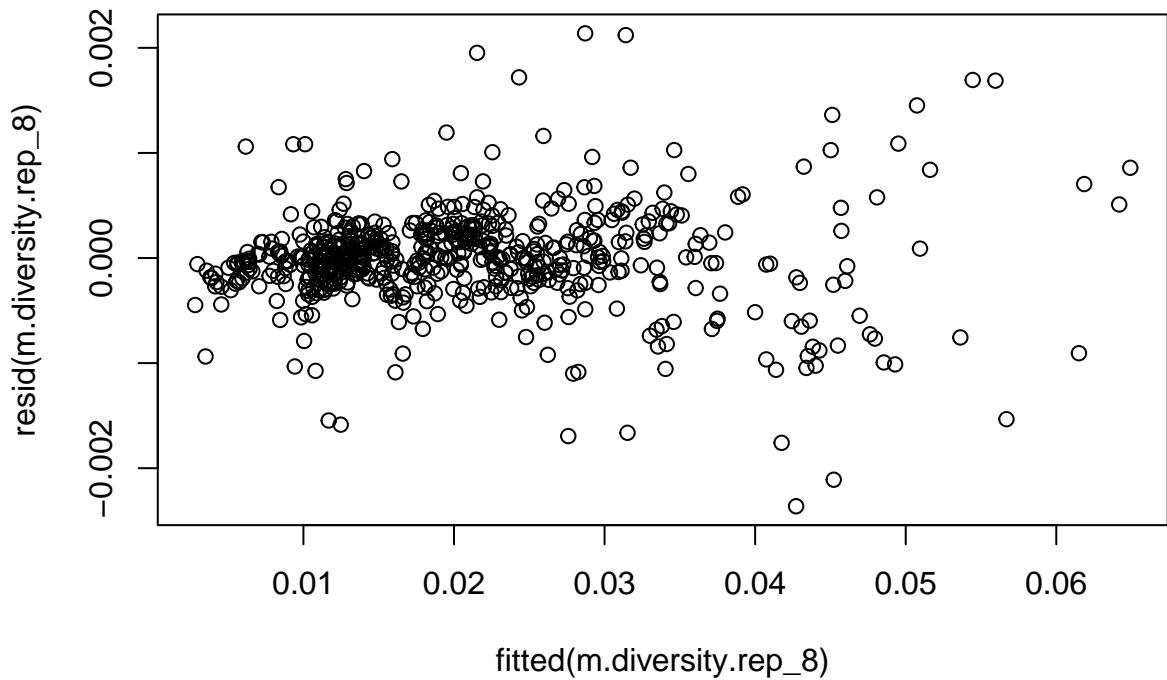
inf.lands.50kb.rep_8$bin <- 1:nrow(inf.lands.50kb.rep_8)

inf.lands.50kb.rep_8$Replicate <- 8

m.diversity.rep_8 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_8)

plot(resid(m.diversity.rep_8) ~ fitted(m.diversity.rep_8))

```

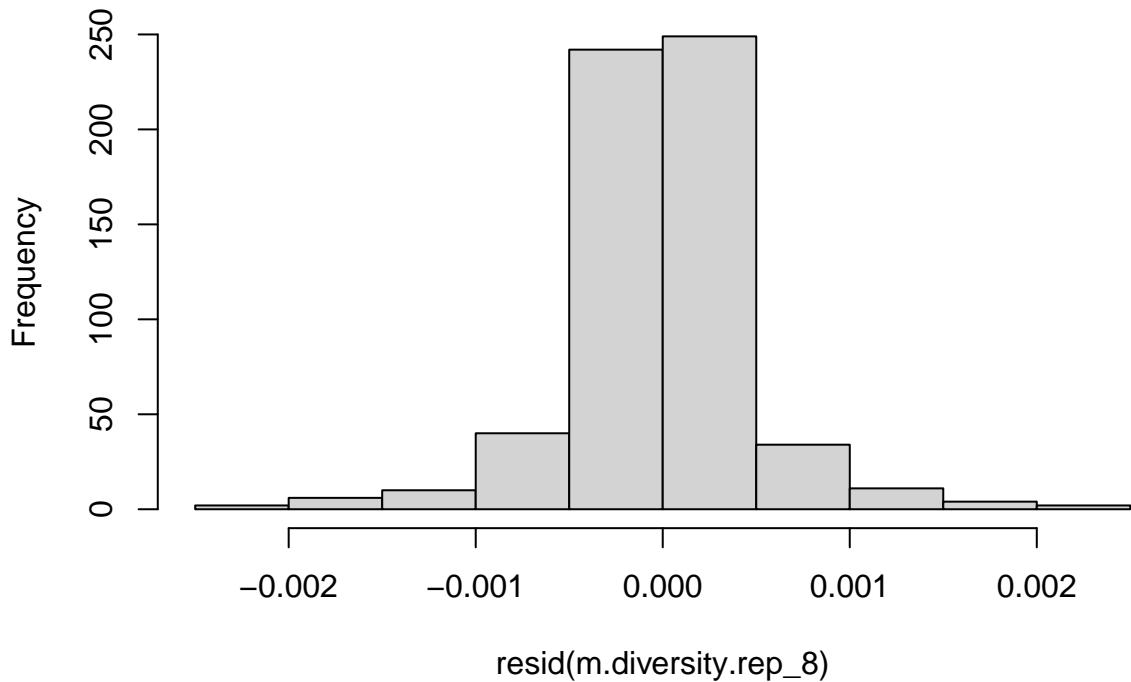


```
dwtest(m.diversity.rep_8)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_8
## DW = 1.3796, p-value = 6.877e-15
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_8)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_8
## HMC = 0.62278, p-value = 1
hist(resid(m.diversity.rep_8))
```

Histogram of resid(m.diversity.rep_8)



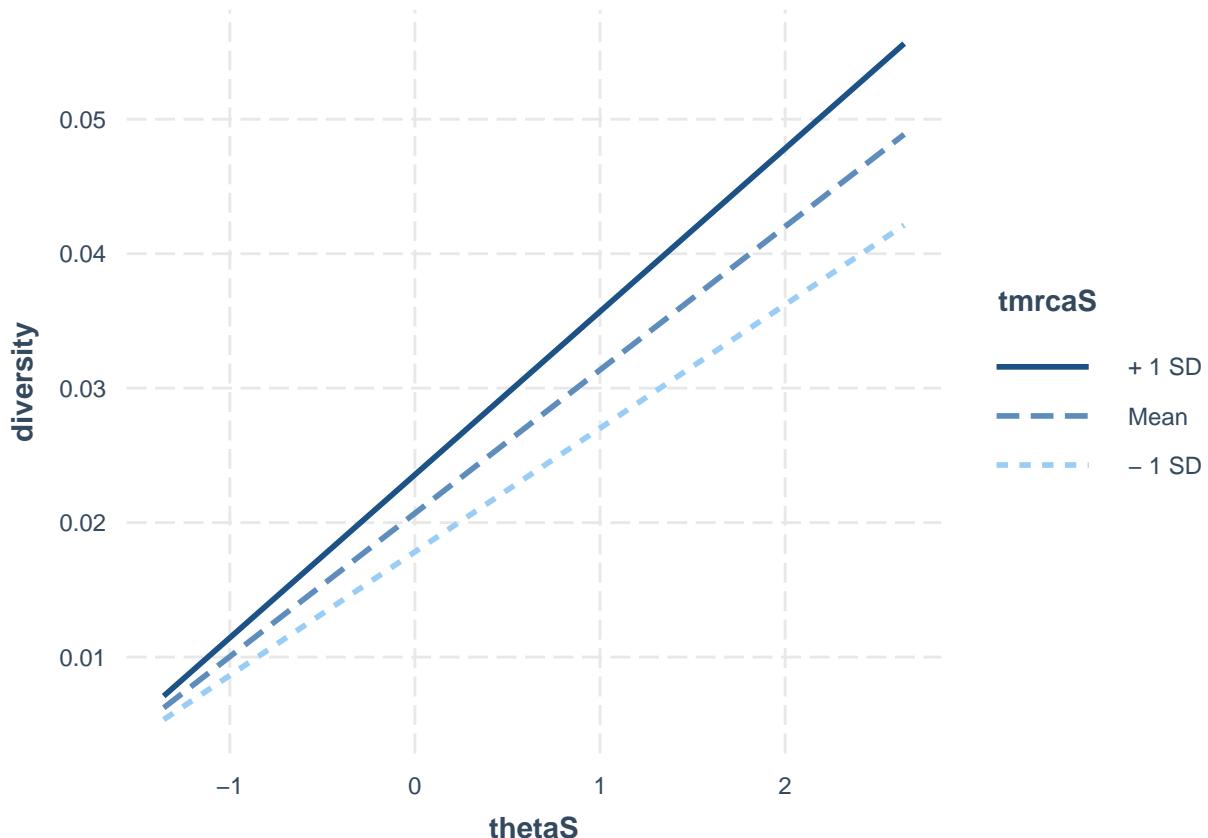
```
summary(m.diversity.rep_8)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.50kb.rep_8)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -2.362e-03 -1.893e-04  3.500e-07  2.086e-04  2.138e-03 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 2.070e-02 1.938e-05 1067.98 <2e-16 ***
## thetaS      1.066e-02 1.948e-05  547.27 <2e-16 ***
## rhoS       -8.583e-06 1.949e-05   -0.44    0.66    
## tmrcaS      2.868e-03 1.985e-05   144.50 <2e-16 ***
## thetaS:tmrcaS 1.469e-03 1.676e-05    87.61 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0004737 on 595 degrees of freedom
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9982 
## F-statistic: 8.292e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_8)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.012794    1.014124    1.051494    1.044054
```

```
interact_plot(m.diversity.rep_8, pred = thetaS, modx= tmrcaS)
```



```
g.rep_8 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_8, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_8)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_8
##          AIC      BIC    logLik
##     -7548.618 -7517.839  3781.309
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.3796214
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020703134 2.929892e-05 706.6176 0.0000
## thetaS       0.010670227 2.543405e-05 419.5253 0.0000
## tmrcaS       0.002823421 2.112706e-05 133.6401 0.0000
## rhoS         0.000005961 1.842746e-05    0.3235 0.7465
## thetaS:tmrcaS 0.001402255 1.846302e-05   75.9494 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS     -0.004 -0.069
## rhoS        0.001  0.012  0.067
## thetaS:tmrcaS -0.048  0.026  0.075 -0.015
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.79143530 -0.40162824  0.00873902  0.44671770  4.52028563
##
## Residual standard error: 0.0004791766
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_8)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.006009    1.015515    1.005156    1.006994

g.rep_8.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_8, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_8.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_8
##      AIC      BIC logLik
## -5369.959 -5347.975 2689.98
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4676478
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020814330 0.0002097878 99.21612 0.0000
## thetaS      0.010911671 0.0001681892 64.87738 0.0000
## rhoS      -0.000114073 0.0001110840 -1.02690 0.3049
##
## Correlation:
##           (Intr) thetaS
## thetaS 0.000
## rhoS   0.000  0.012
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -7.41084899 -0.48902470 -0.01613762  0.49491223  5.48392430
##
## Residual standard error: 0.003091654
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_8)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 8] <- anova.diversity$VarExp[4] * 100

```

2.1.9 Replicate 9

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_9/rs.pair_9.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 609380, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9830727

inf.lands.50kb.rep_9 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_9) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.50kb.rep_9$thetaS <- (inf.lands.50kb.rep_9$theta - mean(inf.lands.50kb.rep_9$theta)) / sd(inf.lands.50kb.rep_9$theta)
inf.lands.50kb.rep_9$tmrcaS <- (inf.lands.50kb.rep_9$tmrca - mean(inf.lands.50kb.rep_9$tmrca)) / sd(inf.lands.50kb.rep_9$tmrca)
inf.lands.50kb.rep_9$rhoS <- (inf.lands.50kb.rep_9$rho - mean(inf.lands.50kb.rep_9$rho)) / sd(inf.lands.50kb.rep_9$rho)

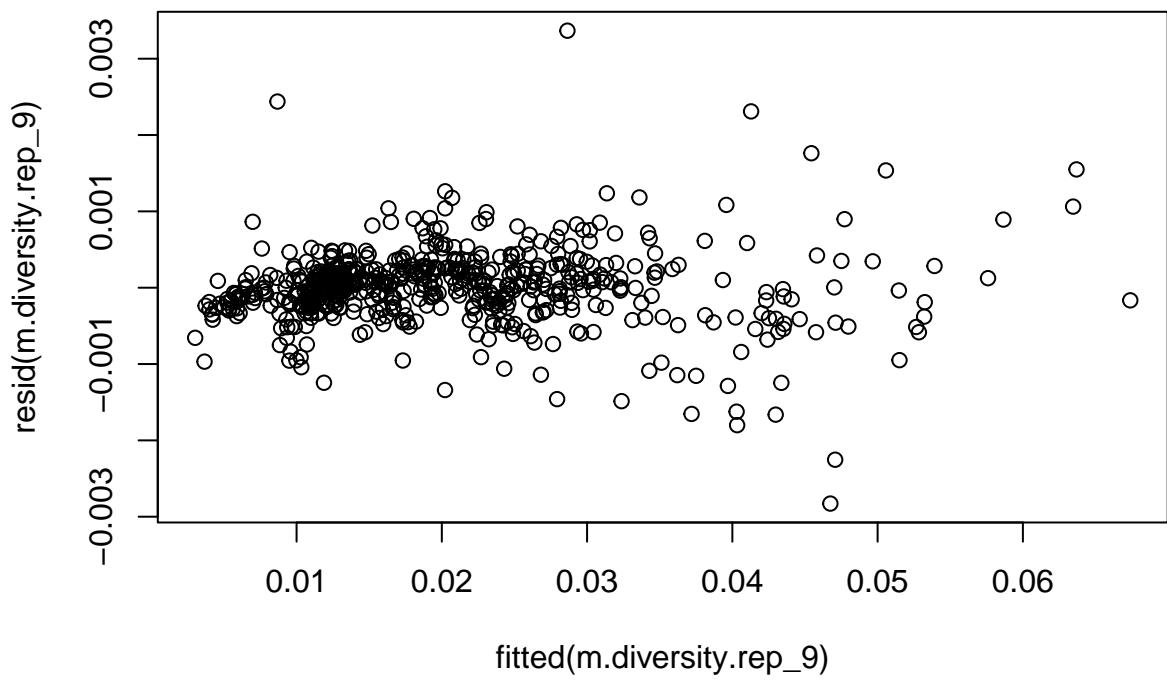
inf.lands.50kb.rep_9$bin <- 1:nrow(inf.lands.50kb.rep_9)

inf.lands.50kb.rep_9$Replicate <- 9

m.diversity.rep_9 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_9)

plot(resid(m.diversity.rep_9)~fitted(m.diversity.rep_9))

```

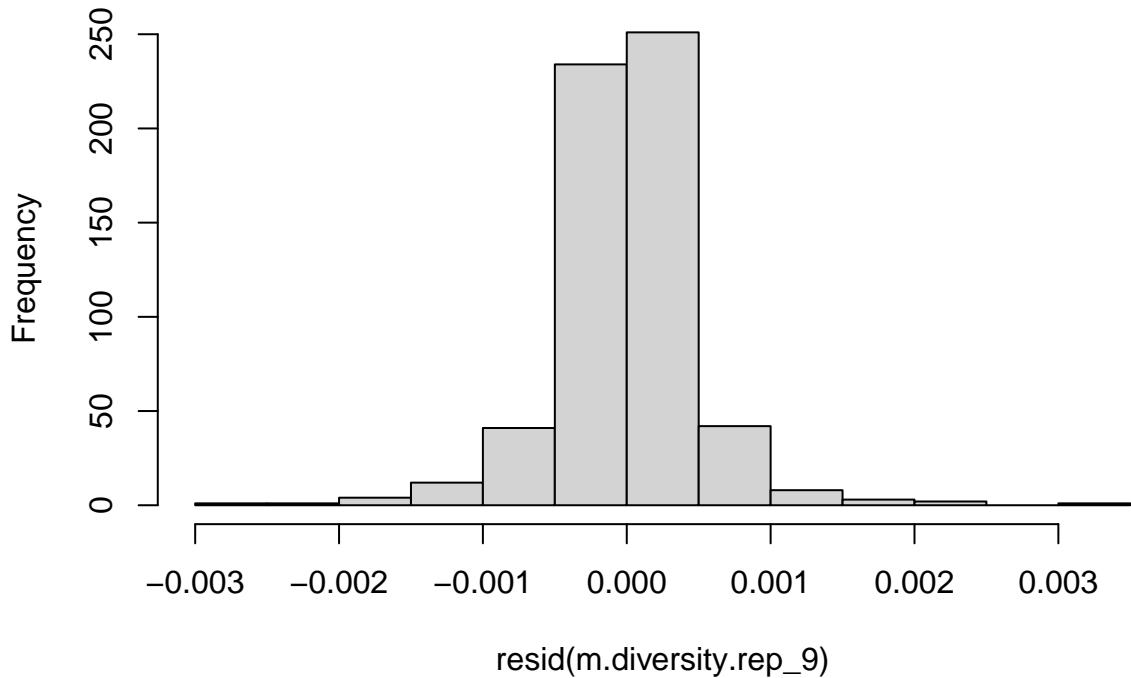


```
dwtest(m.diversity.rep_9)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_9
## DW = 1.3455, p-value = 2.541e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_9)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_9
## HMC = 0.52947, p-value = 0.843
hist(resid(m.diversity.rep_9))
```

Histogram of resid(m.diversity.rep_9)



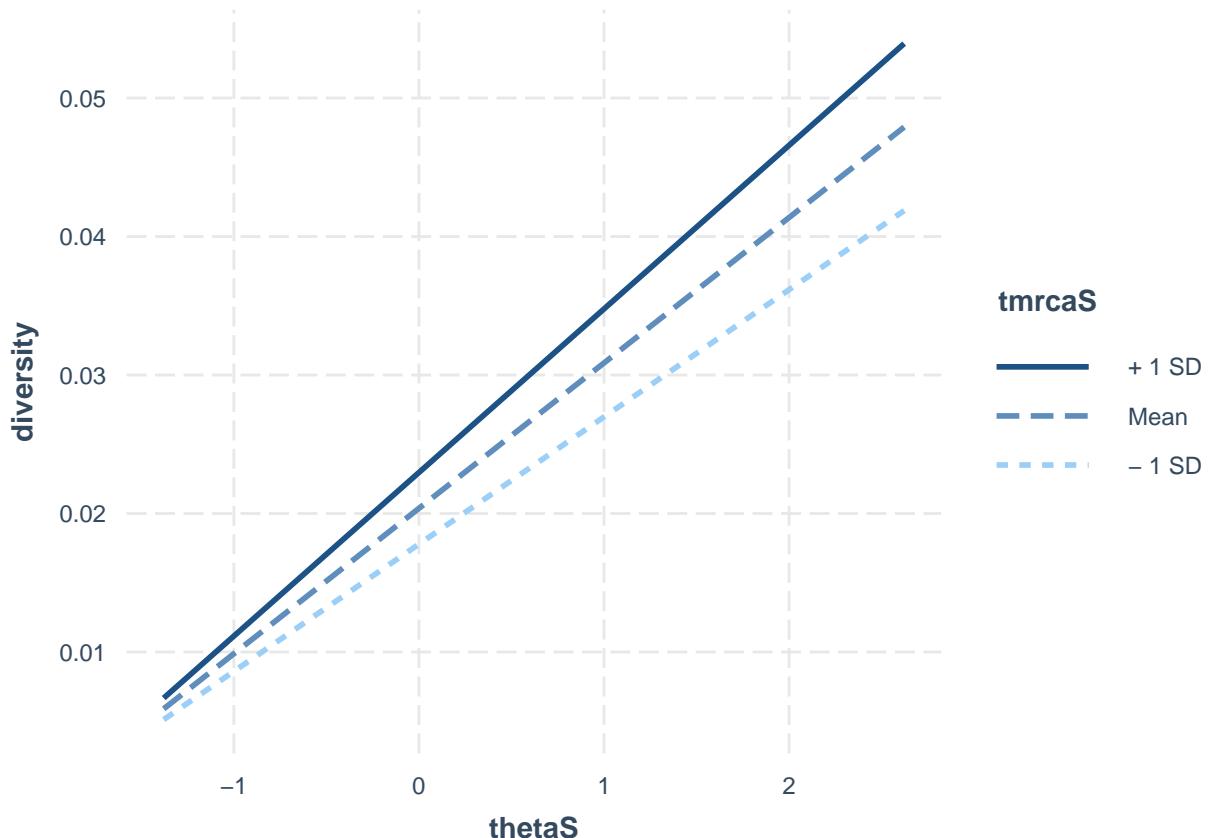
```
summary(m.diversity.rep_9)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.50kb.rep_9)
##
## Residuals:
##       Min         1Q      Median         3Q        Max
## -0.0028280 -0.0002274  0.0000078  0.0002235  0.0033670
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.037e-02 2.069e-05 984.748 <2e-16 ***
## thetaS      1.050e-02 2.075e-05 505.918 <2e-16 ***
## rhoS        1.416e-05 2.077e-05   0.682   0.496
## tmrcaS      2.587e-03 2.102e-05 123.090 <2e-16 ***
## thetaS:tmrcaS 1.313e-03 1.768e-05  74.239 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0005043 on 595 degrees of freedom
## Multiple R-squared:  0.998, Adjusted R-squared:  0.998
## F-statistic: 7.306e+04 on 4 and 595 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_9)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.014389 1.016585 1.040405 1.017894
```

```
interact_plot(m.diversity.rep_9, pred = thetaS, modx= tmrcaS)
```



```
g.rep_9 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_9, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_9)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_9
##          AIC      BIC    logLik
##     -7487.186 -7456.408  3750.593
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.412105
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020383482 3.257124e-05 625.8123 0.0000
## thetaS       0.010499421 2.766864e-05 379.4701 0.0000
## tmrcaS       0.002523327 2.134664e-05 118.2072 0.0000
## rhoS        0.000001758 1.928100e-05    0.0912 0.9274
## thetaS:tmrcaS 0.001238743 1.860130e-05   66.5944 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.003
## tmrcaS     0.001 -0.125
## rhoS       -0.004  0.017  0.041
## thetaS:tmrcaS -0.067 -0.040 -0.014  0.076
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.86419788 -0.43551103  0.02063926  0.43146966  6.60989139
##
## Residual standard error: 0.0005120851
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_9)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.018252     1.018249     1.008251     1.008039

g.rep_9.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_9, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_9.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_9
##      AIC      BIC    logLik
## -5406.246 -5384.261 2708.123
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3833499
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020529891 0.0001758026 116.77810 0.0000
## thetaS      0.010960389 0.0001518094  72.19836 0.0000
## rhoS       -0.000201324 0.0001095635  -1.83751 0.0666
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.026
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.88951873 -0.46241592  0.05059189  0.47484598  6.24257165
##
## Residual standard error: 0.002870881
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_9)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 9] <- anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.50kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 9] <- anova.diversity$VarExp[4] * 100

```

2.1.10 Replicate 10

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_10/rs.pair_10.", sep = "")
pi.50kb <- read.table(paste(p, "diversity.50kb.bedgraph", sep = ""), header = T)
pi.50kb$avg <- apply(pi.50kb[4:ncol(pi.50kb)], 1, mean)
tmrca.50kb <- read.table(paste(p, "TMRCA.50kb.bedgraph", sep = ""), header = T)
tmrca.50kb$avg <- apply(tmrca.50kb[4:ncol(tmrca.50kb)], 1, mean)
rho.50kb <- read.table(paste(p, "rho.50kb.bedgraph", sep = ""), header = T)
theta.50kb <- read.table(paste(p, "theta.50kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.50kb$sim, theta.50kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.50kb$sim and theta.50kb$sample_mean
## S = 558257, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9844928

inf.lands.50kb.rep_10 <- as.data.frame(cbind(pi.50kb$avg, theta.50kb$sample_mean, rho.50kb$sample_mean,
names(inf.lands.50kb.rep_10) <- c("diversity", "theta", "rho", "tmrca"))

# standardizing
inf.lands.50kb.rep_10$thetaS <- (inf.lands.50kb.rep_10$theta - mean(inf.lands.50kb.rep_10$theta)) / sd(inf.lands.50kb.rep_10$theta)
inf.lands.50kb.rep_10$tmrcaS <- (inf.lands.50kb.rep_10$tmrca - mean(inf.lands.50kb.rep_10$tmrca)) / sd(inf.lands.50kb.rep_10$tmrca)
inf.lands.50kb.rep_10$rhoS <- (inf.lands.50kb.rep_10$rho - mean(inf.lands.50kb.rep_10$rho)) / sd(inf.lands.50kb.rep_10$rho)

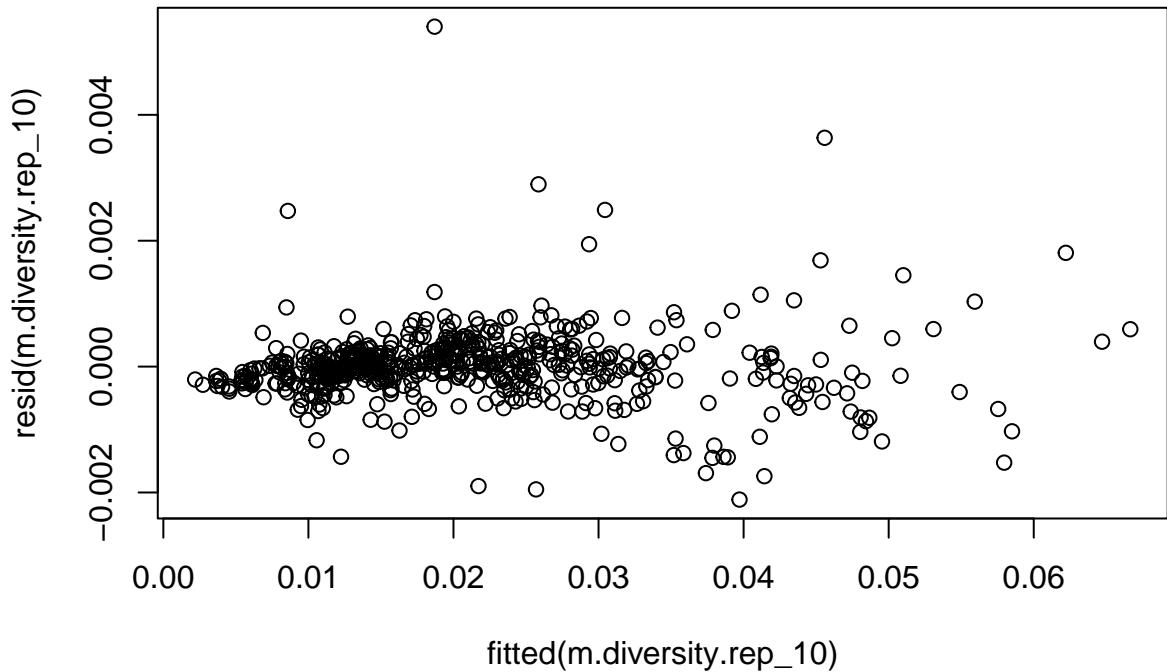
inf.lands.50kb.rep_10$bin <- 1:nrow(inf.lands.50kb.rep_10)

inf.lands.50kb.rep_10$Replicate <- 10

m.diversity.rep_10 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.50kb.rep_10)

plot(resid(m.diversity.rep_10)~fitted(m.diversity.rep_10))

```

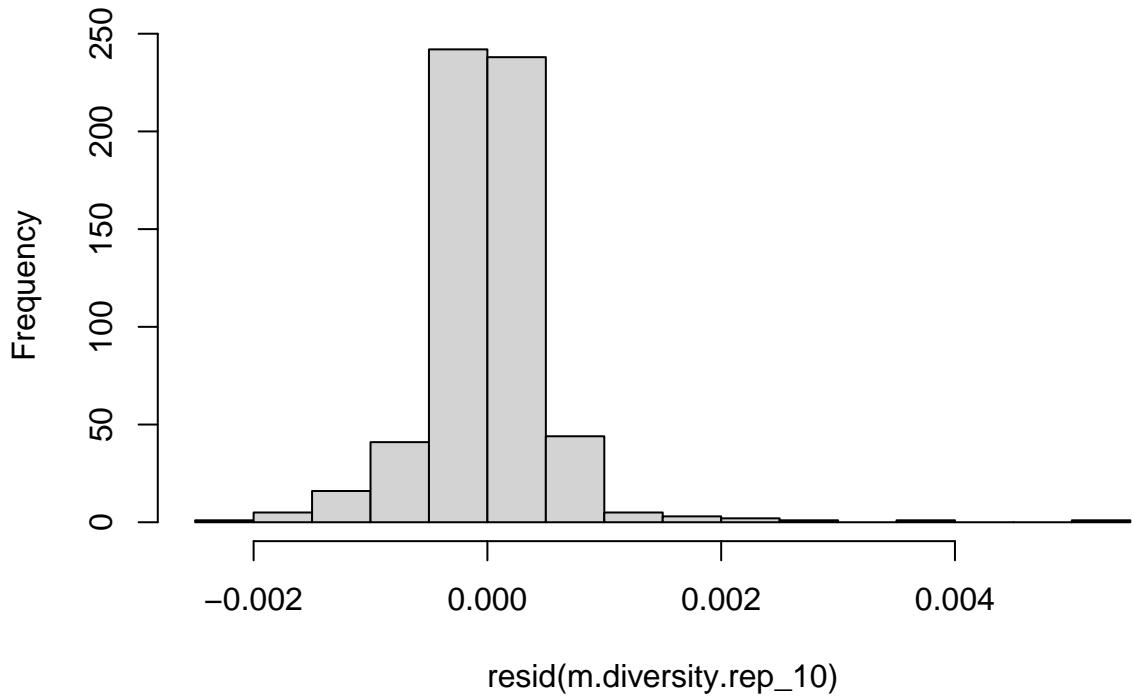


```
dwtest(m.diversity.rep_10)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_10
## DW = 1.3449, p-value = 2.3e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_10)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_10
## HMC = 0.67092, p-value = 1
hist(resid(m.diversity.rep_10))
```

Histogram of resid(m.diversity.rep_10)



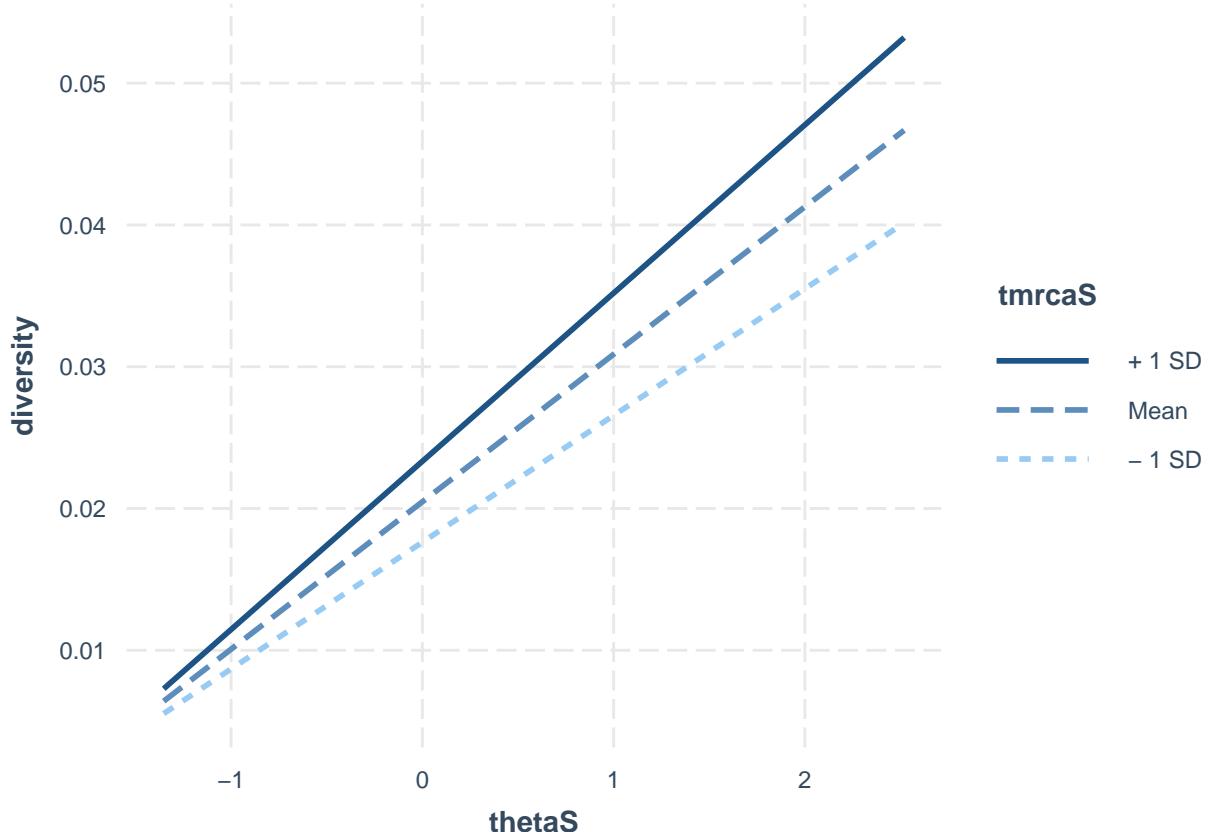
```
summary(m.diversity.rep_10)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.50kb.rep_10)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -0.0021127 -0.0002121 -0.0000085  0.0001956  0.0054007  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.048e-02 2.313e-05 885.243 <2e-16 ***  
## thetaS       1.040e-02 2.330e-05 446.391 <2e-16 ***  
## rhoS        -2.795e-05 2.314e-05 -1.208   0.227  
## tmrcaS       2.853e-03 2.435e-05 117.152 <2e-16 ***  
## thetaS:tmrcaS 1.462e-03 2.084e-05 70.181 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.000561 on 595 degrees of freedom  
## Multiple R-squared:  0.9975, Adjusted R-squared:  0.9975  
## F-statistic: 6.053e+04 on 4 and 595 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_10)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.033066 1.018870 1.128984 1.096067
```

```
interact_plot(m.diversity.rep_10, pred = thetaS, modx= tmrcaS)
```



```
g.rep_10 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.50kb.rep_1, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_10)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep_1
##          AIC      BIC logLik
##     -7367.645 -7336.866 3690.822
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.3212747
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020438810 3.125509e-05 653.9355 0.0000
## thetaS       0.010435258 2.837609e-05 367.7482 0.0000
## tmrcaS       0.002817637 2.481844e-05 113.5300 0.0000
## rhoS        0.000004491 2.161341e-05    0.2078 0.8355
## thetaS:tmrcaS 0.001426645 2.293513e-05   62.2035 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.010
## tmrcaS     -0.018 -0.155
## rhoS       -0.003  0.009  0.012
## thetaS:tmrcaS -0.096 -0.101  0.181  0.042
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -5.45341396 -0.37367657  0.05022105  0.36056906  6.43069153
##
## Residual standard error: 0.000544344
## Degrees of freedom: 600 total; 595 residual
vif(g.rep_10)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.030576     1.054551     1.001941     1.041465

g.rep_10.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.50kb.rep_10, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_10.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.50kb.rep_10
##      AIC      BIC    logLik
## -5437.978 -5415.994 2723.989
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.4549714
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020708204 0.0001936334 106.94544 0.0000
## thetaS      0.011234806 0.0001578890  71.15634 0.0000
## rhoS      -0.000216985 0.0001055177  -2.05638 0.0402
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.000
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.86544315 -0.50573567  0.01449108  0.52601610  6.72401412
##
## Residual standard error: 0.002899699
## Degrees of freedom: 600 total; 597 residual
anova.diversity <- Anova(m.diversity.rep_10)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.50kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.50kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.inf.50kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.inf.50kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.inf.50kb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.inf.50kb$average <- rowMeans(r2.inf.50kb)
r2.inf.50kb <- transform(r2.inf.50kb, sd=apply(r2.inf.50kb, 1, sd, na.rm = TRUE))

```

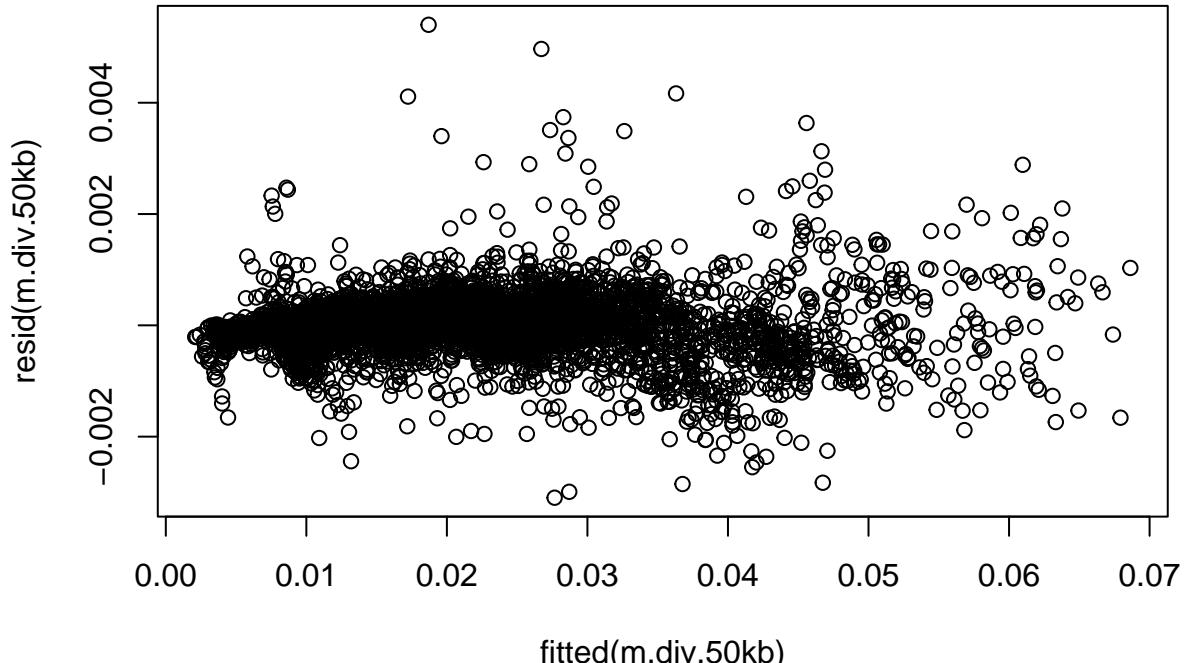
2.1.11 all replicates:

```

inf.lands.50kb.all <- rbind(inf.lands.50kb.rep_1, inf.lands.50kb.rep_2, inf.lands.50kb.rep_3, inf.lands

m.div.50kb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)*as.factor(Replicate), data = inf.l
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.3249, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##

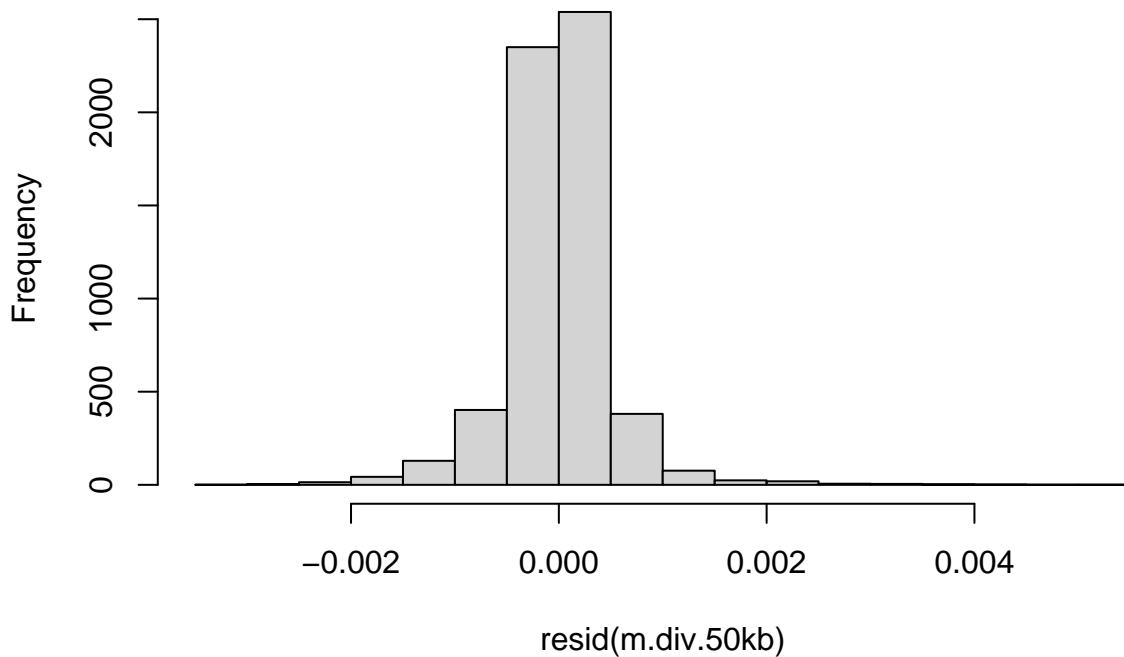
```

```

## data: m.div.50kb
## HMC = 0.50366, p-value = 0.656
hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```

m.div.50kb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replica)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as.factor(Replica)

```

```

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

```

```

##          df      AIC
## m.div.50kb   51 -73877.32
## m.div.50kb.2 61 -73868.89
## m.div.50kb.3 71 -73992.94

```

```

summary(m.div.50kb)

```

```

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##     as.factor(Replicate), data = inf.lands.50kb.all)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -0.0030973 -0.0002036  0.0000076  0.0002133  0.0054007
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2.043e-02  2.101e-05 972.548 < 2e-16 ***
## thetaS                     1.041e-02  2.110e-05 493.438 < 2e-16 ***
## rhoS                      -5.658e-06 2.093e-05   -0.270  0.78691

```

```

## tmrcaS          2.854e-03  2.172e-05 131.441 < 2e-16 ***
## as.factor(Replicate)2 -2.363e-06  2.968e-05 -0.080  0.93653
## as.factor(Replicate)3  1.266e-04  2.968e-05  4.266  2.02e-05 ***
## as.factor(Replicate)4  1.793e-04  2.961e-05  6.054  1.50e-09 ***
## as.factor(Replicate)5  3.524e-05  2.963e-05  1.189  0.23433
## as.factor(Replicate)6  3.133e-05  2.964e-05  1.057  0.29053
## as.factor(Replicate)7  3.036e-05  2.964e-05  1.024  0.30573
## as.factor(Replicate)8  2.651e-04  2.963e-05  8.947 < 2e-16 ***
## as.factor(Replicate)9 -5.825e-05  2.967e-05 -1.963  0.04970 *
## as.factor(Replicate)10 4.479e-05  2.975e-05  1.506  0.13220
## thetaS:tmrcaS      1.473e-03  1.997e-05 73.755 < 2e-16 ***
## thetaS:as.factor(Replicate)2 -1.097e-06  2.979e-05 -0.037  0.97063
## thetaS:as.factor(Replicate)3  1.365e-04  2.983e-05  4.576  4.84e-06 ***
## thetaS:as.factor(Replicate)4  3.112e-04  2.971e-05 10.476 < 2e-16 ***
## thetaS:as.factor(Replicate)5  1.457e-04  2.974e-05  4.899  9.88e-07 ***
## thetaS:as.factor(Replicate)6  1.453e-04  2.973e-05  4.887  1.05e-06 ***
## thetaS:as.factor(Replicate)7  6.703e-05  2.975e-05  2.254  0.02426 *
## thetaS:as.factor(Replicate)8  2.469e-04  2.977e-05  8.293 < 2e-16 ***
## thetaS:as.factor(Replicate)9  8.585e-05  2.978e-05  2.883  0.00396 **
## thetaS:as.factor(Replicate)10 -1.335e-05  2.992e-05 -0.446  0.65540
## rhoS:as.factor(Replicate)2 -8.986e-06  2.962e-05 -0.303  0.76159
## rhoS:as.factor(Replicate)3 -1.179e-05  2.960e-05 -0.398  0.69036
## rhoS:as.factor(Replicate)4 -8.321e-06  2.966e-05 -0.281  0.77904
## rhoS:as.factor(Replicate)5 -2.745e-06  2.965e-05 -0.093  0.92623
## rhoS:as.factor(Replicate)6  1.791e-05  2.974e-05  0.602  0.54700
## rhoS:as.factor(Replicate)7 -4.435e-05  2.956e-05 -1.500  0.13364
## rhoS:as.factor(Replicate)8 -2.925e-06  2.966e-05 -0.099  0.92144
## rhoS:as.factor(Replicate)9  1.982e-05  2.968e-05  0.668  0.50422
## rhoS:as.factor(Replicate)10 -2.229e-05  2.969e-05 -0.751  0.45282
## tmrcaS:as.factor(Replicate)2 -1.264e-04  3.069e-05 -4.119  3.86e-05 ***
## tmrcaS:as.factor(Replicate)3  2.399e-05  3.035e-05  0.791  0.42926
## tmrcaS:as.factor(Replicate)4  5.082e-05  3.032e-05  1.676  0.09379 .
## tmrcaS:as.factor(Replicate)5 -8.629e-05  3.035e-05 -2.844  0.00448 **
## tmrcaS:as.factor(Replicate)6 -1.761e-04  3.056e-05 -5.762  8.72e-09 ***
## tmrcaS:as.factor(Replicate)7 -1.481e-04  3.054e-05 -4.849  1.27e-06 ***
## tmrcaS:as.factor(Replicate)8  1.358e-05  3.049e-05  0.445  0.65611
## tmrcaS:as.factor(Replicate)9 -2.674e-04  3.041e-05 -8.794 < 2e-16 ***
## tmrcaS:as.factor(Replicate)10 -1.141e-06  3.103e-05 -0.037  0.97068
## thetaS:tmrcaS:as.factor(Replicate)2 -8.373e-05  2.693e-05 -3.109  0.00189 **
## thetaS:tmrcaS:as.factor(Replicate)3 -5.557e-05  2.678e-05 -2.075  0.03805 *
## thetaS:tmrcaS:as.factor(Replicate)4  1.888e-05  2.771e-05  0.681  0.49559
## thetaS:tmrcaS:as.factor(Replicate)5 -6.033e-05  2.652e-05 -2.275  0.02294 *
## thetaS:tmrcaS:as.factor(Replicate)6 -1.164e-04  2.701e-05 -4.310  1.66e-05 ***
## thetaS:tmrcaS:as.factor(Replicate)7 -1.180e-04  2.751e-05 -4.290  1.81e-05 ***
## thetaS:tmrcaS:as.factor(Replicate)8 -4.269e-06  2.693e-05 -0.158  0.87407
## thetaS:tmrcaS:as.factor(Replicate)9 -1.600e-04  2.683e-05 -5.963  2.61e-09 ***
## thetaS:tmrcaS:as.factor(Replicate)10 -1.056e-05  2.754e-05 -0.383  0.70146
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0005107 on 5950 degrees of freedom
## Multiple R-squared:  0.9979, Adjusted R-squared:  0.9979
## F-statistic: 5.859e+04 on 49 and 5950 DF,  p-value: < 2.2e-16

```

2.1.12 Plots

```

scale.3d <- function(x) sprintf("%.3f", x)

rho.plot <- as.data.frame(cbind(inf.lands.50kb.rep_1$bin,
                                sim.rho.50kb$sim,
                                inf.lands.50kb.rep_1$rho,
                                inf.lands.50kb.rep_2$rho,
                                inf.lands.50kb.rep_3$rho,
                                inf.lands.50kb.rep_4$rho,
                                inf.lands.50kb.rep_5$rho,
                                inf.lands.50kb.rep_6$rho,
                                inf.lands.50kb.rep_7$rho,
                                inf.lands.50kb.rep_8$rho,
                                inf.lands.50kb.rep_9$rho,
                                inf.lands.50kb.rep_10$rho))

rho.plot[,3:ncol(rho.plot)] <- 1.53 * rho.plot[,3:ncol(rho.plot)] # scaling because of SCRM NO vs Ne

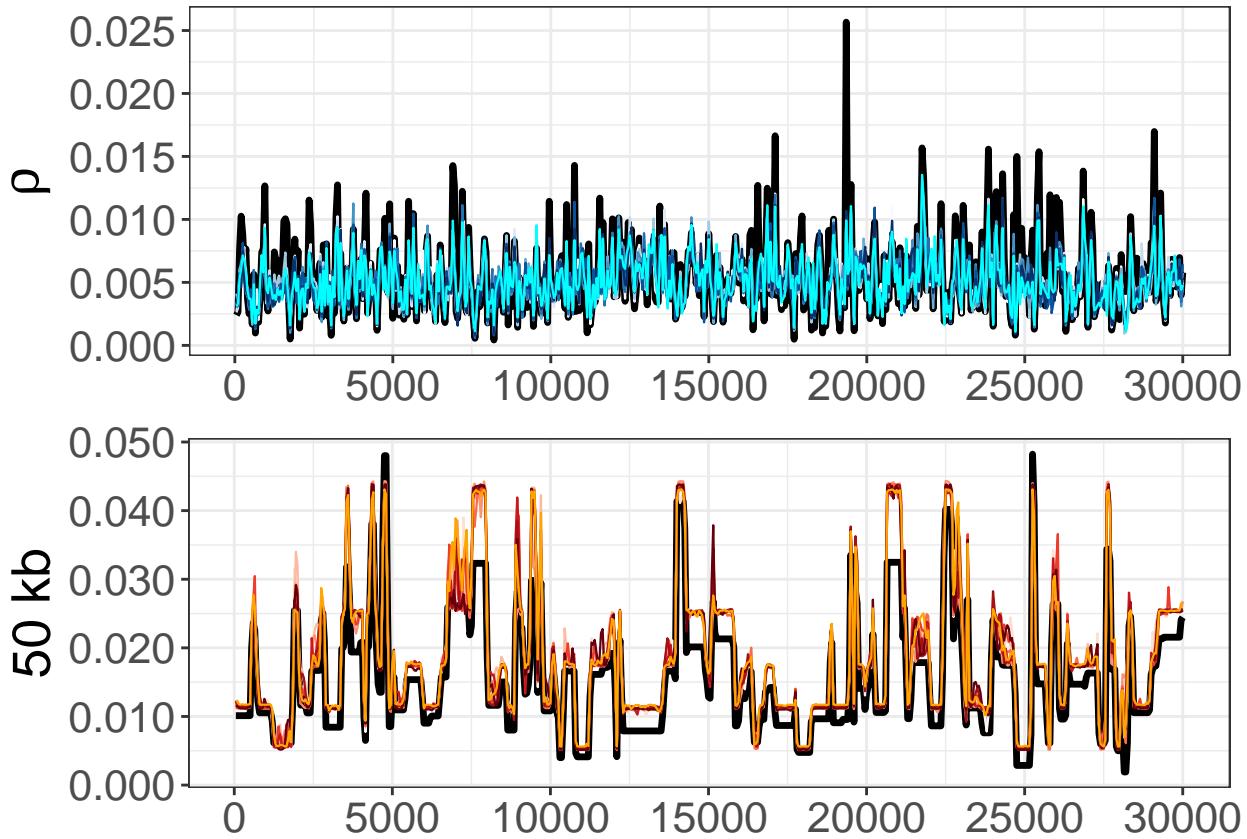
names(rho.plot) <- c("bin", "sim", reps)
molten.rho <- melt(rho.plot, id.vars = "bin")
rho.map.50kb <- ggplot(data = molten.rho, aes(x = bin * 50, y = value, colour = variable)) + theme_bw()
rho.map.50kb <- rho.map.50kb + geom_line(data = molten.rho, aes(size = variable)) + scale_size_manual(values = c(1, 1.5, 2))
rho.map.50kb <- rho.map.50kb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Blues")))
rho.map.50kb <- rho.map.50kb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
rho.map.50kb <- rho.map.50kb + labs(title = NULL, x = NULL, y = expression(rho))
rho.map.50kb <- rho.map.50kb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 16))

theta.plot <- as.data.frame(cbind(inf.lands.50kb.rep_1$bin,
                                    sim.theta.50kb$sim,
                                    inf.lands.50kb.rep_1$theta,
                                    inf.lands.50kb.rep_2$theta,
                                    inf.lands.50kb.rep_3$theta,
                                    inf.lands.50kb.rep_4$theta,
                                    inf.lands.50kb.rep_5$theta,
                                    inf.lands.50kb.rep_6$theta,
                                    inf.lands.50kb.rep_7$theta,
                                    inf.lands.50kb.rep_8$theta,
                                    inf.lands.50kb.rep_9$theta,
                                    inf.lands.50kb.rep_10$theta))

names(theta.plot) <- c("bin", "sim", reps)
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.50kb <- ggplot(data = molten.theta, aes(x = bin * 50, y = value, colour = variable)) + theme_bw()
theta.map.50kb <- theta.map.50kb + geom_line(data = molten.theta, aes(size = variable)) + scale_size_manual(values = c(1, 1.5, 2))
theta.map.50kb <- theta.map.50kb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Reds")))
theta.map.50kb <- theta.map.50kb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
theta.map.50kb <- theta.map.50kb + labs(title = NULL, x = NULL, y = "50 kb")
theta.map.50kb <- theta.map.50kb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 16))

plot_grid(rho.map.50kb, theta.map.50kb, nrow = 2, ncol = 1)

```



2.2 200 kb scale

```
r2.inf.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.inf.200kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.inf.200kb) <- reps

# sim landscapes
sim.rho.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.rho.2e+05.txt")
sim.theta.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.theta.2e+05.txt")
sim.lands.200kb <- as.data.frame(cbind(sim.theta.200kb$sim, sim.rho.200kb$sim))
names(sim.lands.200kb ) <- c("theta", "rho")
```

2.2.1 Replicate 1

```
p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_1/rs.pair_1.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
```

```

##  

## data: sim.theta.200kb$sim and theta.200kb$sample_mean  

## S = 8264.3, p-value < 2.2e-16  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## 0.9853072  

inf.lands.200kb.rep_1 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_1) <- c("diversity", "theta", "rho", "tmrca")  

# standardizing
inf.lands.200kb.rep_1$thetaS <- (inf.lands.200kb.rep_1$theta - mean(inf.lands.200kb.rep_1$theta)) / sd(inf.lands.200kb.rep_1$theta)
inf.lands.200kb.rep_1$tmrcaS <- (inf.lands.200kb.rep_1$tmrca - mean(inf.lands.200kb.rep_1$tmrca)) / sd(inf.lands.200kb.rep_1$tmrca)
inf.lands.200kb.rep_1$rhoS <- (inf.lands.200kb.rep_1$rho - mean(inf.lands.200kb.rep_1$rho)) / sd(inf.lands.200kb.rep_1$rho)  

inf.lands.200kb.rep_1$bin <- 1:nrow(inf.lands.200kb.rep_1)  

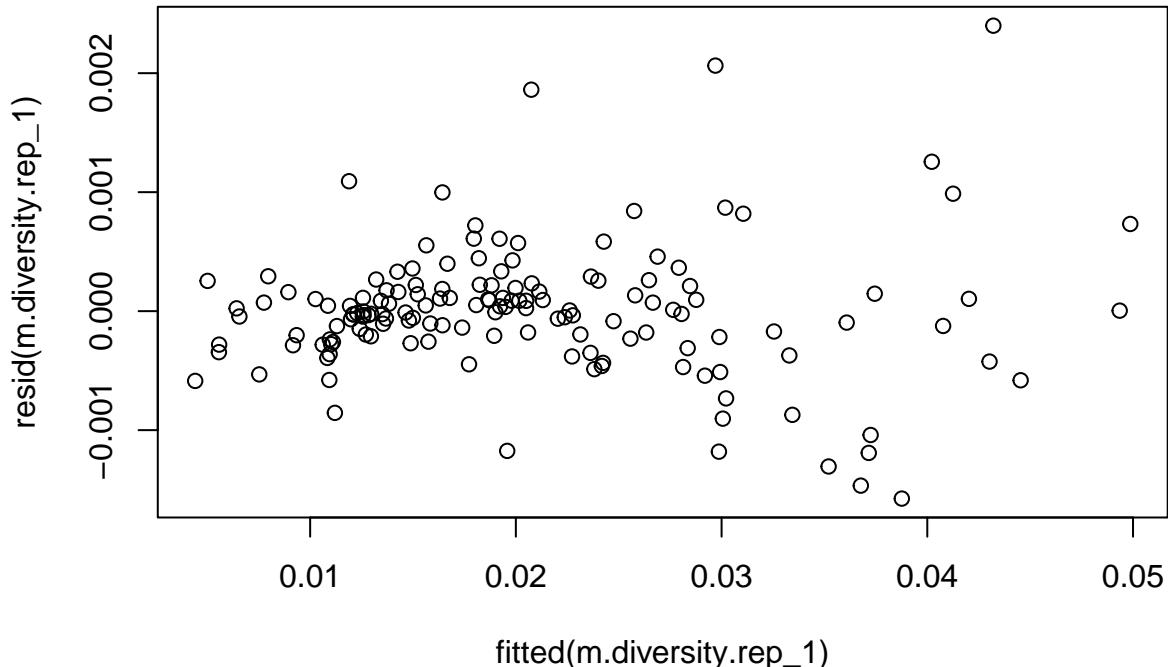
  

inf.lands.200kb.rep_1$Replicate <- 1  

m.diversity.rep_1 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_1)
plot(resid(m.diversity.rep_1) ~ fitted(m.diversity.rep_1))

```



```

dwtest(m.diversity.rep_1)
  

##  

## Durbin-Watson test  

##  

## data: m.diversity.rep_1  

## DW = 1.8429, p-value = 0.1407  

## alternative hypothesis: true autocorrelation is greater than 0

```

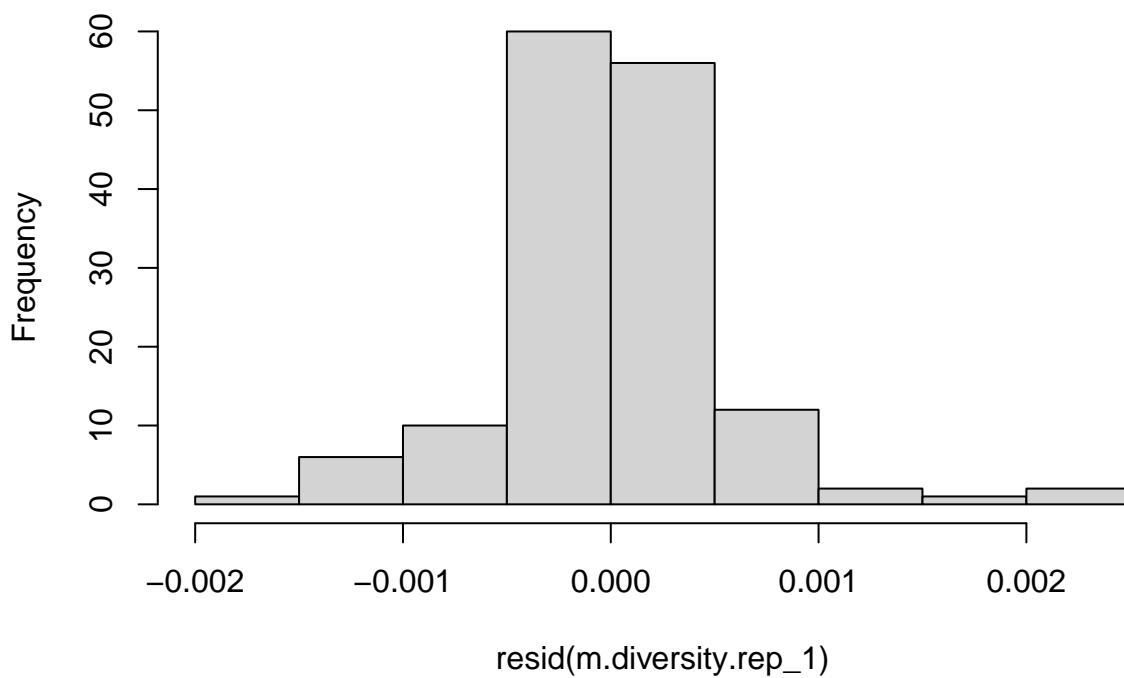
```

hmctest(m.diversity.rep_1)

##
##  Harrison-McCabe test
##
## data: m.diversity.rep_1
## HMC = 0.49224, p-value = 0.457
hist(resid(m.diversity.rep_1))

```

Histogram of resid(m.diversity.rep_1)



```
summary(m.diversity.rep_1)
```

```

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##      data = inf.lands.200kb.rep_1)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.575e-03 -2.359e-04 -1.035e-05  1.834e-04  2.399e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.049e-02  4.583e-05 447.178 <2e-16 ***
## thetaS       9.304e-03  4.600e-05 202.263 <2e-16 ***
## rhoS        1.063e-05  4.731e-05   0.225   0.823
## tmrcaS      2.164e-03  5.156e-05  41.966 <2e-16 ***
## thetaS:tmrcaS 1.069e-03  4.530e-05  23.595 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

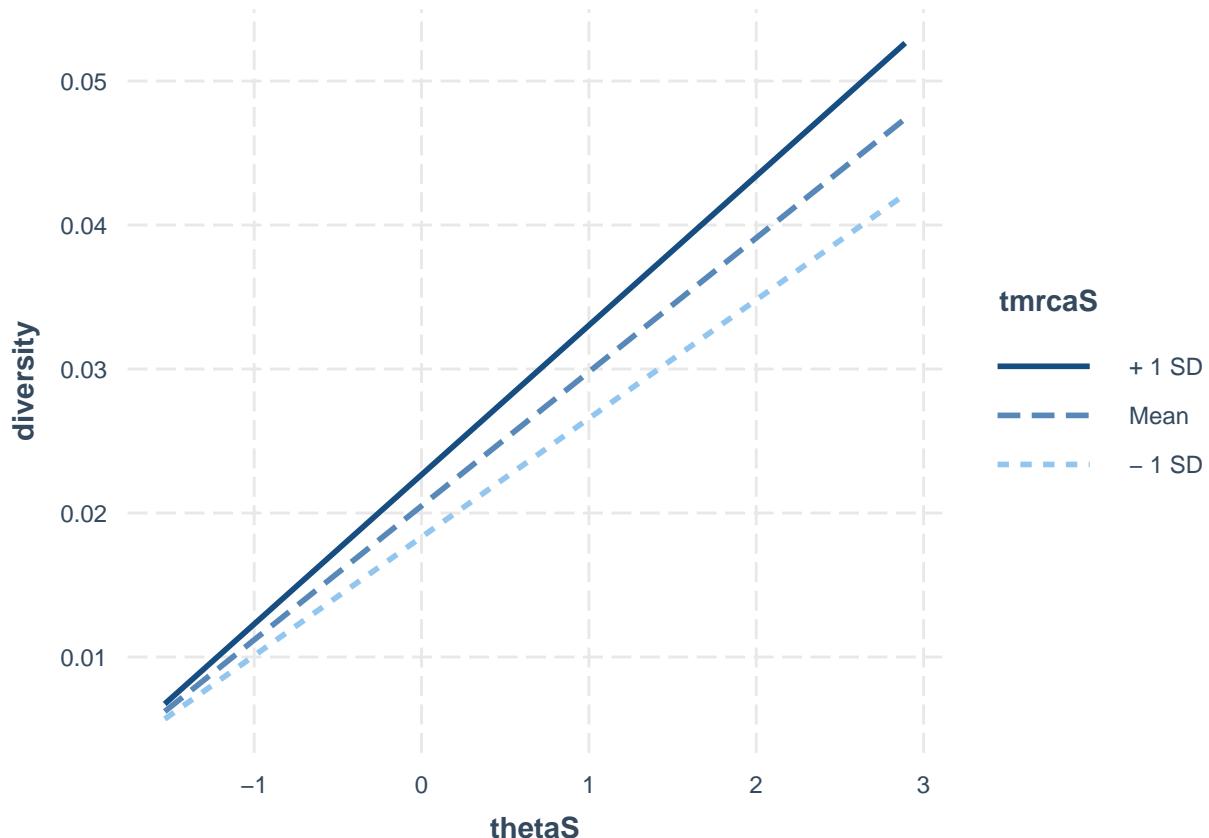
## 
## Residual standard error: 0.0005573 on 145 degrees of freedom
## Multiple R-squared:  0.9968, Adjusted R-squared:  0.9967
## F-statistic: 1.131e+04 on 4 and 145 DF,  p-value: < 2.2e-16
vif(m.diversity.rep_1)

```

```

##          thetaS          rhoS        tmrcaS thetaS:tmrcaS
## 1.015202    1.073614    1.275300     1.184066
interact_plot(m.diversity.rep_1, pred = thetaS, modx= tmrcaS)

```



```

g.rep_1 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                 data = inf.lands.200kb.rep_1, cor = corAR1(0, ~bin), method = "ML")

```

```
summary(g.rep_1)
```

```

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_1
##      AIC      BIC   logLik
## -1814.128 -1793.054  914.0641
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##           Phi
## 0.08562895
##

```

```

## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020495842 4.988827e-05 410.8349 0.0000
## thetaS       0.009311061 4.778895e-05 194.8371 0.0000
## tmrcaS      0.002162321 5.209260e-05  41.5092 0.0000
## rhoS        0.000016367 4.723723e-05   0.3465 0.7295
## thetaS:tmrcaS 0.001058085 4.650120e-05  22.7539 0.0000
##
## Correlation:
##            (Intr) thetaS tmrcaS rhoS
## thetaS     -0.001
## tmrcaS    -0.043 -0.110
## rhoS       -0.010 -0.009  0.248
## thetaS:tmrcaS -0.113  0.010  0.375  0.090
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.94983846 -0.42035716 -0.01013693  0.33115763  4.40016170
##
## Residual standard error: 0.0005481049
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_1)

##          thetaS         tmrcaS         rhoS thetaS:tmrcaS
##          1.015853       1.249427       1.066075       1.167458

g.rep_1.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_1, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_1.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_1
##      AIC      BIC      logLik
## -1432.216 -1417.163  721.1082
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## 0.2090144
##
## Coefficients:
##              Value    Std.Error  t-value p-value
## (Intercept) 0.020629702 0.0002057241 100.27847 0.0000
## thetaS       0.009546181 0.0001792629  53.25239 0.0000
## rhoS        -0.000425486 0.0001636252  -2.60037 0.0103
##
## Correlation:
##            (Intr) thetaS
## thetaS  0.000
## rhoS   0.001  0.015
##
```

```

## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.46691260 -0.42444799  0.03262027  0.46216734  3.67858710
##
## Residual standard error: 0.002021045
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_1)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.200kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 1] <- anova.diversity$VarExp[4] * 100

```

2.2.2 Replicate 2

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_2/rs.pair_2.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 6148.2, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9890693

inf.lands.200kb.rep_2 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_2) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_2$thetaS <- (inf.lands.200kb.rep_2$theta - mean(inf.lands.200kb.rep_2$theta)) / sd(inf.lands.200kb.rep_2$theta)
inf.lands.200kb.rep_2$tmrcaS <- (inf.lands.200kb.rep_2$tmrca - mean(inf.lands.200kb.rep_2$tmrca)) / sd(inf.lands.200kb.rep_2$tmrca)
inf.lands.200kb.rep_2$rhoS <- (inf.lands.200kb.rep_2$rho - mean(inf.lands.200kb.rep_2$rho)) / sd(inf.lands.200kb.rep_2$rho)

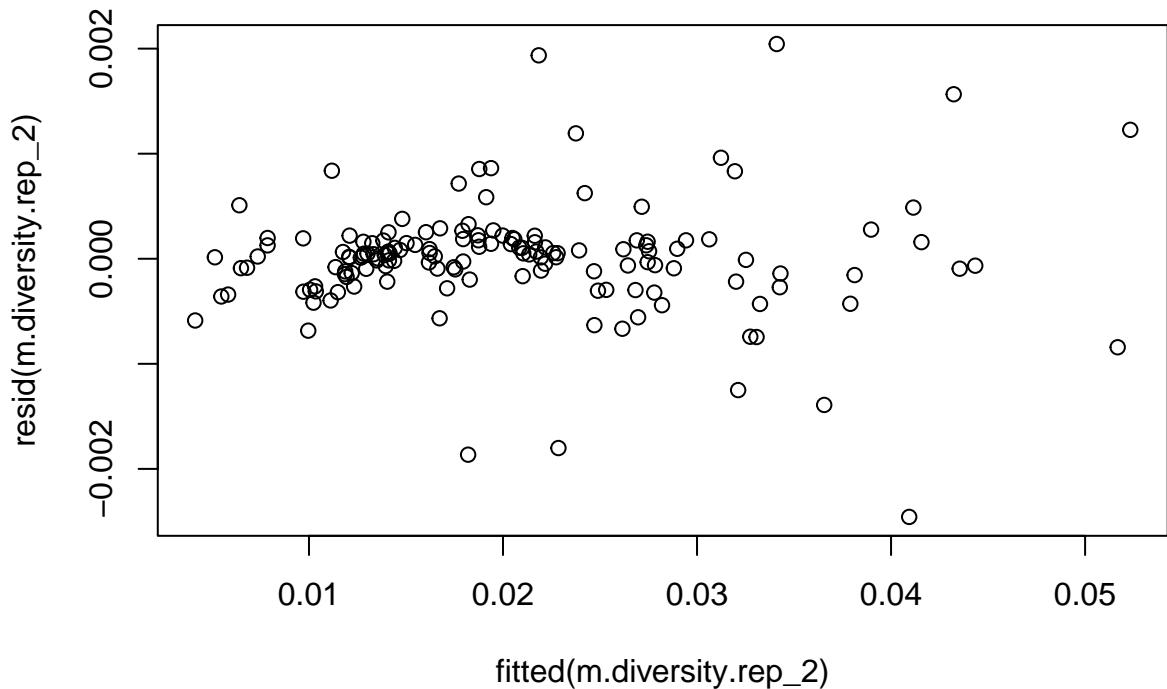
inf.lands.200kb.rep_2$bin <- 1:nrow(inf.lands.200kb.rep_2)

inf.lands.200kb.rep_2$Replicate <- 2

m.diversity.rep_2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_2)

plot(resid(m.diversity.rep_2) ~ fitted(m.diversity.rep_2))

```



```

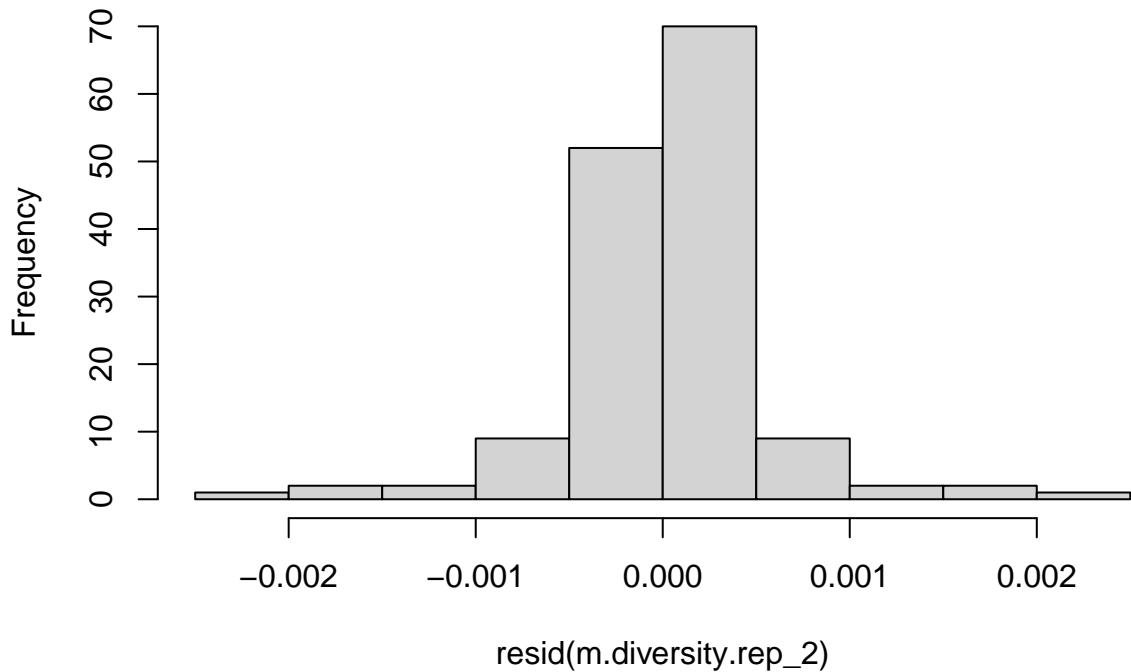
dwtest(m.diversity.rep_2)

##
## Durbin-Watson test
##
## data: m.diversity.rep_2
## DW = 1.7156, p-value = 0.03159
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_2)

##
## Harrison-McCabe test
##
## data: m.diversity.rep_2
## HMC = 0.50531, p-value = 0.509
hist(resid(m.diversity.rep_2))

```

Histogram of resid(m.diversity.rep_2)



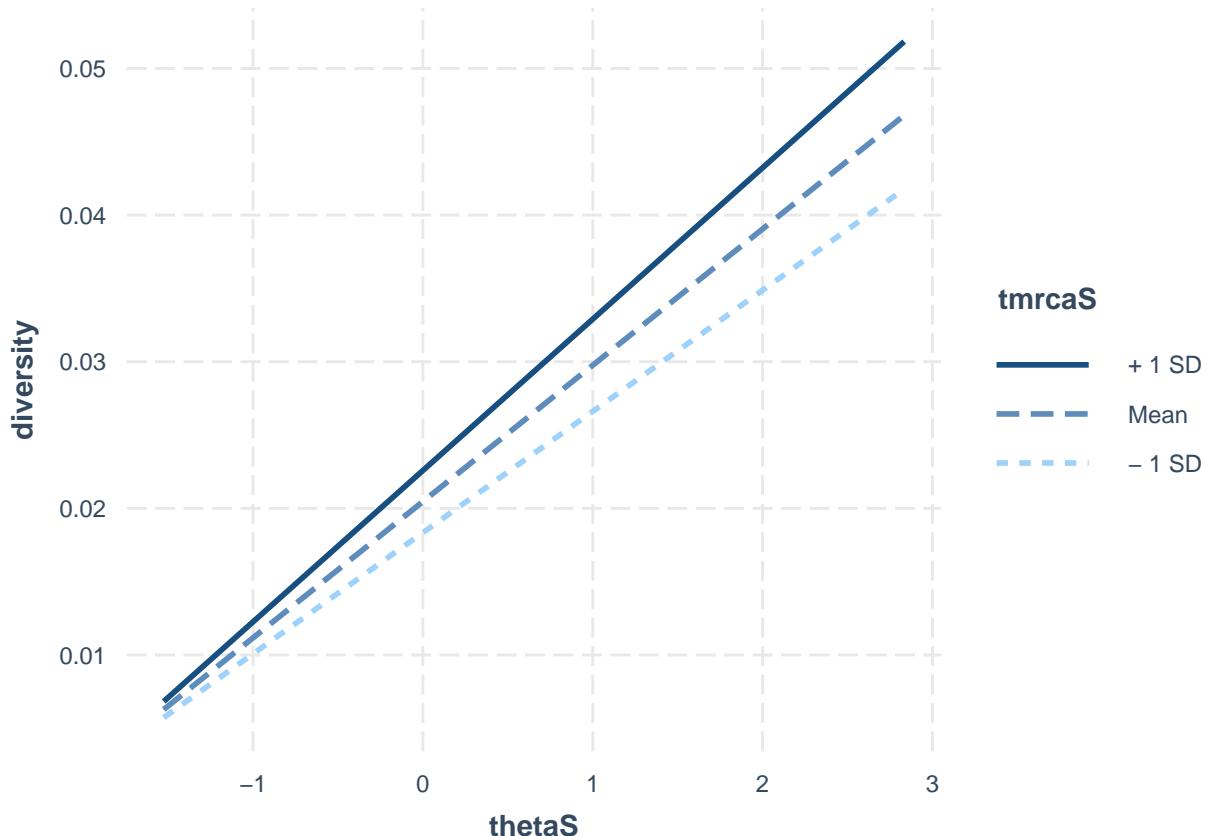
```
summary(m.diversity.rep_2)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.200kb.rep_2)
##
## Residuals:
##       Min         1Q      Median         3Q        Max
## -2.457e-03 -1.632e-04  2.314e-05  1.700e-04  2.044e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.046e-02 4.515e-05 453.271 <2e-16 ***
## thetaS       9.296e-03 4.536e-05 204.913 <2e-16 ***
## rhoS        6.479e-06 4.578e-05   0.142   0.888
## tmrcaS      2.119e-03 5.353e-05  39.582 <2e-16 ***
## thetaS:tmrcaS 1.028e-03 4.397e-05  23.381 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0005487 on 145 degrees of freedom
## Multiple R-squared:  0.9969, Adjusted R-squared:  0.9968
## F-statistic: 1.164e+04 on 4 and 145 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_2)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.018421    1.037185    1.418020    1.364901
```

```
interact_plot(m.diversity.rep_2, pred = thetaS, modx= tmrcaS)
```



```
g.rep_2 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_2, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_2)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_2
##          AIC      BIC    logLik
##     -1821.325 -1800.251  917.6627
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.1654346
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020468080 5.328964e-05 384.0912 0.0000
## thetaS       0.009307885 4.854920e-05 191.7207 0.0000
## tmrcaS       0.002110354 5.491646e-05  38.4284 0.0000
## rhoS        -0.000004254 4.460197e-05  -0.0954 0.9242
## thetaS:tmrcaS 0.000998188 4.498116e-05  22.1912 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.005
## tmrcaS     -0.054 -0.150
## rhoS       -0.013 -0.022  0.171
## thetaS:tmrcaS -0.108 -0.049  0.491  0.125
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.58086608 -0.34056969  0.06376542  0.29976087  3.77133875
##
## Residual standard error: 0.0005405587
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_2)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.023970    1.366753    1.032349    1.320968

g.rep_2.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_2, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_2.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_2
##      AIC      BIC logLik
## -1465.219 -1450.166 737.6095
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3137584
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020600840 0.0002121094 97.12366 0.0000
## thetaS      0.009645554 0.0001663662 57.97785 0.0000
## rhoS      -0.000279070 0.0001401935 -1.99061 0.0484
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.002  0.001
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.31916797 -0.44159324  0.03266396  0.49987953  3.39180105
##
## Residual standard error: 0.001864311
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_2)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.200kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 2] <- anova.diversity$VarExp[4] * 100

```

2.2.3 Replicate 3

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_3/rs.pair_3.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 9791.4, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9825924

inf.lands.200kb.rep_3 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_3) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_3$thetaS <- (inf.lands.200kb.rep_3$theta - mean(inf.lands.200kb.rep_3$theta)) / sd(inf.lands.200kb.rep_3$theta)
inf.lands.200kb.rep_3$tmrcaS <- (inf.lands.200kb.rep_3$tmrca - mean(inf.lands.200kb.rep_3$tmrca)) / sd(inf.lands.200kb.rep_3$tmrca)
inf.lands.200kb.rep_3$rhoS <- (inf.lands.200kb.rep_3$rho - mean(inf.lands.200kb.rep_3$rho)) / sd(inf.lands.200kb.rep_3$rho)

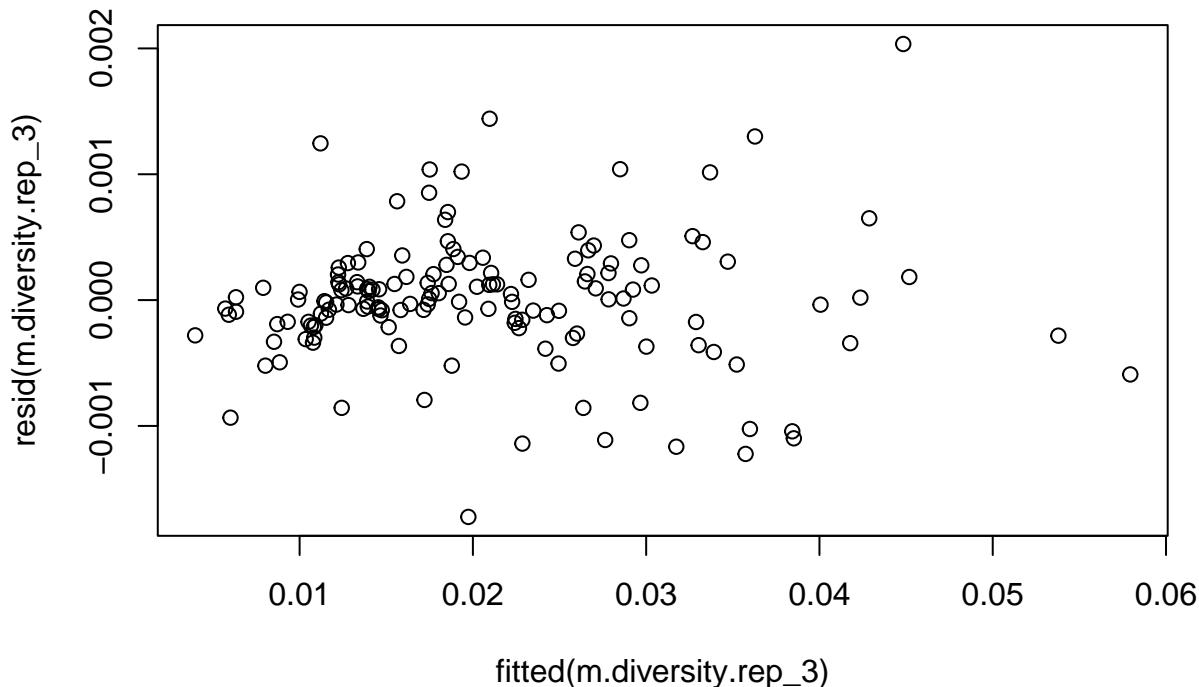
inf.lands.200kb.rep_3$bin <- 1:nrow(inf.lands.200kb.rep_3)

inf.lands.200kb.rep_3$Replicate <- 3

m.diversity.rep_3 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_3)

plot(resid(m.diversity.rep_3)~fitted(m.diversity.rep_3))

```



```

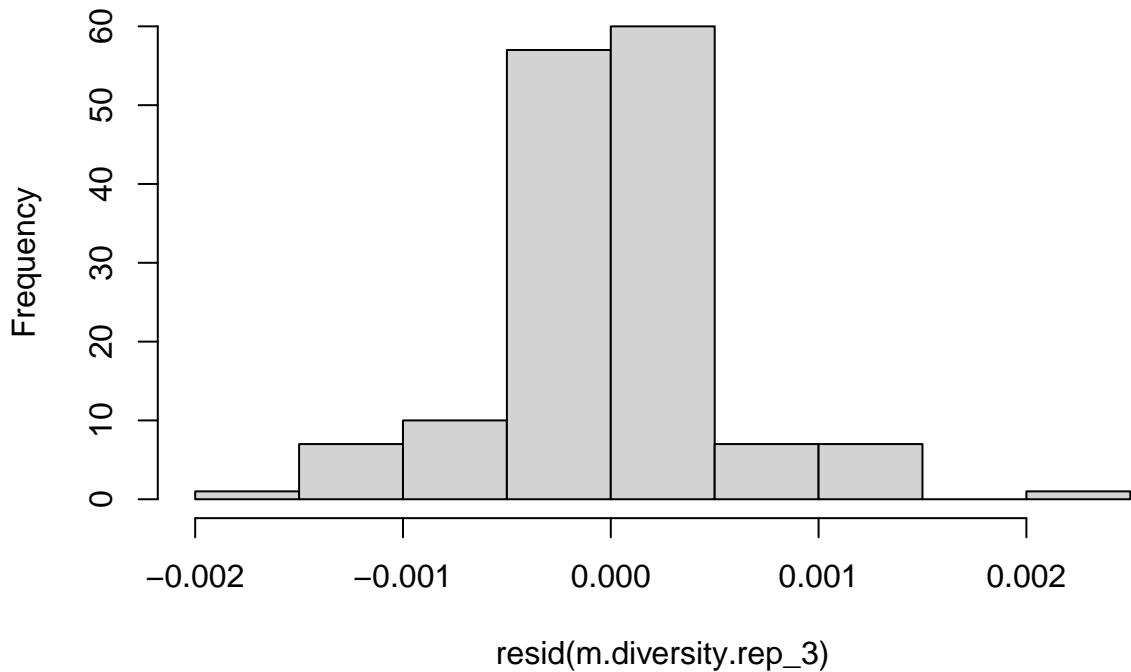
dwtest(m.diversity.rep_3)

##
## Durbin-Watson test
##
## data: m.diversity.rep_3
## DW = 1.7271, p-value = 0.03626
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_3)

##
## Harrison-McCabe test
##
## data: m.diversity.rep_3
## HMC = 0.49269, p-value = 0.436
hist(resid(m.diversity.rep_3))

```

Histogram of resid(m.diversity.rep_3)



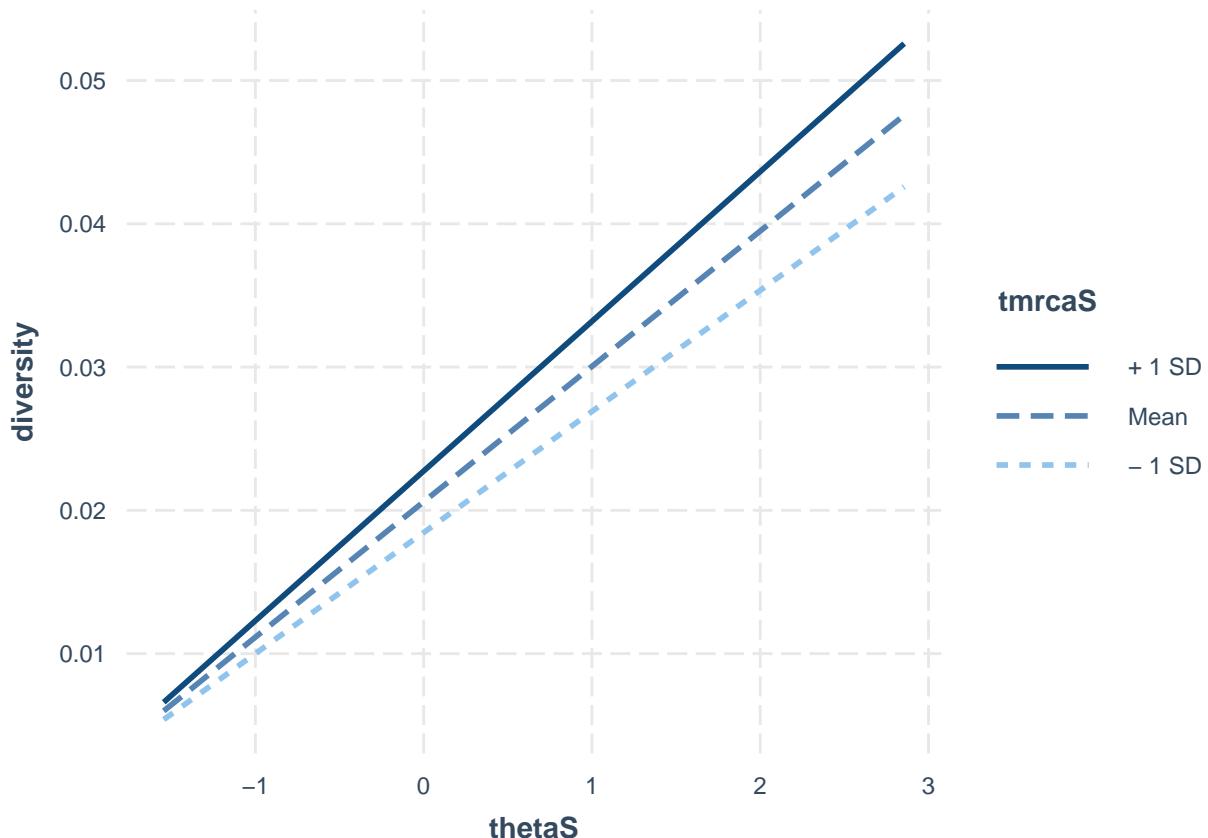
```
summary(m.diversity.rep_3)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_3)  
##  
## Residuals:  
##      Min        1Q     Median        3Q       Max  
## -1.723e-03 -1.975e-04 -2.090e-06  2.053e-04  2.035e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.060e-02 4.271e-05 482.307 <2e-16 ***  
## thetaS       9.450e-03 4.305e-05 219.494 <2e-16 ***  
## rhoS        2.539e-05 4.324e-05   0.587   0.558  
## tmrcaS      2.146e-03 4.450e-05  48.218 <2e-16 ***  
## thetaS:tmrcaS 9.984e-04 3.487e-05  28.629 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005196 on 145 degrees of freedom  
## Multiple R-squared:  0.9974, Adjusted R-squared:  0.9973  
## F-statistic: 1.387e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_3)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.022814    1.031923    1.092620    1.042561
```

```
interact_plot(m.diversity.rep_3, pred = thetaS, modx= tmrcaS)
```



```
g.rep_3 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_3, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_3)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_3
##          AIC      BIC    logLik
##     -1837.259 -1816.184  925.6294
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.1534496
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020600045 4.978633e-05 413.7691 0.0000
## thetaS       0.009461799 4.584821e-05 206.3723 0.0000
## tmrcaS       0.002149192 4.552731e-05  47.2067 0.0000
## rhoS        0.000030344 4.317566e-05    0.7028 0.4833
## thetaS:tmrcaS 0.000979013 3.607400e-05   27.1390 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.006
## tmrcaS     -0.020 -0.153
## rhoS       -0.009 -0.025  0.167
## thetaS:tmrcaS -0.101 -0.061  0.181  0.089
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.38419912 -0.35874981 -0.00849962  0.40321853  4.03279383
##
## Residual standard error: 0.0005116005
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_3)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.025025    1.081264    1.032608    1.039063

g.rep_3.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_3, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_3.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_3
##      AIC      BIC logLik
## -1403.367 -1388.314 706.6834
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.2774686
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020742949 0.0002477221 83.73477 0.000
## thetaS      0.009869059 0.0002025119 48.73324 0.000
## rhoS       -0.000360078 0.0001797499 -2.00322 0.047
##
## Correlation:
##           (Intr) thetaS
## thetaS 0.000
## rhoS   0.001  0.003
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.57656146 -0.41478403  0.08100049  0.42358182  3.69818275
##
## Residual standard error: 0.002264567
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_3)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.200kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 3] <- anova.diversity$VarExp[4] * 100

```

2.2.4 Replicate 4

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_4/rs.pair_4.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 9866.4, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.982459

inf.lands.200kb.rep_4 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_4) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_4$thetaS <- (inf.lands.200kb.rep_4$theta - mean(inf.lands.200kb.rep_4$theta)) / sd(inf.lands.200kb.rep_4$theta)
inf.lands.200kb.rep_4$tmrcaS <- (inf.lands.200kb.rep_4$tmrca - mean(inf.lands.200kb.rep_4$tmrca)) / sd(inf.lands.200kb.rep_4$tmrca)
inf.lands.200kb.rep_4$rhoS <- (inf.lands.200kb.rep_4$rho - mean(inf.lands.200kb.rep_4$rho)) / sd(inf.lands.200kb.rep_4$rho)

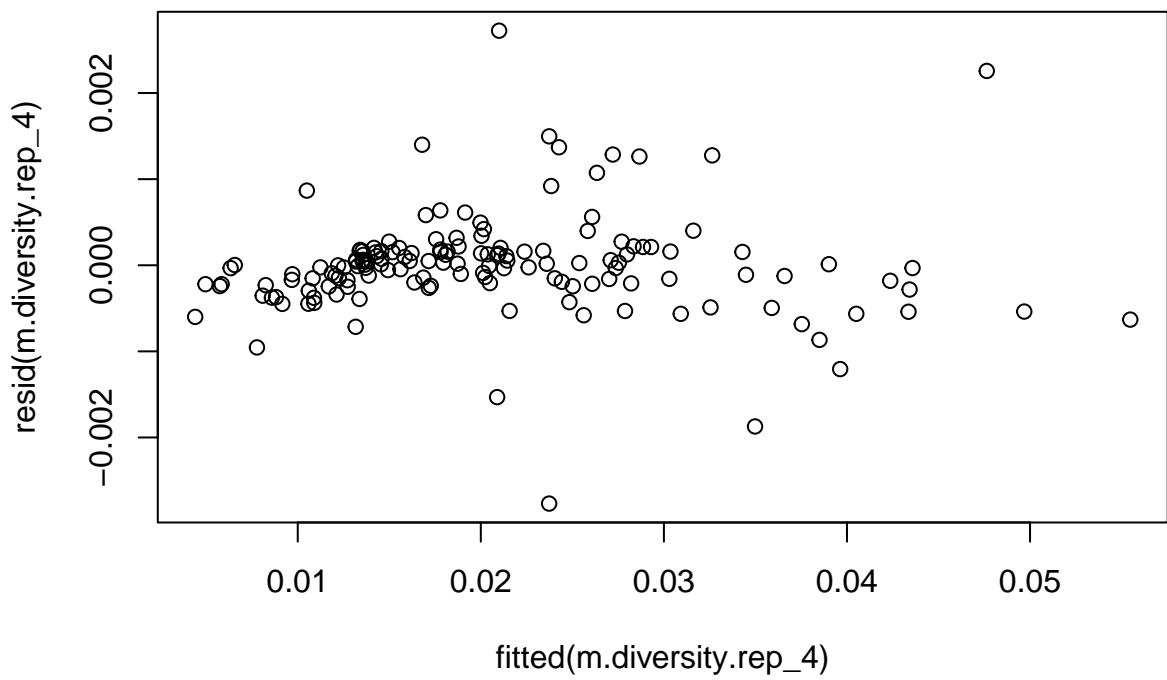
inf.lands.200kb.rep_4$bin <- 1:nrow(inf.lands.200kb.rep_4)

inf.lands.200kb.rep_4$Replicate <- 4

m.diversity.rep_4 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_4)

plot(resid(m.diversity.rep_4)~fitted(m.diversity.rep_4))

```

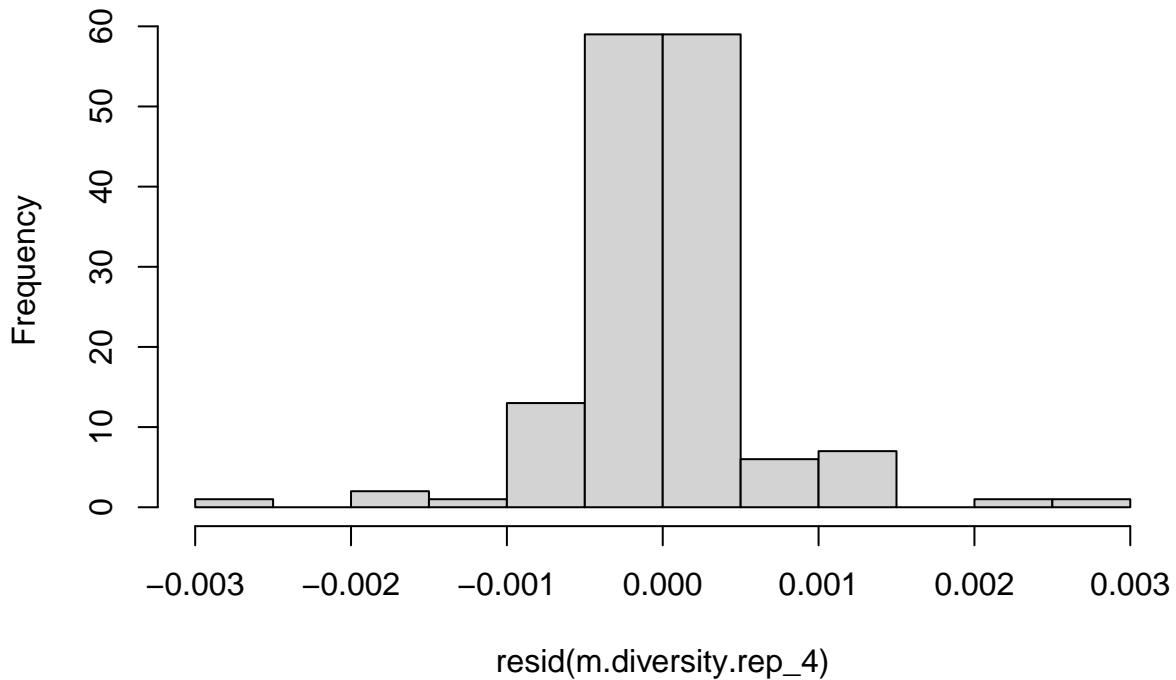


```
dwtest(m.diversity.rep_4)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_4
## DW = 1.6283, p-value = 0.00823
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_4)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_4
## HMC = 0.54628, p-value = 0.801
hist(resid(m.diversity.rep_4))
```

Histogram of resid(m.diversity.rep_4)



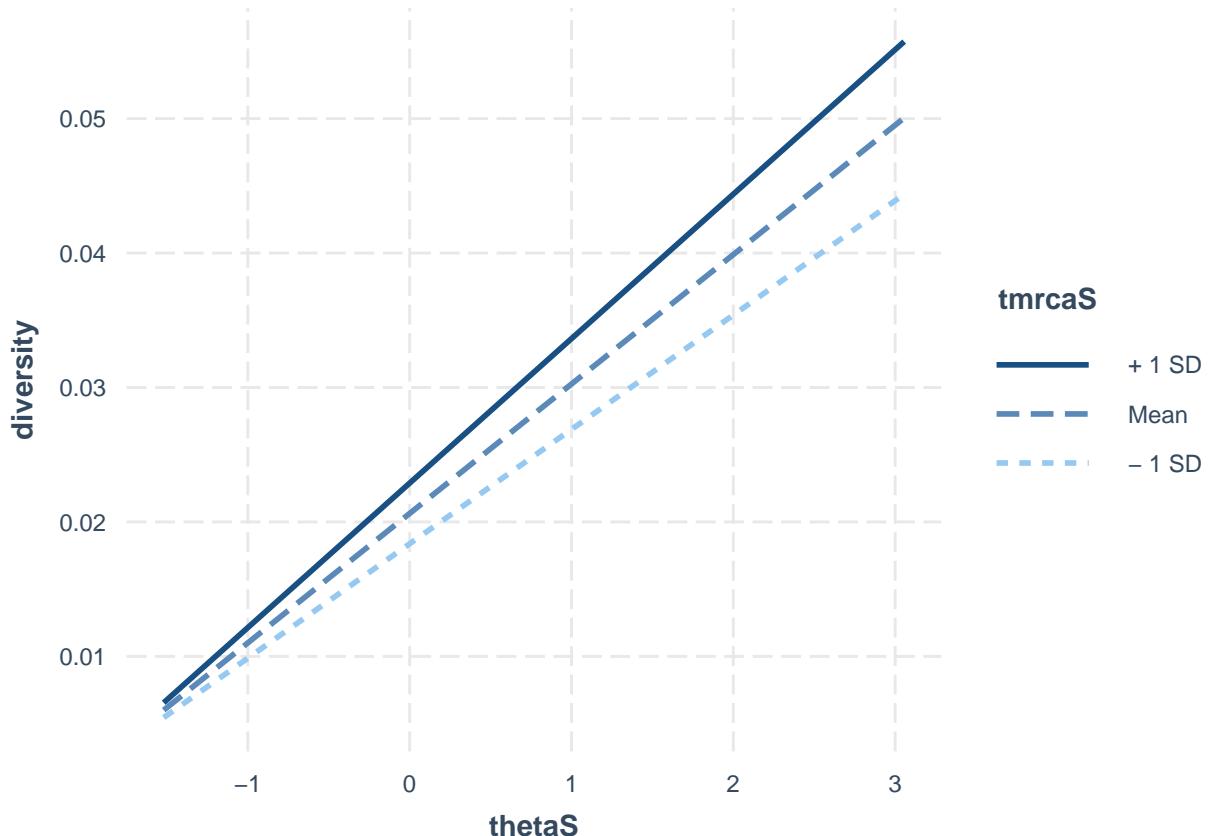
```
summary(m.diversity.rep_4)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_4)  
##  
## Residuals:  
##      Min        1Q     Median        3Q       Max  
## -2.768e-03 -2.282e-04 -4.140e-06  1.588e-04  2.724e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.063e-02 4.965e-05 415.535 <2e-16 ***  
## thetaS       9.627e-03 5.010e-05 192.138 <2e-16 ***  
## rhoS         4.448e-05 5.099e-05   0.872   0.384  
## tmrcaS       2.255e-03 5.329e-05  42.319 <2e-16 ***  
## thetaS:tmrcaS 1.120e-03 5.049e-05  22.178 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006075 on 145 degrees of freedom  
## Multiple R-squared:  0.9963, Adjusted R-squared:  0.9962  
## F-statistic:  9799 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_4)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.013615 1.049736 1.146572 1.107550
```

```
interact_plot(m.diversity.rep_4, pred = thetaS, modx= tmrcaS)
```



```
g.rep_4 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_4, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_4)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_4
##          AIC      BIC    logLik
##     -1792.908 -1771.834  903.4542
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.1996946
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020634635 6.076133e-05 339.6014 0.0000
## thetaS       0.009603855 5.361677e-05 179.1204 0.0000
## tmrcaS       0.002263942 5.453402e-05  41.5143 0.0000
## rhoS         0.000049037 4.906171e-05    0.9995 0.3192
## thetaS:tmrcaS 0.001095939 5.249914e-05   20.8754 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.003
## tmrcaS     -0.012 -0.039
## rhoS       -0.002  0.018  0.182
## thetaS:tmrcaS -0.040  0.064  0.264  0.027
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.63571446 -0.38925930 -0.02298232  0.24825431  4.56473653
##
## Residual standard error: 0.0005980989
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_4)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.008269    1.115533    1.035414    1.081806

g.rep_4.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_4, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_4.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_4
##      AIC      BIC logLik
## -1406.204 -1391.151 708.1021
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.2791937
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020689764 0.0002459711 84.11461 0.0000
## thetaS      0.009677540 0.0002002974 48.31587 0.0000
## rhoS      -0.000283273 0.0001734135 -1.63351 0.1045
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.00
## rhoS   0.00  0.02
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.9242575 -0.4591282  0.0538119  0.4694468  4.4837294
##
## Residual standard error: 0.002244411
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_4)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.200kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 4] <- anova.diversity$VarExp[4] * 100

```

2.2.5 Replicate 5

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_5/rs.pair_5.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 7360.3, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9869145

inf.lands.200kb.rep_5 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_5) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_5$thetaS <- (inf.lands.200kb.rep_5$theta - mean(inf.lands.200kb.rep_5$theta)) / sd(inf.lands.200kb.rep_5$theta)
inf.lands.200kb.rep_5$tmrcaS <- (inf.lands.200kb.rep_5$tmrca - mean(inf.lands.200kb.rep_5$tmrca)) / sd(inf.lands.200kb.rep_5$tmrca)
inf.lands.200kb.rep_5$rhoS <- (inf.lands.200kb.rep_5$rho - mean(inf.lands.200kb.rep_5$rho)) / sd(inf.lands.200kb.rep_5$rho)

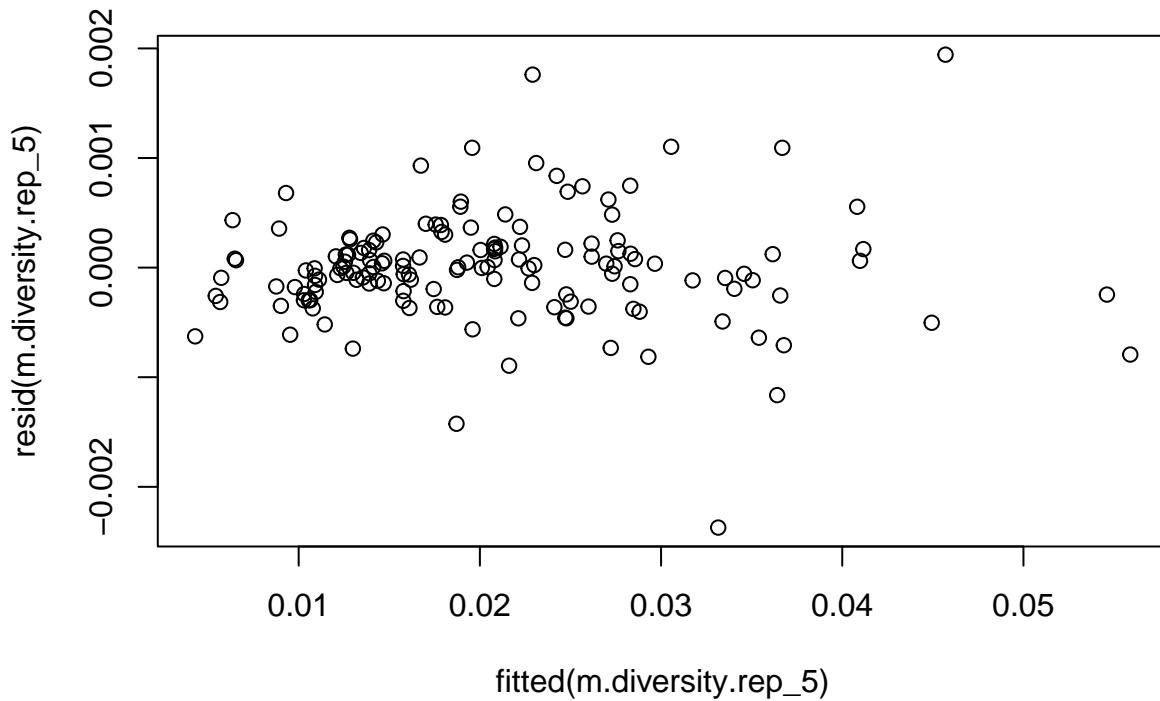
inf.lands.200kb.rep_5$bin <- 1:nrow(inf.lands.200kb.rep_5)

inf.lands.200kb.rep_5$Replicate <- 5

m.diversity.rep_5 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_5)

plot(resid(m.diversity.rep_5)~fitted(m.diversity.rep_5))

```

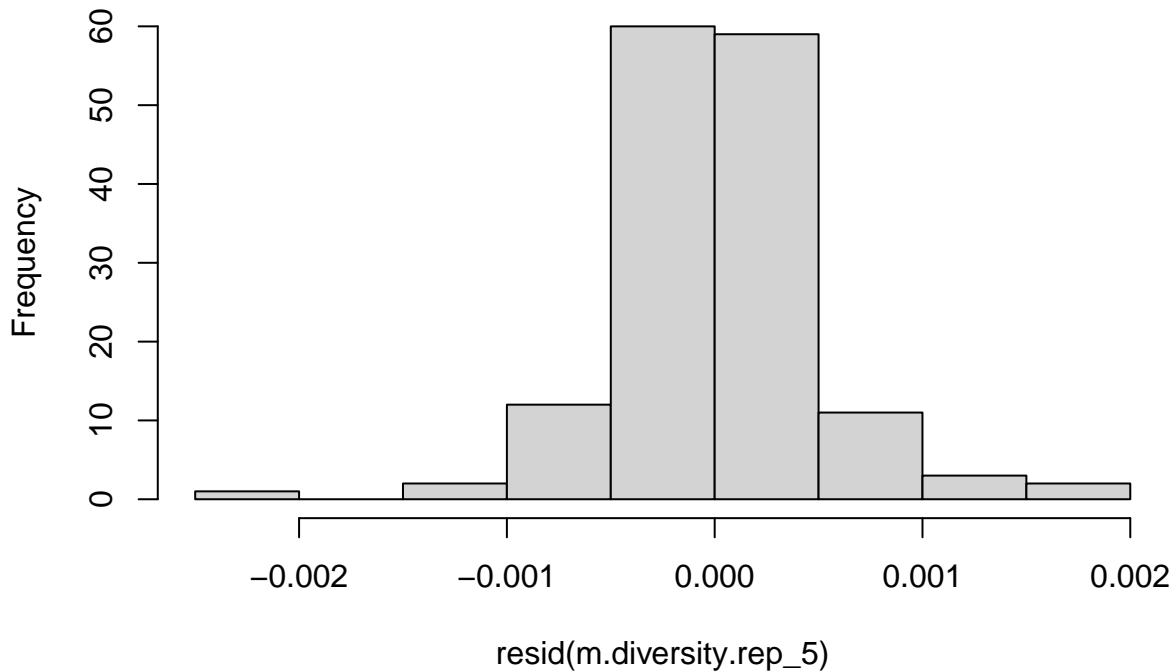


```
dwtest(m.diversity.rep_5)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_5
## DW = 1.473, p-value = 0.0003904
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_5)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_5
## HMC = 0.42356, p-value = 0.101
hist(resid(m.diversity.rep_5))
```

Histogram of resid(m.diversity.rep_5)



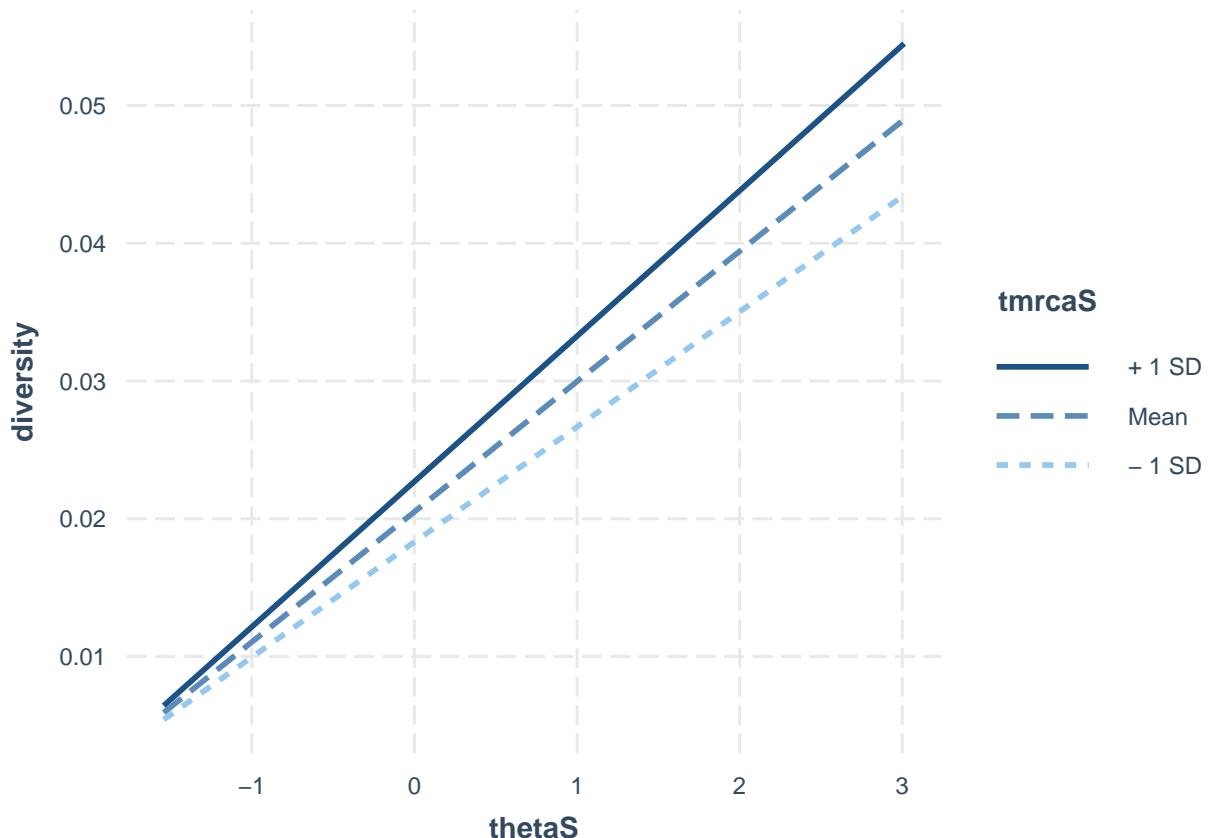
```
summary(m.diversity.rep_5)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_5)  
##  
## Residuals:  
##      Min        1Q     Median        3Q       Max  
## -0.0023718 -0.0002435  0.0000000  0.0001819  0.0019428  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.051e-02 4.143e-05 495.020 <2e-16 ***  
## thetaS       9.457e-03 4.173e-05 226.607 <2e-16 ***  
## rhoS        5.876e-05 4.270e-05   1.376  0.171  
## tmrcaS      2.196e-03 4.469e-05  49.148 <2e-16 ***  
## thetaS:tmrcaS 1.098e-03 3.566e-05  30.786 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005067 on 145 degrees of freedom  
## Multiple R-squared:  0.9974, Adjusted R-squared:  0.9973  
## F-statistic: 1.37e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_5)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.010914    1.058382    1.159252    1.119225
```

```
interact_plot(m.diversity.rep_5, pred = thetaS, modx= tmrcaS)
```



```
g.rep_5 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_5, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_5)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_5
##          AIC      BIC    logLik
##     -1853.508 -1832.434  933.7542
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.2890306
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020509139 5.581452e-05 367.4517 0.0000
## thetaS       0.009435033 4.516016e-05 208.9238 0.0000
## tmrcaS       0.002213089 4.538677e-05  48.7607 0.0000
## rhoS         0.000062103 4.105603e-05    1.5126 0.1325
## thetaS:tmrcaS 0.001068248 3.556924e-05  30.0329 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS     -0.009 -0.098
## rhoS       -0.006 -0.045  0.198
## thetaS:tmrcaS -0.038  0.025  0.256  0.166
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.69081849 -0.45570753 -0.04325154  0.33563272  4.08749773
##
## Residual standard error: 0.0005001316
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_5)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.013524    1.111015    1.057373    1.089764

g.rep_5.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_5, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_5.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_5
##      AIC      BIC logLik
## -1410.762 -1395.709 710.3812
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.2658747
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020571613 0.0002379126 86.46709 0.0000
## thetaS      0.009596944 0.0001963043 48.88811 0.0000
## rhoS      -0.000424637 0.0001764299 -2.40683 0.0173
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.000 -0.032
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.2105114 -0.4827096  0.0393999  0.4735940  3.9755306
##
## Residual standard error: 0.002201973
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_5)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.200kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 5] <- anova.diversity$VarExp[4] * 100

```

2.2.6 Replicate 6

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_6/rs.pair_6.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 7436.3, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9867794

inf.lands.200kb.rep_6 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_6) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_6$thetaS <- (inf.lands.200kb.rep_6$theta - mean(inf.lands.200kb.rep_6$theta)) / sd(inf.lands.200kb.rep_6$theta)
inf.lands.200kb.rep_6$tmrcaS <- (inf.lands.200kb.rep_6$tmrca - mean(inf.lands.200kb.rep_6$tmrca)) / sd(inf.lands.200kb.rep_6$tmrca)
inf.lands.200kb.rep_6$rhoS <- (inf.lands.200kb.rep_6$rho - mean(inf.lands.200kb.rep_6$rho)) / sd(inf.lands.200kb.rep_6$rho)

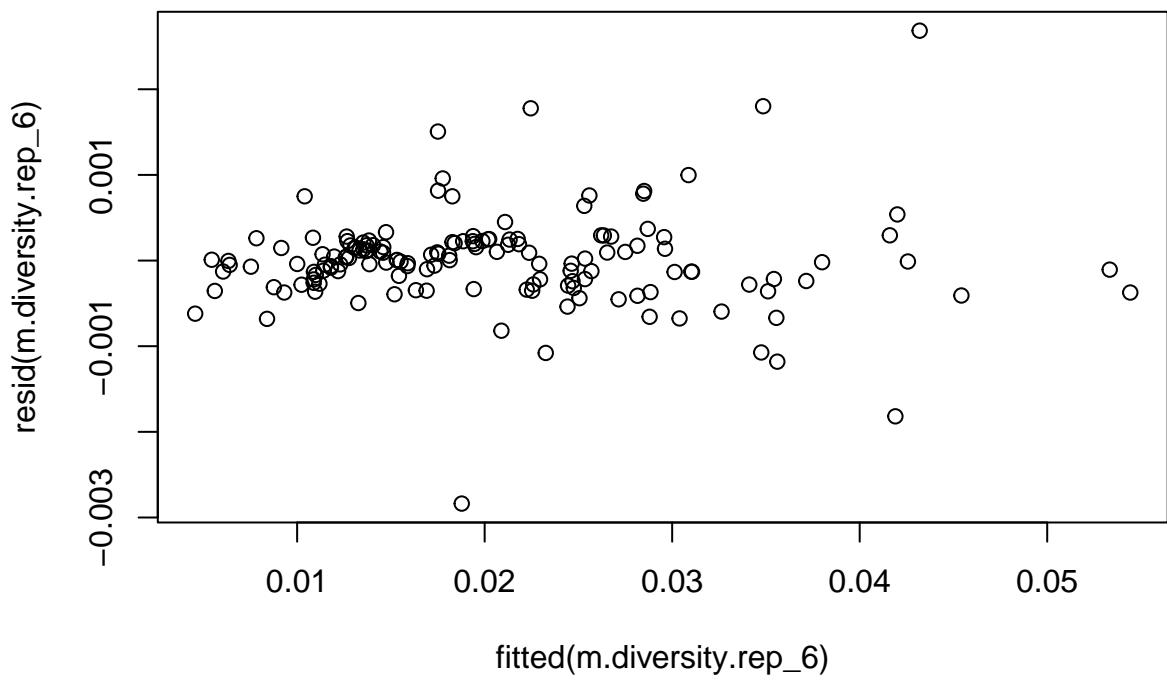
inf.lands.200kb.rep_6$bin <- 1:nrow(inf.lands.200kb.rep_6)

inf.lands.200kb.rep_6$Replicate <- 6

m.diversity.rep_6 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_6)

plot(resid(m.diversity.rep_6)~fitted(m.diversity.rep_6))

```

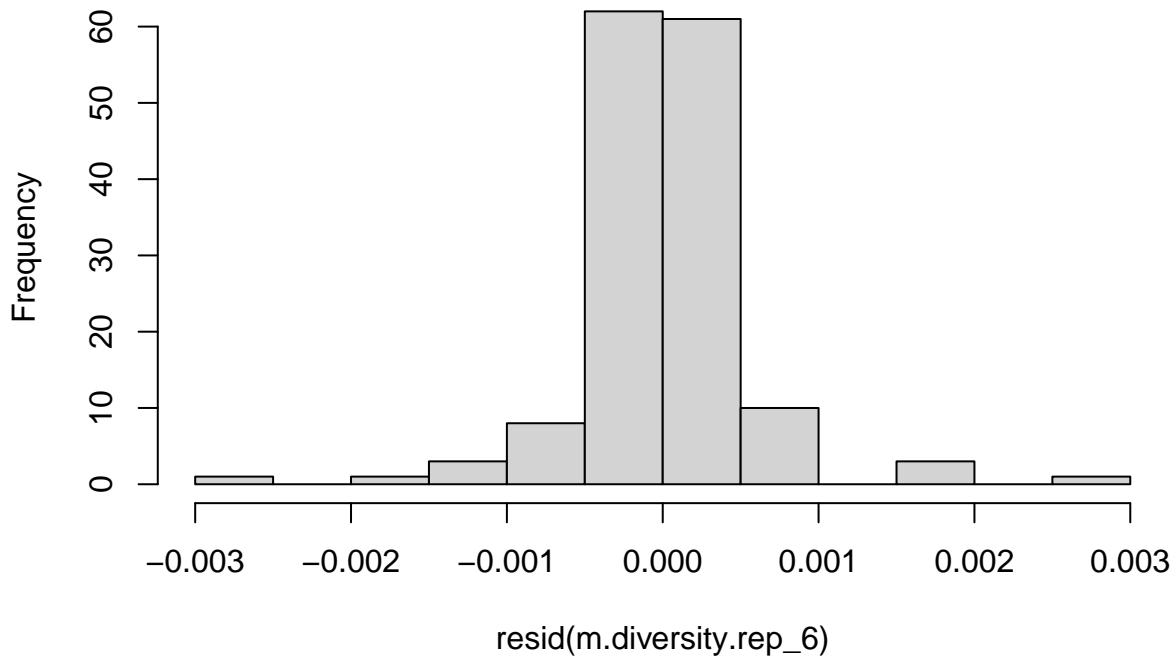


```
dwtest(m.diversity.rep_6)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_6
## DW = 1.6828, p-value = 0.01928
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_6)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_6
## HMC = 0.48734, p-value = 0.404
hist(resid(m.diversity.rep_6))
```

Histogram of resid(m.diversity.rep_6)



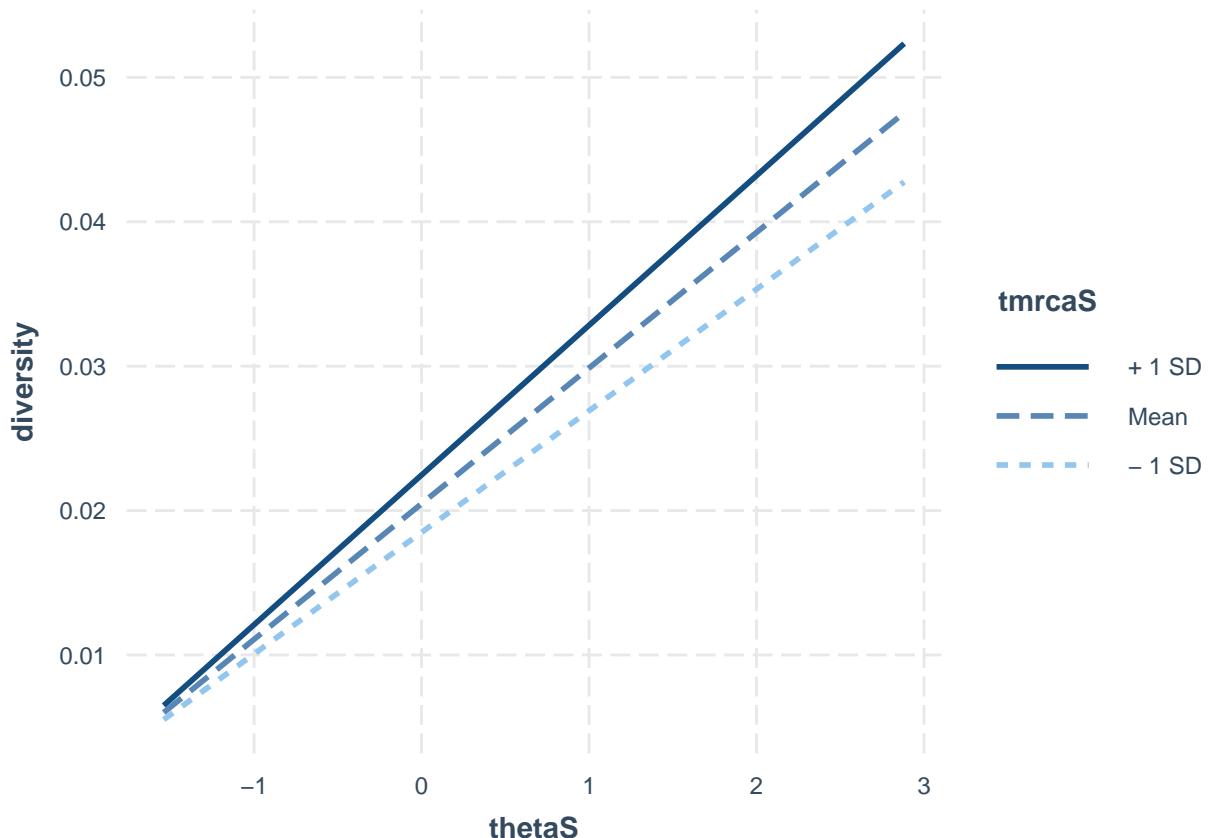
```
summary(m.diversity.rep_6)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_6)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -2.837e-03 -2.547e-04  3.600e-07  2.011e-04  2.684e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.048e-02 4.657e-05 439.670 <2e-16 ***  
## thetaS       9.395e-03 4.679e-05 200.771 <2e-16 ***  
## rhoS        3.816e-05 4.999e-05   0.763   0.447  
## tmrcaS      1.986e-03 5.227e-05  37.991 <2e-16 ***  
## thetaS:tmrcaS 9.736e-04 4.107e-05  23.708 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.000568 on 145 degrees of freedom  
## Multiple R-squared:  0.9967, Adjusted R-squared:  0.9966  
## F-statistic: 1.106e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_6)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.011424    1.154464    1.262171    1.090757
```

```
interact_plot(m.diversity.rep_6, pred = thetaS, modx= tmrcaS)
```



```
g.rep_6 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_6, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_6)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_6
##          AIC      BIC    logLik
##        -1811.57 -1790.496  912.7851
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.1730188
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020479216 5.540422e-05 369.6328 0.0000
## thetaS       0.009400111 4.997396e-05 188.1002 0.0000
## tmrcaS       0.001993622 5.376207e-05  37.0823 0.0000
## rhoS         0.000034238 4.917537e-05     0.6962 0.4874
## thetaS:tmrcaS 0.000951305 4.232596e-05  22.4757 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.002
## tmrcaS     -0.023 -0.109
## rhoS       -0.008 -0.005  0.340
## thetaS:tmrcaS -0.080 -0.023  0.278  0.116
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -5.126866241 -0.430648507 -0.002042255  0.325479464  4.863421007
##
## Residual standard error: 0.0005591586
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_6)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.013289    1.224420    1.132487    1.084133

g.rep_6.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_6, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_6.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_6
##      AIC      BIC logLik
## -1450.868 -1435.815 730.4341
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3062371
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020583999 0.0002201173 93.51378 0e+00
## thetaS       0.009631973 0.0001737792 55.42651 0e+00
## rhoS        -0.000574664 0.0001525197 -3.76780 2e-04
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.002  0.031
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.19333658 -0.46017960  0.02519769  0.43441985  3.88632753
##
## Residual standard error: 0.001950655
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_6)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.200kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 6] <- anova.diversity$VarExp[4] * 100

```

2.2.7 Replicate 7

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_7/rs.pair_7.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

## Warning in cor.test.default(sim.theta.200kb$sim, theta.200kb$sample_mean, :
## Cannot compute exact p-value with ties

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 7134.3, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9873163

inf.lands.200kb.rep_7 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_7) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_7$thetaS <- (inf.lands.200kb.rep_7$theta - mean(inf.lands.200kb.rep_7$theta)) / sd(inf.lands.200kb.rep_7$theta)
inf.lands.200kb.rep_7$tmrcaS <- (inf.lands.200kb.rep_7$tmrca - mean(inf.lands.200kb.rep_7$tmrca)) / sd(inf.lands.200kb.rep_7$tmrca)
inf.lands.200kb.rep_7$rhoS <- (inf.lands.200kb.rep_7$rho - mean(inf.lands.200kb.rep_7$rho)) / sd(inf.lands.200kb.rep_7$rho)

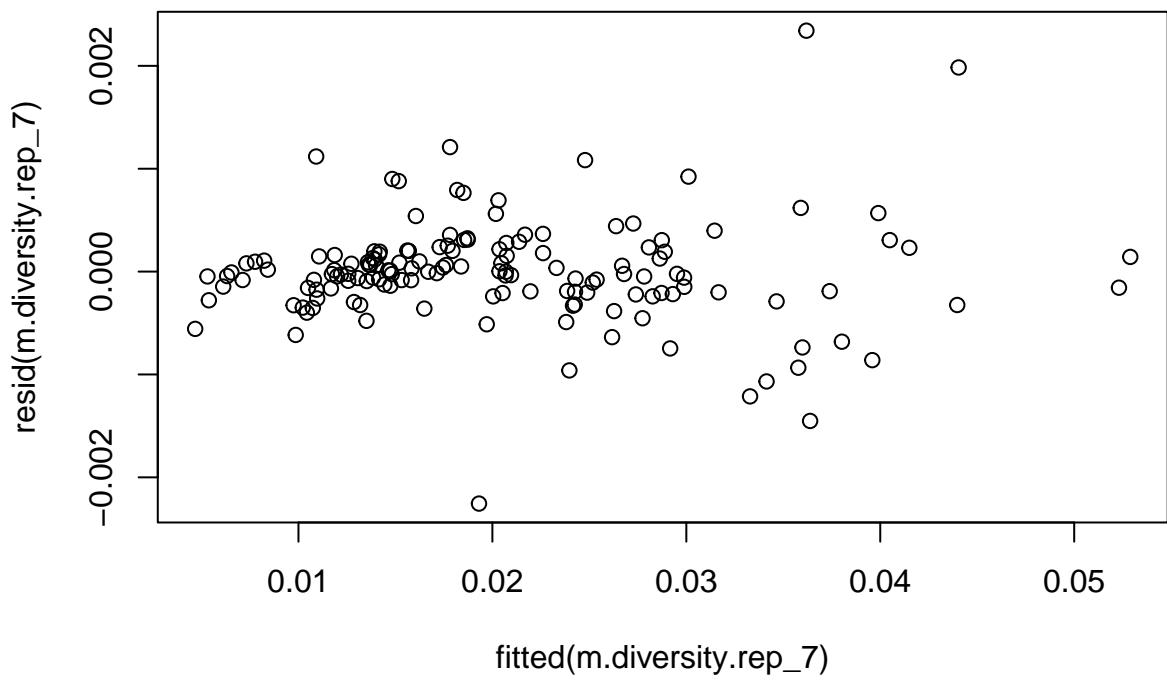
inf.lands.200kb.rep_7$bin <- 1:nrow(inf.lands.200kb.rep_7)

inf.lands.200kb.rep_7$Replicate <- 7

m.diversity.rep_7 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_7)

plot(resid(m.diversity.rep_7) ~ fitted(m.diversity.rep_7))

```

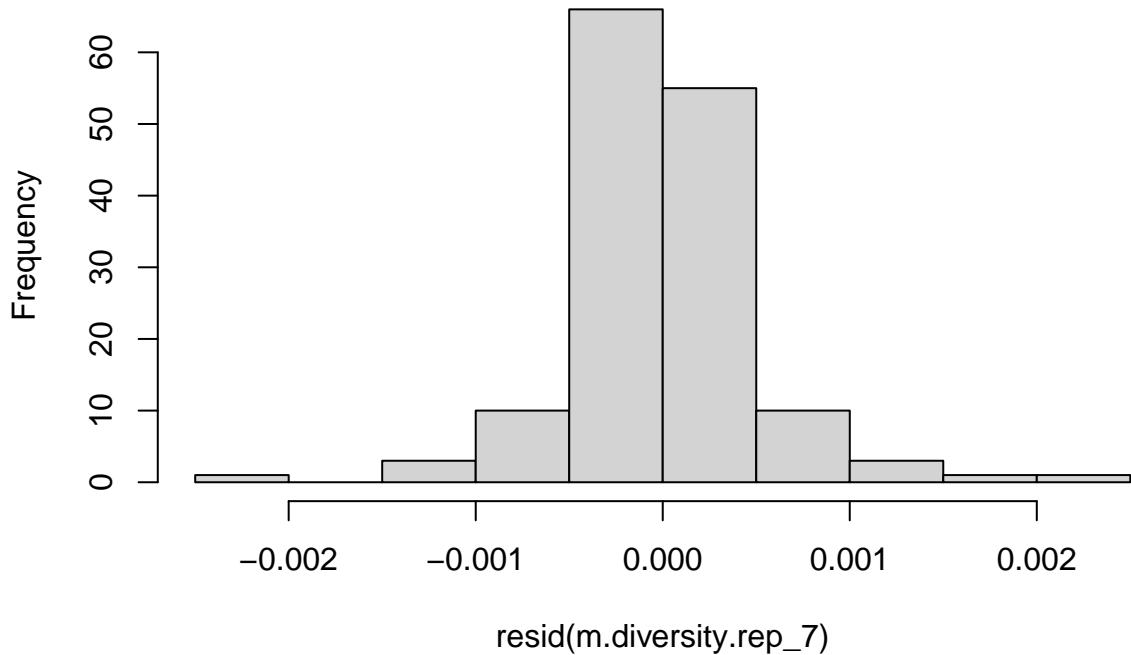


```
dwtest(m.diversity.rep_7)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_7
## DW = 1.6673, p-value = 0.01553
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_7)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_7
## HMC = 0.43605, p-value = 0.14
hist(resid(m.diversity.rep_7))
```

Histogram of resid(m.diversity.rep_7)



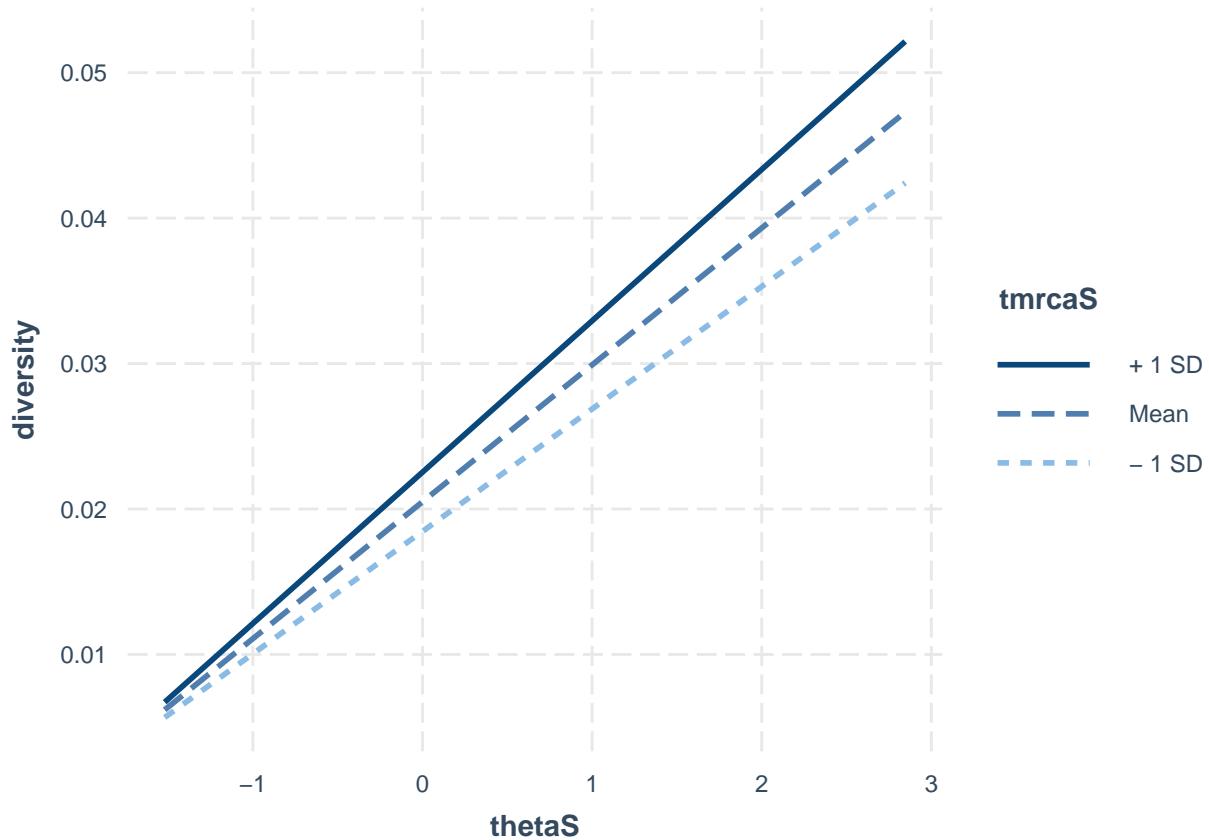
```
summary(m.diversity.rep_7)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_7)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -2.255e-03 -2.038e-04 -2.189e-05  1.931e-04  2.342e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.050e-02 4.270e-05 480.036 <2e-16 ***  
## thetaS       9.411e-03 4.296e-05 219.050 <2e-16 ***  
## rhoS        -1.376e-05 4.337e-05 -0.317   0.752  
## tmrcaS       2.036e-03 4.668e-05 43.612 <2e-16 ***  
## thetaS:tmrcaS 9.940e-04 3.869e-05 25.694 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005216 on 145 degrees of freedom  
## Multiple R-squared:  0.9972, Adjusted R-squared:  0.9971  
## F-statistic: 1.281e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_7)
```

```
## there are higher-order terms (interactions) in this model  
## consider setting type = 'predictor'; see ?vif  
##           thetaS          rhoS          tmrcaS    thetaS:tmrcaS
```

```
##      1.011011     1.030247     1.193464     1.162177
interact_plot(m.diversity.rep_7, pred = thetaS, modx= tmrcaS)
```



```
g.rep_7 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_7, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_7)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_7
##          AIC        BIC    logLik
## -1837.873 -1816.799  925.9367
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.1935696
##
## Coefficients:
##              Value Std.Error t-value p-value
## (Intercept) 0.020499661 5.196105e-05 394.5197 0.0000
## thetaS       0.009426538 4.614902e-05 204.2630 0.0000
## tmrcaS       0.002022035 4.763455e-05   42.4489 0.0000
## rhoS        -0.000009825 4.282366e-05  -0.2294 0.8189
## thetaS:tmrcaS 0.000962183 3.908333e-05  24.6188 0.0000
```

```

## Correlation:
##          (Intr) thetaS tmrcaS rhoS
## thetaS     -0.002
## tmrcaS    -0.021 -0.082
## rhoS      -0.003 -0.022  0.167
## thetaS:tmrcaS -0.060  0.039  0.329  0.078
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.36585180 -0.42077188 -0.01421357  0.38381511  4.57664531
##
## Residual standard error: 0.0005142079
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_7)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.011928     1.158318     1.029312     1.127670

g.rep_7.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_7, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_7.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_7
##      AIC      BIC   logLik
## -1444.025 -1428.971 727.0123
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.2825213
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020579587 0.0002178324 94.47441 0.0000
## thetaS      0.009591179 0.0001768106 54.24550 0.0000
## rhoS      -0.000326427 0.0001562165 -2.08958 0.0384
##
## Correlation:
##          (Intr) thetaS
## thetaS  0.000
## rhoS   0.002 -0.007
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.4561092 -0.4625831  0.1353834  0.5540699  4.0615520
##
## Residual standard error: 0.001980566
## Degrees of freedom: 150 total; 147 residual

```

```

anova.diversity <- Anova(m.diversity.rep_7)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.200kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 7] <- anova.diversity$VarExp[4] * 100

```

2.2.8 Replicate 8

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_8/rs.pair_8.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 6883.3, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9877762

inf.lands.200kb.rep_8 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_8) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_8$thetaS <- (inf.lands.200kb.rep_8$theta - mean(inf.lands.200kb.rep_8$theta)) / sd(inf.lands.200kb.rep_8$theta)
inf.lands.200kb.rep_8$tmrcaS <- (inf.lands.200kb.rep_8$tmrca - mean(inf.lands.200kb.rep_8$tmrca)) / sd(inf.lands.200kb.rep_8$tmrca)
inf.lands.200kb.rep_8$rhoS <- (inf.lands.200kb.rep_8$rho - mean(inf.lands.200kb.rep_8$rho)) / sd(inf.lands.200kb.rep_8$rho)

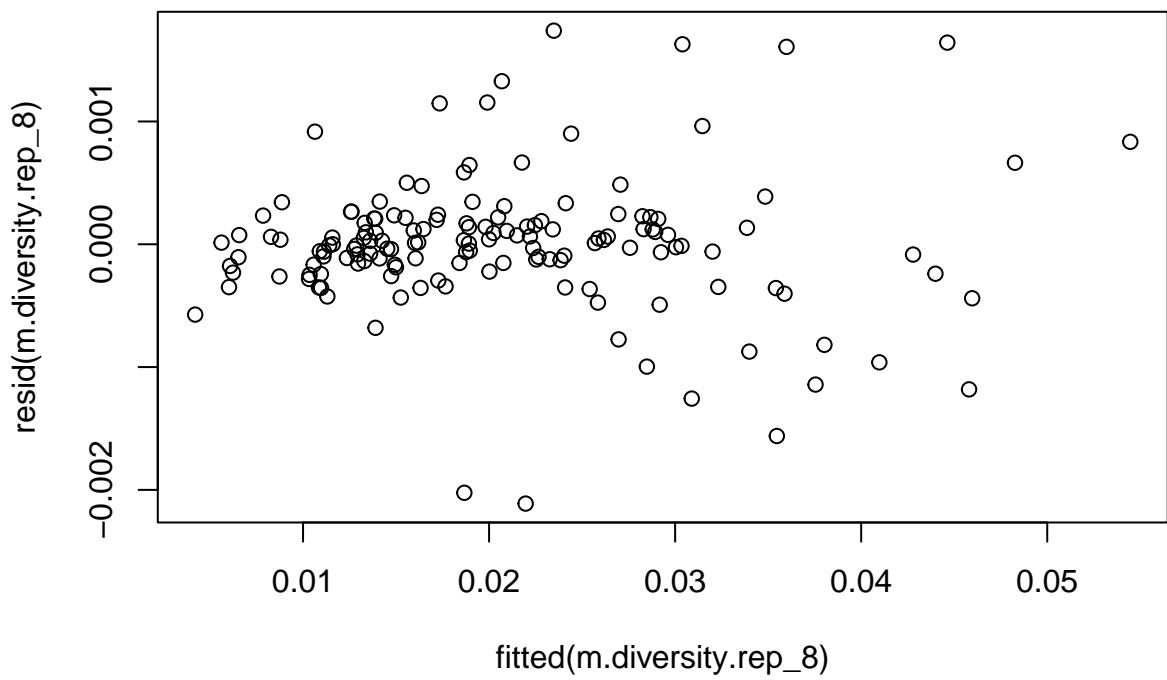
inf.lands.200kb.rep_8$bin <- 1:nrow(inf.lands.200kb.rep_8)

inf.lands.200kb.rep_8$Replicate <- 8

m.diversity.rep_8 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_8)

plot(resid(m.diversity.rep_8)~fitted(m.diversity.rep_8))

```

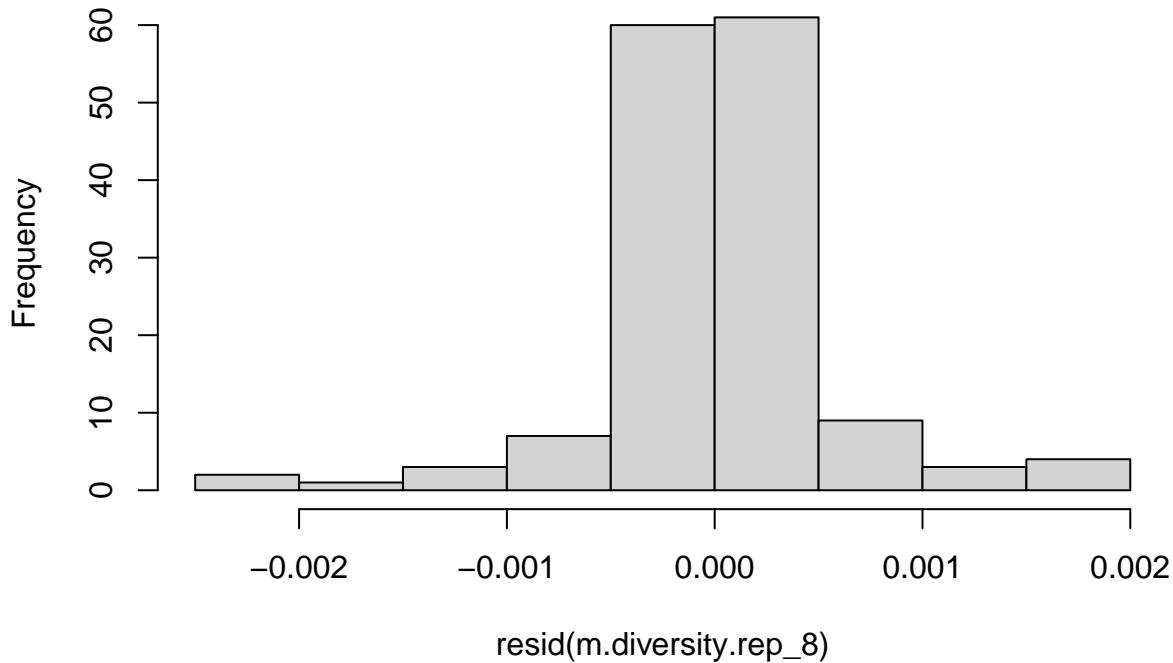


```
dwtest(m.diversity.rep_8)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_8
## DW = 1.5909, p-value = 0.004238
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_8)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_8
## HMC = 0.45552, p-value = 0.23
hist(resid(m.diversity.rep_8))
```

Histogram of resid(m.diversity.rep_8)



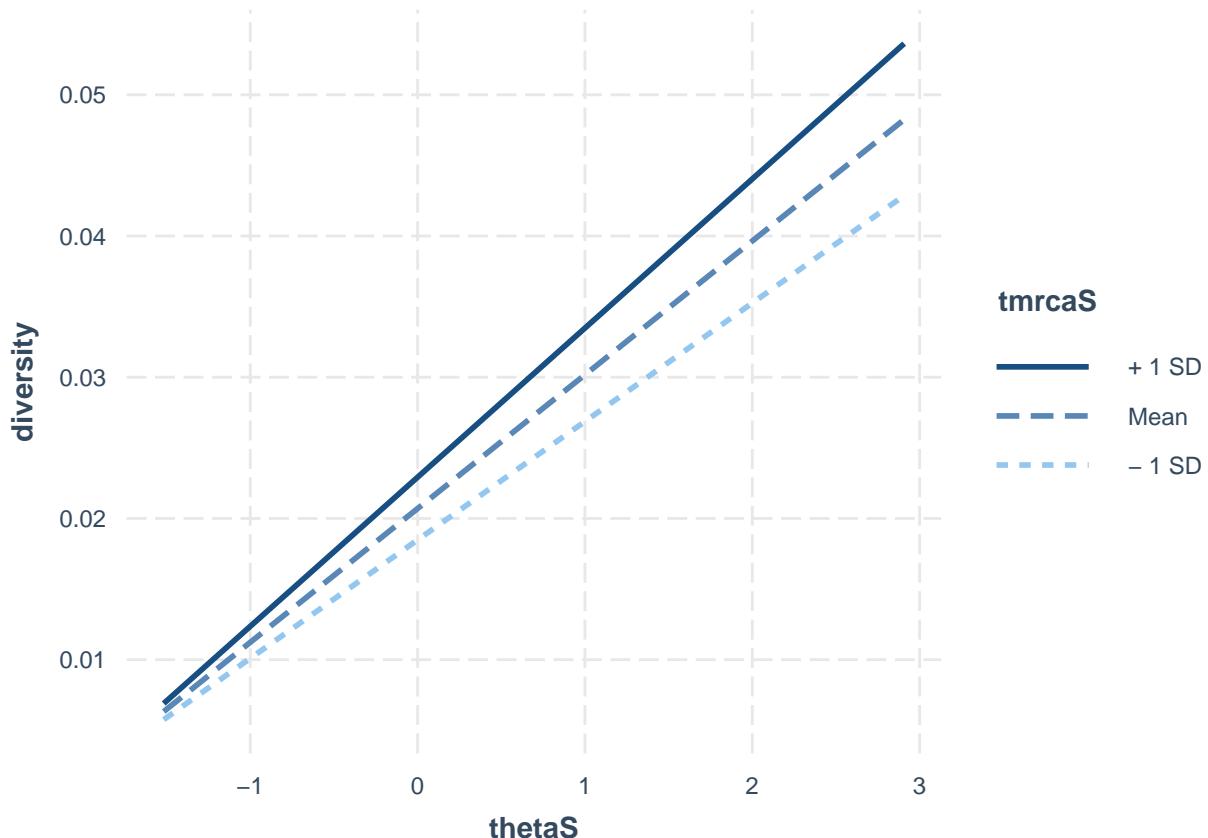
```
summary(m.diversity.rep_8)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_8)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -2.112e-03 -1.846e-04  7.690e-06  1.961e-04  1.739e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.070e-02 4.624e-05 447.65 <2e-16 ***  
## thetaS       9.474e-03 4.651e-05 203.69 <2e-16 ***  
## rhoS        4.644e-05 4.737e-05   0.98  0.329  
## tmrcaS      2.219e-03 5.200e-05   42.68 <2e-16 ***  
## thetaS:tmrcaS 1.087e-03 4.238e-05   25.64 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005639 on 145 degrees of freedom  
## Multiple R-squared:  0.9968, Adjusted R-squared:  0.9967  
## F-statistic: 1.124e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_8)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.013518    1.051544    1.266934    1.211311
```

```
interact_plot(m.diversity.rep_8, pred = thetaS, modx= tmrcaS)
```



```
g.rep_8 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_8, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_8)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_8
##          AIC      BIC    logLik
##     -1816.857 -1795.783  915.4287
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.2325221
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020704224 5.858643e-05 353.3963 0.0000
## thetaS       0.009464706 5.036703e-05 187.9147 0.0000
## tmrcaS       0.002214528 5.337776e-05  41.4878 0.0000
## rhoS         0.000039361 4.591151e-05    0.8573 0.3927
## thetaS:tmrcaS 0.001046093 4.285662e-05  24.4091 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS     -0.026 -0.121
## rhoS       -0.003 -0.003  0.185
## thetaS:tmrcaS -0.074  0.014  0.351  0.043
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.78620355 -0.37183043 -0.03601008  0.33263464  3.19188937
##
## Residual standard error: 0.0005563072
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_8)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.019264    1.202188    1.036381    1.145973

g.rep_8.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_8, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_8.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_8
##      AIC      BIC logLik
## -1429.786 -1414.733 719.8932
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3033588
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020811072 0.0002351765 88.49129 0.0000
## thetaS       0.009729211 0.0001864523 52.18069 0.0000
## rhoS        -0.000292104 0.0001632246 -1.78958 0.0756
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.000  0.018
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.25604299 -0.41587461  0.04359114  0.48798012  3.54428535
##
## Residual standard error: 0.002090655
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_8)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.200kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 8] <- anova.diversity$VarExp[4] * 100

```

2.2.9 Replicate 9

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_9/rs.pair_9.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 7233.3, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9871403

inf.lands.200kb.rep_9 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_9) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_9$thetaS <- (inf.lands.200kb.rep_9$theta - mean(inf.lands.200kb.rep_9$theta)) / sd(inf.lands.200kb.rep_9$theta)
inf.lands.200kb.rep_9$tmrcaS <- (inf.lands.200kb.rep_9$tmrca - mean(inf.lands.200kb.rep_9$tmrca)) / sd(inf.lands.200kb.rep_9$tmrca)
inf.lands.200kb.rep_9$rhoS <- (inf.lands.200kb.rep_9$rho - mean(inf.lands.200kb.rep_9$rho)) / sd(inf.lands.200kb.rep_9$rho)

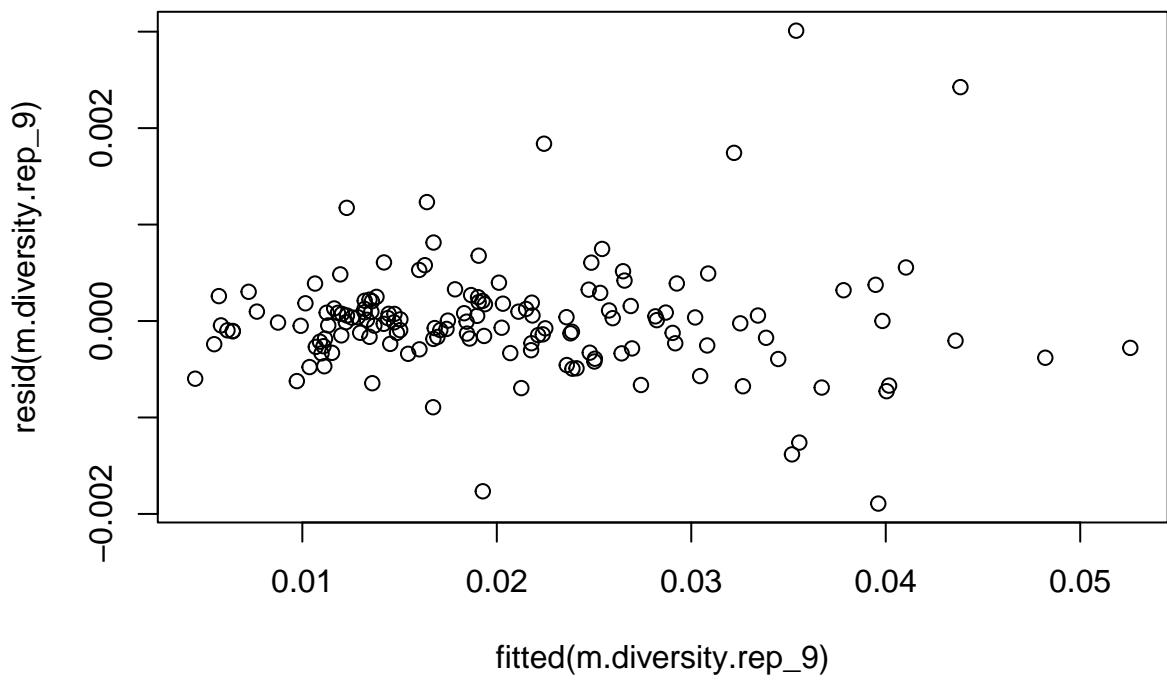
inf.lands.200kb.rep_9$bin <- 1:nrow(inf.lands.200kb.rep_9)

inf.lands.200kb.rep_9$Replicate <- 9

m.diversity.rep_9 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_9)

plot(resid(m.diversity.rep_9)~fitted(m.diversity.rep_9))

```

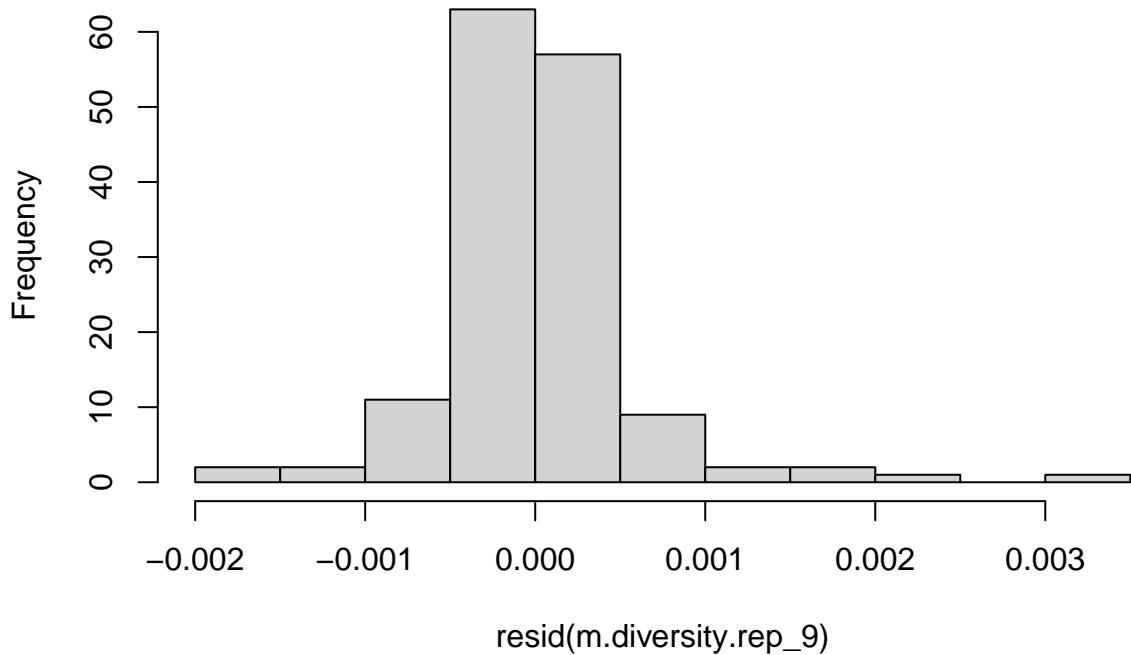


```
dwtest(m.diversity.rep_9)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_9
## DW = 1.6772, p-value = 0.01787
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_9)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_9
## HMC = 0.38369, p-value = 0.024
hist(resid(m.diversity.rep_9))
```

Histogram of resid(m.diversity.rep_9)



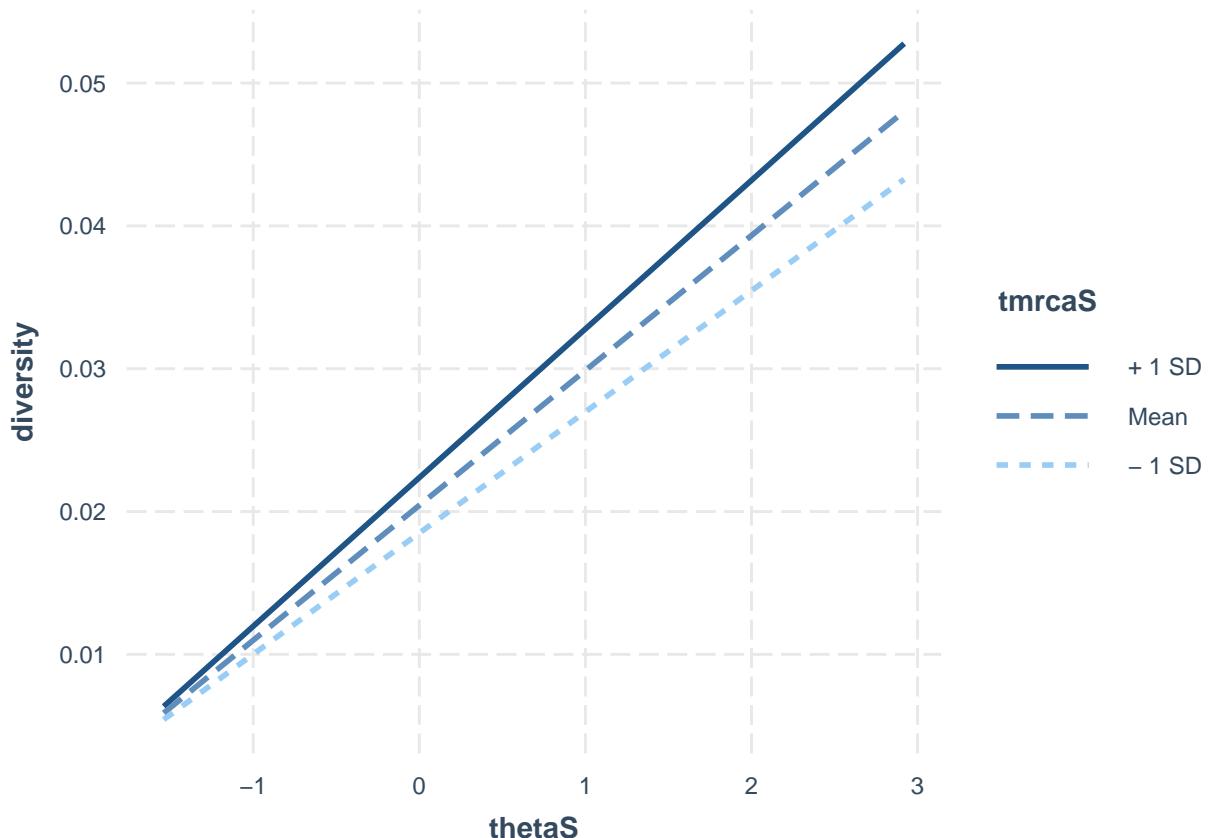
```
summary(m.diversity.rep_9)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.200kb.rep_9)  
##  
## Residuals:  
##      Min        1Q     Median        3Q       Max  
## -0.0018926 -0.0002394 -0.0000149  0.0001830  0.0030102  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.044e-02 4.788e-05 426.832 <2e-16 ***  
## thetaS       9.447e-03 4.835e-05 195.371 <2e-16 ***  
## rhoS        8.234e-05 5.010e-05   1.643   0.102  
## tmrcaS      1.941e-03 5.332e-05  36.402 <2e-16 ***  
## thetaS:tmrcaS 9.618e-04 4.467e-05  21.530 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.000584 on 145 degrees of freedom  
## Multiple R-squared:  0.9965, Adjusted R-squared:  0.9964  
## F-statistic: 1.02e+04 on 4 and 145 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_9)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.021393  1.096673  1.242088   1.150724
```

```
interact_plot(m.diversity.rep_9, pred = thetaS, modx= tmrcaS)
```



```
g.rep_9 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.200kb.rep_9, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_9)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep_9
##          AIC      BIC    logLik
##     -1804.101 -1783.026  909.0504
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.2058788
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020439448 5.911181e-05 345.7760 0.0000
## thetaS       0.009454656 5.195185e-05 181.9888 0.0000
## tmrcaS       0.001951847 5.500071e-05  35.4877 0.0000
## rhoS         0.000106064 4.916687e-05    2.1572 0.0326
## thetaS:tmrcaS 0.000919495 4.629566e-05 19.8614 0.0000
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.006
## tmrcaS     -0.029 -0.067
## rhoS       -0.008  0.011  0.270
## thetaS:tmrcaS -0.076  0.077  0.351  0.110
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.22090386 -0.40412235 -0.03092443  0.30494856  5.19848696
##
## Residual standard error: 0.000576945
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_9)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.017102     1.228533    1.079801     1.153832

g.rep_9.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_9, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_9.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_9
##      AIC      BIC logLik
## -1464.018 -1448.965 737.009
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3448494
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020537857 0.0002229473 92.11977 0.0000
## thetaS      0.009582837 0.0001677256 57.13401 0.0000
## rhoS      -0.000329055 0.0001450777 -2.26813 0.0248
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.002  0.028
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -4.01675167 -0.35192121 -0.05519082  0.39502917  4.12501538
##
## Residual standard error: 0.00189327
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_9)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.inf.200kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 9] <- anova.diversity$VarExp[4] * 100

```

2.2.10 Replicate 10

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_10/rs.pair_10.", sep = "")
pi.200kb <- read.table(paste(p, "diversity.200kb.bedgraph", sep = ""), header = T)
pi.200kb$avg <- apply(pi.200kb[4:ncol(pi.200kb)], 1, mean)
tmrca.200kb <- read.table(paste(p, "TMRCA.200kb.bedgraph", sep = ""), header = T)
tmrca.200kb$avg <- apply(tmrca.200kb[4:ncol(tmrca.200kb)], 1, mean)
rho.200kb <- read.table(paste(p, "rho.200kb.bedgraph", sep = ""), header = T)
theta.200kb <- read.table(paste(p, "theta.200kb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.200kb$sim, theta.200kb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.200kb$sim and theta.200kb$sample_mean
## S = 6266.2, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9888595

inf.lands.200kb.rep_10 <- as.data.frame(cbind(pi.200kb$avg, theta.200kb$sample_mean, rho.200kb$sample_mean))
names(inf.lands.200kb.rep_10) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.200kb.rep_10$thetaS <- (inf.lands.200kb.rep_10$theta - mean(inf.lands.200kb.rep_10$theta)) / sd(inf.lands.200kb.rep_10$theta)
inf.lands.200kb.rep_10$tmrcaS <- (inf.lands.200kb.rep_10$tmrca - mean(inf.lands.200kb.rep_10$tmrca)) / sd(inf.lands.200kb.rep_10$tmrca)
inf.lands.200kb.rep_10$rhoS <- (inf.lands.200kb.rep_10$rho - mean(inf.lands.200kb.rep_10$rho)) / sd(inf.lands.200kb.rep_10$rho)

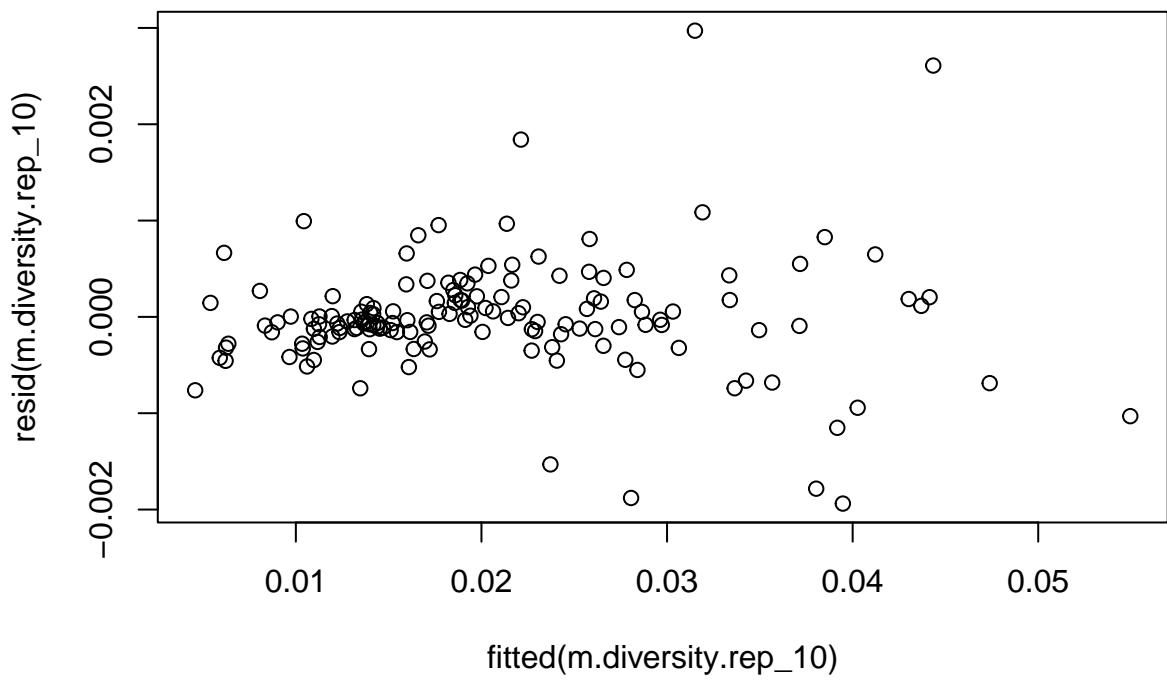
inf.lands.200kb.rep_10$bin <- 1:nrow(inf.lands.200kb.rep_10)

inf.lands.200kb.rep_10$Replicate <- 10

m.diversity.rep_10 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.200kb.rep_10)

plot(resid(m.diversity.rep_10)~fitted(m.diversity.rep_10))

```

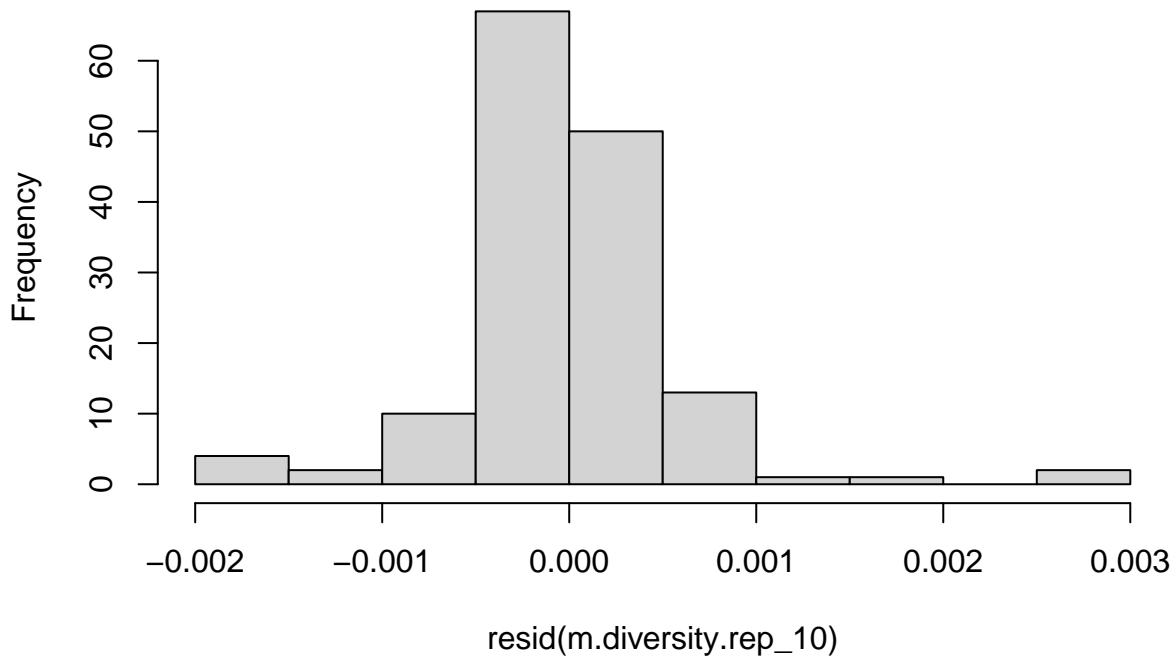


```
dwtest(m.diversity.rep_10)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_10
## DW = 1.777, p-value = 0.06912
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_10)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_10
## HMC = 0.6193, p-value = 0.984
hist(resid(m.diversity.rep_10))
```

Histogram of resid(m.diversity.rep_10)



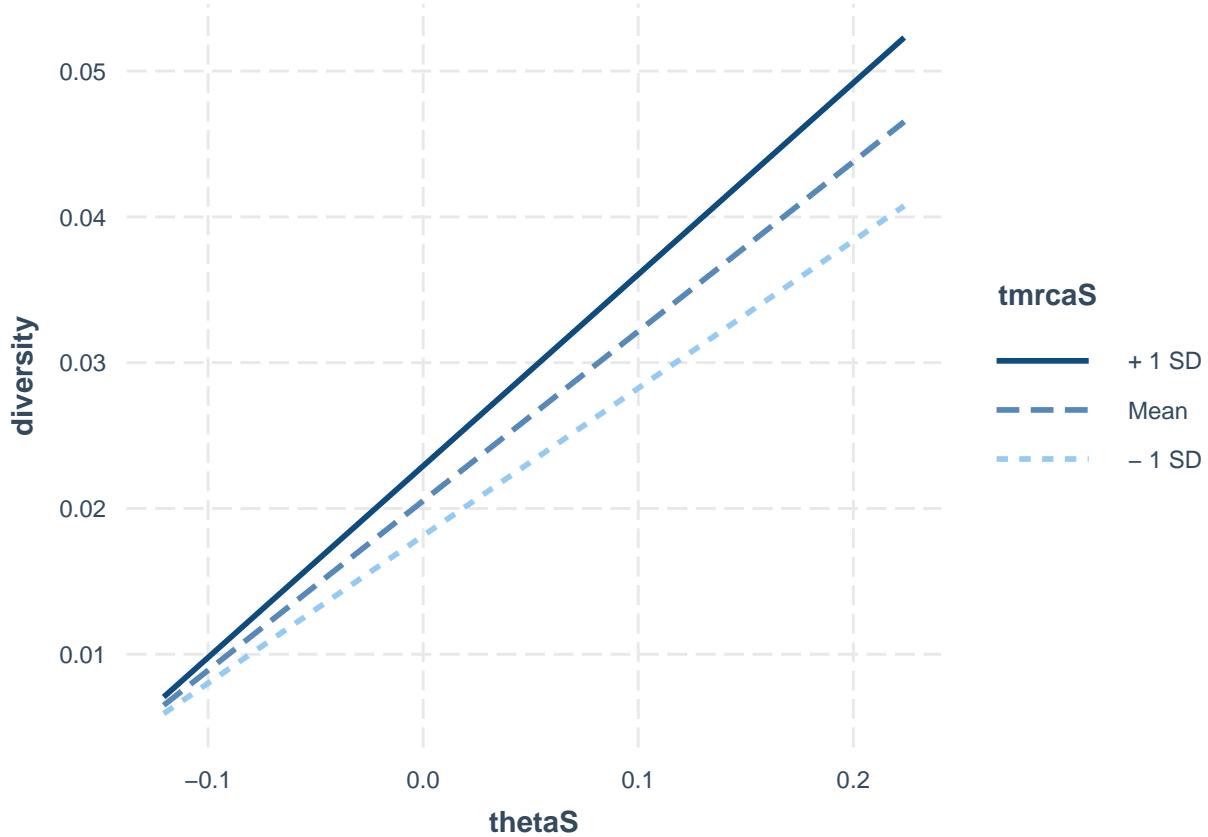
```
summary(m.diversity.rep_10)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.200kb.rep_10)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.938e-03 -1.748e-04 -4.971e-05  1.828e-04  2.971e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.053e-02 5.021e-05 408.838 <2e-16 ***
## thetaS      1.163e-01 6.297e-04 184.625 <2e-16 ***
## rhoS        2.164e-03 7.654e-03  0.283   0.778
## tmrcaS      2.391e-03 6.173e-05 38.738 <2e-16 ***
## thetaS:tmrcaS 1.511e-02 6.911e-04 21.866 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0006067 on 145 degrees of freedom
## Multiple R-squared:  0.9963, Adjusted R-squared:  0.9962
## F-statistic:  9827 on 4 and 145 DF,  p-value: < 2.2e-16

vif(m.diversity.rep_10)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.032911  1.071527  1.542591   1.447353
```

```
interact_plot(m.diversity.rep_10, pred = thetaS, modx= tmrcaS)
```



```
g.rep_10 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,  
                  data = inf.lands.200kb.rep_1, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_10)
```

```
## Generalized least squares fit by maximum likelihood  
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS  
##   Data: inf.lands.200kb.rep_1  
##          AIC      BIC  logLik  
##        -1814.128 -1793.054 914.0641  
##  
## Correlation Structure: AR(1)  
##   Formula: ~bin  
## Parameter estimate(s):  
##           Phi  
## 0.08562895  
##  
## Coefficients:  
##             Value Std. Error t-value p-value  
## (Intercept) 0.020495842 4.988827e-05 410.8349 0.0000  
## thetaS       0.009311061 4.778895e-05 194.8371 0.0000  
## tmrcaS       0.002162321 5.209260e-05  41.5092 0.0000  
## rhoS         0.000016367 4.723723e-05    0.3465 0.7295  
## thetaS:tmrcaS 0.001058085 4.650120e-05  22.7539 0.0000  
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS     -0.043 -0.110
## rhoS       -0.010 -0.009  0.248
## thetaS:tmrcaS -0.113  0.010  0.375  0.090
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -2.94983846 -0.42035716 -0.01013693  0.33115763  4.40016170
##
## Residual standard error: 0.0005481049
## Degrees of freedom: 150 total; 145 residual
vif(g.rep_10)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.015853     1.249427     1.066075     1.167458

g.rep_10.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.200kb.rep_10, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_10.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.200kb.rep_10
##      AIC      BIC    logLik
## -1442.284 -1427.23 726.1418
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## 0.3304014
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.02071315 0.000234587 88.29634 0.0000
## thetaS      0.12318309 0.002267579 54.32360 0.0000
## rhoS      -0.05434884 0.022943808 -2.36878 0.0191
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.002 -0.030
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -2.75464197 -0.53844834  0.02521541  0.52547583  4.31476850
##
## Residual standard error: 0.002024422
## Degrees of freedom: 150 total; 147 residual
anova.diversity <- Anova(m.diversity.rep_10)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.200kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] + anova.diversity$VarExp[4]) * 100
r2.inf.200kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.inf.200kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.inf.200kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.inf.200kb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.inf.200kb$average <- rowMeans(r2.inf.200kb)
r2.inf.200kb <- transform(r2.inf.200kb, sd=apply(r2.inf.200kb, 1, sd, na.rm = TRUE))

```

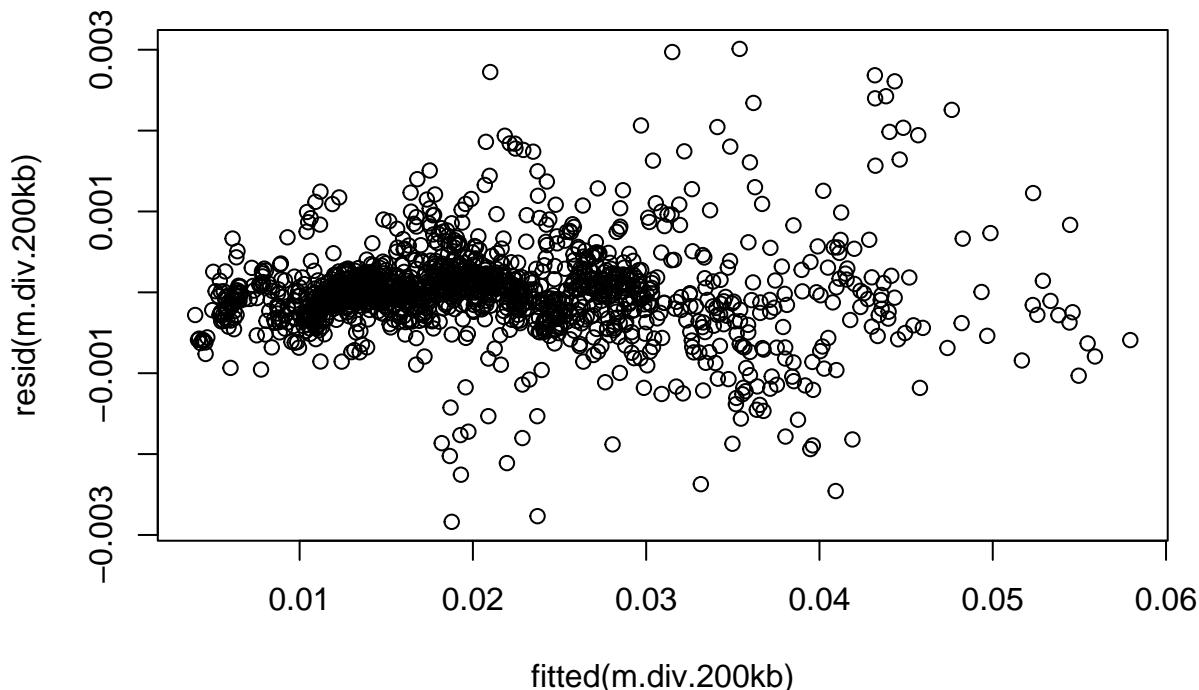
2.2.11 all replicates:

```

inf.lands.200kb.all <- rbind(inf.lands.200kb.rep_1, inf.lands.200kb.rep_2, inf.lands.200kb.rep_3, inf.lands.200kb.rep_4, inf.lands.200kb.rep_5, inf.lands.200kb.rep_6, inf.lands.200kb.rep_7, inf.lands.200kb.rep_8, inf.lands.200kb.rep_9, inf.lands.200kb.rep_10)

m.div.200kb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)*as.factor(Replicate), data = inf.lands.200kb.all)
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.6825, p-value = 8.31e-12
## alternative hypothesis: true autocorrelation is greater than 0

hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##

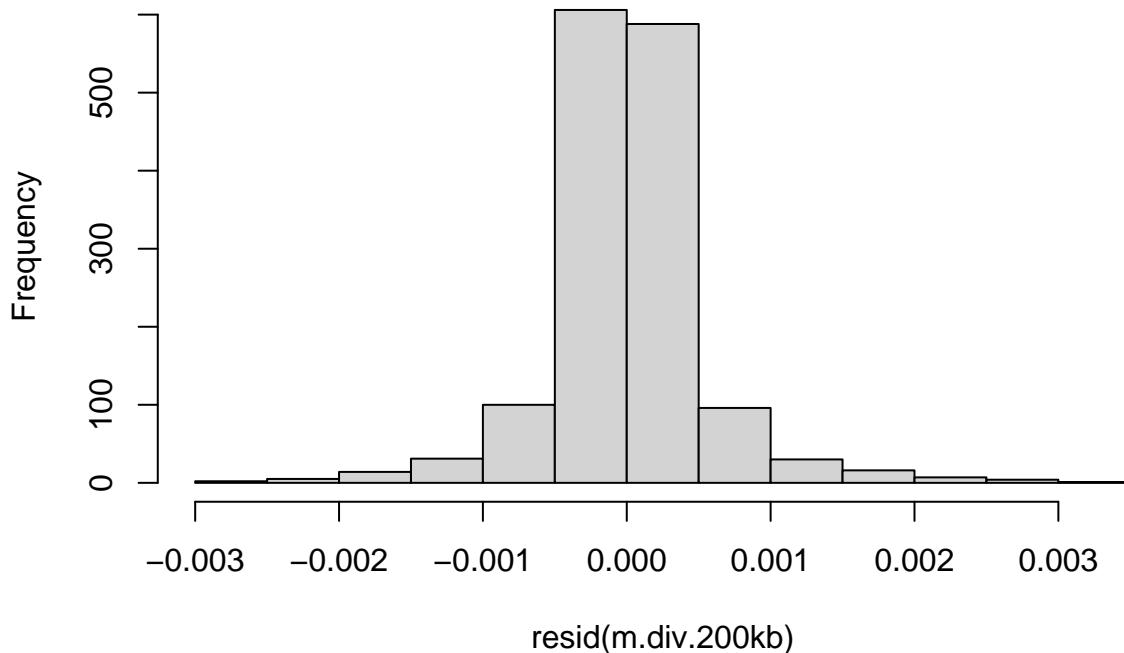
```

```

## data: m.div.200kb
## HMC = 0.48172, p-value = 0.148
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

m.div.200kb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replicat
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as

```

```

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

```

```

##          df      AIC
## m.div.200kb 51 -18158.03
## m.div.200kb.2 61 -18155.65
## m.div.200kb.3 71 -18154.31

```

```

summary(m.div.200kb)

```

```

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##     as.factor(Replicate), data = inf.lands.200kb.all)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -2.837e-03 -2.188e-04 -6.580e-06  1.836e-04  3.010e-03
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2.049e-02  4.600e-05 445.509 < 2e-16 ***
## thetaS                     9.304e-03  4.617e-05 201.508 < 2e-16 ***
## rhoS                      1.063e-05  4.748e-05   0.224  0.82295

```

```

## tmrcaS          2.164e-03  5.175e-05  41.809 < 2e-16 ***
## as.factor(Replicate)2 -3.060e-05  6.507e-05 -0.470  0.63829
## as.factor(Replicate)3  1.025e-04  6.504e-05  1.576  0.11529
## as.factor(Replicate)4  1.385e-04  6.486e-05  2.136  0.03288 *
## as.factor(Replicate)5  1.180e-05  6.487e-05  0.182  0.85564
## as.factor(Replicate)6 -1.818e-05  6.496e-05 -0.280  0.77959
## as.factor(Replicate)7  2.154e-06  6.491e-05  0.033  0.97353
## as.factor(Replicate)8  2.053e-04  6.496e-05  3.160  0.00161 **
## as.factor(Replicate)9 -5.912e-05  6.496e-05 -0.910  0.36292
## as.factor(Replicate)10 3.230e-05  6.526e-05  0.495  0.62077
## thetaS:tmrcaS      1.069e-03  4.547e-05  23.507 < 2e-16 ***
## thetaS:as.factor(Replicate)2 -8.783e-06  6.535e-05 -0.134  0.89311
## thetaS:as.factor(Replicate)3  1.452e-04  6.542e-05  2.220  0.02656 *
## thetaS:as.factor(Replicate)4  3.223e-04  6.527e-05  4.937  8.86e-07 ***
## thetaS:as.factor(Replicate)5  1.526e-04  6.523e-05  2.339  0.01948 *
## thetaS:as.factor(Replicate)6  9.049e-05  6.524e-05  1.387  0.16564
## thetaS:as.factor(Replicate)7  1.069e-04  6.523e-05  1.639  0.10142
## thetaS:as.factor(Replicate)8  1.692e-04  6.527e-05  2.593  0.00962 **
## thetaS:as.factor(Replicate)9  1.425e-04  6.540e-05  2.178  0.02953 *
## thetaS:as.factor(Replicate)10 1.069e-01  5.824e-04  183.629 < 2e-16 ***
## rhoS:as.factor(Replicate)2 -4.148e-06  6.658e-05 -0.062  0.95033
## rhoS:as.factor(Replicate)3  1.476e-05  6.650e-05  0.222  0.82435
## rhoS:as.factor(Replicate)4  3.385e-05  6.678e-05  0.507  0.61229
## rhoS:as.factor(Replicate)5  4.813e-05  6.691e-05  0.719  0.47204
## rhoS:as.factor(Replicate)6  2.753e-05  6.841e-05  0.403  0.68736
## rhoS:as.factor(Replicate)7 -2.439e-05  6.647e-05 -0.367  0.71376
## rhoS:as.factor(Replicate)8  3.581e-05  6.681e-05  0.536  0.59199
## rhoS:as.factor(Replicate)9  7.171e-05  6.751e-05  1.062  0.28831
## rhoS:as.factor(Replicate)10 2.154e-03  7.058e-03  0.305  0.76028
## tmrcaS:as.factor(Replicate)2 -4.493e-05  7.521e-05 -0.597  0.55029
## tmrcaS:as.factor(Replicate)3 -1.814e-05  7.052e-05 -0.257  0.79700
## tmrcaS:as.factor(Replicate)4  9.139e-05  7.132e-05  1.281  0.20024
## tmrcaS:as.factor(Replicate)5  3.271e-05  7.150e-05  0.457  0.64743
## tmrcaS:as.factor(Replicate)6 -1.778e-04  7.300e-05 -2.435  0.01501 *
## tmrcaS:as.factor(Replicate)7 -1.279e-04  7.200e-05 -1.776  0.07596 .
## tmrcaS:as.factor(Replicate)8  5.539e-05  7.307e-05  0.758  0.44851
## tmrcaS:as.factor(Replicate)9 -2.227e-04  7.271e-05 -3.062  0.00224 **
## tmrcaS:as.factor(Replicate)10 2.275e-04  7.693e-05  2.958  0.00315 **
## thetaS:tmrcaS:as.factor(Replicate)2 -4.079e-05  6.386e-05 -0.639  0.52302
## thetaS:tmrcaS:as.factor(Replicate)3 -7.057e-05  5.897e-05 -1.197  0.23161
## thetaS:tmrcaS:as.factor(Replicate)4  5.089e-05  6.504e-05  0.783  0.43403
## thetaS:tmrcaS:as.factor(Replicate)5  2.890e-05  6.015e-05  0.480  0.63099
## thetaS:tmrcaS:as.factor(Replicate)6 -9.539e-05  6.086e-05 -1.567  0.11722
## thetaS:tmrcaS:as.factor(Replicate)7 -7.496e-05  6.156e-05 -1.218  0.22353
## thetaS:tmrcaS:as.factor(Replicate)8  1.788e-05  6.193e-05  0.289  0.77290
## thetaS:tmrcaS:as.factor(Replicate)9 -1.071e-04  6.244e-05 -1.716  0.08639 .
## thetaS:tmrcaS:as.factor(Replicate)10 1.404e-02  6.389e-04  21.982 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0005594 on 1450 degrees of freedom
## Multiple R-squared:  0.9968, Adjusted R-squared:  0.9967
## F-statistic:  9292 on 49 and 1450 DF,  p-value: < 2.2e-16

```

2.2.12 Plots

```

scale.3d <- function(x) sprintf("%.3f", x)

rho.plot <- as.data.frame(cbind(inf.lands.200kb.rep_1$bin,
                                sim.rho.200kb$sim,
                                inf.lands.200kb.rep_1$rho,
                                inf.lands.200kb.rep_2$rho,
                                inf.lands.200kb.rep_3$rho,
                                inf.lands.200kb.rep_4$rho,
                                inf.lands.200kb.rep_5$rho,
                                inf.lands.200kb.rep_6$rho,
                                inf.lands.200kb.rep_7$rho,
                                inf.lands.200kb.rep_8$rho,
                                inf.lands.200kb.rep_9$rho,
                                inf.lands.200kb.rep_10$rho))

rho.plot[,3:ncol(rho.plot)] <- 1.53 * rho.plot[,3:ncol(rho.plot)] # scaling because of SCRM NO vs Ne

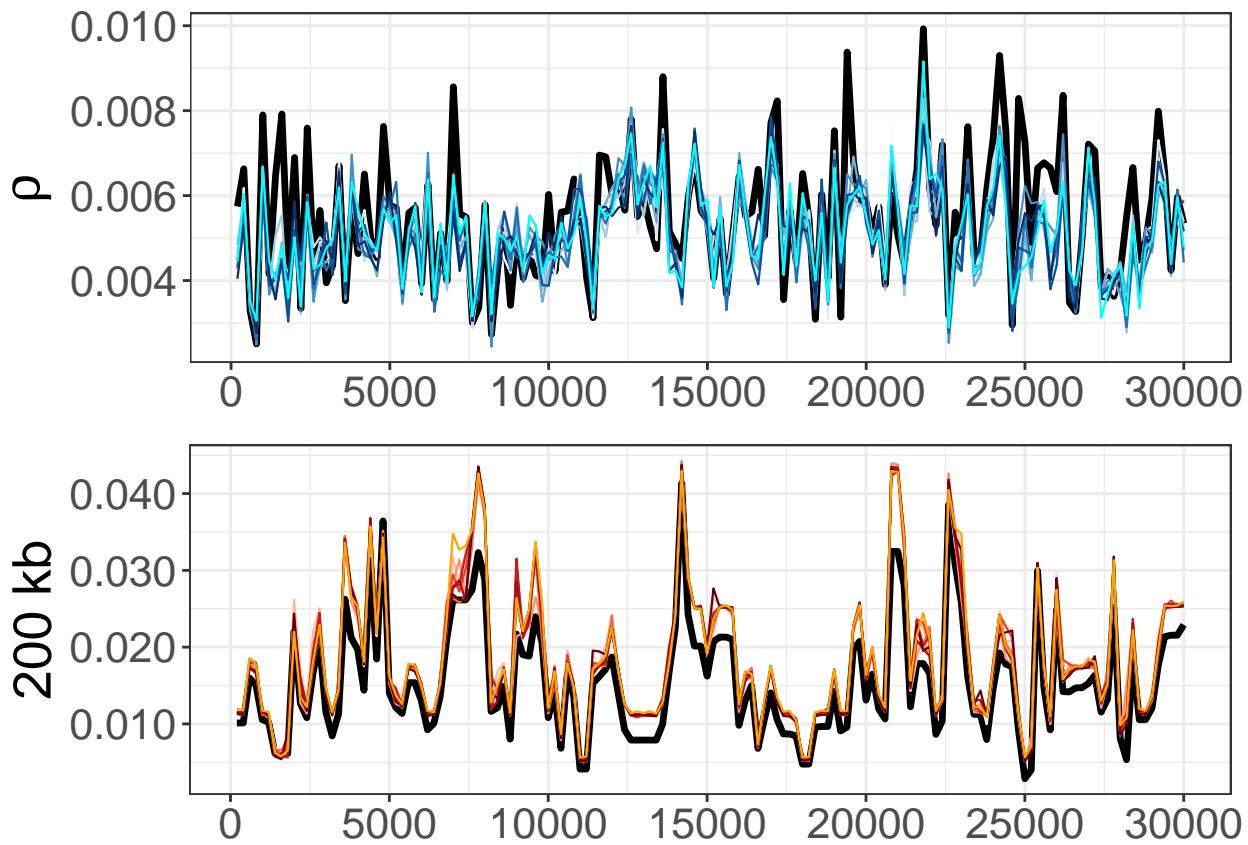
names(rho.plot) <- c("bin", "sim", reps)
molten.rho <- melt(rho.plot, id.vars = "bin")
rho.map.200kb <- ggplot(data = molten.rho, aes(x = bin * 200, y = value, colour = variable)) + theme_bw()
rho.map.200kb <- rho.map.200kb + geom_line(data = molten.rho, aes(size = variable)) + scale_size_manual()
rho.map.200kb <- rho.map.200kb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Blues"))
rho.map.200kb <- rho.map.200kb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
rho.map.200kb <- rho.map.200kb + labs(title = NULL, x = NULL, y = expression(rho))
rho.map.200kb <- rho.map.200kb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))

theta.plot <- as.data.frame(cbind(inf.lands.200kb.rep_1$bin,
                                    sim.theta.200kb$sim,
                                    inf.lands.200kb.rep_1$theta,
                                    inf.lands.200kb.rep_2$theta,
                                    inf.lands.200kb.rep_3$theta,
                                    inf.lands.200kb.rep_4$theta,
                                    inf.lands.200kb.rep_5$theta,
                                    inf.lands.200kb.rep_6$theta,
                                    inf.lands.200kb.rep_7$theta,
                                    inf.lands.200kb.rep_8$theta,
                                    inf.lands.200kb.rep_9$theta,
                                    inf.lands.200kb.rep_10$theta))

names(theta.plot) <- c("bin", "sim", reps)
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.200kb <- ggplot(data = molten.theta, aes(x = bin * 200, y = value, colour = variable)) + theme_bw()
theta.map.200kb <- theta.map.200kb + geom_line(data = molten.theta, aes(size = variable)) + scale_size_manual()
theta.map.200kb <- theta.map.200kb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Reds"))
theta.map.200kb <- theta.map.200kb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
theta.map.200kb <- theta.map.200kb + labs(title = NULL, x = NULL, y = "200 kb")
theta.map.200kb <- theta.map.200kb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))

plot_grid(rho.map.200kb, theta.map.200kb, nrow = 2, ncol = 1)

```



2.3 1 Mb scale

```
r2.inf.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.inf.1Mb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.inf.1Mb) <- reps

# sim landscapes
sim.rho.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.rho.1e+06.txt")
sim.theta.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_coal_sims/dm.sim.theta.1e+06.txt")
sim.lands.1Mb <- as.data.frame(cbind(sim.theta.1Mb$sim, sim.rho.1Mb$sim))
names(sim.lands.1Mb) <- c("theta", "rho")
```

2.3.1 Replicate 1

```
p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_1/rs.pair_1.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
```

```

##  

## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean  

## S = 94, p-value < 2.2e-16  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## 0.9790879  

inf.lands.1Mb.rep_1 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$sample_mean))  

names(inf.lands.1Mb.rep_1) <- c("diversity", "theta", "rho", "tmrca")  

# standardizing  

inf.lands.1Mb.rep_1$thetaS <- (inf.lands.1Mb.rep_1$theta - mean(inf.lands.1Mb.rep_1$theta)) / sd(inf.lands.1Mb.rep_1$theta)  

inf.lands.1Mb.rep_1$tmrcaS <- (inf.lands.1Mb.rep_1$tmrca - mean(inf.lands.1Mb.rep_1$tmrca)) / sd(inf.lands.1Mb.rep_1$tmrca)  

inf.lands.1Mb.rep_1$rhoS <- (inf.lands.1Mb.rep_1$rho - mean(inf.lands.1Mb.rep_1$rho)) / sd(inf.lands.1Mb.rep_1$rho)  

inf.lands.1Mb.rep_1$bin <- 1:nrow(inf.lands.1Mb.rep_1)  

inf.lands.1Mb.rep_1$Replicate <- 1  

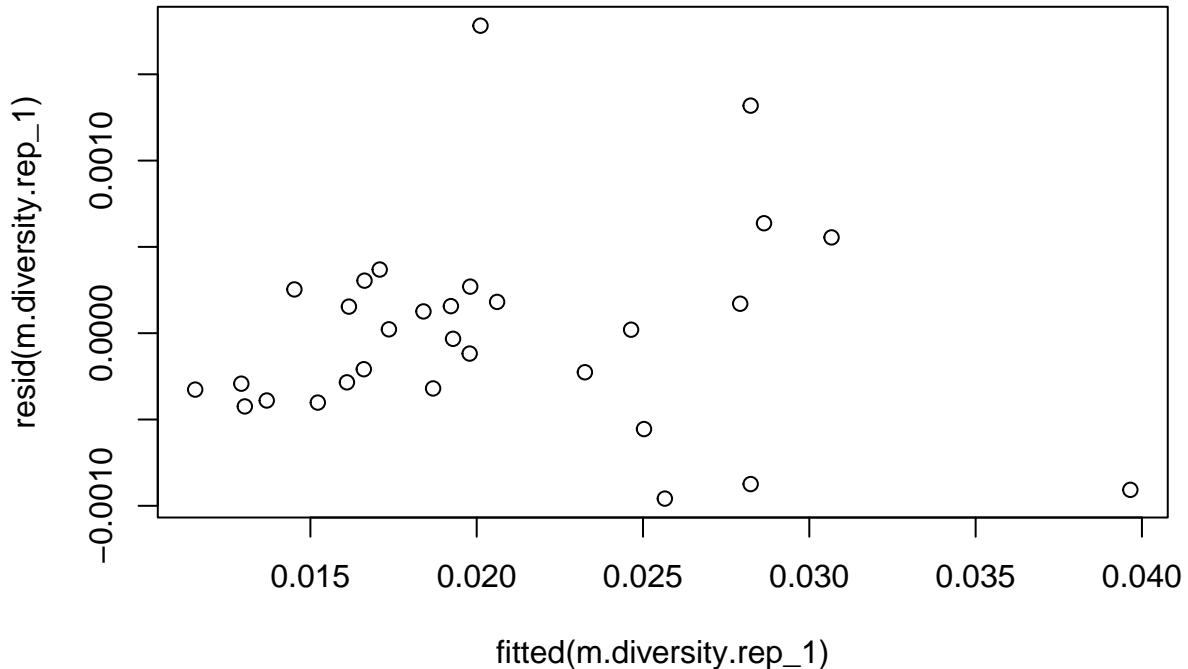
  

m.diversity.rep_1 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_1)  

plot(resid(m.diversity.rep_1) ~ fitted(m.diversity.rep_1))

```



```

dwtest(m.diversity.rep_1)
  

##  

## Durbin-Watson test  

##  

## data: m.diversity.rep_1  

## DW = 1.9667, p-value = 0.4252  

## alternative hypothesis: true autocorrelation is greater than 0

```

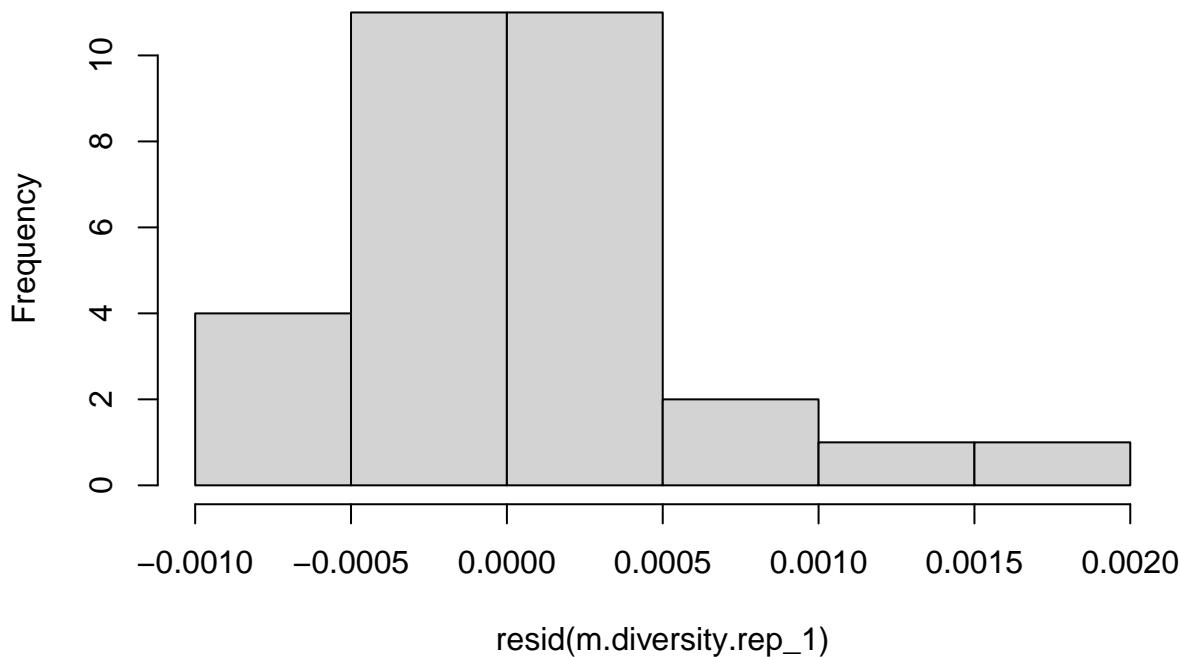
```

hmctest(m.diversity.rep_1)

##
##  Harrison-McCabe test
##
## data: m.diversity.rep_1
## HMC = 0.46606, p-value = 0.41
hist(resid(m.diversity.rep_1))

```

Histogram of resid(m.diversity.rep_1)



```

summary(m.diversity.rep_1)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##      data = inf.lands.1Mb.rep_1)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -0.0009583 -0.0003251 -0.0000061  0.0002355  0.0017816
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.062e-02 1.150e-04 179.401 < 2e-16 ***
## thetaS       6.300e-03 1.219e-04   51.697 < 2e-16 ***
## rhoS        1.166e-06 1.322e-04    0.009   0.993
## tmrcaS      9.079e-04 1.622e-04    5.596 8.05e-06 ***
## thetaS:tmrcaS 2.569e-04 1.562e-04    1.645    0.113
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

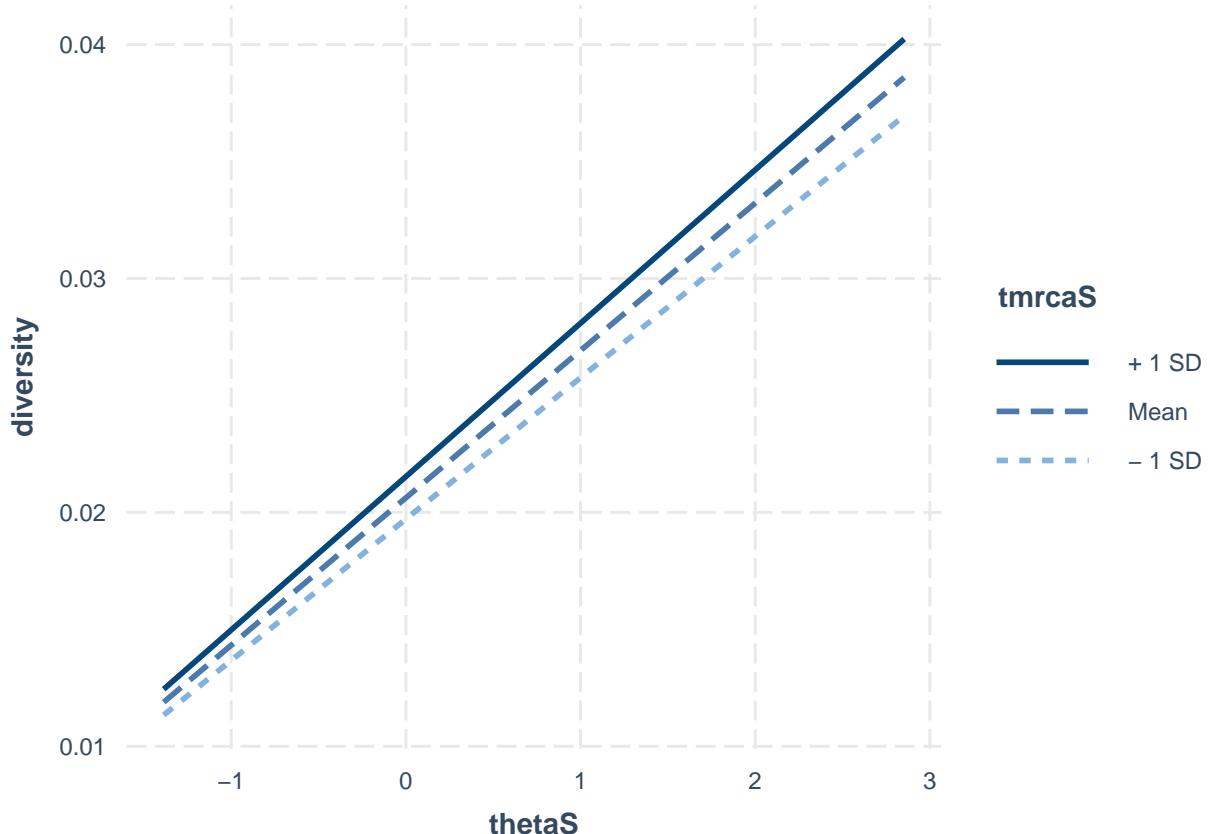
## 
## Residual standard error: 0.0006297 on 25 degrees of freedom
## Multiple R-squared:  0.9917, Adjusted R-squared:  0.9904
## F-statistic: 749.1 on 4 and 25 DF,  p-value: < 2.2e-16
vif(m.diversity.rep_1)

```

```

##          thetaS          rhoS        tmrcaS thetaS:tmrcaS
## 1.086064    1.279110    1.925445     1.730966
interact_plot(m.diversity.rep_1, pred = thetaS, modx= tmrcaS)

```



```

g.rep_1 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                 data = inf.lands.1Mb.rep_1, cor = corAR1(0, ~bin), method = "ML")

```

```
summary(g.rep_1)
```

```

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_1
##       AIC      BIC logLik
##   -348.56 -338.7516 181.28
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## 0.0188108
##

```

```

## Coefficients:
##                               Value     Std.Error   t-value p-value
## (Intercept)      0.020624763 0.0001170758 176.16584 0.0000
## thetaS          0.006298915 0.0001222271  51.53453 0.0000
## tmrcaS          0.000914620 0.0001612620   5.67164 0.0000
## rhoS            0.000000297 0.0001325695   0.00224 0.9982
## thetaS:tmrcaS  0.000263026 0.0001559369   1.68675 0.1041
##
## Correlation:
##              (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS      0.001 -0.171
## rhoS        0.000 -0.021  0.376
## thetaS:tmrcaS 0.004 -0.283  0.575 -0.003
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.67095844 -0.56781078 -0.01108315  0.40839933  3.09944720
##
## Residual standard error: 0.0005748314
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_1)

##           thetaS         tmrcaS         rhoS thetaS:tmrcaS
##           1.087501      1.898249      1.271394      1.717045

g.rep_1.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_1, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_1.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_1
## AIC      BIC    logLik
## -329.2361 -322.2301 169.618
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##           Phi
## -0.3222673
##
## Coefficients:
##                               Value     Std.Error   t-value p-value
## (Intercept)  0.020608957 0.0001241807 165.95945 0.0000
## thetaS       0.006308014 0.0001520989  41.47310 0.0000
## rhoS        -0.000358265 0.0001456336  -2.46004 0.0206
##
## Correlation:
##              (Intr) thetaS
## thetaS      0.002
## rhoS      -0.001 -0.056
##

```

```

## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.3284963 -0.5352289  0.1792210  0.6290505  1.9096098
##
## Residual standard error: 0.0008939388
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_1)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 1] <- anova.diversity$VarExp[4] * 100

```

2.3.2 Replicate 2

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_2/rs.pair_2.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 114, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.9746385

inf.lands.1Mb.rep_2 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_2) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_2$thetaS <- (inf.lands.1Mb.rep_2$theta - mean(inf.lands.1Mb.rep_2$theta)) / sd(inf.lands.1Mb.rep_2$theta)
inf.lands.1Mb.rep_2$tmrcaS <- (inf.lands.1Mb.rep_2$tmrca - mean(inf.lands.1Mb.rep_2$tmrca)) / sd(inf.lands.1Mb.rep_2$tmrca)
inf.lands.1Mb.rep_2$rhoS <- (inf.lands.1Mb.rep_2$rho - mean(inf.lands.1Mb.rep_2$rho)) / sd(inf.lands.1Mb.rep_2$rho)

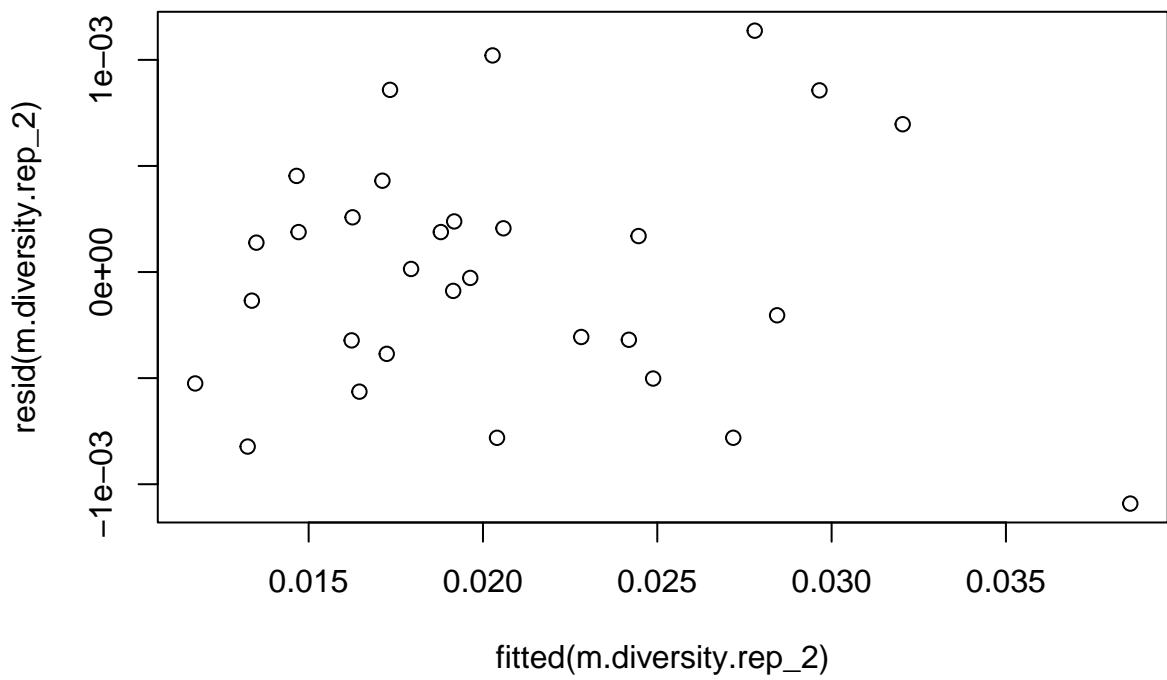
inf.lands.1Mb.rep_2$bin <- 1:nrow(inf.lands.1Mb.rep_2)

inf.lands.1Mb.rep_2$Replicate <- 2

m.diversity.rep_2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_2)

plot(resid(m.diversity.rep_2) ~ fitted(m.diversity.rep_2))

```

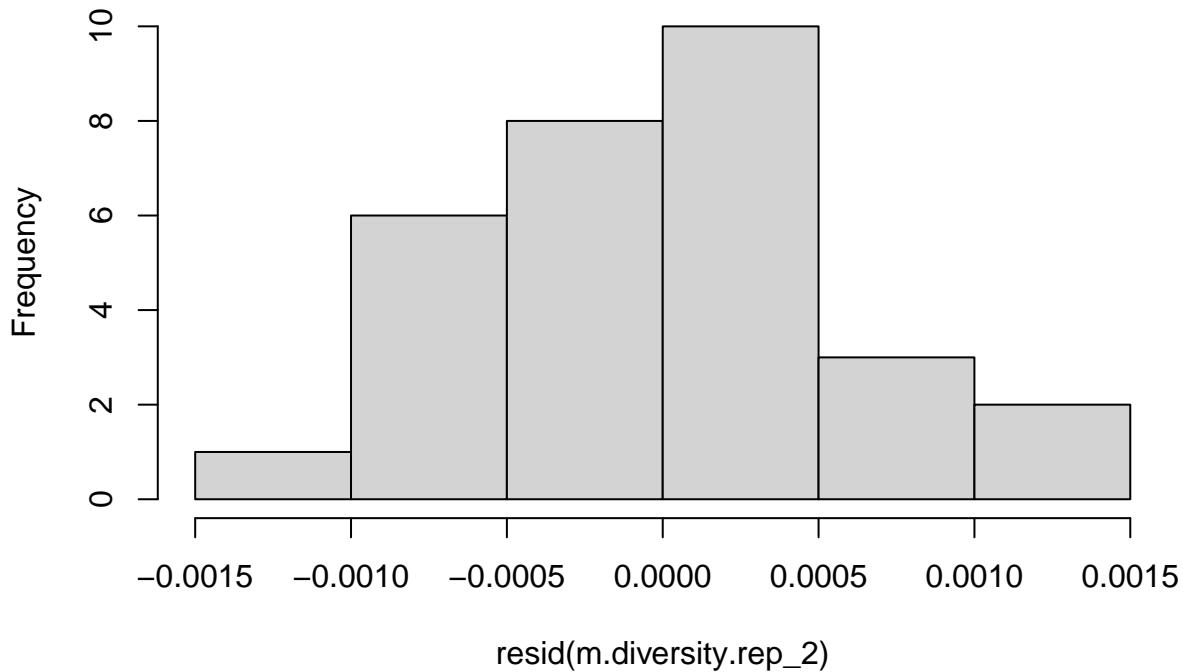


```
dwtest(m.diversity.rep_2)
```

```
##
## Durbin-Watson test
##
## data: m.diversity.rep_2
## DW = 1.966, p-value = 0.4212
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_2)
```

```
##
## Harrison-McCabe test
##
## data: m.diversity.rep_2
## HMC = 0.4866, p-value = 0.434
hist(resid(m.diversity.rep_2))
```

Histogram of resid(m.diversity.rep_2)



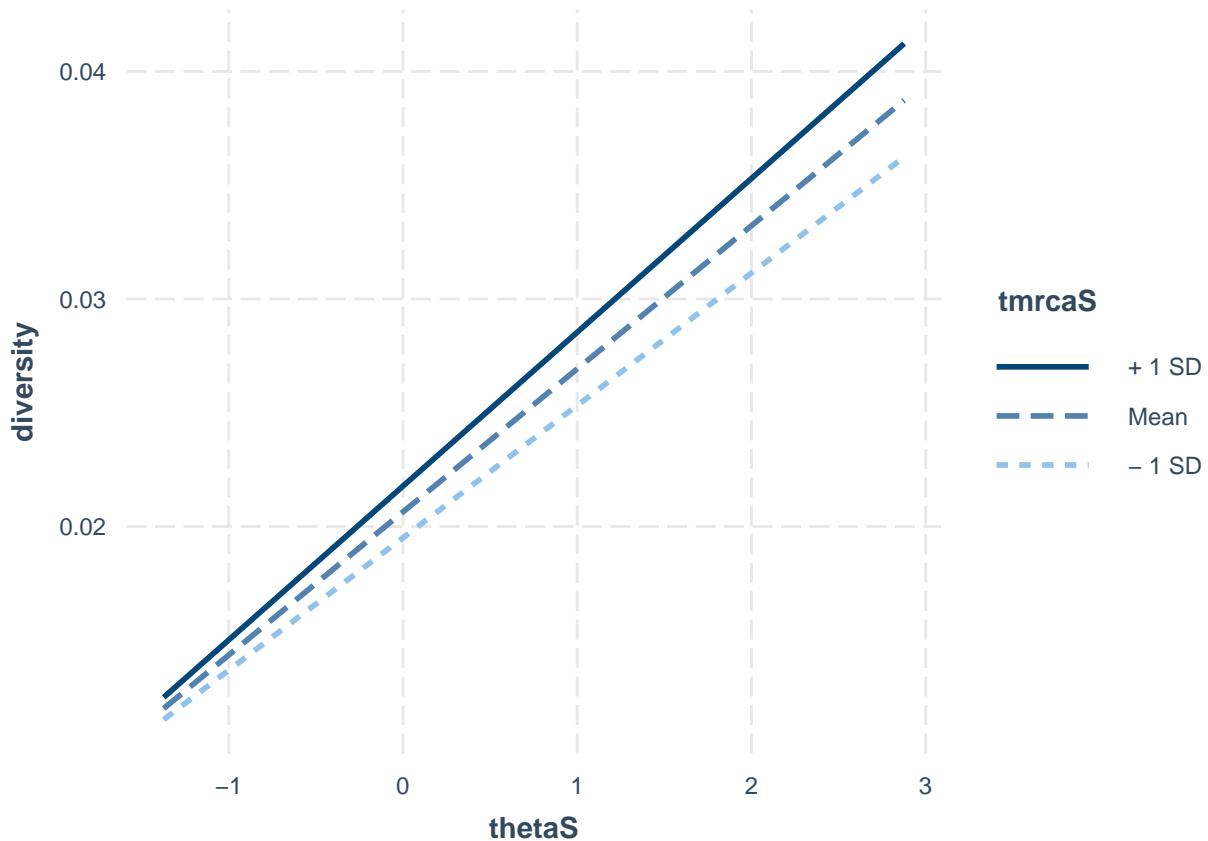
```
summary(m.diversity.rep_2)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_2)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.091e-03 -3.697e-04 -6.640e-06  2.531e-04  1.138e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0.0206424  0.0001134 182.048 < 2e-16 ***  
## thetaS       0.0062884  0.0001152  54.577 < 2e-16 ***  
## rhoS        0.0001060  0.0001383   0.766  0.4508  
## tmrcaS      0.0011363  0.0001517   7.489 7.66e-08 ***  
## thetaS:tmrcaS 0.0004715  0.0001704   2.768  0.0105 *## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006138 on 25 degrees of freedom  
## Multiple R-squared:  0.9919, Adjusted R-squared:  0.9906  
## F-statistic: 765.1 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_2)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.021979 1.472693 1.772180 2.014626
```

```
interact_plot(m.diversity.rep_2, pred = thetaS, modx= tmrcaS)
```



```
g.rep_2 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_2, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_2)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_2
##          AIC      BIC logLik
##     -350.0905 -340.2821 182.0452
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.01325283
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020642766 0.0001148064 179.80497 0.0000
## thetaS       0.006287821 0.0001152966  54.53607 0.0000
## tmrcaS      0.001136259 0.0001515512   7.49753 0.0000
## rhoS        0.000102832 0.0001387114    0.74134 0.4654
## thetaS:tmrcaS 0.000475113 0.0001702324   2.79097 0.0099
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.015
## tmrcaS      0.078  0.012
## rhoS        -0.056  0.004  0.165
## thetaS:tmrcaS  0.150 -0.097  0.527 -0.369
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.95006224 -0.66519213 -0.01401553  0.44798577  2.03312007
##
## Residual standard error: 0.0005603058
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_2)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.021369     1.764385     1.468410     2.007938

g.rep_2.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_2, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_2.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_2
##      AIC      BIC    logLik
## -318.0822 -311.0762 164.0411
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.01297054
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020593660 0.0001940573 106.12154 0.0000
## thetaS       0.006254517 0.0002002727  31.23000 0.0000
## rhoS        -0.000170535 0.0001996216  -0.85429 0.4005
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.000 -0.081
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.0512845 -0.6085269  0.1849871  0.5460123  1.6511980
##
## Residual standard error: 0.00102108
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_2)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 2] <- anova.diversity$VarExp[4] * 100

```

2.3.3 Replicate 3

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_3/rs.pair_3.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 86, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9808676

inf.lands.1Mb.rep_3 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_3) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_3$thetaS <- (inf.lands.1Mb.rep_3$theta - mean(inf.lands.1Mb.rep_3$theta)) / sd(inf.lands.1Mb.rep_3$theta)
inf.lands.1Mb.rep_3$tmrcaS <- (inf.lands.1Mb.rep_3$tmrca - mean(inf.lands.1Mb.rep_3$tmrca)) / sd(inf.lands.1Mb.rep_3$tmrca)
inf.lands.1Mb.rep_3$rhoS <- (inf.lands.1Mb.rep_3$rho - mean(inf.lands.1Mb.rep_3$rho)) / sd(inf.lands.1Mb.rep_3$rho)

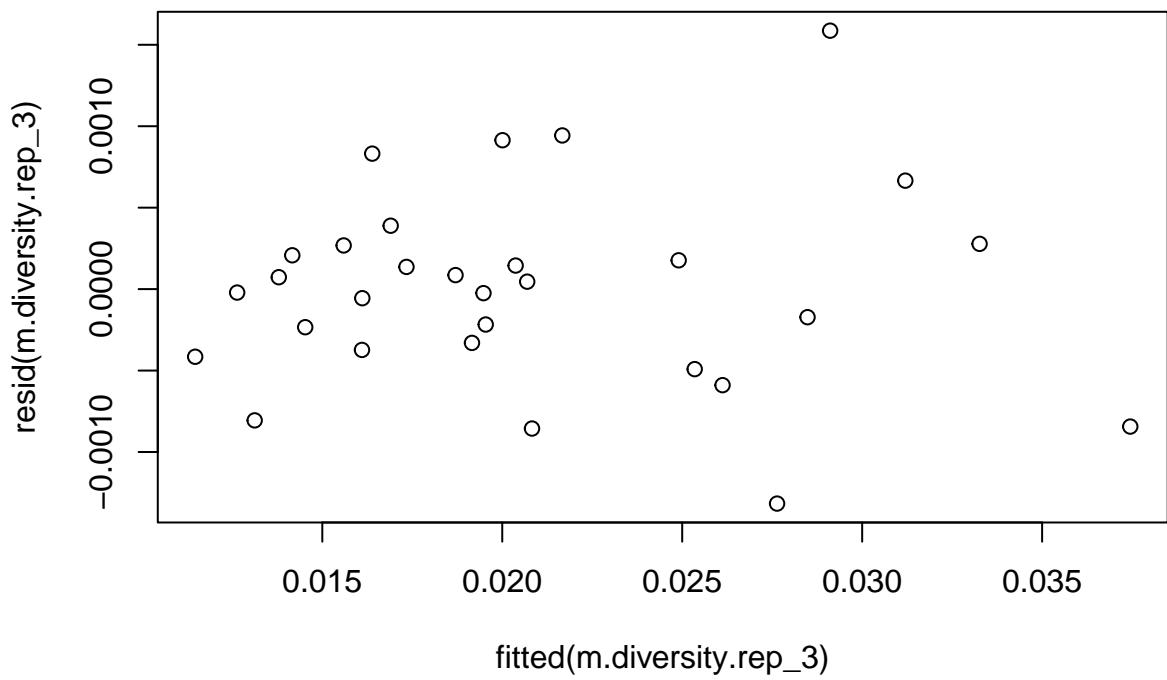
inf.lands.1Mb.rep_3$bin <- 1:nrow(inf.lands.1Mb.rep_3)

inf.lands.1Mb.rep_3$Replicate <- 3

m.diversity.rep_3 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_3)

plot(resid(m.diversity.rep_3)~fitted(m.diversity.rep_3))

```

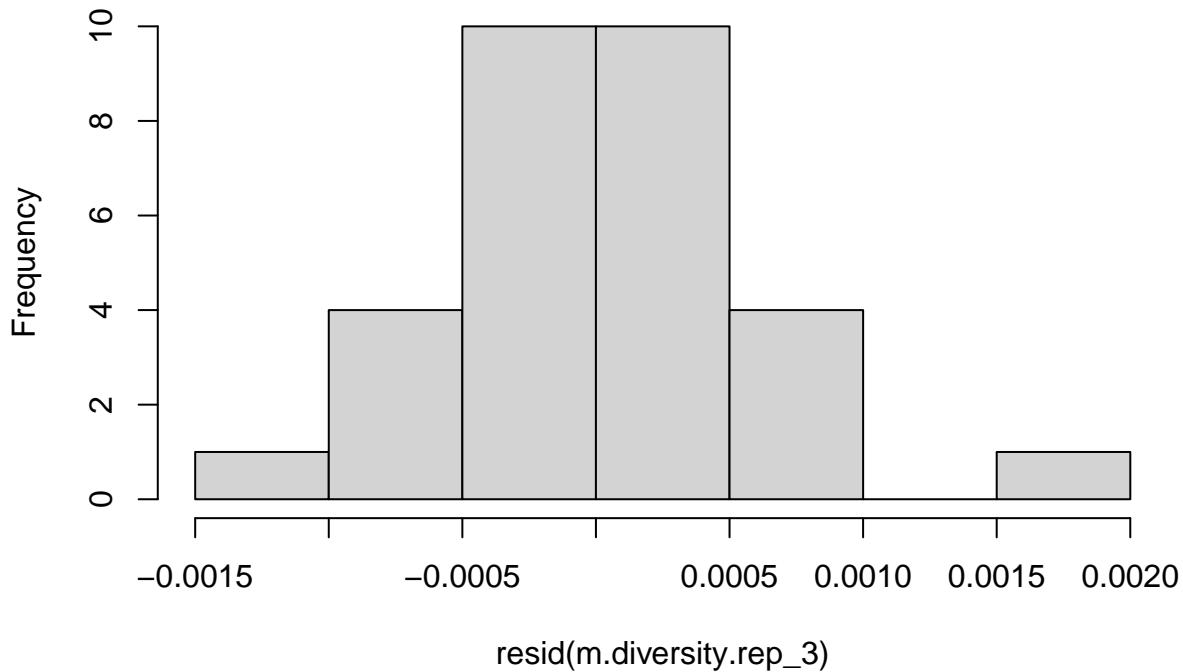


```
dwtest(m.diversity.rep_3)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_3
## DW = 1.3502, p-value = 0.02515
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_3)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_3
## HMC = 0.51975, p-value = 0.556
hist(resid(m.diversity.rep_3))
```

Histogram of resid(m.diversity.rep_3)



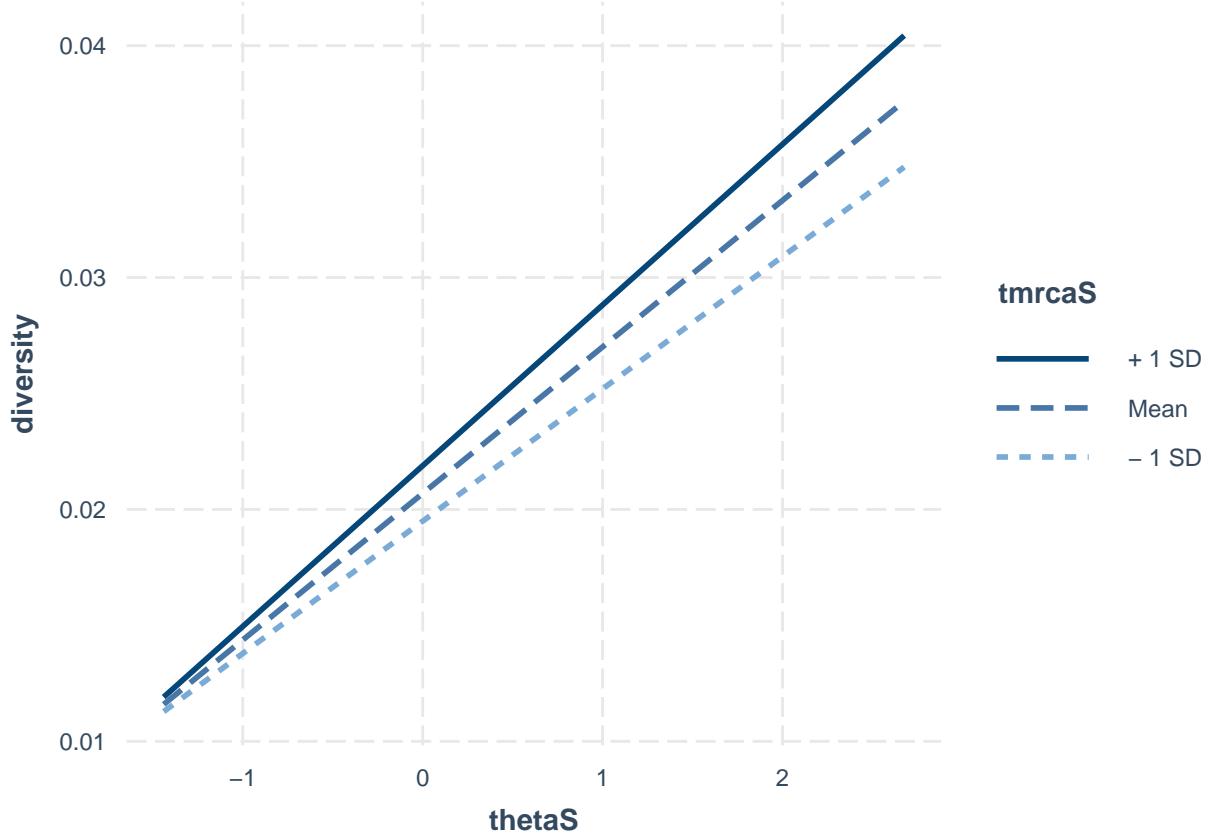
```
summary(m.diversity.rep_3)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_3)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.317e-03 -3.626e-04  1.232e-05  2.530e-04  1.587e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.069e-02 1.206e-04 171.565 < 2e-16 ***  
## thetaS       6.318e-03 1.260e-04  50.146 < 2e-16 ***  
## rhoS        5.387e-05 1.386e-04   0.389  0.70076  
## tmrcaS      1.195e-03 1.461e-04   8.177 1.57e-08 ***  
## thetaS:tmrcaS 6.129e-04 1.704e-04   3.596  0.00139 **  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006567 on 25 degrees of freedom  
## Multiple R-squared:  0.9915, Adjusted R-squared:  0.9901  
## F-statistic: 728.3 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_3)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.067499 1.291344 1.435859 1.632013
```

```
interact_plot(m.diversity.rep_3, pred = thetaS, modx= tmrcaS)
```



```
g.rep_3 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                 data = inf.lands.1Mb.rep_3, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_3)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_3
##          AIC      BIC    logLik
##     -349.3777 -339.5693 181.6889
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.3277574
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020686282 0.0001662473 124.43077 0.0000
## thetaS       0.006300258 0.0001217608  51.74291 0.0000
## tmrcaS       0.001233606 0.0001289727   9.56486 0.0000
## rhoS        0.000032878 0.0001293407   0.25420 0.8014
## thetaS:tmrcaS 0.000666344 0.0001545784   4.31072 0.0002
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.024
## tmrcaS     -0.051 -0.272
## rhoS        0.026  0.090  0.062
## thetaS:tmrcaS -0.081 -0.284  0.478 -0.312
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.06120732 -0.59725161  0.02282195  0.36381078  2.61148857
##
## Residual standard error: 0.0005989662
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_3)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.119139     1.425723     1.185890     1.564342
g.rep_3.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_3, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_3.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_3
##      AIC      BIC    logLik
## -311.0899 -304.0839 160.5449
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.06226692
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020733044 0.0002082301 99.56794 0.0000
## thetaS      0.006488505 0.0002221686 29.20532 0.0000
## rhoS       -0.000114023 0.0002210716 -0.51578 0.6102
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   -0.001 -0.036
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.20029757 -0.55512347  0.03085907  0.50826091  1.89284077
##
## Residual standard error: 0.00114935
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_3)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.1Mb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 3] <- anova.diversity$VarExp[4] * 100

```

2.3.4 Replicate 4

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_4/rs.pair_4.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 80, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9822024

inf.lands.1Mb.rep_4 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_4) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_4$thetaS <- (inf.lands.1Mb.rep_4$theta - mean(inf.lands.1Mb.rep_4$theta)) / sd(inf.lands.1Mb.rep_4$theta)
inf.lands.1Mb.rep_4$tmrcaS <- (inf.lands.1Mb.rep_4$tmrca - mean(inf.lands.1Mb.rep_4$tmrca)) / sd(inf.lands.1Mb.rep_4$tmrca)
inf.lands.1Mb.rep_4$rhoS <- (inf.lands.1Mb.rep_4$rho - mean(inf.lands.1Mb.rep_4$rho)) / sd(inf.lands.1Mb.rep_4$rho)

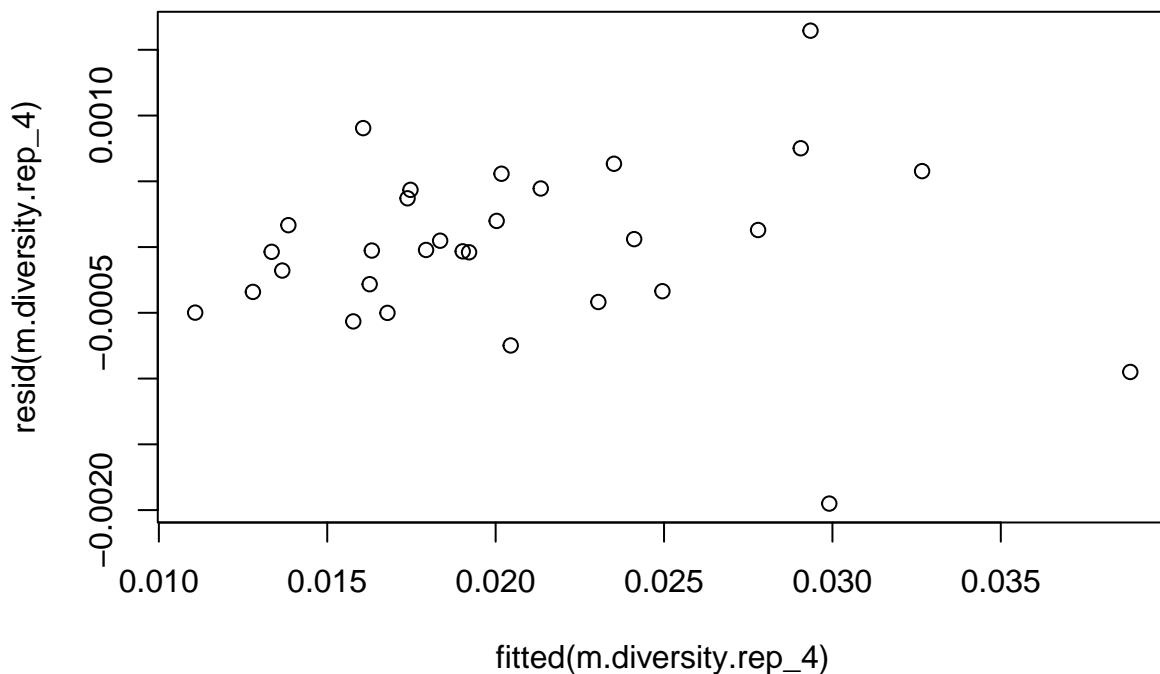
inf.lands.1Mb.rep_4$bin <- 1:nrow(inf.lands.1Mb.rep_4)

inf.lands.1Mb.rep_4$Replicate <- 4

m.diversity.rep_4 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_4)

plot(resid(m.diversity.rep_4) ~ fitted(m.diversity.rep_4))

```

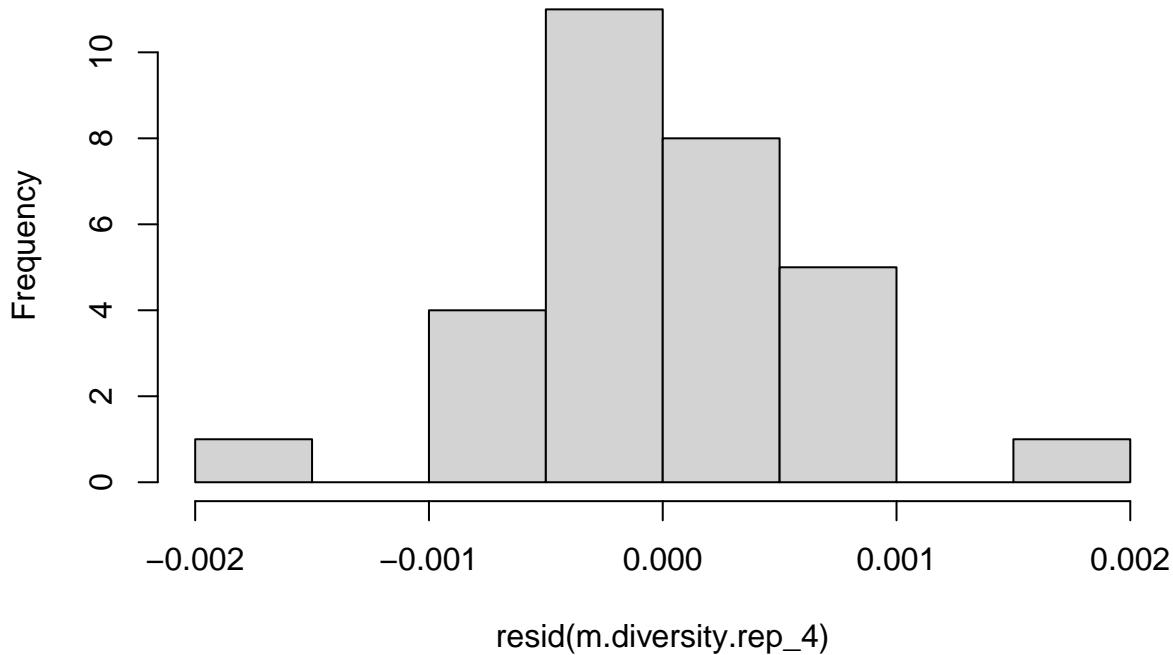


```
dwtest(m.diversity.rep_4)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_4
## DW = 2.0871, p-value = 0.5863
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_4)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_4
## HMC = 0.42593, p-value = 0.285
hist(resid(m.diversity.rep_4))
```

Histogram of resid(m.diversity.rep_4)



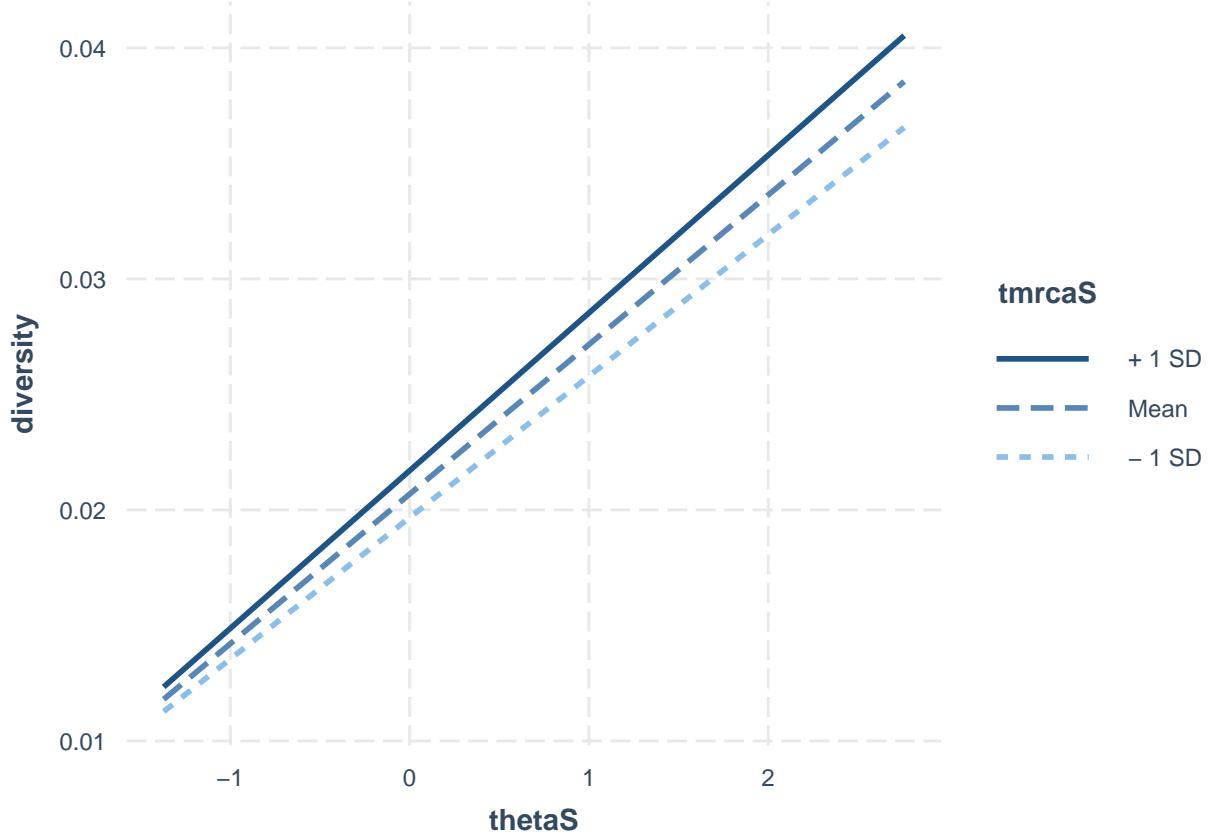
```
summary(m.diversity.rep_4)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_4)  
##  
## Residuals:  
##      Min        1Q    Median        3Q       Max  
## -1.950e-03 -3.397e-04 -2.417e-05  4.190e-04  1.645e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0.0206840 0.0001284 161.149 < 2e-16 ***  
## thetaS       0.0064755 0.0001308  49.520 < 2e-16 ***  
## rhoS        -0.0000109 0.0001471  -0.074   0.942  
## tmrcaS       0.0010166 0.0001896   5.363 1.46e-05 ***  
## thetaS:tmrcaS 0.0003526 0.0002292   1.538   0.137  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.000703 on 25 degrees of freedom  
## Multiple R-squared:  0.9901, Adjusted R-squared:  0.9886  
## F-statistic: 628.1 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_4)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.003391 1.269919 2.108641 2.097578
```

```
interact_plot(m.diversity.rep_4, pred = thetaS, modx= tmrcaS)
```



```
g.rep_4 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_4, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_4)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_4
##          AIC      BIC    logLik
##     -342.0193 -332.2109 178.0096
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## -0.05853672
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020683851 0.0001213164 170.49504 0.0000
## thetaS       0.006477694 0.0001294896  50.02482 0.0000
## tmrcaS      0.000989578 0.0001927169   5.13488 0.0000
## rhoS        -0.000015021 0.0001449330  -0.10364 0.9183
## thetaS:tmrcaS 0.000321760 0.0002315284    1.38972 0.1769
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.001
## tmrcaS     -0.003 -0.036
## rhoS        0.002  0.016  0.215
## thetaS:tmrcaS -0.006 -0.054  0.653 -0.181
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.03132272 -0.49951188 -0.03148496  0.64957883  2.58514901
##
## Residual standard error: 0.0006419926
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_4)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.002978    2.181651    1.293335    2.154008

g.rep_4.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_4, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_4.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_4
##      AIC      BIC   logLik
## -323.3904 -316.3844 166.6952
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.3430849
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020679766 0.0001347863 153.42630 0.0000
## thetaS      0.006499529 0.0001673925  38.82807 0.0000
## rhoS       -0.000371115 0.0001562284  -2.37546 0.0249
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.004
## rhoS   0.003  0.002
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.3370913 -0.2969692  0.1671986  0.5302828  2.0808719
##
## Residual standard error: 0.0009928647
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_4)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 4] <- anova.diversity$VarExp[4] * 100

```

2.3.5 Replicate 5

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_5/rs.pair_5.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 76, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9830923

inf.lands.1Mb.rep_5 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_5) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_5$thetaS <- (inf.lands.1Mb.rep_5$theta - mean(inf.lands.1Mb.rep_5$theta)) / sd(inf.lands.1Mb.rep_5$theta)
inf.lands.1Mb.rep_5$tmrcaS <- (inf.lands.1Mb.rep_5$tmrca - mean(inf.lands.1Mb.rep_5$tmrca)) / sd(inf.lands.1Mb.rep_5$tmrca)
inf.lands.1Mb.rep_5$rhoS <- (inf.lands.1Mb.rep_5$rho - mean(inf.lands.1Mb.rep_5$rho)) / sd(inf.lands.1Mb.rep_5$rho)

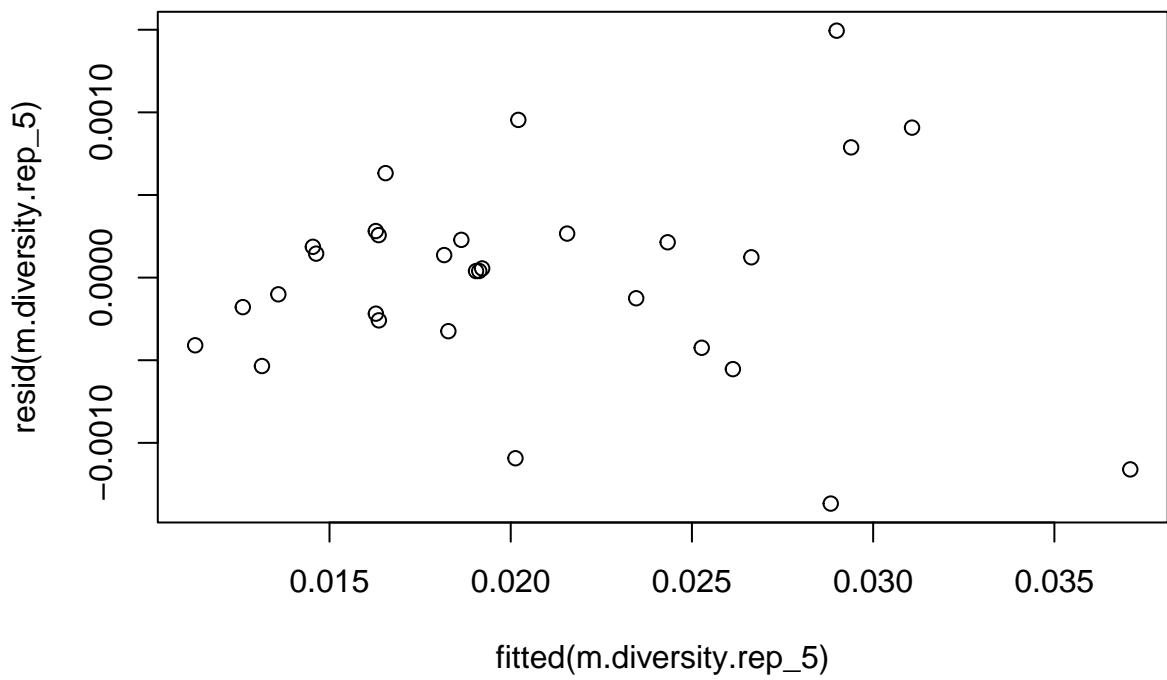
inf.lands.1Mb.rep_5$bin <- 1:nrow(inf.lands.1Mb.rep_5)

inf.lands.1Mb.rep_5$Replicate <- 5

m.diversity.rep_5 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_5)

plot(resid(m.diversity.rep_5)~fitted(m.diversity.rep_5))

```

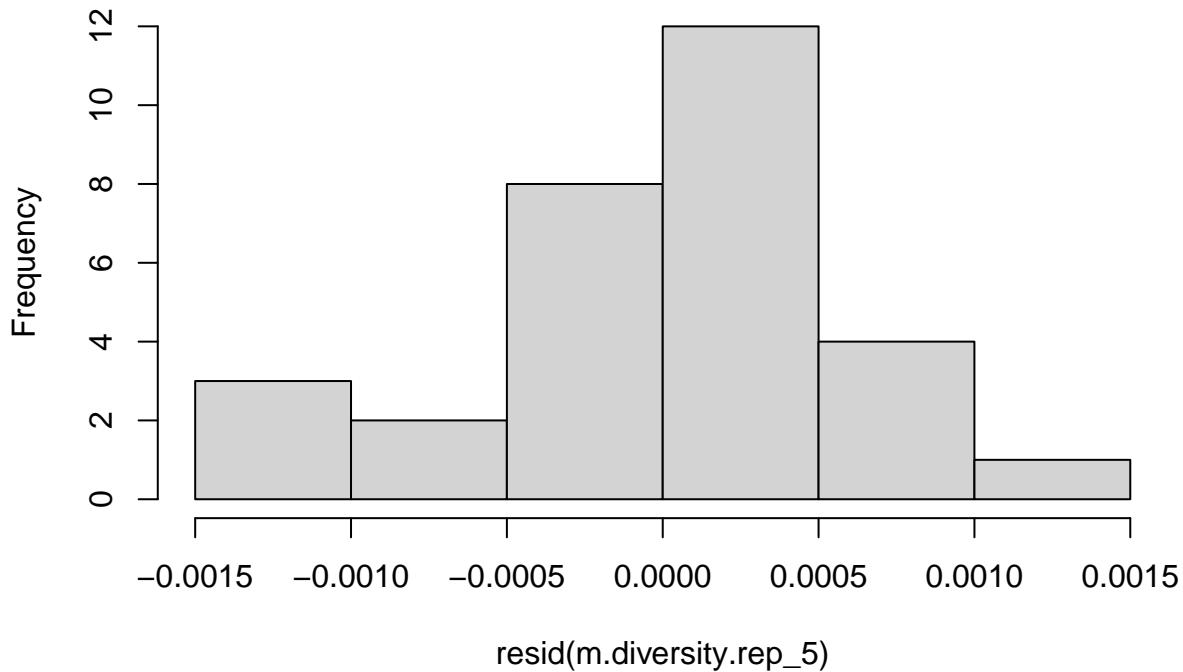


```
dwtest(m.diversity.rep_5)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_5
## DW = 1.8381, p-value = 0.2796
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_5)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_5
## HMC = 0.49429, p-value = 0.458
hist(resid(m.diversity.rep_5))
```

Histogram of resid(m.diversity.rep_5)



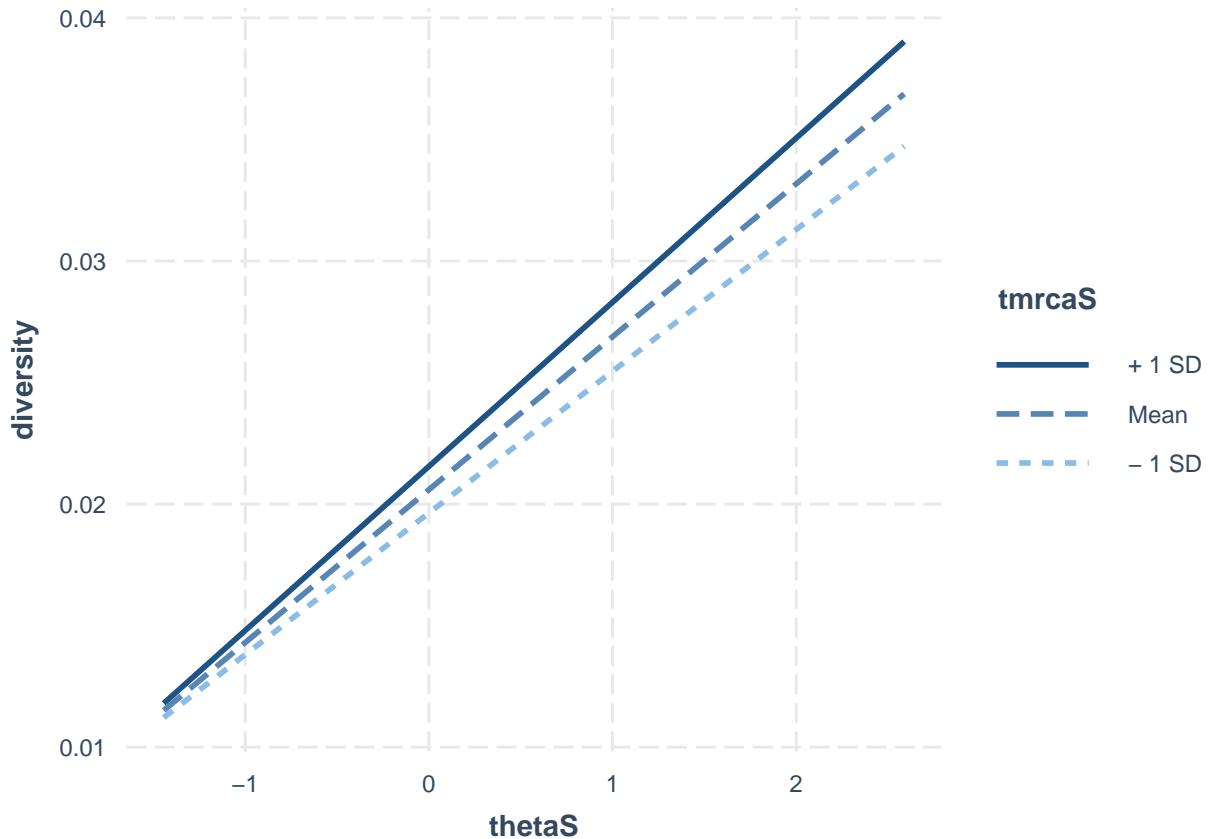
```
summary(m.diversity.rep_5)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_5)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.367e-03 -3.078e-04  4.773e-05  2.499e-04  1.494e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.059e-02 1.215e-04 169.475 < 2e-16 ***  
## thetaS       6.291e-03 1.237e-04  50.855 < 2e-16 ***  
## rhoS        -7.338e-04 2.362e-03   -0.311  0.7586  
## tmrcaS       9.891e-05 1.894e-05   5.224  2.09e-05 ***  
## thetaS:tmrcaS 4.759e-05 2.090e-05    2.277  0.0316 *## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006642 on 25 degrees of freedom  
## Multiple R-squared:  0.9905, Adjusted R-squared:  0.989  
## F-statistic: 650.9 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_5)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.005906 1.358330 2.216555 1.881869
```

```
interact_plot(m.diversity.rep_5, pred = thetaS, modx= tmrcaS)
```



```
g.rep_5 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_5, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_5)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_5
##          AIC      BIC    logLik
##     -345.5754 -335.767 179.7877
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.09742974
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020593322 0.0001335763 154.16894 0.0000
## thetaS       0.006289699 0.0001243303  50.58862 0.0000
## tmrcaS      0.000102000 0.0000185454   5.50000 0.0000
## rhoS        -0.000671391 0.0023700424  -0.28328 0.7793
## thetaS:tmrcaS 0.000052459 0.0000206457   2.54093 0.0176
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.002
## tmrcaS     0.033  0.055
## rhoS       -0.002  0.016  0.365
## thetaS:tmrcaS  0.058  0.056  0.609 -0.028
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.2002408 -0.4979867  0.0723577  0.3822209  2.4009759
##
## Residual standard error: 0.0006068364
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_5)

##          thetaS         tmrcaS        rhoS thetaS:tmrcaS
##          1.003874       2.071251      1.303671      1.797134

g.rep_5.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_5, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_5.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_5
##      AIC      BIC    logLik
## -327.0266 -320.0206 168.5133
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## -0.151117
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020569710 0.0001476467 139.31706 0.0000
## thetaS       0.006238359 0.0001667110   37.42021 0.0000
## rhoS        -0.006901949 0.0026735091  -2.58161 0.0156
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.001
## rhoS  -0.002 -0.018
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.9762372 -0.5677260  0.1592677  0.6160406  2.4429343
##
## Residual standard error: 0.0008894714
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_5)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 5] <- anova.diversity$VarExp[4] * 100

```

2.3.6 Replicate 6

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_6/rs.pair_6.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 84, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9813126

inf.lands.1Mb.rep_6 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_6) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_6$thetaS <- (inf.lands.1Mb.rep_6$theta - mean(inf.lands.1Mb.rep_6$theta)) / sd(inf.lands.1Mb.rep_6)
inf.lands.1Mb.rep_6$tmrcaS <- (inf.lands.1Mb.rep_6$tmrca - mean(inf.lands.1Mb.rep_6$tmrca)) / sd(inf.lands.1Mb.rep_6)
inf.lands.1Mb.rep_6$rhoS <- (inf.lands.1Mb.rep_6$rho - mean(inf.lands.1Mb.rep_6$rho)) / sd(inf.lands.1Mb.rep_6)

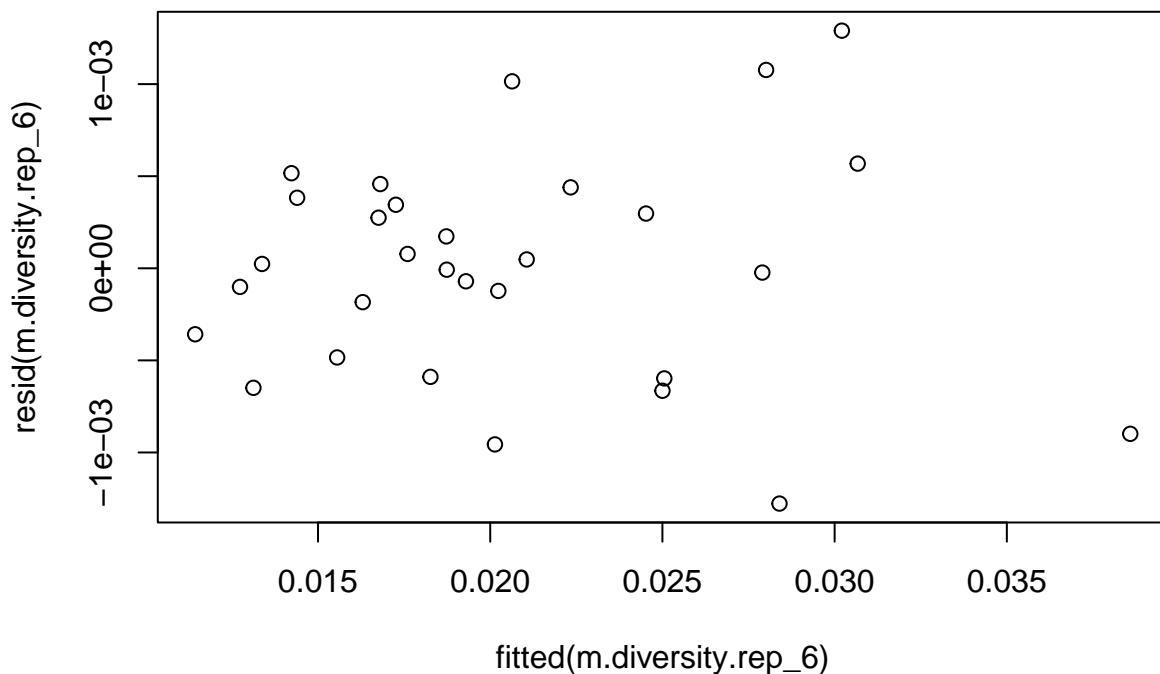
inf.lands.1Mb.rep_6$bin <- 1:nrow(inf.lands.1Mb.rep_6)

inf.lands.1Mb.rep_6$Replicate <- 6

m.diversity.rep_6 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_6)

plot(resid(m.diversity.rep_6) ~ fitted(m.diversity.rep_6))

```

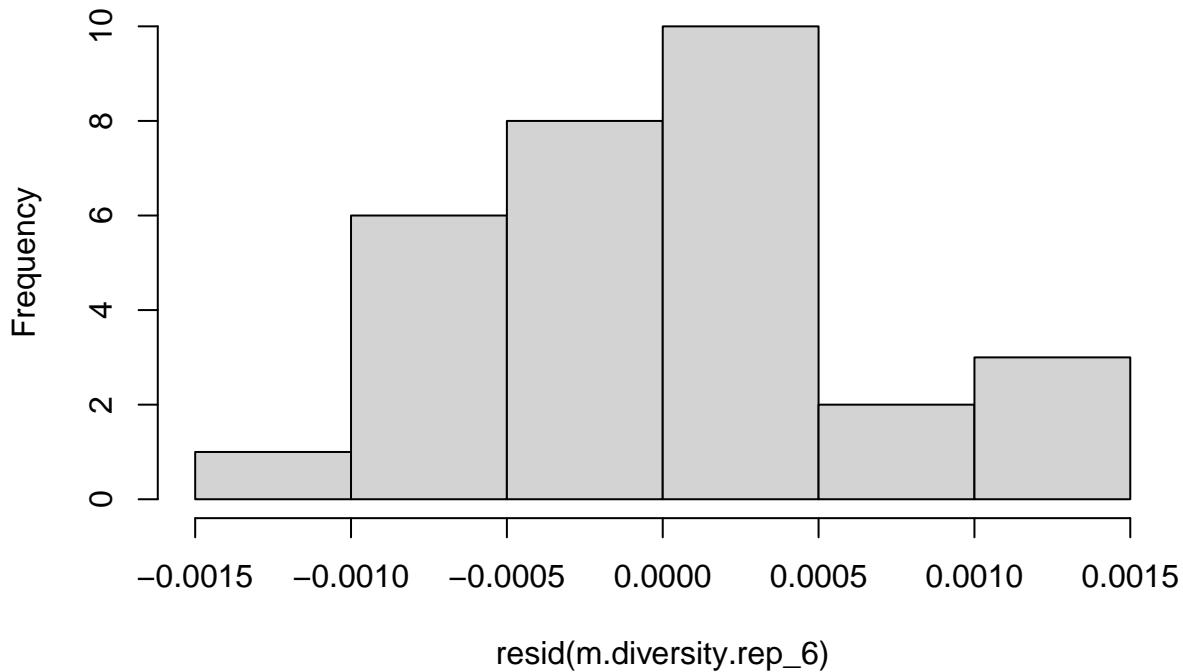


```
dwtest(m.diversity.rep_6)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_6
## DW = 1.7678, p-value = 0.2162
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_6)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_6
## HMC = 0.38206, p-value = 0.175
hist(resid(m.diversity.rep_6))
```

Histogram of resid(m.diversity.rep_6)



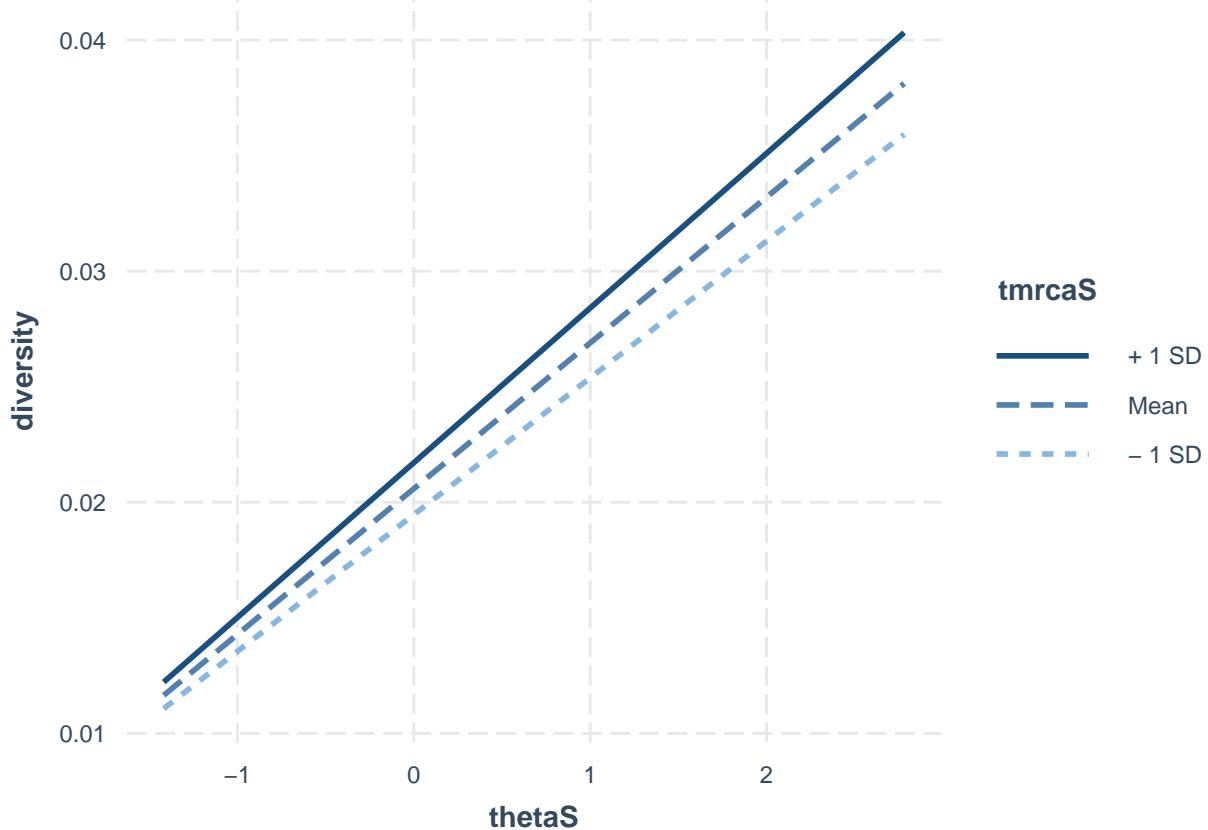
```
summary(m.diversity.rep_6)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_6)  
##  
## Residuals:  
##      Min        1Q    Median        3Q       Max  
## -1.277e-03 -4.527e-04  7.960e-06  3.734e-04  1.290e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 0.0205897  0.0001193 172.524 < 2e-16 ***  
## thetaS       0.0063060  0.0001232  51.167 < 2e-16 ***  
## rhoS        0.0001654  0.0001529   1.082  0.2897  
## tmrcaS      0.0011233  0.0001604   7.004 2.43e-07 ***  
## thetaS:tmrcaS 0.0003879  0.0001649   2.352  0.0269 *  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006531 on 25 degrees of freedom  
## Multiple R-squared:  0.9911, Adjusted R-squared:  0.9897  
## F-statistic: 694.4 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_6)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.032601  1.589130  1.748838   1.416209
```

```
interact_plot(m.diversity.rep_6, pred = thetaS, modx= tmrcaS)
```



```
g.rep_6 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_6, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_6)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_6
##          AIC      BIC    logLik
##     -346.8212 -337.0128 180.4106
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.1358209
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020592380 0.0001362541 151.13216 0.0000
## thetaS       0.006299404 0.0001239804  50.80966 0.0000
## tmrcaS       0.001133198 0.0001570286   7.21651 0.0000
## rhoS         0.000143376 0.0001542687   0.92939 0.3616
## thetaS:tmrcaS 0.000435077 0.0001634509   2.66182 0.0134
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.007
## tmrcaS      0.000 -0.065
## rhoS        -0.010  0.040  0.485
## thetaS:tmrcaS 0.033 -0.186  0.336 -0.157
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.09674866 -0.76764130  0.02681106  0.64010637  2.02153252
##
## Residual standard error: 0.0005969812
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_6)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.036142     1.691913     1.539768     1.360141

g.rep_6.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_6, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_6.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_6
##      AIC      BIC    logLik
## -317.8306 -310.8246 163.9153
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.04598612
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020574682 0.0001889124 108.91122 0.0000
## thetaS      0.006311497 0.0001990837  31.70273 0.0000
## rhoS      -0.000349915 0.0001977951  -1.76908 0.0882
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS  -0.001 -0.001
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.7855991 -0.6320726  0.1751760  0.5604975  2.9148885
##
## Residual standard error: 0.001026338
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_6)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 6] <- anova.diversity$VarExp[4] * 100

```

2.3.7 Replicate 7

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_7/rs.pair_7.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 112, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9750834

inf.lands.1Mb.rep_7 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_7) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_7$thetaS <- (inf.lands.1Mb.rep_7$theta - mean(inf.lands.1Mb.rep_7$theta)) / sd(inf.lands.1Mb.rep_7$theta)
inf.lands.1Mb.rep_7$tmrcaS <- (inf.lands.1Mb.rep_7$tmrca - mean(inf.lands.1Mb.rep_7$tmrca)) / sd(inf.lands.1Mb.rep_7$tmrca)
inf.lands.1Mb.rep_7$rhoS <- (inf.lands.1Mb.rep_7$rho - mean(inf.lands.1Mb.rep_7$rho)) / sd(inf.lands.1Mb.rep_7$rho)

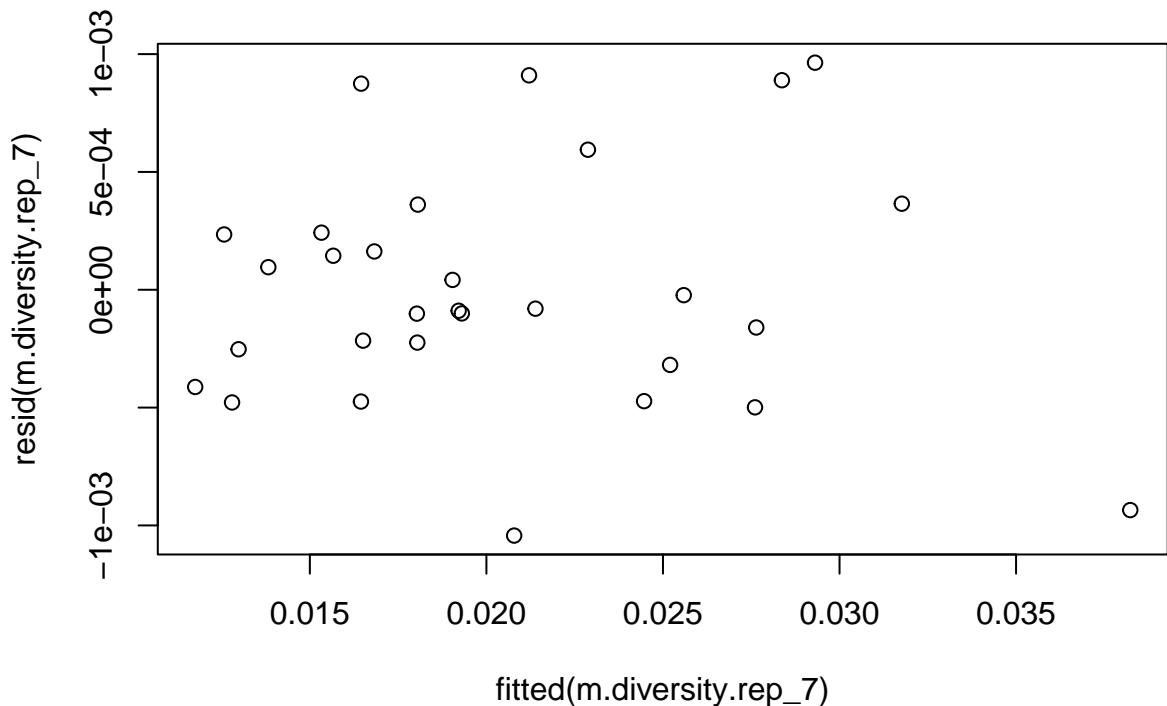
inf.lands.1Mb.rep_7$bin <- 1:nrow(inf.lands.1Mb.rep_7)

inf.lands.1Mb.rep_7$Replicate <- 7

m.diversity.rep_7 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_7)

plot(resid(m.diversity.rep_7) ~ fitted(m.diversity.rep_7))

```

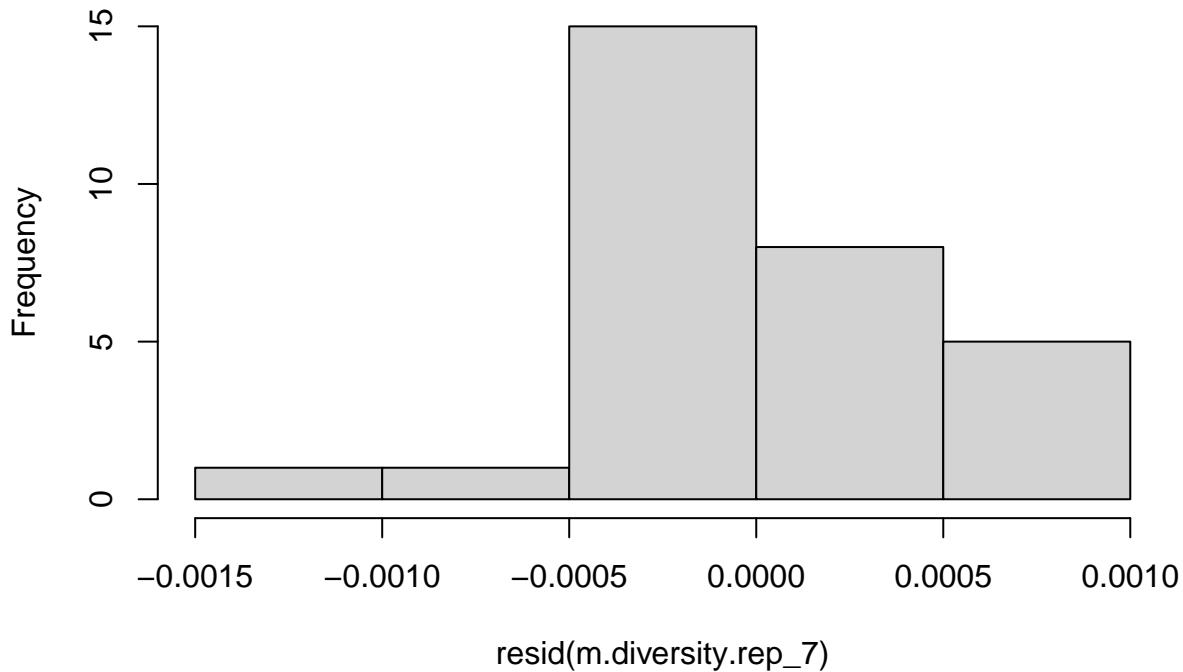


```
dwtest(m.diversity.rep_7)
```

```
##
##  Durbin-Watson test
##
## data: m.diversity.rep_7
## DW = 1.6938, p-value = 0.1634
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_7)
```

```
##
##  Harrison-McCabe test
##
## data: m.diversity.rep_7
## HMC = 0.40789, p-value = 0.224
hist(resid(m.diversity.rep_7))
```

Histogram of resid(m.diversity.rep_7)



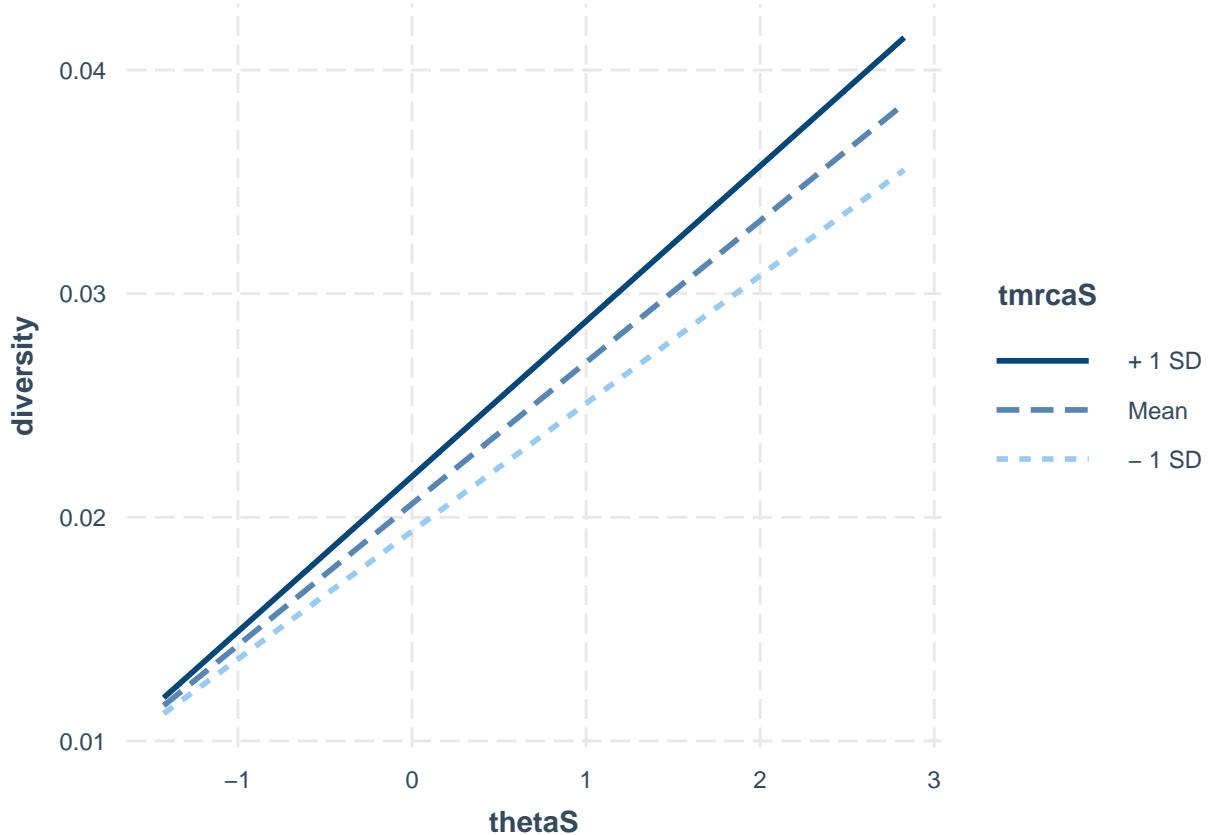
```
summary(m.diversity.rep_7)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_7)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -0.0010431 -0.0003022 -0.0000846  0.0002404  0.0009636  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.060e-02 1.001e-04 205.827 < 2e-16 ***  
## thetaS       6.328e-03 1.026e-04   61.661 < 2e-16 ***  
## rhoS        2.408e-05 1.192e-04    0.202 0.841513  
## tmrcaS      1.227e-03 1.432e-04    8.568 6.58e-09 ***  
## thetaS:tmrcaS 6.121e-04 1.441e-04    4.248 0.000262 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0005471 on 25 degrees of freedom  
## Multiple R-squared:  0.9937, Adjusted R-squared:  0.9927  
## F-statistic: 992.7 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_7)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.020457 1.376198 1.985735 1.972300
```

```
interact_plot(m.diversity.rep_7, pred = thetaS, modx= tmrcaS)
```



```
g.rep_7 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_7, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_7)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_7
##          AIC      BIC    logLik
##     -357.7791 -347.9708 185.8896
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.1726746
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020604107 0.0001183950 174.02851 0.0000
## thetaS       0.006330465 0.0001029690  61.47931 0.0000
## tmrcaS      0.001201640 0.0001383881   8.68312 0.0000
## rhoS        -0.000015831 0.0001187358  -0.13333 0.8950
## thetaS:tmrcaS 0.000613682 0.0001380243    4.44619 0.0002
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.005
## tmrcaS      0.022 -0.097
## rhoS        -0.009 -0.074  0.228
## thetaS:tmrcaS 0.046 -0.103  0.586 -0.198
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.1497675 -0.5506932 -0.1283266  0.4700014  1.9723133
##
## Residual standard error: 0.0005001377
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_7)

##          thetaS         tmrcaS         rhoS     thetaS:tmrcaS
## 1.020214      1.873531      1.290005      1.862508

g.rep_7.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_7, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_7.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_7
##      AIC      BIC logLik
## -319.9699 -312.9639 164.985
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##          Phi
## 0.1179429
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020581847 0.0002148595 95.79213 0.0000
## thetaS       0.006399198 0.0001974295 32.41258 0.0000
## rhoS        -0.000287101 0.0002007978 -1.42980 0.1642
##
## Correlation:
##           (Intr) thetaS
## thetaS -0.001
## rhoS   0.002 -0.097
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.37431231 -0.29863999  0.01070772  0.55844318  2.30950358
##
## Residual standard error: 0.0009960966
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_7)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 7] <- anova.diversity$VarExp[4] * 100

```

2.3.8 Replicate 8

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_8/rs.pair_8.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 80, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9822024

inf.lands.1Mb.rep_8 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_8) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_8$thetaS <- (inf.lands.1Mb.rep_8$theta - mean(inf.lands.1Mb.rep_8$theta)) / sd(inf.lands.1Mb.rep_8)
inf.lands.1Mb.rep_8$tmrcaS <- (inf.lands.1Mb.rep_8$tmrca - mean(inf.lands.1Mb.rep_8$tmrca)) / sd(inf.lands.1Mb.rep_8)
inf.lands.1Mb.rep_8$rhoS <- (inf.lands.1Mb.rep_8$rho - mean(inf.lands.1Mb.rep_8$rho)) / sd(inf.lands.1Mb.rep_8)

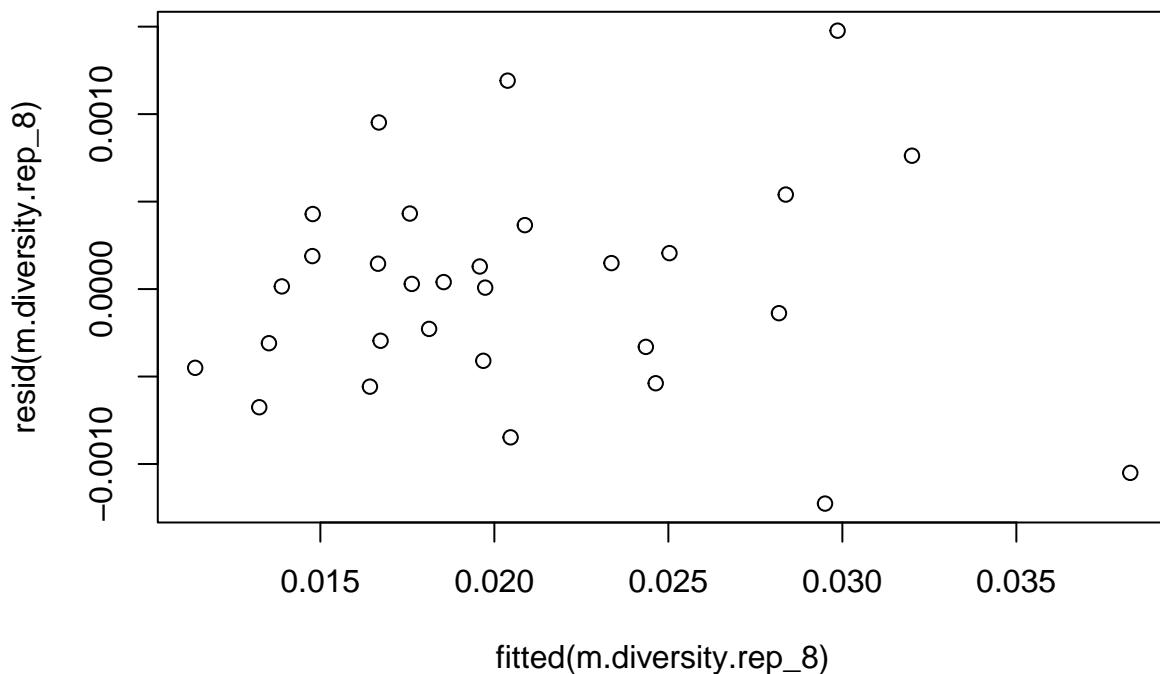
inf.lands.1Mb.rep_8$bin <- 1:nrow(inf.lands.1Mb.rep_8)

inf.lands.1Mb.rep_8$Replicate <- 8

m.diversity.rep_8 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_8)

plot(resid(m.diversity.rep_8)~fitted(m.diversity.rep_8))

```



```

dwtest(m.diversity.rep_8)

##
##  Durbin-Watson test
##
## data: m.diversity.rep_8
## DW = 1.6816, p-value = 0.17
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_8)

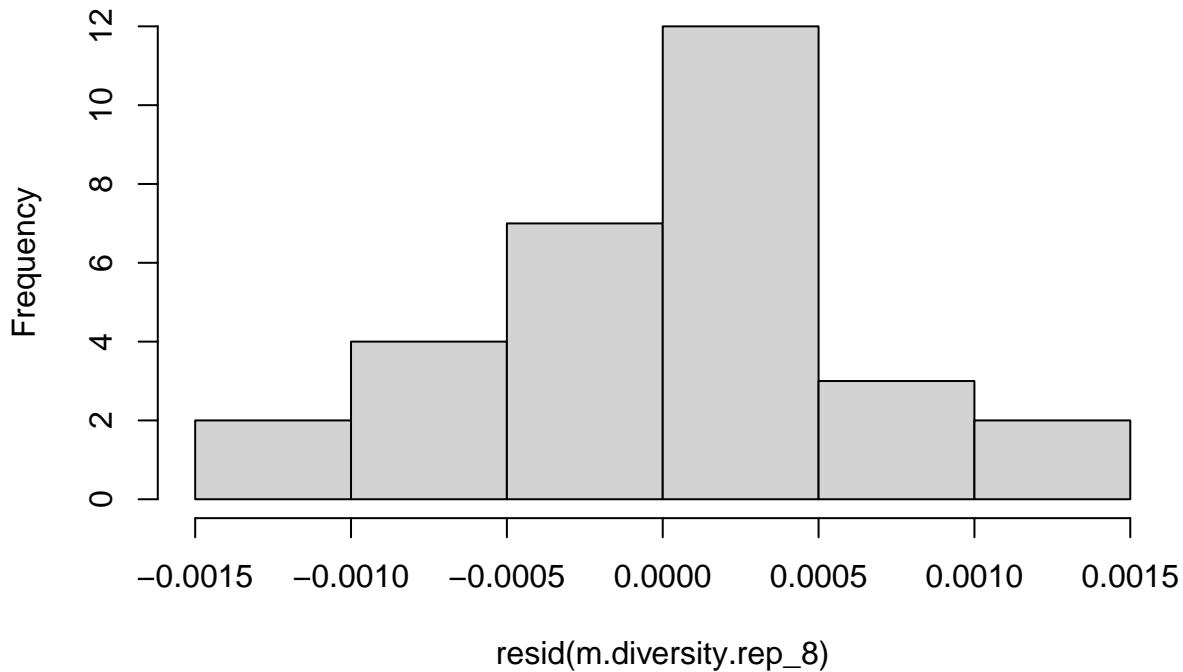
```

```

##
##  Harrison-McCabe test
##
## data: m.diversity.rep_8
## HMC = 0.45613, p-value = 0.368
hist(resid(m.diversity.rep_8))

```

Histogram of resid(m.diversity.rep_8)



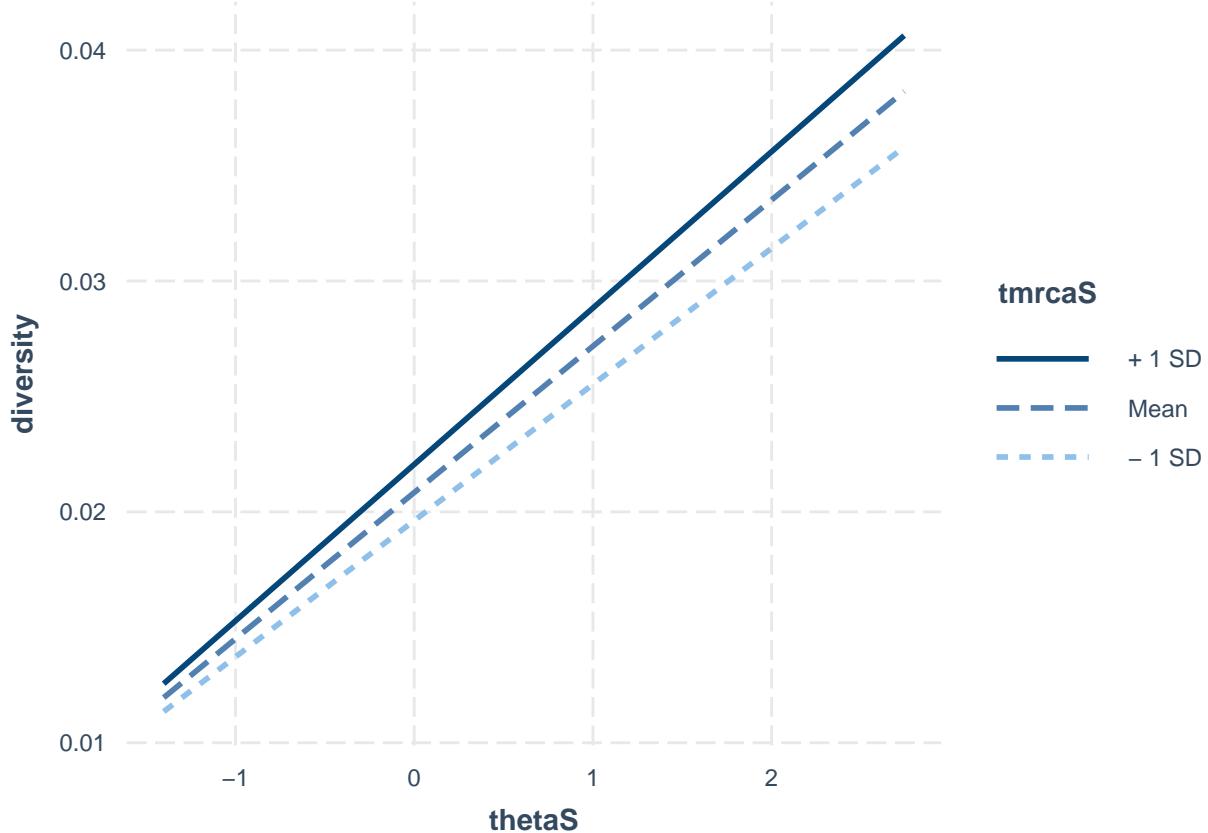
```
summary(m.diversity.rep_8)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,
##     data = inf.lands.1Mb.rep_8)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.226e-03 -3.903e-04  2.222e-05  3.255e-04  1.477e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.0208365  0.0001224 170.170 < 2e-16 ***
## thetaS       0.0063380  0.0001252  50.620 < 2e-16 ***
## rhoS        0.0001281  0.0001427   0.897  0.3781
## tmrcaS      0.0012170  0.0002058   5.915 3.58e-06 ***
## thetaS:tmrcaS 0.0004373  0.0001878   2.329   0.0282 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0006676 on 25 degrees of freedom
## Multiple R-squared:  0.9906, Adjusted R-squared:  0.9891
## F-statistic: 660.6 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_8)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.020075  1.325433  2.754909   2.930929
```

```
interact_plot(m.diversity.rep_8, pred = thetaS, modx= tmrcaS)
```



```
g.rep_8 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_8, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_8)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_8
##          AIC      BIC    logLik
##     -345.8378 -336.0294 179.9189
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.1655662
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020838721 0.0001435030 145.21451 0.0000
## thetaS       0.006320203 0.0001245996  50.72412 0.0000
## tmrcaS       0.001246236 0.0001908528   6.52983 0.0000
## rhoS         0.000120494 0.0001459813    0.82541 0.4169
## thetaS:tmrcaS 0.000474550 0.0001759369    2.69727 0.0123
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.012
## tmrcaS      0.046 -0.065
## rhoS        -0.024  0.082  0.056
## thetaS:tmrcaS 0.071 -0.140  0.721 -0.279
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.96269837 -0.63215676  0.03038078  0.52605973  2.37801009
##
## Residual standard error: 0.0006095428
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_8)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.023443     2.452808     1.275892     2.678721

g.rep_8.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_8, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_8.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_8
##      AIC      BIC    logLik
## -319.0793 -312.0733 164.5397
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.1415906
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020803517 0.0001699309 122.42339 0.0000
## thetaS      0.006310129 0.0001914735  32.95562 0.0000
## rhoS       -0.000199993 0.0001849373  -1.08141 0.2891
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.001
## rhoS   0.001 -0.012
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.87467372 -0.74418645  0.07635072  0.53300754  2.76001890
##
## Residual standard error: 0.001014048
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_8)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 8] <- anova.diversity$VarExp[4] * 100

```

2.3.9 Replicate 9

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_9/rs.pair_9.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 84, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9813126

inf.lands.1Mb.rep_9 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_9) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_9$thetaS <- (inf.lands.1Mb.rep_9$theta - mean(inf.lands.1Mb.rep_9$theta)) / sd(inf.lands.1Mb.rep_9)
inf.lands.1Mb.rep_9$tmrcaS <- (inf.lands.1Mb.rep_9$tmrca - mean(inf.lands.1Mb.rep_9$tmrca)) / sd(inf.lands.1Mb.rep_9)
inf.lands.1Mb.rep_9$rhoS <- (inf.lands.1Mb.rep_9$rho - mean(inf.lands.1Mb.rep_9$rho)) / sd(inf.lands.1Mb.rep_9)

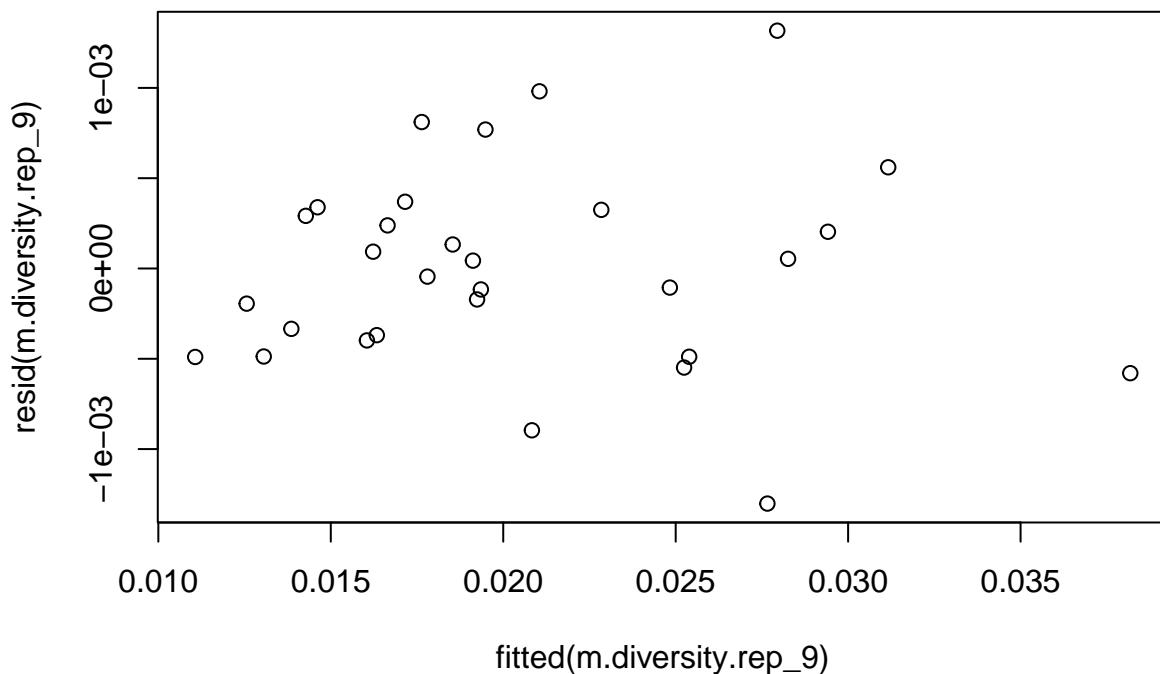
inf.lands.1Mb.rep_9$bin <- 1:nrow(inf.lands.1Mb.rep_9)

inf.lands.1Mb.rep_9$Replicate <- 9

m.diversity.rep_9 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_9)

plot(resid(m.diversity.rep_9)~fitted(m.diversity.rep_9))

```

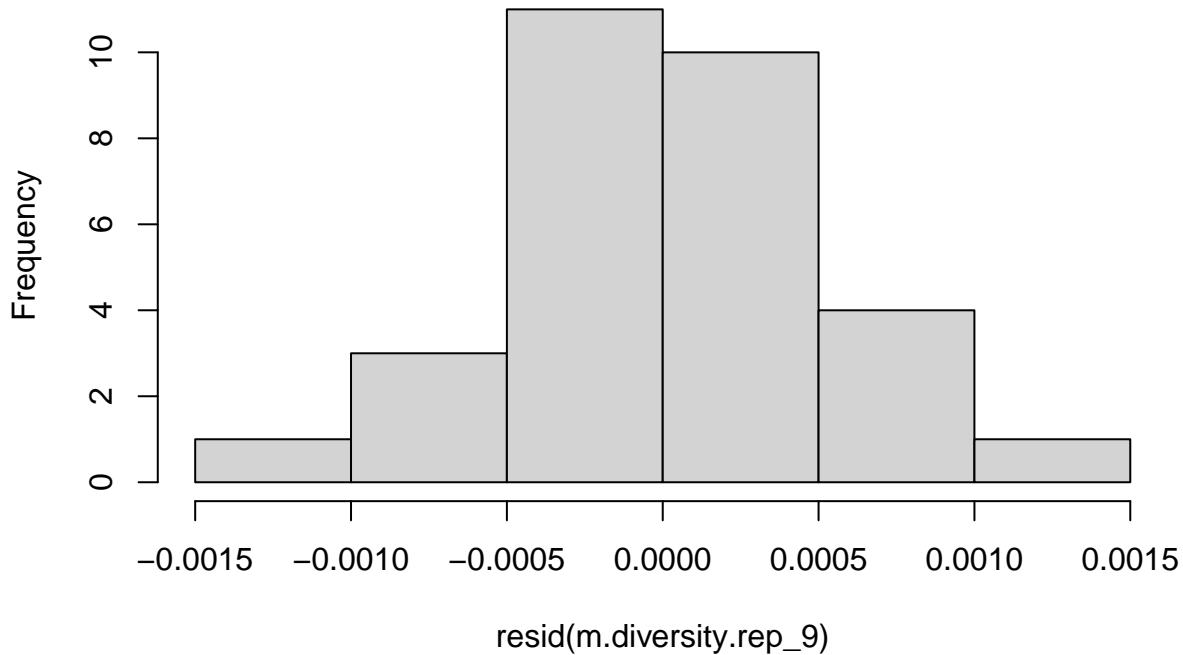


```
dwtest(m.diversity.rep_9)
```

```
##
##  Durbin-Watson test
##
##  data: m.diversity.rep_9
##  DW = 1.686, p-value = 0.1501
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_9)
```

```
##
##  Harrison-McCabe test
##
##  data: m.diversity.rep_9
##  HMC = 0.49123, p-value = 0.476
hist(resid(m.diversity.rep_9))
```

Histogram of resid(m.diversity.rep_9)



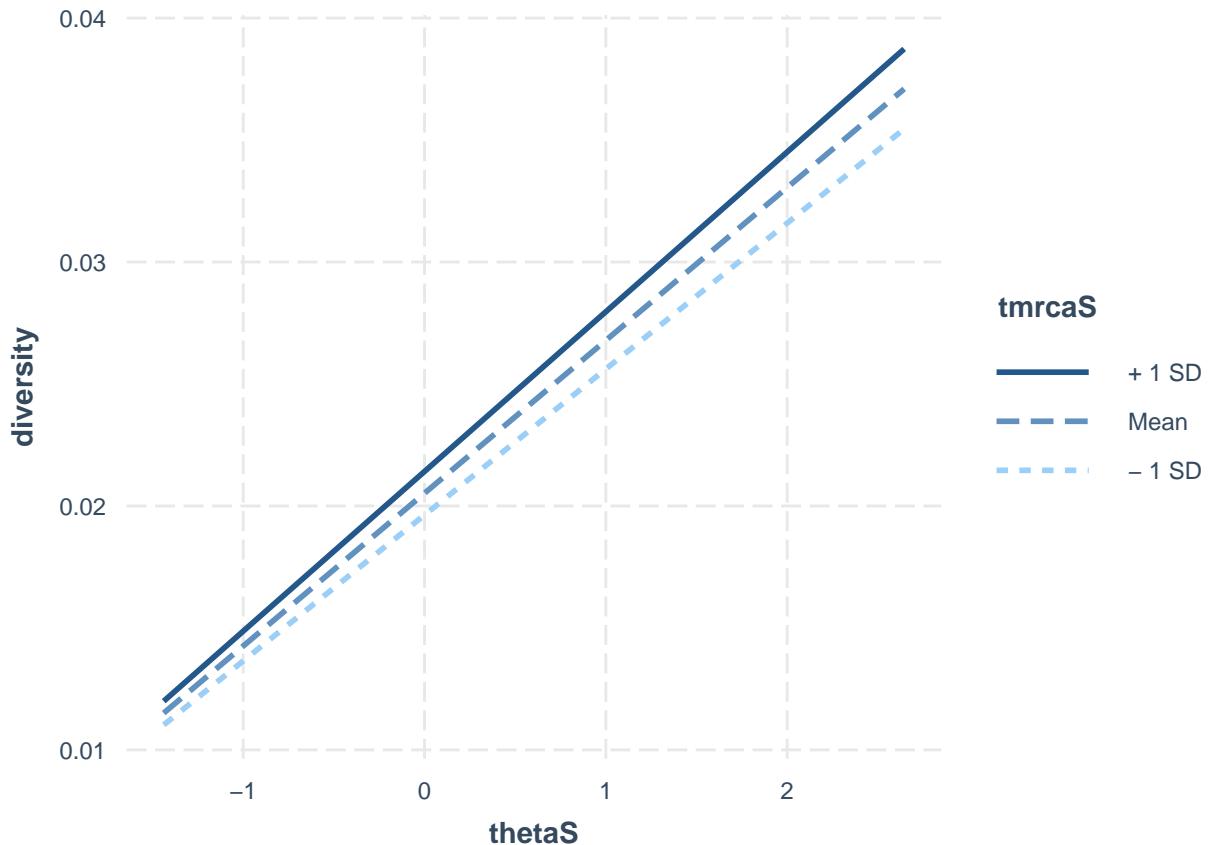
```
summary(m.diversity.rep_9)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_9)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.302e-03 -3.910e-04 -8.900e-07  3.164e-04  1.317e-03  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.052e-02 1.107e-04 185.445 < 2e-16 ***  
## thetaS       6.265e-03 1.139e-04  55.004 < 2e-16 ***  
## rhoS        6.536e-05 1.304e-04   0.501  0.6205  
## tmrcaS      8.922e-04 1.363e-04   6.547 7.39e-07 ***  
## thetaS:tmrcaS 2.822e-04 1.308e-04   2.158  0.0407 *## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0006061 on 25 degrees of freedom  
## Multiple R-squared:  0.9922, Adjusted R-squared:  0.991  
## F-statistic: 799.9 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_9)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.024324    1.342177    1.466363    1.290932
```

```
interact_plot(m.diversity.rep_9, pred = thetaS, modx= tmrcaS)
```



```
g.rep_9 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                 data = inf.lands.1Mb.rep_9, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_9)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_9
##          AIC      BIC    logLik
##     -351.6229 -341.8146 182.8115
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.1633414
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020523996 0.0001296981 158.24435 0.0000
## thetaS       0.006241612 0.0001134046  55.03845 0.0000
## tmrcaS      0.000904089 0.0001283011   7.04662 0.0000
## rhoS        0.000075891 0.0001311077   0.57885 0.5679
## thetaS:tmrcaS 0.000285637 0.0001311836   2.17739 0.0391
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      0.004
## tmrcaS     -0.021 -0.112
## rhoS       0.002  0.012  0.321
## thetaS:tmrcaS -0.022 -0.171  0.296 -0.217
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -2.277428606 -0.752076800 -0.002716583  0.581067343  2.423831154
##
## Residual standard error: 0.0005533147
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_9)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
## 1.034584    1.327310    1.266322    1.268614

g.rep_9.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_9, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_9.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_9
##      AIC      BIC logLik
## -325.8718 -318.8658 167.9359
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.2006686
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020514406 0.0001444358 142.03128 0.0000
## thetaS      0.006312166 0.0001690106  37.34776 0.0000
## rhoS      -0.000327436 0.0001615530  -2.02680 0.0527
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.001
## rhoS  -0.004 -0.041
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -2.57578335 -0.68638049 -0.02735148  0.65238571  1.96492871
##
## Residual standard error: 0.0009146795
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_9)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.inf.1Mb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 9] <- anova.diversity$VarExp[4] * 100

```

2.3.10 Replicate 10

```

p <- paste("dm_data/dm_chr_maps/2L/dm_coal_sims/rep_10/rs.pair_10.", sep = "")
pi.1Mb <- read.table(paste(p, "diversity.1Mb.bedgraph", sep = ""), header = T)
pi.1Mb$avg <- apply(pi.1Mb[4:ncol(pi.1Mb)], 1, mean)
tmrca.1Mb <- read.table(paste(p, "TMRCA.1Mb.bedgraph", sep = ""), header = T)
tmrca.1Mb$avg <- apply(tmrca.1Mb[4:ncol(tmrca.1Mb)], 1, mean)
rho.1Mb <- read.table(paste(p, "rho.1Mb.bedgraph", sep = ""), header = T)
theta.1Mb <- read.table(paste(p, "theta.1Mb.bedgraph", sep = ""), header = T)

cor.test(sim.theta.1Mb$sim, theta.1Mb$sample_mean, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: sim.theta.1Mb$sim and theta.1Mb$sample_mean
## S = 70, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.9844271

inf.lands.1Mb.rep_10 <- as.data.frame(cbind(pi.1Mb$avg, theta.1Mb$sample_mean, rho.1Mb$sample_mean, tmrca.1Mb$avg))
names(inf.lands.1Mb.rep_10) <- c("diversity", "theta", "rho", "tmrca")

# standardizing
inf.lands.1Mb.rep_10$thetaS <- (inf.lands.1Mb.rep_10$theta - mean(inf.lands.1Mb.rep_10$theta)) / sd(inf.lands.1Mb.rep_10$theta)
inf.lands.1Mb.rep_10$tmrcaS <- (inf.lands.1Mb.rep_10$tmrca - mean(inf.lands.1Mb.rep_10$tmrca)) / sd(inf.lands.1Mb.rep_10$tmrca)
inf.lands.1Mb.rep_10$rhoS <- (inf.lands.1Mb.rep_10$rho - mean(inf.lands.1Mb.rep_10$rho)) / sd(inf.lands.1Mb.rep_10$rho)

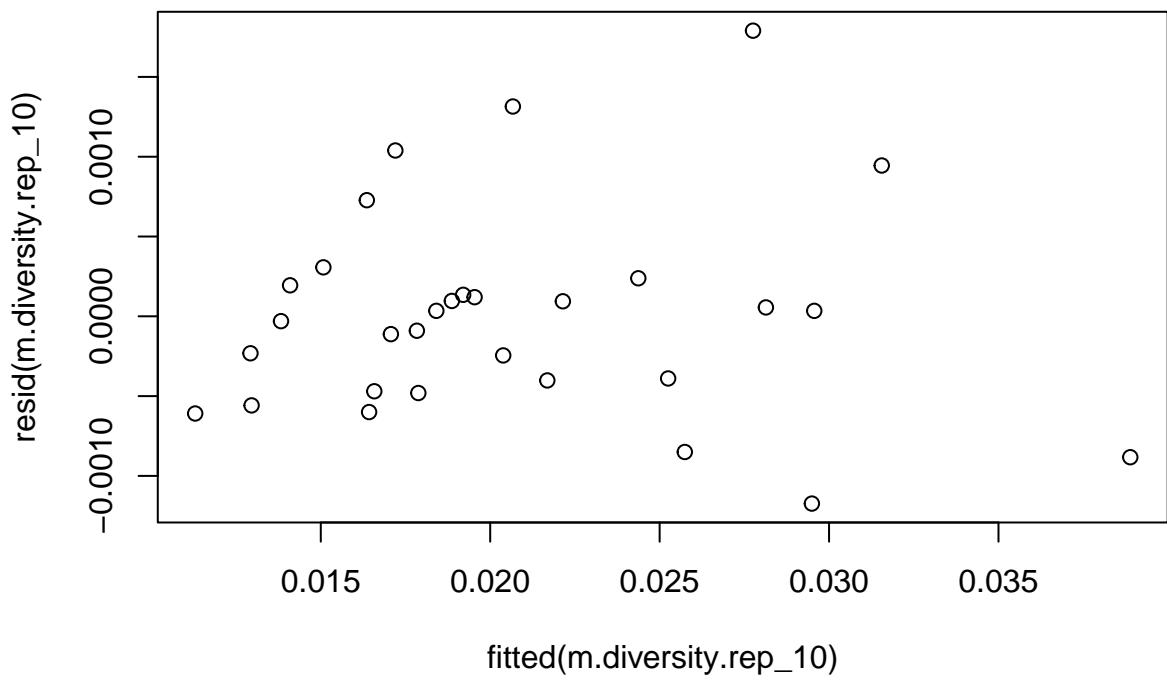
inf.lands.1Mb.rep_10$bin <- 1:nrow(inf.lands.1Mb.rep_10)

inf.lands.1Mb.rep_10$Replicate <- 10

m.diversity.rep_10 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS*tmrcaS, data = inf.lands.1Mb.rep_10)

plot(resid(m.diversity.rep_10) ~ fitted(m.diversity.rep_10))

```



```

dwtest(m.diversity.rep_10)

##
##  Durbin-Watson test
##
## data: m.diversity.rep_10
## DW = 1.5209, p-value = 0.06939
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.diversity.rep_10)

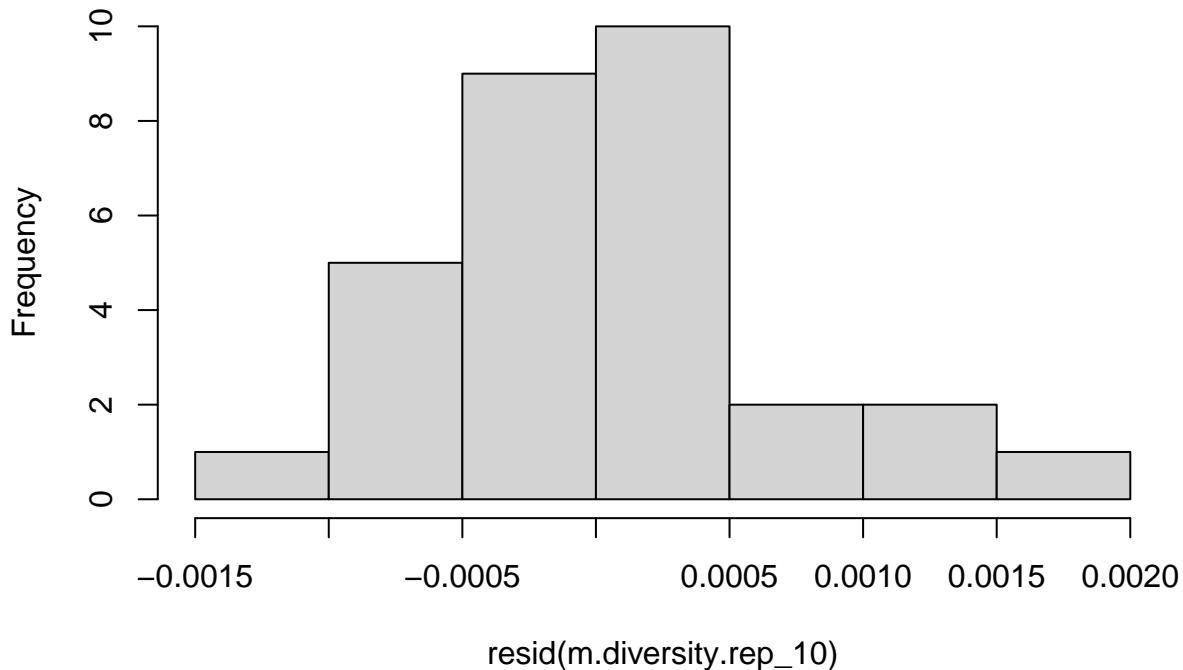
```

```

##
##  Harrison-McCabe test
##
## data: m.diversity.rep_10
## HMC = 0.59687, p-value = 0.79
hist(resid(m.diversity.rep_10))

```

Histogram of resid(m.diversity.rep_10)



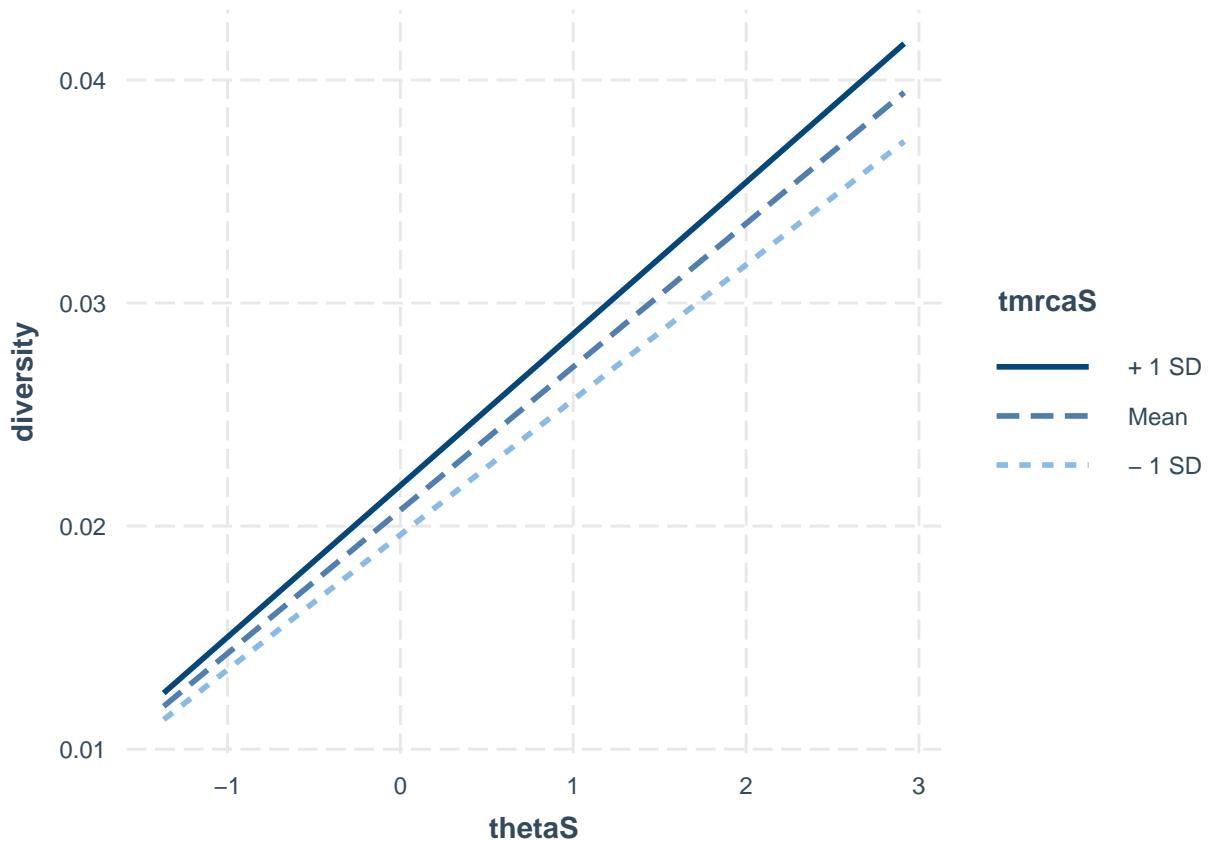
```
summary(m.diversity.rep_10)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS * tmrcaS,  
##      data = inf.lands.1Mb.rep_10)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -0.0011734 -0.0004527  0.0000019  0.0001794  0.0017898  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.072e-02 1.292e-04 160.343 < 2e-16 ***  
## thetaS       6.424e-03 1.321e-04  48.641 < 2e-16 ***  
## rhoS        2.264e-05 1.492e-04   0.152  0.8806  
## tmrcaS      1.105e-03 1.860e-04   5.940 3.35e-06 ***  
## thetaS:tmrcaS 3.732e-04 1.781e-04   2.096  0.0464 *## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0007071 on 25 degrees of freedom  
## Multiple R-squared:  0.9898, Adjusted R-squared:  0.9882  
## F-statistic: 605.8 on 4 and 25 DF,  p-value: < 2.2e-16
```

```
vif(m.diversity.rep_10)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.011696    1.290310    2.007133    2.085711
```

```
interact_plot(m.diversity.rep_10, pred = thetaS, modx= tmrcaS)
```



```
g.rep_10 <- gls(diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS,
                  data = inf.lands.1Mb.rep_1, cor = corAR1(0, ~bin), method = "ML")
```

```
summary(g.rep_10)
```

```
## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + tmrcaS + rhoS + thetaS:tmrcaS
##   Data: inf.lands.1Mb.rep_1
##          AIC      BIC logLik
##     -348.56 -338.7516 181.28
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.0188108
##
## Coefficients:
##             Value Std. Error t-value p-value
## (Intercept) 0.020624763 0.0001170758 176.16584 0.0000
## thetaS       0.006298915 0.0001222271  51.53453 0.0000
## tmrcaS      0.000914620 0.0001612620   5.67164 0.0000
## rhoS        0.000000297 0.0001325695   0.00224 0.9982
## thetaS:tmrcaS 0.000263026 0.0001559369   1.68675 0.1041
##
```

```

## Correlation:
##           (Intr) thetaS tmrcaS rhoS
## thetaS      -0.001
## tmrcaS      0.001 -0.171
## rhoS        0.000 -0.021  0.376
## thetaS:tmrcaS 0.004 -0.283  0.575 -0.003
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.67095844 -0.56781078 -0.01108315  0.40839933  3.09944720
##
## Residual standard error: 0.0005748314
## Degrees of freedom: 30 total; 25 residual
vif(g.rep_10)

##      thetaS      tmrcaS      rhoS thetaS:tmrcaS
##      1.087501     1.898249     1.271394     1.717045

g.rep_10.no.tmrca <- gls(diversity ~ thetaS + rhoS,
                           data = inf.lands.1Mb.rep_10, cor = corAR1(0, ~bin), method = "ML")

summary(g.rep_10.no.tmrca)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS
## Data: inf.lands.1Mb.rep_10
##      AIC      BIC    logLik
## -316.9544 -309.9484 163.4772
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##      Phi
## -0.01181333
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.020705049 0.0001979583 104.59296 0.0000
## thetaS       0.006429287 0.0002044684  31.44392 0.0000
## rhoS        -0.000251137 0.0002041256  -1.23031 0.2292
##
## Correlation:
##           (Intr) thetaS
## thetaS  0.000
## rhoS   0.000 -0.106
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.05588562 -0.66664272 -0.06688445  0.53908458  1.87562405
##
## Residual standard error: 0.001040441
## Degrees of freedom: 30 total; 27 residual
anova.diversity <- Anova(m.diversity.rep_10)
apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.inf.1Mb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.inf.1Mb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.inf.1Mb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.inf.1Mb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.inf.1Mb[5, 10] <- anova.diversity$VarExp[4] * 100

r2.inf.1Mb$average <- rowMeans(r2.inf.1Mb)
r2.inf.1Mb <- transform(r2.inf.1Mb, sd=apply(r2.inf.1Mb, 1, sd, na.rm = TRUE))

```

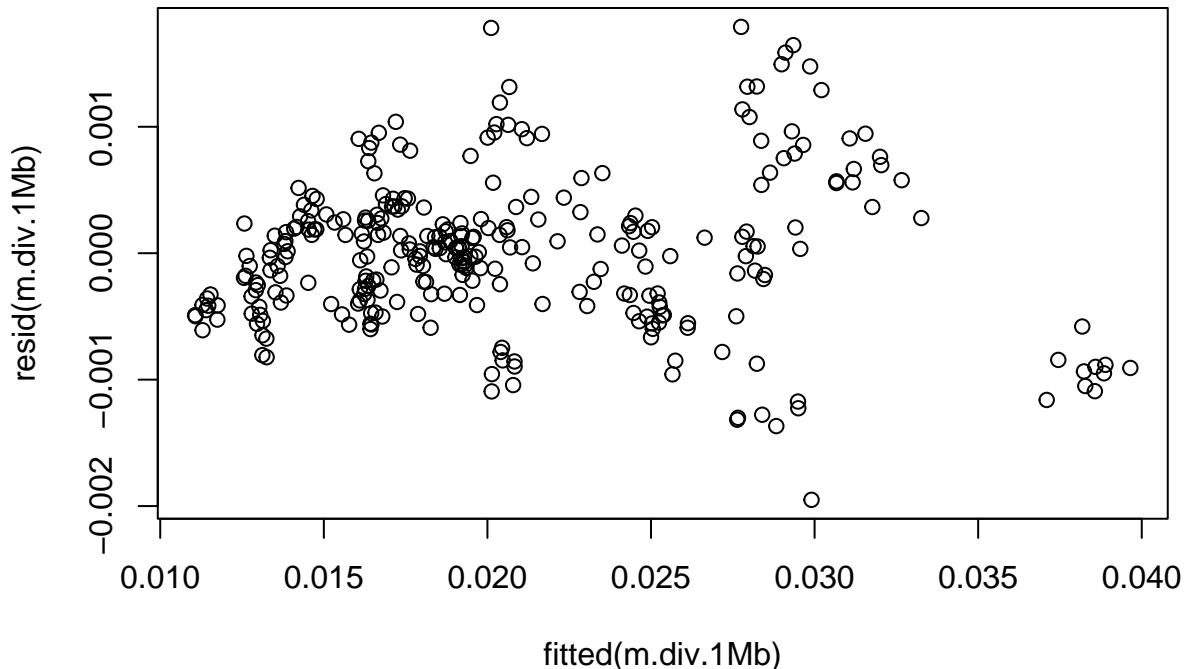
2.3.11 all replicates:

```

inf.lands.1Mb.all <- rbind(inf.lands.1Mb.rep_1, inf.lands.1Mb.rep_2, inf.lands.1Mb.rep_3, inf.lands.1Mb

m.div.1Mb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)*as.factor(Replicate), data = inf.la
plot(resid(m.div.1Mb)~fitted(m.div.1Mb))

```



```
dwtest(m.div.1Mb)
```

```

## 
## Durbin-Watson test
## 
## data: m.div.1Mb
## DW = 1.7602, p-value = 0.001541
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)

```

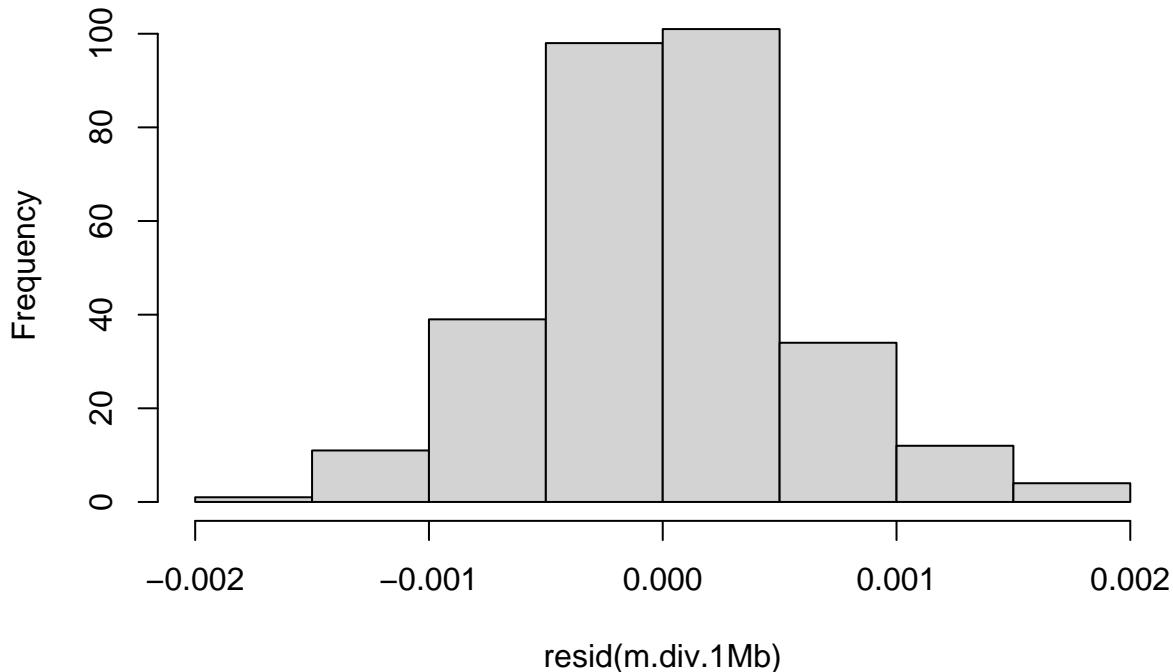
```

## 
## Harrison-M McCabe test
## 
## data: m.div.1Mb

```

```
## HMC = 0.51208, p-value = 0.609
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
m.div.1Mb.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS)*as.factor(Replicate), data = inf.lands.1Mb.all)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS + thetaS:rhoS + rhoS:tmrcaS)*as.factor(Replicate), data = inf.lands.1Mb.all)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##             df      AIC
## m.div.1Mb   51 -3507.758
## m.div.1Mb.2 61 -3522.377
## m.div.1Mb.3 71 -3504.645

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS) *
##     as.factor(Replicate), data = inf.lands.1Mb.all)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -0.0019505 -0.0003895  0.0000113  0.0002755  0.0017898 
##
## Coefficients:
## (Intercept)          Estimate Std. Error t value Pr(>|t|)    
## (Intercept)          2.062e-02 1.180e-04 174.750 < 2e-16 ***
## thetaS              6.300e-03 1.251e-04  50.357 < 2e-16 ***
## rhoS               1.166e-06 1.358e-04   0.009   0.993  
## tmrcaS              9.079e-04 1.666e-04   5.451 1.20e-07 ***
```

```

## as.factor(Replicate)2      1.783e-05  1.679e-04  0.106  0.915
## as.factor(Replicate)3      6.531e-05  1.674e-04  0.390  0.697
## as.factor(Replicate)4      5.942e-05  1.669e-04  0.356  0.722
## as.factor(Replicate)5     -3.448e-05  1.671e-04 -0.206  0.837
## as.factor(Replicate)6     -3.480e-05  1.670e-04 -0.208  0.835
## as.factor(Replicate)7     -2.047e-05  1.671e-04 -0.123  0.903
## as.factor(Replicate)8      2.120e-04  1.673e-04  1.267  0.206
## as.factor(Replicate)9     -1.013e-04  1.669e-04 -0.607  0.545
## as.factor(Replicate)10     9.189e-05  1.670e-04  0.550  0.583
## thetaS:tmrcaS             2.569e-04  1.603e-04  1.602  0.110
## thetaS:as.factor(Replicate)2 -1.117e-05  1.743e-04 -0.064  0.949
## thetaS:as.factor(Replicate)3  1.849e-05  1.762e-04  0.105  0.916
## thetaS:as.factor(Replicate)4  1.759e-04  1.735e-04  1.014  0.312
## thetaS:as.factor(Replicate)5 -8.703e-06  1.736e-04 -0.050  0.960
## thetaS:as.factor(Replicate)6  6.393e-06  1.747e-04  0.037  0.971
## thetaS:as.factor(Replicate)7  2.830e-05  1.742e-04  0.162  0.871
## thetaS:as.factor(Replicate)8  3.844e-05  1.742e-04  0.221  0.826
## thetaS:as.factor(Replicate)9 -3.451e-05  1.744e-04 -0.198  0.843
## thetaS:as.factor(Replicate)10 1.248e-04  1.739e-04  0.718  0.474
## rhoS:as.factor(Replicate)2   1.048e-04  1.991e-04  0.526  0.599
## rhoS:as.factor(Replicate)3   5.270e-05  1.925e-04  0.274  0.784
## rhoS:as.factor(Replicate)4  -1.207e-05  1.917e-04 -0.063  0.950
## rhoS:as.factor(Replicate)5  -7.350e-04  2.303e-03 -0.319  0.750
## rhoS:as.factor(Replicate)6   1.642e-04  2.033e-04  0.808  0.420
## rhoS:as.factor(Replicate)7   2.291e-05  1.956e-04  0.117  0.907
## rhoS:as.factor(Replicate)8   1.269e-04  1.937e-04  0.655  0.513
## rhoS:as.factor(Replicate)9   6.420e-05  1.943e-04  0.330  0.741
## rhoS:as.factor(Replicate)10  2.148e-05  1.924e-04  0.112  0.911
## tmrcaS:as.factor(Replicate)2  2.284e-04  2.308e-04  0.990  0.323
## tmrcaS:as.factor(Replicate)3  2.870e-04  2.201e-04  1.304  0.193
## tmrcaS:as.factor(Replicate)4  1.087e-04  2.411e-04  0.451  0.652
## tmrcaS:as.factor(Replicate)5 -8.090e-04  1.676e-04 -4.827  2.41e-06 ***
## tmrcaS:as.factor(Replicate)6  2.155e-04  2.301e-04  0.936  0.350
## tmrcaS:as.factor(Replicate)7  3.186e-04  2.374e-04  1.342  0.181
## tmrcaS:as.factor(Replicate)8  3.092e-04  2.597e-04  1.190  0.235
## tmrcaS:as.factor(Replicate)9 -1.569e-05  2.211e-04 -0.071  0.943
## tmrcaS:as.factor(Replicate)10 1.972e-04  2.380e-04  0.828  0.408
## thetaS:tmrcaS:as.factor(Replicate)2  2.147e-04  2.406e-04  0.892  0.373
## thetaS:tmrcaS:as.factor(Replicate)3  3.560e-04  2.321e-04  1.534  0.126
## thetaS:tmrcaS:as.factor(Replicate)4  9.570e-05  2.648e-04  0.361  0.718
## thetaS:tmrcaS:as.factor(Replicate)5 -2.093e-04  1.616e-04 -1.295  0.197
## thetaS:tmrcaS:as.factor(Replicate)6  1.310e-04  2.288e-04  0.573  0.567
## thetaS:tmrcaS:as.factor(Replicate)7  3.553e-04  2.339e-04  1.519  0.130
## thetaS:tmrcaS:as.factor(Replicate)8  1.804e-04  2.424e-04  0.744  0.457
## thetaS:tmrcaS:as.factor(Replicate)9  2.537e-05  2.125e-04  0.119  0.905
## thetaS:tmrcaS:as.factor(Replicate)10 1.163e-04  2.285e-04  0.509  0.611
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0006464 on 250 degrees of freedom
## Multiple R-squared:  0.9913, Adjusted R-squared:  0.9896
## F-statistic: 582.5 on 49 and 250 DF,  p-value: < 2.2e-16

```

2.3.12 Plots

```

scale.3d <- function(x) sprintf("%.3f", x)

rho.plot <- as.data.frame(cbind(inf.lands.1Mb.rep_1$bin,
                                sim.rho.1Mb$sim,
                                inf.lands.1Mb.rep_1$rho,
                                inf.lands.1Mb.rep_2$rho,
                                inf.lands.1Mb.rep_3$rho,
                                inf.lands.1Mb.rep_4$rho,
                                inf.lands.1Mb.rep_5$rho,
                                inf.lands.1Mb.rep_6$rho,
                                inf.lands.1Mb.rep_7$rho,
                                inf.lands.1Mb.rep_8$rho,
                                inf.lands.1Mb.rep_9$rho,
                                inf.lands.1Mb.rep_10$rho))

rho.plot[,3:ncol(rho.plot)] <- 1.53 * rho.plot[,3:ncol(rho.plot)] # scaling because of SCRM NO vs Ne

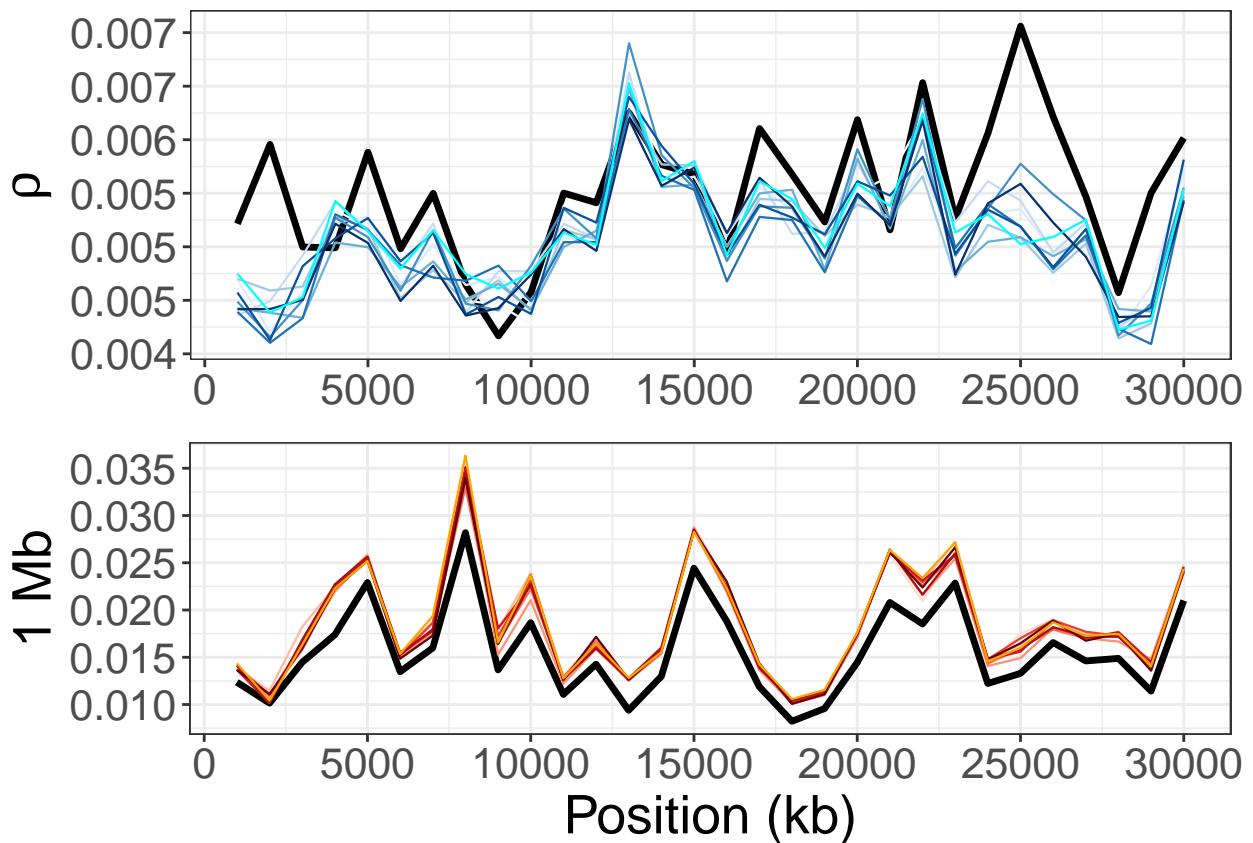
names(rho.plot) <- c("bin", "sim", reps)
molten.rho <- melt(rho.plot, id.vars = "bin")
rho.map.1Mb <- ggplot(data = molten.rho, aes(x = bin * 1000, y = value, colour = variable)) + theme_bw()
rho.map.1Mb <- rho.map.1Mb + geom_line(data = molten.rho, aes(size = variable)) + scale_size_manual(values = c(1, 2, 3, 4, 5, 6, 7, 8, 9, 10))
rho.map.1Mb <- rho.map.1Mb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Blues")))
rho.map.1Mb <- rho.map.1Mb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
rho.map.1Mb <- rho.map.1Mb + labs(title = NULL, x = NULL, y = expression(rho))
rho.map.1Mb <- rho.map.1Mb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))

theta.plot <- as.data.frame(cbind(inf.lands.1Mb.rep_1$bin,
                                    sim.theta.1Mb$sim,
                                    inf.lands.1Mb.rep_1$theta,
                                    inf.lands.1Mb.rep_2$theta,
                                    inf.lands.1Mb.rep_3$theta,
                                    inf.lands.1Mb.rep_4$theta,
                                    inf.lands.1Mb.rep_5$theta,
                                    inf.lands.1Mb.rep_6$theta,
                                    inf.lands.1Mb.rep_7$theta,
                                    inf.lands.1Mb.rep_8$theta,
                                    inf.lands.1Mb.rep_9$theta,
                                    inf.lands.1Mb.rep_10$theta))

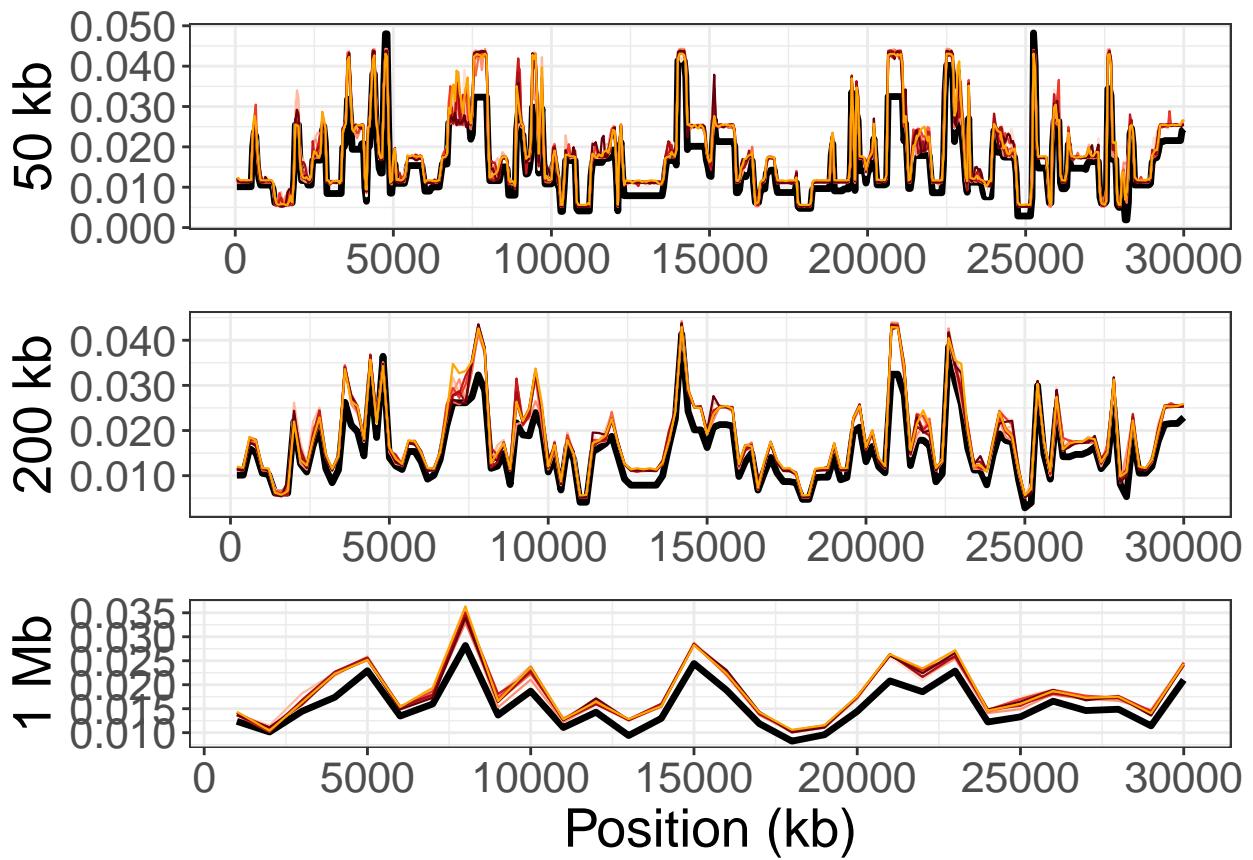
names(theta.plot) <- c("bin", "sim", reps)
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.1Mb <- ggplot(data = molten.theta, aes(x = bin * 1000, y = value, colour = variable)) + theme_bw()
theta.map.1Mb <- theta.map.1Mb + geom_line(data = molten.theta, aes(size = variable)) + scale_size_manual(values = c(1, 2, 3, 4, 5, 6, 7, 8, 9, 10))
theta.map.1Mb <- theta.map.1Mb + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Reds")))
theta.map.1Mb <- theta.map.1Mb + scale_x_continuous(breaks = pretty_breaks()) + scale_y_continuous(breaks = pretty_breaks())
theta.map.1Mb <- theta.map.1Mb + labs(title = NULL, x = "Position (kb)", y = "1 Mb")
theta.map.1Mb <- theta.map.1Mb + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))

plot_grid(rho.map.1Mb, theta.map.1Mb, nrow = 2, ncol = 1)

```



```
theta.maps.coal <- plot_grid(theta.map.50kb, theta.map.200kb, theta.map.1Mb, nrow = 3, ncol = 1)
theta.maps.coal
```



3 Real Drosophila data.

We first focus on chr 2L for comparing R^2 with simulations

```
r2.dm.tab <- as.data.frame(matrix(ncol = 6, nrow = 3))
colnames(r2.dm.tab) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA", "bin.size")

# 50kb
# recombination landscapes
rho.dm.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.50kb.bedgraph", header = T)

# diversity
diversity.dm.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.50kb.bedgraph", header = T)
diversity.dm.50kb$avg <- apply(diversity.dm.50kb[4:ncol(diversity.dm.50kb)], 1, mean)

# mutation landscapes
theta.dm.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.50kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCA.50kb.bedgraph", header = T)
tmrca.dm.50kb$sample_mean <- apply(tmrca.dm.50kb[4:ncol(tmrca.dm.50kb)], 1, mean)

# missing data
missing.prop.50kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.50kb.bedgraph", header =
intersect.50kb <- apply(missing.prop.50kb[4:ncol(missing.prop.50kb)], 1, function(x) any(x > 0.1))
```

```

dm.lands.50kb <- as.data.frame(cbind(diversity.dm.50kb$avg,
                                         theta.dm.50kb$sample_mean,
                                         rho.dm.50kb$sample_mean,
                                         tmrca.dm.50kb$sample_mean))

names(dm.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")
dm.lands.50kb$bin <- 1:nrow(dm.lands.50kb)

dm.lands.50kb <- dm.lands.50kb[which(intersect.50kb == F),] # filters based on missing data

# correlation between inferred TMRCA and Pi
cor.test(dm.lands.50kb$diversity, dm.lands.50kb$tmrca, method = "spearman")

## Spearman's rank correlation rho
## data: dm.lands.50kb$diversity and dm.lands.50kb$tmrca
## S = 1694418, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.6983048

# correlation with Comeron map
comeron.50kb <- read.table("dm_bgs_sims/RecombinationMap_50kb.csv", sep = ",", header = T)
comeron.50kb$chrom <- "2L"
comeron.50kb_gr <- makeGRangesFromDataFrame(comeron.50kb, keep.extra.columns = T)

rho.dm.50kb$chromStart <- rho.dm.50kb$chromStart + 1
rho.dm.50kb$chrom <- "2L"
rho.dm.50kb_gr <- makeGRangesFromDataFrame(rho.dm.50kb[,c(1:3, ncol(rho.dm.50kb))], keep.extra.columns = T)

hits <- findOverlaps(query = rho.dm.50kb_gr, subject = comeron.50kb_gr, type = "equal")

comeron.50kb_gr <- comeron.50kb_gr[subjectHits(hits),]
rho.dm.50kb_gr <- rho.dm.50kb_gr[queryHits(hits),]

rec_df <- merge(as.data.frame(rho.dm.50kb_gr), as.data.frame(comeron.50kb_gr))
cor.test(rec_df[,6], rec_df[,7], method = "spearman")

## Spearman's rank correlation rho
## data: rec_df[, 6] and rec_df[, 7]
## S = 6581510, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.5942997

# OLS

# standardizing
dm.lands.50kb$thetaS <- (dm.lands.50kb$theta - mean(dm.lands.50kb$theta)) / sd(dm.lands.50kb$theta)
dm.lands.50kb$tmrcaS <- (dm.lands.50kb$tmrca - mean(dm.lands.50kb$tmrca)) / sd(dm.lands.50kb$tmrca)

```

```

dm.lands.50kb$rhoS <- (dm.lands.50kb$rho - mean(dm.lands.50kb$rho)) / sd(dm.lands.50kb$rho)

m.diversity <- lm(diversity ~ thetaS + rhoS + tmrcaS + tmrcaS*thetaS, data = dm.lands.50kb)

# type 2 ANOVA
anova.diversity <- Anova(m.diversity)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.dm.tab[1,] <- c((anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
                      anova.diversity$VarExp[1] * 100,
                      anova.diversity$VarExp[2] * 100,
                      anova.diversity$VarExp[3] * 100,
                      anova.diversity$VarExp[4] * 100, 50))

# 200kb
# recombination landscapes
rho.dm.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.200kb.bedgraph", header = T)

# diversity
diversity.dm.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.200kb.bedgraph", header = T)
diversity.dm.200kb$avg <- apply(diversity.dm.200kb[4:ncol(diversity.dm.200kb)], 1, mean)

# mutation landscapes
theta.dm.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.200kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCA.200kb.bedgraph", header = T)
tmrca.dm.200kb$sample_mean <- apply(tmrca.dm.200kb[4:ncol(tmrca.dm.200kb)], 1, mean)

# missing data
missing.prop.200kb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.200kb.bedgraph", header = T)
intersect.200kb <- apply(missing.prop.200kb[4:ncol(missing.prop.200kb)], 1, function(x) any(x > 0.1))

dm.lands.200kb <- as.data.frame(cbind(diversity.dm.200kb$avg,
                                         theta.dm.200kb$sample_mean,
                                         rho.dm.200kb$sample_mean,
                                         tmrca.dm.200kb$sample_mean))

names(dm.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")
dm.lands.200kb$bin <- 1:nrow(dm.lands.200kb)
# filters based on missing data
dm.lands.200kb <- dm.lands.200kb[which(intersect.200kb == F),]

# correlation between inferred TMRCA and Pi
cor.test(dm.lands.200kb$diversity, dm.lands.200kb$tmrca, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: dm.lands.200kb$diversity and dm.lands.200kb$tmrca
## S = 32240, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
```

```

##      rho
## 0.6616431
# correlation with Comeron map
comeron.200kb <- read.table("dm_bgs_sims/RecombinationMap_200kb.csv", sep = ",", header = T)
comeron.200kb$chrom <- "2L"
comeron.200kb_gr <- makeGRangesFromDataFrame(comeron.200kb, keep.extra.columns = T)

rho_dm.200kb$chromStart <- rho_dm.200kb$chromStart + 1
rho_dm.200kb$chrom <- "2L"
rho_dm.200kb_gr <- makeGRangesFromDataFrame(rho_dm.200kb[,c(1:3, ncol(rho_dm.200kb))], keep.extra.columns = T)

hits <- findOverlaps(query = rho_dm.200kb_gr, subject = comeron.200kb_gr, type = "equal")

comeron.200kb_gr <- comeron.200kb_gr[subjectHits(hits),]
rho_dm.200kb_gr <- rho_dm.200kb_gr[queryHits(hits),]

rec_df <- merge(as.data.frame(rho_dm.200kb_gr), as.data.frame(cameron.200kb_gr))
cor.test(rec_df[,6], rec_df[,7], method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rec_df[, 6] and rec_df[, 7]
## S = 77773, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.6931551

# OLS

dm.lands.200kb$thetaS <- (dm.lands.200kb$theta - mean(dm.lands.200kb$theta)) / sd(dm.lands.200kb$theta)
dm.lands.200kb$tmrcaS <- (dm.lands.200kb$tmrca - mean(dm.lands.200kb$tmrca)) / sd(dm.lands.200kb$tmrca)
dm.lands.200kb$rhoS <- (dm.lands.200kb$rho - mean(dm.lands.200kb$rho)) / sd(dm.lands.200kb$rho)

m.diversity <- lm(diversity ~ thetaS + rhoS + tmrcaS + tmrcaS*thetaS, data = dm.lands.200kb)

# type 2 ANOVA
anova.diversity <- Anova(m.diversity)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2_dm.tab[2,] <- c((anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
  anova.diversity$VarExp[1] * 100,
  anova.diversity$VarExp[2] * 100,
  anova.diversity$VarExp[3] * 100,
  anova.diversity$VarExp[4] * 100, 200))

#
# 1Mb
# recombination landscapes
rho_dm.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.1Mb.bedgraph", header = T)

# diversity
diversity_dm.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.1Mb.bedgraph", header = T)

```

```

diversity.dm.1Mb$avg <- apply(diversity.dm.1Mb[4:ncol(diversity.dm.1Mb)], 1, mean)

# mutation landscapes
theta.dm.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.1Mb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCA.1Mb.bedgraph", header = T)
tmrca.dm.1Mb$sample_mean <- apply(tmrca.dm.1Mb[4:ncol(tmrca.dm.1Mb)], 1, mean)

# missing data
missing.prop.1Mb <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.1Mb.bedgraph", header = T)
intersect.1Mb <- apply(missing.prop.1Mb[4:ncol(missing.prop.1Mb)], 1, function(x) any(x > 0.1))

dm.lands.1Mb <- as.data.frame(cbind(diversity.dm.1Mb$avg,
                                       theta.dm.1Mb$sample_mean,
                                       rho.dm.1Mb$sample_mean,
                                       tmrca.dm.1Mb$sample_mean))

names(dm.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")
dm.lands.1Mb$bin <- 1:nrow(dm.lands.1Mb)
# filters based on missing data
dm.lands.1Mb <- dm.lands.1Mb[which(intersect.1Mb == F),]

# correlation between inferred TMRCA and Pi
cor.test(dm.lands.1Mb$diversity, dm.lands.1Mb$tmrca, method = "spearman")

## Spearman's rank correlation rho
## data: dm.lands.1Mb$diversity and dm.lands.1Mb$tmrca
## S = 156, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.8631579

# correlation with Comeron map
comeron.1Mb <- read.table("dm_bgs_sims/RecombinationMap_1000kb.csv", sep = ",", header = T)
comeron.1Mb$chrom <- "2L"
comeron.1Mb_gr <- makeGRangesFromDataFrame(comeron.1Mb, keep.extra.columns = T)

rho.dm.1Mb$chromStart <- rho.dm.1Mb$chromStart + 1
rho.dm.1Mb$chrom <- "2L"
rho.dm.1Mb_gr <- makeGRangesFromDataFrame(rho.dm.1Mb[,c(1:3, ncol(rho.dm.1Mb))], keep.extra.columns = T)

hits <- findOverlaps(query = rho.dm.1Mb_gr, subject = comeron.1Mb_gr, type = "equal")

comeron.1Mb_gr <- comeron.1Mb_gr[subjectHits(hits),]
rho.dm.1Mb_gr <- rho.dm.1Mb_gr[queryHits(hits),]

rec_df <- merge(as.data.frame(rho.dm.1Mb_gr), as.data.frame(comeron.1Mb_gr))
cor.test(rec_df[,6], rec_df[,7], method = "spearman")

##

```

```

## Spearman's rank correlation rho
##
## data: rec_df[, 6] and rec_df[, 7]
## S = 274, p-value = 2.329e-06
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
## rho
## 0.8646245

# OLS
dm.lands.1Mb$thetaS <- (dm.lands.1Mb$theta - mean(dm.lands.1Mb$theta))
dm.lands.1Mb$tmrcaS <- (dm.lands.1Mb$tmrca - mean(dm.lands.1Mb$tmrca))
dm.lands.1Mb$rhoS <- (dm.lands.1Mb$rho - mean(dm.lands.1Mb$rho))

m.diversity <- lm(diversity ~ thetaS + rhoS + tmrcaS + tmrcaS*thetaS, data = dm.lands.1Mb)

# type 2 ANOVA
anova.diversity <- Anova(m.diversity)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.dm.tab[3,] <- c((anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
  anova.diversity$VarExp[4]) * 100,
  anova.diversity$VarExp[1] * 100,
  anova.diversity$VarExp[2] * 100,
  anova.diversity$VarExp[3] * 100,
  anova.diversity$VarExp[4] * 100, 1000)

```

We now move on to whole-genome analyses

3.1 50 kb windows

```

# Chr 2L

# recombination landscapes
rho.dm.50kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.50kb.bedgraph", header = T)

# diversity
diversity.dm.50kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.50kb.bedgraph", header =
diversity.dm.50kb.2L$avg <- apply(diversity.dm.50kb.2L[4:ncol(diversity.dm.50kb.2L)], 1, mean)

# mutation landscapes
theta.dm.50kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.50kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.50kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCA.50kb.bedgraph", header = T)
tmrca.dm.50kb.2L$sample_mean <- apply(tmrca.dm.50kb.2L[4:ncol(tmrca.dm.50kb.2L)], 1, mean)

# missing data
missing.prop.50kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.50kb.bedgraph", header =
intersect.50kb.2L <- apply(missing.prop.50kb.2L[4:ncol(missing.prop.50kb.2L)], 1, function(x) any(x > 0))

dm.lands.50kb.2L <- as.data.frame(cbind(diversity.dm.50kb.2L$chromStart,

```

```

            diversity.dm.50kb.2L$chromEnd,
            diversity.dm.50kb.2L$avg,
            theta.dm.50kb.2L$sample_mean,
            rho.dm.50kb.2L$sample_mean,
            tmrca.dm.50kb.2L$sample_mean))
names(dm.lands.50kb.2L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.50kb.2L$bin <- 1:nrow(dm.lands.50kb.2L)

# filters based on missing data
dm.lands.50kb.2L <- dm.lands.50kb.2L[which(intersect.50kb.2L == F),]

dm.lands.50kb.2L$chr <- "2L"

dm.lands.50kb.2L$thetaS <- (dm.lands.50kb.2L$theta - mean(dm.lands.50kb.2L$theta)) / sd(dm.lands.50kb.2L$theta)
dm.lands.50kb.2L$tmrcaS <- (dm.lands.50kb.2L$tmrca - mean(dm.lands.50kb.2L$tmrca)) / sd(dm.lands.50kb.2L$tmrca)
dm.lands.50kb.2L$rhoS <- (dm.lands.50kb.2L$rho - mean(dm.lands.50kb.2L$rho)) / sd(dm.lands.50kb.2L$rho)

g.div.dm.50kb.2L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.50kb.2L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), na.action = na.omit)

summary(g.div.dm.50kb.2L)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.50kb.2L
##          AIC      BIC logLik
## -4690.441 -4660.219 2353.22
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.1318436
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.02239814
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.009712999 1.086516e-05 893.9585 0.0000
## thetaS       0.002296955 1.174194e-05 195.6197 0.0000
## rhoS        0.000013747 1.131652e-05   1.2148 0.2253
## tmrcaS      0.000847496 1.415952e-05  59.8534 0.0000
## thetaS:tmrcaS 0.000187792 7.006312e-06  26.8033 0.0000
##
## Correlation:
##           (Intr) thetaS rhoS    tmrcaS
## thetaS     -0.016
## rhoS       0.027  0.026
## tmrcaS    -0.132 -0.379 -0.456
## thetaS:tmrcaS -0.306  0.061 -0.088  0.402

```

```

##  

## Standardized residuals:  

##      Min       Q1       Med       Q3       Max  

## -3.60864294 -0.52688547 -0.05949911  0.51229899  4.16571201  

##  

## Residual standard error: 0.0001704629  

## Degrees of freedom: 323 total; 318 residual  

# Chr 2R  
  

# recombination landscapes  

rho.dm.50kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.rho.50kb.bedgraph", header = T)  
  

# diversity  

diversity.dm.50kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.diversity.50kb.bedgraph", header = T)  

diversity.dm.50kb.2R$avg <- apply(diversity.dm.50kb.2R[4:ncol(diversity.dm.50kb.2R)], 1, mean)  
  

# mutation landscapes  

theta.dm.50kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.theta.50kb.bedgraph", header = T)  
  

# TMRCAs landscapes  

tmrca.dm.50kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.TMRCA.50kb.bedgraph", header = T)  

tmrca.dm.50kb.2R$sample_mean <- apply(tmrca.dm.50kb.2R[4:ncol(tmrca.dm.50kb.2R)], 1, mean)  
  

# missing data  

missing.prop.50kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.missing.prop.50kb.bedgraph", header = T)  

intersect.50kb.2R <- apply(missing.prop.50kb.2R[4:ncol(missing.prop.50kb.2R)], 1, function(x) any(x > 0))  
  

dm.lands.50kb.2R <- as.data.frame(cbind(diversity.dm.50kb.2R$chromStart,  

                                             diversity.dm.50kb.2R$chromEnd,  

                                             diversity.dm.50kb.2R$avg,  

                                             theta.dm.50kb.2R$sample_mean,  

                                             rho.dm.50kb.2R$sample_mean,  

                                             tmrca.dm.50kb.2R$sample_mean))  

names(dm.lands.50kb.2R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")  

dm.lands.50kb.2R$bin <- 1:nrow(dm.lands.50kb.2R)  
  

# filters based on missing data  

dm.lands.50kb.2R <- dm.lands.50kb.2R[which(intersect.50kb.2R == F),]  
  

dm.lands.50kb.2R$chr <- "2R"  
  

dm.lands.50kb.2R$thetaS <- (dm.lands.50kb.2R$theta - mean(dm.lands.50kb.2R$theta)) / sd(dm.lands.50kb.2R$theta)  

dm.lands.50kb.2R$tmrcaS <- (dm.lands.50kb.2R$tmrca - mean(dm.lands.50kb.2R$tmrca)) / sd(dm.lands.50kb.2R$tmrca)  

dm.lands.50kb.2R$rhoS <- (dm.lands.50kb.2R$rho - mean(dm.lands.50kb.2R$rho)) / sd(dm.lands.50kb.2R$rho)  
  

g.div.dm.50kb.2R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),  

                           data = dm.lands.50kb.2R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin),  
  

summary(g.div.dm.50kb.2R)  
  

## Generalized least squares fit by maximum likelihood  

##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)  

##   Data: dm.lands.50kb.2R  

##          AIC      BIC    logLik
```

```

## -4473.266 -4443.583 2244.633
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.1094586
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.05919674
##
## Coefficients:
##              Value   Std.Error t-value p-value
## (Intercept) 0.008565213 9.380579e-06 913.0793 0.0000
## thetaS       0.002258458 8.399497e-06 268.8801 0.0000
## rhoS        0.0000001107 9.546538e-06   0.1160 0.9078
## tmrcaS      0.000679336 1.139247e-05   59.6303 0.0000
## thetaS:tmrcaS 0.000144456 6.673200e-06  21.6472 0.0000
##
## Correlation:
##             (Intr) thetaS rhoS   tmrcaS
## thetaS      0.044
## rhoS       -0.003  0.084
## tmrcaS     -0.103 -0.360 -0.381
## thetaS:tmrcaS -0.260 -0.114  0.022  0.341
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.56718360 -0.56905223  0.01512333  0.64333846  3.32352563
##
## Residual standard error: 0.0001503138
## Degrees of freedom: 302 total; 297 residual
# recombination landscapes
rho.dm.50kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.rho.50kb.bedgraph", header = T)

# diversity
diversity.dm.50kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.diversity.50kb.bedgraph", header =
diversity.dm.50kb.3L$avg <- apply(diversity.dm.50kb.3L[4:ncol(diversity.dm.50kb.3L)], 1, mean)

# mutation landscapes
theta.dm.50kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.theta.50kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.50kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.TMRCA.50kb.bedgraph", header = T)
tmrca.dm.50kb.3L$sample_mean <- apply(tmrca.dm.50kb.3L[4:ncol(tmrca.dm.50kb.3L)], 1, mean)

# missing data
missing.prop.50kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.missing.prop.50kb.bedgraph", header =
intersect.50kb.3L <- apply(missing.prop.50kb.3L[4:ncol(missing.prop.50kb.3L)], 1, function(x) any(x > 0))

```

```

dm.lands.50kb.3L <- as.data.frame(cbind(diversity.dm.50kb.3L$chromStart,
                                         diversity.dm.50kb.3L$chromEnd,
                                         diversity.dm.50kb.3L$avg,
                                         theta.dm.50kb.3L$sample_mean,
                                         rho.dm.50kb.3L$sample_mean,
                                         tmrca.dm.50kb.3L$sample_mean))
names(dm.lands.50kb.3L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.50kb.3L$bin <- 1:nrow(dm.lands.50kb.3L)

# filters based on missing data
dm.lands.50kb.3L <- dm.lands.50kb.3L[which(intersect.50kb.3L == F),]

dm.lands.50kb.3L$chr <- "3L"

dm.lands.50kb.3L$thetaS <- (dm.lands.50kb.3L$theta - mean(dm.lands.50kb.3L$theta)) / sd(dm.lands.50kb.3L$theta)
dm.lands.50kb.3L$tmrcaS <- (dm.lands.50kb.3L$tmrca - mean(dm.lands.50kb.3L$tmrca)) / sd(dm.lands.50kb.3L$tmrca)
dm.lands.50kb.3L$rhoS <- (dm.lands.50kb.3L$rho - mean(dm.lands.50kb.3L$rho)) / sd(dm.lands.50kb.3L$rho)

g.div.dm.50kb.3L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.50kb.3L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin),
                           summary(g.div.dm.50kb.3L)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.50kb.3L
##          AIC      BIC    logLik
## -5025.491 -4994.674 2520.746
##
## Correlation Structure: ARMA(1,0)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi1
## 0.2696667
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.06685875
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008955574 1.251395e-05 715.6471 0.0000
## thetaS       0.002871271 1.332006e-05 215.5600 0.0000
## rhoS        0.000024709 1.243714e-05   1.9867 0.0477
## tmrcaS      0.001241658 1.613800e-05  76.9400 0.0000
## thetaS:tmrcaS 0.000340870 9.410582e-06  36.2220 0.0000
##
## Correlation:
## (Intr) thetaS rhoS   tmrcaS
## thetaS     -0.004
## rhoS      0.004  0.150
## tmrcaS    -0.106 -0.427 -0.517

```

```

## thetaS:tmrcaS -0.323  0.045 -0.029  0.309
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.70241395 -0.68659890  0.01012415  0.61472090  3.79680208
##
## Residual standard error: 0.0001904737
## Degrees of freedom: 348 total; 343 residual
# Chr 3R

# recombination landscapes
rho.dm.50kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.rho.50kb.bedgraph", header = T)

# diversity
diversity.dm.50kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.diversity.50kb.bedgraph", header =
diversity.dm.50kb.3R$avg <- apply(diversity.dm.50kb.3R[4:ncol(diversity.dm.50kb.3R)], 1, mean)

# mutation landscapes
theta.dm.50kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.theta.50kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.50kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.TMRCA.50kb.bedgraph", header = T)
tmrca.dm.50kb.3R$sample_mean <- apply(tmrca.dm.50kb.3R[4:ncol(tmrca.dm.50kb.3R)], 1, mean)

# missing data
missing.prop.50kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.missing.prop.50kb.bedgraph", header =
intersect.50kb.3R <- apply(missing.prop.50kb.3R[4:ncol(missing.prop.50kb.3R)], 1, function(x) any(x > 0))

dm.lands.50kb.3R <- as.data.frame(cbind(diversity.dm.50kb.3R$chromStart,
                                            diversity.dm.50kb.3R$chromEnd,
                                            diversity.dm.50kb.3R$avg,
                                            theta.dm.50kb.3R$sample_mean,
                                            rho.dm.50kb.3R$sample_mean,
                                            tmrca.dm.50kb.3R$sample_mean))
names(dm.lands.50kb.3R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.50kb.3R$bin <- 1:nrow(dm.lands.50kb.3R)

# filters based on missing data
dm.lands.50kb.3R <- dm.lands.50kb.3R[which(intersect.50kb.3R == F),]

dm.lands.50kb.3R$chr <- "3R"

dm.lands.50kb.3R$thetaS <- (dm.lands.50kb.3R$theta - mean(dm.lands.50kb.3R$theta)) / sd(dm.lands.50kb.3R$theta)
dm.lands.50kb.3R$tmrcaS <- (dm.lands.50kb.3R$tmrca - mean(dm.lands.50kb.3R$tmrca)) / sd(dm.lands.50kb.3R$tmrca)
dm.lands.50kb.3R$rhoS <- (dm.lands.50kb.3R$rho - mean(dm.lands.50kb.3R$rho)) / sd(dm.lands.50kb.3R$rho)

g.div.dm.50kb.3R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.50kb.3R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin),

summary(g.div.dm.50kb.3R)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.50kb.3R

```

```

##          AIC      BIC  logLik
## -6576.594 -6543.846 3296.297
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.2356751
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.1042665
##
## Coefficients:
##              Value   Std.Error t-value p-value
## (Intercept) 0.007533415 8.949417e-06 841.7772 0.0000
## thetaS       0.002597237 8.926272e-06 290.9655 0.0000
## rhoS        -0.000014567 9.973726e-06 -1.4606 0.1449
## tmrcaS       0.001147132 1.426828e-05  80.3973 0.0000
## thetaS:tmrcaS 0.000308911 1.077443e-05  28.6708 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS    0.003
## rhoS     -0.022  0.107
## tmrcaS   -0.203 -0.346 -0.501
## thetaS:tmrcaS -0.384 -0.089  0.039  0.507
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -3.64020083 -0.59320311  0.03347561  0.68857658  4.67175243
##
## Residual standard error: 0.0001618053
## Degrees of freedom: 443 total; 438 residual
# all together now
dm.lands.50kb <- rbind.data.frame(dm.lands.50kb.2L, dm.lands.50kb.2R, dm.lands.50kb.3L, dm.lands.50kb.3R)

write.table(dm.lands.50kb, "dm_data/dm_chr_maps/dm.maps.50kb.tsv", quote = F, sep = "\t", row.names = F)

# genome-wide correlations
cor.test(~rho + diversity, data = dm.lands.50kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and diversity
## S = 369190884, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##     rho
## 0.2197879

```

```

cor.test(~rho + tmrca, data = dm.lands.50kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  rho and tmrca
## S = 245063950, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.4821057

cor.test(~theta + tmrca, data = dm.lands.50kb, method = "spearman")

##
##  Spearman's rank correlation rho
##
## data:  theta and tmrca
## S = 254806288, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.4615172

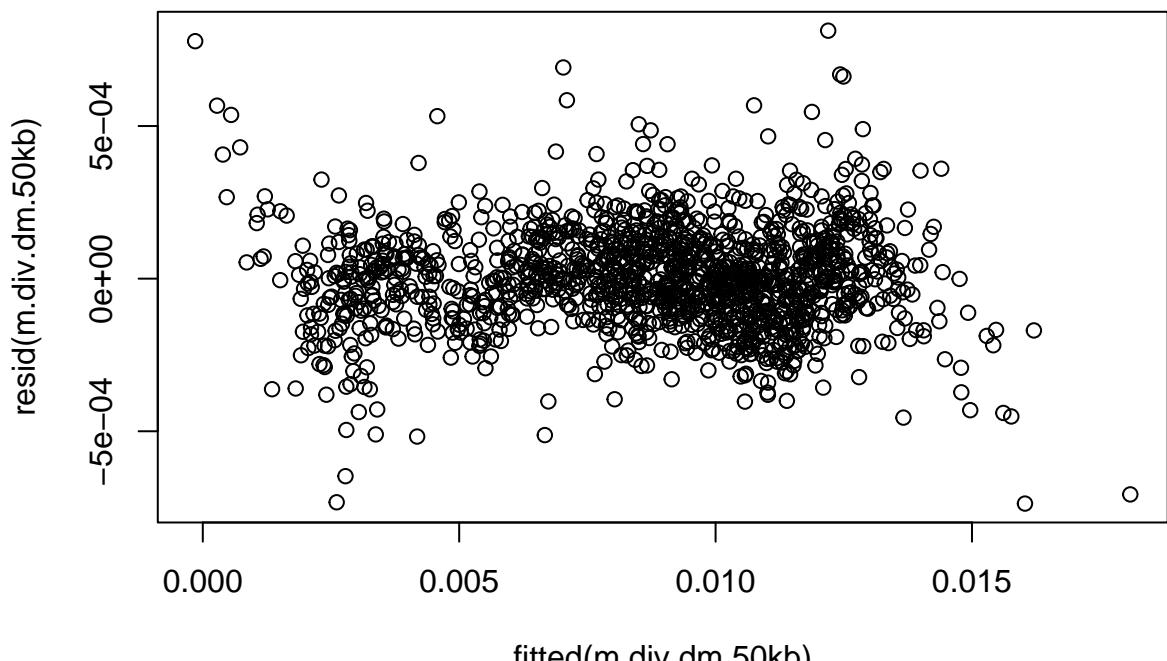
# Linear models
# standardizing
dm.lands.50kb$thetaS <- (dm.lands.50kb$theta - mean(dm.lands.50kb$theta)) / sd(dm.lands.50kb$theta)
dm.lands.50kb$tmrcaS <- (dm.lands.50kb$tmrca - mean(dm.lands.50kb$tmrca)) / sd(dm.lands.50kb$tmrca)
dm.lands.50kb$rhoS <- (dm.lands.50kb$rho - mean(dm.lands.50kb$rho)) / sd(dm.lands.50kb$rho)

dm.lands.50kb$bin <- 1:nrow(dm.lands.50kb)

m.div.dm.50kb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS), data = dm.lands.50kb)

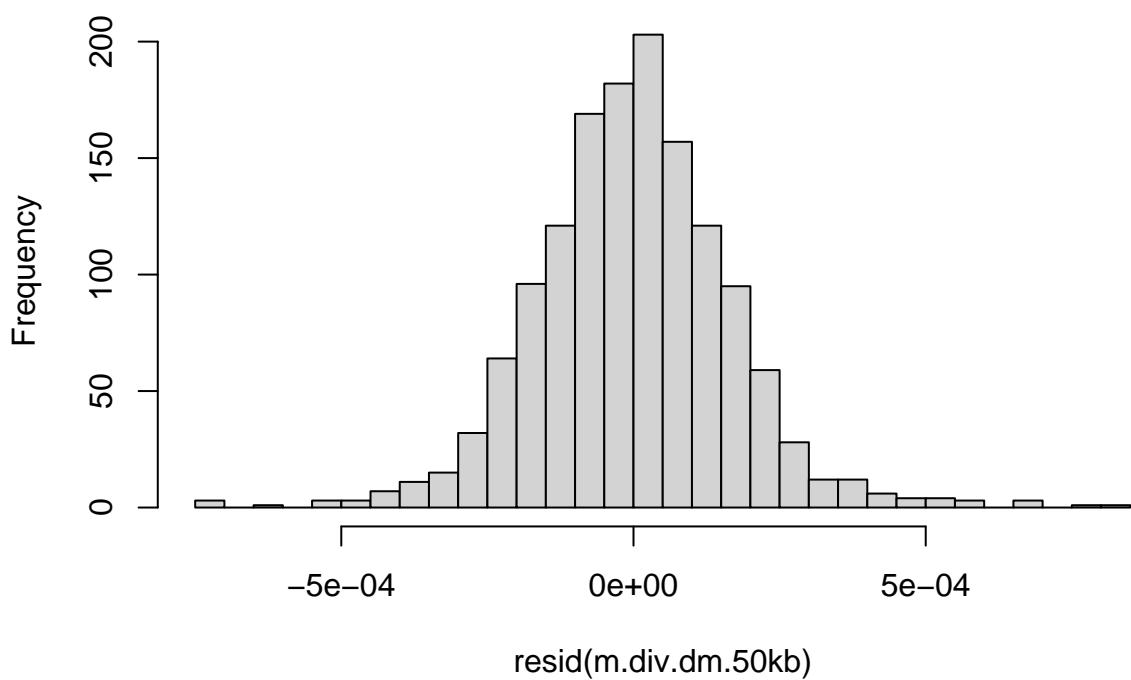
plot(resid(m.div.dm.50kb) ~ fitted(m.div.dm.50kb))

```



```
hist(resid(m.div.dm.50kb), nclass = 30)
```

Histogram of `resid(m.div.dm.50kb)`



```
dwtest(m.div.dm.50kb)
```

```
##
##  Durbin-Watson test
##
##  data:  m.div.dm.50kb
##  DW = 1.5747, p-value = 3.694e-16
```

```

## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.dm.50kb, nsim = 10000)

##
##  Harrison-McCabe test
##
## data: m.div.dm.50kb
## HMC = 0.50534, p-value = 0.6159
summary(m.div.dm.50kb)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
##      data = dm.lands.50kb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -7.369e-04 -1.007e-04  1.500e-07  9.777e-05  8.124e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 8.603e-03 4.838e-06 1778.154 <2e-16 ***
## thetaS       2.713e-03 5.066e-06  535.514 <2e-16 ***
## rhoS        9.656e-06 5.490e-06   1.759  0.0788 .  
## tmrcaS      1.027e-03 7.018e-06  146.379 <2e-16 *** 
## thetaS:tmrcaS 2.670e-04 4.148e-06   64.386 <2e-16 *** 
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001675 on 1411 degrees of freedom
## Multiple R-squared:  0.9973, Adjusted R-squared:  0.9973 
## F-statistic: 1.286e+05 on 4 and 1411 DF,  p-value: < 2.2e-16

vif(m.div.dm.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.294662     1.520540     2.484427     1.557110

# type 2 ANOVA
anova.diversity <- Anova(m.div.dm.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
anova.diversity

## Anova Table (Type II tests)
##
## Response: diversity
##           Sum Sq Df  F value Pr(>F)  VarExp
## thetaS      0.0081479  1 2.9046e+05 0.000000 0.92684
## rhoS       0.0000001  1 3.0932e+00 0.078838 0.00001
## tmrcaS     0.0004872  1 1.7367e+04 0.000000 0.05542
## thetaS:tmrcaS 0.0001163  1 4.1456e+03 0.000000 0.01323
## Residuals   0.0000396 1411                      0.00450

# GLS
g.div.dm.50kb.1 <- gls(diversity ~ (thetaS + rhoS + tmrcaS +

```

```

            data = dm.lands.50kb, weights = varPower(0, ~tmrcaS|chr), cor = corAR1(0, ~bin|chr)

g.div.dm.50kb.2 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.50kb, weights = varPower(0, ~theta|chr), cor = corAR1(0, ~bin|chr))

g.div.dm.50kb.3 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.50kb, weights = varPower(0, ~theta|chr), method = "ML")

g.div.dm.50kb.4 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.50kb, weights = varPower(0, ~tmrcaS|chr), method = "ML")

AIC(g.div.dm.50kb.1, g.div.dm.50kb.2, g.div.dm.50kb.3, g.div.dm.50kb.4)

##          df      AIC
## g.div.dm.50kb.1 11 -20703.80
## g.div.dm.50kb.2 11 -20681.77
## g.div.dm.50kb.3 10 -20620.30
## g.div.dm.50kb.4 10 -20638.55

summary(g.div.dm.50kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.50kb
##       AIC      BIC  logLik
## -20703.8 -20645.99 10362.9
##
## Correlation Structure: AR(1)
##   Formula: ~bin | chr
## Parameter estimate(s):
##   Phi
## 0.2202824
## Variance function:
##   Structure: Power of variance covariate, different strata
##   Formula: ~tmrcaS | chr
## Parameter estimates:
##        2L      2R      3L      3R
## 0.04460111 0.08496022 0.05903078 0.13129580
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008591977 5.604965e-06 1532.9225 0.0000
## thetaS       0.002708023 5.808029e-06  466.2550 0.0000
## rhoS        0.000004864 5.653025e-06   0.8605 0.3897
## tmrcaS      0.001044101 7.626117e-06  136.9113 0.0000
## thetaS:tmrcaS 0.000276806 4.678859e-06   59.1611 0.0000
##
## Correlation:
##           (Intr) thetaS rhoS    tmrcaS
## thetaS     0.022
## rhoS      0.005  0.135
## tmrcaS    -0.135 -0.380 -0.482
## thetaS:tmrcaS -0.285 -0.042  0.001  0.377
##
```

```

## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.25429784 -0.59755951  0.02639997  0.63307472  4.57004970
##
## Residual standard error: 0.0001790389
## Degrees of freedom: 1416 total; 1411 residual
vif(g.div.dm.50kb.1)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.195063 1.382728 1.872266 1.250111

# Linear model without TMRCA --> rho becomes significant
g.div.dm.50kb.5 <- gls(diversity ~ (thetaS + rhoS),
                         data = dm.lands.50kb, weights = varPower(0, ~thetaS|chr), cor = corAR1(0, ~bin|chr))

summary(g.div.dm.50kb.5)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS)
## Data: dm.lands.50kb
##      AIC      BIC logLik
## -16766.39 -16719.09 8392.194
##
## Correlation Structure: AR(1)
## Formula: ~bin | chr
## Parameter estimate(s):
##      Phi
## 0.222041
## Variance function:
## Structure: Power of variance covariate, different strata
## Formula: ~thetaS | chr
## Parameter estimates:
##      2L      2R      3L      3R
## 0.15844323 0.05935649 0.14568514 0.10009426
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008741224 2.144029e-05 407.7007     0
## thetaS       0.003045861 2.346945e-05 129.7798     0
## rhoS        0.000401770 1.903572e-05 21.1061     0
##
## Correlation:
##      (Intr) thetaS
## thetaS -0.028
## rhoS   0.029 -0.141
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -14.414443196 -0.543580512 -0.000430244  0.585993239  3.218547625
##
## Residual standard error: 0.000707202
## Degrees of freedom: 1416 total; 1413 residual
vif(g.div.dm.50kb.5)

```

```

## thetaS      rhoS
## 1.020325 1.020325



### 3.2 200 kb windows



# Chr 2L

# recombination landscapes
rho.dm.200kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.200kb.bedgraph", header = T)

# diversity
diversity.dm.200kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.200kb.bedgraph", header = T)
diversity.dm.200kb.2L$avg <- apply(diversity.dm.200kb.2L[4:ncol(diversity.dm.200kb.2L)], 1, mean)

# mutation landscapes
theta.dm.200kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.200kb.bedgraph", header = T)

# TMRCAs landscapes
tmrca.dm.200kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCAs.200kb.bedgraph", header = T)
tmrca.dm.200kb.2L$sample_mean <- apply(tmrca.dm.200kb.2L[4:ncol(tmrca.dm.200kb.2L)], 1, mean)

# missing data
missing.prop.200kb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.200kb.bedgraph", header = T)
intersect.200kb.2L <- apply(missing.prop.200kb.2L[4:ncol(missing.prop.200kb.2L)], 1, function(x) any(x))

dm.lands.200kb.2L <- as.data.frame(cbind(diversity.dm.200kb.2L$chromStart,
                                             diversity.dm.200kb.2L$chromEnd,
                                             diversity.dm.200kb.2L$avg,
                                             theta.dm.200kb.2L$sample_mean,
                                             rho.dm.200kb.2L$sample_mean,
                                             tmrca.dm.200kb.2L$sample_mean))
names(dm.lands.200kb.2L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.200kb.2L$bin <- 1:nrow(dm.lands.200kb.2L)

# filters based on missing data
dm.lands.200kb.2L <- dm.lands.200kb.2L[which(intersect.200kb.2L == F),]

dm.lands.200kb.2L$chr <- "2L"

dm.lands.200kb.2L$thetaS <- (dm.lands.200kb.2L$theta - mean(dm.lands.200kb.2L$theta)) / sd(dm.lands.200kb.2L$theta)
dm.lands.200kb.2L$tmrcaS <- (dm.lands.200kb.2L$tmrca - mean(dm.lands.200kb.2L$tmrca)) / sd(dm.lands.200kb.2L$tmrca)
dm.lands.200kb.2L$rhoS <- (dm.lands.200kb.2L$rho - mean(dm.lands.200kb.2L$rho)) / sd(dm.lands.200kb.2L$rho)

g.div.dm.200kb.2L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                            data = dm.lands.200kb.2L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin))

summary(g.div.dm.200kb.2L)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.200kb.2L
##          AIC      BIC  logLik
## -1244.082 -1224.731 630.041
##
```

```

## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.1002962
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.05640964
##
## Coefficients:
##             Value   Std.Error t-value p-value
## (Intercept) 0.009685117 1.589668e-05 609.2540 0.0000
## thetaS       0.002127407 1.828930e-05 116.3197 0.0000
## rhoS        0.000020279 1.866681e-05   1.0864 0.2807
## tmrcaS      0.000617392 3.120432e-05  19.7855 0.0000
## thetaS:tmrcaS 0.000112009 1.103284e-05 10.1524 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.034
## rhoS        0.100  0.195
## tmrcaS     -0.244 -0.449 -0.572
## thetaS:tmrcaS -0.337 -0.112 -0.276  0.696
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.8896987 -0.6840157 -0.1976799  0.4999174  3.1380216
##
## Residual standard error: 0.0001297071
## Degrees of freedom: 83 total; 78 residual
# Chr 2R

# recombination landscapes
rho.dm.200kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.rho.200kb.bedgraph", header = T)

# diversity
diversity.dm.200kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.diversity.200kb.bedgraph", header = T)
diversity.dm.200kb.2R$avg <- apply(diversity.dm.200kb.2R[4:ncol(diversity.dm.200kb.2R)], 1, mean)

# mutation landscapes
theta.dm.200kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.theta.200kb.bedgraph", header = T)

# TMRCAs landscapes
tmrca.dm.200kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.TMRCA.200kb.bedgraph", header = T)
tmrca.dm.200kb.2R$sample_mean <- apply(tmrca.dm.200kb.2R[4:ncol(tmrca.dm.200kb.2R)], 1, mean)

# missing data
missing.prop.200kb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.missing.prop.200kb.bedgraph", header = T)
intersect.200kb.2R <- apply(missing.prop.200kb.2R[4:ncol(missing.prop.200kb.2R)], 1, function(x) any(x))

```

```

dm.lands.200kb.2R <- as.data.frame(cbind(diversity.dm.200kb.2R$chromStart,
                                            diversity.dm.200kb.2R$chromEnd,
                                            diversity.dm.200kb.2R$avg,
                                            theta.dm.200kb.2R$sample_mean,
                                            rho.dm.200kb.2R$sample_mean,
                                            tmrca.dm.200kb.2R$sample_mean))
names(dm.lands.200kb.2R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.200kb.2R$bin <- 1:nrow(dm.lands.200kb.2R)

# filters based on missing data
dm.lands.200kb.2R <- dm.lands.200kb.2R[which(intersect.200kb.2R == F),]

dm.lands.200kb.2R$chr <- "2R"

dm.lands.200kb.2R$thetaS <- (dm.lands.200kb.2R$theta - mean(dm.lands.200kb.2R$theta)) / sd(dm.lands.200kb.2R$theta)
dm.lands.200kb.2R$tmrcaS <- (dm.lands.200kb.2R$tmrca - mean(dm.lands.200kb.2R$tmrca)) / sd(dm.lands.200kb.2R$tmrca)
dm.lands.200kb.2R$rhoS <- (dm.lands.200kb.2R$rho - mean(dm.lands.200kb.2R$rho)) / sd(dm.lands.200kb.2R$rho)

g.div.dm.200kb.2R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                            data = dm.lands.200kb.2R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin))

summary(g.div.dm.200kb.2R)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.200kb.2R
##          AIC      BIC    logLik
##     -1165.932 -1147.499 590.9659
##
## Correlation Structure: ARMA(1,0)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi1
## 0.2372428
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.06275132
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008539183 1.263509e-05 675.8307 0.0000
## thetaS       0.002457245 1.280128e-05 191.9530 0.0000
## rhoS        0.000010548 1.124604e-05   0.9379 0.3516
## tmrcaS      0.000382626 1.512599e-05  25.2959 0.0000
## thetaS:tmrcaS 0.000082382 9.704038e-06   8.4894 0.0000
##
## Correlation:
## (Intr) thetaS rhoS   tmrcaS
## thetaS    0.030
## rhoS     -0.063  0.097
## tmrcaS   -0.153 -0.376 -0.219

```

```

## thetaS:tmrcaS -0.290 -0.069  0.120  0.497
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.13836840 -0.68198223  0.08032991  0.80898896  2.57448459
##
## Residual standard error: 8.89356e-05
## Degrees of freedom: 74 total; 69 residual
# recombination landscapes
rho.dm.200kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.rho.200kb.bedgraph", header = T)

# diversity
diversity.dm.200kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.diversity.200kb.bedgraph", header = T)
diversity.dm.200kb.3L$avg <- apply(diversity.dm.200kb.3L[4:ncol(diversity.dm.200kb.3L)], 1, mean)

# mutation landscapes
theta.dm.200kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.theta.200kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.200kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.TMRCA.200kb.bedgraph", header = T)
tmrca.dm.200kb.3L$sample_mean <- apply(tmrca.dm.200kb.3L[4:ncol(tmrca.dm.200kb.3L)], 1, mean)

# missing data
missing.prop.200kb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.missing.prop.200kb.bedgraph", header = T)
intersect.200kb.3L <- apply(missing.prop.200kb.3L[4:ncol(missing.prop.200kb.3L)], 1, function(x) any(x))

dm.lands.200kb.3L <- as.data.frame(cbind(diversity.dm.200kb.3L$chromStart,
                                             diversity.dm.200kb.3L$chromEnd,
                                             diversity.dm.200kb.3L$avg,
                                             theta.dm.200kb.3L$sample_mean,
                                             rho.dm.200kb.3L$sample_mean,
                                             tmrca.dm.200kb.3L$sample_mean))
names(dm.lands.200kb.3L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.200kb.3L$bin <- 1:nrow(dm.lands.200kb.3L)

# filters based on missing data
dm.lands.200kb.3L <- dm.lands.200kb.3L[which(intersect.200kb.3L == F),]

dm.lands.200kb.3L$chr <- "3L"

dm.lands.200kb.3L$thetaS <- (dm.lands.200kb.3L$theta - mean(dm.lands.200kb.3L$theta)) / sd(dm.lands.200kb.3L)
dm.lands.200kb.3L$tmrcaS <- (dm.lands.200kb.3L$tmrca - mean(dm.lands.200kb.3L$tmrca)) / sd(dm.lands.200kb.3L)
dm.lands.200kb.3L$rhoS <- (dm.lands.200kb.3L$rho - mean(dm.lands.200kb.3L$rho)) / sd(dm.lands.200kb.3L)

g.div.dm.200kb.3L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                            data = dm.lands.200kb.3L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin))

summary(g.div.dm.200kb.3L)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.200kb.3L
##       AIC      BIC    logLik
##   -1307.956 -1288.321  661.9781

```

```

##
## Correlation Structure: ARMA(1,0)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi1
## 0.2105682
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## -0.01470136
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.008947413 1.815834e-05 492.7438 0.0000
## thetaS       0.002775488 2.084148e-05 133.1713 0.0000
## rhoS        0.000046521 1.554662e-05   2.9923 0.0037
## tmrcaS      0.000728686 2.894097e-05   25.1784 0.0000
## thetaS:tmrcaS 0.000152921 1.496396e-05  10.2193 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.133
## rhoS       0.079  0.300
## tmrcaS    -0.394 -0.661 -0.463
## thetaS:tmrcaS -0.587 -0.238 -0.153  0.680
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.89079240 -0.54320978  0.05844326  0.51224633  2.31374278
##
## Residual standard error: 0.0001102298
## Degrees of freedom: 86 total; 81 residual
# Chr 3R

# recombination landscapes
rho.dm.200kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.rho.200kb.bedgraph", header = T)

# diversity
diversity.dm.200kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.diversity.200kb.bedgraph", header = T)

diversity.dm.200kb.3R$avg <- apply(diversity.dm.200kb.3R[4:ncol(diversity.dm.200kb.3R)], 1, mean)

# mutation landscapes
theta.dm.200kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.theta.200kb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.200kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.TMRCA.200kb.bedgraph", header = T)
tmrca.dm.200kb.3R$sample_mean <- apply(tmrca.dm.200kb.3R[4:ncol(tmrca.dm.200kb.3R)], 1, mean)

# missing data
missing.prop.200kb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.missing.prop.200kb.bedgraph", header = T)

```

```

intersect.200kb.3R <- apply(missing.prop.200kb.3R[4:ncol(missing.prop.200kb.3R)], 1, function(x) any(x))

dm.lands.200kb.3R <- as.data.frame(cbind(diversity.dm.200kb.3R$chromStart,
                                             diversity.dm.200kb.3R$chromEnd,
                                             diversity.dm.200kb.3R$avg,
                                             theta.dm.200kb.3R$sample_mean,
                                             rho.dm.200kb.3R$sample_mean,
                                             tmrca.dm.200kb.3R$sample_mean))
names(dm.lands.200kb.3R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.200kb.3R$bin <- 1:nrow(dm.lands.200kb.3R)

# filters based on missing data
dm.lands.200kb.3R <- dm.lands.200kb.3R[which(intersect.200kb.3R == F),]

dm.lands.200kb.3R$chr <- "3R"

dm.lands.200kb.3R$thetaS <- (dm.lands.200kb.3R$theta - mean(dm.lands.200kb.3R$theta)) / sd(dm.lands.200kb.3R$theta)
dm.lands.200kb.3R$tmrcaS <- (dm.lands.200kb.3R$tmrca - mean(dm.lands.200kb.3R$tmrca)) / sd(dm.lands.200kb.3R$tmrca)
dm.lands.200kb.3R$rhoS <- (dm.lands.200kb.3R$rho - mean(dm.lands.200kb.3R$rho)) / sd(dm.lands.200kb.3R$rho)

g.div.dm.200kb.3R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                            data = dm.lands.200kb.3R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin))

summary(g.div.dm.200kb.3R)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.200kb.3R
##          AIC      BIC  logLik
##     -1883.368 -1861.135 949.684
##
## Correlation Structure: ARMA(1,0)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi1
## 0.09974947
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.1960113
##
## Coefficients:
##             Value    Std.Error t-value p-value
## (Intercept) 0.007566141 1.039634e-05 727.7696 0.0000
## thetaS      0.002532598 1.014172e-05 249.7209 0.0000
## rhoS       -0.000027958 1.195302e-05  -2.3390 0.0211
## tmrcaS      0.000981423 2.689006e-05   36.4976 0.0000
## thetaS:tmrcaS 0.000196288 1.830320e-05  10.7242 0.0000
##
## Correlation:
##           (Intr) thetaS rhoS   tmrcaS
## thetaS      0.283

```

```

## rhoS          0.214  0.306
## tmrcaS       -0.574 -0.559 -0.546
## thetaS:tmrcaS -0.625 -0.374 -0.215  0.781
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.78869608 -0.72931864 -0.06801681  0.64535064  2.75174311
##
## Residual standard error: 0.0001028136
## Degrees of freedom: 119 total; 114 residual
# all together now
dm.lands.200kb <- rbind.data.frame(dm.lands.200kb.2L, dm.lands.200kb.2R, dm.lands.200kb.3L, dm.lands.200kb.3R)

write.table(dm.lands.200kb, "dm_data/dm_chr_maps/dm.maps.200kb.tsv", quote = F, sep = "\t", row.names = FALSE)

# genome-wide correlations
cor.test(~rho + diversity, data = dm.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and diversity
## S = 6652998, p-value = 0.002515
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.1585153

cor.test(~rho + tmrca, data = dm.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 4384696, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.4454147

cor.test(~theta + tmrca, data = dm.lands.200kb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 3844174, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.513781

# Linear models
# standardizing
dm.lands.200kb$thetaS <- (dm.lands.200kb$theta - mean(dm.lands.200kb$theta)) / sd(dm.lands.200kb$theta)
dm.lands.200kb$tmrcaS <- (dm.lands.200kb$tmrca - mean(dm.lands.200kb$tmrca)) / sd(dm.lands.200kb$tmrca)

```

```

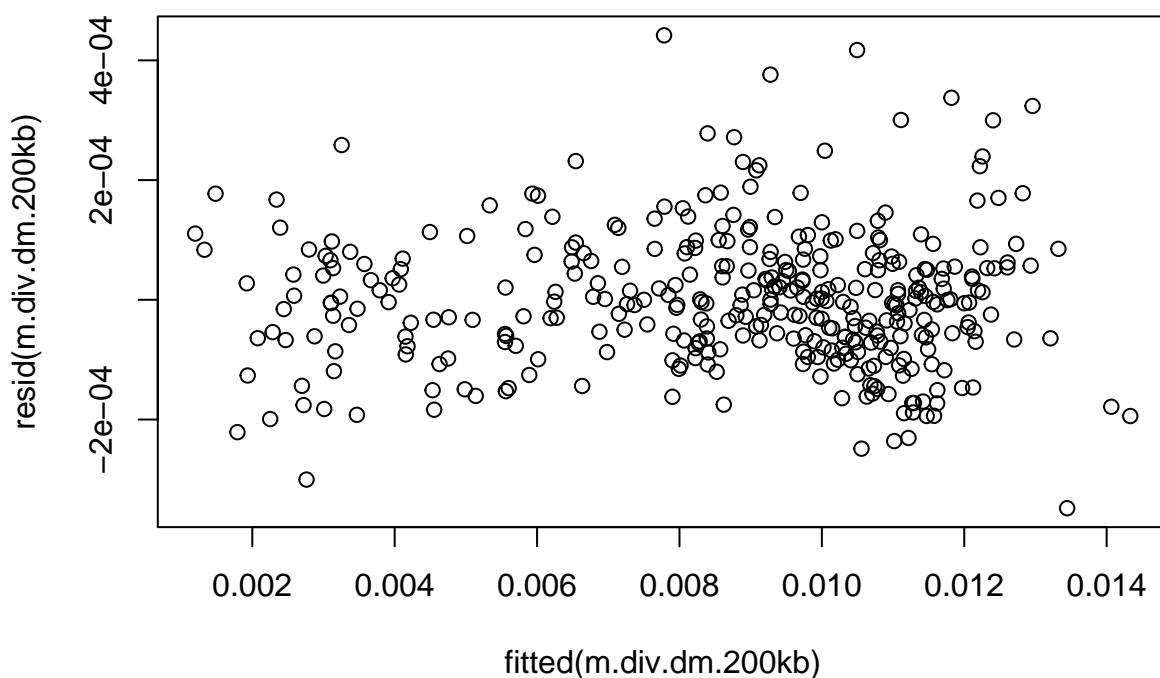
dm.lands.200kb$rhoS <- (dm.lands.200kb$rho - mean(dm.lands.200kb$rho)) / sd(dm.lands.200kb$rho)

dm.lands.200kb$bin <- 1:nrow(dm.lands.200kb)

m.div.dm.200kb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS), data = dm.lands.200kb)

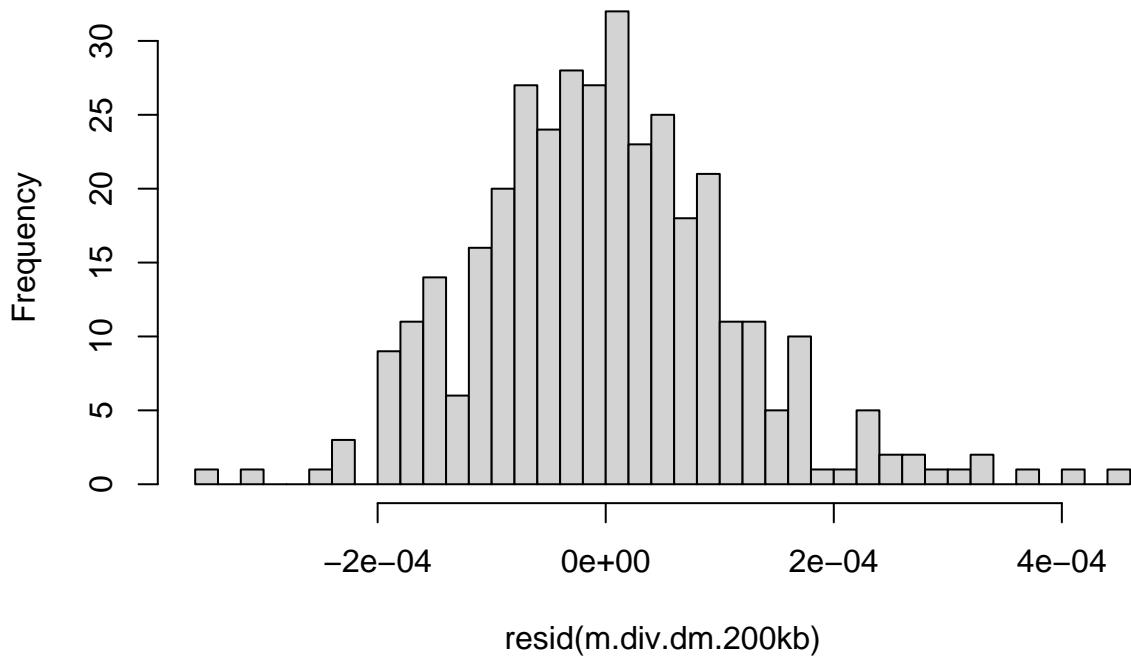
plot(resid(m.div.dm.200kb) ~ fitted(m.div.dm.200kb))

```



```
hist(resid(m.div.dm.200kb), nclass = 30)
```

Histogram of resid(m.div.dm.200kb)



```
dwtest(m.div.dm.200kb)

##
##  Durbin-Watson test
##
## data: m.div.dm.200kb
## DW = 1.4463, p-value = 3.114e-08
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.dm.200kb, nsim = 10000)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.dm.200kb
## HMC = 0.56948, p-value = 0.9688
summary(m.div.dm.200kb)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
##     data = dm.lands.200kb)
##
## Residuals:
##       Min        1Q      Median        3Q       Max
## -3.481e-04 -6.976e-05 -4.240e-06  6.351e-05  4.418e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 8.571e-03 7.361e-06 1164.402   <2e-16 ***
```

```

## thetaS      2.587e-03 7.721e-06 335.083 <2e-16 ***
## rhoS       9.685e-06 7.737e-06   1.252    0.211
## tmrcaS     7.752e-04 1.470e-05  52.753 <2e-16 ***
## thetaS:tmrcaS 1.626e-04 7.893e-06  20.604 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001143 on 357 degrees of freedom
## Multiple R-squared:  0.9985, Adjusted R-squared:  0.9985
## F-statistic: 6.074e+04 on 4 and 357 DF,  p-value: < 2.2e-16

vif(m.div.dm.200kb)

##          thetaS          rhoS          tmrcaS        thetaS:tmrcaS
## 1.646067    1.652579    5.961897    3.721737

# type 2 ANOVA
anova.diversity <- Anova(m.div.dm.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
anova.diversity

## Anova Table (Type II tests)
##
## Response: diversity
##             Sum Sq Df  F value Pr(>F)  VarExp
## thetaS      0.00165091  1 126265.729 0.00000 0.96688
## rhoS       0.00000002  1      1.567 0.21147 0.00001
## tmrcaS     0.00004631  1    3541.894 0.00000 0.02712
## thetaS:tmrcaS 0.00000555  1     424.530 0.00000 0.00325
## Residuals   0.00000467 357                  0.00273

# GLS
g.div.dm.200kb.1 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.200kb, weights = varPower(0, ~tmrcaS|chr), cor = corAR1(0, ~bin|chr))

g.div.dm.200kb.2 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.200kb, weights = varPower(0, ~thetaS|chr), cor = corAR1(0, ~bin|chr))

g.div.dm.200kb.3 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.200kb, weights = varPower(0, ~thetaS|chr), method = "ML")

g.div.dm.200kb.4 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.200kb, weights = varPower(0, ~tmrcaS|chr), method = "ML")

AIC(g.div.dm.200kb.1, g.div.dm.200kb.2, g.div.dm.200kb.3, g.div.dm.200kb.4)

##          df      AIC
## g.div.dm.200kb.1 11 -5572.433
## g.div.dm.200kb.2 11 -5581.537
## g.div.dm.200kb.3 10 -5552.913
## g.div.dm.200kb.4 10 -5544.269

summary(g.div.dm.200kb.1)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)

```

```

## Data: dm.lands.200kb
##      AIC      BIC  logLik
## -5572.433 -5529.625 2797.217
##
## Correlation Structure: AR(1)
## Formula: ~bin | chr
## Parameter estimate(s):
##     Phi
## 0.3007644
## Variance function:
## Structure: Power of variance covariate, different strata
## Formula: ~tmrcaS | chr
## Parameter estimates:
##          2L        2R        3L        3R
## -0.10668694 0.10590761 -0.02949391 0.09853841
##
## Coefficients:
##             Value   Std.Error t-value p-value
## (Intercept) 0.008555930 8.650992e-06 989.0114 0.0000
## thetaS       0.002574166 8.570710e-06 300.3445 0.0000
## rhoS        0.000004540 8.030014e-06   0.5654 0.5721
## tmrcaS      0.000788411 1.409513e-05  55.9350 0.0000
## thetaS:tmrcaS 0.000173631 7.825349e-06 22.1882 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS      0.106
## rhoS        -0.002  0.180
## tmrcaS     -0.299 -0.475 -0.447
## thetaS:tmrcaS -0.434 -0.205 -0.075  0.705
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.72141081 -0.58127726  0.07056482  0.58993636  3.65529479
##
## Residual standard error: 0.0001151488
## Degrees of freedom: 362 total; 357 residual
vif(g.div.dm.200kb.1)

##      thetaS        rhoS        tmrcaS thetaS:tmrcaS
## 1.373146     1.485517     3.683706     2.461695

# Linear model without TMRCA --> rho becomes significant
g.div.dm.200kb.5 <- gls(diversity ~ (thetaS + rhoS),
                           data = dm.lands.200kb, weights = varPower(0, ~thetaS), cor = corAR1(0, ~bin), me

summary(g.div.dm.200kb.5)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS)
## Data: dm.lands.200kb
##      AIC      BIC  logLik
## -4723.291 -4699.941 2367.645
##

```

```

## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## 0.4168254
## Variance function:
## Structure: Power of variance covariate
## Formula: ~thetaS
## Parameter estimates:
##     power
## 0.13171
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.008688913 3.045635e-05 285.29066      0
## thetaS       0.002853184 3.097921e-05  92.09995      0
## rhoS        0.000276861 2.255108e-05 12.27706      0
##
## Correlation:
##          (Intr) thetaS
## thetaS -0.016
## rhoS   0.048 -0.145
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -5.445432702 -0.523327124 -0.009243674  0.572229138  2.972069433
##
## Residual standard error: 0.0004130832
## Degrees of freedom: 362 total; 359 residual
vif(g.div.dm.200kb.5)

##     thetaS     rhoS
## 1.021358 1.021358

```

3.3 1 Mb windows

```

# Chr 2L

# recombination landscapes
rho.dm.1Mb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.rho.1Mb.bedgraph", header = T)

# diversity
diversity.dm.1Mb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.diversity.1Mb.bedgraph", header = T)
diversity.dm.1Mb.2L$avg <- apply(diversity.dm.1Mb.2L[4:ncol(diversity.dm.1Mb.2L)], 1, mean)

# mutation landscapes
theta.dm.1Mb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.theta.1Mb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.1Mb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.TMRCA.1Mb.bedgraph", header = T)
tmrca.dm.1Mb.2L$sample_mean <- apply(tmrca.dm.1Mb.2L[4:ncol(tmrca.dm.1Mb.2L)], 1, mean)

# missing data

```

```

missing.prop.1Mb.2L <- read.table("dm_data/dm_chr_maps/2L/dm_30x5x5.missing.prop.1Mb.bedgraph", header = TRUE)
intersect.1Mb.2L <- apply(missing.prop.1Mb.2L[4:ncol(missing.prop.1Mb.2L)], 1, function(x) any(x > 0.1))

dm.lands.1Mb.2L <- as.data.frame(cbind(diversity.dm.1Mb.2L$chromStart,
                                         diversity.dm.1Mb.2L$chromEnd,
                                         diversity.dm.1Mb.2L$avg,
                                         theta.dm.1Mb.2L$sample_mean,
                                         rho.dm.1Mb.2L$sample_mean,
                                         tmrca.dm.1Mb.2L$sample_mean))
names(dm.lands.1Mb.2L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.1Mb.2L$bin <- 1:nrow(dm.lands.1Mb.2L)

# filters based on missing data
dm.lands.1Mb.2L <- dm.lands.1Mb.2L[which(intersect.1Mb.2L == F),]

dm.lands.1Mb.2L$chr <- "2L"

dm.lands.1Mb.2L$thetaS <- (dm.lands.1Mb.2L$theta - mean(dm.lands.1Mb.2L$theta)) / sd(dm.lands.1Mb.2L$theta)
dm.lands.1Mb.2L$tmrcaS <- (dm.lands.1Mb.2L$tmrca - mean(dm.lands.1Mb.2L$tmrca)) / sd(dm.lands.1Mb.2L$tmrca)
dm.lands.1Mb.2L$rhoS <- (dm.lands.1Mb.2L$rho - mean(dm.lands.1Mb.2L$rho)) / sd(dm.lands.1Mb.2L$rho)

g.div.dm.1Mb.2L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.1Mb.2L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), na.action = na.omit)

summary(g.div.dm.1Mb.2L)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.1Mb.2L
##      AIC      BIC    logLik
## -299.3268 -291.7713 157.6634
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.3144048
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## -0.04167166
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.010112367 2.513180e-05 402.3734 0.0000
## thetaS       0.001482486 3.056196e-05 48.5076 0.0000
## rhoS        0.000004499 2.386795e-05   0.1885 0.8532
## tmrcaS      0.000367251 3.471251e-05 10.5798 0.0000
## thetaS:tmrcaS 0.000078084 1.341728e-05    5.8197 0.0000
##
## Correlation:
##          (Intr) thetaS rhoS   tmrcaS

```

```

## thetaS      -0.006
## rhoS       0.168  0.107
## tmrcaS     -0.247 -0.591 -0.594
## thetaS:tmrcaS -0.447  0.063 -0.394  0.584
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.4305539 -0.5991356 -0.1638086  0.5088896  2.4443876
##
## Residual standard error: 6.059571e-05
## Degrees of freedom: 19 total; 14 residual
# Chr 2R

# recombination landscapes
rho.dm.1Mb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.rho.1Mb.bedgraph", header = T)

# diversity
diversity.dm.1Mb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.diversity.1Mb.bedgraph", header = T)
diversity.dm.1Mb.2R$avg <- apply(diversity.dm.1Mb.2R[4:ncol(diversity.dm.1Mb.2R)], 1, mean)

# mutation landscapes
theta.dm.1Mb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.theta.1Mb.bedgraph", header = T)

# TMRCAs landscapes
tmrca.dm.1Mb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.TMRCA.1Mb.bedgraph", header = T)
tmrca.dm.1Mb.2R$sample_mean <- apply(tmrca.dm.1Mb.2R[4:ncol(tmrca.dm.1Mb.2R)], 1, mean)

# missing data
missing.prop.1Mb.2R <- read.table("dm_data/dm_chr_maps/2R/dm_30x5x5.missing.prop.1Mb.bedgraph", header = T)
intersect.1Mb.2R <- apply(missing.prop.1Mb.2R[4:ncol(missing.prop.1Mb.2R)], 1, function(x) any(x > 0.1))

dm.lands.1Mb.2R <- as.data.frame(cbind(diversity.dm.1Mb.2R$chromStart,
                                           diversity.dm.1Mb.2R$chromEnd,
                                           diversity.dm.1Mb.2R$avg,
                                           theta.dm.1Mb.2R$sample_mean,
                                           rho.dm.1Mb.2R$sample_mean,
                                           tmrca.dm.1Mb.2R$sample_mean))
names(dm.lands.1Mb.2R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.1Mb.2R$bin <- 1:nrow(dm.lands.1Mb.2R)

# filters based on missing data
dm.lands.1Mb.2R <- dm.lands.1Mb.2R[which(intersect.1Mb.2R == F),]

dm.lands.1Mb.2R$chr <- "2R"

dm.lands.1Mb.2R$thetaS <- (dm.lands.1Mb.2R$theta - mean(dm.lands.1Mb.2R$theta)) / sd(dm.lands.1Mb.2R$theta)
dm.lands.1Mb.2R$tmrcaS <- (dm.lands.1Mb.2R$tmrca - mean(dm.lands.1Mb.2R$tmrca)) / sd(dm.lands.1Mb.2R$tmrca)
dm.lands.1Mb.2R$rhoS <- (dm.lands.1Mb.2R$rho - mean(dm.lands.1Mb.2R$rho)) / sd(dm.lands.1Mb.2R$rho)

g.div.dm.1Mb.2R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.1Mb.2R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), na.action = na.omit)

summary(g.div.dm.1Mb.2R)

```

```

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.1Mb.2R
##      AIC      BIC  logLik
## -260.3174 -253.6517 138.1587
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## -0.02184561
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## -0.286626
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.009155188 2.832317e-05 323.2402 0.0000
## thetaS       0.001868053 4.094254e-05 45.6262 0.0000
## rhoS        0.000023538 2.409532e-05   0.9769 0.3479
## tmrcaS      0.0000200999 3.703936e-05   5.4266 0.0002
## thetaS:tmrcaS 0.000019395 1.900705e-05   1.0204 0.3277
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     -0.233
## rhoS       0.302  -0.140
## tmrcaS    -0.353 -0.638 -0.213
## thetaS:tmrcaS -0.803  0.231 -0.355  0.536
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -1.4712709 -0.4619228 -0.3324611  0.4352917  2.9199214
##
## Residual standard error: 4.577664e-05
## Degrees of freedom: 17 total; 12 residual

# recombination landscapes
rho.dm.1Mb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.rho.1Mb.bedgraph", header = T)

# diversity
diversity.dm.1Mb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.diversity.1Mb.bedgraph", header = T)
diversity.dm.1Mb.3L$avg <- apply(diversity.dm.1Mb.3L[4:ncol(diversity.dm.1Mb.3L)], 1, mean)

# mutation landscapes
theta.dm.1Mb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.theta.1Mb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.1Mb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.TMRCA.1Mb.bedgraph", header = T)
tmrca.dm.1Mb.3L$sample_mean <- apply(tmrca.dm.1Mb.3L[4:ncol(tmrca.dm.1Mb.3L)], 1, mean)

```

```

# missing data
missing.prop.1Mb.3L <- read.table("dm_data/dm_chr_maps/3L/dm_30x5x5.missing.prop.1Mb.bedgraph", header = TRUE)
intersect.1Mb.3L <- apply(missing.prop.1Mb.3L[4:ncol(missing.prop.1Mb.3L)], 1, function(x) any(x > 0.1))

dm.lands.1Mb.3L <- as.data.frame(cbind(diversity.dm.1Mb.3L$chromStart,
                                         diversity.dm.1Mb.3L$chromEnd,
                                         diversity.dm.1Mb.3L$avg,
                                         theta.dm.1Mb.3L$sample_mean,
                                         rho.dm.1Mb.3L$sample_mean,
                                         tmrca.dm.1Mb.3L$sample_mean))
names(dm.lands.1Mb.3L) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.1Mb.3L$bin <- 1:nrow(dm.lands.1Mb.3L)

# filters based on missing data
dm.lands.1Mb.3L <- dm.lands.1Mb.3L[which(intersect.1Mb.3L == F),]

dm.lands.1Mb.3L$chr <- "3L"

dm.lands.1Mb.3L$thetaS <- (dm.lands.1Mb.3L$theta - mean(dm.lands.1Mb.3L$theta)) / sd(dm.lands.1Mb.3L$theta)
dm.lands.1Mb.3L$tmrcaS <- (dm.lands.1Mb.3L$tmrca - mean(dm.lands.1Mb.3L$tmrca)) / sd(dm.lands.1Mb.3L$tmrca)
dm.lands.1Mb.3L$rhoS <- (dm.lands.1Mb.3L$rho - mean(dm.lands.1Mb.3L$rho)) / sd(dm.lands.1Mb.3L$rho)

g.div.dm.1Mb.3L <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.1Mb.3L, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), na.action = na.omit)

summary(g.div.dm.1Mb.3L)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.1Mb.3L
##          AIC      BIC    logLik
## -348.8084 -340.0801 182.4042
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## 0.249026
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.3377385
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.009181282 2.404774e-05 381.7940 0.0000
## thetaS       0.002615494 3.244090e-05  80.6233 0.0000
## rhoS        0.000034900 1.950167e-05   1.7896 0.0913
## tmrcaS      0.000517909 5.784910e-05   8.9528 0.0000
## thetaS:tmrcaS 0.000062953 2.655589e-05   2.3706 0.0298
##

```

```

## Correlation:
##           (Intr) thetaS rhoS   tmrcaS
## thetaS      0.400
## rhoS       0.531  0.320
## tmrcaS     -0.622 -0.738 -0.571
## thetaS:tmrcaS -0.618 -0.348 -0.438  0.689
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.71883315 -0.45696303  0.01830762  0.69607904  1.69584501
##
## Residual standard error: 8.201734e-05
## Degrees of freedom: 22 total; 17 residual

# Chr 3R

# recombination landscapes
rho.dm.1Mb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.rho.1Mb.bedgraph", header = T)

# diversity
diversity.dm.1Mb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.diversity.1Mb.bedgraph", header = T)
diversity.dm.1Mb.3R$avg <- apply(diversity.dm.1Mb.3R[4:ncol(diversity.dm.1Mb.3R)], 1, mean)

# mutation landscapes
theta.dm.1Mb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.theta.1Mb.bedgraph", header = T)

# TMRCA landscapes
tmrca.dm.1Mb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.TMRCA.1Mb.bedgraph", header = T)
tmrca.dm.1Mb.3R$sample_mean <- apply(tmrca.dm.1Mb.3R[4:ncol(tmrca.dm.1Mb.3R)], 1, mean)

# missing data
missing.prop.1Mb.3R <- read.table("dm_data/dm_chr_maps/3R/dm_30x5x5.missing.prop.1Mb.bedgraph", header = T)
intersect.1Mb.3R <- apply(missing.prop.1Mb[4:ncol(missing.prop.1Mb.3R)], 1, function(x) any(x > 0.1))

dm.lands.1Mb.3R <- as.data.frame(cbind(diversity.dm.1Mb.3R$chromStart,
                                           diversity.dm.1Mb.3R$chromEnd,
                                           diversity.dm.1Mb.3R$avg,
                                           theta.dm.1Mb.3R$sample_mean,
                                           rho.dm.1Mb.3R$sample_mean,
                                           tmrca.dm.1Mb.3R$sample_mean))
names(dm.lands.1Mb.3R) <- c("start", "end", "diversity", "theta", "rho", "tmrca")
dm.lands.1Mb.3R$bin <- 1:nrow(dm.lands.1Mb.3R)

# filters based on missing data
dm.lands.1Mb.3R <- dm.lands.1Mb.3R[which(intersect.1Mb.3R == F),]

dm.lands.1Mb.3R$chr <- "3R"

dm.lands.1Mb.3R$thetaS <- (dm.lands.1Mb.3R$theta - mean(dm.lands.1Mb.3R$theta)) / sd(dm.lands.1Mb.3R$theta)
dm.lands.1Mb.3R$tmrcaS <- (dm.lands.1Mb.3R$tmrca - mean(dm.lands.1Mb.3R$tmrca)) / sd(dm.lands.1Mb.3R$tmrca)
dm.lands.1Mb.3R$rhoS <- (dm.lands.1Mb.3R$rho - mean(dm.lands.1Mb.3R$rho)) / sd(dm.lands.1Mb.3R$rho)

g.div.dm.1Mb.3R <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                           data = dm.lands.1Mb.3R, weights = varPower(0, ~tmrcaS), cor = corAR1(0, ~bin), na.action = na.omit)

```

```

summary(g.div.dm.1Mb.3R)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
## Data: dm.lands.1Mb.3R
##      AIC      BIC logLik
## -324.5017 -316.9462 170.2509
##
## Correlation Structure: ARMA(1,0)
## Formula: ~bin
## Parameter estimate(s):
##     Phi1
## -0.4823526
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##     power
## 0.8128992
##
## Coefficients:
##             Value    Std.Error   t-value p-value
## (Intercept) 0.006724616 2.251544e-05 298.66684 0.0000
## thetaS       0.002582348 1.759737e-05 146.74630 0.0000
## rhoS        0.000018618 1.440997e-05   1.29200 0.2173
## tmrcaS      0.000969833 5.083886e-05  19.07661 0.0000
## thetaS:tmrcaS 0.000203782 4.894035e-05   4.16389 0.0010
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.911
## rhoS        -0.280  0.066
## tmrcaS     -0.923 -0.944 -0.023
## thetaS:tmrcaS -0.940 -0.881  0.320  0.856
##
## Standardized residuals:
##      Min      Q1      Med      Q3      Max
## -1.7308894 -0.4913490  0.1058365  0.6374128  1.9989783
##
## Residual standard error: 6.652517e-05
## Degrees of freedom: 19 total; 14 residual
# all together now
dm.lands.1Mb <- rbind.data.frame(dm.lands.1Mb.2L, dm.lands.1Mb.2R, dm.lands.1Mb.3L, dm.lands.1Mb.3R)

write.table(dm.lands.1Mb, "dm_data/dm_chr_maps/dm.maps.1Mb.tsv", quote = F, sep = "\t", row.names = F, )

# genome-wide correlations
cor.test(~rho + diversity, data = dm.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and diversity

```

```

## S = 60404, p-value = 0.07236
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.2060045
cor.test(~rho + tmrca, data = dm.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: rho and tmrca
## S = 42930, p-value = 8.798e-05
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.4356959
cor.test(~theta + tmrca, data = dm.lands.1Mb, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: theta and tmrca
## S = 22964, p-value < 2.2e-16
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##      rho
## 0.698144

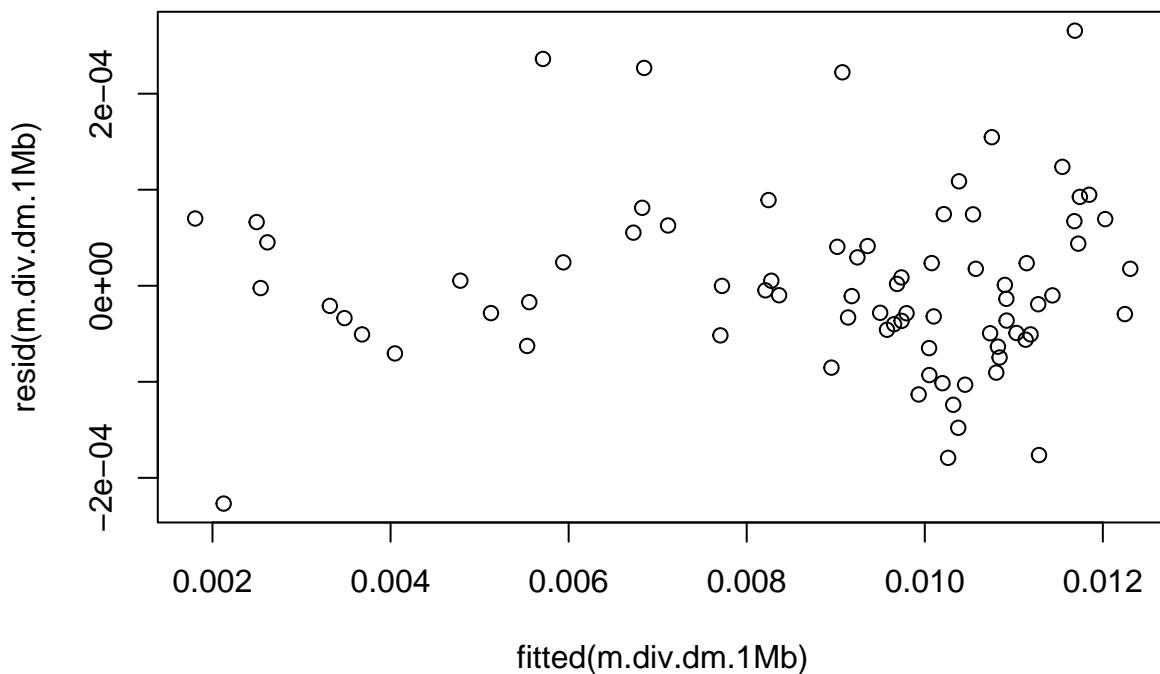
# Linear models
# standardizing
dm.lands.1Mb$thetaS <- (dm.lands.1Mb$theta - mean(dm.lands.1Mb$theta)) / sd(dm.lands.1Mb$theta)
dm.lands.1Mb$tmrcaS <- (dm.lands.1Mb$tmrca - mean(dm.lands.1Mb$tmrca)) / sd(dm.lands.1Mb$tmrca)
dm.lands.1Mb$rhoS <- (dm.lands.1Mb$rho - mean(dm.lands.1Mb$rho)) / sd(dm.lands.1Mb$rho)

dm.lands.1Mb$bin <- 1:nrow(dm.lands.1Mb)

m.div.dm.1Mb <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS), data = dm.lands.1Mb)

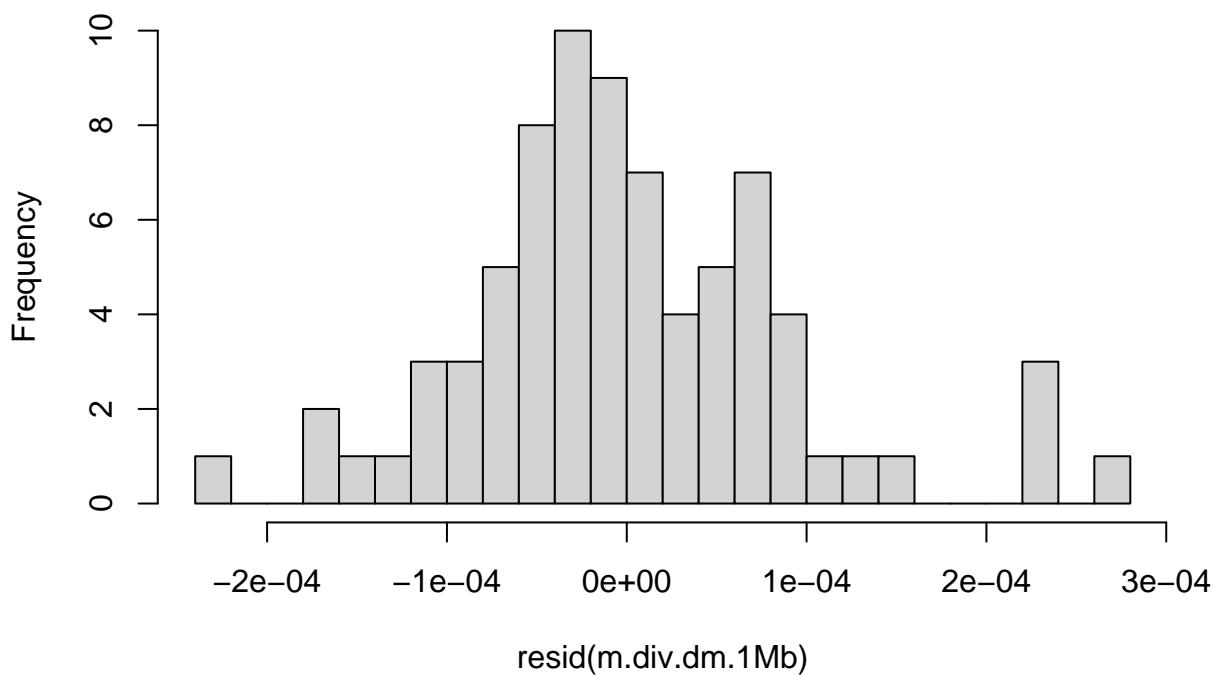
plot(resid(m.div.dm.1Mb) ~ fitted(m.div.dm.1Mb))

```



```
hist(resid(m.div.dm.1Mb), nclass = 30)
```

Histogram of $\text{resid}(m.\text{div}.\text{dm}.1\text{Mb})$



```
dwttest(m.div.dm.1Mb)
```

```
##
## Durbin-Watson test
##
## data: m.div.dm.1Mb
## DW = 1.6563, p-value = 0.03648
```

```

## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.dm.1Mb, nsim = 10000)

##
##  Harrison-McCabe test
##
## data: m.div.dm.1Mb
## HMC = 0.72492, p-value = 0.999
summary(m.div.dm.1Mb)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
##      data = dm.lands.1Mb)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -2.268e-04 -5.063e-05 -1.004e-05  4.519e-05  2.656e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 8.808e-03 1.551e-05 568.036 < 2e-16 ***
## thetaS       2.445e-03 1.657e-05 147.497 < 2e-16 ***
## rhoS        3.015e-05 1.405e-05   2.145  0.0353 *  
## tmrcaS      6.043e-04 3.829e-05  15.784 < 2e-16 *** 
## thetaS:tmrcaS 7.632e-05 1.769e-05   4.315 4.99e-05 *** 
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.283e-05 on 72 degrees of freedom
## Multiple R-squared:  0.999, Adjusted R-squared:  0.9989 
## F-statistic: 1.74e+04 on 4 and 72 DF,  p-value: < 2.2e-16

vif(m.div.dm.1Mb)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 2.422826    1.741910    12.927873    7.711517

# type 2 ANOVA
anova.diversity <- Anova(m.div.dm.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
anova.diversity

## Anova Table (Type II tests)
##
## Response: diversity
##           Sum Sq Df  F value    Pr(>F)  VarExp
## thetaS    2.4658e-04  1 28614.4891 0.000000 0.97371
## rhoS     4.0000e-08  1     4.6028 0.035293 0.00016
## tmrcaS   5.8360e-06  1    677.2706 0.000000 0.02305
## thetaS:tmrcaS 1.6000e-07  1     18.6226 0.000050 0.00063
## Residuals 6.2000e-07 72                  0.00245

# GLS
g.div.dm.1Mb.1 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),

```

```

        data = dm.lands.1Mb, weights = varPower(0, ~tmrcaS|chr), cor = corAR1(0, ~bin|chr)

g.div.dm.1Mb.2 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.1Mb, weights = varPower(0, ~theta|chr), cor = corAR1(0, ~bin|chr))

g.div.dm.1Mb.3 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.1Mb, weights = varPower(0, ~theta|chr), method = "ML")

g.div.dm.1Mb.4 <- gls(diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS),
                         data = dm.lands.1Mb, weights = varPower(0, ~tmrcaS|chr), method = "ML")

AIC(g.div.dm.1Mb.1, g.div.dm.1Mb.2, g.div.dm.1Mb.3, g.div.dm.1Mb.4)

##           df      AIC
## g.div.dm.1Mb.1 11 -1225.918
## g.div.dm.1Mb.2 11 -1202.198
## g.div.dm.1Mb.3 10 -1202.415
## g.div.dm.1Mb.4 10 -1217.967

summary(g.div.dm.1Mb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS + tmrcaS + thetaS:tmrcaS)
##   Data: dm.lands.1Mb
##          AIC      BIC  logLik
## -1225.918 -1200.136 623.9591
##
## Correlation Structure: AR(1)
## Formula: ~bin | chr
## Parameter estimate(s):
##   Phi
## 0.581682
## Variance function:
##   Structure: Power of variance covariate, different strata
##   Formula: ~tmrcaS | chr
##   Parameter estimates:
##     2L      2R      3L      3R
## 0.37995450 0.05817476 0.46667745 0.77367312
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008752066 8.873720e-06 986.2903 0.0000
## thetaS       0.002417340 9.855870e-06 245.2691 0.0000
## rhoS        0.000002480 9.655180e-06   0.2568 0.7980
## tmrcaS      0.000648198 3.397848e-05 19.0767 0.0000
## thetaS:tmrcaS 0.000090139 2.387994e-05   3.7747 0.0003
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS      0.008
## rhoS        0.477  0.584
## tmrcaS     -0.152 -0.488 -0.546
## thetaS:tmrcaS -0.114 -0.148 -0.237  0.438
##
```

```

## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -1.0805313 -0.1152080  0.4338327  1.0150849  2.7175860
##
## Residual standard error: 0.0001394046
## Degrees of freedom: 77 total; 72 residual
vif(g.div.dm.1Mb.1)

##      thetaS       rhoS      tmrcaS thetaS:tmrcaS
##      1.630894    1.757698    1.789243    1.247969

# Linear model without TMRCA --> rho becomes significant
g.div.dm.1Mb.5 <- gls(diversity ~ (thetaS + rhoS),
  data = dm.lands.1Mb, weights = varPower(0, ~thetaS|chr), cor = corAR1(0, ~bin|chr))

summary(g.div.dm.1Mb.5)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ (thetaS + rhoS)
##   Data: dm.lands.1Mb
##          AIC      BIC  logLik
## -1054.675 -1033.581 536.3375
##
## Correlation Structure: AR(1)
##   Formula: ~bin | chr
## Parameter estimate(s):
##   Phi
## 0.5686675
## Variance function:
##   Structure: Power of variance covariate, different strata
##   Formula: ~thetaS | chr
## Parameter estimates:
##      2L      2R      3L      3R
## 0.3737074 0.1255485 0.2621324 0.5031969
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.008916718 3.759919e-05 237.15183     0
## thetaS       0.002695004 4.945118e-05  54.49828     0
## rhoS        0.000153498 3.164833e-05   4.85011     0
##
## Correlation:
##   (Intr) thetaS
## thetaS -0.071
## rhoS   0.043 -0.282
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.85658001 -0.62173922 -0.01623445  0.46158057  1.27574549
##
## Residual standard error: 0.0003189399
## Degrees of freedom: 77 total; 74 residual
vif(g.div.dm.1Mb.5)

```

```
##   thetaS      rhoS
## 1 0.086593 1.086593
```

3.4 Divergence with D. yakuba

```
lands.divergence.dm <- read.table("dm_data/dm_maps_50kb_divergence.tsv", header = T, sep = "\t")

cor.test(lands.divergence.dm$divergence, lands.divergence.dm$theta, method = "spearman")

##
## Spearman's rank correlation rho
##
## data: lands.divergence.dm$divergence and lands.divergence.dm$theta
## S = 97624952, p-value = 2.989e-09
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##       rho
## 0.1965015
```

3.5 Evolutionary (Protein) Rates

This is how we generated the table from raw data:

```
# loads data
dm.raw <- read.table("dm_data/dm_misc/dpgp2_Dsimulans_bpp.all.csv", header = TRUE, sep = "\t") %>%
  select(GeneID, MeanNumberSynPos, PiN, PiS, MeanNumberSynPosDiv, dS, dN) %>% na.omit()

# summarises
dm.tbl <- ddply(dm.raw, .variables = "GeneID", .fun = plyr::summarize,
  MeanNumberNonSynPos = sum(3 - MeanNumberSynPos),
  MeanNumberSynPos = sum(MeanNumberSynPos),
  PiN = sum(PiN),
  PiS = sum(PiS),
  MeanNumberNonSynPosDiv = sum(3 - MeanNumberSynPosDiv),
  MeanNumberSynPosDiv = sum(MeanNumberSynPosDiv),
  dN = sum(dN),
  dS = sum(dS))

dm.tbl$PiN <- (dm.tbl$PiN / dm.tbl$MeanNumberNonSynPos)
dm.tbl$PiS <- (dm.tbl$PiS / dm.tbl$MeanNumberSynPos)
dm.tbl$dN <- (dm.tbl$dN / dm.tbl$MeanNumberNonSynPosDiv)
dm.tbl$dS <- (dm.tbl$dS / dm.tbl$MeanNumberSynPosDiv)

# computes ratios
dm.tbl$PiN_PiS <- with(dm.tbl, PiN / PiS)
dm.tbl$dN_dS <- with(dm.tbl, dN / dS)

# we ignore genes with ratios above 1
dm.tbl <- dm.tbl[dm.tbl$PiN_PiS < 1,]
dm.tbl <- dm.tbl[dm.tbl$dN_dS < 1,]
dm.tbl <- na.omit(dm.tbl)

dm.genes.coord <- read.table("dm_data/dm_misc/Dmel_trans_nooverlaps-final.txt", header = F) %>% select(
  names(dm.genes.coord) <- c("chr", "start", "end", "GeneID")
```

```

dm.evol <- merge(dm.genes.coord, dm.tbl, by = "GeneID")
dm.evol <- arrange(dm.evol, chr, start)

# reorder maps to use GR
dm.maps.50kb <- dm.lands.50kb[,c(8,1:6)]

# mapping genes to 50kb windows in ismc maps
dm.lands.gr <- makeGRangesFromDataFrame(dm.maps.50kb)
values(dm.lands.gr) <- select(dm.maps.50kb, diversity, theta, rho, tmrca)
evolrate.gr <- makeGRangesFromDataFrame(dm.evol)
values(evolrate.gr) <- select(dm.evol, PiN, PiS, dN, dS)

hits_1 <- findOverlaps(query = evolrate.gr, subject = dm.lands.gr, type = "within")

evolrate.gr.df <- as.data.frame(evolrate.gr[queryHits(hits_1)], row.names = NULL)
dm.lands.gr.df <- as.data.frame(dm.lands.gr[subjectHits(hits_1)], row.names = NULL)

dm.lands.evolrate <- cbind.data.frame(dm.lands.gr.df[,c(1:3,6:9)], evolrate.gr.df[,c(2:4,6:9)])

names(dm.lands.evolrate)[1] <- "chr"
names(dm.lands.evolrate)[2] <- "start.window"
names(dm.lands.evolrate)[3] <- "end.window"
names(dm.lands.evolrate)[8] <- "start.gene"
names(dm.lands.evolrate)[9] <- "end.gene"
names(dm.lands.evolrate)[10] <- "length.gene"

dm.lands.evolrate <- arrange(dm.lands.evolrate, chr, start.window, start.gene)

dm.lands.evolrate.bins <- ddply(dm.lands.evolrate, .variables = c("chr", "start.window"), .fun = plyr:::
  diversity = mean(diversity),
  theta = mean(theta),
  rho = mean(rho),
  tmrca = mean(tmrca),
  exonic.sites = sum(length.gene),
  PiN.window = sum(PiN*length.gene) / sum(length.gene),
  PiS.window = sum(PiS*length.gene) / sum(length.gene),
  dN.window = sum(dN*length.gene) / sum(length.gene),
  dS.window = sum(dS*length.gene) / sum(length.gene))

dm.lands.evolrate.bins$bin <- 1:nrow(dm.lands.evolrate.bins)

write.table(dm.lands.evolrate.bins, "dm_data/dm_chr_maps/dm_maps_50kb_protein_rates.tsv",
            sep = "\t", quote = F, col.names = T, row.names = F)

```

We can read the table generated and move on with the analyses:

```

dm.lands.evolrate.bins <- read.table("dm_data/dm_chr_maps/dm_maps_50kb_protein_rates.tsv", header = T, )

# linear model in windows with more than 20kb exonic sites
dm.lands.genes <- filter(dm.lands.evolrate.bins, exonic.sites > 2e+4)

# standardizing
dm.lands.genes$thetaS <- (dm.lands.genes$theta - mean(dm.lands.genes$theta))

```

```

dm.lands.genes$tmrcaS <- (dm.lands.genes$tmrca - mean(dm.lands.genes$tmrca))
dm.lands.genes$rhoS <- (dm.lands.genes$rho - mean(dm.lands.genes$rho))

m.dm.cds.1 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS*tmrcaS), data = dm.lands.genes)
m.dm.cds.2 <- lm(diversity ~ (thetaS + rhoS + tmrcaS + thetaS*tmrcaS + rhoS*tmrcaS), data = dm.lands.genes)

AIC(m.dm.cds.1, m.dm.cds.2)

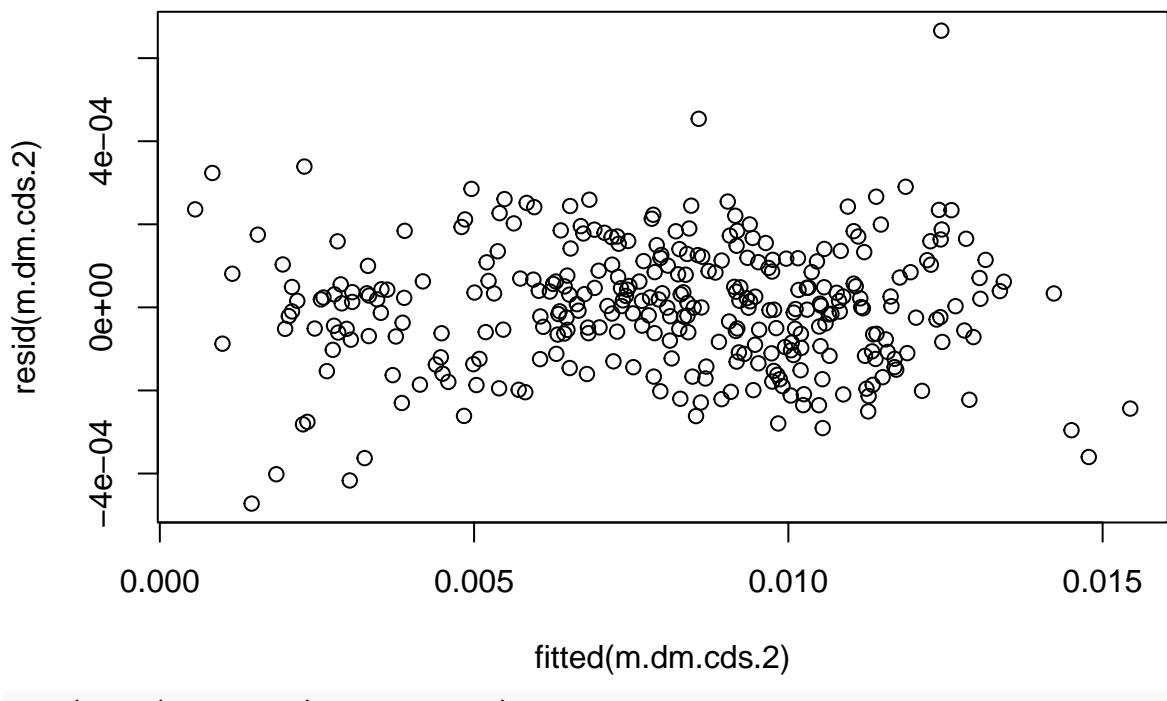
##          df      AIC
## m.dm.cds.1 6 -4778.177
## m.dm.cds.2 7 -4782.425

summary(m.dm.cds.2)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS * tmrcaS +
##     rhoS * tmrcaS), data = dm.lands.genes)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -4.723e-04 -9.596e-05  3.810e-06  8.994e-05  6.661e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.890e-03 9.716e-06 812.013   <2e-16 ***
## thetaS      9.511e-01 3.665e-03 259.551   <2e-16 ***
## rhoS        1.053e-03 1.530e-03  0.688   0.4919
## tmrcaS      1.120e-02 1.964e-04  57.010   <2e-16 ***
## thetaS:tmrcaS 1.079e+00 4.299e-02  25.098   <2e-16 ***
## rhoS:tmrcaS  2.110e-02 8.481e-03  2.488   0.0133 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000149 on 318 degrees of freedom
## Multiple R-squared:  0.9977, Adjusted R-squared:  0.9977
## F-statistic: 2.785e+04 on 5 and 318 DF, p-value: < 2.2e-16

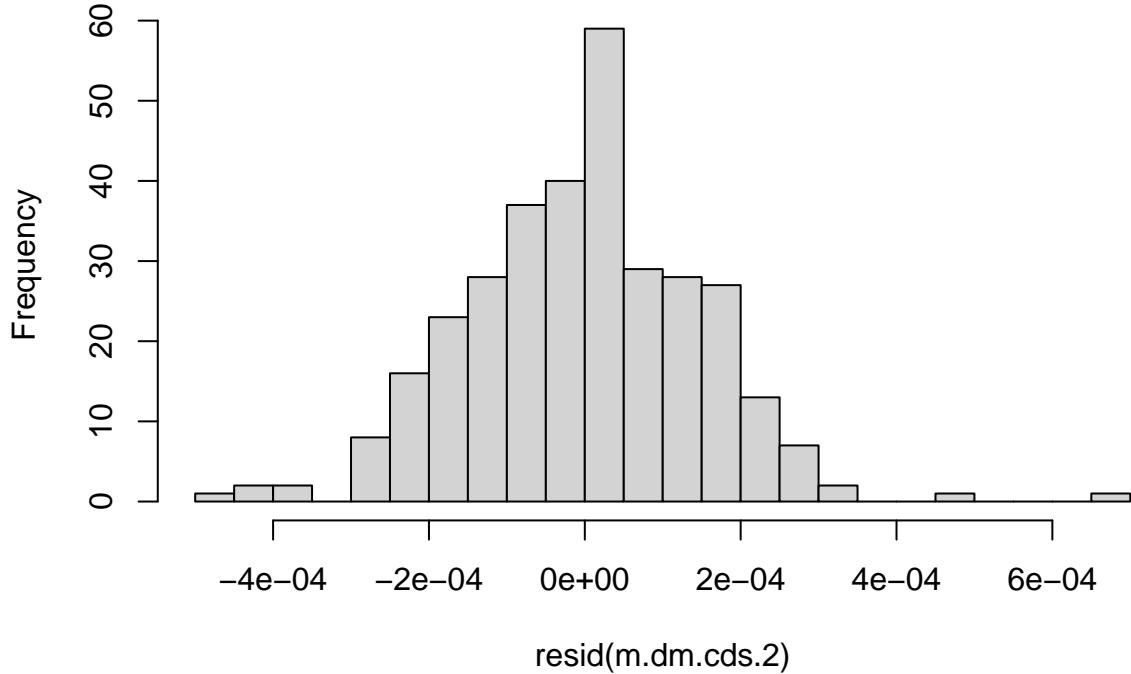
# picking best OLS for ANOVA
plot(resid(m.dm.cds.2)~fitted(m.dm.cds.2))

```



```
hist(resid(m.dm.cds.2), nclass = 30)
```

Histogram of `resid(m.dm.cds.2)`



```
dwttest(m.dm.cds.2)
```

```
##  
## Durbin-Watson test  
##  
## data: m.dm.cds.2  
## DW = 2.0035, p-value = 0.4719
```

```

## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.dm.cds.2, nsim = 10000)

##
##  Harrison-McCabe test
##
## data: m.dm.cds.2
## HMC = 0.41117, p-value = 0.0117
summary(m.dm.cds.2)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS + thetaS * tmrcaS +
##     rhoS * tmrcaS), data = dm.lands.genes)
##
## Residuals:
##       Min        1Q      Median        3Q       Max
## -4.723e-04 -9.596e-05  3.810e-06  8.994e-05  6.661e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 7.890e-03 9.716e-06 812.013 <2e-16 ***
## thetaS      9.511e-01 3.665e-03 259.551 <2e-16 ***
## rhoS        1.053e-03 1.530e-03  0.688  0.4919
## tmrcaS      1.120e-02 1.964e-04  57.010 <2e-16 ***
## thetaS:tmrcaS 1.079e+00 4.299e-02 25.098 <2e-16 ***
## rhoS:tmrcaS  2.110e-02 8.481e-03  2.488  0.0133 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000149 on 318 degrees of freedom
## Multiple R-squared:  0.9977, Adjusted R-squared:  0.9977
## F-statistic: 2.785e+04 on 5 and 318 DF,  p-value: < 2.2e-16

# type 2 anova
anova.diversity.cds <- Anova(m.dm.cds.2)
apiss <- anova.diversity.cds$"Sum Sq"
anova.diversity.cds$VarExp <- apiss / sum(apiss)

anova.diversity.cds

## Anova Table (Type II tests)
##
## Response: diversity
##             Sum Sq Df   F value    Pr(>F)  VarExp
## thetaS      1.544e-03  1 69536.4716 0.000000 0.93236
## rhoS        5.000e-08  1     2.1199 0.146386 0.00003
## tmrcaS      9.078e-05  1  4088.1586 0.000000 0.05482
## thetaS:tmrcaS 1.399e-05  1   629.9096 0.000000 0.00845
## rhoS:tmrcaS  1.400e-07  1     6.1917 0.013347 0.00008
## Residuals    7.060e-06 318                 0.00426

# simple correlations
cor.test(dm.lands.evolrate.bins$theta, dm.lands.evolrate.bins$exonic.sites, method = "spearman")

```

```

##  

## Spearman's rank correlation rho  

##  

## data: dm.lands.evolrate.bins$theta and dm.lands.evolrate.bins$exonic.sites  

## S = 339155743, p-value = 6.388e-06  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## -0.1289611  

cor.test(dm.lands.evolrate.bins$tmrca, dm.lands.evolrate.bins$exonic.sites, method = "spearman")  

##  

## Spearman's rank correlation rho  

##  

## data: dm.lands.evolrate.bins$tmrca and dm.lands.evolrate.bins$exonic.sites  

## S = 360421366, p-value = 2.034e-12  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## -0.1997488  

pcor.test(dm.lands.evolrate.bins$tmrca, dm.lands.evolrate.bins$exonic.sites, dm.lands.evolrate.bins$the  

##      estimate      p.value statistic    n gp   Method  

## 1 -0.1582194 2.912866e-08 -5.583083 1217  1 spearman  

pcor.test(dm.lands.evolrate.bins$theta, dm.lands.evolrate.bins$exonic.sites, dm.lands.evolrate.bins$tmr  

##      estimate      p.value statistic    n gp   Method  

## 1 -0.0374759 0.1915716 -1.306672 1217  1 spearman  

cor.test(dm.lands.evolrate.bins$PiN, dm.lands.evolrate.bins$theta, method = "spearman")  

##  

## Spearman's rank correlation rho  

##  

## data: dm.lands.evolrate.bins$PiN and dm.lands.evolrate.bins$theta  

## S = 192322126, p-value < 2.2e-16  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## 0.3598097  

cor.test(dm.lands.evolrate.bins$PiS, dm.lands.evolrate.bins$theta, method = "spearman")  

##  

## Spearman's rank correlation rho  

##  

## data: dm.lands.evolrate.bins$PiS and dm.lands.evolrate.bins$theta  

## S = 78488708, p-value < 2.2e-16  

## alternative hypothesis: true rho is not equal to 0  

## sample estimates:  

## rho  

## 0.7387315  

pcor.test(dm.lands.evolrate.bins$PiN, dm.lands.evolrate.bins$theta, dm.lands.evolrate.bins$tmrca, metho
```

```

##      estimate      p.value statistic     n gp    Method
## 1 0.2711637 6.149318e-22  9.815788 1217  1 spearman
pcor.test(dm.lands.evolrate.bins$PiS, dm.lands.evolrate.bins$theta, dm.lands.evolrate.bins$tmrca, method='spearman')

##      estimate      p.value statistic     n gp    Method
## 1 0.6767774 1.129784e-163 32.03071 1217  1 spearman

# bootstrapping PiN and PiS correlations
boot.tbl <- dm.lands.evolrate.bins %>% dplyr::select(PiN.window, theta, PiS.window, tmrca)
boot.PiN.theta <- boot(boot.tbl,
  statistic = function(boot.tbl, i) {
    pcor.test(boot.tbl[i, "PiN.window"], boot.tbl[i, "theta"], boot.tbl[i, "tmrca"], method='spearman')
  },
  R = 10000
)
boot.ci(boot.PiN.theta, type = "basic")

## BOOTSTRAP CONFIDENCE INTERVAL CALCULATIONS
## Based on 10000 bootstrap replicates
##
## CALL :
## boot.ci(boot.out = boot.PiN.theta, type = "basic")
##
## Intervals :
## Level      Basic
## 95%   ( 0.2202,  0.3240 )
## Calculations and Intervals on Original Scale
boot.PiS.theta <- boot(boot.tbl,
  statistic = function(boot.tbl, i) {
    pcor.test(boot.tbl[i, "PiS.window"], boot.tbl[i, "theta"], boot.tbl[i, "tmrca"], method='spearman')
  },
  R = 10000
)
boot.ci(boot.PiS.theta, type = "basic")

## BOOTSTRAP CONFIDENCE INTERVAL CALCULATIONS
## Based on 10000 bootstrap replicates
##
## CALL :
## boot.ci(boot.out = boot.PiS.theta, type = "basic")
##
## Intervals :
## Level      Basic
## 95%   ( 0.6417,  0.7154 )
## Calculations and Intervals on Original Scale

```

4 R^2 plot with real, simulated (true) and simulated (inferred) data.

```

# true landscapes
r2.sim.avg <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names=TRUE)
colnames(r2.sim.avg) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
r2.sim.avg$bin.size <- c(50, 200, 1000)

```

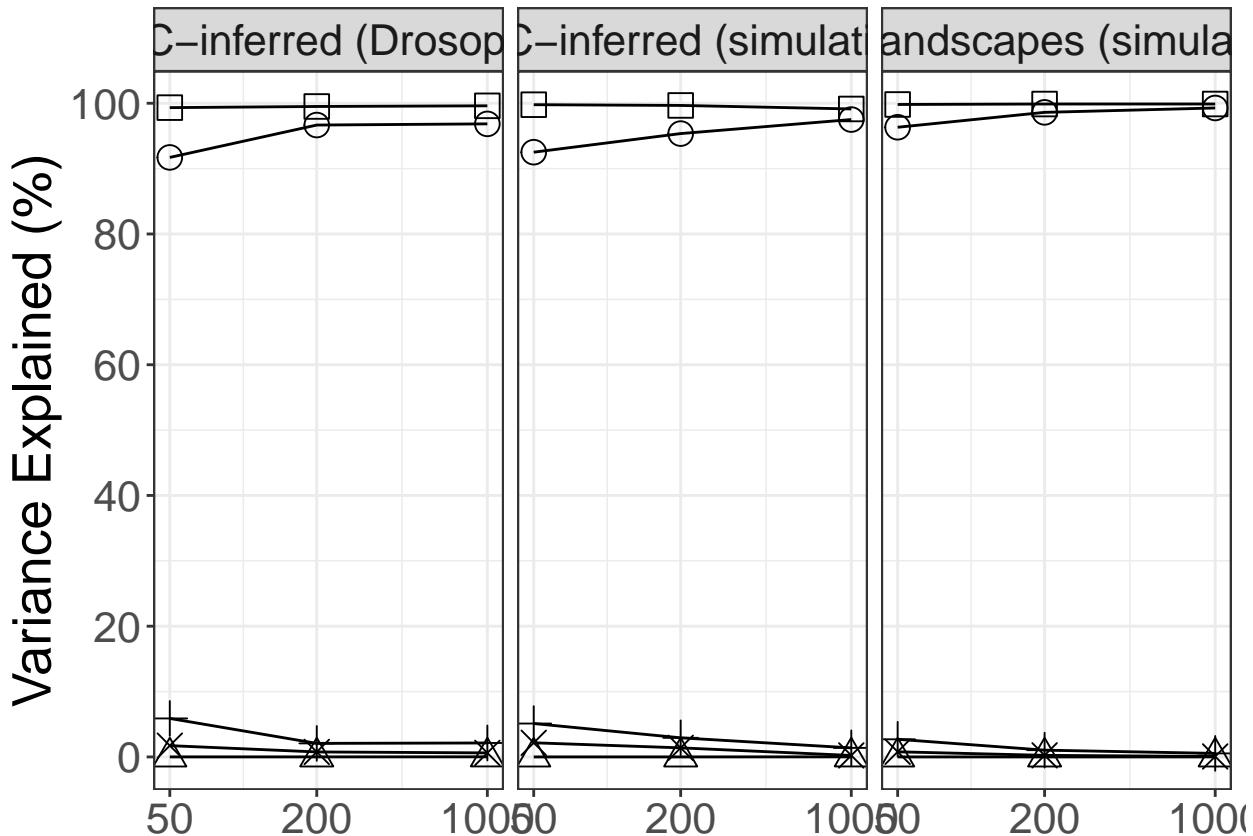
```

# inferred landscapes
r2.inf.avg <- rbind.data.frame(r2.inf.50kb$average, r2.inf.200kb$average, r2.inf.1Mb$average, make.row.names=TRUE)
colnames(r2.inf.avg) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
r2.inf.avg$bin.size <- c(50, 200, 1000)

r2.tab.comb <- rbind.data.frame(r2.dm.tab, r2.sim.avg, r2.inf.avg)
r2.tab.comb$type <- c(rep("iSMC-inferred (Drosophila)", 3), rep("True landscapes (simulations)", 3), rep("SLiM", 3))

molten.r2 <- melt(r2.tab.comb, id.vars = c("bin.size", "type"))
r2.coal.plot <- ggplot(data = molten.r2, aes(x = bin.size, y = value, shape = variable))
r2.coal.plot <- r2.coal.plot + geom_line(data = molten.r2)
r2.coal.plot <- r2.coal.plot + geom_point(aes(shape = variable), size = 4) + facet_wrap(~type)
r2.coal.plot <- r2.coal.plot + scale_x_continuous(breaks = c(50, 200, 1000), trans="log10")
r2.coal.plot <- r2.coal.plot + scale_y_continuous(breaks = pretty_breaks())
r2.coal.plot <- r2.coal.plot + scale_shape_manual(values = c(0, 1, 2, 3, 4))
r2.coal.plot <- r2.coal.plot + labs(title = NULL, x = NULL, y = "Variance Explained (%)")
r2.coal.plot <- r2.coal.plot + theme_bw()
r2.coal.plot <- r2.coal.plot + theme(axis.title = element_text(size = 20), axis.text = element_text(size = 16),
                                         strip.text.x = element_text(size = 16), legend.position = "none")
r2.coal.plot

```



5 Simulations with BGS and Gamma Mutation Landscape in SLiM

```

cor.table.theta <- as.data.frame(matrix(ncol = 3, nrow = nreps))
row.names(cor.table.theta) <- reps

```

```

colnames(cor.table.theta) <- c("50kb", "200kb", "1Mb")

cor.table.rho <- as.data.frame(matrix(ncol = 3, nrow = nreps))
row.names(cor.table.rho) <- reps
colnames(cor.table.rho) <- c("50kb", "200kb", "1Mb")

cor.table.tmrca <- as.data.frame(matrix(ncol = 3, nrow = nreps))
row.names(cor.table.tmrca) <- reps
colnames(cor.table.tmrca) <- c("50kb", "200kb", "1Mb")

```

5.1 50 kb scale

```

r2.bgs.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.50kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.50kb) <- reps

r2.bgs.50kb.true <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.50kb.true) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.50kb.true) <- reps

sim.theta.50kb <- read.table("dm_bgs_sims/MutationMap_50kb.csv", sep = ",", header = T)
sim.rho.50kb <- read.table("dm_bgs_sims/RecombinationMap_50kb.csv", sep = ",", header = T)

```

5.1.1 Replicate 1

```

rep1.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep1_w50000.csv", sep = ",", header = T)

rep_1.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.pi")
rep_1.pi.50kb$avg <- apply(rep_1.pi.50kb[4:ncol(rep_1.pi.50kb)], 1, mean)
rep_1.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.rho")
rep_1.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.theta")
rep_1.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.tmrca")
rep_1.tmrca.50kb$avg <- apply(rep_1.tmrca.50kb[4:ncol(rep_1.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep1 <- as.data.frame(cbind(rep_1.pi.50kb$avg, sim.theta.50kb$Rate, rep1.sim.tmrca.50kb))
names(true.lands.50kb.rep1) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep1$thetaS <- (true.lands.50kb.rep1$theta - mean(true.lands.50kb.rep1$theta)) / sd(true.lands.50kb.rep1$theta)
true.lands.50kb.rep1$tmrcaS <- (true.lands.50kb.rep1$tmrca - mean(true.lands.50kb.rep1$tmrca)) / sd(true.lands.50kb.rep1$tmrca)
true.lands.50kb.rep1$rhoS <- (true.lands.50kb.rep1$rho - mean(true.lands.50kb.rep1$rho, na.rm = T)) / sd(true.lands.50kb.rep1$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep1)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 1] <- anova.diversity$VarExp[4] * 100

```

```

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.50kb.rep1)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -1.091e-03 -2.385e-04 -3.662e-05  2.503e-04  1.197e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.503e-03 1.635e-05 214.219 < 2e-16 ***
## thetaS       1.959e-03 1.723e-05 113.703 < 2e-16 ***
## rhoS        7.307e-05 2.130e-05   3.431 0.000657 ***
## tmrcaS      1.024e-03 2.196e-05  46.642 < 2e-16 ***
## thetaS:tmrcaS 6.672e-04 1.939e-05  34.403 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003503 on 457 degrees of freedom
## (9 observations deleted due to missingness)
## Multiple R-squared:  0.9807, Adjusted R-squared:  0.9806
## F-statistic:  5813 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.114087    1.704014    1.701632    1.113668

# now the lm with inferred landscapes
inf.lands.50kb.rep1 <- as.data.frame(cbind(rep_1.pi.50kb$avg, rep_1.theta.50kb$sample_mean, rep_1.tmrca
names(inf.lands.50kb.rep1) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[1, 1] <- cor.test(sim.theta.50kb$Rate, rep_1.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[1, 1] <- cor.test(sim.rho.50kb$Rate, rep_1.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[1, 1] <- cor.test(rep1.sim.tmrca.50kb$AverageTmrca, rep_1.tmrca.50kb$avg, method = "spe

# standardizing
inf.lands.50kb.rep1$thetaS <- (inf.lands.50kb.rep1$theta - mean(inf.lands.50kb.rep1$theta)) / sd(inf.lan
inf.lands.50kb.rep1$tmrcaS <- (inf.lands.50kb.rep1$tmrca - mean(inf.lands.50kb.rep1$tmrca)) / sd(inf.lan
inf.lands.50kb.rep1$rhoS <- (inf.lands.50kb.rep1$rho - mean(inf.lands.50kb.rep1$rho)) / sd(inf.lands.50

inf.lands.50kb.rep1$bin <- 1:nrow(inf.lands.50kb.rep1)
inf.lands.50kb.rep1$Replicate <- 1

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep1)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep1)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

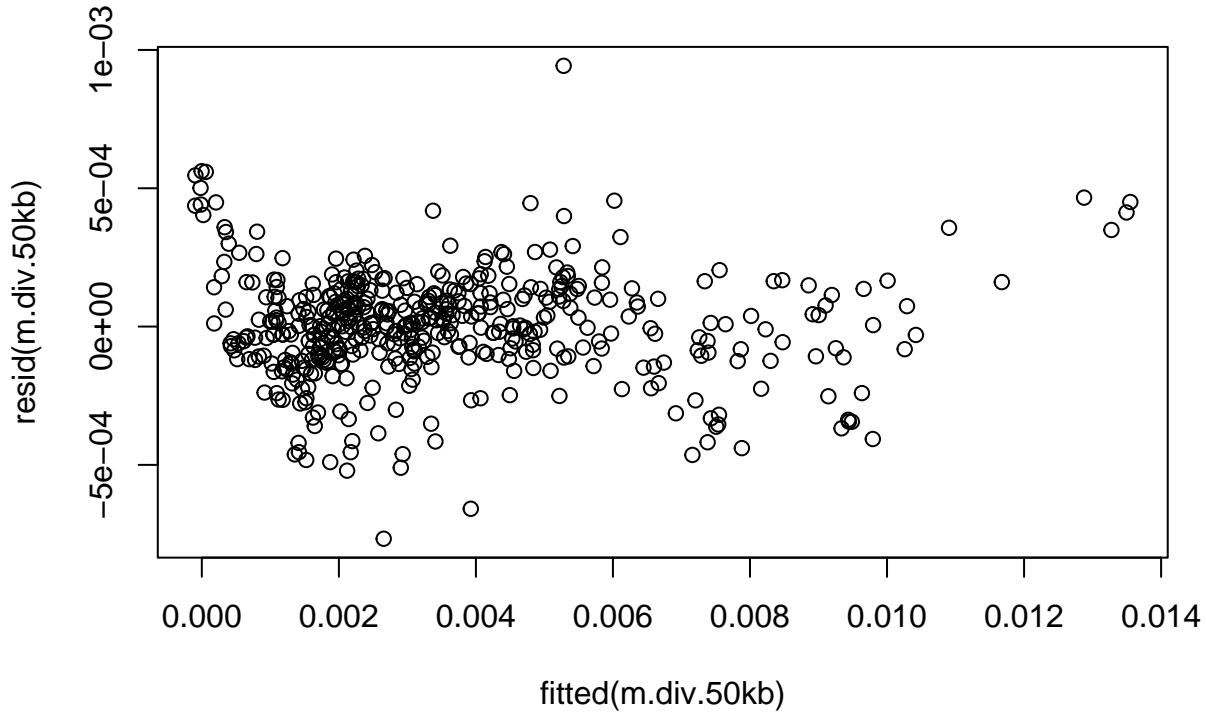
##           df      AIC
## m.div.50kb     6 -6711.225

```

```

## m.div.50kb.2 7 -6769.917
## m.div.50kb.3 8 -6773.287
plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```



```

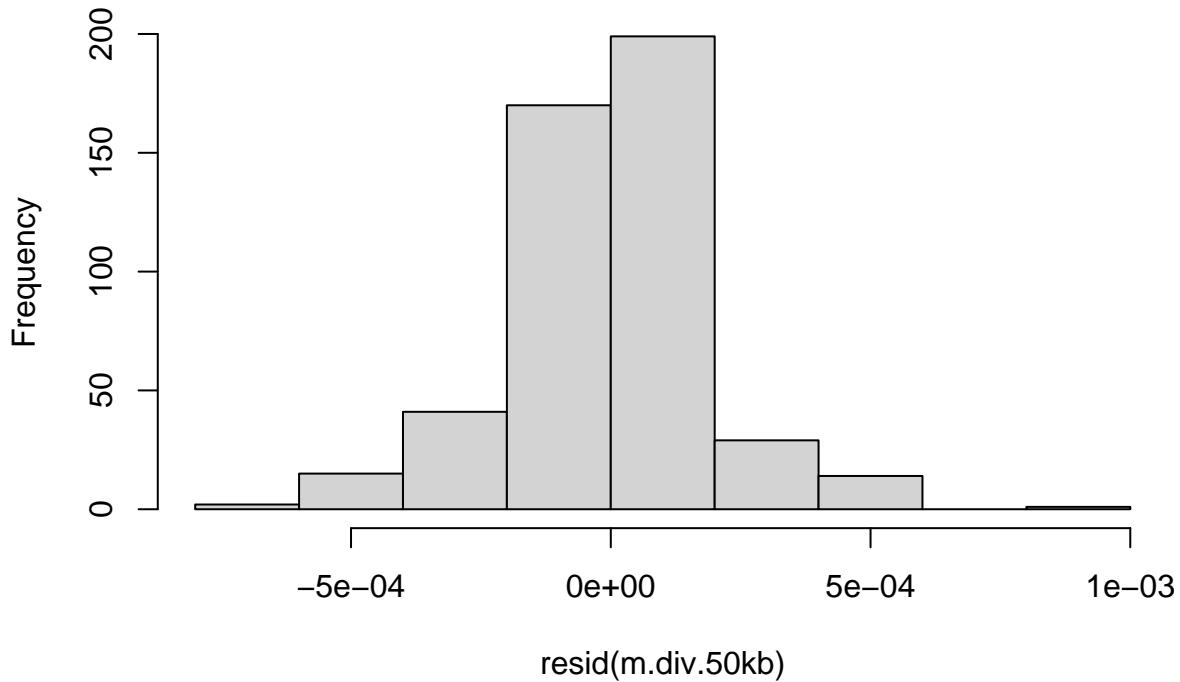
dwtest(m.div.50kb)

##
## Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.81525, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)

##
## Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.46846, p-value = 0.17
hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep1)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -7.669e-04 -1.006e-04  4.840e-06  1.072e-04  9.426e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.450e-03 9.064e-06 380.65 <2e-16 ***
## thetaS       2.026e-03 9.920e-06 204.23 <2e-16 ***
## rhoS        8.951e-05 1.032e-05   8.67 <2e-16 ***
## tmrcaS      9.018e-04 9.899e-06  91.11 <2e-16 ***
## thetaS:tmrcaS 6.090e-04 1.177e-05  51.73 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001934 on 466 degrees of freedom
## Multiple R-squared:  0.9942, Adjusted R-squared:  0.9941 
## F-statistic: 1.981e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.236515  1.339136  1.231290   1.113423
```

```

anova.diversity <- Anova(m.div.50kb.2)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep1, weight = r2.bgs.50kb)
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep1, weight = r2.bgs.50kb)
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep1, weight = r2.bgs.50kb)
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep1, weight = r2.bgs.50kb)

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6931.989
## g.div.50kb.2 8 -6938.978
## g.div.50kb.3 7 -6759.275
## g.div.50kb.4 7 -6765.627

summary(g.div.50kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep1
##       AIC      BIC  logLik
## -6931.989 -6898.751 3473.995
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.5769404
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.1006844
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003445607 1.551854e-05 222.03162 0e+00
## thetaS       0.002054441 1.073496e-05 191.37854 0e+00
## rhoS        0.000056989 1.513565e-05   3.76519 2e-04
## tmrcaS      0.000915495 1.266772e-05  72.26991 0e+00
## thetaS:tmrcaS 0.000589245 1.283907e-05  45.89470 0e+00
##
## Correlation:
##          (Intr) thetaS rhoS    tmrcaS
## thetaS     0.038

```

```

## rhoS          -0.081 -0.206
## tmrcaS        0.016 -0.178 -0.194
## thetaS:tmrcaS -0.036 -0.266 -0.011  0.268
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -5.1154734 -0.3887515  0.1161117  0.5963845  4.9692976
##
## Residual standard error: 0.0002072589
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.1)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.160368 1.108222 1.153479    1.137956

```

5.1.2 Replicate 2

```

rep2.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep2_w50000.csv", sep = ",", header = T)

rep_2.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.di")
rep_2.pi.50kb$avg <- apply(rep_2.pi.50kb[4:ncol(rep_2.pi.50kb)], 1, mean)
rep_2.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.r")
rep_2.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5")
rep_2.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5")
rep_2.tmrca.50kb$avg <- apply(rep_2.tmrca.50kb[4:ncol(rep_2.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep2 <- as.data.frame(cbind(rep_2.pi.50kb$avg, sim.theta.50kb$Rate, rep2.sim.tmrca.50kb))
names(true.lands.50kb.rep2) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep2$thetaS <- (true.lands.50kb.rep2$theta - mean(true.lands.50kb.rep2$theta)) / sd(true.lands.50kb.rep2$theta)
true.lands.50kb.rep2$tmrcaS <- (true.lands.50kb.rep2$tmrca - mean(true.lands.50kb.rep2$tmrca)) / sd(true.lands.50kb.rep2$tmrca)
true.lands.50kb.rep2$rhoS <- (true.lands.50kb.rep2$rho - mean(true.lands.50kb.rep2$rho, na.rm = T)) / sd(true.lands.50kb.rep2$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep2)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) / 3
r2.bgs.50kb.true[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 2] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep2)
##
## Residuals:
##      Min       1Q       Median       3Q       Max
## -1.012e-03 -2.425e-04 -6.150e-06  2.460e-04  9.928e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.485e-03 1.658e-05 210.152 < 2e-16 ***
## thetaS      1.933e-03 1.742e-05 111.005 < 2e-16 ***
## rhoS        7.559e-05 2.178e-05   3.471 0.000567 *** 
## tmrcaS      1.071e-03 2.272e-05  47.149 < 2e-16 ***
## thetaS:tmrcaS 6.969e-04 1.914e-05  36.416 < 2e-16 ***
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0003545 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9806, Adjusted R-squared:  0.9805 
## F-statistic:  5788 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.111183     1.738937     1.743966     1.107792

# now the lm with inferred landscapes
inf.lands.50kb.rep2 <- as.data.frame(cbind(rep_2.pi.50kb$avg, rep_2.theta.50kb$sample_mean, rep_2.tmrca.50kb$sample_mean))
names(inf.lands.50kb.rep2) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[2, 1] <- cor.test(sim.theta.50kb$Rate, rep_2.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[2, 1] <- cor.test(sim.rho.50kb$Rate, rep_2.rho.50kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[2, 1] <- cor.test(rep2.sim.tmrca.50kb$AverageTmrca, rep_2.tmrca.50kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.50kb.rep2$thetaS <- (inf.lands.50kb.rep2$theta - mean(inf.lands.50kb.rep2$theta)) / sd(inf.lands.50kb.rep2)
inf.lands.50kb.rep2$tmrcaS <- (inf.lands.50kb.rep2$tmrca - mean(inf.lands.50kb.rep2$tmrca)) / sd(inf.lands.50kb.rep2)
inf.lands.50kb.rep2$rhoS <- (inf.lands.50kb.rep2$rho - mean(inf.lands.50kb.rep2$rho)) / sd(inf.lands.50kb.rep2)

inf.lands.50kb.rep2$bin <- 1:nrow(inf.lands.50kb.rep2)
inf.lands.50kb.rep2$Replicate <- 2

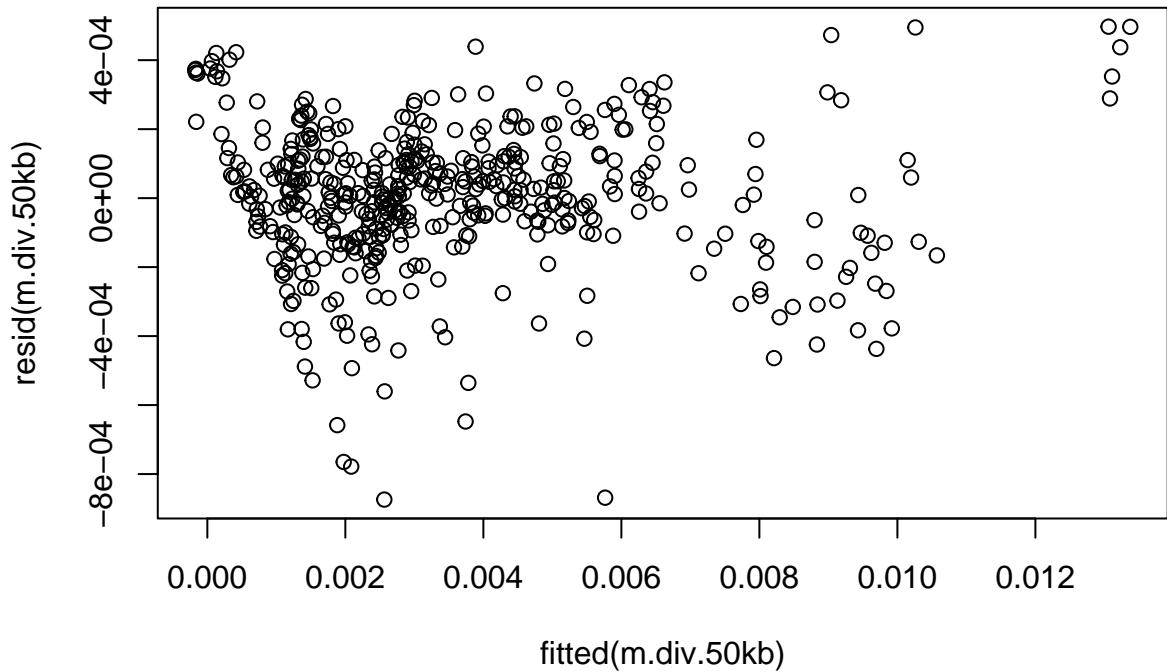
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep2)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep2)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep2)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb    6 -6649.218
## m.div.50kb.2  7 -6767.980
## m.div.50kb.3  8 -6779.854

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```

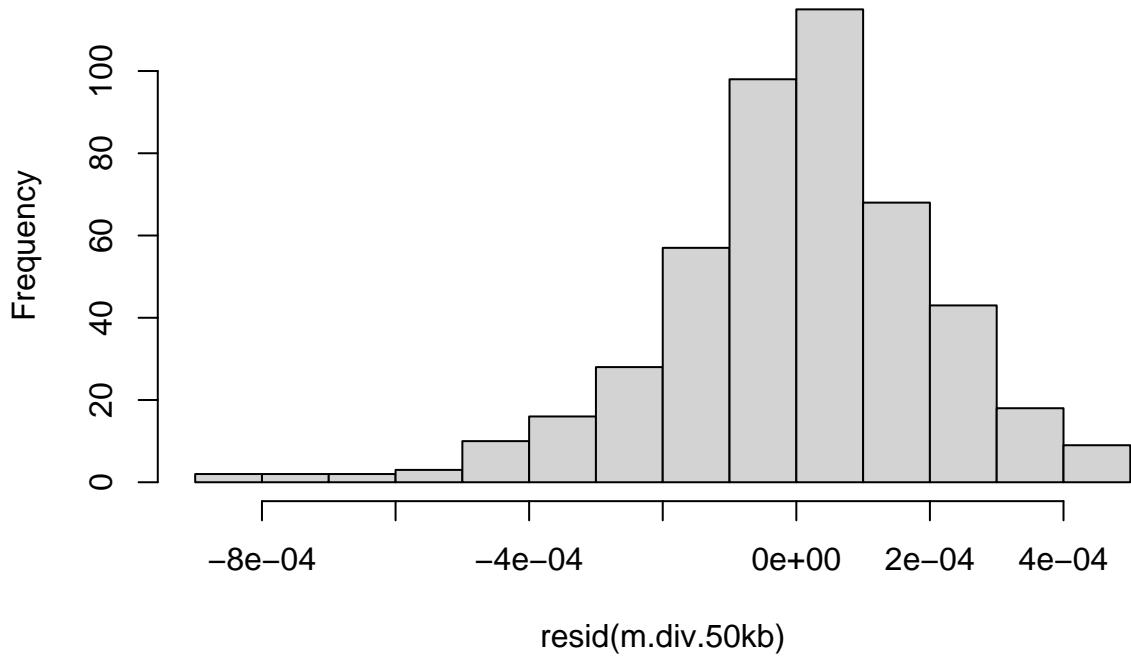


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.92098, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.4077, p-value = 0.001
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep2)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -8.740e-04 -1.030e-04  1.349e-05  1.126e-04  4.971e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.476e-03 9.569e-06 363.28 <2e-16 ***
## thetaS      2.014e-03 1.014e-05 198.57 <2e-16 ***
## rhoS        2.409e-05 1.052e-05   2.29  0.0225 *
## tmrcaS     1.076e-03 1.030e-05 104.47 <2e-16 ***
## thetaS:tmrcaS 6.254e-04 1.147e-05   54.51 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002066 on 466 degrees of freedom
## Multiple R-squared:  0.9935, Adjusted R-squared:  0.9934
## F-statistic: 1.781e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.132837  1.218983  1.168565  1.081734
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 2] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep2, weight = r2.bgs.50kb[, 2])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep2, weight = r2.bgs.50kb[2, ])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep2, weight = r2.bgs.50kb[3, ])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep2, weight = r2.bgs.50kb[4, ])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6821.900
## g.div.50kb.2 8 -6850.592
## g.div.50kb.3 7 -6682.201
## g.div.50kb.4 7 -6679.873

summary(g.div.50kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep2
##   AIC      BIC  logLik
## -6821.9 -6788.661 3418.95
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##   Phi
## 0.5583415
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.06313397
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003457460 1.754571e-05 197.05444 0.000
## thetaS       0.002018313 1.240309e-05 162.72665 0.000
## rhoS        -0.000004126 1.540865e-05 -0.26780 0.789
## tmrcaS       0.001119153 1.433684e-05  78.06132 0.000
## thetaS:tmrcaS 0.000654181 1.358992e-05  48.13725 0.000
##
## Correlation:
##          (Intr) thetaS rhoS    tmrcaS
## thetaS     0.037

```

```

## rhoS          -0.044 -0.104
## tmrcaS        -0.006 -0.204 -0.244
## thetaS:tmrcaS -0.051 -0.310 -0.046  0.311
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.9184966 -0.4180475  0.1296094  0.6393935  2.6009435
##
## Residual standard error: 0.0002182822
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.1)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.151676 1.092087 1.204279   1.190885

```

5.1.3 Replicate 3

```

rep3.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep3_w50000.csv", sep = ",", header = T)

rep_3.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.di")
rep_3.pi.50kb$avg <- apply(rep_3.pi.50kb[4:ncol(rep_3.pi.50kb)], 1, mean)
rep_3.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.r")
rep_3.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5")
rep_3.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5")
rep_3.tmrca.50kb$avg <- apply(rep_3.tmrca.50kb[4:ncol(rep_3.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep3 <- as.data.frame(cbind(rep_3.pi.50kb$avg, sim.theta.50kb$Rate, rep3.sim.tmrca.50kb))
names(true.lands.50kb.rep3) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep3$thetaS <- (true.lands.50kb.rep3$theta - mean(true.lands.50kb.rep3$theta)) / sd(true.lands.50kb.rep3$theta)
true.lands.50kb.rep3$tmrcaS <- (true.lands.50kb.rep3$tmrca - mean(true.lands.50kb.rep3$tmrca)) / sd(true.lands.50kb.rep3$tmrca)
true.lands.50kb.rep3$rhoS <- (true.lands.50kb.rep3$rho - mean(true.lands.50kb.rep3$rho, na.rm = T)) / sd(true.lands.50kb.rep3$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep3)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb.true[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 3] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep3)
##
## Residuals:
##      Min       1Q       Median      3Q       Max
## -1.026e-03 -2.204e-04 -3.281e-05  2.182e-04  8.288e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.505e-03 1.453e-05 241.186 < 2e-16 ***
## thetaS      1.967e-03 1.538e-05 127.842 < 2e-16 ***
## rhoS        7.530e-05 1.925e-05   3.911 0.000106 *** 
## tmrcaS     1.009e-03 1.982e-05  50.919 < 2e-16 *** 
## thetaS:tmrcaS 6.414e-04 1.696e-05  37.825 < 2e-16 *** 
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0003108 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9849, Adjusted R-squared:  0.9848 
## F-statistic: 7445 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.127848    1.768484    1.782787    1.133337

# now the lm with inferred landscapes
inf.lands.50kb.rep3 <- as.data.frame(cbind(rep_3.pi.50kb$avg, rep_3.theta.50kb$sample_mean, rep_3.tmrca
names(inf.lands.50kb.rep3) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[3, 1] <- cor.test(sim.theta.50kb$Rate, rep_3.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[3, 1] <- cor.test(sim.rho.50kb$Rate, rep_3.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[3, 1] <- cor.test(rep3.sim.tmrca.50kb$AverageTmrca, rep_3.tmrca.50kb$avg, method = "spea

# standardizing
inf.lands.50kb.rep3$thetaS <- (inf.lands.50kb.rep3$theta - mean(inf.lands.50kb.rep3$theta)) / sd(inf.lan
inf.lands.50kb.rep3$tmrcaS <- (inf.lands.50kb.rep3$tmrca - mean(inf.lands.50kb.rep3$tmrca)) / sd(inf.lan
inf.lands.50kb.rep3$rhoS <- (inf.lands.50kb.rep3$rho - mean(inf.lands.50kb.rep3$rho)) / sd(inf.lands.50

inf.lands.50kb.rep3$bin <- 1:nrow(inf.lands.50kb.rep3)
inf.lands.50kb.rep3$Replicate <- 3

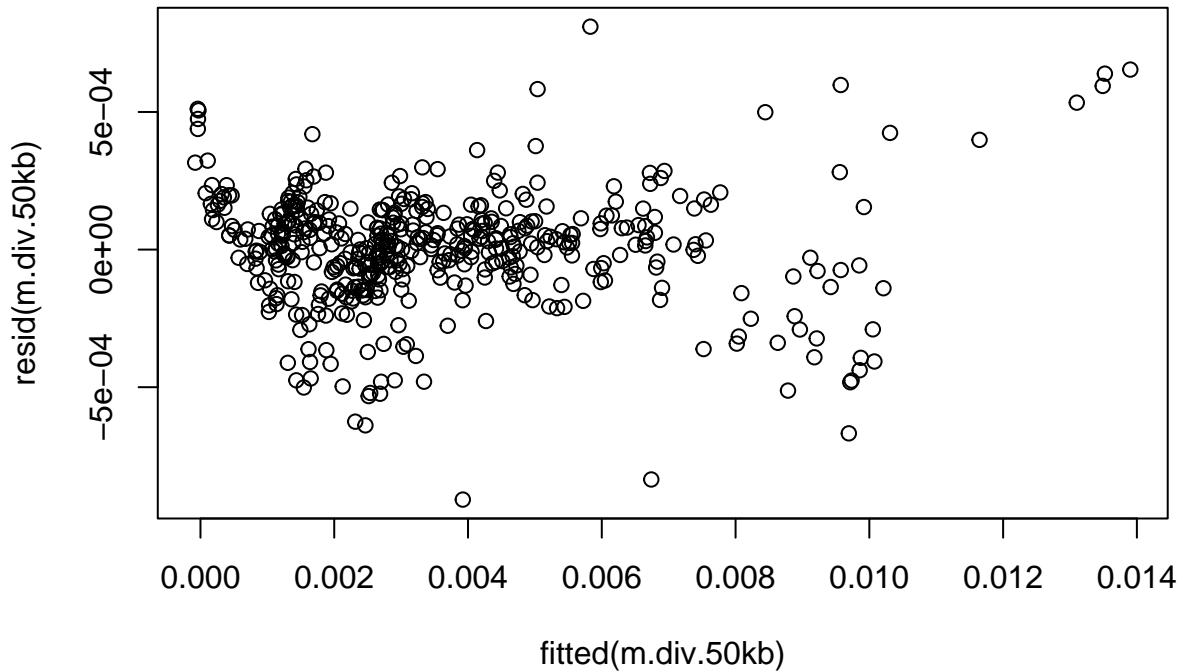
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep3)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep3)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb    6 -6637.516
## m.div.50kb.2   7 -6780.842
## m.div.50kb.3   8 -6801.784

plot(resid(m.div.50kb)~fitted(m.div.50kb))

```

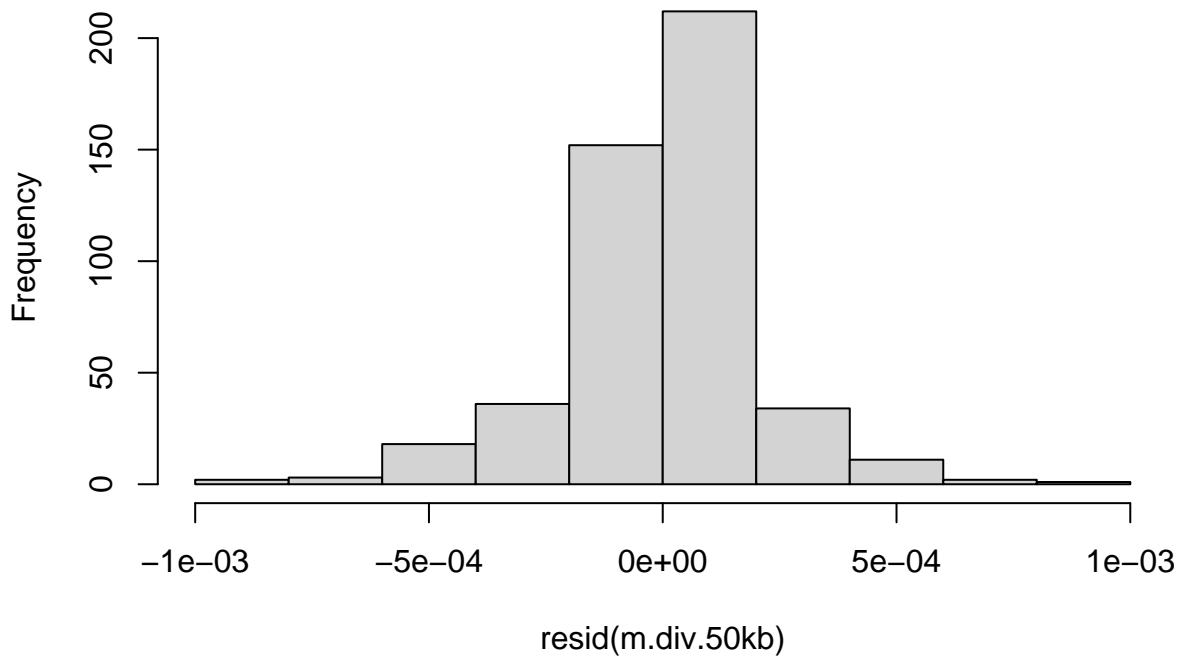


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.89865, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.50047, p-value = 0.522
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep3)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -9.084e-04 -8.949e-05  1.918e-05  1.054e-04  8.099e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.505e-03 9.676e-06 362.237 <2e-16 ***
## thetaS       2.048e-03 1.007e-05 203.462 <2e-16 ***
## rhoS        2.280e-05 1.071e-05   2.129  0.0338 *
## tmrcaS      9.816e-04 1.057e-05  92.838 <2e-16 ***
## thetaS:tmrcaS 5.611e-04 1.131e-05  49.600 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002091 on 466 degrees of freedom
## Multiple R-squared:  0.9932, Adjusted R-squared:  0.9931
## F-statistic: 1.694e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.088858 1.232271 1.201279 1.061097
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 3] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep3, weight = r2.bgs.50kb[1, 3])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep3, weight = r2.bgs.50kb[2, 3])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep3, weight = r2.bgs.50kb[3, 3])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep3, weight = r2.bgs.50kb[4, 3])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6826.837
## g.div.50kb.2 8 -6854.552
## g.div.50kb.3 7 -6699.473
## g.div.50kb.4 7 -6676.519

summary(g.div.50kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.50kb.rep3
##       AIC      BIC    logLik
##   -6826.837 -6793.598 3421.418
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.558335
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.1458885
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003461279 1.630225e-05 212.31906 0.0000
## thetaS       0.002048112 1.153430e-05 177.56708 0.0000
## rhoS        -0.000005817 1.476572e-05 -0.39395 0.6938
## tmrcaS       0.001021913 1.492326e-05  68.47790 0.0000
## thetaS:tmrcaS 0.000579468 1.480192e-05  39.14817 0.0000
##
## Correlation:
##          (Intr) thetaS rhoS   tmrcaS
## thetaS     0.049

```

```

## rhoS          -0.060 -0.108
## tmrcaS        0.011 -0.112 -0.207
## thetaS:tmrcaS -0.008 -0.231 -0.043  0.135
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -4.1273687 -0.2493249  0.3115977  0.7250897  3.4784016
##
## Residual standard error: 0.0002358632
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.1)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.085611 1.066203 1.075774    1.072364

```

5.1.4 Replicate 4

```

rep4.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep4_w50000.csv", sep = ",", header = T)

rep_4.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.di")
rep_4.pi.50kb$avg <- apply(rep_4.pi.50kb[4:ncol(rep_4.pi.50kb)], 1, mean)
rep_4.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.r")
rep_4.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5")
rep_4.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5")
rep_4.tmrca.50kb$avg <- apply(rep_4.tmrca.50kb[4:ncol(rep_4.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep4 <- as.data.frame(cbind(rep_4.pi.50kb$avg, sim.theta.50kb$Rate, rep4.sim.tmrca.50kb))
names(true.lands.50kb.rep4) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep4$thetaS <- (true.lands.50kb.rep4$theta - mean(true.lands.50kb.rep4$theta)) / sd(true.lands.50kb.rep4$theta)
true.lands.50kb.rep4$tmrcaS <- (true.lands.50kb.rep4$tmrca - mean(true.lands.50kb.rep4$tmrca)) / sd(true.lands.50kb.rep4$tmrca)
true.lands.50kb.rep4$rhoS <- (true.lands.50kb.rep4$rho - mean(true.lands.50kb.rep4$rho, na.rm = T)) / sd(true.lands.50kb.rep4$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep4)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) / sum(anova.diversity$VarExp)
r2.bgs.50kb.true[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 4] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep4)
##
## Residuals:
##      Min       1Q       Median       3Q       Max
## -8.233e-04 -2.235e-04 -3.390e-06  1.803e-04  9.716e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.497e-03 1.503e-05 232.708 < 2e-16 ***
## thetaS      1.954e-03 1.577e-05 123.967 < 2e-16 ***
## rhoS        6.202e-05 1.970e-05   3.149  0.00174 ** 
## tmrcaS      1.031e-03 2.047e-05  50.369 < 2e-16 ***
## thetaS:tmrcaS 6.692e-04 1.743e-05  38.387 < 2e-16 *** 
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
## 
## Residual standard error: 0.0003215 on 457 degrees of freedom 
## (9 observations deleted due to missingness) 
## Multiple R-squared:  0.9838, Adjusted R-squared:  0.9836 
## F-statistic:  6917 on 4 and 457 DF,  p-value: < 2.2e-16 

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.107178    1.729899    1.730028    1.100994

# now the lm with inferred landscapes
inf.lands.50kb.rep4 <- as.data.frame(cbind(rep_4.pi.50kb$avg, rep_4.theta.50kb$sample_mean, rep_4.tmrca
names(inf.lands.50kb.rep4) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[4, 1] <- cor.test(sim.theta.50kb$Rate, rep_4.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[4, 1] <- cor.test(sim.rho.50kb$Rate, rep_4.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[4, 1] <- cor.test(rep4.sim.tmrca.50kb$AverageTmrca, rep_4.tmrca.50kb$avg, method = "spea

# standardizing
inf.lands.50kb.rep4$thetaS <- (inf.lands.50kb.rep4$theta - mean(inf.lands.50kb.rep4$theta)) / sd(inf.lan
inf.lands.50kb.rep4$tmrcaS <- (inf.lands.50kb.rep4$tmrca - mean(inf.lands.50kb.rep4$tmrca)) / sd(inf.lan
inf.lands.50kb.rep4$rhoS <- (inf.lands.50kb.rep4$rho - mean(inf.lands.50kb.rep4$rho)) / sd(inf.lands.50

inf.lands.50kb.rep4$bin <- 1:nrow(inf.lands.50kb.rep4)
inf.lands.50kb.rep4$Replicate <- 4

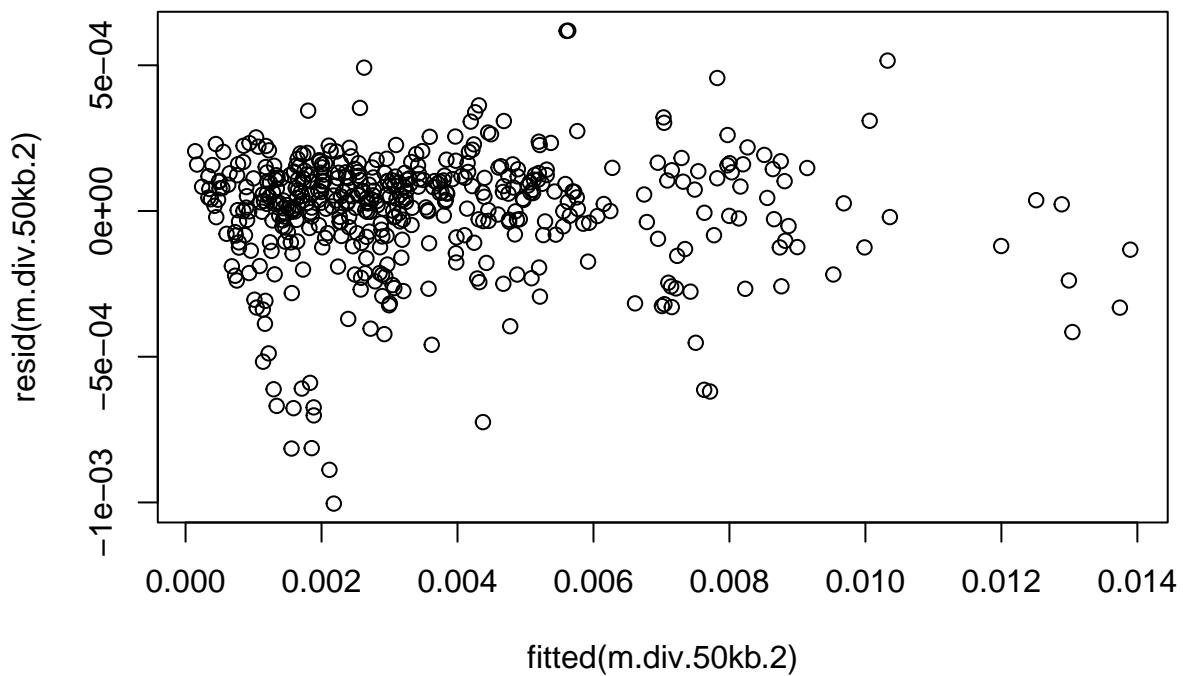
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep4)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep4)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb     6 -6651.111
## m.div.50kb.2    7 -6649.680
## m.div.50kb.3    8 -6651.347

plot(resid(m.div.50kb.2) ~ fitted(m.div.50kb.2))

```

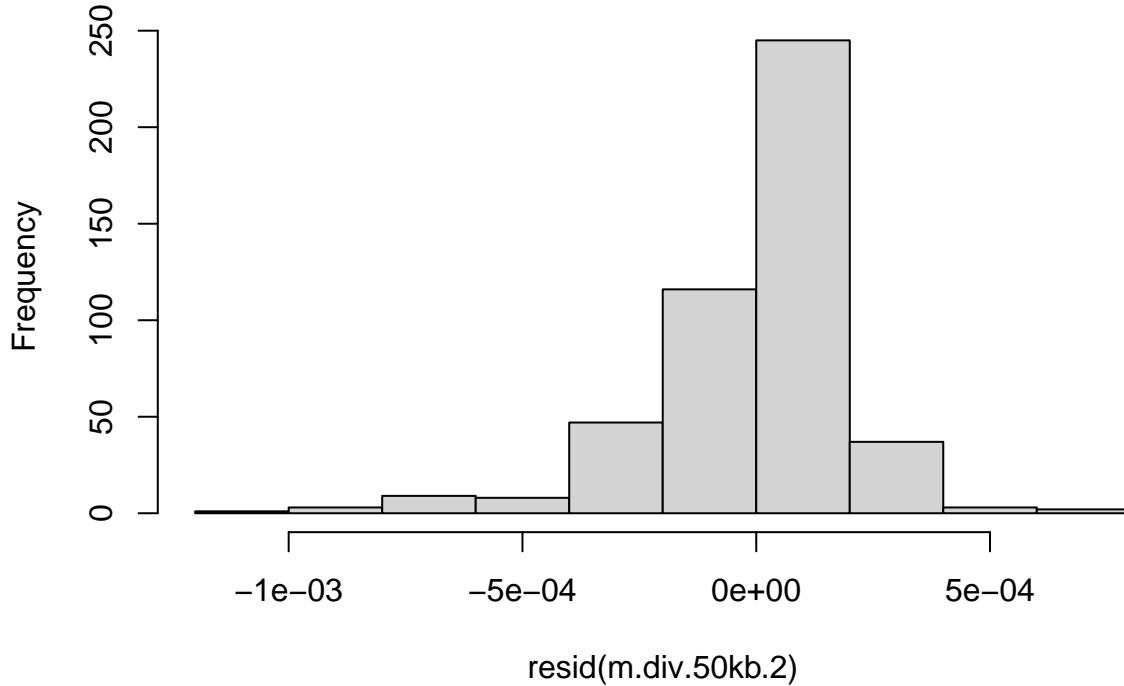


```
dwttest(m.div.50kb.2)
```

```
##
## Durbin-Watson test
##
## data: m.div.50kb.2
## DW = 0.95867, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb.2)
```

```
##
## Harrison-McCabe test
##
## data: m.div.50kb.2
## HMC = 0.43461, p-value = 0.029
hist(resid(m.div.50kb.2))
```

Histogram of resid(m.div.50kb.2)



```
summary(m.div.50kb.2)
```

```
## 
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS +
##     rhoS:tmrcaS, data = inf.lands.50kb.rep4)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -1.004e-03 -7.715e-05  3.875e-05  1.176e-04  6.188e-04 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.441e-03 1.004e-05 342.648 <2e-16 ***
## thetaS      2.125e-03 1.024e-05 207.404 <2e-16 ***
## rhoS        8.801e-05 1.032e-05   8.526 <2e-16 ***
## tmrcaS      7.606e-04 1.582e-05  48.073 <2e-16 ***
## thetaS:tmrcaS 4.920e-04 1.074e-05  45.786 <2e-16 ***
## rhoS:tmrcaS -1.218e-05 1.625e-05  -0.750   0.454  
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0002062 on 465 degrees of freedom
## Multiple R-squared:  0.9934, Adjusted R-squared:  0.9933 
## F-statistic: 1.392e+04 on 5 and 465 DF,  p-value: < 2.2e-16
```

```
vif(m.div.50kb.2)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS    rhoS:tmrcaS
## 1.159492    1.177514    2.766200    1.313775    3.024071
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 4] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep4, weight = r2.bgs.50kb[1, 4])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep4, weight = r2.bgs.50kb[2, 4])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep4, weight = r2.bgs.50kb[3, 4])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep4, weight = r2.bgs.50kb[4, 4])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6872.472
## g.div.50kb.2 8 -6875.271
## g.div.50kb.3 7 -6654.881
## g.div.50kb.4 7 -6700.650

summary(g.div.50kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep4
##          AIC      BIC logLik
## -6654.881 -6625.797 3334.44
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.1527489
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003437235 9.772982e-06 351.7078 0
## thetaS       0.002121016 1.087574e-05 195.0228 0
## rhoS        0.000091087 1.014582e-05   8.9777 0
## tmrcaS      0.000769238 1.023163e-05  75.1824 0
## thetaS:tmrcaS 0.000496872 1.044147e-05  47.5865 0
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS      0.191
## rhoS       -0.009 -0.265
## tmrcaS     -0.080 -0.204 -0.145
## thetaS:tmrcaS -0.232 -0.173  0.053  0.356
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3       Max
## -5.2015408 -0.3778042  0.2017817  0.5787508  2.8135238
##
## Residual standard error: 0.0004990653
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.3)

```

```

##      thetaS       rhoS      tmrcaS thetaS:tmrcaS
## 1.157157 1.133423 1.236016    1.166786

```

5.1.5 Replicate 5

```

rep5.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep5_w50000.csv", sep = ",", header = T)

rep_5.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.d")
rep_5.pi.50kb$avg <- apply(rep_5.pi.50kb[4:ncol(rep_5.pi.50kb)], 1, mean)
rep_5.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.r")
rep_5.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.t")
rep_5.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.s")
rep_5.tmrca.50kb$avg <- apply(rep_5.tmrca.50kb[4:ncol(rep_5.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep5 <- as.data.frame(cbind(rep_5.pi.50kb$avg, sim.theta.50kb$Rate, rep5.sim.tmrca.50kb))
names(true.lands.50kb.rep5) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep5$thetaS <- (true.lands.50kb.rep5$theta - mean(true.lands.50kb.rep5$theta)) / sd(true.lands.50kb.rep5$theta)
true.lands.50kb.rep5$tmrcaS <- (true.lands.50kb.rep5$tmrca - mean(true.lands.50kb.rep5$tmrca)) / sd(true.lands.50kb.rep5$tmrca)
true.lands.50kb.rep5$rhoS <- (true.lands.50kb.rep5$rho - mean(true.lands.50kb.rep5$rho, na.rm = T)) / sd(true.lands.50kb.rep5$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep5)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 5] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.50kb.rep5)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.178e-03 -2.214e-04 -2.666e-05  2.107e-04  1.031e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.478e-03 1.617e-05 215.128 < 2e-16 ***
## thetaS      1.922e-03 1.686e-05 113.987 < 2e-16 ***

```

```

## rhoS           1.104e-04  2.138e-05   5.163 3.63e-07 ***
## tmrcaS        9.899e-04  2.250e-05  43.992 < 2e-16 ***
## thetaS:tmrcaS 6.744e-04  1.862e-05  36.217 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003458 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9807, Adjusted R-squared:  0.9805
## F-statistic:  5800 on 4 and 457 DF,  p-value: < 2.2e-16
vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.095200    1.762274    1.763681    1.090682

# now the lm with inferred landscapes
inf.lands.50kb.rep5 <- as.data.frame(cbind(rep_5.pi.50kb$avg, rep_5.theta.50kb$sample_mean, rep_5.tmrca))
names(inf.lands.50kb.rep5) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[5, 1] <- cor.test(sim.theta.50kb$Rate, rep_5.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[5, 1] <- cor.test(sim.rho.50kb$Rate, rep_5.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[5, 1] <- cor.test(rep5.sim.tmrca.50kb$AverageTmrca, rep_5.tmrca.50kb$avg, method = "spearman")

# standardizing
inf.lands.50kb.rep5$thetaS <- (inf.lands.50kb.rep5$theta - mean(inf.lands.50kb.rep5$theta)) / sd(inf.lands.50kb.rep5$theta)
inf.lands.50kb.rep5$tmrcaS <- (inf.lands.50kb.rep5$tmrca - mean(inf.lands.50kb.rep5$tmrca)) / sd(inf.lands.50kb.rep5$tmrca)
inf.lands.50kb.rep5$rhoS <- (inf.lands.50kb.rep5$rho - mean(inf.lands.50kb.rep5$rho)) / sd(inf.lands.50kb.rep5$rho)

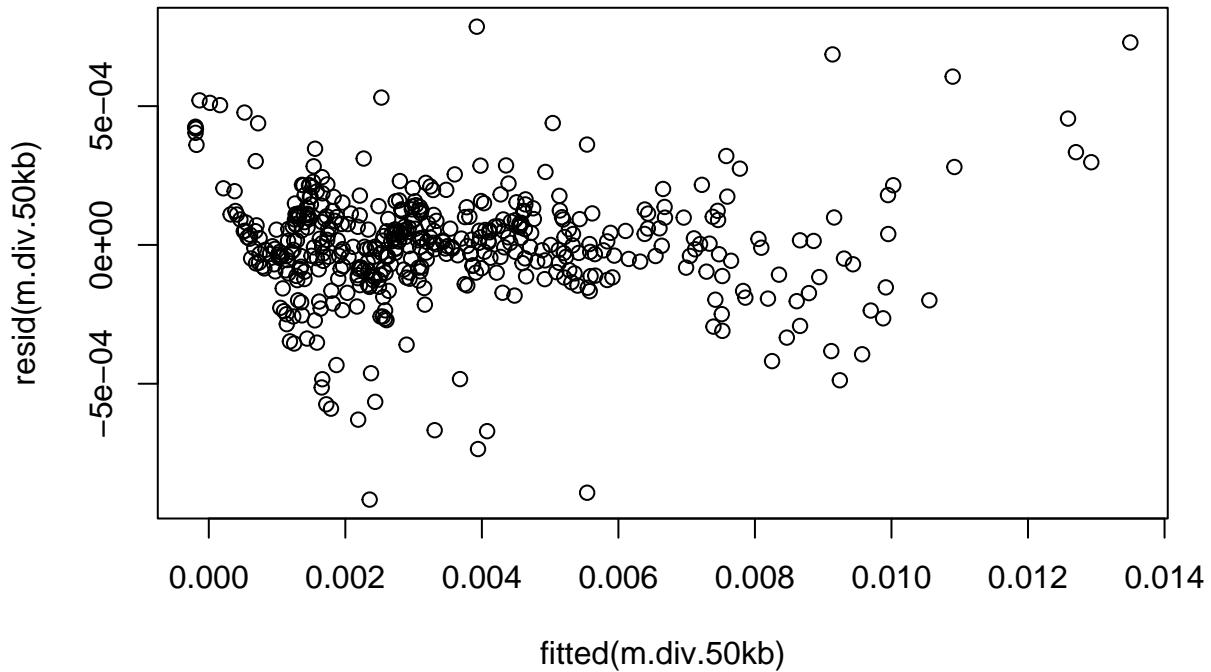
inf.lands.50kb.rep5$bin <- 1:nrow(inf.lands.50kb.rep5)
inf.lands.50kb.rep5$Replicate <- 5

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep5)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep5)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep5)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb     6 -6679.244
## m.div.50kb.2   7 -6802.716
## m.div.50kb.3   8 -6811.009
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```



```

dwtest(m.div.50kb)

##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.98276, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0

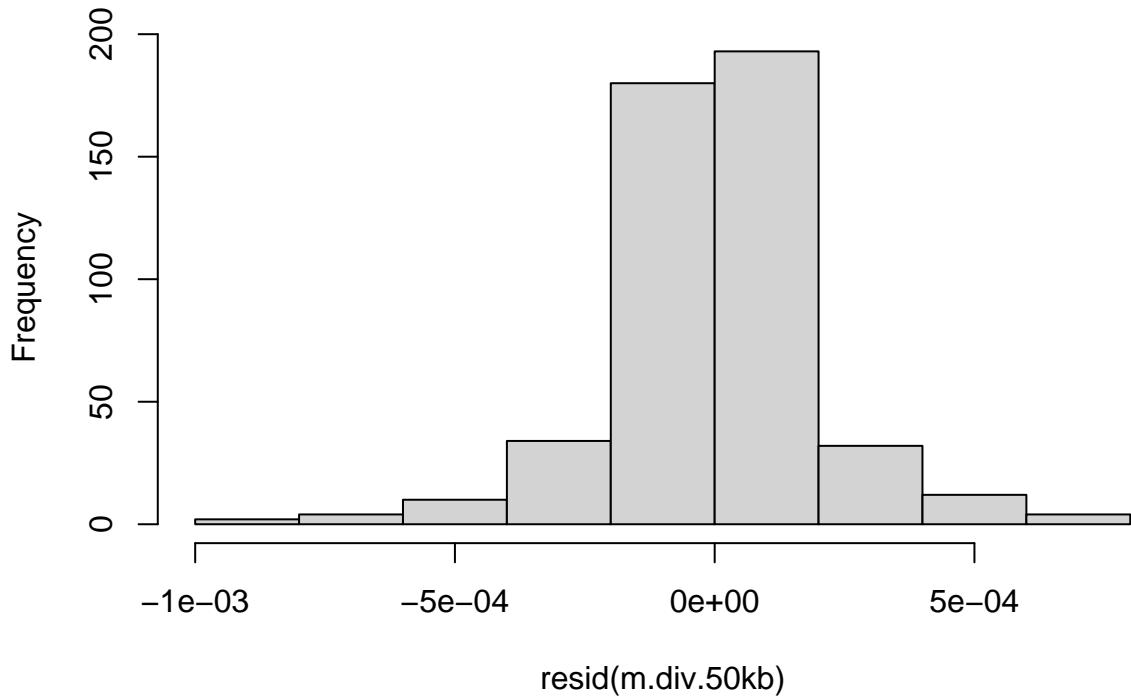
hmctest(m.div.50kb)

##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.39935, p-value = 0.001

hist(resid(m.div.50kb))

```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = inf.lands.50kb.rep5)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -9.174e-04 -8.788e-05  7.320e-06  9.869e-05  7.862e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.452e-03 9.312e-06 370.741 <2e-16 ***
## thetaS       2.040e-03 9.801e-06 208.139 <2e-16 ***
## rhoS        1.816e-05 1.023e-05  1.776  0.0764  
## tmrcaS      9.692e-04 1.002e-05  96.761 <2e-16 ***
## thetaS:tmrcaS 5.711e-04 1.104e-05  51.749 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0002001 on 466 degrees of freedom
## Multiple R-squared:  0.9936, Adjusted R-squared:  0.9936 
## F-statistic: 1.81e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.127883 1.228325 1.177948 1.063576
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 5] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep5, weight = r2.bgs.50kb[1, 5])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep5, weight = r2.bgs.50kb[2, 5])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep5, weight = r2.bgs.50kb[3, 5])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep5, weight = r2.bgs.50kb[4, 5])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6839.185
## g.div.50kb.2 8 -6876.135
## g.div.50kb.3 7 -6721.049
## g.div.50kb.4 7 -6709.999

summary(g.div.50kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep5
##          AIC      BIC logLik
## -6709.999 -6680.915 3362
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.1555841
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003440631 8.803854e-06 390.8096 0.0000
## thetaS       0.002025699 9.120527e-06 222.1033 0.0000
## rhoS        0.000014267 9.344259e-06   1.5268 0.1275
## tmrcaS      0.000989200 1.201364e-05   82.3397 0.0000
## thetaS:tmrcaS 0.000578653 1.328149e-05   43.5684 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS      0.050
## rhoS       -0.076 -0.212
## tmrcaS     -0.100 -0.071 -0.276
## thetaS:tmrcaS -0.135 -0.262  0.007  0.141
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -4.84185032 -0.42707377  0.07698832  0.51577539  4.33216063
##
## Residual standard error: 0.000221376
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.4)

```

```

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.138920     1.150050     1.119252     1.091498

```

5.1.6 Replicate 6

```

rep6.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep6_w50000.csv", sep = ",", header = T)

rep_6.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.dti")
rep_6.pi.50kb$avg <- apply(rep_6.pi.50kb[4:ncol(rep_6.pi.50kb)], 1, mean)
rep_6.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.rti")
rep_6.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.tht")
rep_6.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.tmr")
rep_6.tmrca.50kb$avg <- apply(rep_6.tmrca.50kb[4:ncol(rep_6.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep6 <- as.data.frame(cbind(rep_6.pi.50kb$avg, sim.theta.50kb$Rate, rep6.sim.tmrca.50kb))
names(true.lands.50kb.rep6) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep6$thetaS <- (true.lands.50kb.rep6$theta - mean(true.lands.50kb.rep6$theta)) / sd(true.lands.50kb.rep6$theta)
true.lands.50kb.rep6$tmrcaS <- (true.lands.50kb.rep6$tmrca - mean(true.lands.50kb.rep6$tmrca)) / sd(true.lands.50kb.rep6$tmrca)
true.lands.50kb.rep6$rhoS <- (true.lands.50kb.rep6$rho - mean(true.lands.50kb.rep6$rho, na.rm = T)) / sd(true.lands.50kb.rep6$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep6)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 6] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.50kb.rep6)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.136e-03 -2.271e-04 -1.633e-05  2.173e-04  8.592e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.491e-03 1.578e-05 221.156 < 2e-16 ***
## thetaS      1.973e-03 1.657e-05 119.069 < 2e-16 ***

```

```

## rhoS           9.726e-05  2.076e-05   4.685  3.7e-06 ***
## tmrcaS        1.040e-03  2.138e-05  48.664  < 2e-16 ***
## thetaS:tmrcaS 6.877e-04  1.813e-05  37.935  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003382 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9826, Adjusted R-squared:  0.9824
## F-statistic:  6450 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.104749    1.736548    1.731974    1.099123

# now the lm with inferred landscapes
inf.lands.50kb.rep6 <- as.data.frame(cbind(rep_6.pi.50kb$avg, rep_6.theta.50kb$sample_mean, rep_6.tmrca))
names(inf.lands.50kb.rep6) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[6, 1] <- cor.test(sim.theta.50kb$Rate, rep_6.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[6, 1] <- cor.test(sim.rho.50kb$Rate, rep_6.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[6, 1] <- cor.test(rep6.sim.tmrca.50kb$AverageTmrca, rep_6.tmrca.50kb$avg, method = "spearman")

# standardizing
inf.lands.50kb.rep6$thetaS <- (inf.lands.50kb.rep6$theta - mean(inf.lands.50kb.rep6$theta)) / sd(inf.lands.50kb.rep6)
inf.lands.50kb.rep6$tmrcaS <- (inf.lands.50kb.rep6$tmrca - mean(inf.lands.50kb.rep6$tmrca)) / sd(inf.lands.50kb.rep6)
inf.lands.50kb.rep6$rhoS <- (inf.lands.50kb.rep6$rho - mean(inf.lands.50kb.rep6$rho)) / sd(inf.lands.50kb.rep6)

inf.lands.50kb.rep6$bin <- 1:nrow(inf.lands.50kb.rep6)
inf.lands.50kb.rep6$Replicate <- 6

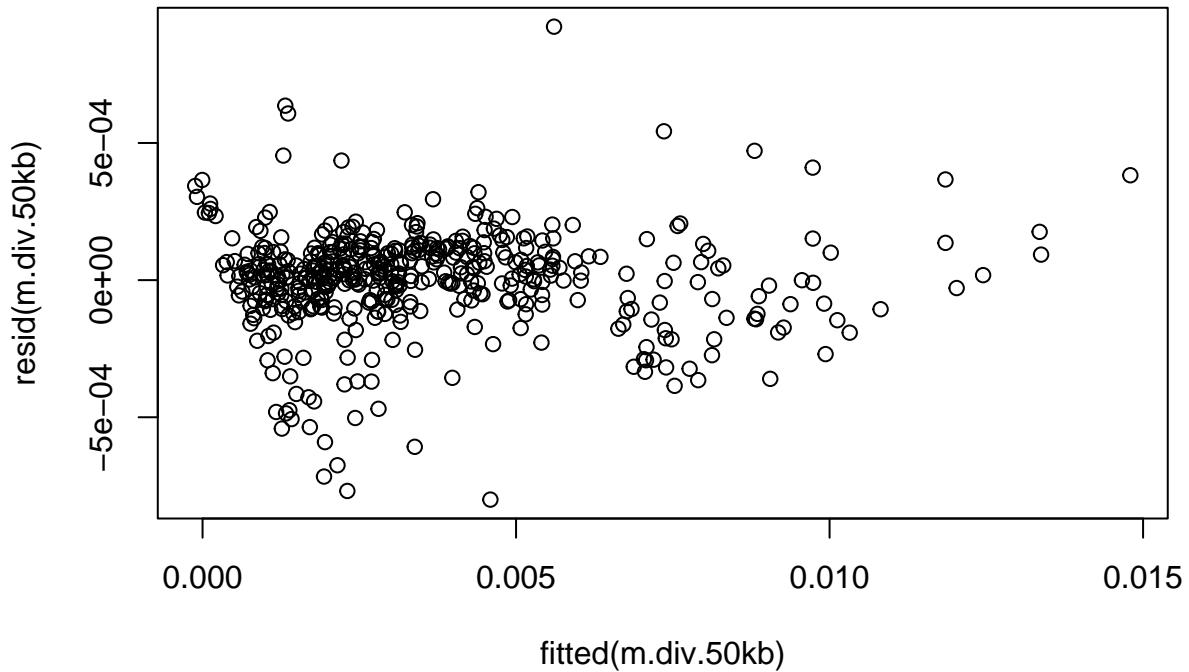
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep6)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep6)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep6)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb     6 -6743.728
## m.div.50kb.2   7 -6802.823
## m.div.50kb.3   8 -6805.058

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```

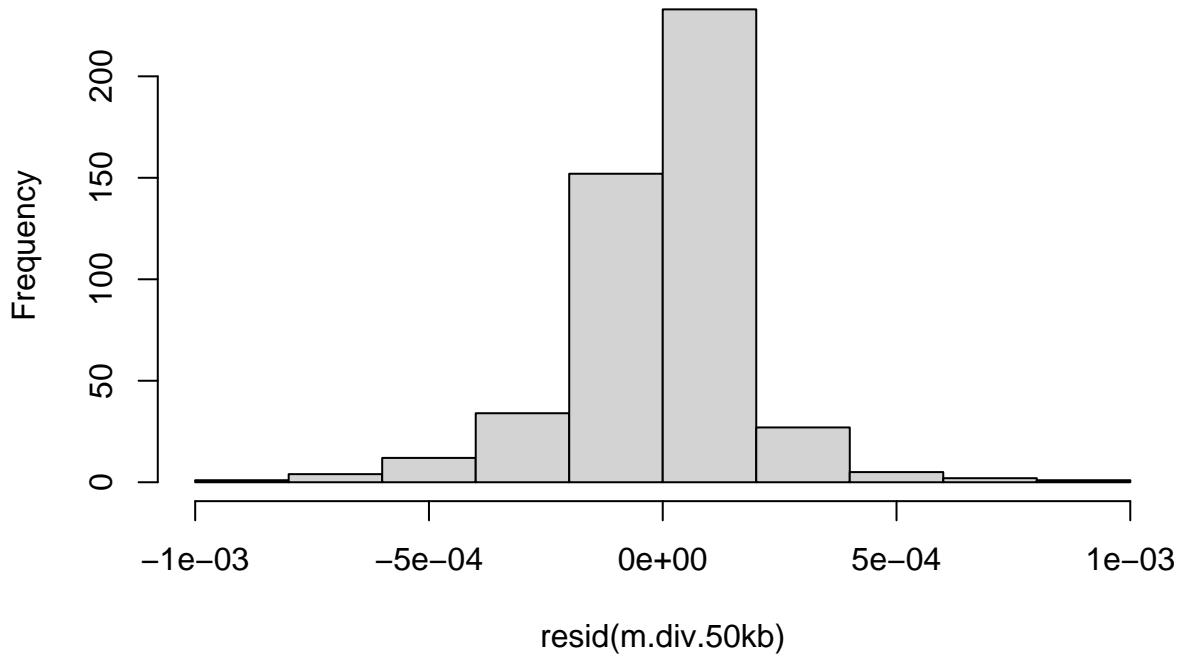


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.93612, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.4347, p-value = 0.026
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = inf.lands.50kb.rep6)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -8.002e-04 -7.326e-05  1.942e-05  9.821e-05  9.241e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.404e-03 8.832e-06 385.358 < 2e-16 ***
## thetaS       2.044e-03 9.356e-06 218.484 < 2e-16 ***
## rhoS         3.985e-05 9.270e-06   4.299 2.09e-05 ***
## tmrcaS       8.965e-04 9.517e-06   94.200 < 2e-16 ***
## thetaS:tmrcaS 5.574e-04 9.219e-06  60.461 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001868 on 466 degrees of freedom
## Multiple R-squared:  0.9947, Adjusted R-squared:  0.9947
## F-statistic: 2.194e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.178612  1.157026  1.219525  1.134820
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 6] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep6, weight = r2.bgs.50kb[1, 6])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep6, weight = r2.bgs.50kb[2, 6])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep6, weight = r2.bgs.50kb[3, 6])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep6, weight = r2.bgs.50kb[4, 6])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6946.467
## g.div.50kb.2 8 -6948.943
## g.div.50kb.3 7 -6762.528
## g.div.50kb.4 7 -6828.222

summary(g.div.50kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep6
##          AIC      BIC    logLik
## -6762.528 -6733.444 3388.264
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##   power
## 0.271011
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003402989 8.908793e-06 381.9809     0
## thetaS       0.002042561 1.019595e-05 200.3305     0
## rhoS        0.000039311 9.107053e-06   4.3166     0
## tmrcaS      0.000897372 9.799877e-06  91.5698     0
## thetaS:tmrcaS 0.000561311 1.039180e-05  54.0148     0
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.338
## rhoS        0.010 -0.168
## tmrcaS     -0.131 -0.232 -0.273
## thetaS:tmrcaS -0.257 -0.299 -0.014  0.493
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3      Max
## -4.1829268 -0.3945907  0.1090670  0.5609412  4.5102796
##
## Residual standard error: 0.0009014532
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.3)

```

```

##      thetaS      rhoS      tmrcaS thetaS:tmrcaS
## 1.167726 1.160985 1.500100    1.400350

```

5.1.7 Replicate 7

```

rep7.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep7_w50000.csv", sep = ",", header = T)

rep_7.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.pi")
rep_7.pi.50kb$avg <- apply(rep_7.pi.50kb[4:ncol(rep_7.pi.50kb)], 1, mean)
rep_7.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.rho")
rep_7.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.theta")
rep_7.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.tmrca")
rep_7.tmrca.50kb$avg <- apply(rep_7.tmrca.50kb[4:ncol(rep_7.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep7 <- as.data.frame(cbind(rep_7.pi.50kb$avg, sim.theta.50kb$Rate, rep7.sim.tmrca.50kb))
names(true.lands.50kb.rep7) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep7$thetaS <- (true.lands.50kb.rep7$theta - mean(true.lands.50kb.rep7$theta)) / sd(true.lands.50kb.rep7$theta)
true.lands.50kb.rep7$tmrcaS <- (true.lands.50kb.rep7$tmrca - mean(true.lands.50kb.rep7$tmrca)) / sd(true.lands.50kb.rep7$tmrca)
true.lands.50kb.rep7$rhoS <- (true.lands.50kb.rep7$rho - mean(true.lands.50kb.rep7$rho, na.rm = T)) / sd(true.lands.50kb.rep7$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep7)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 7] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep7)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.698e-03 -2.258e-04 -2.729e-05  2.286e-04  9.294e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.420e-03 1.570e-05 217.890 < 2e-16 ***
## thetaS      1.876e-03 1.654e-05 113.456 < 2e-16 ***

```

```

## rhoS          9.098e-05  2.082e-05   4.371 1.54e-05 ***
## tmrcaS        1.070e-03  2.162e-05   49.480  < 2e-16 ***
## thetaS:tmrcaS 7.184e-04  1.877e-05   38.281  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003357 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9819, Adjusted R-squared:  0.9818
## F-statistic:  6209 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.117022    1.772582    1.780991    1.118835

# now the lm with inferred landscapes
inf.lands.50kb.rep7 <- as.data.frame(cbind(rep_7.pi.50kb$avg, rep_7.theta.50kb$sample_mean, rep_7.tmrca))
names(inf.lands.50kb.rep7) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[7, 1] <- cor.test(sim.theta.50kb$Rate, rep_7.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[7, 1] <- cor.test(sim.rho.50kb$Rate, rep_7.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[7, 1] <- cor.test(rep7.sim.tmrca.50kb$AverageTmrca, rep_7.tmrca.50kb$avg, method = "spearman")

# standardizing
inf.lands.50kb.rep7$thetaS <- (inf.lands.50kb.rep7$theta - mean(inf.lands.50kb.rep7$theta)) / sd(inf.lands.50kb.rep7$theta)
inf.lands.50kb.rep7$tmrcaS <- (inf.lands.50kb.rep7$tmrca - mean(inf.lands.50kb.rep7$tmrca)) / sd(inf.lands.50kb.rep7$tmrca)
inf.lands.50kb.rep7$rhoS <- (inf.lands.50kb.rep7$rho - mean(inf.lands.50kb.rep7$rho)) / sd(inf.lands.50kb.rep7$rho)

inf.lands.50kb.rep7$bin <- 1:nrow(inf.lands.50kb.rep7)

inf.lands.50kb.rep7$Replicate <- 7

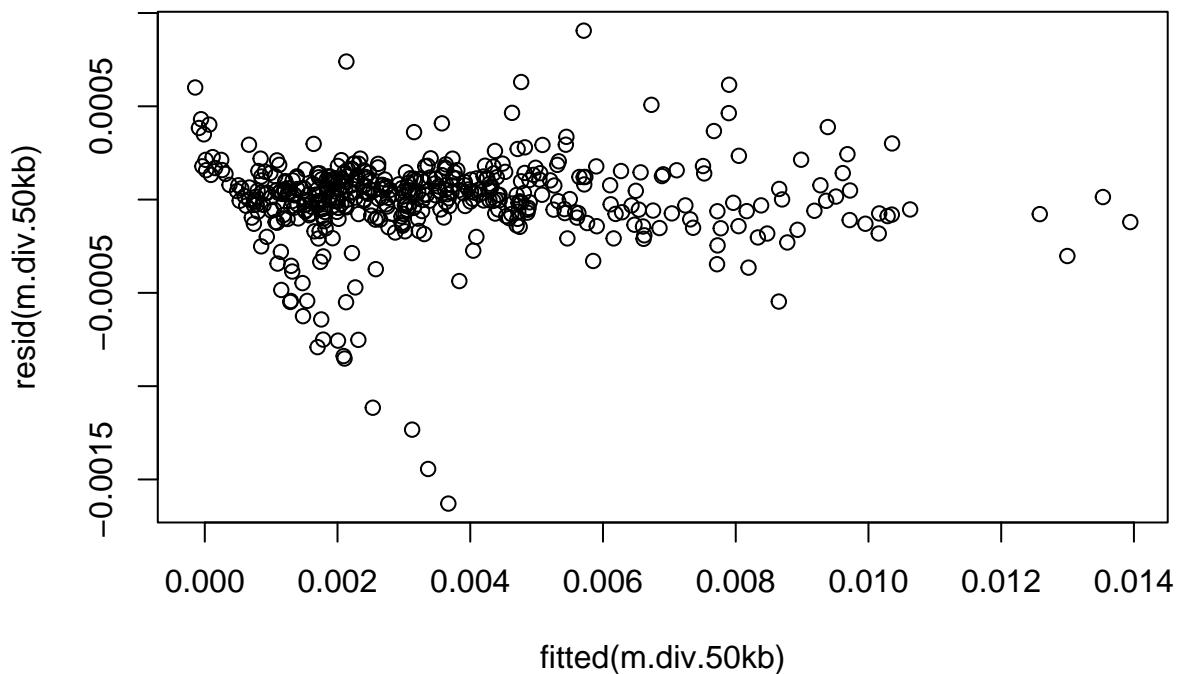
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep7)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep7)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep7)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##           df      AIC
## m.div.50kb     6 -6529.539
## m.div.50kb.2   7 -6563.670
## m.div.50kb.3   8 -6563.389

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```

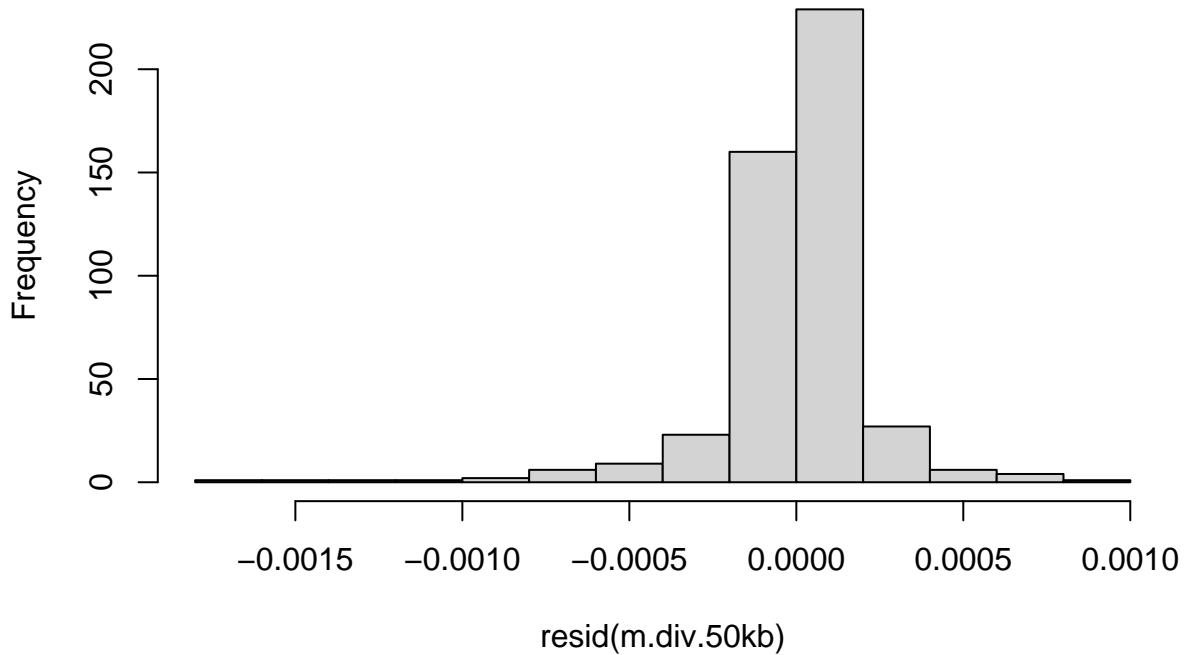


```
dwtest(m.div.50kb)
```

```
##  
## Durbin-Watson test  
##  
## data: m.div.50kb  
## DW = 0.80944, p-value < 2.2e-16  
## alternative hypothesis: true autocorrelation is greater than 0  
hmctest(m.div.50kb)
```

```
##  
## Harrison-McCabe test  
##  
## data: m.div.50kb  
## HMC = 0.3513, p-value < 2.2e-16  
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep7)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -1.629e-03 -6.430e-05  2.768e-05  1.120e-04  9.053e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.322e-03 1.142e-05 290.772 < 2e-16 ***
## thetaS       2.031e-03 1.241e-05 163.749 < 2e-16 ***
## rhoS        6.334e-05 1.190e-05   5.321 1.61e-07 ***
## tmrcaS      8.639e-04 1.326e-05  65.143 < 2e-16 ***
## thetaS:tmrcaS 5.727e-04 1.454e-05  39.399 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002345 on 466 degrees of freedom
## Multiple R-squared:  0.9912, Adjusted R-squared:  0.9912
## F-statistic: 1.317e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.315017    1.210806    1.502811    1.413627
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 7] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep7, weight = r2.bgs.50kb[, 7])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep7, weight = r2.bgs.50kb[1, 7])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep7, weight = r2.bgs.50kb[2, 7])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep7, weight = r2.bgs.50kb[3, 7])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6771.554
## g.div.50kb.2 8 -6847.669
## g.div.50kb.3 7 -6555.954
## g.div.50kb.4 7 -6550.583

summary(g.div.50kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep7
##          AIC      BIC    logLik
## -6550.583 -6521.499 3282.292
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.1219604
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003321669 1.069322e-05 310.63319     0
## thetaS       0.002035680 1.123706e-05 181.15767     0
## rhoS        0.000058896 1.126895e-05  5.22642     0
## tmrcaS      0.000871825 1.505652e-05  57.90352     0
## thetaS:tmrcaS 0.000567394 1.619561e-05  35.03384     0
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.087
## rhoS       -0.065 -0.250
## tmrcaS     -0.154 -0.243 -0.189
## thetaS:tmrcaS -0.273 -0.306  0.062  0.415
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3       Max
## -7.4341009 -0.2863661  0.1378293  0.4721729  3.4660361
##
## Residual standard error: 0.0002586268
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.4)

```

```

##      thetaS      rhoS      tmrcaS thetaS:tmrcaS
## 1.223527 1.157652 1.334434    1.287664

```

5.1.8 Replicate 8

```

rep8.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep8_w50000.csv", sep = ",", header = T)

rep_8.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.dim")
rep_8.pi.50kb$avg <- apply(rep_8.pi.50kb[4:ncol(rep_8.pi.50kb)], 1, mean)
rep_8.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.rho")
rep_8.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.theta")
rep_8.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.tmrca")
rep_8.tmrca.50kb$avg <- apply(rep_8.tmrca.50kb[4:ncol(rep_8.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep8 <- as.data.frame(cbind(rep_8.pi.50kb$avg, sim.theta.50kb$Rate, rep8.sim.tmrca.50kb))
names(true.lands.50kb.rep8) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep8$thetaS <- (true.lands.50kb.rep8$theta - mean(true.lands.50kb.rep8$theta)) / sd(true.lands.50kb.rep8$theta)
true.lands.50kb.rep8$tmrcaS <- (true.lands.50kb.rep8$tmrca - mean(true.lands.50kb.rep8$tmrca)) / sd(true.lands.50kb.rep8$tmrca)
true.lands.50kb.rep8$rhoS <- (true.lands.50kb.rep8$rho - mean(true.lands.50kb.rep8$rho, na.rm = T)) / sd(true.lands.50kb.rep8$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep8)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 8] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep8)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.058e-03 -2.175e-04 -7.010e-06  2.082e-04  1.029e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.446e-03 1.475e-05 233.688 < 2e-16 ***
## thetaS      1.909e-03 1.545e-05 123.559 < 2e-16 ***

```

```

## rhoS           8.309e-05  1.928e-05   4.308 2.01e-05 ***
## tmrcaS        1.058e-03  2.017e-05   52.445 < 2e-16 ***
## thetaS:tmrcaS 7.061e-04  1.721e-05   41.031 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003154 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9841, Adjusted R-squared:  0.9839
## F-statistic:  7061 on 4 and 457 DF,  p-value: < 2.2e-16
vif(m.div.50kb)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
##      1.104338     1.723071     1.732405     1.105630

# now the lm with inferred landscapes
inf.lands.50kb.rep8 <- as.data.frame(cbind(rep_8.pi.50kb$avg, rep_8.theta.50kb$sample_mean, rep_8.tmrca))
names(inf.lands.50kb.rep8) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[8, 1] <- cor.test(sim.theta.50kb$Rate, rep_8.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[8, 1] <- cor.test(sim.rho.50kb$Rate, rep_8.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[8, 1] <- cor.test(rep8.sim.tmrca.50kb$AverageTmrca, rep_8.tmrca.50kb$avg, method = "spearman")

# standardizing
inf.lands.50kb.rep8$thetaS <- (inf.lands.50kb.rep8$theta - mean(inf.lands.50kb.rep8$theta)) / sd(inf.lands.50kb.rep8$theta)
inf.lands.50kb.rep8$tmrcaS <- (inf.lands.50kb.rep8$tmrca - mean(inf.lands.50kb.rep8$tmrca)) / sd(inf.lands.50kb.rep8$tmrca)
inf.lands.50kb.rep8$rhoS <- (inf.lands.50kb.rep8$rho - mean(inf.lands.50kb.rep8$rho)) / sd(inf.lands.50kb.rep8$rho)

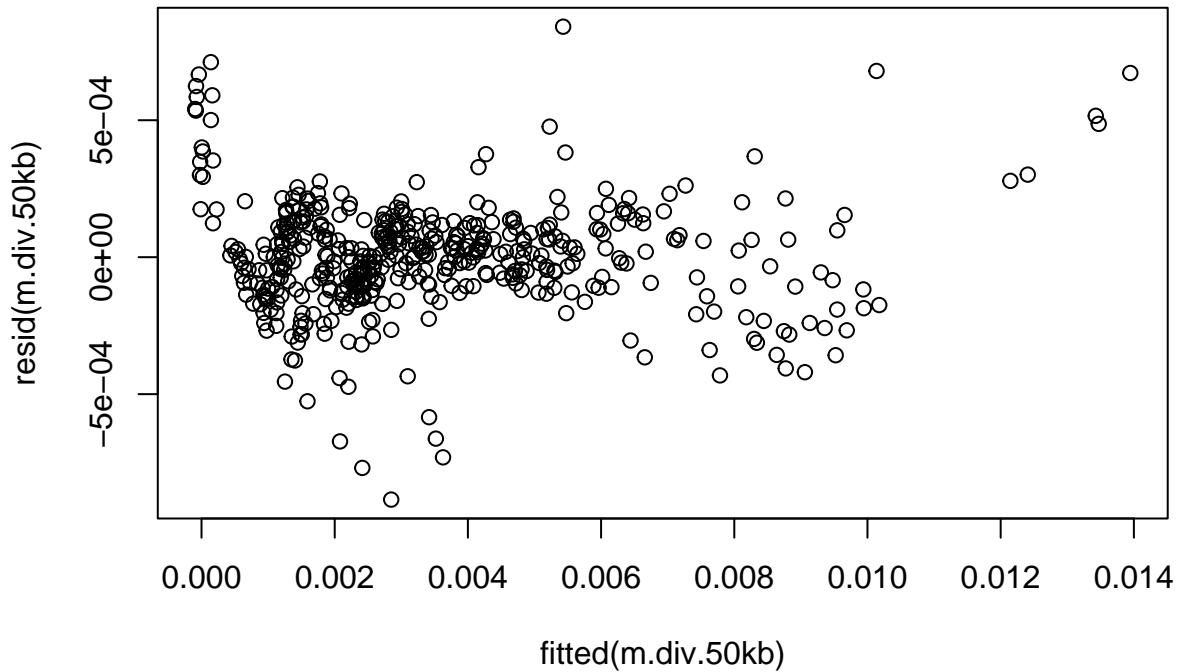
inf.lands.50kb.rep8$bin <- 1:nrow(inf.lands.50kb.rep8)
inf.lands.50kb.rep8$Replicate <- 8

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep8)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep8)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep8)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb    6 -6664.906
## m.div.50kb.2  7 -6820.661
## m.div.50kb.3  8 -6830.462
plot(resid(m.div.50kb)~fitted(m.div.50kb))

```

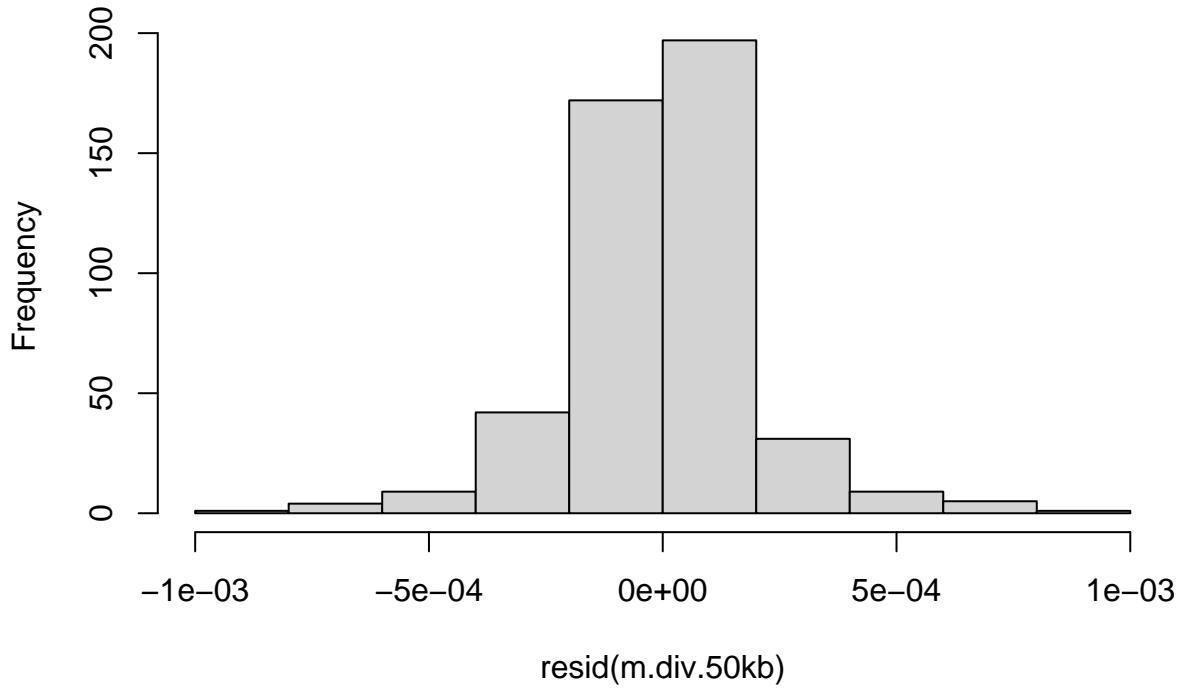


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 0.81053, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.39763, p-value = 0.001
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep8)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -8.849e-04 -1.035e-04  4.480e-06  1.033e-04  8.415e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.424e-03 9.459e-06 361.965 <2e-16 ***
## thetaS      1.938e-03 1.024e-05 189.277 <2e-16 ***
## rhoS        1.664e-05 1.052e-05  1.581   0.115    
## tmrcaS      1.048e-03 1.034e-05 101.373 <2e-16 ***
## thetaS:tmrcaS 6.299e-04 1.253e-05  50.287 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0002031 on 466 degrees of freedom
## Multiple R-squared:  0.9934, Adjusted R-squared:  0.9934 
## F-statistic: 1.766e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.194108  1.261548  1.216556  1.137692
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 8] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep8, weight = r2.bgs.50kb[1, 8])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep8, weight = r2.bgs.50kb[2, 8])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep8, weight = r2.bgs.50kb[3, 8])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep8, weight = r2.bgs.50kb[4, 8])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6889.362
## g.div.50kb.2 8 -6915.099
## g.div.50kb.3 7 -6750.478
## g.div.50kb.4 7 -6740.369

summary(g.div.50kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep8
##          AIC      BIC    logLik
## -6740.369 -6711.285 3377.185
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.2037672
##
## Coefficients:
##             Value   Std.Error t-value p-value
## (Intercept) 0.003402061 8.241027e-06 412.8201 0.0000
## thetaS       0.001927351 8.794558e-06 219.1527 0.0000
## rhoS        0.000006110 8.794726e-06  0.6947 0.4876
## tmrcaS      0.001075631 1.250960e-05  85.9845 0.0000
## thetaS:tmrcaS 0.000636580 1.512170e-05  42.0971 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.092
## rhoS       -0.070 -0.166
## tmrcaS     -0.135 -0.081 -0.284
## thetaS:tmrcaS -0.148 -0.390  0.010  0.101
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3       Max
## -4.0391809 -0.4827786  0.1188580  0.5998090  5.6233877
##
## Residual standard error: 0.0002256576
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.4)

```

```

##      thetaS       rhoS      tmrcaS thetaS:tmrcaS
## 1.229859 1.133775 1.112293   1.188021

```

5.1.9 Replicate 9

```

rep9.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep9_w50000.csv", sep = ",", header = T)

rep_9.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.pi")
rep_9.pi.50kb$avg <- apply(rep_9.pi.50kb[4:ncol(rep_9.pi.50kb)], 1, mean)
rep_9.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.rho")
rep_9.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.theta")
rep_9.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.tmrca")
rep_9.tmrca.50kb$avg <- apply(rep_9.tmrca.50kb[4:ncol(rep_9.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep9 <- as.data.frame(cbind(rep_9.pi.50kb$avg, sim.theta.50kb$Rate, rep9.sim.tmrca.50kb))
names(true.lands.50kb.rep9) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep9$thetaS <- (true.lands.50kb.rep9$theta - mean(true.lands.50kb.rep9$theta)) / sd(true.lands.50kb.rep9$theta)
true.lands.50kb.rep9$tmrcaS <- (true.lands.50kb.rep9$tmrca - mean(true.lands.50kb.rep9$tmrca)) / sd(true.lands.50kb.rep9$tmrca)
true.lands.50kb.rep9$rhoS <- (true.lands.50kb.rep9$rho - mean(true.lands.50kb.rep9$rho, na.rm = T)) / sd(true.lands.50kb.rep9$rho)

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep9)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 9] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.50kb.rep9)
##
## Residuals:
##      Min       1Q       Median      3Q      Max
## -1.364e-03 -2.369e-04 -3.990e-06  2.171e-04  1.065e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.493e-03 1.608e-05 217.282 < 2e-16 ***
## thetaS      1.937e-03 1.701e-05 113.928 < 2e-16 ***

```

```

## rhoS           1.046e-04  2.141e-05   4.885 1.44e-06 ***
## tmrcaS        9.915e-04  2.201e-05   45.040  < 2e-16 ***
## thetaS:tmrcaS 6.939e-04  1.892e-05   36.681  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0003442 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9815, Adjusted R-squared:  0.9814
## F-statistic:  6067 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.123861    1.784137    1.783075    1.120456

# now the lm with inferred landscapes
inf.lands.50kb.rep9 <- as.data.frame(cbind(rep_9.pi.50kb$avg, rep_9.theta.50kb$sample_mean, rep_9.tmrca))
names(inf.lands.50kb.rep9) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[9, 1] <- cor.test(sim.theta.50kb$Rate, rep_9.theta.50kb$sample_mean, method = "spearman")
cor.table.rho[9, 1] <- cor.test(sim.rho.50kb$Rate, rep_9.rho.50kb$sample_mean, method = "spearman")$est
cor.table.tmrca[9, 1] <- cor.test(rep9.sim.tmrca.50kb$AverageTmrca, rep_9.tmrca.50kb$avg, method = "spearman")

# standardizing
inf.lands.50kb.rep9$thetaS <- (inf.lands.50kb.rep9$theta - mean(inf.lands.50kb.rep9$theta)) / sd(inf.lands.50kb.rep9)
inf.lands.50kb.rep9$tmrcaS <- (inf.lands.50kb.rep9$tmrca - mean(inf.lands.50kb.rep9$tmrca)) / sd(inf.lands.50kb.rep9)
inf.lands.50kb.rep9$rhoS <- (inf.lands.50kb.rep9$rho - mean(inf.lands.50kb.rep9$rho)) / sd(inf.lands.50kb.rep9)

inf.lands.50kb.rep9$bin <- 1:nrow(inf.lands.50kb.rep9)
inf.lands.50kb.rep9$Replicate <- 9

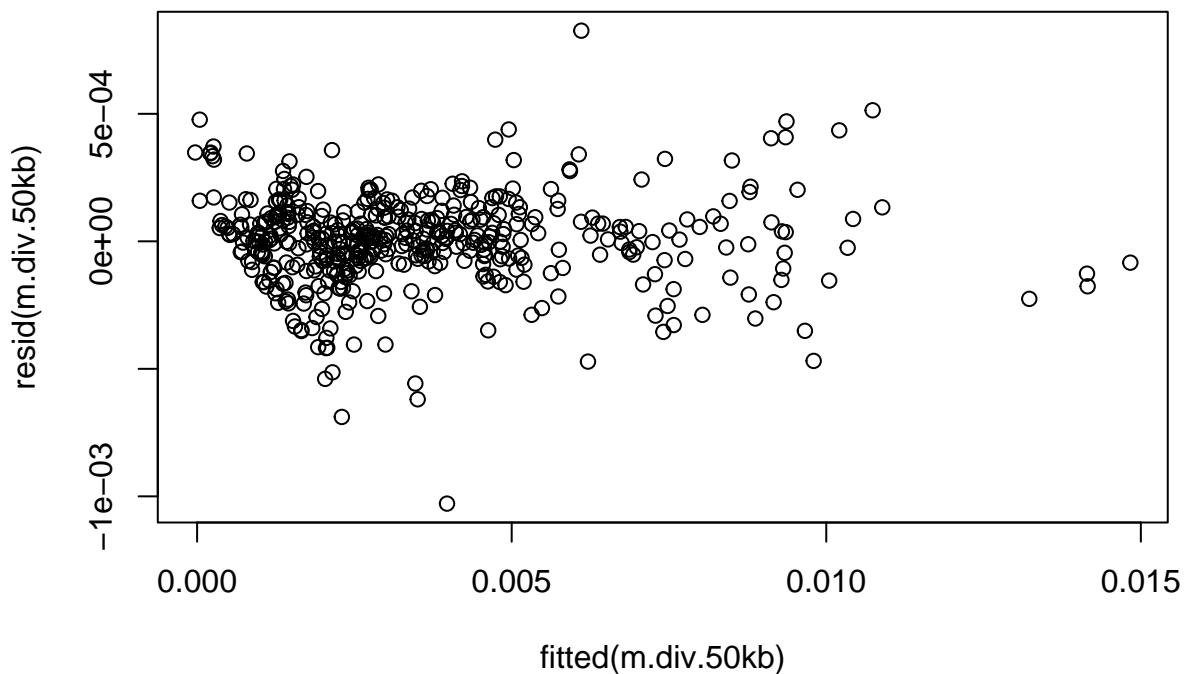
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep9)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep9)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep9)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb     6 -6772.620
## m.div.50kb.2   7 -6788.142
## m.div.50kb.3   8 -6788.032

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```

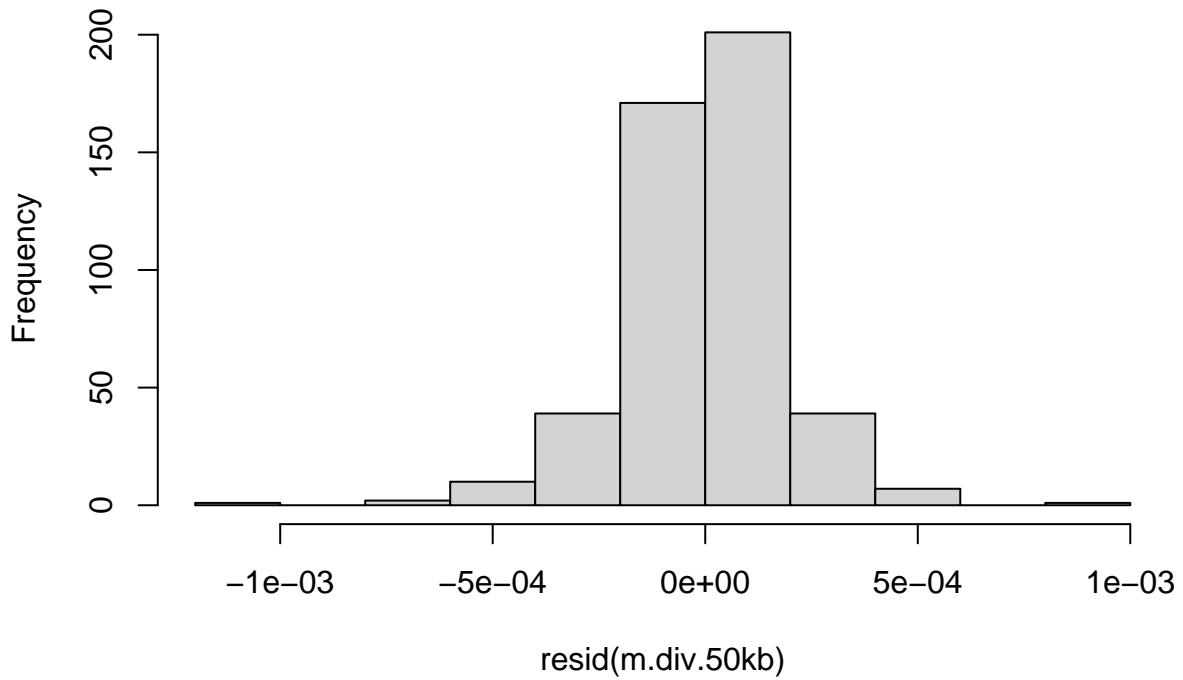


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.2553, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.48698, p-value = 0.347
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = inf.lands.50kb.rep9)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.028e-03 -7.795e-05  1.040e-05  9.457e-05  8.260e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.386e-03 8.797e-06 384.938 < 2e-16 ***
## thetaS      1.948e-03 9.855e-06 197.676 < 2e-16 ***
## rhoS        3.811e-05 9.451e-06   4.032 6.45e-05 ***
## tmrcaS      9.816e-04 1.021e-05  96.094 < 2e-16 ***
## thetaS:tmrcaS 6.367e-04 1.178e-05  54.050 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001812 on 466 degrees of freedom
## Multiple R-squared:  0.9949, Adjusted R-squared:  0.9948
## F-statistic: 2.265e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.390263  1.278726  1.493723  1.427151
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.50kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 9] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep9, weight = r2.bgs.50kb[1, 9])
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep9, weight = r2.bgs.50kb[2, 9])
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep9, weight = r2.bgs.50kb[3, 9])
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep9, weight = r2.bgs.50kb[4, 9])

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6844.364
## g.div.50kb.2 8 -6903.791
## g.div.50kb.3 7 -6804.377
## g.div.50kb.4 7 -6772.655

summary(g.div.50kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep9
##          AIC      BIC    logLik
## -6772.655 -6743.571 3393.328
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.03958415
##
## Coefficients:
##             Value   Std.Error t-value p-value
## (Intercept) 0.003385528 8.745515e-06 387.1159 0e+00
## thetaS       0.001950913 9.694302e-06 201.2432 0e+00
## rhoS        0.000036441 9.323069e-06   3.9087 1e-04
## tmrcaS      0.000983491 1.062180e-05  92.5917 0e+00
## thetaS:tmrcaS 0.000634704 1.225292e-05  51.8002 0e+00
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.137
## rhoS       -0.035 -0.229
## tmrcaS     -0.144 -0.282 -0.299
## thetaS:tmrcaS -0.308 -0.443  0.069  0.409
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -6.34838974 -0.42010395  0.05936447  0.53616068  4.41278716
##
## Residual standard error: 0.0001857483
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.4)

```

	thetaS	rhoS	tmrcaS	thetaS:tmrcaS
##	1.376904	1.257475	1.451802	1.412086

5.1.10 Replicate 10

```

rep10.sim.tmrca.50kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep10_w50000.csv", sep = ",", header = T)

rep_10.pi.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_50kb.csv")
rep_10.pi.50kb$avg <- apply(rep_10.pi.50kb[4:ncol(rep_10.pi.50kb)], 1, mean)
rep_10.rho.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_rho.csv")
rep_10.theta.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_theta.csv")
rep_10.tmrca.50kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_tmrca.csv")
rep_10.tmrca.50kb$avg <- apply(rep_10.tmrca.50kb[4:ncol(rep_10.tmrca.50kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.50kb.rep10 <- as.data.frame(cbind(rep_10.pi.50kb$avg, sim.theta.50kb$Rate, rep10.sim.tmrca.50kb))
names(true.lands.50kb.rep10) <- c("diversity", "theta", "tmrca", "rho")

true.lands.50kb.rep10$thetaS <- (true.lands.50kb.rep10$theta - mean(true.lands.50kb.rep10$theta)) / sd(true.lands.50kb.rep10$theta)
true.lands.50kb.rep10$tmrcaS <- (true.lands.50kb.rep10$tmrca - mean(true.lands.50kb.rep10$tmrca)) / sd(true.lands.50kb.rep10$tmrca)
true.lands.50kb.rep10$rhoS <- (true.lands.50kb.rep10$rho - mean(true.lands.50kb.rep10$rho, na.rm = T))

m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.50kb.rep10)
anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.50kb.true[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.50kb.true[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb.true[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb.true[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb.true[5, 10] <- anova.diversity$VarExp[4] * 100

summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.50kb.rep10)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -1.034e-03 -2.303e-04 -1.764e-05  2.169e-04  1.038e-03
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.489e-03 1.641e-05 212.600 < 2e-16 ***
## thetaS      1.958e-03 1.725e-05 113.499 < 2e-16 ***

```

```

## rhoS           7.022e-05  2.181e-05   3.219  0.00138 **
## tmrcaS        1.023e-03  2.254e-05  45.374  < 2e-16 ***
## thetaS:tmrcaS 6.400e-04  1.848e-05  34.623  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000351 on 457 degrees of freedom
##   (9 observations deleted due to missingness)
## Multiple R-squared:  0.9809, Adjusted R-squared:  0.9807
## F-statistic:  5871 on 4 and 457 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.111835    1.780013    1.782888    1.105947

# now the lm with inferred landscapes
inf.lands.50kb.rep10 <- as.data.frame(cbind(rep_10.pi.50kb$avg, rep_10.theta.50kb$sample_mean, rep_10.tmrca.50kb$sample_mean))
names(inf.lands.50kb.rep10) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[10, 1] <- cor.test(sim.theta.50kb$Rate, rep_10.theta.50kb$sample_mean, method = "spearman")$estimate
cor.table.rho[10, 1] <- cor.test(sim.rho.50kb$Rate, rep_10.rho.50kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[10, 1] <- cor.test(rep10.sim.tmrca.50kb$AverageTmrca, rep_10.tmrca.50kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.50kb.rep10$thetaS <- (inf.lands.50kb.rep10$theta - mean(inf.lands.50kb.rep10$theta)) / sd(inf.lands.50kb.rep10$theta)
inf.lands.50kb.rep10$tmrcaS <- (inf.lands.50kb.rep10$tmrca - mean(inf.lands.50kb.rep10$tmrca)) / sd(inf.lands.50kb.rep10$tmrca)
inf.lands.50kb.rep10$rhoS <- (inf.lands.50kb.rep10$rho - mean(inf.lands.50kb.rep10$rho)) / sd(inf.lands.50kb.rep10$rho)

inf.lands.50kb.rep10$bin <- 1:nrow(inf.lands.50kb.rep10)
inf.lands.50kb.rep10$Replicate <- 10

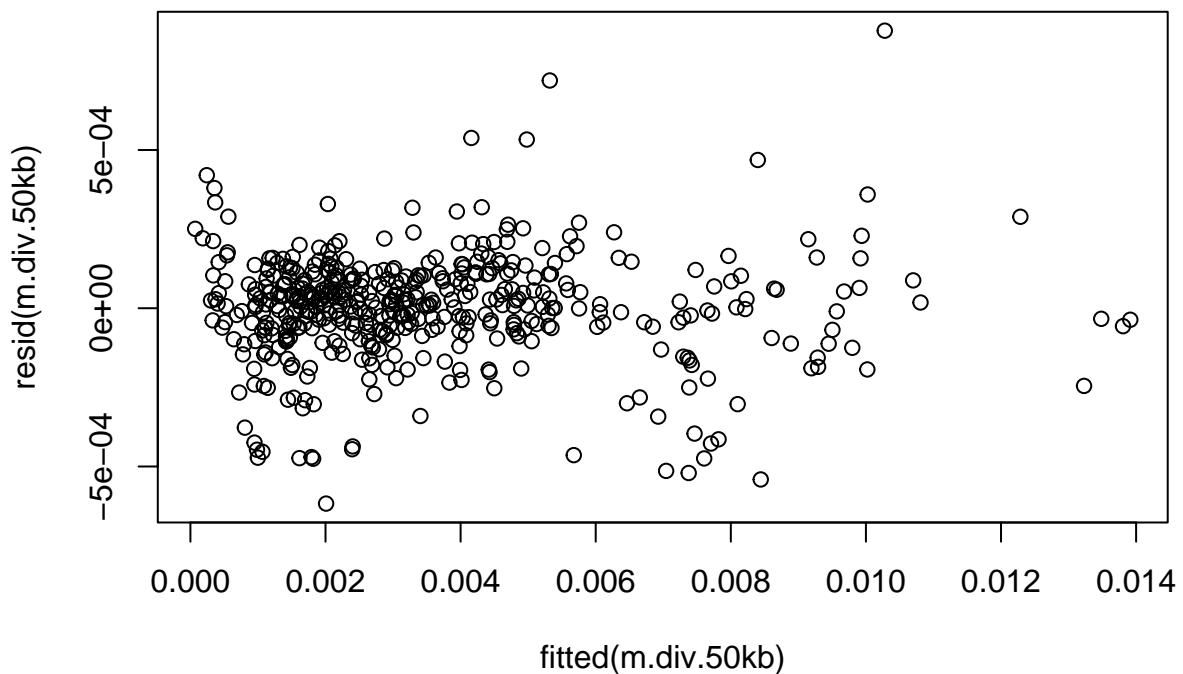
m.div.50kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep10)
m.div.50kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.50kb.rep10)
m.div.50kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.50kb.rep10)

AIC(m.div.50kb, m.div.50kb.2, m.div.50kb.3)

##          df      AIC
## m.div.50kb     6 -6830.551
## m.div.50kb.2   7 -6838.420
## m.div.50kb.3   8 -6849.626

plot(resid(m.div.50kb) ~ fitted(m.div.50kb))

```

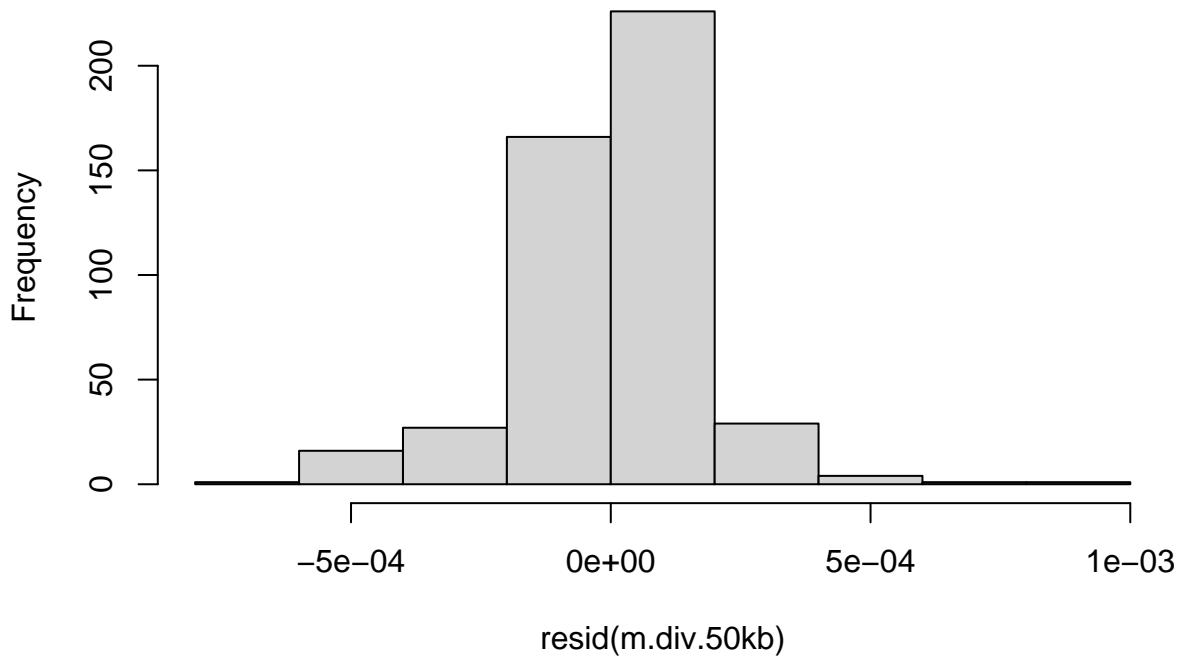


```
dwtest(m.div.50kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.50kb
## DW = 1.1672, p-value < 2.2e-16
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.50kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.50kb
## HMC = 0.47978, p-value = 0.271
hist(resid(m.div.50kb))
```

Histogram of resid(m.div.50kb)



```
summary(m.div.50kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.50kb.rep10)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -6.172e-04 -6.760e-05  1.266e-05  9.275e-05  8.769e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.443e-03 8.020e-06 429.318 < 2e-16 ***
## thetaS       2.093e-03 8.540e-06 245.081 < 2e-16 ***
## rhoS        6.913e-05 9.289e-06  7.442 4.84e-13 ***
## tmrcaS      8.255e-04 8.971e-06  92.015 < 2e-16 ***
## thetaS:tmrcaS 5.158e-04 8.760e-06  58.877 < 2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0001704 on 466 degrees of freedom
## Multiple R-squared:  0.9955, Adjusted R-squared:  0.9955 
## F-statistic: 2.585e+04 on 4 and 466 DF,  p-value: < 2.2e-16

vif(m.div.50kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.180696  1.397004  1.302995  1.059032
```

```

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.50kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.50kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.50kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.50kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.50kb[5, 10] <- anova.diversity$VarExp[4] * 100

g.div.50kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep10, we
g.div.50kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep10, we
g.div.50kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep10, we
g.div.50kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.50kb.rep10, we

AIC(g.div.50kb.1, g.div.50kb.2, g.div.50kb.3, g.div.50kb.4)

##           df      AIC
## g.div.50kb.1 8 -6942.468
## g.div.50kb.2 8 -6997.019
## g.div.50kb.3 7 -6868.321
## g.div.50kb.4 7 -6861.577

summary(g.div.50kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.50kb.rep10
##          AIC      BIC    logLik
## -6861.577 -6832.493 3437.788
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.1346477
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003438775 7.492138e-06 458.9844     0
## thetaS       0.002087051 7.782151e-06 268.1844     0
## rhoS        0.000060473 8.713770e-06   6.9400     0
## tmrcaS      0.000835601 1.034657e-05  80.7611     0
## thetaS:tmrcaS 0.000519404 1.025782e-05  50.6349     0
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.023
## rhoS       -0.067 -0.278
## tmrcaS     -0.052 -0.049 -0.368
## thetaS:tmrcaS -0.165 -0.186  0.003  0.124
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3      Max
## -3.8326396 -0.4055932  0.1177342  0.5940115  4.4305194
##
## Residual standard error: 0.0001868616
## Degrees of freedom: 471 total; 466 residual
vif(g.div.50kb.4)

##          thetaS         rhoS        tmrcaS thetaS:tmrcaS
##     1.150711     1.287968     1.204706     1.050372

```

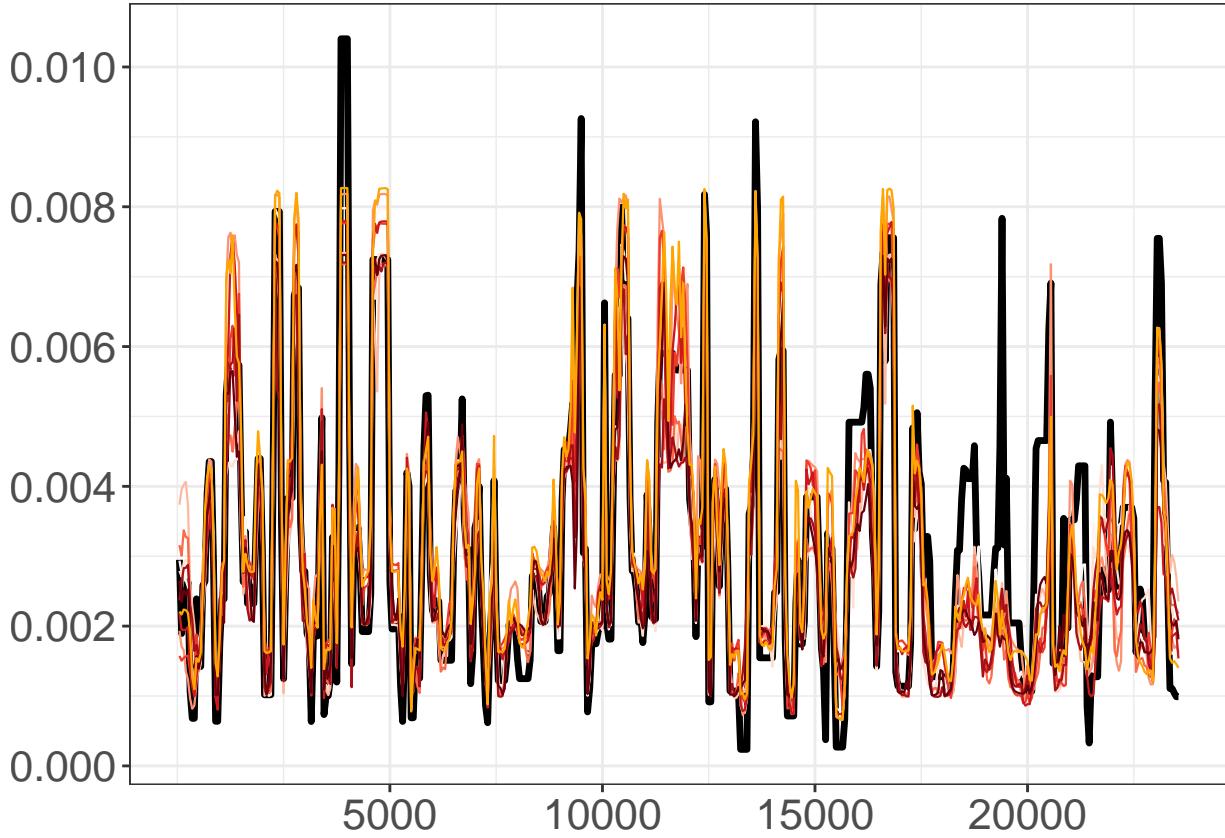
5.2 all replicates:

```

theta.plot <- as.data.frame(cbind(1:nrow(sim.theta.50kb),
                                    sim.theta.50kb$Rate * 1e-7 * 3e+4,
                                    rep_1.theta.50kb$sample_mean,
                                    rep_2.theta.50kb$sample_mean,
                                    rep_3.theta.50kb$sample_mean,
                                    rep_4.theta.50kb$sample_mean,
                                    rep_5.theta.50kb$sample_mean,
                                    rep_6.theta.50kb$sample_mean,
                                    rep_7.theta.50kb$sample_mean,
                                    rep_8.theta.50kb$sample_mean,
                                    rep_9.theta.50kb$sample_mean,
                                    rep_10.theta.50kb$sample_mean))

names(theta.plot) <- c("bin", "sim", "reps")
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.50kb.bgs <- ggplot(data = molten.theta, aes(x = bin * 50, y = value, colour = variable)) +
  theta.map.50kb.bgs + geom_line(data = molten.theta, aes(size = variable)) + scale_color_manual(values = brewer.pal(n = 9, name = "Set1"))
theta.map.50kb.bgs <- theta.map.50kb.bgs + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Set1")))
theta.map.50kb.bgs <- theta.map.50kb.bgs + scale_x_continuous(breaks = c(5000, 10000, 15000, 20000)) +
  theta.map.50kb.bgs + labs(title = NULL, x = NULL, y = NULL)
theta.map.50kb.bgs <- theta.map.50kb.bgs + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))
theta.map.50kb.bgs

```



5.3 200 kb scale

```
r2.bgs.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.200kb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.200kb) <- reps

r2.bgs.200kb.true <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.200kb.true) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.200kb.true) <- reps

sim.theta.200kb <- read.table("dm_bgs_sims/MutationMap_200kb.csv", sep = ",", header = T)
sim.rho.200kb <- read.table("dm_bgs_sims/RecombinationMap_200kb.csv", sep = ",", header = T)
```

5.3.1 Replicate 1

```
rep1.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep1_w200000.csv", sep = ",", header = T)

rep_1.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.d")
rep_1.pi.200kb$avg <- apply(rep_1.pi.200kb[4:ncol(rep_1.pi.200kb)], 1, mean)
rep_1.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.d")
rep_1.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.d")
rep_1.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.d")
rep_1.tmrca.200kb$avg <- apply(rep_1.tmrca.200kb[4:ncol(rep_1.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep1 <- as.data.frame(cbind(rep_1.pi.200kb$avg, sim.theta.200kb$Rate, rep1.sim.tmrca.200kb$avg))
```

```

names(true.lands.200kb.rep1) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep1$thetaS <- (true.lands.200kb.rep1$theta - mean(true.lands.200kb.rep1$theta)) / sd(true.lands.200kb.rep1$theta)
true.lands.200kb.rep1$tmrcaS <- (true.lands.200kb.rep1$tmrca - mean(true.lands.200kb.rep1$tmrca)) / sd(true.lands.200kb.rep1$tmrca)
true.lands.200kb.rep1$rhoS <- (true.lands.200kb.rep1$rho - mean(true.lands.200kb.rep1$rho), na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep1)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 1] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep1)
##
## Residuals:
##       Min         1Q        Median         3Q        Max
## -6.029e-04 -1.244e-04 -1.404e-05  1.606e-04  5.984e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.478e-03 2.097e-05 165.884 <2e-16 ***
## thetaS       1.607e-03 2.233e-05  71.976 <2e-16 ***
## rhoS         7.187e-05 3.028e-05   2.373  0.0193 *
## tmrcaS       9.865e-04 3.098e-05  31.847 <2e-16 ***
## thetaS:tmrcaS 5.461e-04 2.465e-05  22.151 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002246 on 111 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.9896, Adjusted R-squared:  0.9892
## F-statistic:  2630 on 4 and 111 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.136928    2.090432    2.044317    1.135292

# now the lm with inferred landscapes
inf.lands.200kb.rep1 <- as.data.frame(cbind(rep_1.pi.200kb$avg, rep_1.theta.200kb$sample_mean, rep_1.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep1) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[1, 2] <- cor.test(sim.theta.200kb$Rate, rep_1.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[1, 2] <- cor.test(sim.rho.200kb$Rate, rep_1.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[1, 2] <- cor.test(rep1.sim.tmrca.200kb$AverageTmrca, rep_1.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing

```

```

inf.lands.200kb.rep1$thetaS <- (inf.lands.200kb.rep1$theta - mean(inf.lands.200kb.rep1$theta)) / sd(inf.lands.200kb.rep1$theta)
inf.lands.200kb.rep1$tmrcaS <- (inf.lands.200kb.rep1$tmrca - mean(inf.lands.200kb.rep1$tmrca)) / sd(inf.lands.200kb.rep1$tmrca)
inf.lands.200kb.rep1$rhoS <- (inf.lands.200kb.rep1$rho - mean(inf.lands.200kb.rep1$rho)) / sd(inf.lands.200kb.rep1$rho)

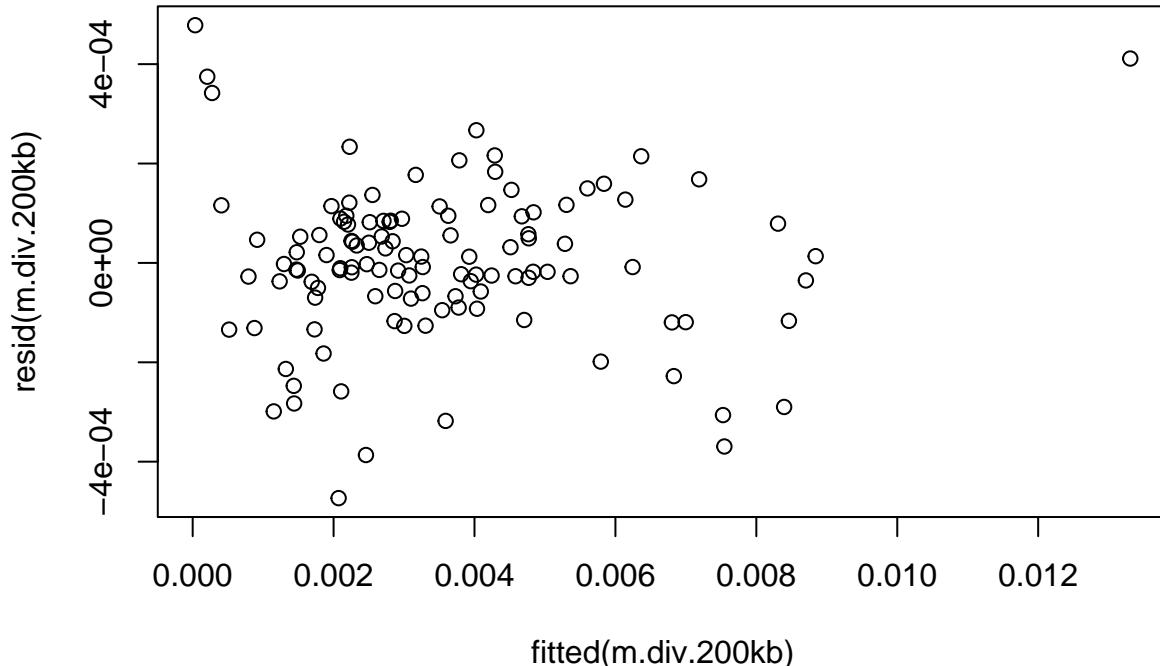
inf.lands.200kb.rep1$bin <- 1:nrow(inf.lands.200kb.rep1)
inf.lands.200kb.rep1$Replicate <- 1

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep1)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep1)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep1)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb     6 -1724.393
## m.div.200kb.2   7 -1740.570
## m.div.200kb.3   8 -1739.520
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```

dwtest(m.div.200kb)

##
##  Durbin-Watson test
##
##  data:  m.div.200kb
##  DW = 1.1469, p-value = 6.359e-07
##  alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)

##
##  Harrison-McCabe test
##

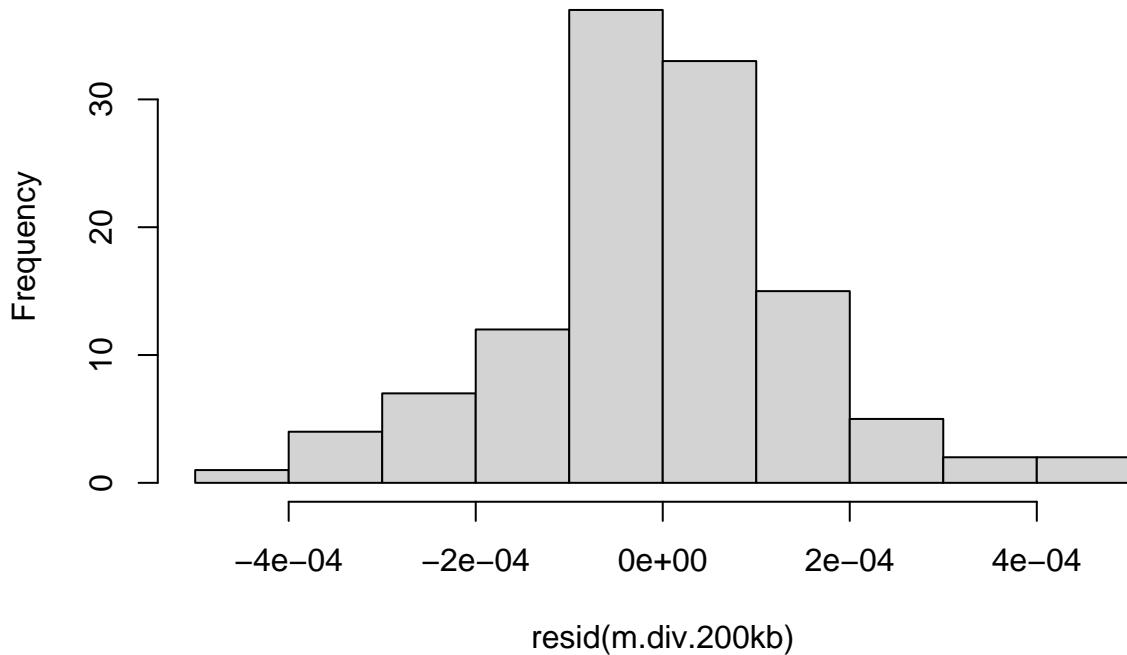
```

```

## data: m.div.200kb
## HMC = 0.42407, p-value = 0.122
hist(resid(m.div.200kb))

```

Histogram of resid(m.div.200kb)



```

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.200kb.rep1)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -4.733e-04 -6.710e-05 -5.440e-06  8.481e-05  4.783e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.464e-03 1.475e-05 234.833 < 2e-16 ***
## thetaS       1.708e-03 1.694e-05 100.835 < 2e-16 ***
## rhoS         7.899e-05 1.792e-05   4.408 2.39e-05 ***
## tmrcaS       8.093e-04 1.650e-05   49.041 < 2e-16 ***
## thetaS:tmrcaS 4.727e-04 1.875e-05  25.218 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001577 on 113 degrees of freedom
## Multiple R-squared:  0.9949, Adjusted R-squared:  0.9948
## F-statistic: 5544 on 4 and 113 DF,  p-value: < 2.2e-16

```

```

vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##      1.349802     1.510710     1.281403     1.129196

anova.diversity <- Anova(m.div.200kb.2)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep1, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep1, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep1, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep1, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1766.542
## g.div.200kb.2 8 -1764.701
## g.div.200kb.3 7 -1743.945
## g.div.200kb.4 7 -1752.612

summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep1
##       AIC      BIC    logLik
##   -1743.945 -1724.551 878.9727
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
## Parameter estimates:
##   power
## 0.7361752
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003470732 1.499192e-05 231.50685     0
## thetaS       0.001723448 1.780040e-05  96.82072     0
## rhoS        0.000086650 1.465621e-05   5.91220     0
## tmrcaS      0.000800168 1.619640e-05  49.40405     0
## thetaS:tmrcaS 0.000423137 1.911815e-05 22.13273     0
##
## Correlation:
##           (Intr) thetaS rhoS   tmrcaS
## thetaS      0.563
## rhoS       0.004 -0.373

```

```

## tmrcaS      -0.076  0.027 -0.377
## thetaS:tmrcaS -0.149 -0.092 -0.098  0.550
##
## Standardized residuals:
##          Min       Q1       Med       Q3       Max
## -3.34897044 -0.50845520 -0.03176751  0.64399094  2.60457466
##
## Residual standard error: 0.01046373
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##           thetaS        rhoS        tmrcaS thetaS:tmrcaS
## 1.190126     1.391290     1.695926     1.471880

```

5.3.2 Replicate 2

```

rep2.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep2_w200000.csv", sep = ",", header = T)

rep_2.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.d")
rep_2.pi.200kb$avg <- apply(rep_2.pi.200kb[4:ncol(rep_2.pi.200kb)], 1, mean)
rep_2.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.d")
rep_2.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.d")
rep_2.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.d")
rep_2.tmrca.200kb$avg <- apply(rep_2.tmrca.200kb[4:ncol(rep_2.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep2 <- as.data.frame(cbind(rep_2.pi.200kb$avg, sim.theta.200kb$Rate, rep2.sim.tmrca.200kb))
names(true.lands.200kb.rep2) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep2$thetaS <- (true.lands.200kb.rep2$theta - mean(true.lands.200kb.rep2$theta)) / sd(true.lands.200kb.rep2$theta)
true.lands.200kb.rep2$tmrcaS <- (true.lands.200kb.rep2$tmrca - mean(true.lands.200kb.rep2$tmrca)) / sd(true.lands.200kb.rep2$tmrca)
true.lands.200kb.rep2$rhoS <- (true.lands.200kb.rep2$rho - mean(true.lands.200kb.rep2$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep2)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 2] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.200kb.rep2)
##
## Residuals:
##          Min       1Q       Median      3Q       Max
## -6.365e-04 -1.425e-04  2.284e-05  1.304e-04  5.883e-04
##
## Coefficients:
```

```

##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.457e-03 2.256e-05 153.216 < 2e-16 ***
## thetaS      1.572e-03 2.382e-05  66.005 < 2e-16 ***
## rhoS        9.339e-05 3.269e-05   2.857  0.00511 **
## tmrcaS     1.018e-03 3.393e-05  30.009 < 2e-16 ***
## thetaS:tmrcaS 5.555e-04 2.545e-05  21.828 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002409 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9882, Adjusted R-squared:  0.9877
## F-statistic:  2318 on 4 and 111 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.123652    2.116945    2.085783    1.116405

# now the lm with inferred landscapes
inf.lands.200kb.rep2 <- as.data.frame(cbind(rep_2.pi.200kb$avg, rep_2.theta.200kb$sample_mean, rep_2.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep2) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[2, 2] <- cor.test(sim.theta.200kb$Rate, rep_2.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[2, 2] <- cor.test(sim.rho.200kb$Rate, rep_2.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[2, 2] <- cor.test(rep2.sim.tmrca.200kb$AverageTmrca, rep_2.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep2$thetaS <- (inf.lands.200kb.rep2$theta - mean(inf.lands.200kb.rep2$theta)) / sd(inf.lands.200kb.rep2$theta)
inf.lands.200kb.rep2$tmrcaS <- (inf.lands.200kb.rep2$tmrca - mean(inf.lands.200kb.rep2$tmrca)) / sd(inf.lands.200kb.rep2$tmrca)
inf.lands.200kb.rep2$rhoS <- (inf.lands.200kb.rep2$rho - mean(inf.lands.200kb.rep2$rho)) / sd(inf.lands.200kb.rep2$rho)

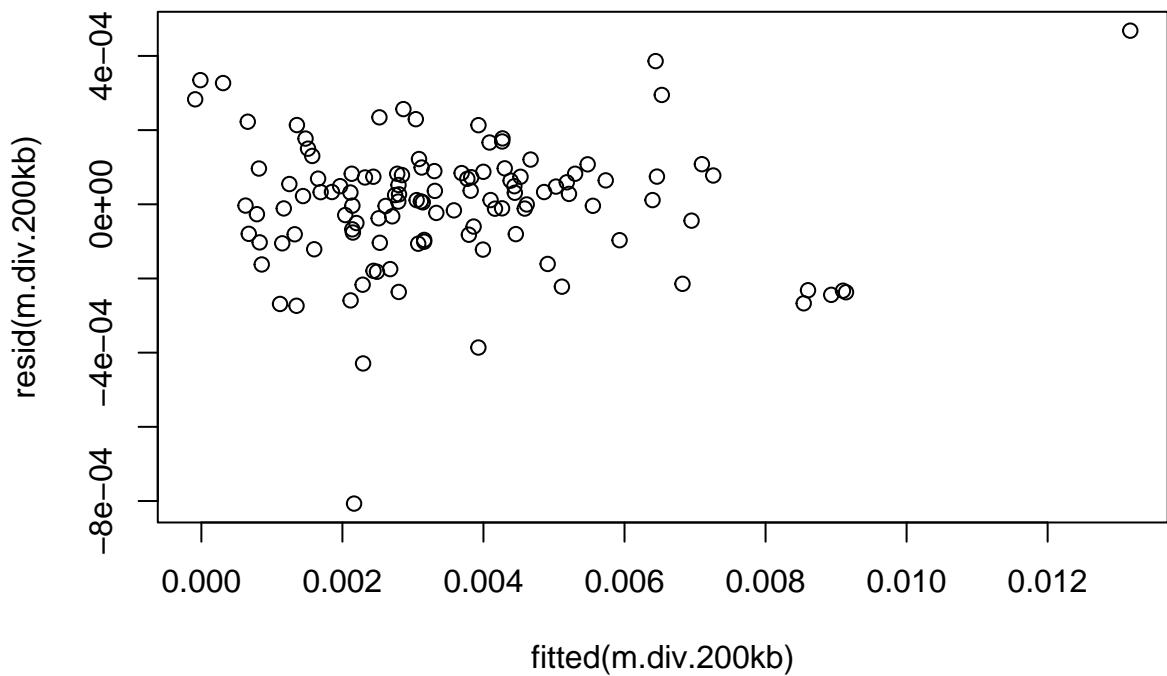
inf.lands.200kb.rep2$bin <- 1:nrow(inf.lands.200kb.rep2)
inf.lands.200kb.rep2$Replicate <- 2

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep2)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep2)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep2)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##            df      AIC
## m.div.200kb    6 -1700.943
## m.div.200kb.2  7 -1724.292
## m.div.200kb.3  8 -1728.465
plot(resid(m.div.200kb)~fitted(m.div.200kb))

```

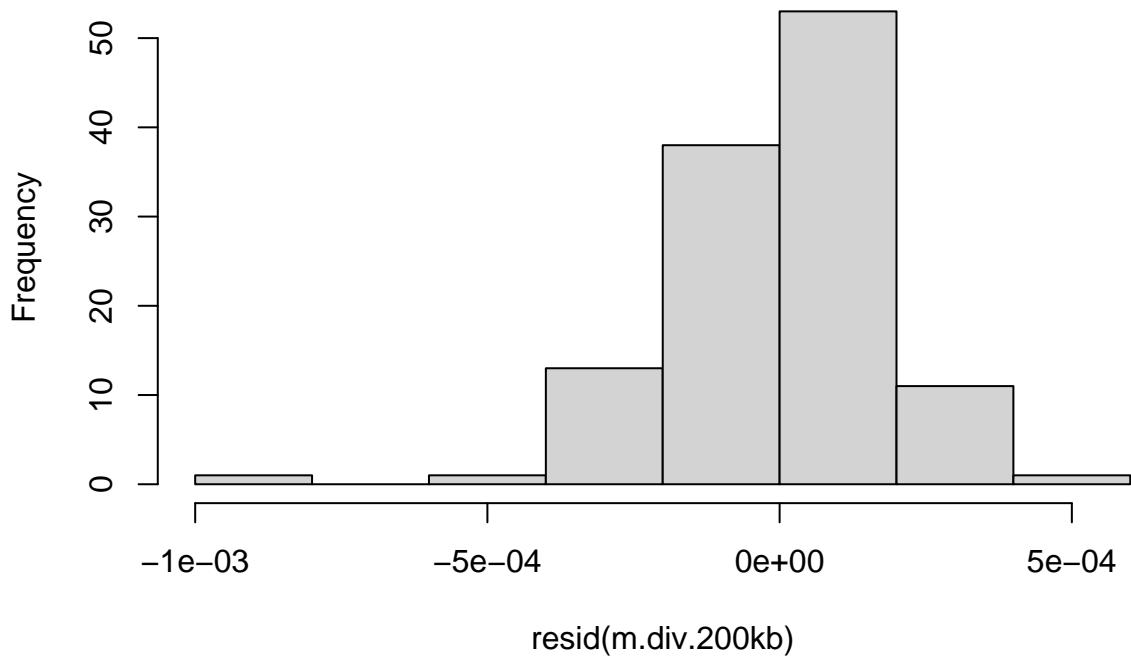


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.4796, p-value = 0.001381
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.31601, p-value = 0.003
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
## 
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.200kb.rep2)
## 
## Residuals:
##       Min         1Q     Median         3Q        Max 
## -8.069e-04 -8.170e-05  1.681e-05  8.234e-05  4.681e-04 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.490e-03 1.608e-05 217.015 <2e-16 ***
## thetaS      1.700e-03 1.742e-05  97.564 <2e-16 ***
## rhoS        2.854e-05 1.858e-05   1.536   0.127    
## tmrcaS      9.721e-04 1.789e-05  54.351 <2e-16 ***
## thetaS:tmrcaS 4.837e-04 1.808e-05  26.756 <2e-16 ***  
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
## 
## Residual standard error: 0.0001742 on 113 degrees of freedom
## Multiple R-squared:  0.9939, Adjusted R-squared:  0.9937 
## F-statistic: 4640 on 4 and 113 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS 
## 1.170895    1.332140    1.234020    1.082681
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.200kb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 2] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep2, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep2, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep2, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep2, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1726.678
## g.div.200kb.2 8 -1710.004
## g.div.200kb.3 7 -1704.923
## g.div.200kb.4 7 -1719.743
summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep2
##          AIC      BIC   logLik
## -1704.923 -1685.528 859.4613
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.3678003
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003491174 1.612364e-05 216.52518 0.0000
## thetaS       0.001698512 1.902661e-05  89.27034 0.0000
## rhoS        0.000040052 1.800286e-05   2.22477 0.0281
## tmrcaS      0.000969361 1.755570e-05  55.21633 0.0000
## thetaS:tmrcaS 0.000469909 1.998044e-05  23.51846 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.314
## rhoS      0.006 -0.302
## tmrcaS    -0.020  0.079 -0.408
## thetaS:tmrcaS -0.087 -0.224 -0.018  0.173
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -4.90801162 -0.54193854  0.09032308  0.52513685  2.21280365
##
## Residual standard error: 0.0014917
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.168684     1.316209     1.240963     1.095538

```

5.3.3 Replicate 3

```

rep3.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep3_w200000.csv", sep = ",", header = T)

rep_3.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.d")
rep_3.pi.200kb$avg <- apply(rep_3.pi.200kb[4:ncol(rep_3.pi.200kb)], 1, mean)
rep_3.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.d")
rep_3.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.d")
rep_3.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.d")
rep_3.tmrca.200kb$avg <- apply(rep_3.tmrca.200kb[4:ncol(rep_3.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep3 <- as.data.frame(cbind(rep_3.pi.200kb$avg, sim.theta.200kb$Rate, rep3.sim.tmrca.200kb))
names(true.lands.200kb.rep3) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep3$thetaS <- (true.lands.200kb.rep3$theta - mean(true.lands.200kb.rep3$theta)) / sd(true.lands.200kb.rep3$theta)
true.lands.200kb.rep3$tmrcaS <- (true.lands.200kb.rep3$tmrca - mean(true.lands.200kb.rep3$tmrca)) / sd(true.lands.200kb.rep3$tmrca)
true.lands.200kb.rep3$rhoS <- (true.lands.200kb.rep3$rho - mean(true.lands.200kb.rep3$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep3)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 3] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep3)
##
## Residuals:
##          Min         1Q     Median         3Q        Max
## -5.180e-04 -1.382e-04 -1.511e-05  1.135e-04  6.801e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.478e-03 2.049e-05 169.724 < 2e-16 ***
## thetaS       1.618e-03 2.185e-05  74.043 < 2e-16 ***
## rhoS        8.909e-05 3.002e-05   2.967  0.00368 **

```

```

## tmrcaS      9.557e-04  3.087e-05  30.960  < 2e-16 ***
## thetaS:tmrcaS 5.022e-04  2.425e-05  20.714  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002184 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9902, Adjusted R-squared:  0.9898
## F-statistic:  2790 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1 1.150871     2.172513     2.173341     1.175595

# now the lm with inferred landscapes
inf.lands.200kb.rep3 <- as.data.frame(cbind(rep_3.pi.200kb$avg, rep_3.theta.200kb$sample_mean, rep_3.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep3) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[3, 2] <- cor.test(sim.theta.200kb$Rate, rep_3.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[3, 2] <- cor.test(sim.rho.200kb$Rate, rep_3.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[3, 2] <- cor.test(rep3.sim.tmrca.200kb$AverageTmrca, rep_3.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep3$thetaS <- (inf.lands.200kb.rep3$theta - mean(inf.lands.200kb.rep3$theta)) / sd(inf.lands.200kb.rep3$theta)
inf.lands.200kb.rep3$tmrcaS <- (inf.lands.200kb.rep3$tmrca - mean(inf.lands.200kb.rep3$tmrca)) / sd(inf.lands.200kb.rep3$tmrca)
inf.lands.200kb.rep3$rhoS <- (inf.lands.200kb.rep3$rho - mean(inf.lands.200kb.rep3$rho)) / sd(inf.lands.200kb.rep3$rho)

inf.lands.200kb.rep3$bin <- 1:nrow(inf.lands.200kb.rep3)
inf.lands.200kb.rep3$Replicate <- 3

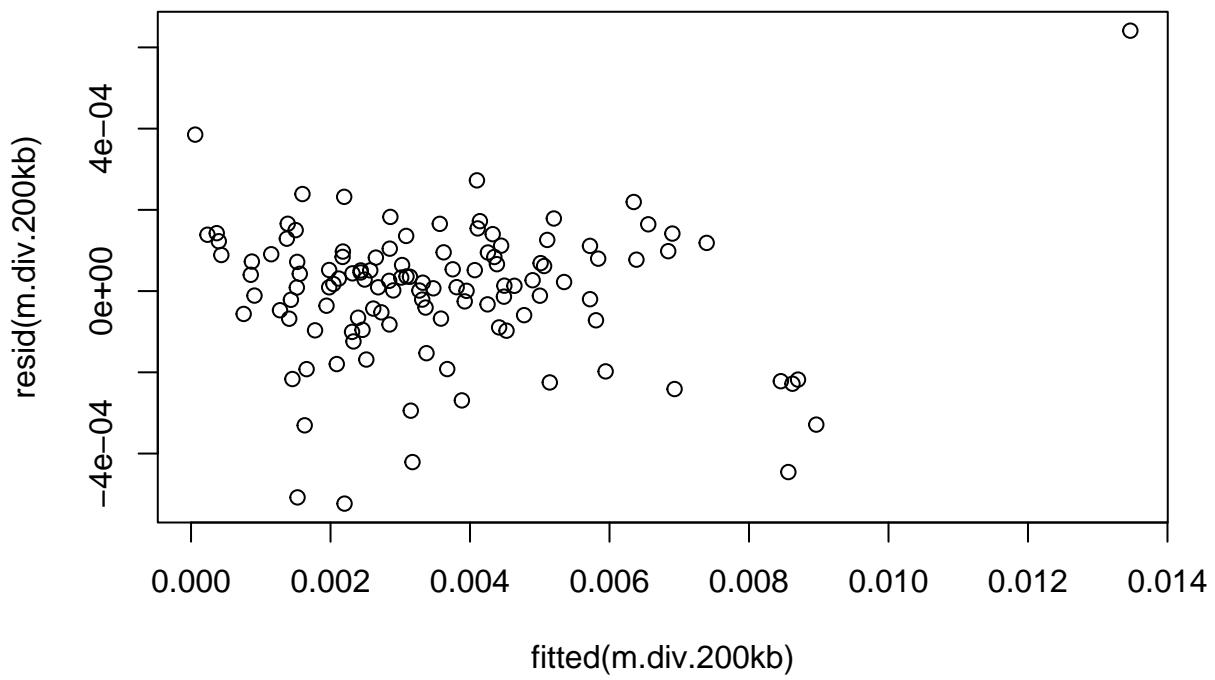
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep3)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep3)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep3)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1707.314
## m.div.200kb.2  7 -1754.542
## m.div.200kb.3  8 -1764.055

plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```

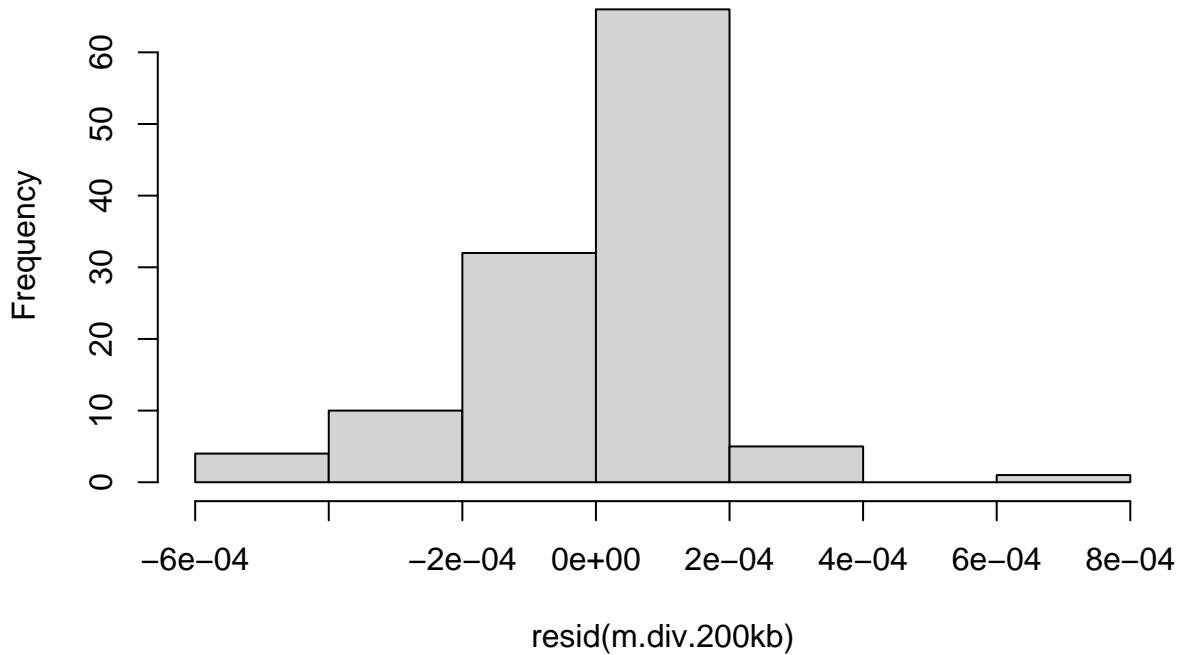


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.3035, p-value = 3.818e-05
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.44743, p-value = 0.22
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.200kb.rep3)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -5.233e-04 -6.723e-05  2.374e-05  9.394e-05  6.412e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.519e-03 1.563e-05 225.098 <2e-16 ***
## thetaS      1.728e-03 1.676e-05 103.074 <2e-16 ***
## rhoS        2.999e-05 1.826e-05   1.643   0.103
## tmrcaS      8.940e-04 1.825e-05  48.993 <2e-16 ***
## thetaS:tmrcaS 4.364e-04 1.763e-05  24.752 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001695 on 113 degrees of freedom
## Multiple R-squared:  0.9941, Adjusted R-squared:  0.9939
## F-statistic:  4792 on 4 and 113 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.143982 1.356825 1.355470 1.142884
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.200kb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 3] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep3, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep3, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep3, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep3, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1726.196
## g.div.200kb.2 8 -1733.453
## g.div.200kb.3 7 -1719.642
## g.div.200kb.4 7 -1713.673
summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep3
##          AIC      BIC    logLik
## -1713.673 -1694.279 863.8366
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.2740241
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003489756 1.470381e-05 237.33691 0.0000
## thetaS       0.001690600 1.606192e-05 105.25514 0.0000
## rhoS        0.000038090 1.674956e-05   2.27410 0.0248
## tmrcaS      0.000919654 2.611619e-05  35.21392 0.0000
## thetaS:tmrcaS 0.000445293 2.553435e-05  17.43898 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.075
## rhoS       -0.001 -0.320
## tmrcaS     -0.217  0.061 -0.320
## thetaS:tmrcaS -0.072 -0.338  0.065 -0.168
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3      Max
## -3.6509137 -0.3975915  0.1965430  0.7668138  2.9312986
##
## Residual standard error: 0.0002076519
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##     1.269847    1.252981    1.154326    1.170223

```

5.3.4 Replicate 4

```

rep4.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep4_w200000.csv", sep = ",", header = T)

rep_4.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.d")
rep_4.pi.200kb$avg <- apply(rep_4.pi.200kb[4:ncol(rep_4.pi.200kb)], 1, mean)
rep_4.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.d")
rep_4.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.d")
rep_4.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.d")
rep_4.tmrca.200kb$avg <- apply(rep_4.tmrca.200kb[4:ncol(rep_4.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep4 <- as.data.frame(cbind(rep_4.pi.200kb$avg, sim.theta.200kb$Rate, rep4.sim.tmrca.200kb))
names(true.lands.200kb.rep4) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep4$thetaS <- (true.lands.200kb.rep4$theta - mean(true.lands.200kb.rep4$theta)) / sd(true.lands.200kb.rep4$theta)
true.lands.200kb.rep4$tmrcaS <- (true.lands.200kb.rep4$tmrca - mean(true.lands.200kb.rep4$tmrca)) / sd(true.lands.200kb.rep4$tmrca)
true.lands.200kb.rep4$rhoS <- (true.lands.200kb.rep4$rho - mean(true.lands.200kb.rep4$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep4)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 4] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep4)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.555e-04 -1.511e-04  6.850e-06  1.106e-04  6.395e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.474e-03 2.016e-05 172.334 <2e-16 ***
## thetaS      1.626e-03 2.117e-05  76.799 <2e-16 ***
## rhoS        7.178e-05 2.927e-05   2.452  0.0158 *

```

```

## tmrcaS      9.817e-04  3.025e-05  32.448   <2e-16 ***
## thetaS:tmrcaS 5.183e-04  2.369e-05  21.877   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002153 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9904, Adjusted R-squared:  0.99
## F-statistic:  2854 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.111217    2.124992    2.090788    1.096365

# now the lm with inferred landscapes
inf.lands.200kb.rep4 <- as.data.frame(cbind(rep_4.pi.200kb$avg, rep_4.theta.200kb$sample_mean, rep_4.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep4) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[4, 2] <- cor.test(sim.theta.200kb$Rate, rep_4.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[4, 2] <- cor.test(sim.rho.200kb$Rate, rep_4.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[4, 2] <- cor.test(rep4.sim.tmrca.200kb$AverageTmrca, rep_4.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep4$thetaS <- (inf.lands.200kb.rep4$theta - mean(inf.lands.200kb.rep4$theta))
inf.lands.200kb.rep4$tmrcaS <- (inf.lands.200kb.rep4$tmrca - mean(inf.lands.200kb.rep4$tmrca))
inf.lands.200kb.rep4$rhoS <- (inf.lands.200kb.rep4$rho - mean(inf.lands.200kb.rep4$rho))

inf.lands.200kb.rep4$bin <- 1:nrow(inf.lands.200kb.rep4)
inf.lands.200kb.rep4$Replicate <- 4

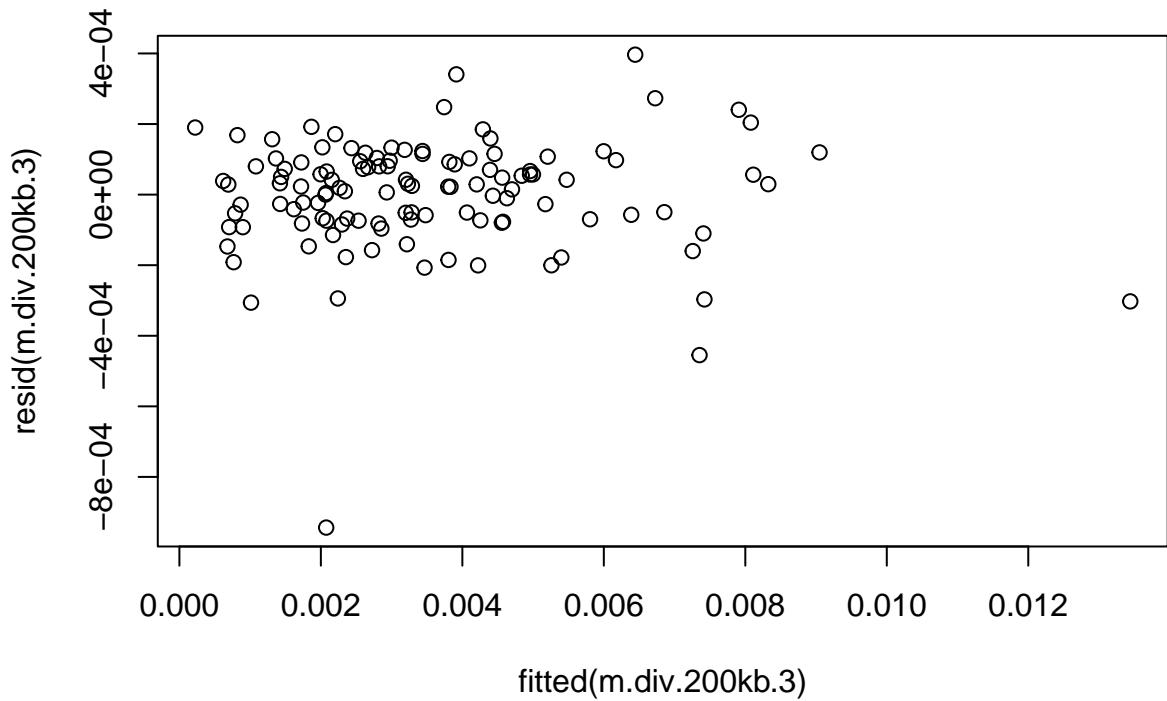
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep4)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep4)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep4)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb     6 -1713.378
## m.div.200kb.2    7 -1712.955
## m.div.200kb.3    8 -1711.494

plot(resid(m.div.200kb.3) ~ fitted(m.div.200kb.3))

```

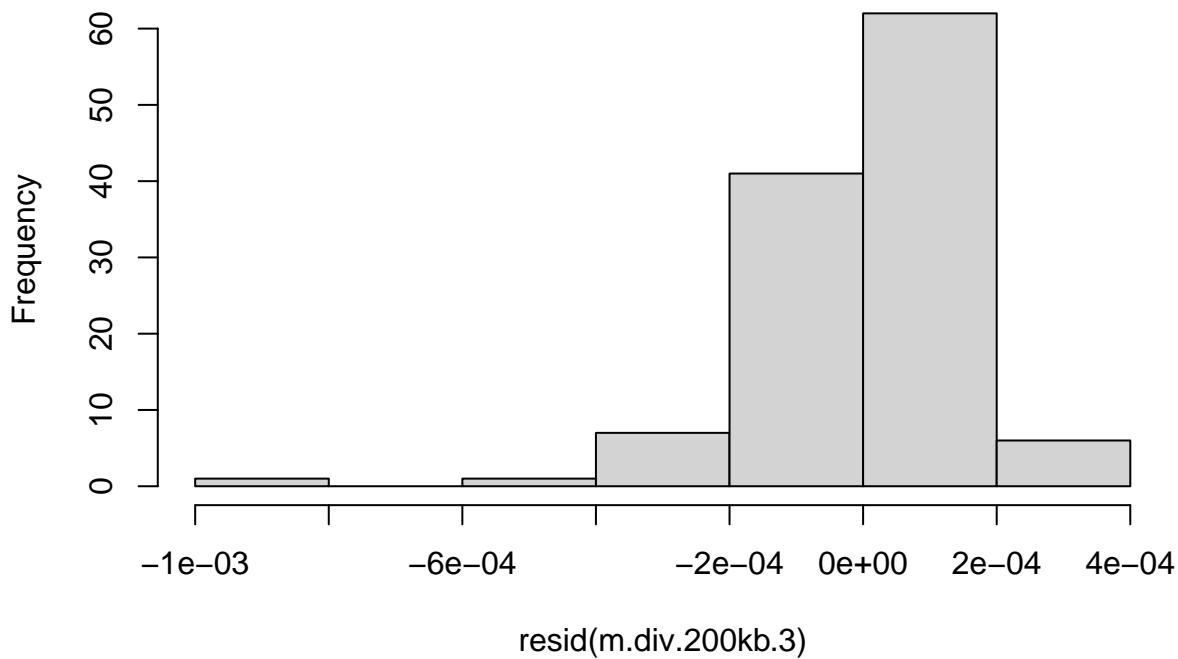


```
dwtest(m.div.200kb.3)
```

```
##
## Durbin-Watson test
##
## data: m.div.200kb.3
## DW = 1.4595, p-value = 0.0007677
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb.3)
```

```
##
## Harrison-McCabe test
##
## data: m.div.200kb.3
## HMC = 0.54901, p-value = 0.762
hist(resid(m.div.200kb.3))
```

Histogram of resid(m.div.200kb.3)



```
summary(m.div.200kb.3)

##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep4)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -9.435e-04 -7.361e-05  2.391e-05  9.403e-05  3.965e-04 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.466e-03 1.784e-05 194.268 < 2e-16 ***
## thetaS      1.054e+00 1.016e-02 103.696 < 2e-16 ***
## rhoS        4.932e-02 9.039e-03  5.457 2.98e-07 ***
## tmrcaS      4.830e-03 2.196e-04 21.998 < 2e-16 ***
## thetaS:rhoS -3.303e+00 4.633e+00 -0.713  0.477  
## thetaS:tmrcaS 1.529e+00 7.132e-02 21.440 < 2e-16 ***
## rhoS:tmrcaS -1.322e-01 1.051e-01 -1.257  0.211  
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001652 on 111 degrees of freedom
## Multiple R-squared:  0.9945, Adjusted R-squared:  0.9942 
## F-statistic: 3357 on 6 and 111 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb.3)

##          thetaS          rhoS          tmrcaS    thetaS:rhoS    thetaS:tmrcaS
## 1.311262  1.350122  3.587912  1.134489  1.348406
## rhoS:tmrcaS
```

```

##      3.644331

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 4] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep4, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep4, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep4, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep4, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1734.204
## g.div.200kb.2 8 -1714.992
## g.div.200kb.3 7 -1711.444
## g.div.200kb.4 7 -1731.676

summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep4
##      AIC      BIC logLik
## -1711.444 -1692.05 862.7222
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##      power
## 0.03207734
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.0034535 0.00001562 221.09509     0
## thetaS       1.0511893 0.00995135 105.63281     0
## rhoS        0.0461182 0.00870646  5.29701     0
## tmrcaS      0.0050657 0.00012452 40.68200     0
## thetaS:tmrcaS 1.4907778 0.06401702 23.28721     0
##
## Correlation:
## (Intr) thetaS rhoS   tmrcaS
## thetaS    0.065
## rhoS     -0.019 -0.338
## tmrcaS   -0.038 -0.172 -0.220
## thetaS:tmrcaS -0.228 -0.170  0.085  0.171
##

```

```

## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -5.95926937 -0.46066423  0.09235141  0.57624590  2.39702801
##
## Residual standard error: 0.0001948346
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##      thetaS       rhoS      tmrcaS thetaS:tmrcaS
##      1.229295    1.247833    1.162730     1.058662

```

5.3.5 Replicate 5

```

rep5.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep5_w200000.csv", sep = ",", header = T)

rep_5.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.d")
rep_5.pi.200kb$avg <- apply(rep_5.pi.200kb[4:ncol(rep_5.pi.200kb)], 1, mean)
rep_5.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.d")
rep_5.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.d")
rep_5.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.d")
rep_5.tmrca.200kb$avg <- apply(rep_5.tmrca.200kb[4:ncol(rep_5.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep5 <- as.data.frame(cbind(rep_5.pi.200kb$avg, sim.theta.200kb$Rate, rep5.sim.tmrca.200kb))
names(true.lands.200kb.rep5) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep5$thetaS <- (true.lands.200kb.rep5$theta - mean(true.lands.200kb.rep5$theta)) / sd(true.lands.200kb.rep5$theta)
true.lands.200kb.rep5$tmrcaS <- (true.lands.200kb.rep5$tmrca - mean(true.lands.200kb.rep5$tmrca)) / sd(true.lands.200kb.rep5$tmrca)
true.lands.200kb.rep5$rhoS <- (true.lands.200kb.rep5$rho - mean(true.lands.200kb.rep5$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep5)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.200kb.true[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 5] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep5)
##
## Residuals:
##      Min       1Q       Median      3Q      Max
## -6.280e-04 -1.776e-04  1.017e-05  1.643e-04  6.656e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.448e-03 2.192e-05 157.322 < 2e-16 ***
## thetaS      1.588e-03 2.306e-05  68.876 < 2e-16 ***

```

```

## rhoS          1.148e-04  3.220e-05   3.567  0.000535 ***
## tmrcaS       9.394e-04  3.374e-05  27.841  < 2e-16 ***
## thetaS:tmrcaS 5.327e-04  2.444e-05  21.800  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000234 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9885, Adjusted R-squared:  0.9881
## F-statistic:  2390 on 4 and 111 DF,  p-value: < 2.2e-16
vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.116568     2.177071     2.145037     1.100877

# now the lm with inferred landscapes
inf.lands.200kb.rep5 <- as.data.frame(cbind(rep_5.pi.200kb$avg, rep_5.theta.200kb$sample_mean, rep_5.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep5) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[5, 2] <- cor.test(sim.theta.200kb$Rate, rep_5.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[5, 2] <- cor.test(sim.rho.200kb$Rate, rep_5.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[5, 2] <- cor.test(rep5.sim.tmrca.200kb$AverageTmrca, rep_5.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep5$thetaS <- (inf.lands.200kb.rep5$theta - mean(inf.lands.200kb.rep5$theta)) / sd(inf.lands.200kb.rep5$theta)
inf.lands.200kb.rep5$tmrcaS <- (inf.lands.200kb.rep5$tmrca - mean(inf.lands.200kb.rep5$tmrca)) / sd(inf.lands.200kb.rep5$tmrca)
inf.lands.200kb.rep5$rhoS <- (inf.lands.200kb.rep5$rho - mean(inf.lands.200kb.rep5$rho)) / sd(inf.lands.200kb.rep5$rho)

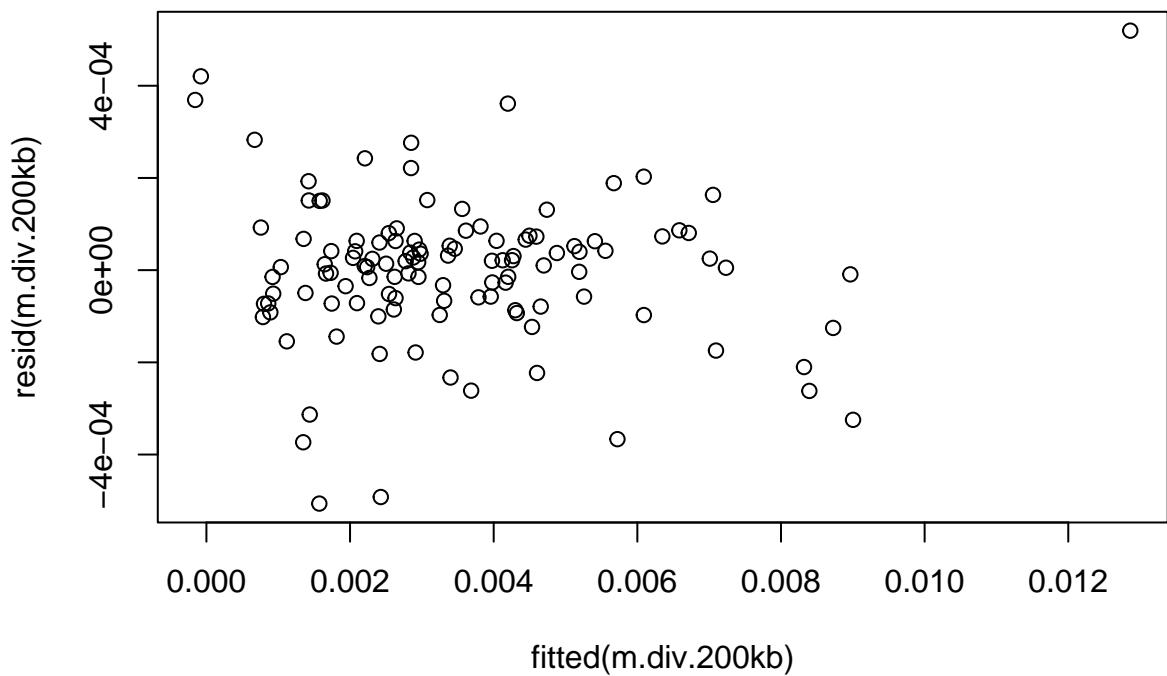
inf.lands.200kb.rep5$bin <- 1:nrow(inf.lands.200kb.rep5)
inf.lands.200kb.rep5$Replicate <- 5

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep5)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep5)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep5)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1719.223
## m.div.200kb.2  7 -1752.807
## m.div.200kb.3  8 -1753.702
plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```

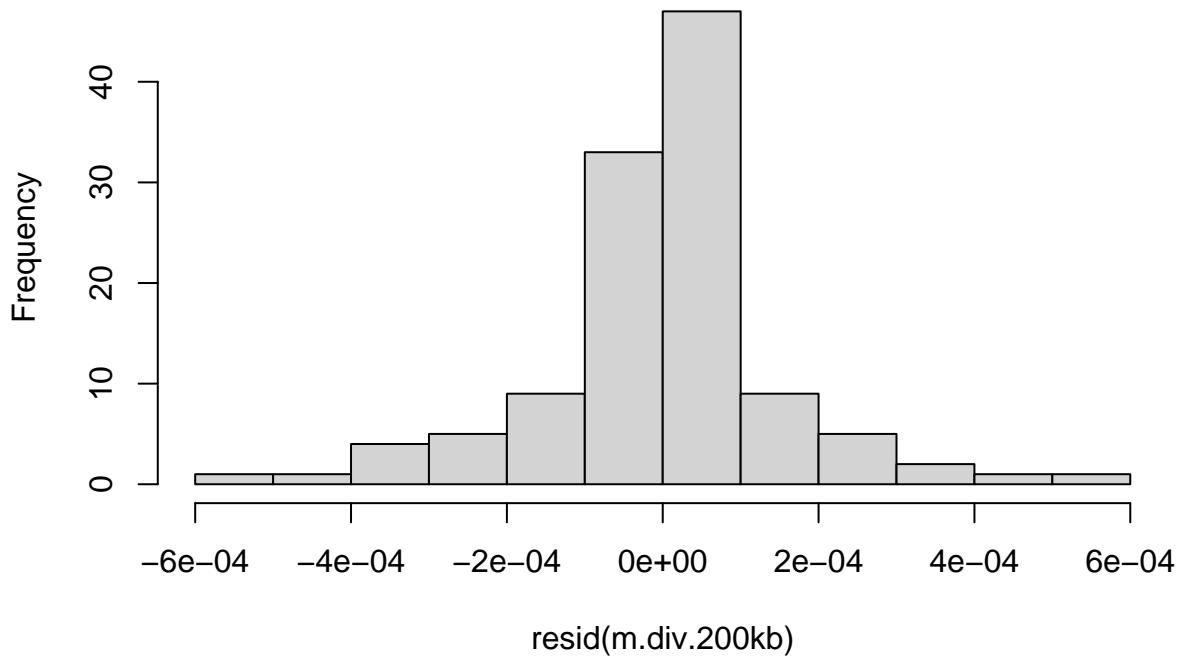


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.3237, p-value = 6.006e-05
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.38497, p-value = 0.034
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = inf.lands.200kb.rep5)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -5.064e-04 -7.206e-05  1.342e-05  6.558e-05  5.195e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.461e-03 1.497e-05 231.248 <2e-16 ***  
## thetaS      1.746e-03 1.628e-05 107.250 <2e-16 ***  
## rhoS        1.074e-05 1.741e-05  0.617  0.539  
## tmrcaS      8.733e-04 1.645e-05  53.084 <2e-16 ***  
## thetaS:tmrcaS 4.289e-04 1.624e-05  26.410 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001612 on 113 degrees of freedom  
## Multiple R-squared:  0.9947, Adjusted R-squared:  0.9945  
## F-statistic:  5272 on 4 and 113 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.194238 1.364822 1.219006 1.052749
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.200kb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 5] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep5, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep5, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep5, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep5, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1755.478
## g.div.200kb.2 8 -1740.007
## g.div.200kb.3 7 -1725.582
## g.div.200kb.4 7 -1749.740
summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep5
##          AIC      BIC    logLik
## -1725.582 -1706.187 869.7909
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.4273153
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003463751 1.505192e-05 230.12028 0.0000
## thetaS       0.001741480 1.812070e-05  96.10447 0.0000
## rhoS        0.000023430 1.714491e-05   1.36660 0.1745
## tmrcaS      0.000869143 1.642206e-05  52.92532 0.0000
## thetaS:tmrcaS 0.000411399 1.810073e-05  22.72832 0.0000
##
## Correlation:
## (Intr) thetaS rhoS   tmrcaS
## thetaS     0.368
## rhoS      0.004 -0.344
## tmrcaS    -0.053  0.016 -0.393
## thetaS:tmrcaS -0.148 -0.190 -0.011  0.342
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.75640462 -0.47240720  0.07496887  0.41643045  2.69009455
##
## Residual standard error: 0.001969146
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.190932     1.375450     1.374444     1.190572

```

5.3.6 Replicate 6

```

rep6.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep6_w200000.csv", sep = ",", header = T)

rep_6.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.d")
rep_6.pi.200kb$avg <- apply(rep_6.pi.200kb[4:ncol(rep_6.pi.200kb)], 1, mean)
rep_6.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.d")
rep_6.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.d")
rep_6.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.d")
rep_6.tmrca.200kb$avg <- apply(rep_6.tmrca.200kb[4:ncol(rep_6.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep6 <- as.data.frame(cbind(rep_6.pi.200kb$avg, sim.theta.200kb$Rate, rep6.sim.tmrca.200kb))
names(true.lands.200kb.rep6) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep6$thetaS <- (true.lands.200kb.rep6$theta - mean(true.lands.200kb.rep6$theta)) / sd(true.lands.200kb.rep6$theta)
true.lands.200kb.rep6$tmrcaS <- (true.lands.200kb.rep6$tmrca - mean(true.lands.200kb.rep6$tmrca)) / sd(true.lands.200kb.rep6$tmrca)
true.lands.200kb.rep6$rhoS <- (true.lands.200kb.rep6$rho - mean(true.lands.200kb.rep6$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep6)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 6] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep6)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.238e-04 -1.321e-04 -2.466e-05  1.243e-04  5.906e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.448e-03 2.096e-05 164.547 < 2e-16 ***
## thetaS      1.613e-03 2.220e-05  72.655 < 2e-16 ***
## rhoS       9.544e-05 3.064e-05   3.115  0.00234 **

```

```

## tmrcaS      1.018e-03 3.149e-05 32.314 < 2e-16 ***
## thetaS:tmrcaS 5.587e-04 2.448e-05 22.828 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002237 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9901, Adjusted R-squared:  0.9898
## F-statistic:  2782 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.132667     2.157213     2.133494     1.128188

# now the lm with inferred landscapes
inf.lands.200kb.rep6 <- as.data.frame(cbind(rep_6.pi.200kb$avg, rep_6.theta.200kb$sample_mean, rep_6.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep6) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[6, 2] <- cor.test(sim.theta.200kb$Rate, rep_6.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[6, 2] <- cor.test(sim.rho.200kb$Rate, rep_6.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[6, 2] <- cor.test(rep6.sim.tmrca.200kb$AverageTmrca, rep_6.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep6$thetaS <- (inf.lands.200kb.rep6$theta - mean(inf.lands.200kb.rep6$theta)) / sd(inf.lands.200kb.rep6)
inf.lands.200kb.rep6$tmrcaS <- (inf.lands.200kb.rep6$tmrca - mean(inf.lands.200kb.rep6$tmrca)) / sd(inf.lands.200kb.rep6)
inf.lands.200kb.rep6$rhoS <- (inf.lands.200kb.rep6$rho - mean(inf.lands.200kb.rep6$rho)) / sd(inf.lands.200kb.rep6)

inf.lands.200kb.rep6$bin <- 1:nrow(inf.lands.200kb.rep6)
inf.lands.200kb.rep6$Replicate <- 6

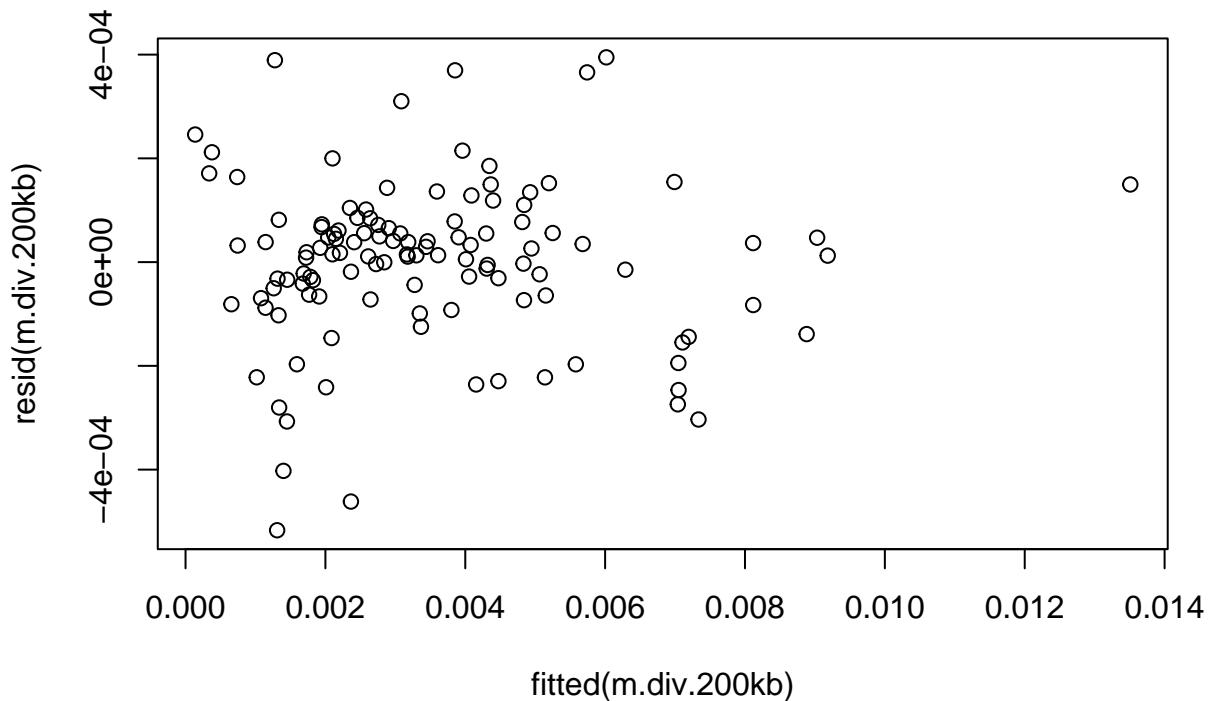
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep6)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep6)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep6)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1721.284
## m.div.200kb.2  7 -1738.537
## m.div.200kb.3  8 -1737.848

plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```

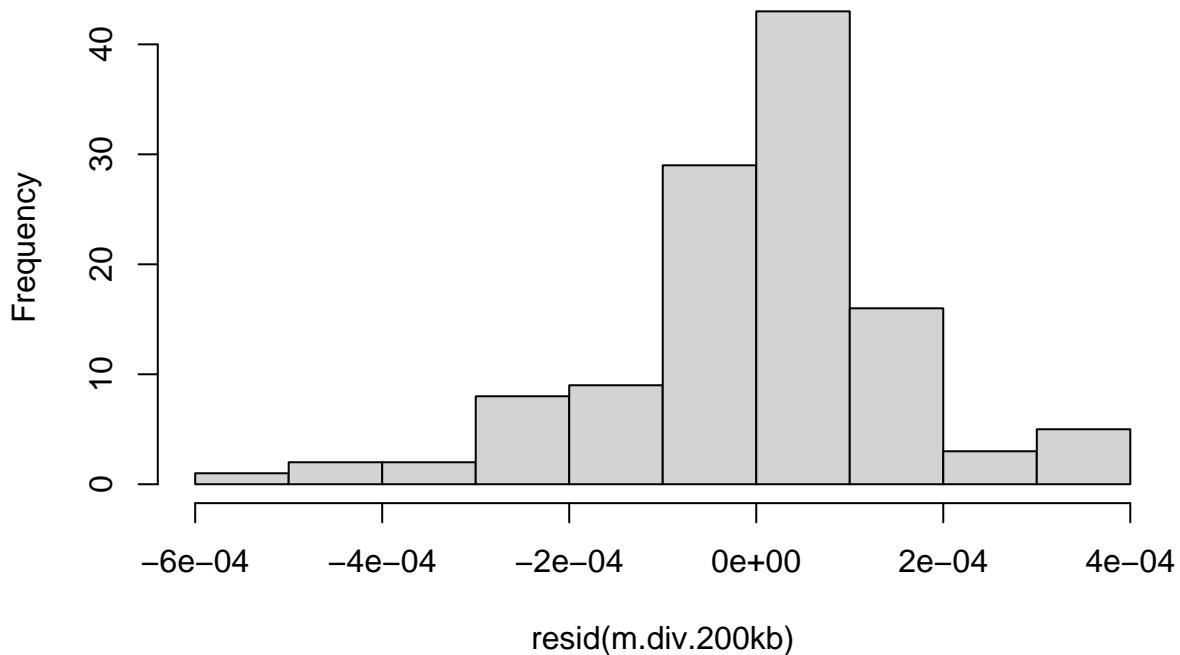


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.1428, p-value = 6.441e-07
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.37066, p-value = 0.02
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.200kb.rep6)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -5.169e-04 -6.868e-05  1.496e-05  7.251e-05  3.947e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.420e-03  1.512e-05 226.13 <2e-16 ***
## thetaS      1.761e-03  1.631e-05 107.98 <2e-16 ***
## rhoS        3.867e-05  1.646e-05   2.35  0.0205 *  
## tmrcaS      8.002e-04  1.654e-05  48.37 <2e-16 ***
## thetaS:tmrcaS 4.255e-04  1.545e-05   27.55 <2e-16 ***
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001598 on 113 degrees of freedom
## Multiple R-squared:  0.995, Adjusted R-squared:  0.9949 
## F-statistic: 5662 on 4 and 113 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.218686 1.240995 1.254307 1.128567
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 6] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep6, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep6, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep6, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep6, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1750.916
## g.div.200kb.2 8 -1746.207
## g.div.200kb.3 7 -1722.532
## g.div.200kb.4 7 -1738.724
summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep6
##          AIC      BIC  logLik
## -1722.532 -1703.137 868.266
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.2643174
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003418882 1.528718e-05 223.64371 0.0000
## thetaS       0.001769647 1.743069e-05 101.52477 0.0000
## rhoS        0.000038668 1.626590e-05   2.37724 0.0191
## tmrcaS      0.000797890 1.686843e-05  47.30080 0.0000
## thetaS:tmrcaS 0.000425161 1.733549e-05  24.52543 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.297
## rhoS        0.011 -0.220
## tmrcaS     -0.115 -0.201 -0.326
## thetaS:tmrcaS -0.265 -0.294 -0.019  0.420
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3      Max
## -3.8683483 -0.4416453  0.1205680  0.5114539  2.3563921
##
## Residual standard error: 0.0007276808
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##     1.202416     1.242707     1.436129     1.292643

```

5.3.7 Replicate 7

```

rep7.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep7_w200000.csv", sep = ",", header = T)

rep_7.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.d")
rep_7.pi.200kb$avg <- apply(rep_7.pi.200kb[4:ncol(rep_7.pi.200kb)], 1, mean)
rep_7.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.d")
rep_7.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.d")
rep_7.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.d")
rep_7.tmrca.200kb$avg <- apply(rep_7.tmrca.200kb[4:ncol(rep_7.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep7 <- as.data.frame(cbind(rep_7.pi.200kb$avg, sim.theta.200kb$Rate, rep7.sim.tmrca.200kb))
names(true.lands.200kb.rep7) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep7$thetaS <- (true.lands.200kb.rep7$theta - mean(true.lands.200kb.rep7$theta)) / sd(true.lands.200kb.rep7$theta)
true.lands.200kb.rep7$tmrcaS <- (true.lands.200kb.rep7$tmrca - mean(true.lands.200kb.rep7$tmrca)) / sd(true.lands.200kb.rep7$tmrca)
true.lands.200kb.rep7$rhoS <- (true.lands.200kb.rep7$rho - mean(true.lands.200kb.rep7$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep7)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 7] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep7)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.0008334 -0.0001297  0.0000016  0.0001455  0.0007245
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.393e-03 2.171e-05 156.30 < 2e-16 ***
## thetaS      1.566e-03 2.289e-05  68.41 < 2e-16 ***
## rhoS       1.086e-04 3.185e-05   3.41 0.000908 ***

```

```

## tmrcaS      9.978e-04  3.286e-05   30.36 < 2e-16 ***
## thetaS:tmrcaS 5.408e-04  2.489e-05   21.73 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002316 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9889, Adjusted R-squared:  0.9885
## F-statistic:  2481 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.123292     2.173929     2.143539     1.118905

# now the lm with inferred landscapes
inf.lands.200kb.rep7 <- as.data.frame(cbind(rep_7.pi.200kb$avg, rep_7.theta.200kb$sample_mean, rep_7.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep7) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[7, 2] <- cor.test(sim.theta.200kb$Rate, rep_7.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[7, 2] <- cor.test(sim.rho.200kb$Rate, rep_1.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[7, 2] <- cor.test(rep7.sim.tmrca.200kb$AverageTmrca, rep_7.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep7$thetaS <- (inf.lands.200kb.rep7$theta - mean(inf.lands.200kb.rep7$theta)) / sd(inf.lands.200kb.rep7$theta)
inf.lands.200kb.rep7$tmrcaS <- (inf.lands.200kb.rep7$tmrca - mean(inf.lands.200kb.rep7$tmrca)) / sd(inf.lands.200kb.rep7$tmrca)
inf.lands.200kb.rep7$rhoS <- (inf.lands.200kb.rep7$rho - mean(inf.lands.200kb.rep7$rho)) / sd(inf.lands.200kb.rep7$rho)

inf.lands.200kb.rep7$bin <- 1:nrow(inf.lands.200kb.rep7)
inf.lands.200kb.rep7$Replicate <- 7

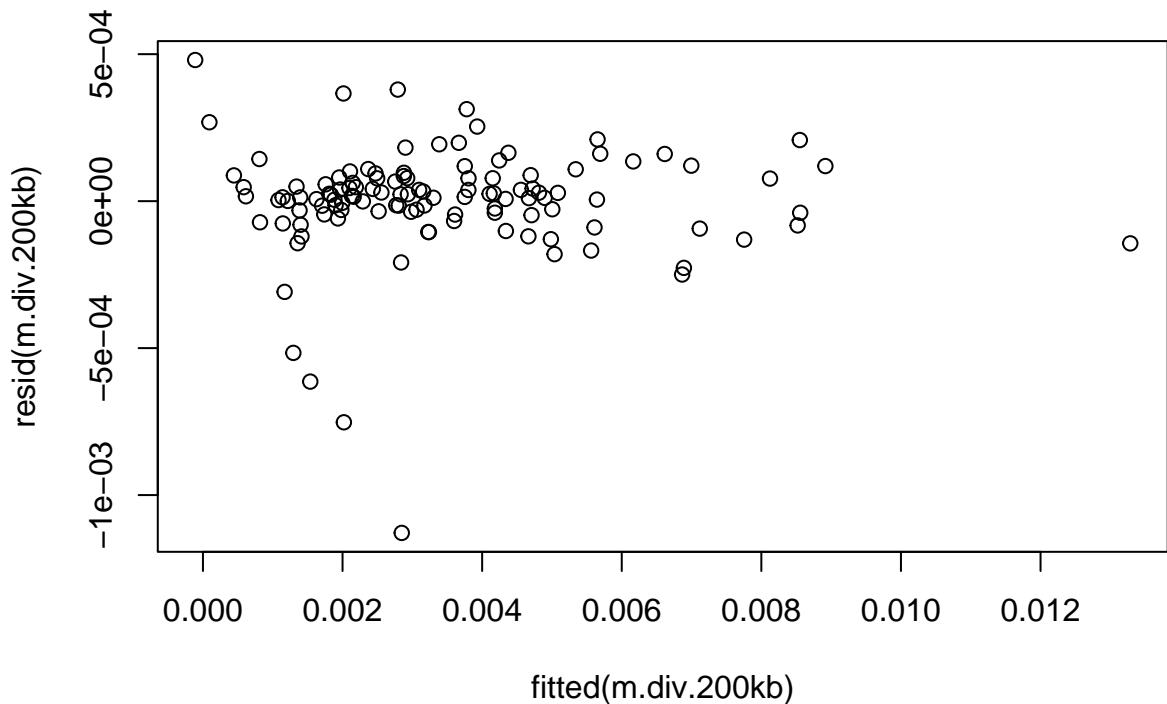
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep7)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep7)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep7)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1675.014
## m.div.200kb.2  7 -1686.944
## m.div.200kb.3  8 -1685.792

plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```



```
dwtest(m.div.200kb)
```

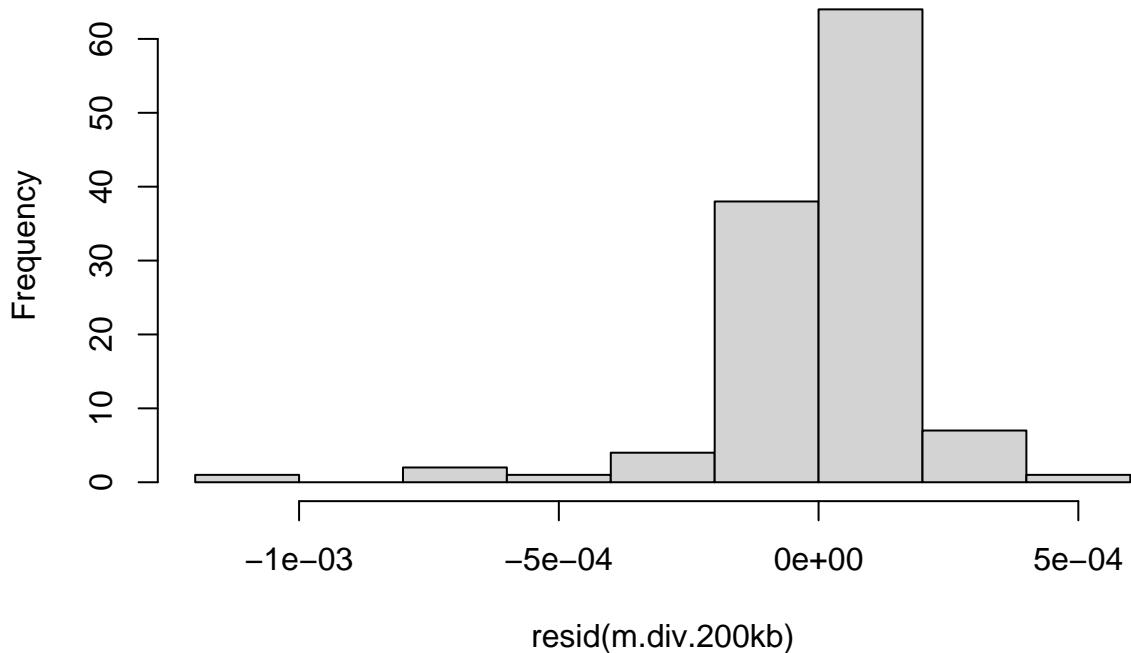
```
##  
## Durbin-Watson test  
##  
## data: m.div.200kb  
## DW = 1.4537, p-value = 0.0008495  
## alternative hypothesis: true autocorrelation is greater than 0
```

```
hmctest(m.div.200kb)
```

```
##  
## Harrison-McCabe test  
##  
## data: m.div.200kb  
## HMC = 0.2727, p-value < 2.2e-16
```

```
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = inf.lands.200kb.rep7)  
##  
## Residuals:  
##       Min        1Q     Median        3Q       Max  
## -1.129e-03 -4.377e-05  1.575e-05  7.812e-05  4.801e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.341e-03 1.908e-05 175.137 <2e-16 ***  
## thetaS      1.759e-03 2.163e-05  81.322 <2e-16 ***  
## rhoS        5.173e-05 2.089e-05   2.477  0.0147 *  
## tmrcaS      7.373e-04 2.268e-05  32.515 <2e-16 ***  
## thetaS:tmrcaS 4.077e-04 2.234e-05  18.247 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001944 on 113 degrees of freedom  
## Multiple R-squared:  0.9923, Adjusted R-squared:  0.9921  
## F-statistic: 3652 on 4 and 113 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.448403 1.350946 1.592234 1.429919
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 7] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep7, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep7, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep7, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep7, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1699.268
## g.div.200kb.2 8 -1683.987
## g.div.200kb.3 7 -1674.195
## g.div.200kb.4 7 -1698.505
summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep7
##          AIC      BIC   logLik
## -1674.195 -1654.801 844.0976
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.2235436
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003337941 1.960767e-05 170.23653 0.0000
## thetaS       0.001755110 2.330934e-05  75.29644 0.0000
## rhoS        0.000054046 2.121448e-05   2.54762 0.0122
## tmrcaS      0.000740737 2.422442e-05  30.57810 0.0000
## thetaS:tmrcaS 0.000418080 2.553241e-05  16.37449 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS      0.309
## rhoS       -0.017 -0.333
## tmrcaS     -0.248 -0.333 -0.236
## thetaS:tmrcaS -0.396 -0.376  0.054  0.631
##
## Standardized residuals:
```

```

##      Min       Q1       Med       Q3       Max
## -5.6176121 -0.2278995  0.1068782  0.4264629  2.6382834
##
## Residual standard error: 0.0007080388
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##     1.430415     1.377155     2.059089     1.818743

```

5.3.8 Replicate 8

```

rep8.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep8_w200000.csv", sep = ",", header = T)

rep_8.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.d")
rep_8.pi.200kb$avg <- apply(rep_8.pi.200kb[4:ncol(rep_8.pi.200kb)], 1, mean)
rep_8.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.d")
rep_8.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.d")
rep_8.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.d")
rep_8.tmrca.200kb$avg <- apply(rep_8.tmrca.200kb[4:ncol(rep_8.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep8 <- as.data.frame(cbind(rep_8.pi.200kb$avg, sim.theta.200kb$Rate, rep8.sim.tmrca.200kb))
names(true.lands.200kb.rep8) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep8$thetaS <- (true.lands.200kb.rep8$theta - mean(true.lands.200kb.rep8$theta)) / sd(true.lands.200kb.rep8$theta)
true.lands.200kb.rep8$tmrcaS <- (true.lands.200kb.rep8$tmrca - mean(true.lands.200kb.rep8$tmrca)) / sd(true.lands.200kb.rep8$tmrca)
true.lands.200kb.rep8$rhoS <- (true.lands.200kb.rep8$rho - mean(true.lands.200kb.rep8$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep8)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 8] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep8)
##
## Residuals:
##      Min       1Q       Median       3Q       Max
## -6.127e-04 -1.414e-04 -2.110e-06  1.274e-04  7.647e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.417e-03 2.194e-05 155.752 < 2e-16 ***
## thetaS      1.575e-03 2.312e-05  68.136 < 2e-16 ***
## rhoS       8.791e-05 3.157e-05   2.784  0.00631 **

```

```

## tmrcaS      9.999e-04  3.285e-05  30.442  < 2e-16 ***
## thetaS:tmrcaS 5.343e-04  2.496e-05  21.405  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002341 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9886, Adjusted R-squared:  0.9882
## F-statistic:  2401 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.121484     2.091228     2.066490     1.116633

# now the lm with inferred landscapes
inf.lands.200kb.rep8 <- as.data.frame(cbind(rep_8.pi.200kb$avg, rep_8.theta.200kb$sample_mean, rep_8.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep8) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[8, 2] <- cor.test(sim.theta.200kb$Rate, rep_8.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[8, 2] <- cor.test(sim.rho.200kb$Rate, rep_8.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[8, 2] <- cor.test(rep8.sim.tmrca.200kb$AverageTmrca, rep_8.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep8$thetaS <- (inf.lands.200kb.rep8$theta - mean(inf.lands.200kb.rep8$theta)) / sd(inf.lands.200kb.rep8)
inf.lands.200kb.rep8$tmrcaS <- (inf.lands.200kb.rep8$tmrca - mean(inf.lands.200kb.rep8$tmrca)) / sd(inf.lands.200kb.rep8)
inf.lands.200kb.rep8$rhoS <- (inf.lands.200kb.rep8$rho - mean(inf.lands.200kb.rep8$rho)) / sd(inf.lands.200kb.rep8)

inf.lands.200kb.rep8$bin <- 1:nrow(inf.lands.200kb.rep8)
inf.lands.200kb.rep8$Replicate <- 8

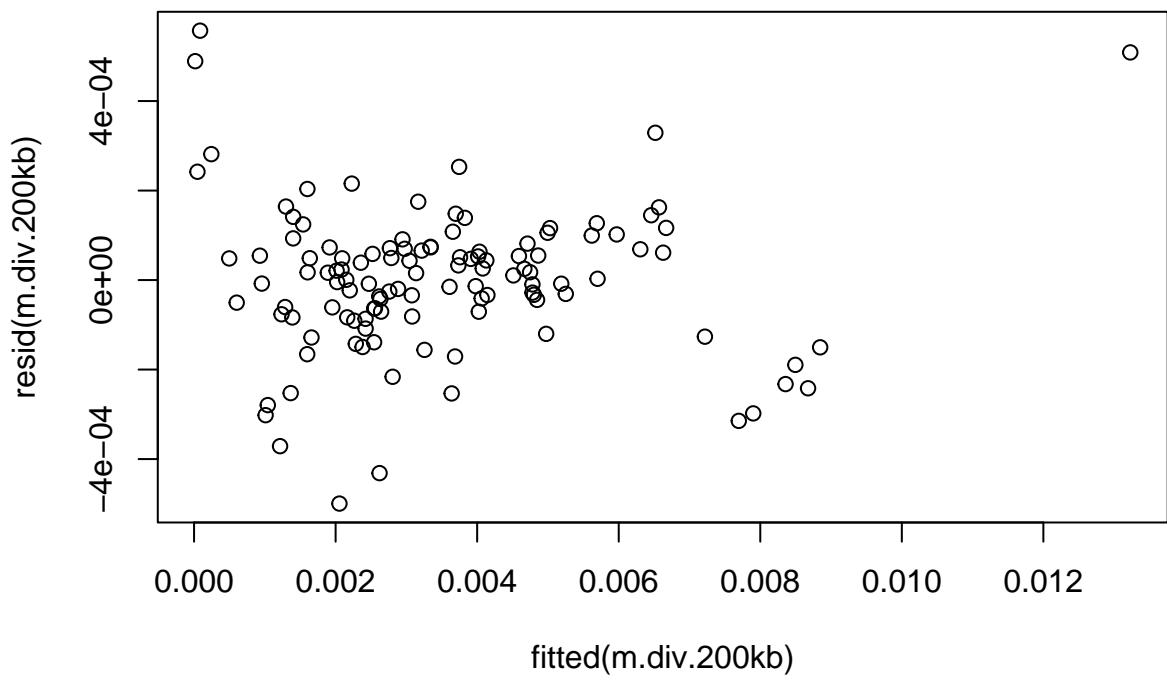
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep8)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep8)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep8)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1711.201
## m.div.200kb.2  7 -1752.777
## m.div.200kb.3  8 -1754.136

plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```

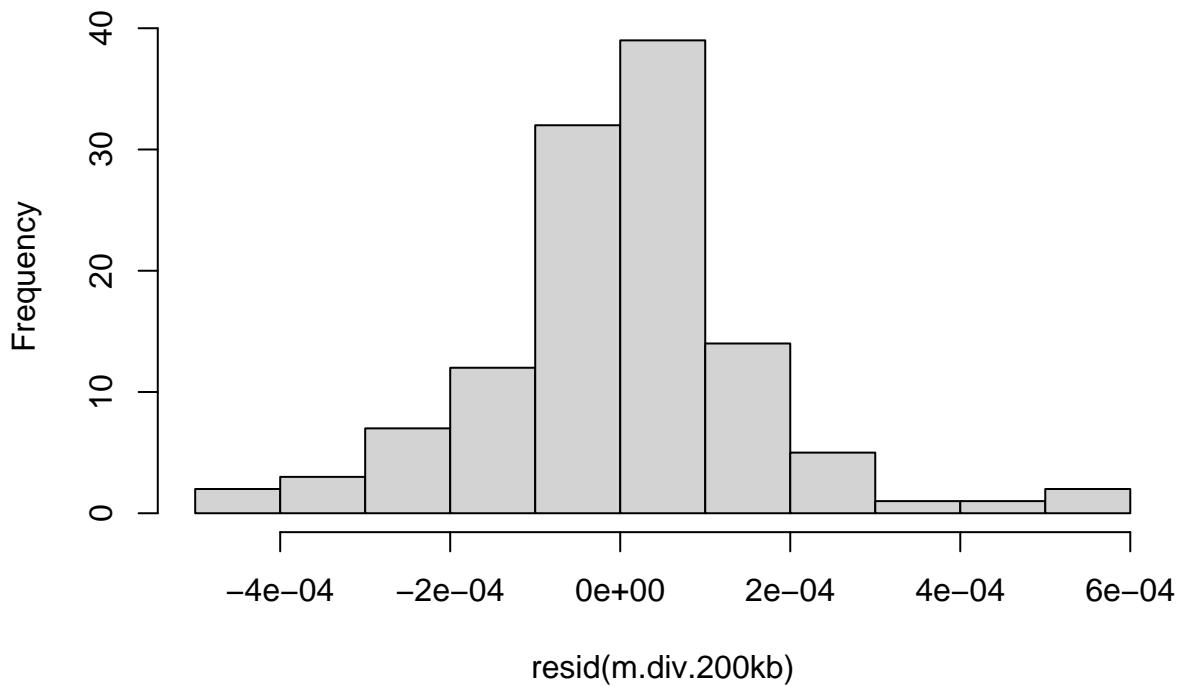


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.4172, p-value = 0.0004208
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.36722, p-value = 0.018
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.200kb.rep8)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.995e-04 -7.501e-05  1.296e-05  7.253e-05  5.573e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.435e-03 1.548e-05 221.813 <2e-16 ***
## thetaS      1.640e-03 1.724e-05  95.133 <2e-16 ***
## rhoS        1.806e-05 1.814e-05   0.996   0.322
## tmrcaS     9.569e-04 1.745e-05  54.824 <2e-16 ***
## thetaS:tmrcaS 4.956e-04 1.962e-05  25.255 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001668 on 113 degrees of freedom
## Multiple R-squared:  0.9943, Adjusted R-squared:  0.9941
## F-statistic: 4932 on 4 and 113 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.250197    1.385057    1.281836    1.151172
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 8] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep8, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep8, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep8, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep8, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##           df      AIC
## g.div.200kb.1 8 -1755.740
## g.div.200kb.2 8 -1748.646
## g.div.200kb.3 7 -1738.511
## g.div.200kb.4 7 -1746.257
summary(g.div.200kb.3)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep8
##          AIC      BIC    logLik
## -1738.511 -1719.117 876.2557
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##       power
## 0.9408611
##
## Coefficients:
##             Value   Std.Error  t-value p-value
## (Intercept) 0.003441349 1.605530e-05 214.34353 0.0000
## thetaS       0.001656159 1.902817e-05  87.03720 0.0000
## rhoS        0.000027573 1.528320e-05   1.80415 0.0739
## tmrcaS      0.000946314 1.679220e-05  56.35435 0.0000
## thetaS:tmrcaS 0.000399466 2.119286e-05 18.84906 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.669
## rhoS      -0.030 -0.307
## tmrcaS    -0.024  0.044 -0.398
## thetaS:tmrcaS -0.138 -0.320  0.016  0.489
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.28659664 -0.55199225  0.07202289  0.46452382  2.73812395
##
## Residual standard error: 0.03959627
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.3)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.256856     1.355579     1.701715     1.595889

```

5.3.9 Replicate 9

```

rep9.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep9_w200000.csv", sep = ",", header = T)

rep_9.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.d")
rep_9.pi.200kb$avg <- apply(rep_9.pi.200kb[4:ncol(rep_9.pi.200kb)], 1, mean)
rep_9.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.d")
rep_9.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.d")
rep_9.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.d")
rep_9.tmrca.200kb$avg <- apply(rep_9.tmrca.200kb[4:ncol(rep_9.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep9 <- as.data.frame(cbind(rep_9.pi.200kb$avg, sim.theta.200kb$Rate, rep9.sim.tmrca.200kb))
names(true.lands.200kb.rep9) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep9$thetaS <- (true.lands.200kb.rep9$theta - mean(true.lands.200kb.rep9$theta)) / sd(true.lands.200kb.rep9$theta)
true.lands.200kb.rep9$tmrcaS <- (true.lands.200kb.rep9$tmrca - mean(true.lands.200kb.rep9$tmrca)) / sd(true.lands.200kb.rep9$tmrca)
true.lands.200kb.rep9$rhoS <- (true.lands.200kb.rep9$rho - mean(true.lands.200kb.rep9$rho, na.rm = T))

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep9)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.200kb.true[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 9] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep9)
##
## Residuals:
##          Min         1Q     Median         3Q        Max
## -0.0008667 -0.0001304 -0.0000092  0.0001453  0.0005902
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.470e-03 2.182e-05 159.047 < 2e-16 ***
## thetaS      1.606e-03 2.326e-05  69.038 < 2e-16 ***
## rhoS       1.107e-04 3.273e-05   3.383 0.000992 ***

```

```

## tmrcaS      9.397e-04  3.347e-05  28.076  < 2e-16 ***
## thetaS:tmrcaS 5.353e-04  2.538e-05  21.094  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0002332 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9889, Adjusted R-squared:  0.9885
## F-statistic:  2464 on 4 and 111 DF,  p-value: < 2.2e-16

vif(m.div.200kb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.144079     2.264736     2.224994     1.143130

# now the lm with inferred landscapes
inf.lands.200kb.rep9 <- as.data.frame(cbind(rep_9.pi.200kb$avg, rep_9.theta.200kb$sample_mean, rep_9.tmrca.200kb$sample_mean))
names(inf.lands.200kb.rep9) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[9, 2] <- cor.test(sim.theta.200kb$Rate, rep_9.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[9, 2] <- cor.test(sim.rho.200kb$Rate, rep_9.rho.200kb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[9, 2] <- cor.test(rep9.sim.tmrca.200kb$AverageTmrca, rep_9.tmrca.200kb$avg, method = "spearman")$estimate

# standardizing
inf.lands.200kb.rep9$thetaS <- (inf.lands.200kb.rep9$theta - mean(inf.lands.200kb.rep9$theta)) / sd(inf.lands.200kb.rep9$theta)
inf.lands.200kb.rep9$tmrcaS <- (inf.lands.200kb.rep9$tmrca - mean(inf.lands.200kb.rep9$tmrca)) / sd(inf.lands.200kb.rep9$tmrca)
inf.lands.200kb.rep9$rhoS <- (inf.lands.200kb.rep9$rho - mean(inf.lands.200kb.rep9$rho)) / sd(inf.lands.200kb.rep9$rho)

inf.lands.200kb.rep9$bin <- 1:nrow(inf.lands.200kb.rep9)
inf.lands.200kb.rep9$Replicate <- 9

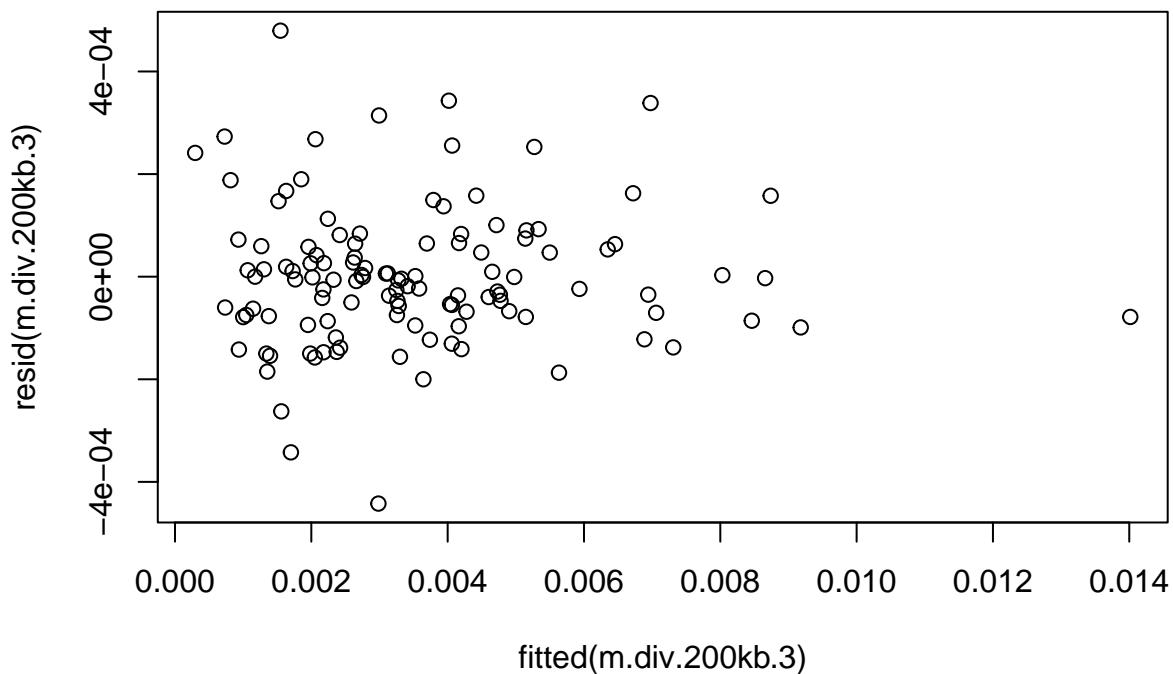
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep9)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep9)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep9)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##           df      AIC
## m.div.200kb    6 -1753.774
## m.div.200kb.2  7 -1752.849
## m.div.200kb.3  8 -1750.851

plot(resid(m.div.200kb.3) ~ fitted(m.div.200kb.3))

```

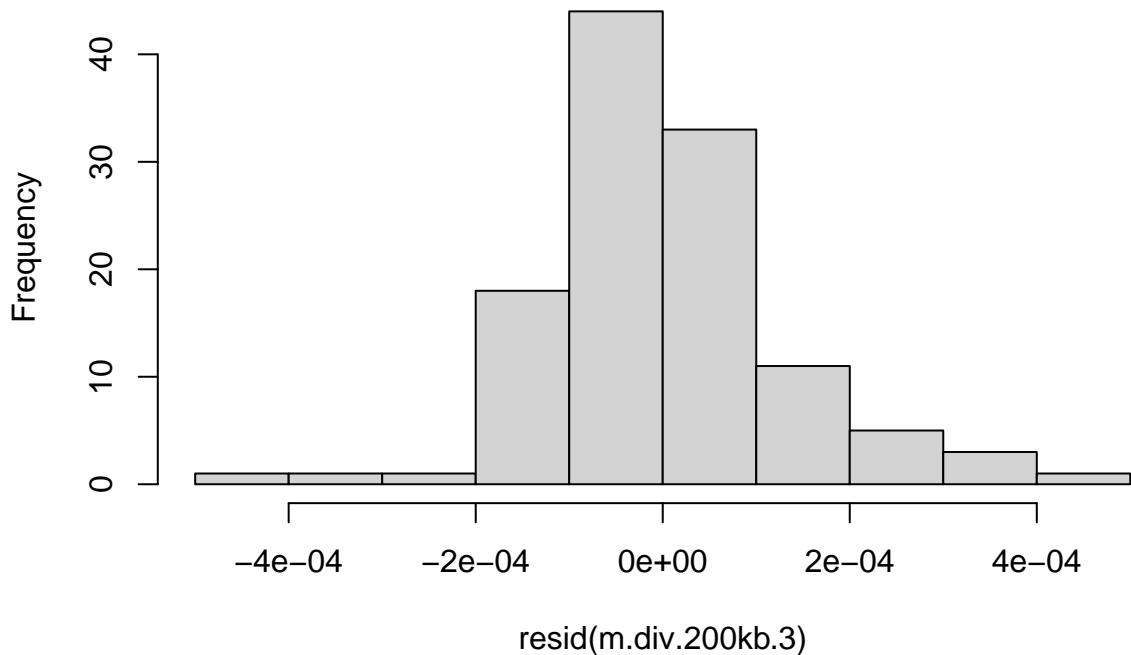


```
dwtest(m.div.200kb.3)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb.3
## DW = 1.9465, p-value = 0.312
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb.3)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb.3
## HMC = 0.31474, p-value = 0.001
hist(resid(m.div.200kb.3))
```

Histogram of resid(m.div.200kb.3)



```
summary(m.div.200kb.3)
```

```
##  
## Call:  
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep9)  
##  
## Residuals:  
##      Min       1Q     Median       3Q      Max  
## -4.423e-04 -7.809e-05 -5.640e-06  6.408e-05  4.795e-04  
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.395e-03  1.920e-05 176.782 <2e-16 ***  
## thetaS       1.644e-03  1.626e-05 101.123 <2e-16 ***  
## rhoS        2.968e-05  1.960e-05   1.515   0.133  
## tmrcaS      8.716e-04  3.074e-05  28.357 <2e-16 ***  
## thetaS:rhoS 5.060e-07  1.184e-05   0.043   0.966  
## thetaS:tmrcaS 4.529e-04  1.789e-05  25.317 <2e-16 ***  
## rhoS:tmrcaS 3.126e-05  3.099e-05   1.009   0.315  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001398 on 111 degrees of freedom  
## Multiple R-squared:  0.9961, Adjusted R-squared:  0.9959  
## F-statistic: 4736 on 6 and 111 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb.3)
```

```
##          thetaS          rhoS          tmrcaS    thetaS:rhoS    thetaS:tmrcaS  
## 1.581793  2.297505  5.652415  1.286144  1.691315  
## rhoS:tmrcaS
```

```

##      4.947599

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 9] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep9, w
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep9, w
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep9, w
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep9, w

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1763.451
## g.div.200kb.2 8 -1750.490
## g.div.200kb.3 7 -1752.426
## g.div.200kb.4 7 -1765.407

summary(g.div.200kb.2)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep9
##      AIC      BIC  logLik
## -1750.49 -1728.325 883.2452
##
## Correlation Structure: AR(1)
## Formula: ~bin
## Parameter estimate(s):
##     Phi
## 0.02629291
## Variance function:
## Structure: Power of variance covariate
## Formula: ~theta
## Parameter estimates:
##     power
## 0.1488318
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003409319 1.396278e-05 244.17197 0.0000
## thetaS       0.001644282 1.656318e-05  99.27332 0.0000
## rhoS        0.000039900 1.599479e-05   2.49457 0.0141
## tmrcaS      0.000843881 1.608580e-05  52.46124 0.0000
## thetaS:tmrcaS 0.000456588 1.712556e-05  26.66121 0.0000
##
## Correlation:
##           (Intr) thetaS rhoS    tmrcaS

```

```

## thetaS      0.250
## rhoS       -0.023 -0.303
## tmrcaS     -0.139 -0.246 -0.367
## thetaS:tmrcaS -0.331 -0.451  0.082  0.414
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -2.79064045 -0.51820778 -0.04541142  0.41899672  3.46658576
##
## Residual standard error: 0.000329768
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.2)

```

```

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.461322 1.449022 1.590181    1.453830

```

5.3.10 Replicate 10

```

rep10.sim.tmrca.200kb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep10_w200000.csv", sep = ",", header = T)

rep_10.pi.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_pi.csv")
rep_10.pi.200kb$avg <- apply(rep_10.pi.200kb[4:ncol(rep_10.pi.200kb)], 1, mean)
rep_10.rho.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_rho.csv")
rep_10.theta.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_theta.csv")
rep_10.tmrca.200kb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_tmrca.csv")
rep_10.tmrca.200kb$avg <- apply(rep_10.tmrca.200kb[4:ncol(rep_10.tmrca.200kb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.200kb.rep10 <- as.data.frame(cbind(rep_10.pi.200kb$avg, sim.theta.200kb$Rate, rep10.sim.tmrca.200kb))
names(true.lands.200kb.rep10) <- c("diversity", "theta", "tmrca", "rho")
true.lands.200kb.rep10$thetaS <- (true.lands.200kb.rep10$theta - mean(true.lands.200kb.rep10$theta)) / sd(true.lands.200kb.rep10$theta)
true.lands.200kb.rep10$tmrcaS <- (true.lands.200kb.rep10$tmrca - mean(true.lands.200kb.rep10$tmrca)) / sd(true.lands.200kb.rep10$tmrca)
true.lands.200kb.rep10$rhoS <- (true.lands.200kb.rep10$rho - mean(true.lands.200kb.rep10$rho), na.rm = TRUE)

m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.200kb.rep10)
anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.200kb.true[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) / sum(anova.diversity$VarExp)
r2.bgs.200kb.true[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb.true[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb.true[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb.true[5, 10] <- anova.diversity$VarExp[4] * 100

summary(m.div.200kb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.200kb.rep10)
##
## Residuals:
##      Min       1Q   Median       3Q       Max
## -7.201e-04 -1.507e-04 -4.060e-06  1.738e-04  6.900e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.465e-03 2.234e-05 155.11 < 2e-16 ***
## thetaS      1.606e-03 2.377e-05  67.58 < 2e-16 ***
## rhoS        8.994e-05 3.270e-05   2.75  0.00695 ** 
## tmrcaS      9.824e-04 3.369e-05  29.16 < 2e-16 *** 
## thetaS:tmrcaS 4.977e-04 2.526e-05  19.70 < 2e-16 *** 
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0002383 on 111 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.9885, Adjusted R-squared:  0.9881 
## F-statistic: 2379 on 4 and 111 DF, p-value: < 2.2e-16

vif(m.div.200kb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.144480     2.165499     2.145223     1.144113

# now the lm with inferred landscapes
inf.lands.200kb.rep10 <- as.data.frame(cbind(rep_10.pi.200kb$avg, rep_10.theta.200kb$sample_mean, rep_10.rho.200kb$sample_mean))
names(inf.lands.200kb.rep10) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[10, 2] <- cor.test(sim.theta.200kb$Rate, rep_10.theta.200kb$sample_mean, method = "spearman")
cor.table.rho[10, 2] <- cor.test(sim.rho.200kb$Rate, rep_10.rho.200kb$sample_mean, method = "spearman")
cor.table.tmrca[10, 2] <- cor.test(rep10.sim.tmrca.200kb$AverageTmrca, rep_10.tmrca.200kb$avg, method = "spearman")

# standardizing
inf.lands.200kb.rep10$thetaS <- (inf.lands.200kb.rep10$theta - mean(inf.lands.200kb.rep10$theta)) / sd(inf.lands.200kb.rep10$theta)
inf.lands.200kb.rep10$tmrcaS <- (inf.lands.200kb.rep10$tmrca - mean(inf.lands.200kb.rep10$tmrca)) / sd(inf.lands.200kb.rep10$tmrca)
inf.lands.200kb.rep10$rhoS <- (inf.lands.200kb.rep10$rho - mean(inf.lands.200kb.rep10$rho)) / sd(inf.lands.200kb.rep10$rho)

inf.lands.200kb.rep10$bin <- 1:nrow(inf.lands.200kb.rep10)

inf.lands.200kb.rep10$Replicate <- 10

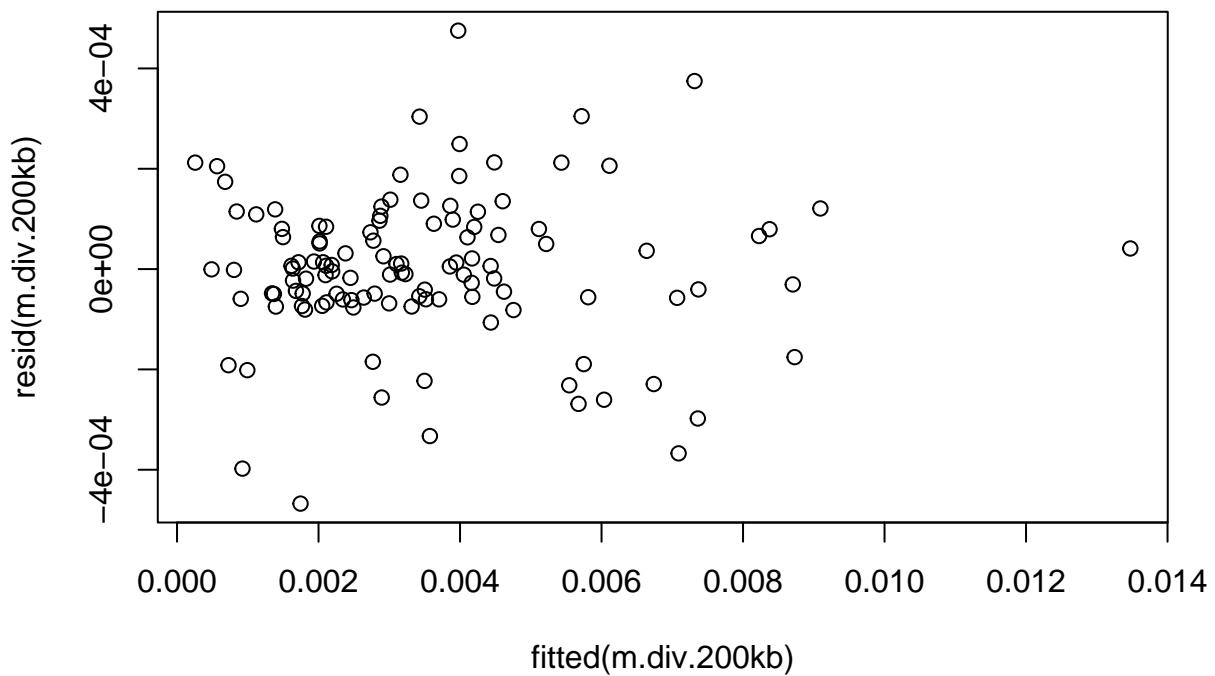
m.div.200kb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep10)
m.div.200kb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.200kb.rep10)
m.div.200kb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.200kb.rep10)

AIC(m.div.200kb, m.div.200kb.2, m.div.200kb.3)

##          df      AIC
## m.div.200kb    6 -1734.618
## m.div.200kb.2  7 -1735.599
## m.div.200kb.3  8 -1737.127

plot(resid(m.div.200kb) ~ fitted(m.div.200kb))

```

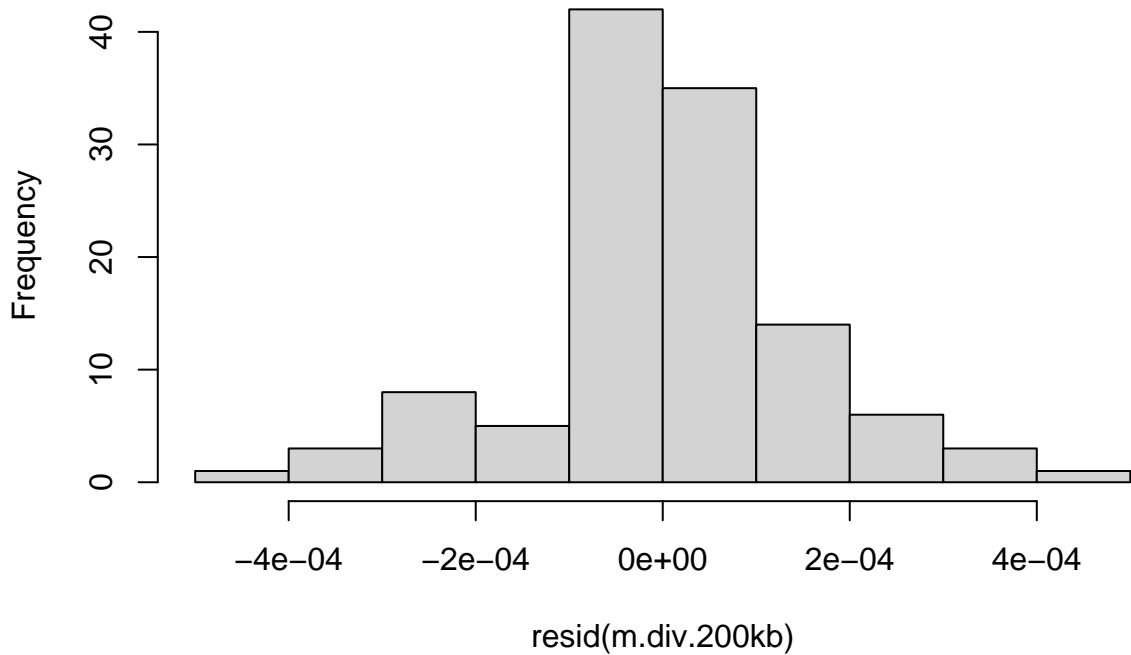


```
dwtest(m.div.200kb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.200kb
## DW = 1.2969, p-value = 3.058e-05
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.200kb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.200kb
## HMC = 0.39016, p-value = 0.042
hist(resid(m.div.200kb))
```

Histogram of resid(m.div.200kb)



```
summary(m.div.200kb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = inf.lands.200kb.rep10)  
##  
## Residuals:  
##      Min       1Q   Median       3Q      Max  
## -4.675e-04 -5.994e-05  2.700e-07  8.305e-05  4.753e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.461e-03 1.419e-05 244.019 < 2e-16 ***  
## thetaS       1.794e-03 1.560e-05 115.002 < 2e-16 ***  
## rhoS        5.741e-05 1.781e-05  3.224  0.00165 **  
## tmrcaS       7.298e-04 1.665e-05 43.821 < 2e-16 ***  
## thetaS:tmrcaS 3.619e-04 1.426e-05 25.371 < 2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.000151 on 113 degrees of freedom  
## Multiple R-squared:  0.9954, Adjusted R-squared:  0.9953  
## F-statistic: 6149 on 4 and 113 DF,  p-value: < 2.2e-16
```

```
vif(m.div.200kb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.248833 1.626728 1.423076 1.050467
```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.200kb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.200kb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.200kb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.200kb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.200kb[5, 10] <- anova.diversity$VarExp[4] * 100

g.div.200kb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep10, v
g.div.200kb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep10, v
g.div.200kb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep10, v
g.div.200kb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.200kb.rep10, v

AIC(g.div.200kb.1, g.div.200kb.2, g.div.200kb.3, g.div.200kb.4)

##          df      AIC
## g.div.200kb.1 8 -1746.826
## g.div.200kb.2 8 -1760.403
## g.div.200kb.3 7 -1740.621
## g.div.200kb.4 7 -1734.608
summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
## Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
## Data: inf.lands.200kb.rep10
##          AIC      BIC logLik
## -1734.608 -1715.213 874.304
##
## Variance function:
## Structure: Power of variance covariate
## Formula: ~tmrcaS
## Parameter estimates:
##       power
## 0.06585754
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003456651 1.395282e-05 247.73845 0.0000
## thetaS       0.001791494 1.545385e-05 115.92545 0.0000
## rhoS        0.000057760 1.745893e-05   3.30831 0.0013
## tmrcaS      0.000731416 1.833740e-05  39.88655 0.0000
## thetaS:tmrcaS 0.000363491 1.607889e-05  22.60670 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS   tmrcaS
## thetaS     0.044
## rhoS      0.022 -0.358
## tmrcaS   -0.071  0.007 -0.475
## thetaS:tmrcaS -0.188 -0.216  0.006  0.071
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.21935933 -0.35120581  0.01652401  0.59170149  3.02405764
##
## Residual standard error: 0.0001583413
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS      tmrcaS thetaS:tmrcaS
##     1.253421    1.545304    1.346750    1.057384

```

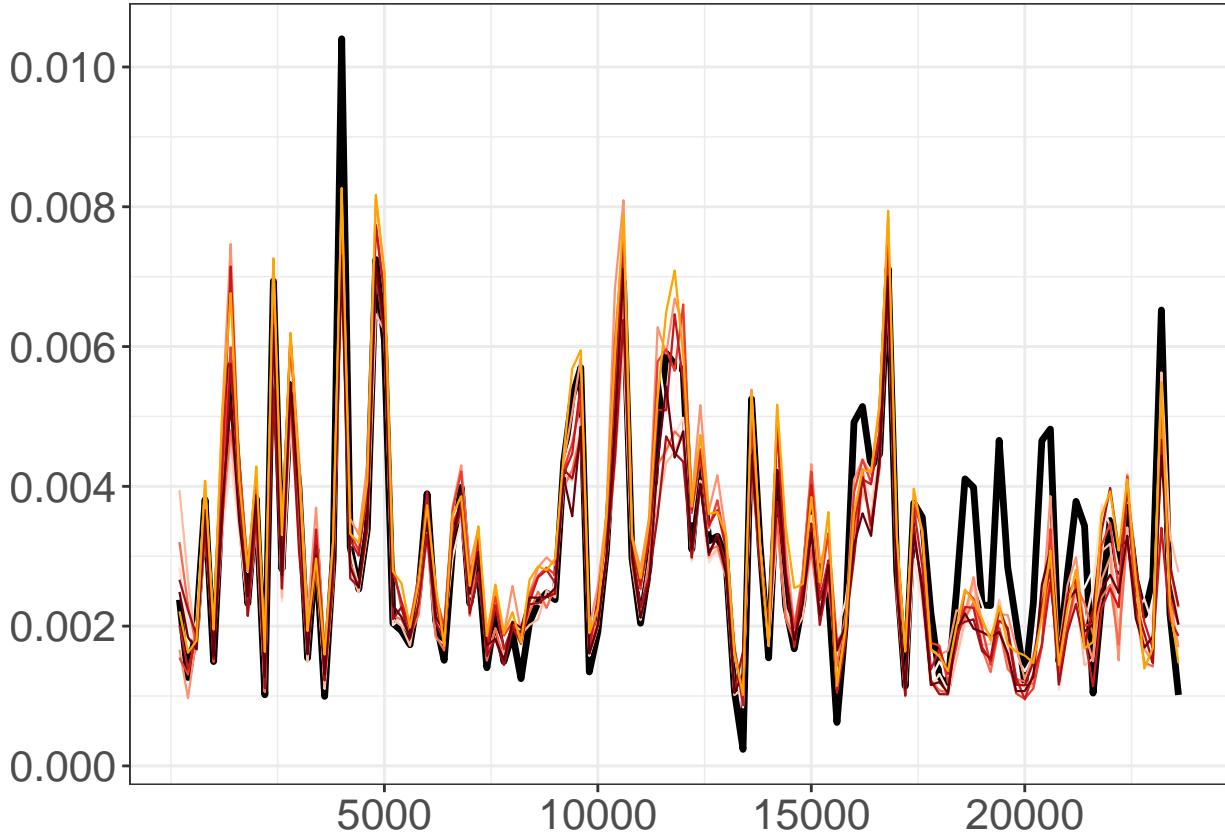
5.4 all replicates:

```

theta.plot <- as.data.frame(cbind(1:nrow(sim.theta.200kb),
                                sim.theta.200kb$Rate * 1e-7 * 3e+4,
                                rep_1.theta.200kb$sample_mean,
                                rep_2.theta.200kb$sample_mean,
                                rep_3.theta.200kb$sample_mean,
                                rep_4.theta.200kb$sample_mean,
                                rep_5.theta.200kb$sample_mean,
                                rep_6.theta.200kb$sample_mean,
                                rep_7.theta.200kb$sample_mean,
                                rep_8.theta.200kb$sample_mean,
                                rep_9.theta.200kb$sample_mean,
                                rep_10.theta.200kb$sample_mean))

names(theta.plot) <- c("bin", "sim", "reps")
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.200kb.bgs <- ggplot(data = molten.theta, aes(x = bin * 200, y = value, colour = variable)) +
  theta.map.200kb.bgs + geom_line(data = molten.theta, aes(size = variable)) + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Set1")))
theta.map.200kb.bgs <- theta.map.200kb.bgs + scale_color_manual(values = c("black", brewer.pal(n = 9, name = "Set1")))
theta.map.200kb.bgs <- theta.map.200kb.bgs + scale_x_continuous(breaks = c(5000, 10000, 15000, 20000))
theta.map.200kb.bgs <- theta.map.200kb.bgs + labs(title = NULL, x = NULL, y = NULL)
theta.map.200kb.bgs <- theta.map.200kb.bgs + theme(text = element_text(size = 20), axis.title.x = element_text(size = 20))
theta.map.200kb.bgs

```



5.5 1 Mb scale

```
r2.bgs.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.1Mb) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.1Mb) <- reps

r2.bgs.1Mb.true <- as.data.frame(matrix(ncol = nreps, nrow = 5))
row.names(r2.bgs.1Mb.true) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
colnames(r2.bgs.1Mb.true) <- reps

sim.theta.1Mb <- read.table("dm_bgs_sims/MutationMap_1000kb.csv", sep = ",", header = T)
sim.rho.1Mb <- read.table("dm_bgs_sims/RecombinationMap_1000kb.csv", sep = ",", header = T)
```

5.5.1 Replicate 1

```
rep1.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep1_w1000000.csv", sep = ",", header = T)

rep_1.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.div")
rep_1.pi.1Mb$avg <- apply(rep_1.pi.1Mb[4:ncol(rep_1.pi.1Mb)], 1, mean)
rep_1.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.rho")
rep_1.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.theta")
rep_1.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep1/dm2L_bgs_rep1_5.tmrca")
rep_1.tmrca.1Mb$avg <- apply(rep_1.tmrca.1Mb[4:ncol(rep_1.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep1 <- as.data.frame(cbind(rep_1.pi.1Mb$avg, sim.theta.1Mb$Rate, rep1.sim.tmrca.1Mb$Avg))
```

```

names(true.lands.1Mb.rep1) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep1$thetaS <- (true.lands.1Mb.rep1$theta - mean(true.lands.1Mb.rep1$theta)) / sd(true.lands.1Mb.rep1$theta)
true.lands.1Mb.rep1$tmrcaS <- (true.lands.1Mb.rep1$tmrca - mean(true.lands.1Mb.rep1$tmrca)) / sd(true.lands.1Mb.rep1$tmrca)
true.lands.1Mb.rep1$rhoS <- (true.lands.1Mb.rep1$rho - mean(true.lands.1Mb.rep1$rho, na.rm = T)) / sd(true.lands.1Mb.rep1$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep1)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 1] <- anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.1Mb.true[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 1] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep1)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -2.546e-04 -4.149e-05 -4.048e-06  8.644e-05  2.733e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.432e-03 3.422e-05 100.309 < 2e-16 ***
## thetaS       7.916e-04 4.445e-05 17.808 2.60e-13 ***
## rhoS        1.545e-04 6.147e-05  2.513  0.0212 *
## tmrcaS       8.871e-04 5.963e-05 14.878 6.36e-12 ***
## thetaS:tmrcaS 3.439e-04 6.204e-05   5.544 2.40e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001588 on 19 degrees of freedom
## Multiple R-squared:  0.9909, Adjusted R-squared:  0.989
## F-statistic: 515.7 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##
##          thetaS          rhoS          tmrcaS    thetaS:tmrcaS
## 1.802694  3.447331  3.243779  1.647176

# now the lm with inferred landscapes
inf.lands.1Mb.rep1 <- as.data.frame(cbind(rep_1.pi.1Mb$avg, rep_1.theta.1Mb$sample_mean, rep_1.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep1) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[1, 3] <- cor.test(sim.theta.1Mb$Rate, rep_1.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[1, 3] <- cor.test(sim.rho.1Mb$Rate, rep_1.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[1, 3] <- cor.test(rep1.sim.tmrca.1Mb$AverageTmrca, rep_1.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep1$thetaS <- (inf.lands.1Mb.rep1$theta - mean(inf.lands.1Mb.rep1$theta)) / sd(inf.lands.1Mb.rep1$theta)
inf.lands.1Mb.rep1$tmrcaS <- (inf.lands.1Mb.rep1$tmrca - mean(inf.lands.1Mb.rep1$tmrca)) / sd(inf.lands.1Mb.rep1$tmrca)
inf.lands.1Mb.rep1$rhoS <- (inf.lands.1Mb.rep1$rho - mean(inf.lands.1Mb.rep1$rho)) / sd(inf.lands.1Mb.rep1$rho)

```

```

inf.lands.1Mb.rep1$tmrcaS <- (inf.lands.1Mb.rep1$tmrca - mean(inf.lands.1Mb.rep1$tmrca)) / sd(inf.lands.1Mb.rep1$tmrca)
inf.lands.1Mb.rep1$rhoS <- (inf.lands.1Mb.rep1$rho - mean(inf.lands.1Mb.rep1$rho)) / sd(inf.lands.1Mb.rep1$rho)

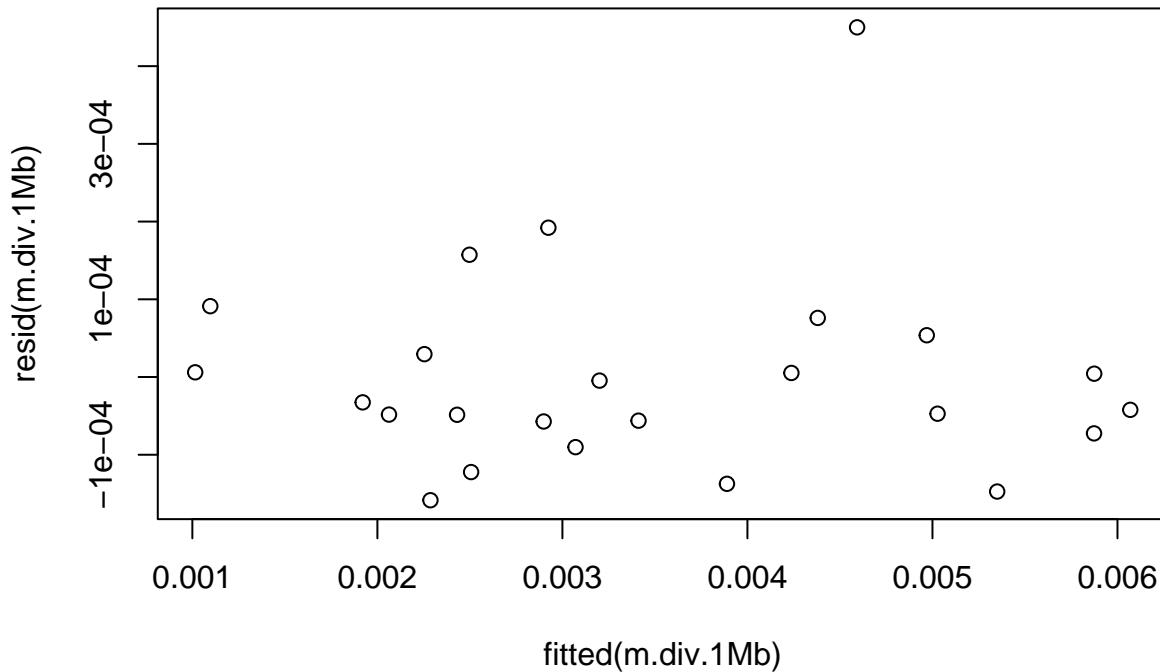
inf.lands.1Mb.rep1$bin <- 1:nrow(inf.lands.1Mb.rep1)
inf.lands.1Mb.rep1$Replicate <- 1

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep1)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep1)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep1)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -350.1912
## m.div.1Mb.2   7 -353.4005
## m.div.1Mb.3   8 -351.4502
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```



```

dwtest(m.div.1Mb)

##
##  Durbin-Watson test
##
##  data:  m.div.1Mb
##  DW = 2.2349, p-value = 0.6279
##  alternative hypothesis: true autocorrelation is greater than 0

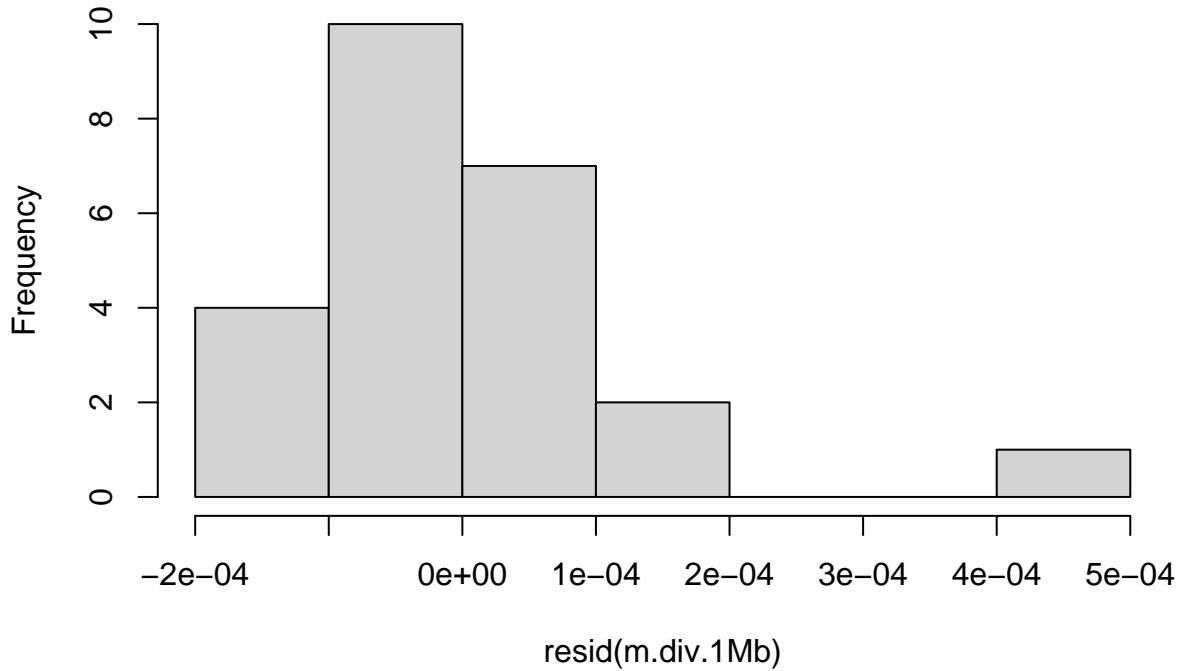
hmctest(m.div.1Mb)

##
##  Harrison-M McCabe test
##
##  data:  m.div.1Mb

```

```
## HMC = 0.69238, p-value = 0.912
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.1Mb.rep1)
##
## Residuals:
##       Min         1Q     Median         3Q        Max
## -1.585e-04 -6.105e-05 -3.743e-05  3.551e-05  4.499e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.434e-03 4.013e-05  85.559 < 2e-16 ***
## thetaS      1.002e-03 7.989e-05 12.540 1.23e-10 ***
## rhoS        1.209e-04 5.160e-05  2.344  0.0301 *
## tmrcaS      7.509e-04 4.358e-05 17.232 4.69e-13 ***
## thetaS:tmrcaS 3.963e-04 1.817e-04   2.181  0.0419 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001437 on 19 degrees of freedom
## Multiple R-squared:  0.9925, Adjusted R-squared:  0.991
## F-statistic: 630.7 on 4 and 19 DF,  p-value: < 2.2e-16
```

```

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##    7.108268    2.965119    2.114943    5.603757

anova.diversity <- Anova(m.div.1Mb.2)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 1] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 1] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 1] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 1] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 1] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep1, weight = r2.bgs.1Mb[1, 1])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep1, weight = r2.bgs.1Mb[2, 1])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep1, weight = r2.bgs.1Mb[3, 1])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep1, weight = r2.bgs.1Mb[4, 1])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -347.5891
## g.div.1Mb.2 8 -348.1816
## g.div.1Mb.3 7 -348.6342
## g.div.1Mb.4 7 -348.6639

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
##   -1746.826 -1724.66 881.413
##
## Correlation Structure: AR(1)
##   Formula: ~bin
## Parameter estimate(s):
##     Phi
## 0.3592005
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.05866752
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003455613 2.011308e-05 171.80925 0.0000
## thetaS       0.001807820 1.524344e-05 118.59656 0.0000
## rhoS        0.000054947 2.033038e-05   2.70268 0.0079
## tmrcaS      0.000723266 1.967362e-05   36.76325 0.0000
## thetaS:tmrcaS 0.000357443 1.414230e-05  25.27477 0.0000

```

```

## Correlation:
##          (Intr) thetaS rhoS   tmrcaS
## thetaS      0.033
## rhoS       0.011 -0.278
## tmrcaS    -0.020 -0.038 -0.400
## thetaS:tmrcaS -0.115 -0.228  0.044  0.008
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.0973545 -0.3676318  0.1123726  0.6318238  3.0894345
##
## Residual standard error: 0.0001583058
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.1)

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
##      1.174005  1.326410  1.225458   1.055518

```

5.5.2 Replicate 2

```

rep2.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep2_w1000000.csv", sep = ",", header = T)

rep_2.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.div")
rep_2.pi.1Mb$avg <- apply(rep_2.pi.1Mb[4:ncol(rep_2.pi.1Mb)], 1, mean)
rep_2.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.rho")
rep_2.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.theta")
rep_2.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep2/dm2L_bgs_rep2_5.tmrca")
rep_2.tmrca.1Mb$avg <- apply(rep_2.tmrca.1Mb[4:ncol(rep_2.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep2 <- as.data.frame(cbind(rep_2.pi.1Mb$avg, sim.theta.1Mb$Rate, rep2.sim.tmrca.1Mb$Ave))
names(true.lands.1Mb.rep2) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep2$thetaS <- (true.lands.1Mb.rep2$theta - mean(true.lands.1Mb.rep2$theta)) / sd(true.lands.1Mb.rep2)
true.lands.1Mb.rep2$tmrcaS <- (true.lands.1Mb.rep2$tmrca - mean(true.lands.1Mb.rep2$tmrca)) / sd(true.lands.1Mb.rep2)
true.lands.1Mb.rep2$rhoS <- (true.lands.1Mb.rep2$rho - mean(true.lands.1Mb.rep2$rho, na.rm = T)) / sd(true.lands.1Mb.rep2)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep2)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 2] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep2)
## 
```

```

## Residuals:
##      Min       1Q    Median       3Q      Max
## -2.779e-04 -7.948e-05 -1.692e-05  1.077e-04  2.483e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.389e-03 3.258e-05 104.009 < 2e-16 ***
## thetaS       7.230e-04 4.106e-05 17.606 3.19e-13 ***
## rhoS        1.777e-04 6.078e-05  2.923  0.00872 **
## tmrcaS      9.377e-04 5.908e-05 15.872 2.03e-12 ***
## thetaS:tmrcaS 4.081e-04 5.480e-05  7.447 4.77e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001493 on 19 degrees of freedom
## Multiple R-squared:  0.9926, Adjusted R-squared:  0.991
## F-statistic: 637.5 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.740475     3.813797     3.602638     1.598807

# now the lm with inferred landscapes
inf.lands.1Mb.rep2 <- as.data.frame(cbind(rep_2.pi.1Mb$avg, rep_2.theta.1Mb$sample_mean, rep_2.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep2) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[2, 3] <- cor.test(sim.theta.1Mb$Rate, rep_2.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[2, 3] <- cor.test(sim.rho.1Mb$Rate, rep_2.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[2, 3] <- cor.test(rep2.sim.tmrca.1Mb$AverageTmrca, rep_2.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep2$thetaS <- (inf.lands.1Mb.rep2$theta - mean(inf.lands.1Mb.rep2$theta)) / sd(inf.lands.1Mb.rep2)
inf.lands.1Mb.rep2$tmrcaS <- (inf.lands.1Mb.rep2$tmrca - mean(inf.lands.1Mb.rep2$tmrca)) / sd(inf.lands.1Mb.rep2)
inf.lands.1Mb.rep2$rhoS <- (inf.lands.1Mb.rep2$rho - mean(inf.lands.1Mb.rep2$rho)) / sd(inf.lands.1Mb.rep2)

inf.lands.1Mb.rep2$bin <- 1:nrow(inf.lands.1Mb.rep2)
inf.lands.1Mb.rep2$Replicate <- 2

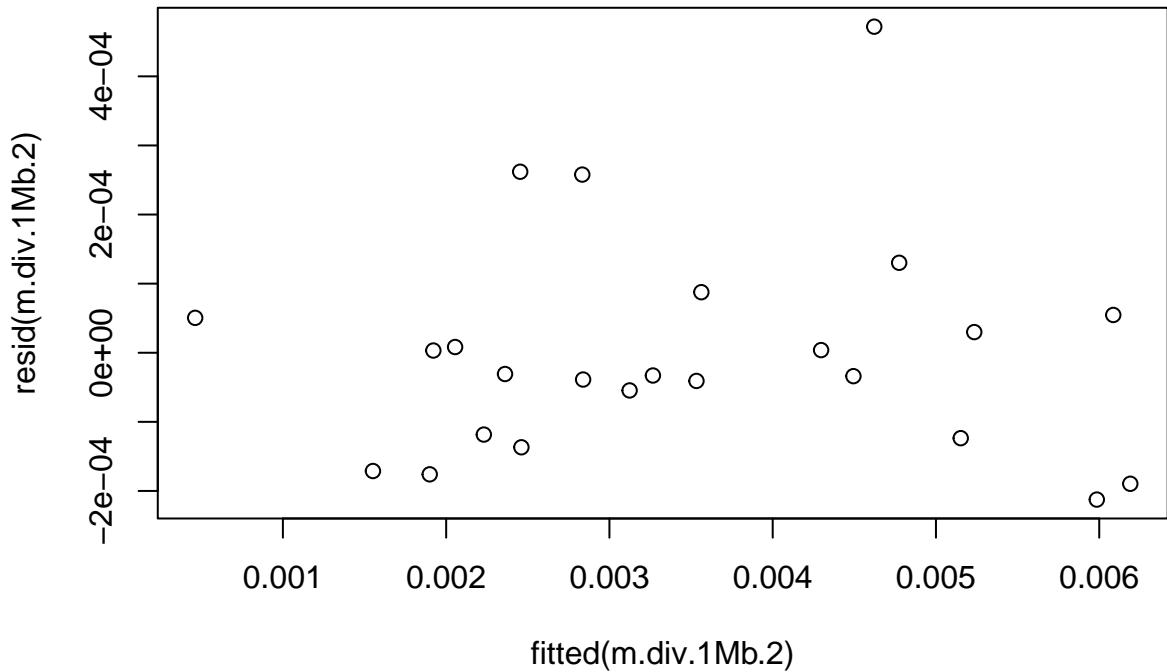
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep2)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep2)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep2)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -340.4890
## m.div.1Mb.2   7 -338.4960
## m.div.1Mb.3   8 -340.4696

plot(resid(m.div.1Mb.2)~fitted(m.div.1Mb.2))

```



```

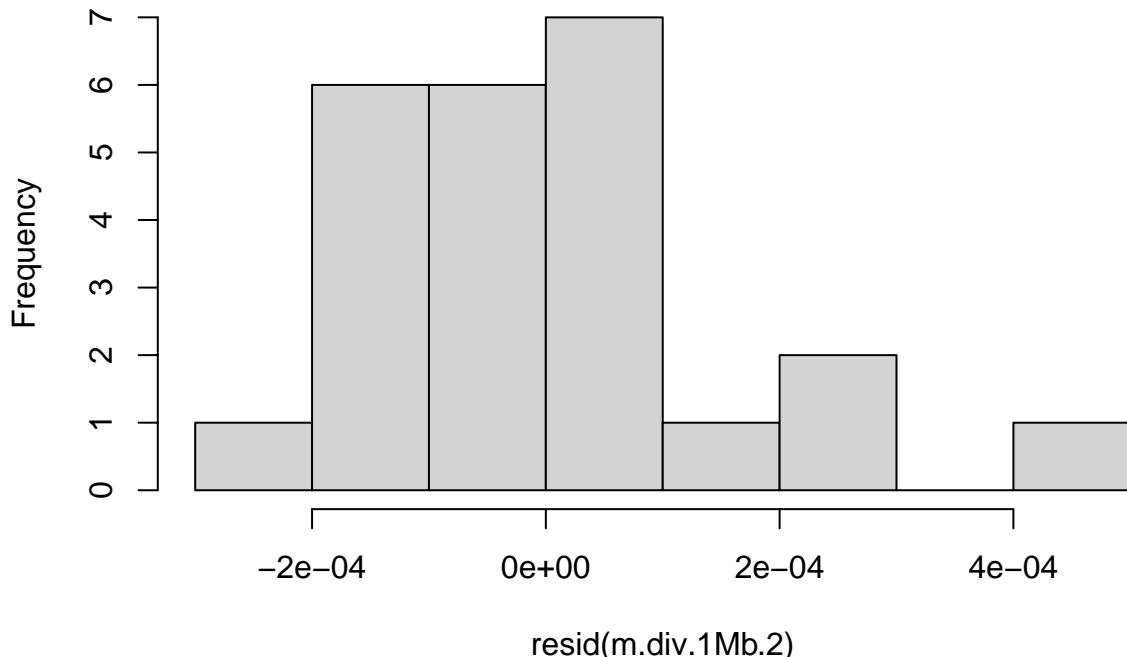
dwtest(m.div.1Mb.2)

##
##  Durbin-Watson test
##
## data: m.div.1Mb.2
## DW = 2.2761, p-value = 0.5681
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb.2)

##
##  Harrison-McCabe test
##
## data: m.div.1Mb.2
## HMC = 0.51593, p-value = 0.503
hist(resid(m.div.1Mb.2))

```

Histogram of resid(m.div.1Mb.2)



```
summary(m.div.1Mb.2)
```

```
## 
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS +
##     rhoS:tmrcaS, data = inf.lands.1Mb.rep2)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -2.125e-04 -1.197e-04 -3.185e-05  5.153e-05  4.719e-04 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.484e-03 1.146e-04 30.398 < 2e-16 ***
## thetaS      1.135e-03 7.922e-05 14.323 2.79e-11 ***
## rhoS        1.870e-05 8.853e-05  0.211  0.83511  
## tmrcaS      9.684e-04 2.311e-04   4.190  0.00055 *** 
## thetaS:tmrcaS 1.235e-04 1.111e-04   1.112  0.28072  
## rhoS:tmrcaS -1.435e-05 1.987e-04  -0.072  0.94322  
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
## 
## Residual standard error: 0.0001807 on 18 degrees of freedom
## Multiple R-squared:  0.9897, Adjusted R-squared:  0.9869 
## F-statistic: 347.1 on 5 and 18 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb.2)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS      rhoS:tmrcaS 
## 4.421602     5.522034    37.637188     5.837428    45.103126
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 2] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 2] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 2] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 2] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 2] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep2, weight = r2.bgs.1Mb[1, 2])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep2, weight = r2.bgs.1Mb[2, 2])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep2, weight = r2.bgs.1Mb[3, 2])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep2, weight = r2.bgs.1Mb[4, 2])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -338.4110
## g.div.1Mb.2 8 -339.3155
## g.div.1Mb.3 7 -340.4491
## g.div.1Mb.4 7 -338.4931

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC  logLik
##   -1746.826 -1724.66 881.413
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.3592005
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.05866752
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003455613 2.011308e-05 171.80925 0.0000
## thetaS       0.001807820 1.524344e-05 118.59656 0.0000
## rhoS        0.000054947 2.033038e-05   2.70268 0.0079
## tmrcaS      0.000723266 1.967362e-05  36.76325 0.0000
## thetaS:tmrcaS 0.000357443 1.414230e-05 25.27477 0.0000
##
## Correlation:
##          (Intr) thetaS rhoS   tmrcaS
## thetaS     0.033

```

```

## rhoS          0.011 -0.278
## tmrcaS       -0.020 -0.038 -0.400
## thetaS:tmrcaS -0.115 -0.228  0.044  0.008
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.0973545 -0.3676318  0.1123726  0.6318238  3.0894345
##
## Residual standard error: 0.0001583058
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.1)

##      thetaS        rhoS        tmrcaS thetaS:tmrcaS
## 1.174005 1.326410 1.225458    1.055518

```

5.5.3 Replicate 3

```

rep3.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep3_w1000000.csv", sep = ",", header = T)

rep_3.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.div")
rep_3.pi.1Mb$avg <- apply(rep_3.pi.1Mb[4:ncol(rep_3.pi.1Mb)], 1, mean)
rep_3.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.rho")
rep_3.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.theta")
rep_3.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep3/dm2L_bgs_rep3_5.tmrca")
rep_3.tmrca.1Mb$avg <- apply(rep_3.tmrca.1Mb[4:ncol(rep_3.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep3 <- as.data.frame(cbind(rep_3.pi.1Mb$avg, sim.theta.1Mb$Rate, rep3.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep3) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep3$thetaS <- (true.lands.1Mb.rep3$theta - mean(true.lands.1Mb.rep3$theta)) / sd(true.lands.1Mb.rep3$theta)
true.lands.1Mb.rep3$tmrcaS <- (true.lands.1Mb.rep3$tmrca - mean(true.lands.1Mb.rep3$tmrca)) / sd(true.lands.1Mb.rep3$tmrca)
true.lands.1Mb.rep3$rhoS <- (true.lands.1Mb.rep3$rho - mean(true.lands.1Mb.rep3$rho, na.rm = T)) / sd(true.lands.1Mb.rep3$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep3)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.1Mb.true[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 3] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.1Mb.rep3)
##
## Residuals:
##      Min       1Q       Median      3Q       Max
## -1.974e-04 -8.805e-05 -2.002e-05  7.479e-05  2.714e-04
##
```

```

## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.448e-03 2.918e-05 118.164 < 2e-16 ***
## thetaS      7.966e-04 3.527e-05  22.588 3.45e-15 ***
## rhoS       1.711e-04 5.416e-05   3.159  0.00517 **
## tmrcaS     8.233e-04 5.415e-05  15.204 4.34e-12 ***
## thetaS:tmrcaS 2.911e-04 4.835e-05   6.020 8.61e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001331 on 19 degrees of freedom
## Multiple R-squared:  0.9933, Adjusted R-squared:  0.9919
## F-statistic: 701.9 on 4 and 19 DF,  p-value: < 2.2e-16
vif(m.div.1Mb)

##          thetaS         rhoS        tmrcaS thetaS:tmrcaS
## 1.616044    3.810700    3.809803    1.527849

# now the lm with inferred landscapes
inf.lands.1Mb.rep3 <- as.data.frame(cbind(rep_3.pi.1Mb$avg, rep_3.theta.1Mb$sample_mean, rep_3.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep3) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[3, 3] <- cor.test(sim.theta.1Mb$Rate, rep_3.theta.1Mb$sample_mean, method = "spearman")$estimate
cor.table.rho[3, 3] <- cor.test(sim.rho.1Mb$Rate, rep_3.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[3, 3] <- cor.test(rep3.sim.tmrca.1Mb$AverageTmrca, rep_3.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep3$thetaS <- (inf.lands.1Mb.rep3$theta - mean(inf.lands.1Mb.rep3$theta)) / sd(inf.lands.1Mb.rep3)
inf.lands.1Mb.rep3$tmrcaS <- (inf.lands.1Mb.rep3$tmrca - mean(inf.lands.1Mb.rep3$tmrca)) / sd(inf.lands.1Mb.rep3)
inf.lands.1Mb.rep3$rhoS <- (inf.lands.1Mb.rep3$rho - mean(inf.lands.1Mb.rep3$rho)) / sd(inf.lands.1Mb.rep3)

inf.lands.1Mb.rep3$bin <- 1:nrow(inf.lands.1Mb.rep3)
inf.lands.1Mb.rep3$Replicate <- 3

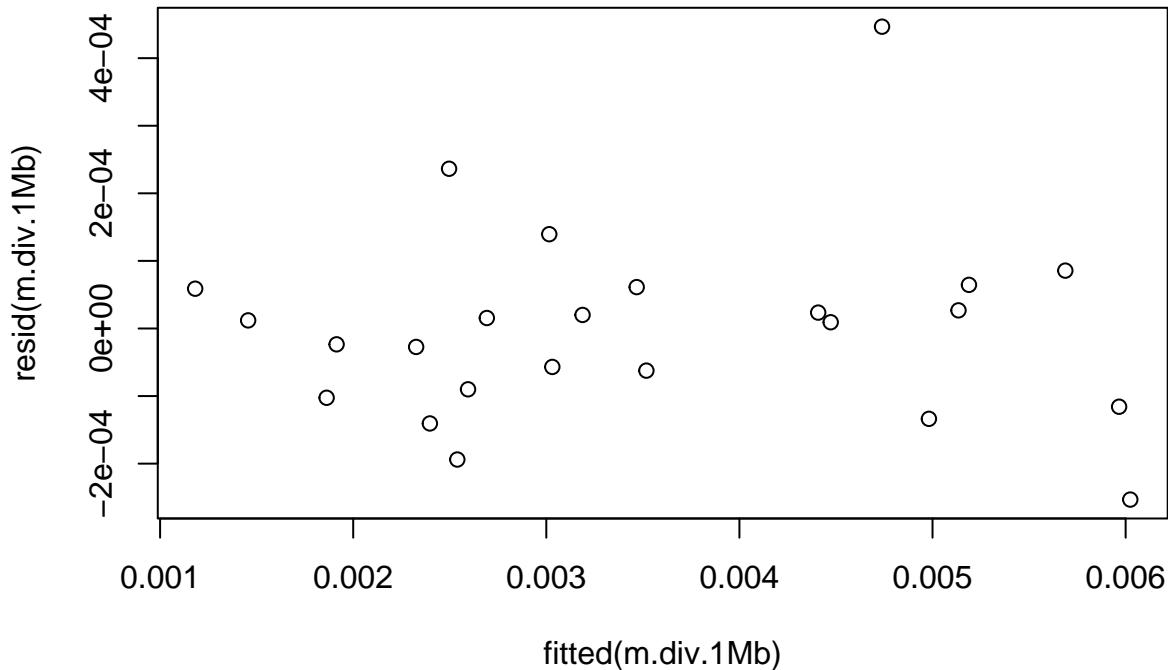
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep3)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep3)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep3)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -345.5820
## m.div.1Mb.2   7 -346.9896
## m.div.1Mb.3   8 -348.3194

plot(resid(m.div.1Mb)~fitted(m.div.1Mb))

```

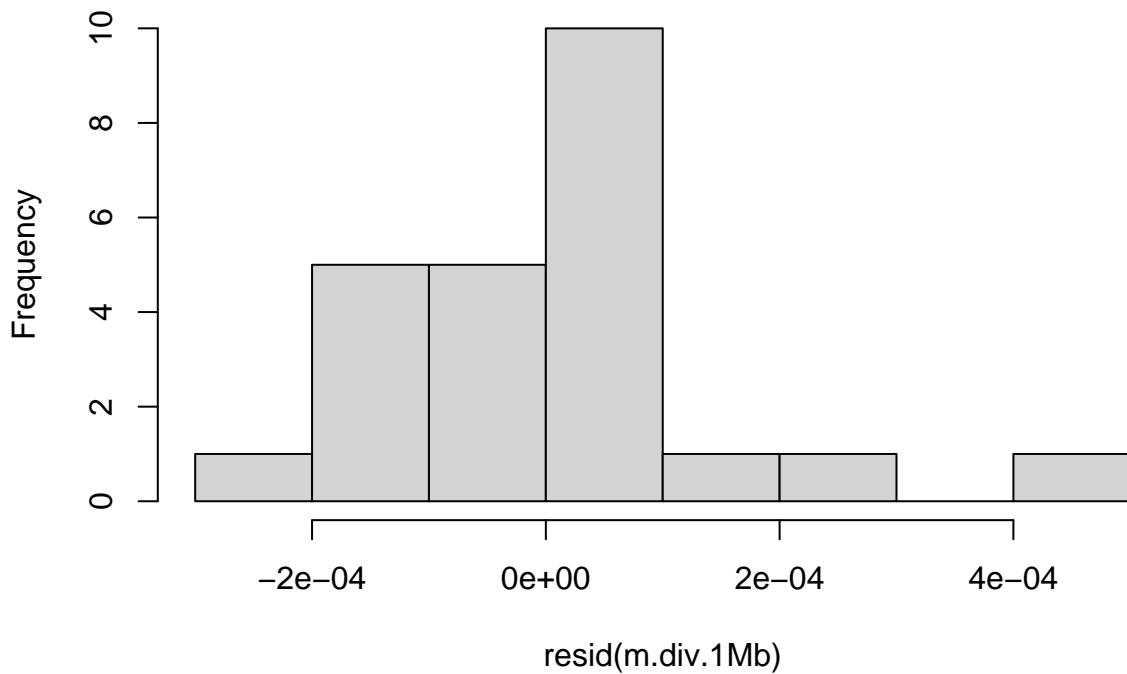


```
dwtest(m.div.1Mb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.5052, p-value = 0.8416
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.52869, p-value = 0.563
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = inf.lands.1Mb.rep3)
##
## Residuals:
##      Min        1Q    Median        3Q       Max 
## -2.532e-04 -9.316e-05  1.061e-05  5.944e-05  4.466e-04
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.517e-03 3.231e-05 108.850 < 2e-16 ***
## thetaS       1.114e-03 3.870e-05  28.788 < 2e-16 ***
## rhoS        -1.151e-05 4.912e-05  -0.234  0.81719  
## tmrcaS       8.973e-04 5.060e-05  17.732 2.81e-13 ***
## thetaS:tmrcaS 1.546e-04 3.399e-05   4.549  0.00022 *** 
## ---        
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.0001582 on 19 degrees of freedom
## Multiple R-squared:  0.9905, Adjusted R-squared:  0.9885 
## F-statistic: 495.2 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.376987    2.217412    2.353574    1.471850
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 3] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 3] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 3] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 3] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 3] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep3, weight = r2.bgs.1Mb[1, 3])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep3, weight = r2.bgs.1Mb[2, 3])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep3, weight = r2.bgs.1Mb[3, 3])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep3, weight = r2.bgs.1Mb[4, 3])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -345.3677
## g.div.1Mb.2 8 -347.1405
## g.div.1Mb.3 7 -346.0258
## g.div.1Mb.4 7 -344.4834

summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
##   -1734.608 -1715.213 874.304
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.06585754
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003456651 1.395282e-05 247.73845 0.0000
## thetaS       0.001791494 1.545385e-05 115.92545 0.0000
## rhoS        0.000057760 1.745893e-05   3.30831 0.0013
## tmrcaS      0.000731416 1.833740e-05  39.88655 0.0000
## thetaS:tmrcaS 0.000363491 1.607889e-05  22.60670 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS     0.044
## rhoS      0.022 -0.358
## tmrcaS   -0.071  0.007 -0.475
## thetaS:tmrcaS -0.188 -0.216  0.006  0.071
##
## Standardized residuals:
```

```

##      Min       Q1      Med       Q3      Max
## -3.21935933 -0.35120581  0.01652401  0.59170149  3.02405764
##
## Residual standard error: 0.0001583413
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##     1.253421     1.545304     1.346750     1.057384

```

5.5.4 Replicate 4

```

rep4.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep4_w1000000.csv", sep = ",", header = T)

rep_4.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.div")
rep_4.pi.1Mb$avg <- apply(rep_4.pi.1Mb[4:ncol(rep_4.pi.1Mb)], 1, mean)
rep_4.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.rho")
rep_4.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.theta")
rep_4.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep4/dm2L_bgs_rep4_5.tmrca")
rep_4.tmrca.1Mb$avg <- apply(rep_4.tmrca.1Mb[4:ncol(rep_4.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep4 <- as.data.frame(cbind(rep_4.pi.1Mb$avg, sim.theta.1Mb$Rate, rep4.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep4) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep4$thetaS <- (true.lands.1Mb.rep4$theta - mean(true.lands.1Mb.rep4$theta)) / sd(true.lands.1Mb.rep4$theta)
true.lands.1Mb.rep4$tmrcaS <- (true.lands.1Mb.rep4$tmrca - mean(true.lands.1Mb.rep4$tmrca)) / sd(true.lands.1Mb.rep4$tmrca)
true.lands.1Mb.rep4$rhoS <- (true.lands.1Mb.rep4$rho - mean(true.lands.1Mb.rep4$rho, na.rm = T)) / sd(true.lands.1Mb.rep4$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep4)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 4] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep4)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.664e-04 -8.501e-05 -7.398e-06  8.566e-05  2.756e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.438e-03 2.729e-05 125.993 < 2e-16 ***
## thetaS      7.971e-04 3.384e-05  23.559 1.59e-15 ***
## rhoS       1.183e-04 5.004e-05   2.365  0.0288 *

```

```

## tmrcaS      9.023e-04  4.865e-05  18.546 1.25e-13 ***
## thetaS:tmrcaS 3.013e-04  4.690e-05   6.426 3.68e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001256 on 19 degrees of freedom
## Multiple R-squared:  0.9942, Adjusted R-squared:  0.993
## F-statistic: 812.9 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1 1.668166    3.649033    3.448834     1.522503

# now the lm with inferred landscapes
inf.lands.1Mb.rep4 <- as.data.frame(cbind(rep_4.pi.1Mb$avg, rep_4.theta.1Mb$sample_mean, rep_4.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep4) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[4, 3] <- cor.test(sim.theta.1Mb$Rate, rep_4.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[4, 3] <- cor.test(sim.rho.1Mb$Rate, rep_4.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[4, 3] <- cor.test(rep4.sim.tmrca.1Mb$AverageTmrca, rep_4.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep4$thetaS <- (inf.lands.1Mb.rep4$theta - mean(inf.lands.1Mb.rep4$theta))
inf.lands.1Mb.rep4$tmrcaS <- (inf.lands.1Mb.rep4$tmrca - mean(inf.lands.1Mb.rep4$tmrca))
inf.lands.1Mb.rep4$rhoS <- (inf.lands.1Mb.rep4$rho - mean(inf.lands.1Mb.rep4$rho))

inf.lands.1Mb.rep4$bin <- 1:nrow(inf.lands.1Mb.rep4)
inf.lands.1Mb.rep4$Replicate <- 4

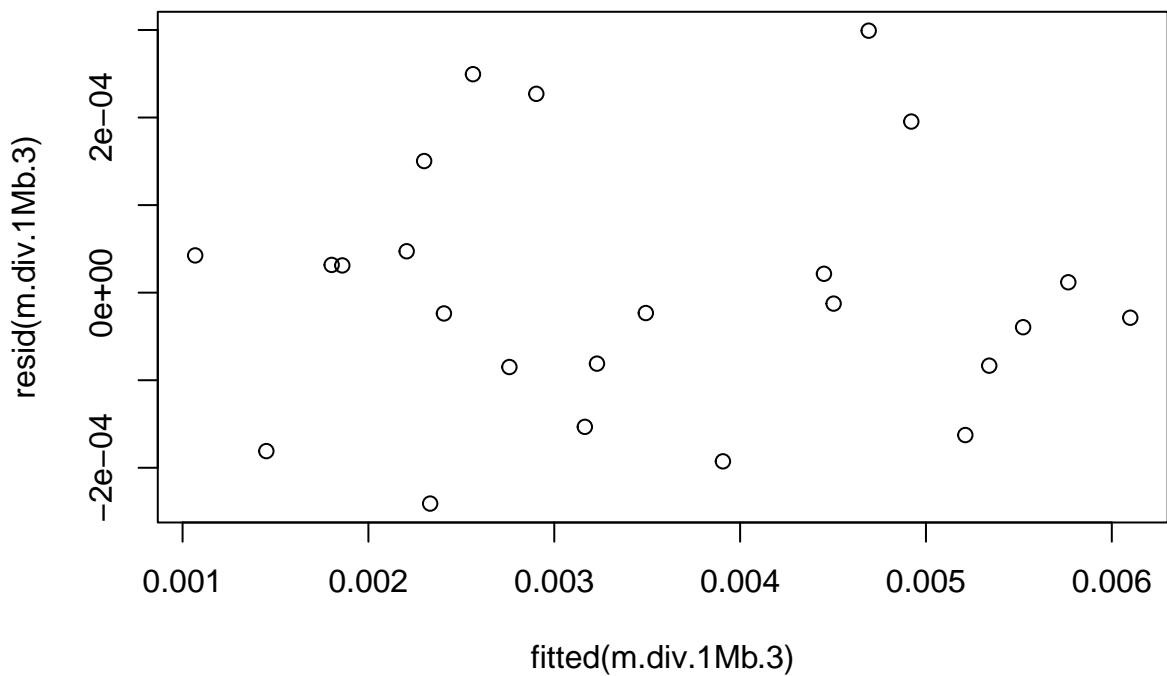
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep4)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep4)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep4)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##           df      AIC
## m.div.1Mb     6 -342.6901
## m.div.1Mb.2   7 -343.4354
## m.div.1Mb.3   8 -341.7061

plot(resid(m.div.1Mb.3)~fitted(m.div.1Mb.3))

```

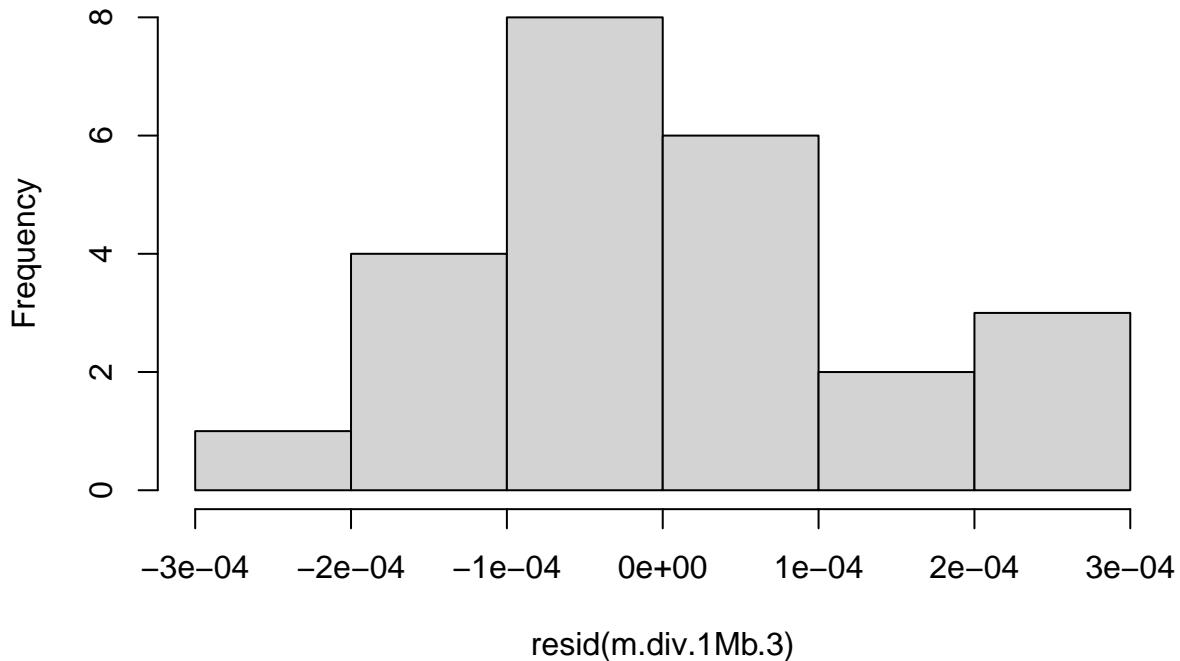


```
dwtest(m.div.1Mb.3)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb.3
## DW = 1.8938, p-value = 0.2539
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb.3)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb.3
## HMC = 0.54567, p-value = 0.603
hist(resid(m.div.1Mb.3))
```

Histogram of resid(m.div.1Mb.3)



```
summary(m.div.1Mb.3)
```

```
##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep4)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -2.409e-04 -8.377e-05 -1.791e-05  4.371e-05  2.992e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.398e-03 8.265e-05 41.111 < 2e-16 ***
## thetaS      9.886e-01 4.371e-02 22.619 3.97e-14 ***
## rhoS        4.135e-02 3.654e-02  1.132 0.273417  
## tmrcaS      6.825e-03 1.429e-03  4.775 0.000176 ***
## thetaS:rhoS -9.764e+00 2.224e+01 -0.439 0.666113  
## thetaS:tmrcaS 2.398e+00 7.423e-01  3.231 0.004912 ** 
## rhoS:tmrcaS  6.272e-01 5.547e-01  1.131 0.273936  
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001668 on 17 degrees of freedom
## Multiple R-squared:  0.9908, Adjusted R-squared:  0.9876 
## F-statistic: 306.4 on 6 and 17 DF,  p-value: 2.331e-16
```

```
vif(m.div.1Mb.3)
```

```
##          thetaS          rhoS          tmrcaS    thetaS:rhoS    thetaS:tmrcaS
## 2.125418  2.952566  24.367534  1.303170  2.387793
## rhoS:tmrcaS
```

```

##      16.558280

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 4] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 4] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 4] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 4] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 4] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep4, weight = r2.bgs.1Mb[1, 4])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep4, weight = r2.bgs.1Mb[2, 4])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep4, weight = r2.bgs.1Mb[3, 4])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep4, weight = r2.bgs.1Mb[4, 4])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -343.6387
## g.div.1Mb.2 8 -338.7066
## g.div.1Mb.3 7 -340.7065
## g.div.1Mb.4 7 -345.6369

summary(g.div.200kb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC  logLik
##   -1760.403 -1738.238 888.2017
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.4617293
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
##   Parameter estimates:
##       power
## 0.5635104
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003462323 2.402517e-05 144.11230 0e+00
## thetaS       0.001820304 1.767755e-05 102.97264 0e+00
## rhoS        0.000075232 1.896687e-05   3.96650 1e-04
## tmrcaS      0.000703320 1.767660e-05  39.78820 0e+00
## thetaS:tmrcaS 0.000356153 1.465143e-05 24.30839 0e+00
##
## Correlation:
##           (Intr) thetaS rhoS   tmrcaS

```

```

## thetaS          0.528
## rhoS           0.044 -0.205
## tmrcaS        -0.048 -0.104 -0.307
## thetaS:tmrcaS -0.134 -0.108  0.071  0.482
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.8410953 -0.3805993  0.0579645  0.6056538  3.2911454
##
## Residual standard error: 0.003912165
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.2)

```

```

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
##     1.078808    1.260217    1.573482    1.398905

```

5.5.5 Replicate 5

```

rep5.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep5_w1000000.csv", sep = ",", header = T)

rep_5.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.div")
rep_5.pi.1Mb$avg <- apply(rep_5.pi.1Mb[4:ncol(rep_5.pi.1Mb)], 1, mean)
rep_5.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.rho")
rep_5.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.theta")
rep_5.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep5/dm2L_bgs_rep5_5.tmrca")
rep_5.tmrca.1Mb$avg <- apply(rep_5.tmrca.1Mb[4:ncol(rep_5.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep5 <- as.data.frame(cbind(rep_5.pi.1Mb$avg, sim.theta.1Mb$Rate, rep5.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep5) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep5$thetaS <- (true.lands.1Mb.rep5$theta - mean(true.lands.1Mb.rep5$theta)) / sd(true.lands.1Mb.rep5$theta)
true.lands.1Mb.rep5$tmrcaS <- (true.lands.1Mb.rep5$tmrca - mean(true.lands.1Mb.rep5$tmrca)) / sd(true.lands.1Mb.rep5$tmrca)
true.lands.1Mb.rep5$rhoS <- (true.lands.1Mb.rep5$rho - mean(true.lands.1Mb.rep5$rho, na.rm = T)) / sd(true.lands.1Mb.rep5$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep5)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 5] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep5)
##
## Residuals:
##      Min       1Q       Median       3Q       Max
## -2.251e-04 -8.895e-05  3.353e-05  7.898e-05  1.757e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.391e-03 2.699e-05 125.599 < 2e-16 ***
## thetaS      7.414e-04 3.429e-05  21.622 7.68e-15 ***
## rhoS        1.949e-04 5.029e-05   3.875  0.00102 **
## tmrcaS      8.608e-04 4.867e-05  17.687 2.94e-13 ***
## thetaS:tmrcaS 3.962e-04 4.612e-05   8.590 5.74e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001252 on 19 degrees of freedom
## Multiple R-squared:  0.9945, Adjusted R-squared:  0.9933
## F-statistic: 854.7 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.726375    3.713634    3.478034    1.591254

# now the lm with inferred landscapes
inf.lands.1Mb.rep5 <- as.data.frame(cbind(rep_5.pi.1Mb$avg, rep_5.theta.1Mb$sample_mean, rep_5.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep5) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[5, 3] <- cor.test(sim.theta.1Mb$Rate, rep_5.theta.1Mb$sample_mean, method = "spearman")$estimate
cor.table.rho[5, 3] <- cor.test(sim.rho.1Mb$Rate, rep_5.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[5, 3] <- cor.test(rep5.sim.tmrca.1Mb$AverageTmrca, rep_5.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep5$thetaS <- (inf.lands.1Mb.rep5$theta - mean(inf.lands.1Mb.rep5$theta)) / sd(inf.lands.1Mb.rep5)
inf.lands.1Mb.rep5$tmrcaS <- (inf.lands.1Mb.rep5$tmrca - mean(inf.lands.1Mb.rep5$tmrca)) / sd(inf.lands.1Mb.rep5)
inf.lands.1Mb.rep5$rhoS <- (inf.lands.1Mb.rep5$rho - mean(inf.lands.1Mb.rep5$rho)) / sd(inf.lands.1Mb.rep5)

inf.lands.1Mb.rep5$bin <- 1:nrow(inf.lands.1Mb.rep5)
inf.lands.1Mb.rep5$Replicate <- 5

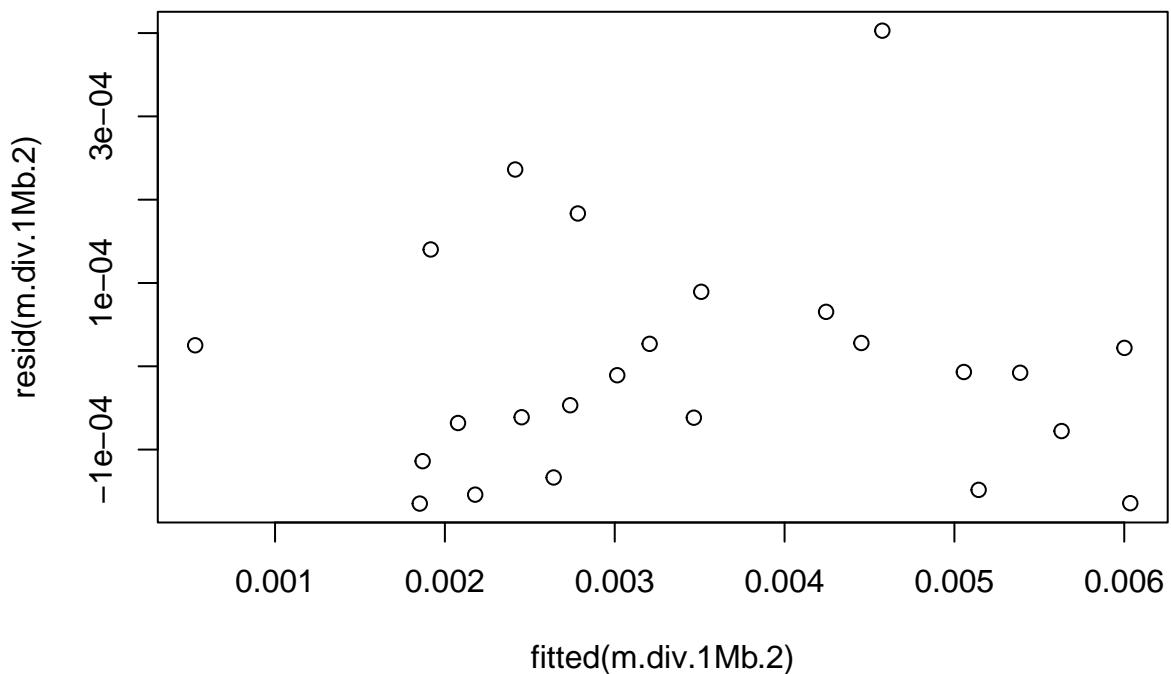
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep5)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep5)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep5)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -346.9226
## m.div.1Mb.2   7 -345.5662
## m.div.1Mb.3   8 -347.9807

plot(resid(m.div.1Mb.2) ~ fitted(m.div.1Mb.2))

```

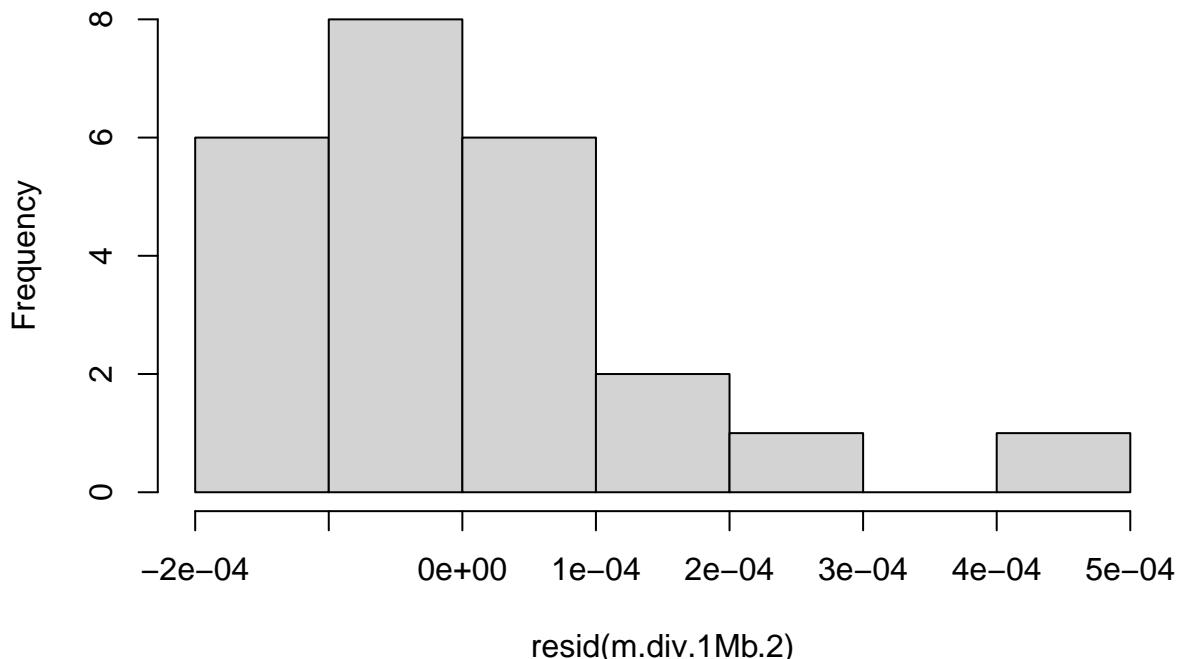


```
dwttest(m.div.1Mb.2)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb.2
## DW = 2.2, p-value = 0.5177
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb.2)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb.2
## HMC = 0.51218, p-value = 0.511
hist(resid(m.div.1Mb.2))
```

Histogram of resid(m.div.1Mb.2)



```
summary(m.div.1Mb.2)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS +  
##       rhoS:tmrcaS, data = inf.lands.1Mb.rep5)  
##  
## Residuals:  
##      Min        1Q     Median        3Q       Max  
## -1.648e-04 -8.679e-05 -9.250e-06  3.732e-05  4.029e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.410e-03 8.174e-05 41.716 < 2e-16 ***  
## thetaS       1.123e-03 5.772e-05 19.448 1.56e-13 ***  
## rhoS        -4.859e-05 6.427e-05 -0.756  0.4595  
## tmrcaS       9.826e-04 1.690e-04  5.815 1.65e-05 ***  
## thetaS:tmrcaS 2.112e-04 7.784e-05  2.713  0.0143 *  
## rhoS:tmrcaS  1.028e-04 1.470e-04  0.699  0.4932  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001559 on 18 degrees of freedom  
## Multiple R-squared:  0.9919, Adjusted R-squared:  0.9896  
## F-statistic: 439.3 on 5 and 18 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb.2)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS    rhoS:tmrcaS  
## 3.151643 3.907254 27.010848 4.254190 33.333839
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 5] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 5] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 5] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 5] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 5] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep5, weight = r2.bgs.1Mb[1, 5])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep5, weight = r2.bgs.1Mb[2, 5])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep5, weight = r2.bgs.1Mb[3, 5])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep5, weight = r2.bgs.1Mb[4, 5])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -345.3251
## g.div.1Mb.2 8 -345.5873
## g.div.1Mb.3 7 -345.9151
## g.div.1Mb.4 7 -345.0317

summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
##   -1734.608 -1715.213 874.304
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.06585754
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003456651 1.395282e-05 247.73845 0.0000
## thetaS       0.001791494 1.545385e-05 115.92545 0.0000
## rhoS        0.000057760 1.745893e-05   3.30831 0.0013
## tmrcaS      0.000731416 1.833740e-05  39.88655 0.0000
## thetaS:tmrcaS 0.000363491 1.607889e-05  22.60670 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS     0.044
## rhoS      0.022 -0.358
## tmrcaS    -0.071  0.007 -0.475
## thetaS:tmrcaS -0.188 -0.216  0.006  0.071
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.21935933 -0.35120581  0.01652401  0.59170149  3.02405764
##
## Residual standard error: 0.0001583413
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.253421     1.545304     1.346750     1.057384

```

5.5.6 Replicate 6

```

rep6.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep6_w1000000.csv", sep = ",", header = T)

rep_6.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.div")
rep_6.pi.1Mb$avg <- apply(rep_6.pi.1Mb[4:ncol(rep_6.pi.1Mb)], 1, mean)
rep_6.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.rho")
rep_6.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.theta")
rep_6.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep6/dm2L_bgs_rep6_5.tmrca")
rep_6.tmrca.1Mb$avg <- apply(rep_6.tmrca.1Mb[4:ncol(rep_6.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep6 <- as.data.frame(cbind(rep_6.pi.1Mb$avg, sim.theta.1Mb$Rate, rep6.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep6) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep6$thetaS <- (true.lands.1Mb.rep6$theta - mean(true.lands.1Mb.rep6$theta)) / sd(true.lands.1Mb.rep6$theta)
true.lands.1Mb.rep6$tmrcaS <- (true.lands.1Mb.rep6$tmrca - mean(true.lands.1Mb.rep6$tmrca)) / sd(true.lands.1Mb.rep6$tmrca)
true.lands.1Mb.rep6$rhoS <- (true.lands.1Mb.rep6$rho - mean(true.lands.1Mb.rep6$rho, na.rm = T)) / sd(true.lands.1Mb.rep6$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep6)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 6] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep6)
##
## Residuals:
##          Min         1Q        Median         3Q        Max
## -2.092e-04 -9.515e-05  1.139e-05  8.170e-05  2.762e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.399e-03 3.082e-05 110.294 < 2e-16 ***
## thetaS       7.623e-04 3.868e-05 19.706 4.17e-14 ***
## rhoS        1.653e-04 5.514e-05   2.997  0.0074 **

```

```

## tmrcaS      9.437e-04  5.404e-05  17.464 3.69e-13 ***
## thetaS:tmrcaS 3.524e-04  5.232e-05   6.735 1.95e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001403 on 19 degrees of freedom
## Multiple R-squared:  0.9934, Adjusted R-squared:  0.992
## F-statistic: 715.9 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.749648    3.554642    3.414063    1.605194

# now the lm with inferred landscapes
inf.lands.1Mb.rep6 <- as.data.frame(cbind(rep_6.pi.1Mb$avg, rep_6.theta.1Mb$sample_mean, rep_6.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep6) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[6, 3] <- cor.test(sim.theta.1Mb$Rate, rep_6.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[6, 3] <- cor.test(sim.rho.1Mb$Rate, rep_6.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[6, 3] <- cor.test(rep6.sim.tmrca.1Mb$AverageTmrca, rep_6.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep6$thetaS <- (inf.lands.1Mb.rep6$theta - mean(inf.lands.1Mb.rep6$theta)) / sd(inf.lands.1Mb.rep6)
inf.lands.1Mb.rep6$tmrcaS <- (inf.lands.1Mb.rep6$tmrca - mean(inf.lands.1Mb.rep6$tmrca)) / sd(inf.lands.1Mb.rep6)
inf.lands.1Mb.rep6$rhoS <- (inf.lands.1Mb.rep6$rho - mean(inf.lands.1Mb.rep6$rho)) / sd(inf.lands.1Mb.rep6)

inf.lands.1Mb.rep6$bin <- 1:nrow(inf.lands.1Mb.rep6)
inf.lands.1Mb.rep6$Replicate <- 6

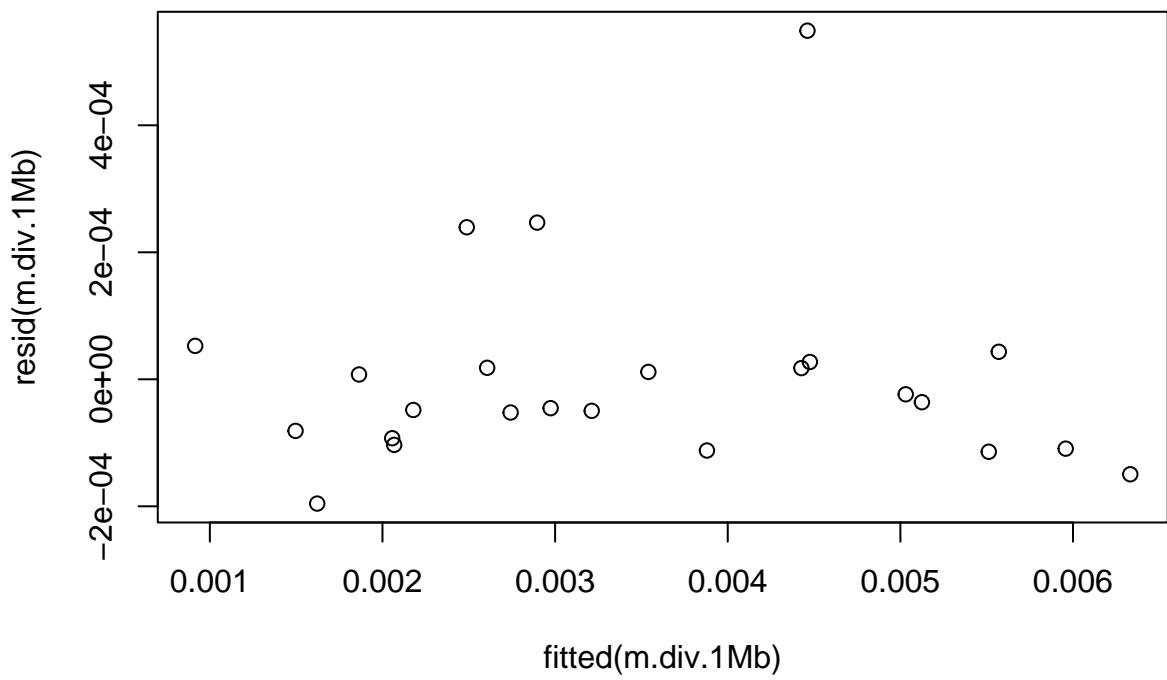
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep6)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep6)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep6)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -341.5943
## m.div.1Mb.2   7 -342.4713
## m.div.1Mb.3   8 -343.2357

plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```

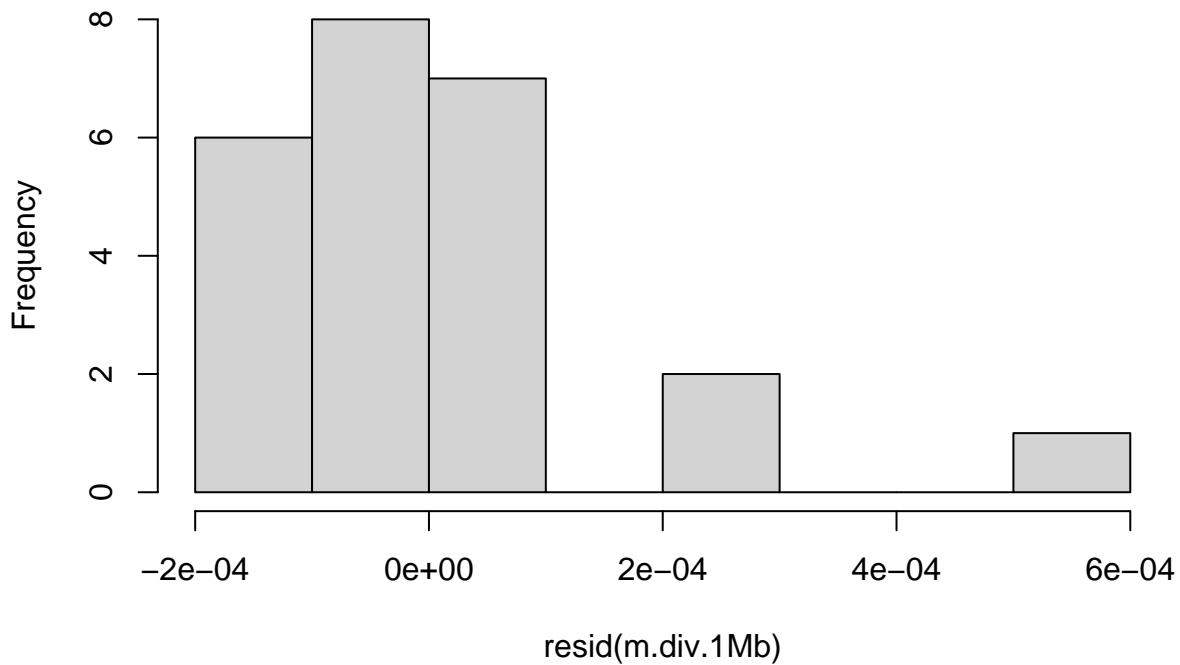


```
dwtest(m.div.1Mb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.1636, p-value = 0.4919
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.65357, p-value = 0.852
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = inf.lands.1Mb.rep6)  
##  
## Residuals:  
##       Min         1Q     Median        3Q       Max  
## -1.957e-04 -9.541e-05 -4.075e-05  2.041e-05  5.490e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.457e-03 3.707e-05 93.270 < 2e-16 ***  
## thetaS       1.212e-03 4.895e-05 24.757 6.38e-16 ***  
## rhoS        4.961e-05 5.086e-05  0.975   0.342  
## tmrcaS       7.178e-04 4.516e-05 15.894 1.98e-12 ***  
## thetaS:tmrcaS 1.438e-04 9.074e-05   1.585   0.129  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001719 on 19 degrees of freedom  
## Multiple R-squared:  0.9901, Adjusted R-squared:  0.988  
## F-statistic: 475.1 on 4 and 19 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.865337  2.013360  1.587815  1.500127
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 6] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 6] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 6] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 6] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 6] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep6, weight = r2.bgs.1Mb[1, 6])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep6, weight = r2.bgs.1Mb[2, 6])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep6, weight = r2.bgs.1Mb[3, 6])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep6, weight = r2.bgs.1Mb[4, 6])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -341.9099
## g.div.1Mb.2 8 -343.7706
## g.div.1Mb.3 7 -342.0432
## g.div.1Mb.4 7 -343.8311

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC  logLik
##   -1746.826 -1724.66 881.413
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.3592005
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.05866752
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003455613 2.011308e-05 171.80925 0.0000
## thetaS       0.001807820 1.524344e-05 118.59656 0.0000
## rhoS        0.000054947 2.033038e-05   2.70268 0.0079
## tmrcaS      0.000723266 1.967362e-05  36.76325 0.0000
## thetaS:tmrcaS 0.000357443 1.414230e-05 25.27477 0.0000
##
## Correlation:
##          (Intr) thetaS rhoS   tmrcaS
## thetaS     0.033

```

```

## rhoS          0.011 -0.278
## tmrcaS       -0.020 -0.038 -0.400
## thetaS:tmrcaS -0.115 -0.228  0.044  0.008
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.0973545 -0.3676318  0.1123726  0.6318238  3.0894345
##
## Residual standard error: 0.0001583058
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.1)

##      thetaS        rhoS        tmrcaS thetaS:tmrcaS
## 1.174005 1.326410 1.225458    1.055518

```

5.5.7 Replicate 7

```

rep7.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep7_w1000000.csv", sep = ",", header = T)

rep_7.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.div")
rep_7.pi.1Mb$avg <- apply(rep_7.pi.1Mb[4:ncol(rep_7.pi.1Mb)], 1, mean)
rep_7.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.rho")
rep_7.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.theta")
rep_7.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep7/dm2L_bgs_rep7_5.tmrca")
rep_7.tmrca.1Mb$avg <- apply(rep_7.tmrca.1Mb[4:ncol(rep_7.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep7 <- as.data.frame(cbind(rep_7.pi.1Mb$avg, sim.theta.1Mb$Rate, rep7.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep7) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep7$thetaS <- (true.lands.1Mb.rep7$theta - mean(true.lands.1Mb.rep7$theta)) / sd(true.lands.1Mb.rep7$theta)
true.lands.1Mb.rep7$tmrcaS <- (true.lands.1Mb.rep7$tmrca - mean(true.lands.1Mb.rep7$tmrca)) / sd(true.lands.1Mb.rep7$tmrca)
true.lands.1Mb.rep7$rhoS <- (true.lands.1Mb.rep7$rho - mean(true.lands.1Mb.rep7$rho, na.rm = T)) / sd(true.lands.1Mb.rep7$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep7)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 7] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.1Mb.rep7)
##
## Residuals:
##      Min       1Q       Median      3Q       Max
## -1.859e-04 -9.077e-05  1.500e-05  9.735e-05  2.201e-04
##
```

```

## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.350e-03 2.955e-05 113.374 < 2e-16 ***
## thetaS      7.576e-04 3.629e-05 20.875 1.46e-14 ***
## rhoS        1.950e-04 5.414e-05   3.602  0.0019 **
## tmrcaS      8.798e-04 5.298e-05 16.608 9.07e-13 ***
## thetaS:tmrcaS 3.368e-04 5.062e-05   6.653 2.31e-06 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001344 on 19 degrees of freedom
## Multiple R-squared: 0.9937, Adjusted R-squared: 0.9924
## F-statistic: 747.1 on 4 and 19 DF, p-value: < 2.2e-16
vif(m.div.1Mb)

##          thetaS         rhoS         tmrcaS thetaS:tmrcaS
## 1.675911    3.729949    3.571198    1.539214

# now the lm with inferred landscapes
inf.lands.1Mb.rep7 <- as.data.frame(cbind(rep_7.pi.1Mb$avg, rep_7.theta.1Mb$sample_mean, rep_7.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep7) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[7, 3] <- cor.test(sim.theta.1Mb$Rate, rep_7.theta.1Mb$sample_mean, method = "spearman")$estimate
cor.table.rho[7, 3] <- cor.test(sim.rho.1Mb$Rate, rep_7.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[7, 3] <- cor.test(rep7.sim.tmrca.1Mb$AverageTmrca, rep_7.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep7$thetaS <- (inf.lands.1Mb.rep7$theta - mean(inf.lands.1Mb.rep7$theta)) / sd(inf.lands.1Mb.rep7)
inf.lands.1Mb.rep7$tmrcaS <- (inf.lands.1Mb.rep7$tmrca - mean(inf.lands.1Mb.rep7$tmrca)) / sd(inf.lands.1Mb.rep7)
inf.lands.1Mb.rep7$rhoS <- (inf.lands.1Mb.rep7$rho - mean(inf.lands.1Mb.rep7$rho)) / sd(inf.lands.1Mb.rep7)

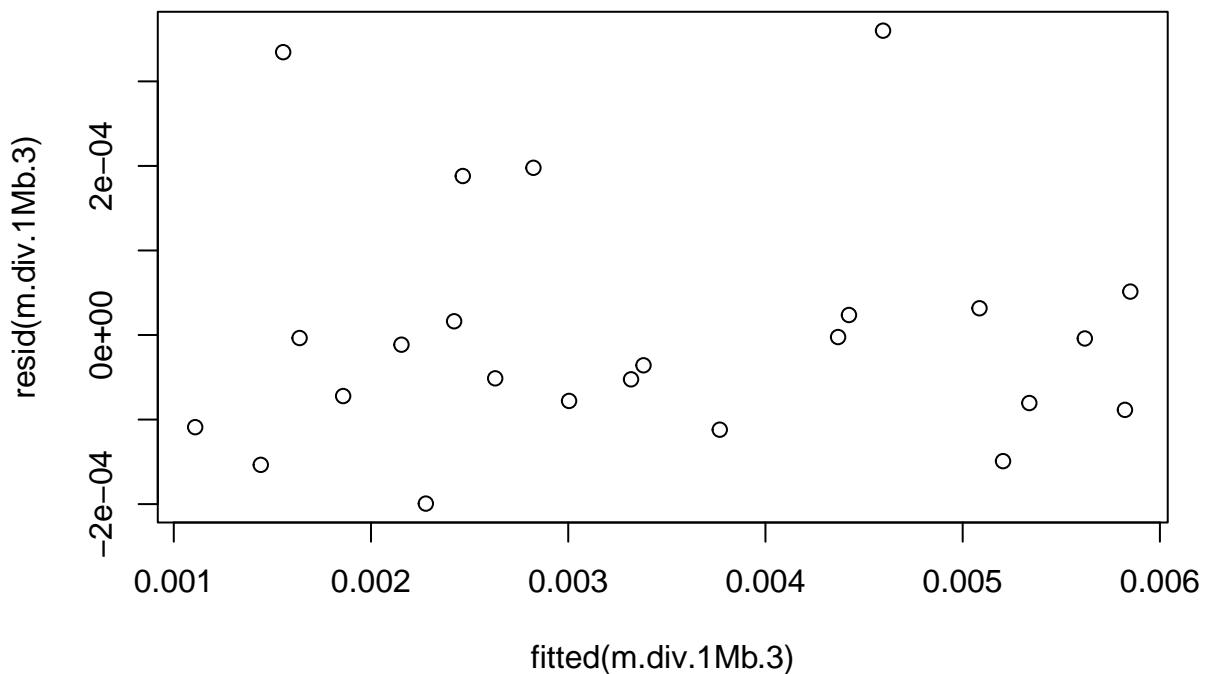
inf.lands.1Mb.rep7$bin <- 1:nrow(inf.lands.1Mb.rep7)
inf.lands.1Mb.rep7$Replicate <- 7

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep7)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep7)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep7)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -345.4274
## m.div.1Mb.2   7 -343.4288
## m.div.1Mb.3   8 -342.2231
plot(resid(m.div.1Mb.3) ~ fitted(m.div.1Mb.3))

```

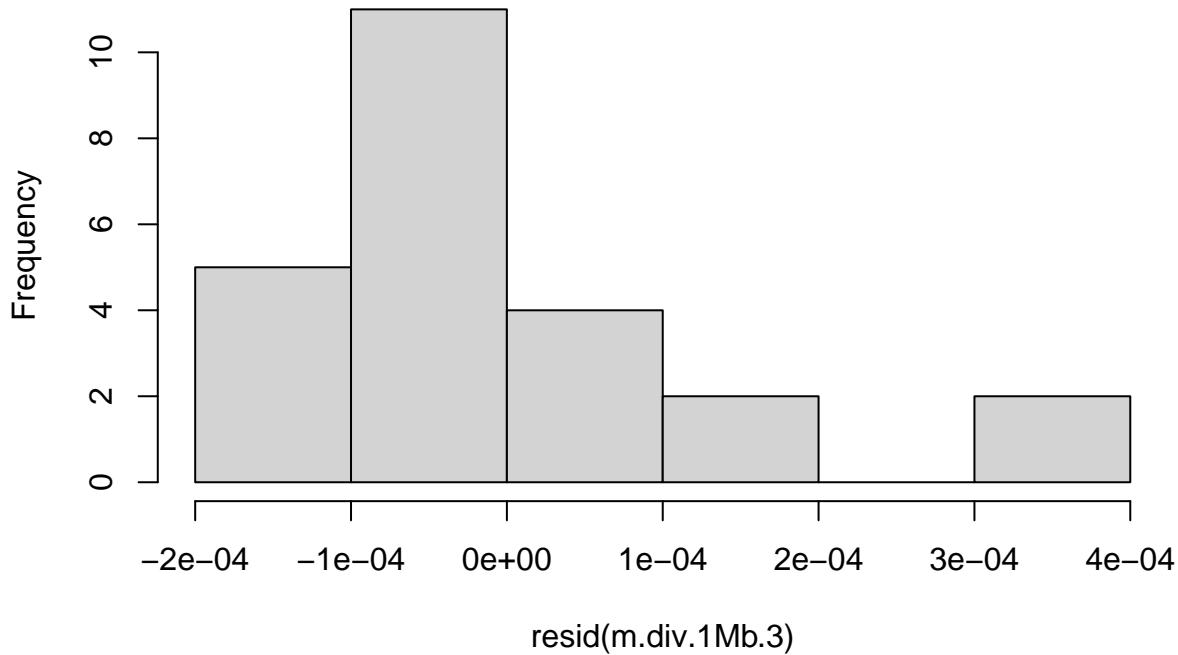


```
dwtest(m.div.1Mb.3)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb.3
## DW = 2.1375, p-value = 0.4535
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb.3)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb.3
## HMC = 0.48139, p-value = 0.464
hist(resid(m.div.1Mb.3))
```

Histogram of resid(m.div.1Mb.3)



```
summary(m.div.1Mb.3)
```

```
##
## Call:
## lm(formula = diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep7)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -1.994e-04 -8.247e-05 -2.363e-05  2.565e-05  3.600e-04 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.359e-03 7.179e-05 46.788 < 2e-16 ***
## thetaS       1.177e-03 6.082e-05 19.360 5.09e-13 ***
## rhoS        3.940e-05 6.508e-05  0.605 0.552926  
## tmrcaS      6.579e-04 1.377e-04  4.778 0.000175 *** 
## thetaS:rhoS -3.009e-05 3.978e-05 -0.756 0.459812  
## thetaS:tmrcaS 2.823e-04 1.456e-04   1.938 0.069410 .  
## rhoS:tmrcaS  1.665e-06 8.118e-05   0.021 0.983872  
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.000165 on 17 degrees of freedom
## Multiple R-squared:  0.9915, Adjusted R-squared:  0.9885 
## F-statistic: 329.9 on 6 and 17 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb.3)
```

```
##          thetaS          rhoS         tmrcaS    thetaS:rhoS    thetaS:tmrcaS
## 3.124615     3.577823    16.010427    1.125325     6.075177
## rhoS:tmrcaS
```

```

##      6.944307

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 7] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 7] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 7] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 7] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 7] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep7, weight = r2.bgs.1Mb[1, 7])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep7, weight = r2.bgs.1Mb[2, 7])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep7, weight = r2.bgs.1Mb[3, 7])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep7, weight = r2.bgs.1Mb[4, 7])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -343.8782
## g.div.1Mb.2 8 -342.3197
## g.div.1Mb.3 7 -343.7752
## g.div.1Mb.4 7 -345.6709

summary(g.div.200kb.2)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC  logLik
##   -1760.403 -1738.238 888.2017
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##       Phi
## 0.4617293
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~theta
##   Parameter estimates:
##       power
## 0.5635104
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003462323 2.402517e-05 144.11230 0e+00
## thetaS       0.001820304 1.767755e-05 102.97264 0e+00
## rhoS        0.000075232 1.896687e-05   3.96650 1e-04
## tmrcaS      0.000703320 1.767660e-05   39.78820 0e+00
## thetaS:tmrcaS 0.000356153 1.465143e-05  24.30839 0e+00
##
## Correlation:
##           (Intr) thetaS rhoS   tmrcaS

```

```

## thetaS      0.528
## rhoS       0.044 -0.205
## tmrcaS     -0.048 -0.104 -0.307
## thetaS:tmrcaS -0.134 -0.108  0.071  0.482
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.8410953 -0.3805993  0.0579645  0.6056538  3.2911454
##
## Residual standard error: 0.003912165
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.2)

```

```

##      thetaS       rhoS       tmrcaS thetaS:tmrcaS
## 1.078808 1.260217 1.573482    1.398905

```

5.5.8 Replicate 8

```

rep8.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep8_w1000000.csv", sep = ",", header = T)

rep_8.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.div")
rep_8.pi.1Mb$avg <- apply(rep_8.pi.1Mb[4:ncol(rep_8.pi.1Mb)], 1, mean)
rep_8.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.rho")
rep_8.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.theta")
rep_8.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep8/dm2L_bgs_rep8_5.tmrca")
rep_8.tmrca.1Mb$avg <- apply(rep_8.tmrca.1Mb[4:ncol(rep_8.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep8 <- as.data.frame(cbind(rep_8.pi.1Mb$avg, sim.theta.1Mb$Rate, rep8.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep8) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep8$thetaS <- (true.lands.1Mb.rep8$theta - mean(true.lands.1Mb.rep8$theta)) / sd(true.lands.1Mb.rep8$theta)
true.lands.1Mb.rep8$tmrcaS <- (true.lands.1Mb.rep8$tmrca - mean(true.lands.1Mb.rep8$tmrca)) / sd(true.lands.1Mb.rep8$tmrca)
true.lands.1Mb.rep8$rhoS <- (true.lands.1Mb.rep8$rho - mean(true.lands.1Mb.rep8$rho, na.rm = T)) / sd(true.lands.1Mb.rep8$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep8)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 8] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep8)
##
## Residuals:
##      Min       1Q       Median       3Q       Max
## -2.103e-04 -1.048e-04 -6.107e-06  1.164e-04  2.676e-04

```

```

## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.380e-03 3.036e-05 111.336 < 2e-16 ***
## thetaS      7.700e-04 3.700e-05  20.813 1.54e-14 ***
## rhoS        1.927e-04 5.588e-05   3.449  0.00269 ** 
## tmrcaS      8.625e-04 5.451e-05  15.822 2.15e-12 ***
## thetaS:tmrcaS 3.144e-04 5.177e-05   6.072 7.71e-06 *** 
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 
## 
## Residual standard error: 0.0001394 on 19 degrees of freedom 
## Multiple R-squared:  0.993, Adjusted R-squared:  0.9916 
## F-statistic: 676.3 on 4 and 19 DF,  p-value: < 2.2e-16 

vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 1.619191    3.693361    3.515056    1.485648 

# now the lm with inferred landscapes
inf.lands.1Mb.rep8 <- as.data.frame(cbind(rep_8.pi.1Mb$avg, rep_8.theta.1Mb$sample_mean, rep_8.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep8) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[8, 3] <- cor.test(sim.theta.1Mb$Rate, rep_8.theta.1Mb$sample_mean, method = "spearman")$estimate
cor.table.rho[8, 3] <- cor.test(sim.rho.1Mb$Rate, rep_8.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[8, 3] <- cor.test(rep8.sim.tmrca.1Mb$AverageTmrca, rep_8.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep8$thetaS <- (inf.lands.1Mb.rep8$theta - mean(inf.lands.1Mb.rep8$theta)) / sd(inf.lands.1Mb.rep8)
inf.lands.1Mb.rep8$tmrcaS <- (inf.lands.1Mb.rep8$tmrca - mean(inf.lands.1Mb.rep8$tmrca)) / sd(inf.lands.1Mb.rep8)
inf.lands.1Mb.rep8$rhoS <- (inf.lands.1Mb.rep8$rho - mean(inf.lands.1Mb.rep8$rho)) / sd(inf.lands.1Mb.rep8)

inf.lands.1Mb.rep8$bin <- 1:nrow(inf.lands.1Mb.rep8)
inf.lands.1Mb.rep8$Replicate <- 8

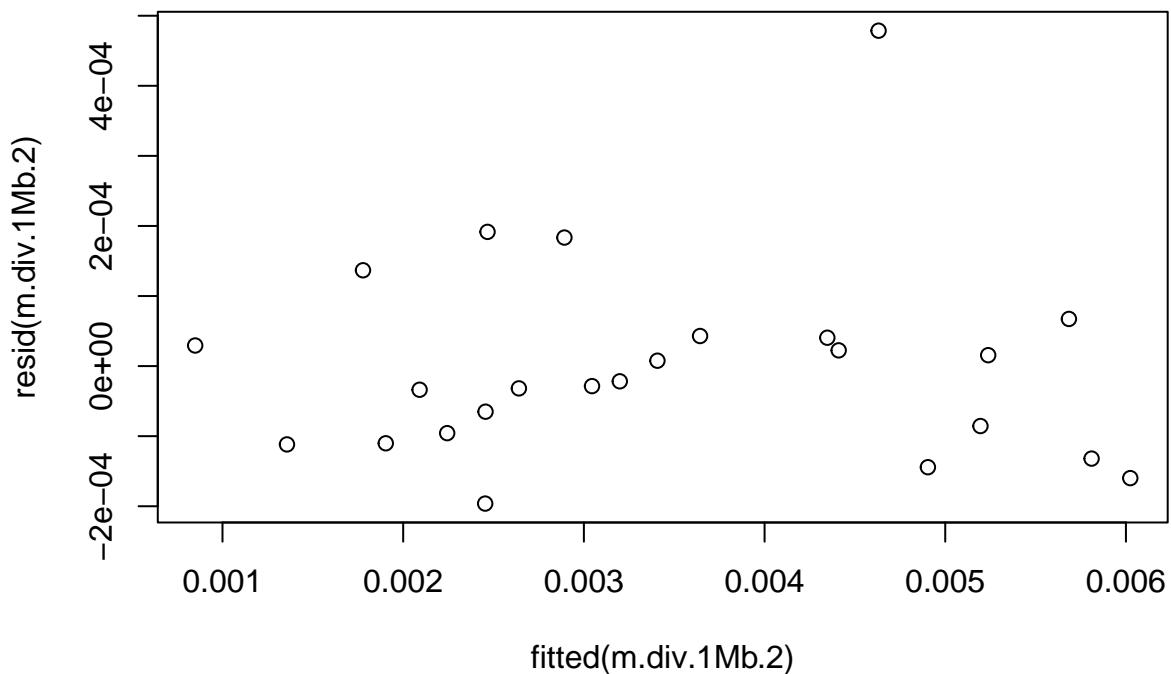
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep8)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep8)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep8)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df      AIC
## m.div.1Mb     6 -345.1858
## m.div.1Mb.2   7 -343.4070
## m.div.1Mb.3   8 -345.1559

plot(resid(m.div.1Mb.2) ~ fitted(m.div.1Mb.2))

```

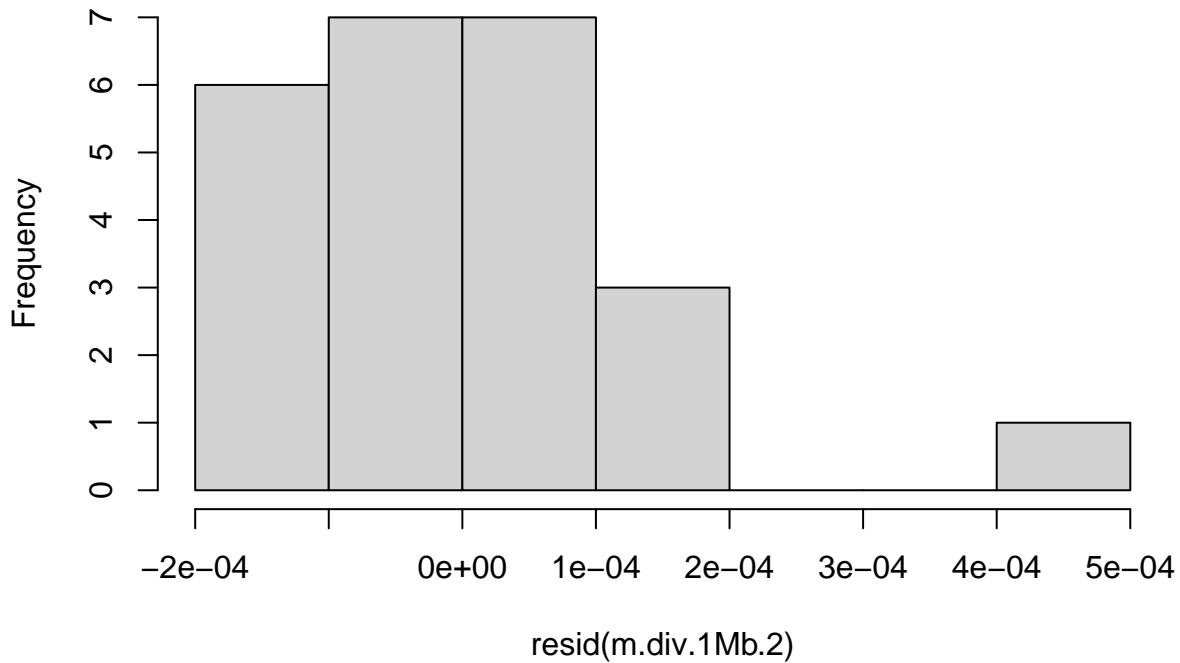


```
dwttest(m.div.1Mb.2)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb.2
## DW = 2.2956, p-value = 0.6128
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb.2)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb.2
## HMC = 0.61122, p-value = 0.79
hist(resid(m.div.1Mb.2))
```

Histogram of resid(m.div.1Mb.2)



```
summary(m.div.1Mb.2)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS +
##     rhoS:tmrcaS, data = inf.lands.1Mb.rep8)
##
## Residuals:
##      Min        1Q    Median        3Q       Max
## -1.962e-04 -9.930e-05 -2.515e-05  4.110e-05  4.787e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.392e-03 9.639e-05 35.184 < 2e-16 ***
## thetaS      1.030e-03 6.354e-05 16.213 3.49e-12 ***
## rhoS       -2.960e-05 7.471e-05 -0.396  0.6967
## tmrcaS      9.636e-04 1.803e-04  5.343 4.44e-05 ***
## thetaS:tmrcaS 1.917e-04 7.981e-05  2.402  0.0273 *
## rhoS:tmrcaS  5.487e-05 1.344e-04  0.408  0.6879
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001631 on 18 degrees of freedom
## Multiple R-squared:  0.991, Adjusted R-squared:  0.9884
## F-statistic: 394.5 on 5 and 18 DF,  p-value: < 2.2e-16

vif(m.div.1Mb.2)

##          thetaS            rhoS            tmrcaS      thetaS:tmrcaS      rhoS:tmrcaS
## 3.490269 4.825265 28.112867 2.779498 25.110263
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 8] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 8] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 8] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 8] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 8] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep8, weight = r2.bgs.1Mb[1, 8])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep8, weight = r2.bgs.1Mb[2, 8])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep8, weight = r2.bgs.1Mb[3, 8])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep8, weight = r2.bgs.1Mb[4, 8])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -344.1779
## g.div.1Mb.2 8 -346.5652
## g.div.1Mb.3 7 -346.9859
## g.div.1Mb.4 7 -343.9414

summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
##   -1734.608 -1715.213 874.304
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##       power
## 0.06585754
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003456651 1.395282e-05 247.73845 0.0000
## thetaS       0.001791494 1.545385e-05 115.92545 0.0000
## rhoS        0.000057760 1.745893e-05   3.30831 0.0013
## tmrcaS      0.000731416 1.833740e-05  39.88655 0.0000
## thetaS:tmrcaS 0.000363491 1.607889e-05  22.60670 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS     0.044
## rhoS      0.022 -0.358
## tmrcaS   -0.071  0.007 -0.475
## thetaS:tmrcaS -0.188 -0.216  0.006  0.071
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.21935933 -0.35120581  0.01652401  0.59170149  3.02405764
##
## Residual standard error: 0.0001583413
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS        tmrcaS thetaS:tmrcaS
##      1.253421     1.545304     1.346750     1.057384

```

5.5.9 Replicate 9

```

rep9.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep9_w1000000.csv", sep = ",", header = T)

rep_9.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.div")
rep_9.pi.1Mb$avg <- apply(rep_9.pi.1Mb[4:ncol(rep_9.pi.1Mb)], 1, mean)
rep_9.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.rho")
rep_9.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.theta")
rep_9.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep9/dm2L_bgs_rep9_5.tmrca")
rep_9.tmrca.1Mb$avg <- apply(rep_9.tmrca.1Mb[4:ncol(rep_9.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep9 <- as.data.frame(cbind(rep_9.pi.1Mb$avg, sim.theta.1Mb$Rate, rep9.sim.tmrca.1Mb$Avg))
names(true.lands.1Mb.rep9) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep9$thetaS <- (true.lands.1Mb.rep9$theta - mean(true.lands.1Mb.rep9$theta)) / sd(true.lands.1Mb.rep9$theta)
true.lands.1Mb.rep9$tmrcaS <- (true.lands.1Mb.rep9$tmrca - mean(true.lands.1Mb.rep9$tmrca)) / sd(true.lands.1Mb.rep9$tmrca)
true.lands.1Mb.rep9$rhoS <- (true.lands.1Mb.rep9$rho - mean(true.lands.1Mb.rep9$rho, na.rm = T)) / sd(true.lands.1Mb.rep9$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep9)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 9] <- anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.bgs.1Mb.true[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 9] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = true.lands.1Mb.rep9)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -2.058e-04 -1.266e-04  1.789e-05  7.418e-05  2.684e-04 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 3.444e-03 3.279e-05 105.023 < 2e-16 ***
## thetaS      8.024e-04 4.072e-05 19.702 4.18e-14 ***
## rhoS       2.186e-04 6.532e-05   3.347  0.00339 ** 
## 
```

```

## tmrcaS      7.931e-04  6.380e-05  12.431 1.42e-10 ***
## thetaS:tmrcaS 2.953e-04  5.603e-05   5.270 4.36e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001517 on 19 degrees of freedom
## Multiple R-squared:  0.9914, Adjusted R-squared:  0.9896
## F-statistic: 549.2 on 4 and 19 DF,  p-value: < 2.2e-16

vif(m.div.1Mb)

##           thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1 1.658112     4.265050     4.069807     1.517928

# now the lm with inferred landscapes
inf.lands.1Mb.rep9 <- as.data.frame(cbind(rep_9.pi.1Mb$avg, rep_9.theta.1Mb$sample_mean, rep_9.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep9) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[9, 3] <- cor.test(sim.theta.1Mb$Rate, rep_9.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[9, 3] <- cor.test(sim.rho.1Mb$Rate, rep_9.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[9, 3] <- cor.test(rep9.sim.tmrca.1Mb$AverageTmrca, rep_9.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep9$thetaS <- (inf.lands.1Mb.rep9$theta - mean(inf.lands.1Mb.rep9$theta)) / sd(inf.lands.1Mb.rep9)
inf.lands.1Mb.rep9$tmrcaS <- (inf.lands.1Mb.rep9$tmrca - mean(inf.lands.1Mb.rep9$tmrca)) / sd(inf.lands.1Mb.rep9)
inf.lands.1Mb.rep9$rhoS <- (inf.lands.1Mb.rep9$rho - mean(inf.lands.1Mb.rep9$rho)) / sd(inf.lands.1Mb.rep9)

inf.lands.1Mb.rep9$bin <- 1:nrow(inf.lands.1Mb.rep9)
inf.lands.1Mb.rep9$Replicate <- 9

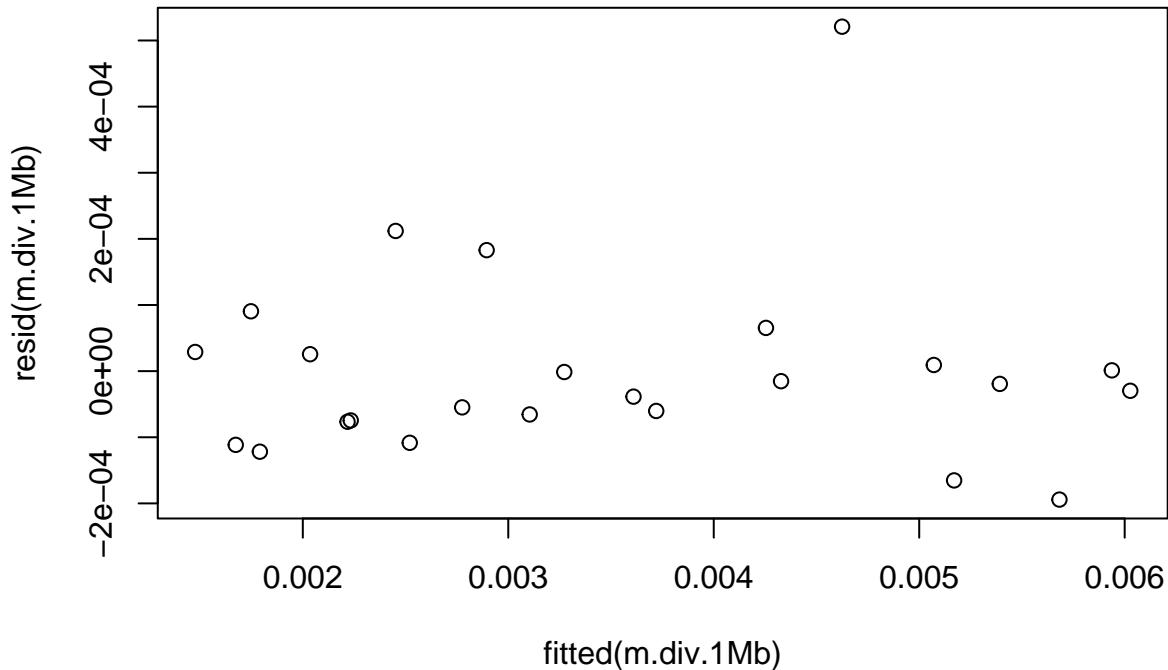
m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep9)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep9)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep9)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##           df      AIC
## m.div.1Mb     6 -344.7058
## m.div.1Mb.2   7 -345.4784
## m.div.1Mb.3   8 -344.8491

plot(resid(m.div.1Mb)~fitted(m.div.1Mb))

```

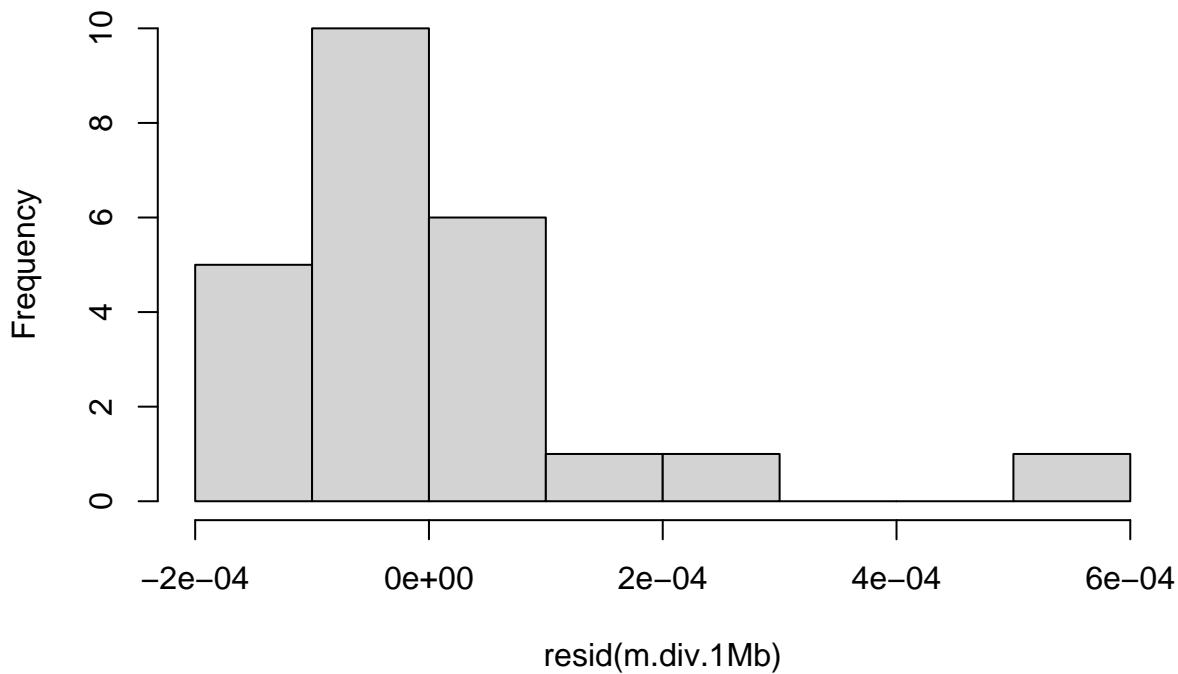


```
dwttest(m.div.1Mb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.6206, p-value = 0.8798
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.64661, p-value = 0.846
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##      data = inf.lands.1Mb.rep9)
##
## Residuals:
##       Min         1Q     Median        3Q       Max
## -1.942e-04 -7.503e-05 -2.451e-05  2.644e-05  5.209e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.453e-03 3.751e-05 92.060 < 2e-16 ***
## thetaS      1.053e-03 4.624e-05 22.783 2.94e-15 ***
## rhoS       -9.680e-06 5.351e-05 -0.181  0.8584
## tmrcaS      7.147e-04 4.670e-05 15.304 3.87e-12 ***
## thetaS:tmrcaS 1.586e-04 6.041e-05  2.626   0.0166 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001611 on 19 degrees of freedom
## Multiple R-squared:  0.9903, Adjusted R-squared:  0.9883
## F-statistic: 486.3 on 4 and 19 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
## 1.894712    2.537876    1.933102    1.345040
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 9] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3] +
r2.bgs.1Mb[2, 9] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 9] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 9] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 9] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep9, weight = r2.bgs.1Mb[1, 9])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep9, weight = r2.bgs.1Mb[2, 9])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep9, weight = r2.bgs.1Mb[3, 9])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep9, weight = r2.bgs.1Mb[4, 9])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##           df      AIC
## g.div.1Mb.1 8 -347.5106
## g.div.1Mb.2 8 -349.8511
## g.div.1Mb.3 7 -346.0547
## g.div.1Mb.4 7 -343.4336

summary(g.div.200kb.4)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
## -1734.608 -1715.213 874.304
##
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
## Parameter estimates:
##   power
## 0.06585754
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 0.003456651 1.395282e-05 247.73845 0.0000
## thetaS       0.001791494 1.545385e-05 115.92545 0.0000
## rhoS        0.000057760 1.745893e-05   3.30831 0.0013
## tmrcaS      0.000731416 1.833740e-05  39.88655 0.0000
## thetaS:tmrcaS 0.000363491 1.607889e-05  22.60670 0.0000
##
## Correlation:
##            (Intr) thetaS rhoS    tmrcaS
## thetaS     0.044
## rhoS      0.022 -0.358
## tmrcaS   -0.071  0.007 -0.475
## thetaS:tmrcaS -0.188 -0.216  0.006  0.071
##
## Standardized residuals:
```

```

##          Min         Q1        Med         Q3        Max
## -3.21935933 -0.35120581  0.01652401  0.59170149  3.02405764
##
## Residual standard error: 0.0001583413
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.4)

##          thetaS        rhoS      tmrcaS thetaS:tmrcaS
##     1.253421    1.545304    1.346750    1.057384

```

5.5.10 Replicate 10

```

rep10.sim.tmrca.1Mb <- read.table("dm_bgs_sims/10r/dm2L_bgs_rep10_w1000000.csv", sep = ",", header = T)

rep_10.pi.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_5.csv")
rep_10.pi.1Mb$avg <- apply(rep_10.pi.1Mb[4:ncol(rep_10.pi.1Mb)], 1, mean)
rep_10.rho.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_5.csv")
rep_10.theta.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_5.csv")
rep_10.tmrca.1Mb <- read.table("dm_bgs_sims/10r/NonHomogeneous/iSMC/NonHomogeneous/rep10/dm2L_bgs_rep10_5.csv")
rep_10.tmrca.1Mb$avg <- apply(rep_10.tmrca.1Mb[4:ncol(rep_10.tmrca.1Mb)], 1, mean)

# first the linear modeling with the true (simulated) landscapes
true.lands.1Mb.rep10 <- as.data.frame(cbind(rep_10.pi.1Mb$avg, sim.theta.1Mb$Rate, rep10.sim.tmrca.1Mb$Rate))
names(true.lands.1Mb.rep10) <- c("diversity", "theta", "tmrca", "rho")
true.lands.1Mb.rep10$thetaS <- (true.lands.1Mb.rep10$theta - mean(true.lands.1Mb.rep10$theta)) / sd(true.lands.1Mb.rep10$theta)
true.lands.1Mb.rep10$tmrcaS <- (true.lands.1Mb.rep10$tmrca - mean(true.lands.1Mb.rep10$tmrca)) / sd(true.lands.1Mb.rep10$tmrca)
true.lands.1Mb.rep10$rhoS <- (true.lands.1Mb.rep10$rho - mean(true.lands.1Mb.rep10$rho, na.rm = T)) / sd(true.lands.1Mb.rep10$rho)

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = true.lands.1Mb.rep10)
anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)
r2.bgs.1Mb.true[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.bgs.1Mb.true[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb.true[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb.true[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb.true[5, 10] <- anova.diversity$VarExp[4] * 100

summary(m.div.1Mb)

##
## Call:
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,
##     data = true.lands.1Mb.rep10)
##
## Residuals:
##          Min         1Q        Median         3Q        Max
## -1.589e-04 -7.774e-05  5.350e-07  4.855e-05  2.404e-04
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.441e-03  2.364e-05 145.584 < 2e-16 ***
## thetaS       8.114e-04  2.918e-05  27.802 < 2e-16 ***
## rhoS        1.905e-04  4.158e-05   4.582 0.000203 ***

```

```

## tmrcaS      8.316e-04  4.066e-05  20.452 2.12e-14 ***
## thetaS:tmrcaS 2.603e-04  3.966e-05   6.563 2.77e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0001069 on 19 degrees of freedom
## Multiple R-squared:  0.9959, Adjusted R-squared:  0.995
## F-statistic:  1147 on 4 and 19 DF,  p-value: < 2.2e-16
vif(m.div.1Mb)

##          thetaS          rhoS          tmrcaS thetaS:tmrcaS
##        1.713486       3.477833       3.325604       1.570761

# now the lm with inferred landscapes
inf.lands.1Mb.rep10 <- as.data.frame(cbind(rep_10.pi.1Mb$avg, rep_10.theta.1Mb$sample_mean, rep_10.tmrca.1Mb$sample_mean))
names(inf.lands.1Mb.rep10) <- c("diversity", "theta", "tmrca", "rho")

cor.table.theta[10, 3] <- cor.test(sim.theta.1Mb$Rate, rep_10.theta.1Mb$sample_mean, method = "spearman")
cor.table.rho[10, 3] <- cor.test(sim.rho.1Mb$Rate, rep_10.rho.1Mb$sample_mean, method = "spearman")$estimate
cor.table.tmrca[10, 3] <- cor.test(rep10.sim.tmrca.1Mb$AverageTmrca, rep_10.tmrca.1Mb$avg, method = "spearman")$estimate

# standardizing
inf.lands.1Mb.rep10$thetaS <- (inf.lands.1Mb.rep10$theta - mean(inf.lands.1Mb.rep10$theta)) / sd(inf.lands.1Mb.rep10$theta)
inf.lands.1Mb.rep10$tmrcaS <- (inf.lands.1Mb.rep10$tmrca - mean(inf.lands.1Mb.rep10$tmrca)) / sd(inf.lands.1Mb.rep10$tmrca)
inf.lands.1Mb.rep10$rhoS <- (inf.lands.1Mb.rep10$rho - mean(inf.lands.1Mb.rep10$rho)) / sd(inf.lands.1Mb.rep10$rho)

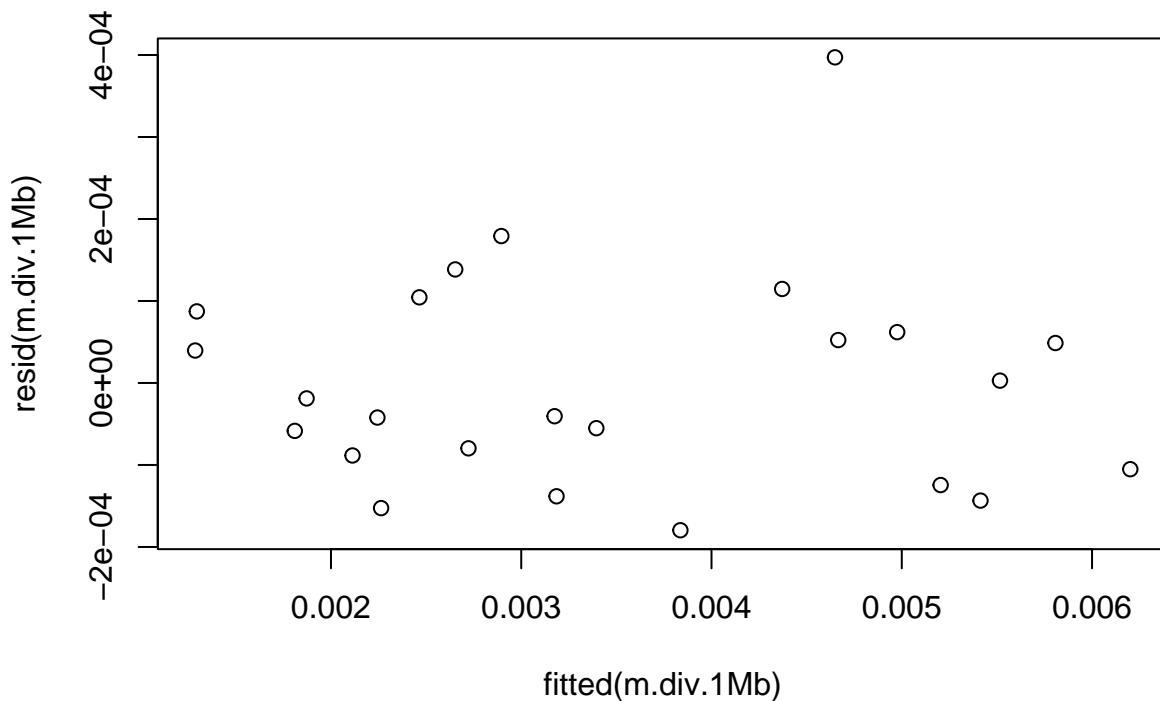
inf.lands.1Mb.rep10$bin <- 1:nrow(inf.lands.1Mb.rep10)
inf.lands.1Mb.rep10$Replicate <- 10

m.div.1Mb <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep10)
m.div.1Mb.2 <- lm(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS + rhoS:tmrcaS, data = inf.lands.1Mb.rep10)
m.div.1Mb.3 <- lm(diversity ~ (thetaS + rhoS + tmrcaS)^2, data = inf.lands.1Mb.rep10)

AIC(m.div.1Mb, m.div.1Mb.2, m.div.1Mb.3)

##          df          AIC
## m.div.1Mb     6 -349.8858
## m.div.1Mb.2   7 -353.7635
## m.div.1Mb.3   8 -351.7726
plot(resid(m.div.1Mb) ~ fitted(m.div.1Mb))

```

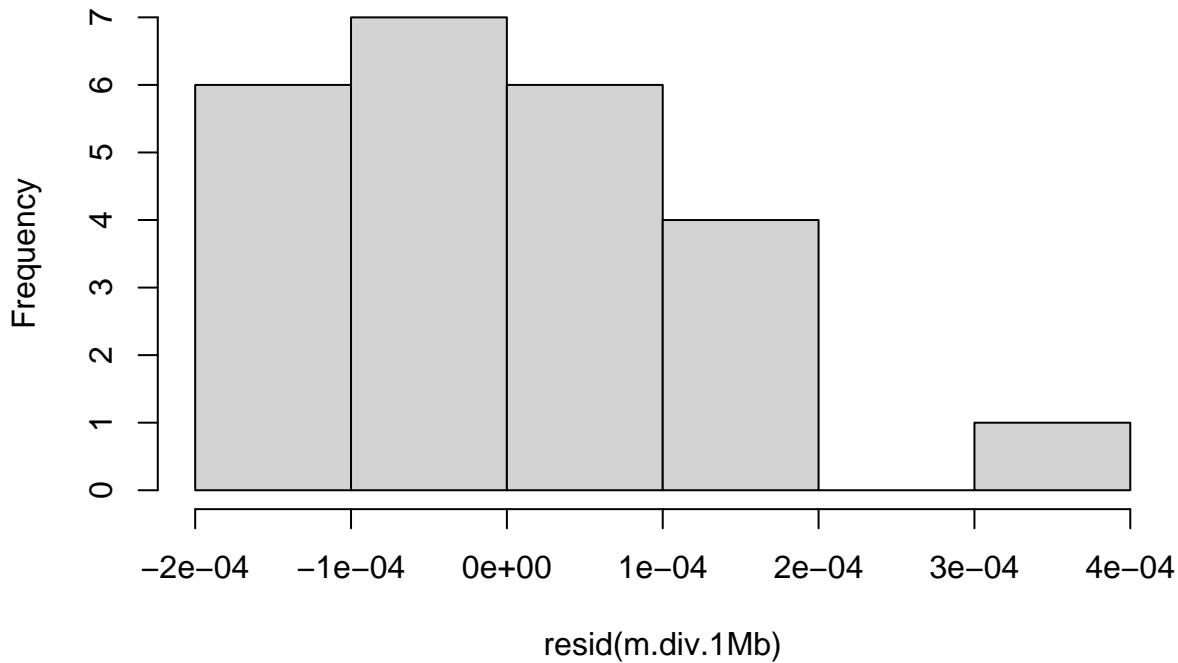


```
dwtest(m.div.1Mb)
```

```
##
##  Durbin-Watson test
##
## data: m.div.1Mb
## DW = 2.0448, p-value = 0.4006
## alternative hypothesis: true autocorrelation is greater than 0
hmctest(m.div.1Mb)
```

```
##
##  Harrison-McCabe test
##
## data: m.div.1Mb
## HMC = 0.61476, p-value = 0.797
hist(resid(m.div.1Mb))
```

Histogram of resid(m.div.1Mb)



```
summary(m.div.1Mb)
```

```
##  
## Call:  
## lm(formula = diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS,  
##      data = inf.lands.1Mb.rep10)  
##  
## Residuals:  
##      Min        1Q    Median        3Q       Max  
## -1.796e-04 -9.261e-05 -2.968e-05  6.834e-05  3.971e-04  
##  
## Coefficients:  
##             Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 3.457e-03 3.521e-05 98.178 < 2e-16 ***  
## thetaS       1.124e-03 4.650e-05 24.171 9.92e-16 ***  
## rhoS         7.688e-05 5.132e-05  1.498  0.1505  
## tmrcaS       6.577e-04 4.431e-05 14.844 6.62e-12 ***  
## thetaS:tmrcaS 1.995e-04 8.776e-05   2.273  0.0348 *  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 0.0001446 on 19 degrees of freedom  
## Multiple R-squared:  0.9925, Adjusted R-squared:  0.9909  
## F-statistic: 624.7 on 4 and 19 DF,  p-value: < 2.2e-16
```

```
vif(m.div.1Mb)
```

```
##          thetaS          rhoS          tmrcaS thetaS:tmrcaS  
## 2.378248 2.895886 2.159194 1.747934
```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.bgs.1Mb[1, 10] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.bgs.1Mb[2, 10] <- anova.diversity$VarExp[1] * 100
r2.bgs.1Mb[3, 10] <- anova.diversity$VarExp[2] * 100
r2.bgs.1Mb[4, 10] <- anova.diversity$VarExp[3] * 100
r2.bgs.1Mb[5, 10] <- anova.diversity$VarExp[4] * 100

g.div.1Mb.1 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep10, weight = r2.bgs.1Mb[1, 10])
g.div.1Mb.2 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep10, weight = r2.bgs.1Mb[2, 10])
g.div.1Mb.3 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep10, weight = r2.bgs.1Mb[3, 10])
g.div.1Mb.4 <- gls(diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS, data = inf.lands.1Mb.rep10, weight = r2.bgs.1Mb[4, 10])

AIC(g.div.1Mb.1, g.div.1Mb.2, g.div.1Mb.3, g.div.1Mb.4)

##          df      AIC
## g.div.1Mb.1 8 -347.2457
## g.div.1Mb.2 8 -348.1811
## g.div.1Mb.3 7 -348.8246
## g.div.1Mb.4 7 -349.0469

summary(g.div.200kb.1)

## Generalized least squares fit by maximum likelihood
##   Model: diversity ~ thetaS + rhoS + tmrcaS + thetaS:tmrcaS
##   Data: inf.lands.200kb.rep10
##       AIC      BIC logLik
##     -1746.826 -1724.66 881.413
##
## Correlation Structure: AR(1)
##   Formula: ~bin
##   Parameter estimate(s):
##     Phi
## 0.3592005
## Variance function:
##   Structure: Power of variance covariate
##   Formula: ~tmrcaS
##   Parameter estimates:
##     power
## 0.05866752
##
## Coefficients:
##             Value    Std.Error  t-value p-value
## (Intercept) 0.003455613 2.011308e-05 171.80925 0.0000
## thetaS       0.001807820 1.524344e-05 118.59656 0.0000
## rhoS        0.000054947 2.033038e-05   2.70268 0.0079
## tmrcaS      0.000723266 1.967362e-05  36.76325 0.0000
## thetaS:tmrcaS 0.000357443 1.414230e-05 25.27477 0.0000
##
## Correlation:
##           (Intr) thetaS rhoS   tmrcaS
## thetaS      0.033

```

```

## rhoS           0.011 -0.278
## tmrcaS        -0.020 -0.038 -0.400
## thetaS:tmrcaS -0.115 -0.228  0.044  0.008
##
## Standardized residuals:
##      Min       Q1       Med       Q3       Max
## -3.0973545 -0.3676318  0.1123726  0.6318238  3.0894345
##
## Residual standard error: 0.0001583058
## Degrees of freedom: 118 total; 113 residual
vif(g.div.200kb.1)

##          thetaS         rhoS         tmrcaS   thetaS:tmrcaS
## 1.174005    1.326410    1.225458    1.055518

```

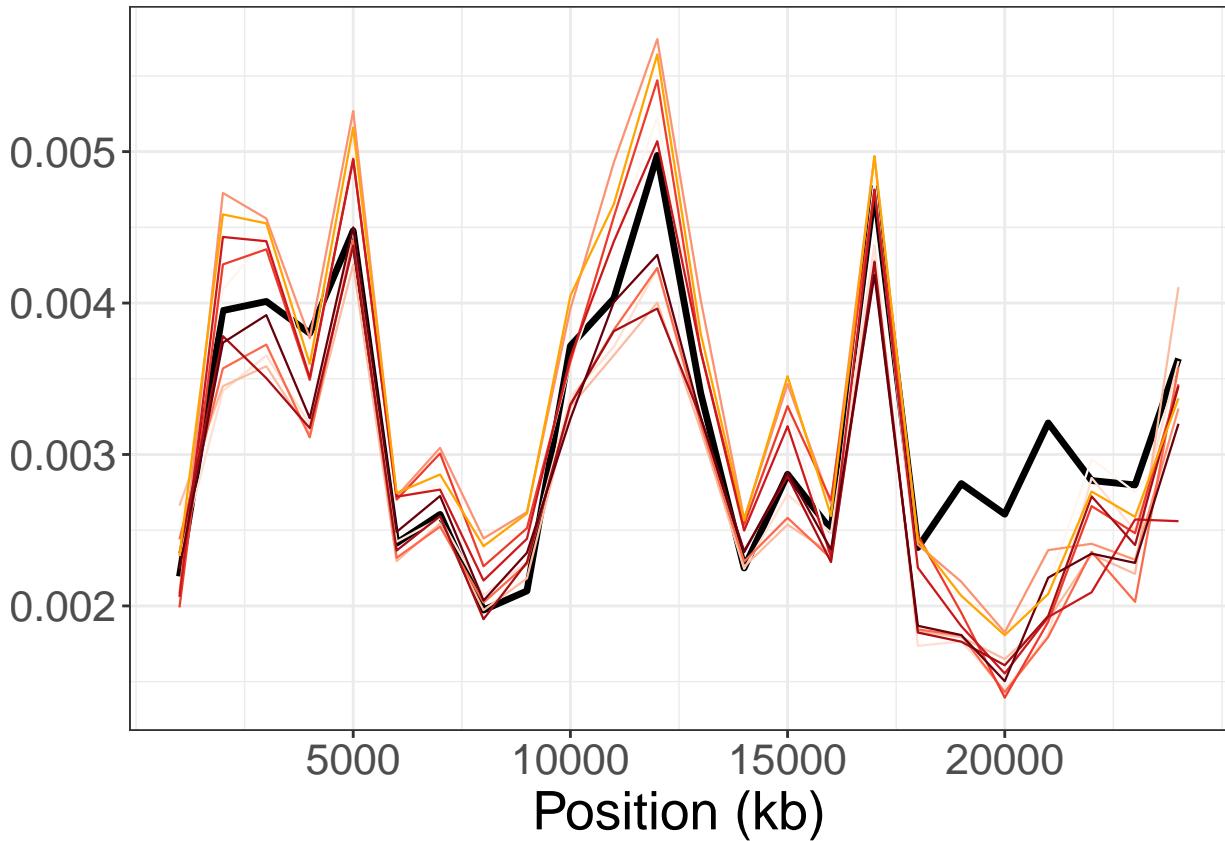
5.6 all replicates:

```

theta.plot <- as.data.frame(cbind(1:nrow(sim.theta.1Mb),
                                sim.theta.1Mb$Rate * 1e-7 * 3e+4,
                                rep_1.theta.1Mb$sample_mean,
                                rep_2.theta.1Mb$sample_mean,
                                rep_3.theta.1Mb$sample_mean,
                                rep_4.theta.1Mb$sample_mean,
                                rep_5.theta.1Mb$sample_mean,
                                rep_6.theta.1Mb$sample_mean,
                                rep_7.theta.1Mb$sample_mean,
                                rep_8.theta.1Mb$sample_mean,
                                rep_9.theta.1Mb$sample_mean,
                                rep_10.theta.1Mb$sample_mean))

names(theta.plot) <- c("bin", "sim", "reps")
molten.theta <- melt(theta.plot, id.vars = "bin")
theta.map.1Mb.bgs <- ggplot(data = molten.theta, aes(x = bin * 1000, y = value, colour = variable)) +
  theta.map.1Mb.bgs + geom_line(data = molten.theta, aes(size = variable)) + scale_size()
theta.map.1Mb.bgs <- theta.map.1Mb.bgs + scale_color_manual(values = c("black", brewer.pal(n = 9, name =
  "Set1")))
theta.map.1Mb.bgs <- theta.map.1Mb.bgs + scale_x_continuous(breaks = c(5000, 10000, 15000, 20000)) + scale_y_continuous()
theta.map.1Mb.bgs <- theta.map.1Mb.bgs + labs(title = NULL, x = "Position (kb)", y = NULL)
theta.map.1Mb.bgs <- theta.map.1Mb.bgs + theme(text = element_text(size = 20), axis.title.x = element_text(
  size = 20))
theta.map.1Mb.bgs

```



6 Plots

```

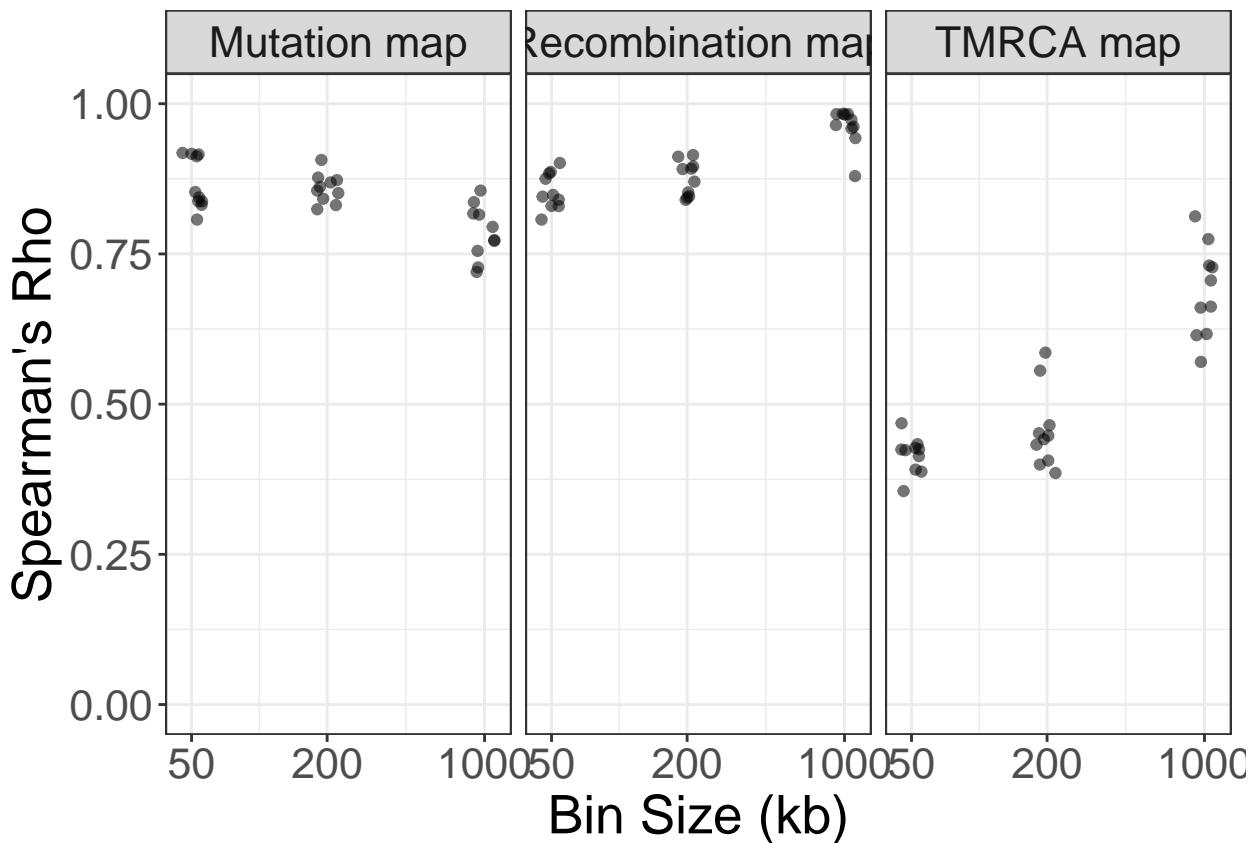
scale.2d <- function(x) sprintf("%.2f", x)

write.table(cor.table.theta, "cor.mutation.bgs.tsv", quote = F, sep = "\t")
write.table(cor.table.tmrca, "cor.tmrca.bgs.tsv", quote = F, sep = "\t")
write.table(cor.table.rho, "cor.rho.bgs.tsv", quote = F, sep = "\t")

cor.table.comb <- rbind.data.frame(t(cor.table.theta), t(cor.table.rho), t(cor.table.tmrca))
cor.table.comb$bin.size <- rep(c(50, 200, 1000), 3)
cor.table.comb$rate <- c(rep("Mutation map", 3), rep("Recombination map", 3), rep("TMRCA map", 3))

molten.cor <- melt(cor.table.comb, id.vars = c("bin.size", "rate"))
cor.bgs.plot <- ggplot(data = molten.cor, aes(x = bin.size, y = value, alpha = 0.6))
cor.bgs.plot <- cor.bgs.plot + geom_jitter(width = 0.05, height = 0.05) + facet_wrap(~rate)
cor.bgs.plot <- cor.bgs.plot + scale_x_continuous(breaks = c(50, 200, 1000), trans="log10")
cor.bgs.plot <- cor.bgs.plot + scale_y_continuous(breaks = pretty_breaks())
cor.bgs.plot <- cor.bgs.plot + labs(title = NULL, x = "Bin Size (kb)", y = "Spearman's Rho")
cor.bgs.plot <- cor.bgs.plot + theme_bw() + ylim(0, 1)
cor.bgs.plot <- cor.bgs.plot + theme(axis.title = element_text(size = 20), axis.text = element_text(size = 16),
                                         strip.text.x = element_text(size = 16), legend.position = "none")
cor.bgs.plot

```



```

ggsave("Figure6.pdf", cor.bgs.plot, device = "pdf", height = 5, width = 12)

# true (simulated) landscapes
r2.bgs.50kb.true$average <- apply(r2.bgs.50kb.true, 1, mean)
r2.bgs.200kb.true$average <- apply(r2.bgs.200kb.true, 1, mean)
r2.bgs.1Mb.true$average <- apply(r2.bgs.1Mb.true, 1, mean)

r2.true.avg <- rbind.data.frame(r2.bgs.50kb.true$average, r2.bgs.200kb.true$average, r2.bgs.1Mb.true$average)
colnames(r2.true.avg) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
r2.true.avg$bin.size <- c(50, 200, 1000)

# inferred landscapes
r2.bgs.50kb$average <- apply(r2.bgs.50kb, 1, mean)
r2.bgs.200kb$average <- apply(r2.bgs.200kb, 1, mean)
r2.bgs.1Mb$average <- apply(r2.bgs.1Mb, 1, mean)

r2.inf.avg <- rbind.data.frame(r2.bgs.50kb$average, r2.bgs.200kb$average, r2.bgs.1Mb$average, make.row=rbind)
colnames(r2.inf.avg) <- c("Total", "Theta", "Rho", "TMRCA", "Theta:TMRCA")
r2.inf.avg$bin.size <- c(50, 200, 1000)

r2.tab.comb <- rbind.data.frame(r2.dm.tab, r2.true.avg, r2.inf.avg)
r2.tab.comb$type <- c(rep("iSMC-inferred (Drosophila)", 3), rep("True landscapes (simulations)", 3), rep("True landscapes (inferred)", 3))

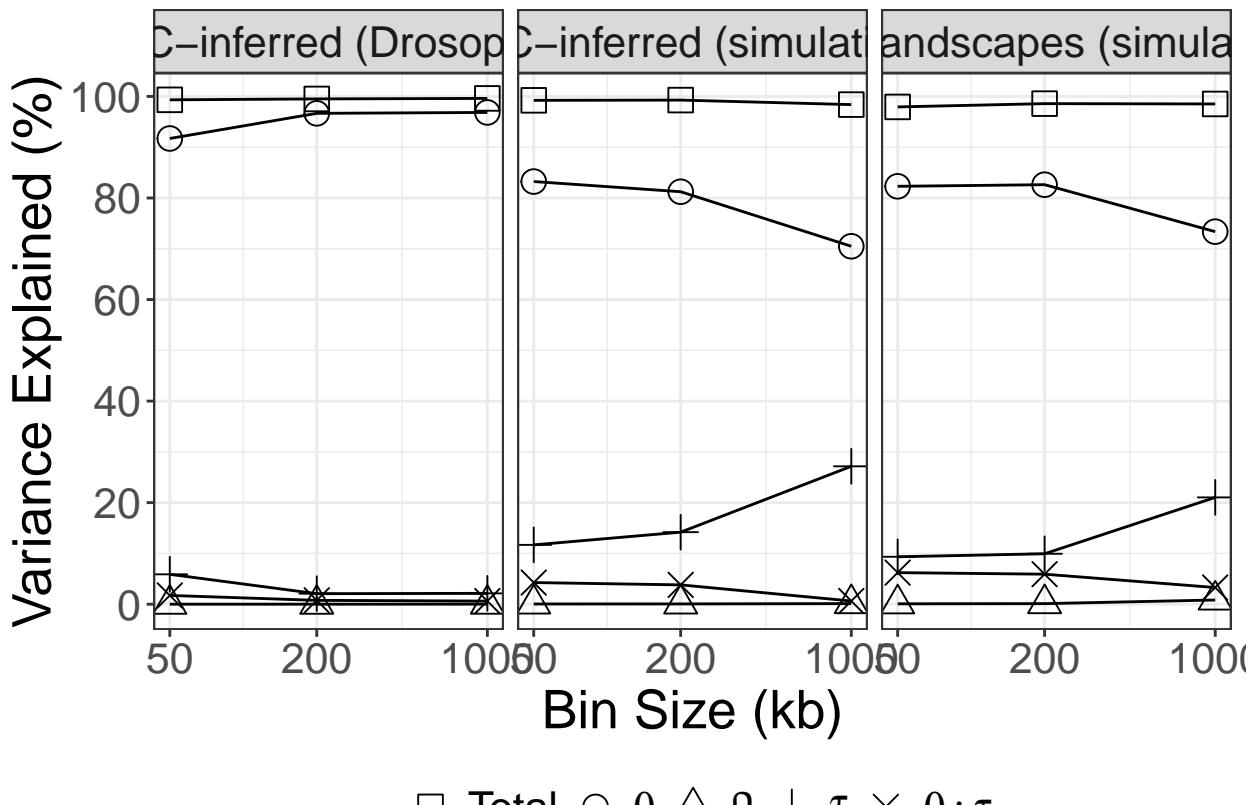
molten.r2 <- melt(r2.tab.comb, id.vars = c("bin.size", "type"))
r2.bgs.plot <- ggplot(data = molten.r2, aes(x = bin.size, y = value, shape = variable))
r2.bgs.plot <- r2.bgs.plot + geom_line(data = molten.r2)
r2.bgs.plot <- r2.bgs.plot + geom_point(aes(shape = variable), size = 4) + facet_wrap(~type)

```

```

r2.bgs.plot <- r2.bgs.plot + scale_x_continuous(breaks = c(50, 200, 1000), trans="log10")
r2.bgs.plot <- r2.bgs.plot + scale_y_continuous(breaks = pretty_breaks())
r2.bgs.plot <- r2.bgs.plot + scale_shape_manual(values = c(0, 1, 2, 3, 4), name = "",
                                                 labels = c("Total", expression(theta), expression(rho),
r2.bgs.plot <- r2.bgs.plot + labs(title = NULL, x = "Bin Size (kb)", y = "Variance Explained (%)")
r2.bgs.plot <- r2.bgs.plot + theme_bw()
r2.bgs.plot <- r2.bgs.plot + theme(axis.title = element_text(size = 20), axis.text = element_text(size =
                                         strip.text.x = element_text(size = 16),
                                         legend.text=element_text(size=16), legend.position = "bottom")
r2.bgs.plot

```



□ Total ○ θ △ ρ + τ × $\theta:\tau$

```

# combine coal and BGS R2 plots
r2.comb.plot <- plot_grid(r2.coal.plot, r2.bgs.plot, nrow = 2, ncol = 1, labels = "AUTO")
cowplot::save_plot("Figure4.pdf", r2.comb.plot, device = "pdf", base_height = 9, base_width = 12)

# bench theta
theta.maps.bgs <- plot_grid(theta.map.50kb.bgs, theta.map.200kb.bgs, theta.map.1Mb.bgs, nrow = 3, ncol = 1)

theta.maps.comb <- plot_grid(theta.maps.coal, theta.maps.bgs, labels = "AUTO", nrow = 1, ncol = 2)
save_plot("Figure2.pdf", theta.maps.comb, base_height = 18, base_width = 14)

# visualise true join landscapes
dm_2L_exome <- read.table("dm_bgs_sims/GeneAnnotations/exons_chr2L.csv", header = F, sep = ",")
names(dm_2L_exome) <- c("exon_start", "exon_end")

genes_barcode <- ggplot(data = dm_2L_exome) + geom_segment(aes(x = exon_start, xend = exon_end, size = 1))

```

```

## 50kb
theta.land.50kb <- cbind.data.frame(1:nrow(sim.theta.50kb), sim.theta.50kb$Rate * 4 * 1e+4 * 1e-7)
names(theta.land.50kb) <- c("bin", "rate")

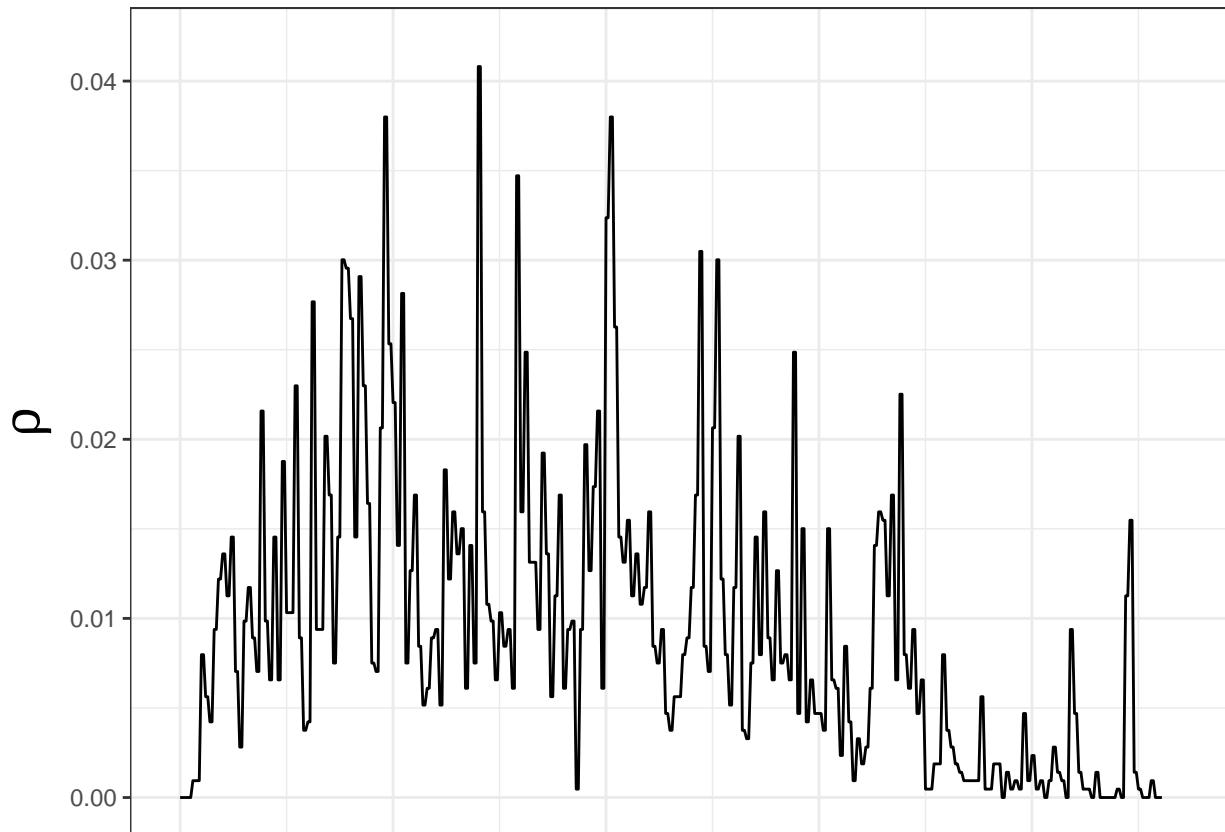
rho.land.50kb <- cbind.data.frame(1:nrow(sim.rho.50kb), sim.rho.50kb$Rate * 1e-7 * 4 * 1e+4)
names(rho.land.50kb) <- c("bin", "rate")

pi.lands.50kb <- cbind.data.frame(1:nrow(sim.theta.50kb), rep_1.pi.50kb$avg, rep_2.pi.50kb$avg, rep_3.pi.50kb$avg)
names(pi.lands.50kb) <- c("bin", "reps")

tau.lands.50kb <- cbind.data.frame(1:nrow(sim.theta.50kb), rep1.sim.tmrca.50kb$AverageTmrca, rep2.sim.tmrca.50kb$AverageTmrca, rep3.sim.tmrca.50kb$AverageTmrca)
names(tau.lands.50kb) <- c("bin", "reps")

rho.map.50kb <- ggplot(data = rho.land.50kb, aes(x = (bin -1) * 50, y = rate))
rho.map.50kb <- rho.map.50kb + geom_line(data = rho.land.50kb) + theme_bw()
rho.map.50kb <- rho.map.50kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.2d, limits = c(0, 0.04))
rho.map.50kb <- rho.map.50kb + labs(title = NULL, x = NULL, y = expression(rho))
rho.map.50kb <- rho.map.50kb + theme(axis.title.x=element_blank(),
                                         axis.text.x=element_blank(),
                                         axis.ticks.x=element_blank(),
                                         axis.title.y=element_text(size = 20), legend.position = "none")
rho.map.50kb

```



```

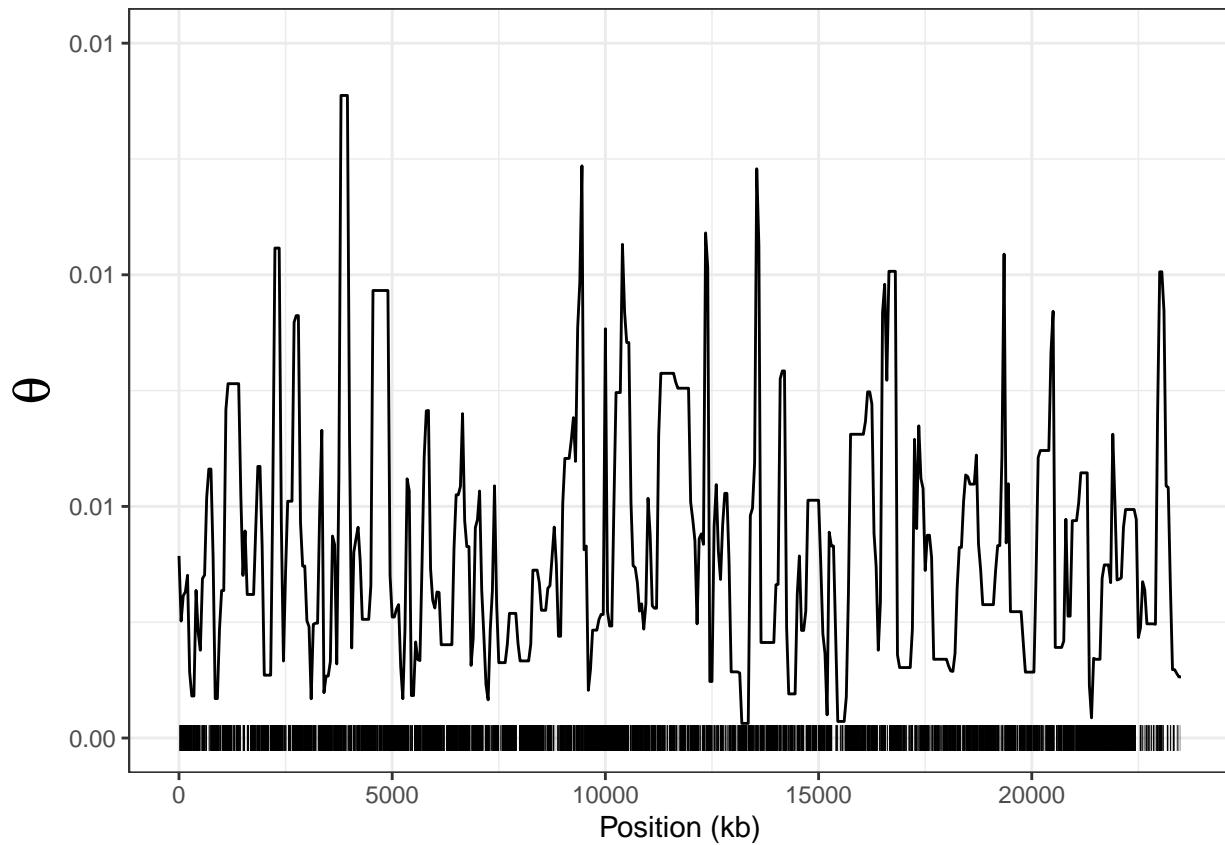
theta.map.50kb <- ggplot(data = theta.land.50kb, aes(x = (bin -1) * 50, y = rate))
theta.map.50kb <- theta.map.50kb + geom_line(data = theta.land.50kb) + theme_bw()
theta.map.50kb <- theta.map.50kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.2d, limits = c(0, 0.04))

```

```

theta.map.50kb <- theta.map.50kb + labs(title = NULL, x = "Position (kb)", y = expression(theta))
theta.map.50kb <- theta.map.50kb + geom_segment(data = dm_2L_exome, aes(x = exon_start / 1000, xend = e)
theta.map.50kb <- theta.map.50kb + theme(legend.position = "none", axis.title.y=element_text(size = 20))
theta.map.50kb

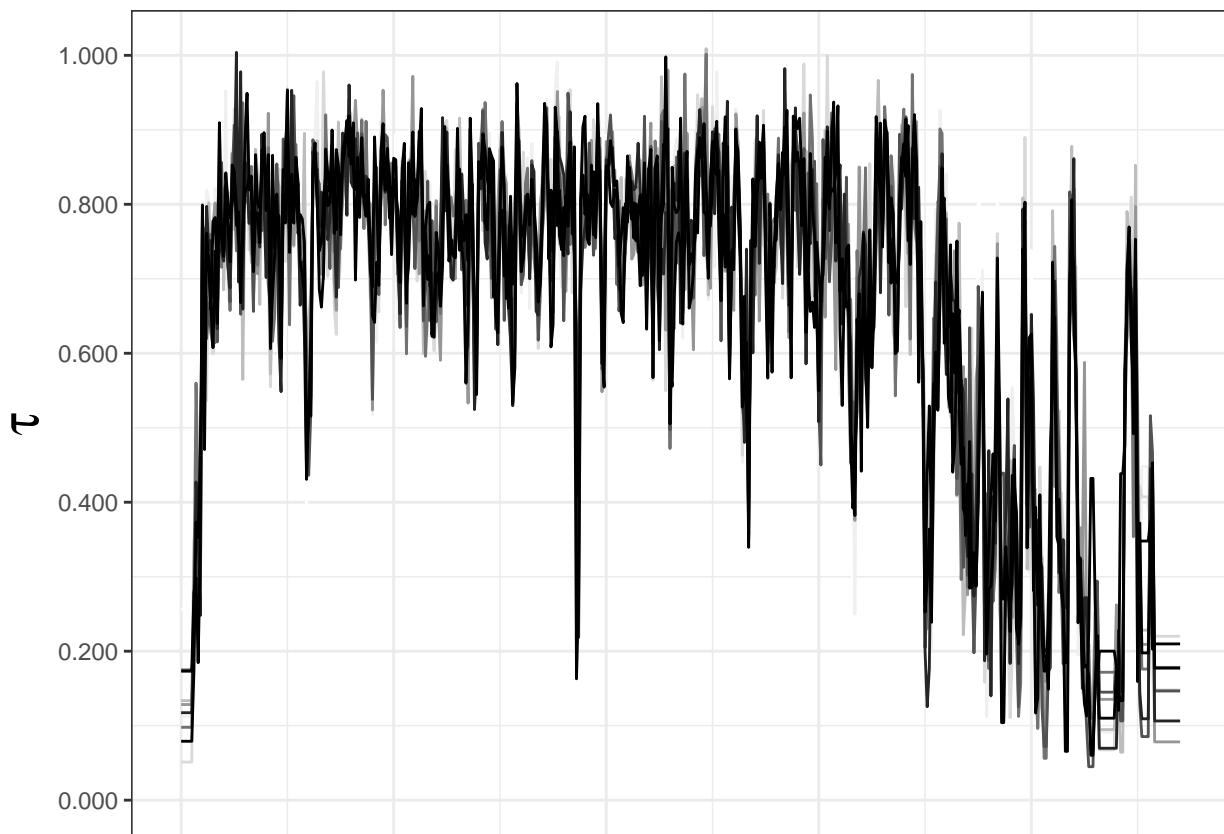
```



```

molten.tau <- melt(tau.lands.50kb, id.vars = "bin")
tau.map.50kb <- ggplot(data = molten.tau, aes(x = (bin -1) * 50, y = value / (4 * 1e+4), colour = variable))
tau.map.50kb <- tau.map.50kb + geom_line(data = molten.tau) + theme_bw()
tau.map.50kb <- tau.map.50kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 1))
tau.map.50kb <- tau.map.50kb + labs(title = NULL, x = NULL, y = expression(tau))
tau.map.50kb <- tau.map.50kb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
tau.map.50kb <- tau.map.50kb + theme(axis.title.x=element_blank(),
                                         axis.text.x=element_blank(),
                                         axis.ticks.x=element_blank(),
                                         axis.title.y=element_text(size = 20), legend.position = "none")
tau.map.50kb

```

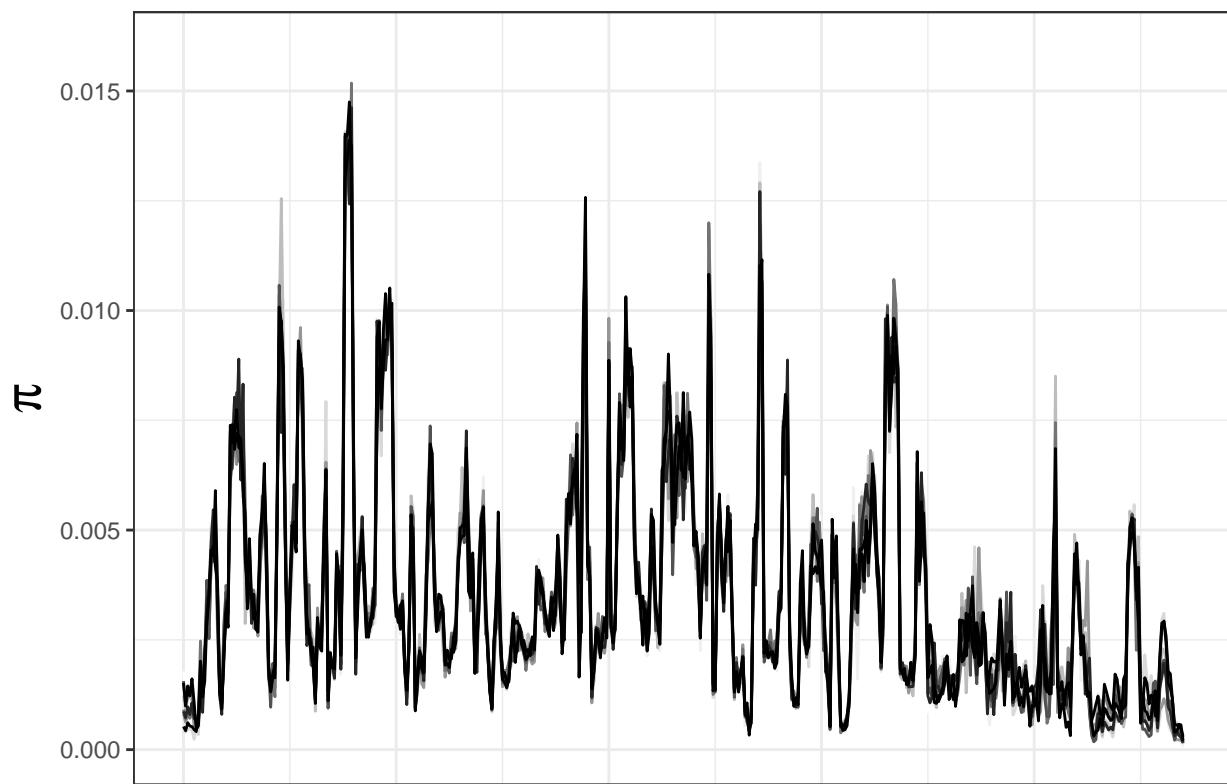


```

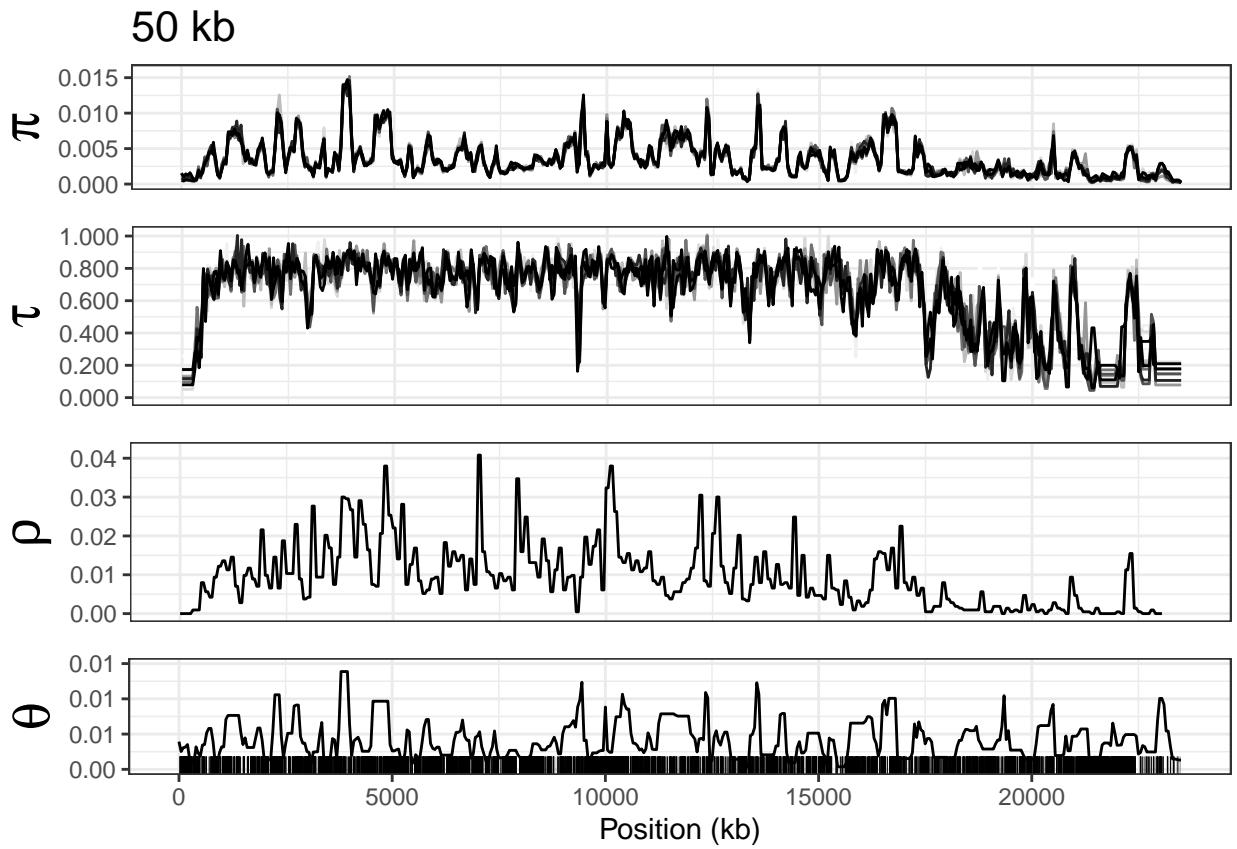
molten.pi <- melt(pi.lands.50kb, id.vars = "bin")
pi.map.50kb <- ggplot(data = molten.pi, aes(x = (bin -1) * 50, y = value, colour = variable))
pi.map.50kb <- pi.map.50kb + geom_line(data = molten.pi) + theme_bw()
pi.map.50kb <- pi.map.50kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 1))
pi.map.50kb <- pi.map.50kb + labs(title = "50 kb", x = NULL, y = expression(pi))
pi.map.50kb <- pi.map.50kb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
pi.map.50kb <- pi.map.50kb + theme(axis.title.x=element_blank(),
                                      axis.text.x=element_blank(),
                                      axis.ticks.x=element_blank(),
                                      axis.title.y=element_text(size = 20),
                                      plot.title = element_text(size = 16), legend.position = "none")
pi.map.50kb

```

50 kb



```
true.maps.50kb <- plot_grid(pi.map.50kb, tau.map.50kb, rho.map.50kb, theta.map.50kb, ncol = 1)  
true.maps.50kb
```



```

## 200kb
theta.land.200kb <- cbind.data.frame(1:nrow(sim.theta.200kb), sim.theta.200kb$Rate * 4 * 1e+4 * 1e-7)
names(theta.land.200kb) <- c("bin", "rate")

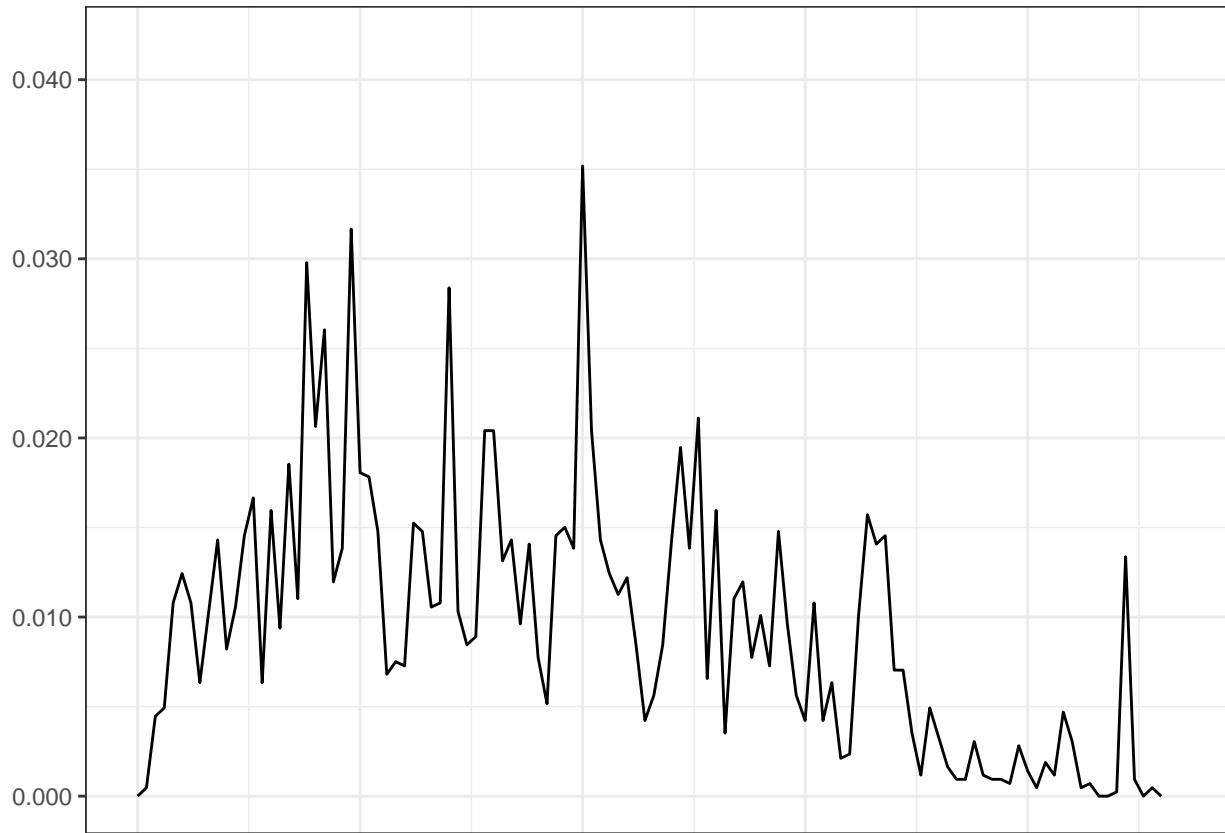
rho.land.200kb <- cbind.data.frame(1:nrow(sim.rho.200kb), sim.rho.200kb$Rate * 1e-7 * 4 * 1e+4)
names(rho.land.200kb) <- c("bin", "rate")

pi.lands.200kb <- cbind.data.frame(1:nrow(sim.theta.200kb), rep_1.pi.200kb$avg, rep_2.pi.200kb$avg, rep_
names(pi.lands.200kb) <- c("bin", "reps")

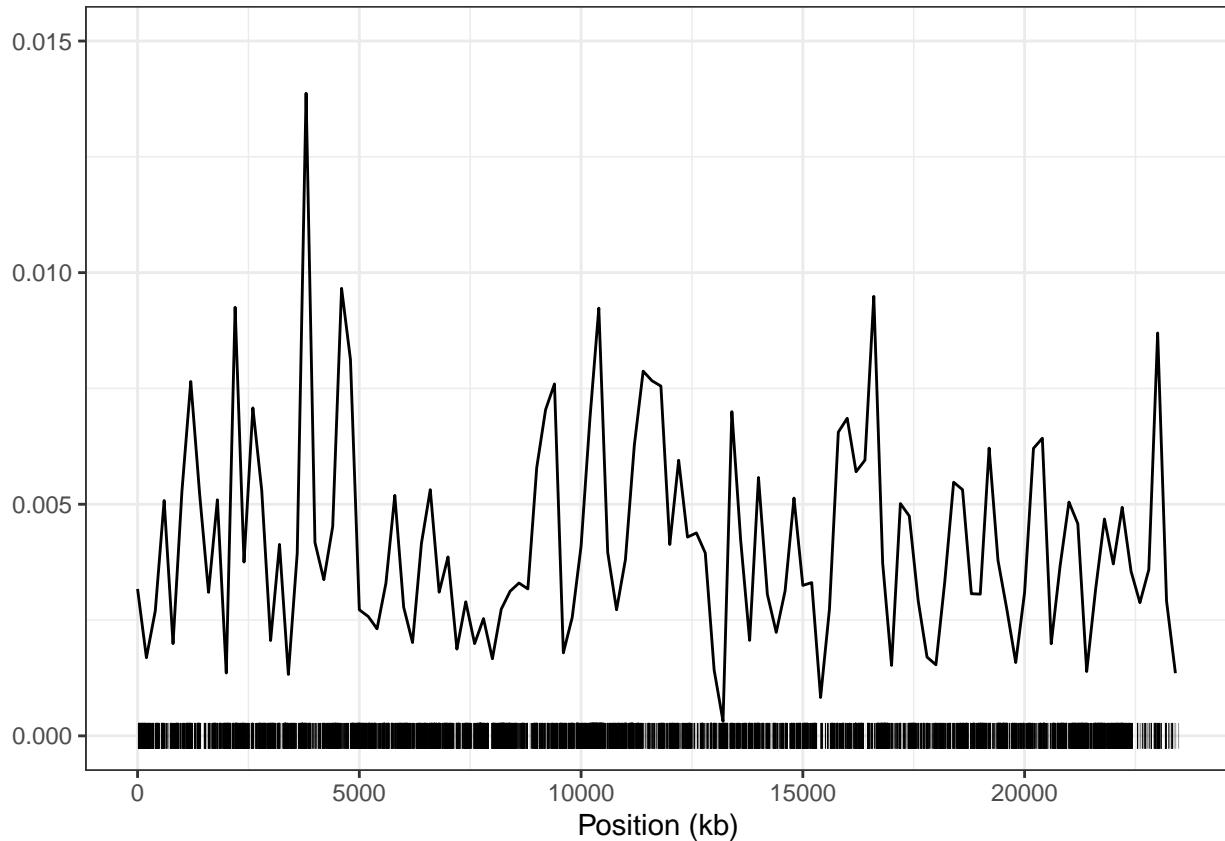
tau.lands.200kb <- cbind.data.frame(1:nrow(sim.theta.200kb), rep1.sim.tmrca.200kb$AverageTmrca, rep2.sim.
names(tau.lands.200kb) <- c("bin", "reps")

rho.map.200kb <- ggplot(data = rho.land.200kb, aes(x = (bin -1) * 200, y = rate))
rho.map.200kb <- rho.map.200kb + geom_line(data = rho.land.200kb) + theme_bw()
rho.map.200kb <- rho.map.200kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits
rho.map.200kb <- rho.map.200kb + labs(title = NULL, x = NULL, y = NULL)
rho.map.200kb <- rho.map.200kb + theme(axis.title.x=element_blank(),
                                         axis.text.x=element_blank(),
                                         axis.ticks.x=element_blank(),
                                         axis.title.y=element_text(size = 20), legend.position = "none")
rho.map.200kb

```



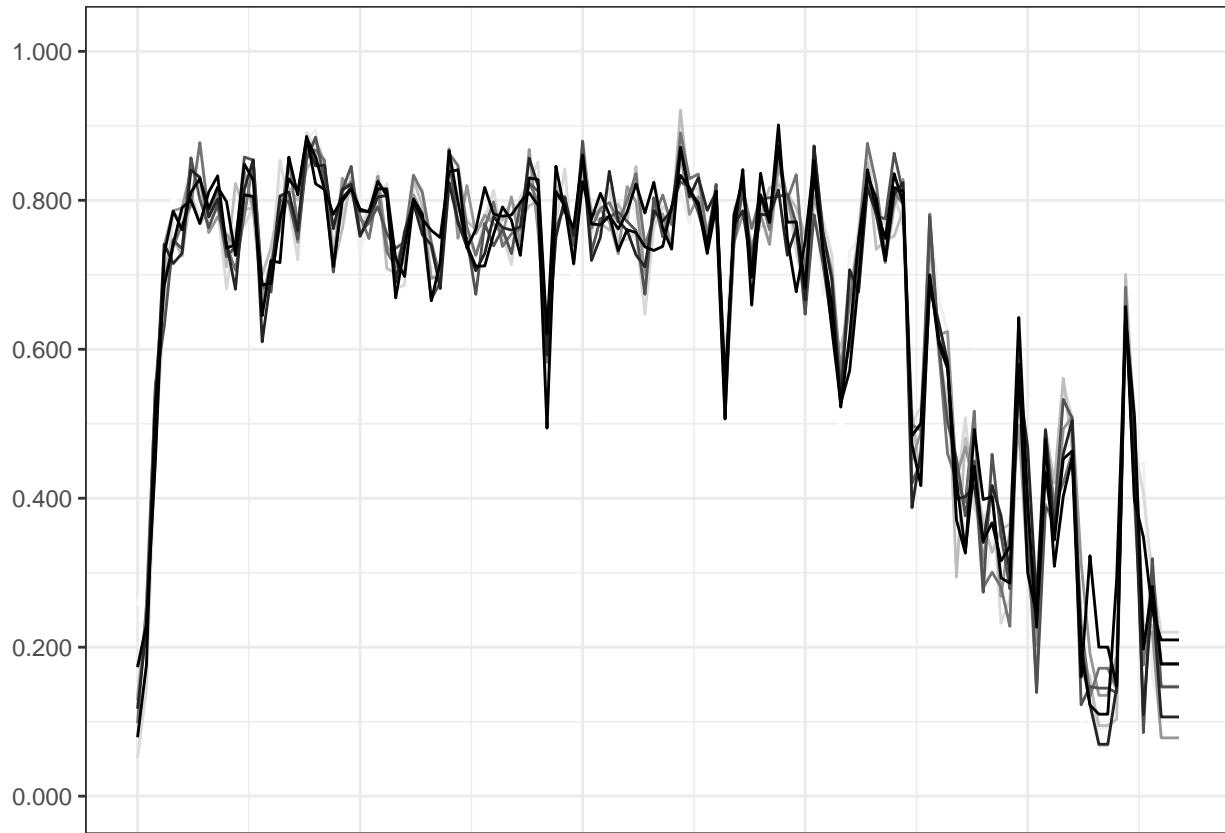
```
theta.map.200kb <- ggplot(data = theta.land.200kb, aes(x = (bin -1) * 200, y = rate))
theta.map.200kb <- theta.map.200kb + geom_line(data = theta.land.200kb) + theme_bw()
theta.map.200kb <- theta.map.200kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, lin
theta.map.200kb <- theta.map.200kb + labs(title = NULL, x = "Position (kb)", y = NULL)
theta.map.200kb <- theta.map.200kb + geom_segment(data = dm_2L_exome, aes(x = exon_start / 1000, xend =
theta.map.200kb <- theta.map.200kb + theme(legend.position = "none", axis.title.y=element_text(size = 20
theta.map.200kb
```



```

molten.tau <- melt(tau.lands.200kb, id.vars = "bin")
tau.map.200kb <- ggplot(data = molten.tau, aes(x = (bin -1) * 200, y = value / (4 * 1e+4), colour = var))
tau.map.200kb <- tau.map.200kb + geom_line(data = molten.tau) + theme_bw()
tau.map.200kb <- tau.map.200kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 0.015))
tau.map.200kb <- tau.map.200kb + labs(title = NULL, x = NULL, y = NULL)
tau.map.200kb <- tau.map.200kb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
tau.map.200kb <- tau.map.200kb + theme(axis.title.x=element_blank(),
                                         axis.text.x=element_blank(),
                                         axis.ticks.x=element_blank(),
                                         axis.title.y=element_text(size = 20), legend.position = "none")
tau.map.200kb

```

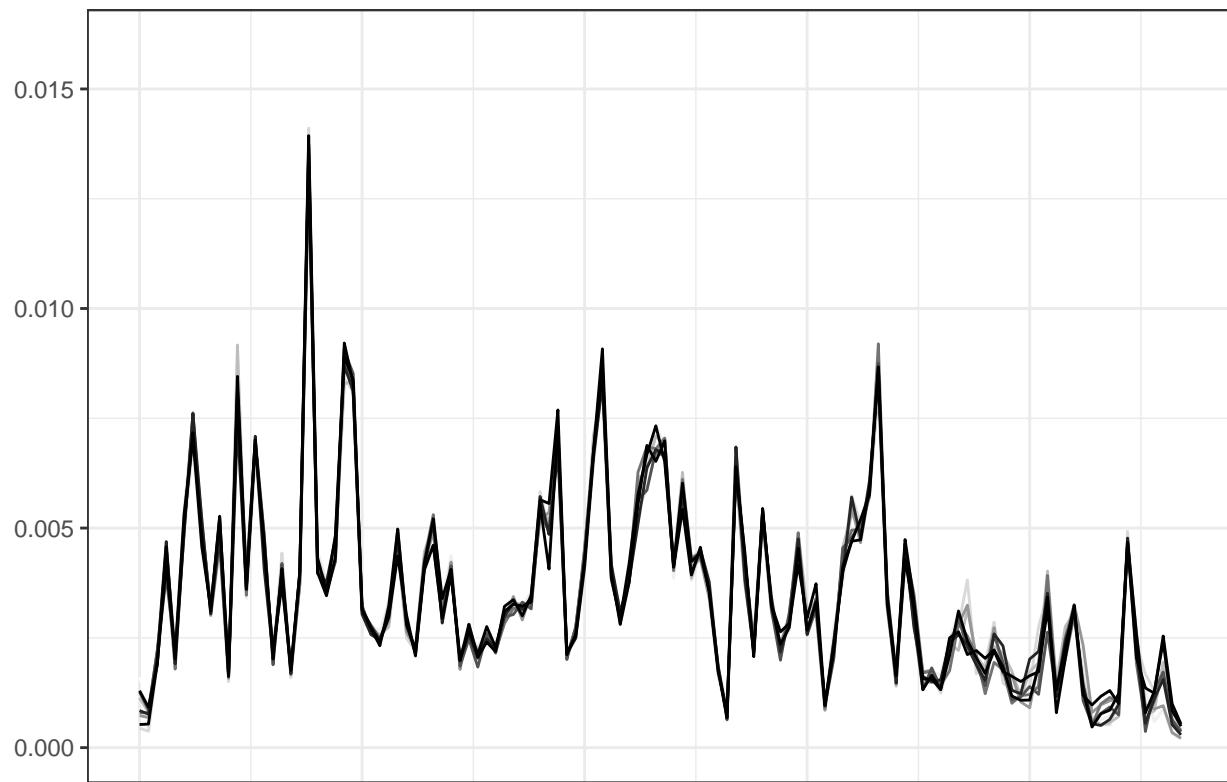


```

molten.pi <- melt(pi.lands.200kb, id.vars = "bin")
pi.map.200kb <- ggplot(data = molten.pi, aes(x = (bin -1) * 200, y = value, colour = variable))
pi.map.200kb <- pi.map.200kb + geom_line(data = molten.pi) + theme_bw()
pi.map.200kb <- pi.map.200kb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits =
pi.map.200kb <- pi.map.200kb + labs(title = "200 kb", x = NULL, y = NULL)
pi.map.200kb <- pi.map.200kb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
pi.map.200kb <- pi.map.200kb + theme(axis.title.x=element_blank(),
                                         axis.text.x=element_blank(),
                                         axis.ticks.x=element_blank(),
                                         axis.title.y=element_text(size = 20),
                                         plot.title = element_text(size = 16), legend.position = "none")
pi.map.200kb

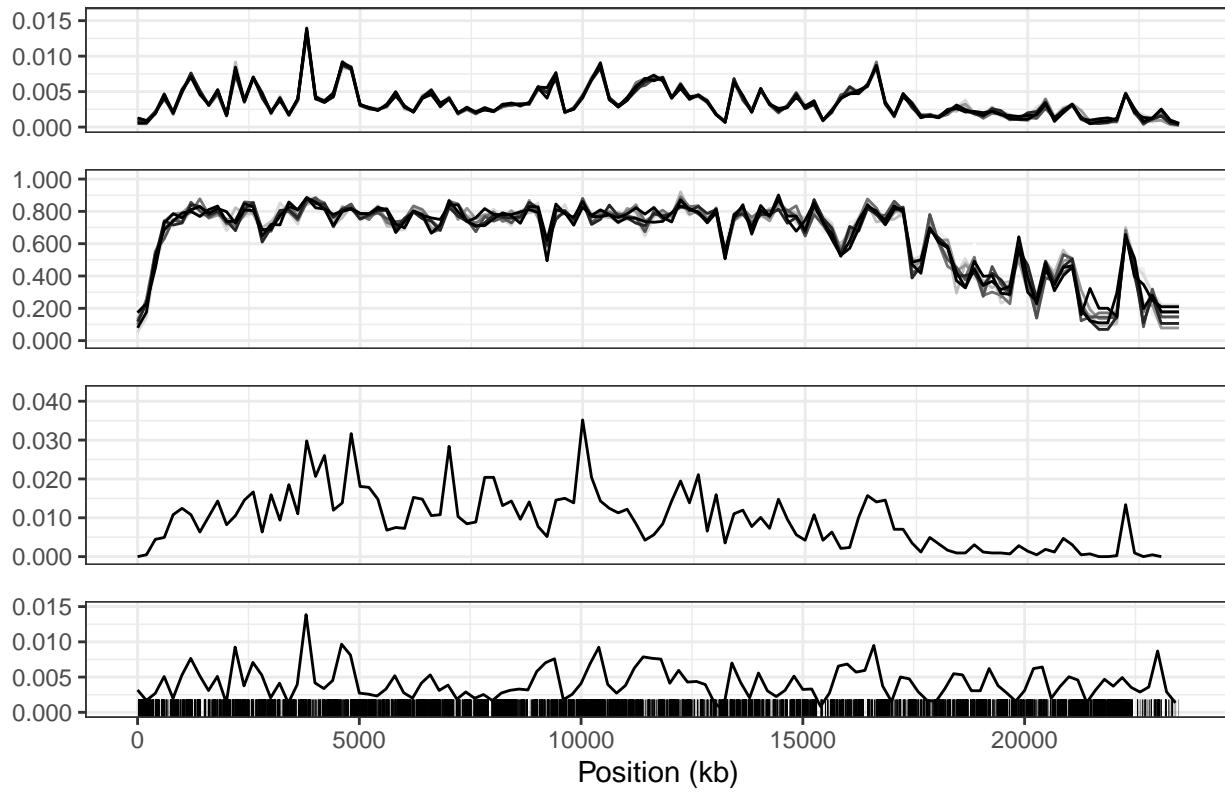
```

200 kb



```
true.maps.200kb <- plot_grid(pi.map.200kb, tau.map.200kb, rho.map.200kb, theta.map.200kb, ncol = 1)
true.maps.200kb
```

200 kb



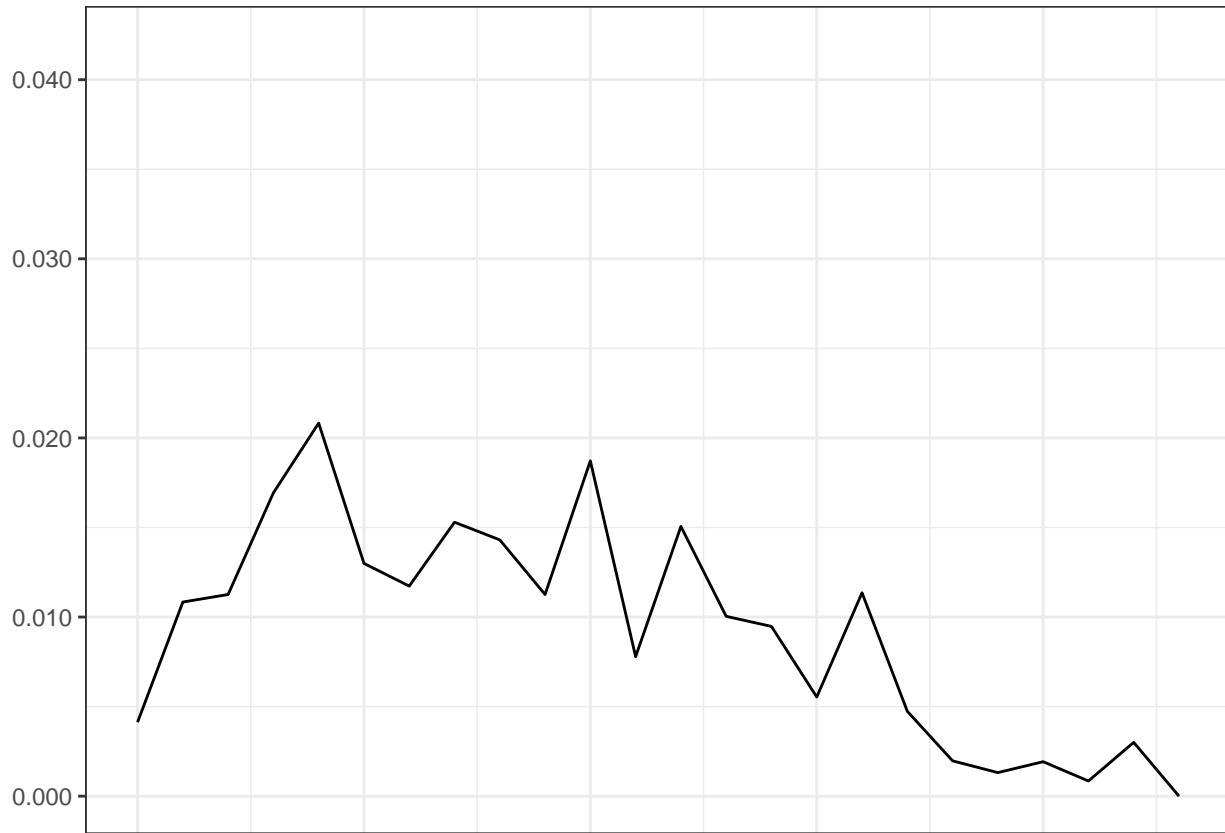
```
## 1Mb
theta.land.1Mb <- cbind.data.frame(1:nrow(sim.theta.1Mb), sim.theta.1Mb$Rate * 4 * 1e+4 * 1e-7)
names(theta.land.1Mb) <- c("bin", "rate")

rho.land.1Mb <- cbind.data.frame(1:nrow(sim.rho.1Mb), sim.rho.1Mb$Rate * 1e-7 * 4 * 1e+4)
names(rho.land.1Mb) <- c("bin", "rate")

pi.lands.1Mb <- cbind.data.frame(1:nrow(sim.theta.1Mb), rep_1.pi.1Mb$avg, rep_2.pi.1Mb$avg, rep_3.pi.1Mb$avg)
names(pi.lands.1Mb) <- c("bin", "reps")

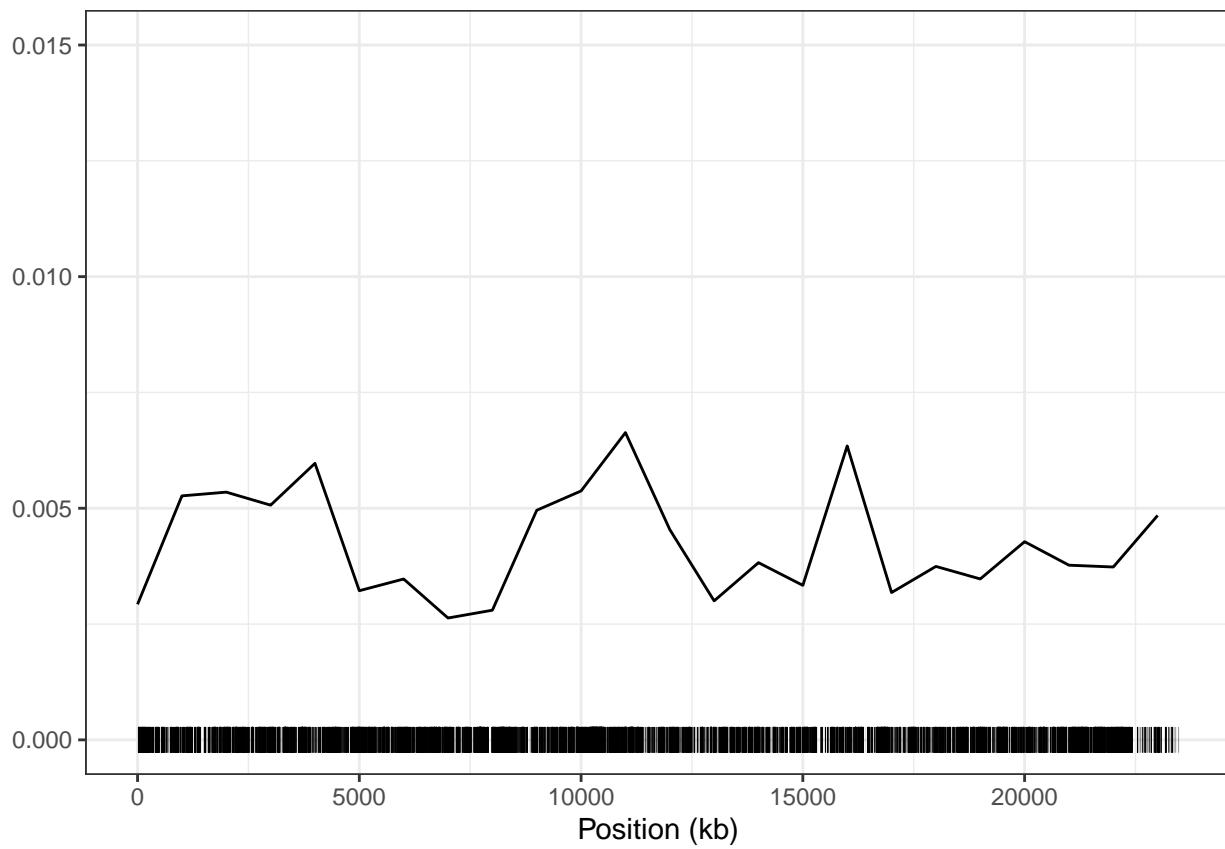
tau.lands.1Mb <- cbind.data.frame(1:nrow(sim.theta.1Mb), rep1.sim.tmrca.1Mb$AverageTmrca, rep2.sim.tmrca.1Mb$AverageTmrca)
names(tau.lands.1Mb) <- c("bin", "reps")

rho.map.1Mb <- ggplot(data = rho.land.1Mb, aes(x = (bin - 1) * 1000, y = rate))
rho.map.1Mb <- rho.map.1Mb + geom_line(data = rho.land.1Mb) + theme_bw()
rho.map.1Mb <- rho.map.1Mb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 1))
rho.map.1Mb <- rho.map.1Mb + labs(title = NULL, x = NULL, y = NULL)
rho.map.1Mb <- rho.map.1Mb + theme(axis.title.x=element_blank(),
                                      axis.text.x=element_blank(),
                                      axis.ticks.x=element_blank(),
                                      axis.title.y=element_text(size = 20), legend.position = "none")
rho.map.1Mb
```



```
theta.map.1Mb <- ggplot(data = theta.land.1Mb, aes(x = (bin -1) * 1000, y = rate))
theta.map.1Mb <- theta.map.1Mb + geom_line(data = theta.land.1Mb) + theme_bw()
theta.map.1Mb <- theta.map.1Mb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 0.04))
theta.map.1Mb <- theta.map.1Mb + labs(title = NULL, x = "Position (kb)", y = NULL)
theta.map.1Mb <- theta.map.1Mb + geom_segment(data = dm_2L_exome, aes(x = exon_start / 1000, xend = exon_end / 1000, y = 0.005))
theta.map.1Mb <- theta.map.1Mb + theme(legend.position = "none", axis.title.y=element_text(size = 20))

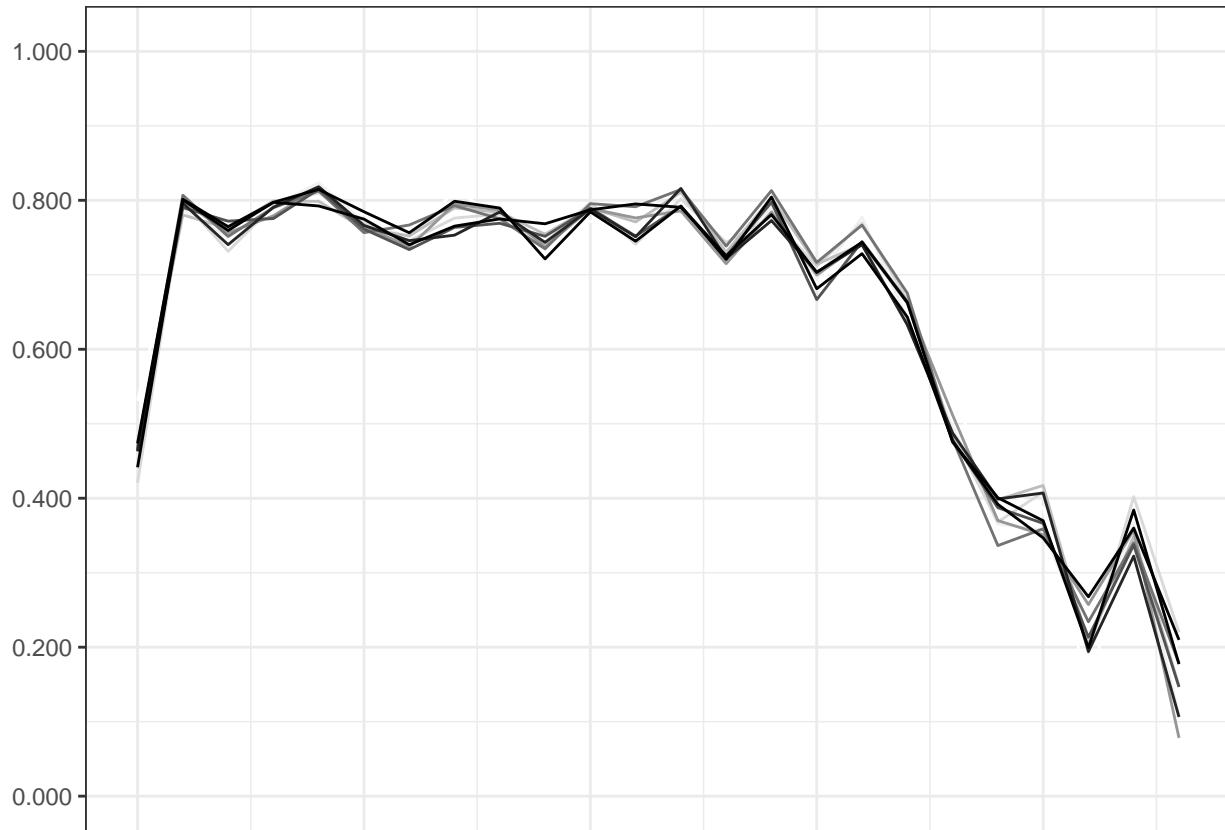
theta.map.1Mb
```



```

molten.tau <- melt(tau.lands.1Mb, id.vars = "bin")
tau.map.1Mb <- ggplot(data = molten.tau, aes(x = (bin -1) * 1000, y = value / (4 * 1e+4), colour = vari)
tau.map.1Mb <- tau.map.1Mb + geom_line(data = molten.tau) + theme_bw()
tau.map.1Mb <- tau.map.1Mb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c
tau.map.1Mb <- tau.map.1Mb + labs(title = NULL, x = NULL, y = NULL)
tau.map.1Mb <- tau.map.1Mb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
tau.map.1Mb <- tau.map.1Mb + theme(axis.title.x=element_blank(),
                                      axis.text.x=element_blank(),
                                      axis.ticks.x=element_blank(),
                                      axis.title.y=element_text(size = 20), legend.position = "none")
tau.map.1Mb

```

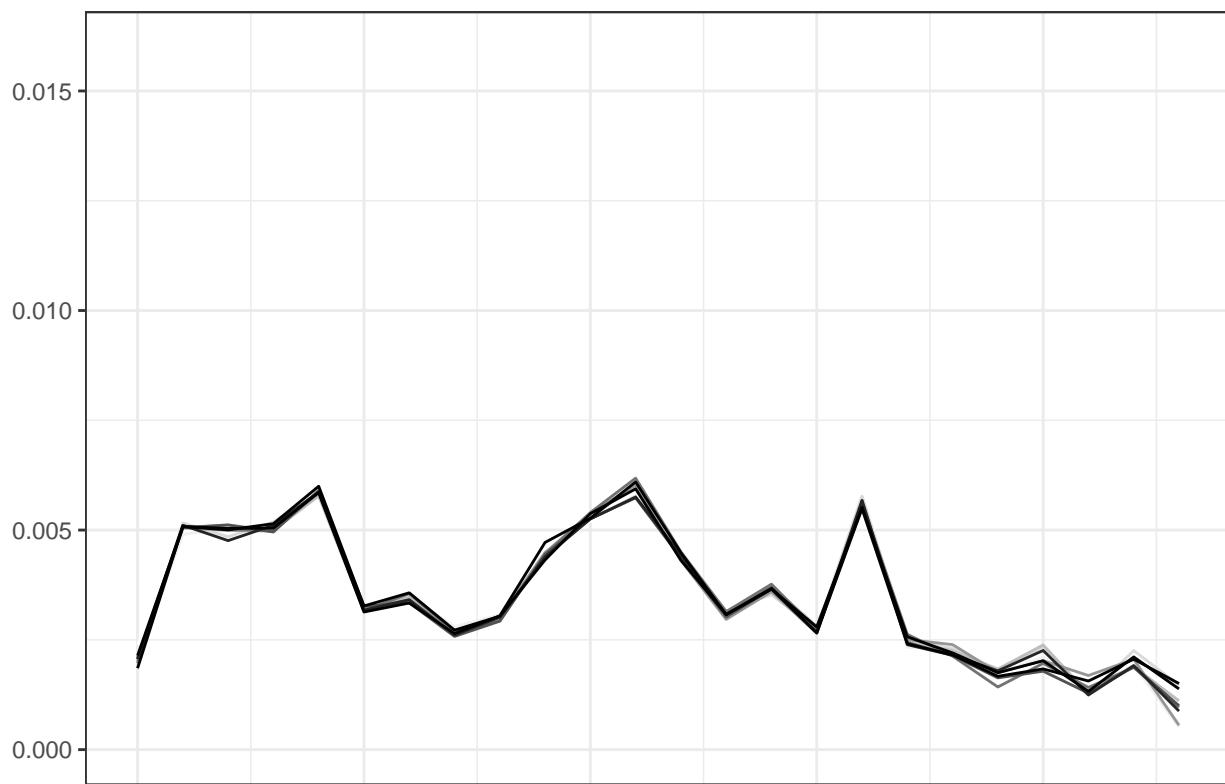


```

molten.pi <- melt(pi.lands.1Mb, id.vars = "bin")
pi.map.1Mb <- ggplot(data = molten.pi, aes(x = (bin -1) * 1000, y = value, colour = variable))
pi.map.1Mb <- pi.map.1Mb + geom_line(data = molten.pi) + theme_bw()
pi.map.1Mb <- pi.map.1Mb + scale_y_continuous(breaks = pretty_breaks(), labels = scale.3d, limits = c(0, 1))
pi.map.1Mb <- pi.map.1Mb + labs(title = "1 Mb", x = NULL, y = NULL)
pi.map.1Mb <- pi.map.1Mb + scale_color_manual(values = c(brewer.pal(n = 9, name = "Greys"), "Black"))
pi.map.1Mb <- pi.map.1Mb + theme(axis.title.x=element_blank(),
                                    axis.text.x=element_blank(),
                                    axis.ticks.x=element_blank(),
                                    axis.title.y=element_text(size = 20),
                                    plot.title = element_text(size = 16), legend.position = "none")
pi.map.1Mb

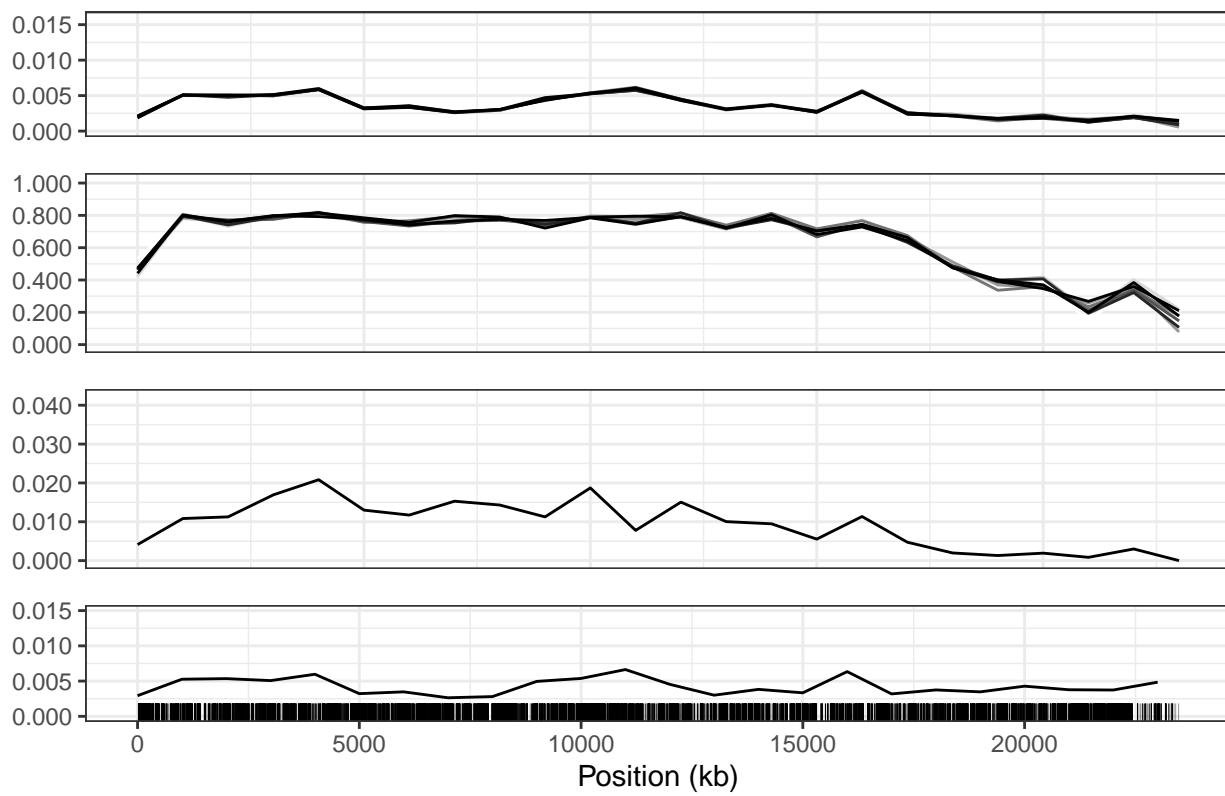
```

1 Mb

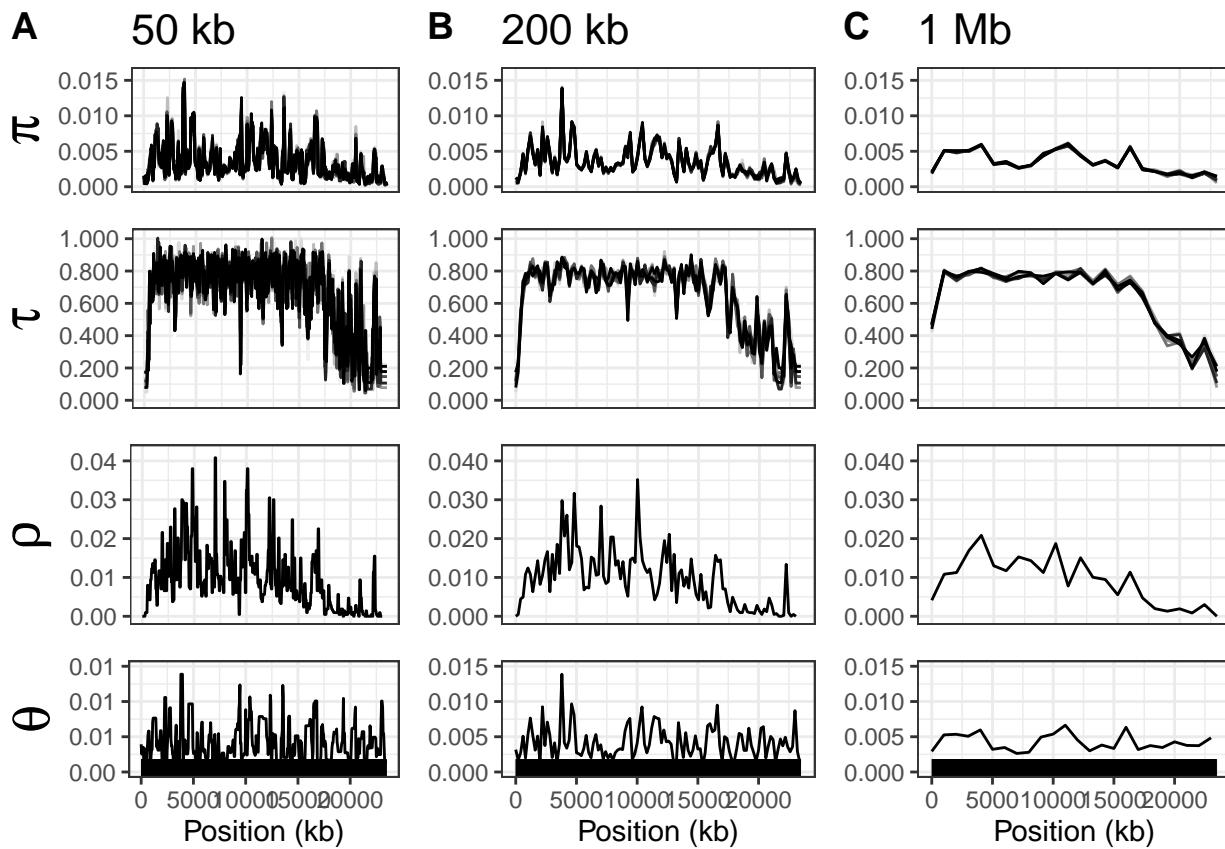


```
true.maps.1Mb <- plot_grid(pi.map.1Mb, tau.map.1Mb, rho.map.1Mb, theta.map.1Mb, ncol = 1)  
true.maps.1Mb
```

1 Mb



```
true.maps <- plot_grid(true.maps.50kb, true.maps.200kb, true.maps.1Mb, labels = "AUTO", ncol = 3, align = "center")  
true.maps
```



```

save_plot("Figure7.pdf", true.maps, base_height = 10, base_width = 20)

mean(apply(tau.lands.50kb[2:ncol(tau.lands.50kb)], 2, sd) / apply(tau.lands.50kb[2:ncol(tau.lands.50kb)])
## [1] 0.3626566

mean(apply(tau.lands.200kb[2:ncol(tau.lands.200kb)], 2, sd) / apply(tau.lands.200kb[2:ncol(tau.lands.200kb)])
## [1] 0.3352754

mean(apply(tau.lands.1Mb[2:ncol(tau.lands.1Mb)], 2, sd) / apply(tau.lands.1Mb[2:ncol(tau.lands.1Mb)], 2)
## [1] 0.3202002

sd(apply(tau.lands.50kb[2:ncol(tau.lands.50kb)], 2, sd) / apply(tau.lands.50kb[2:ncol(tau.lands.50kb)], 2))
## [1] 0.007548117

sd(apply(tau.lands.200kb[2:ncol(tau.lands.200kb)], 2, sd) / apply(tau.lands.200kb[2:ncol(tau.lands.200kb)], 2))
## [1] 0.006994296

sd(apply(tau.lands.1Mb[2:ncol(tau.lands.1Mb)], 2, sd) / apply(tau.lands.1Mb[2:ncol(tau.lands.1Mb)], 2))
## [1] 0.009614134

mean(apply(pi.lands.50kb[2:ncol(pi.lands.50kb)], 2, sd) / apply(pi.lands.50kb[2:ncol(pi.lands.50kb)], 2))
## [1] 0.715368

```

```

mean(apply(pi.lands.200kb[2:ncol(pi.lands.200kb)], 2, sd) / apply(pi.lands.200kb[2:ncol(pi.lands.200kb)], 2, mean))
## [1] 0.6213829

mean(apply(pi.lands.1Mb[2:ncol(pi.lands.1Mb)], 2, sd) / apply(pi.lands.1Mb[2:ncol(pi.lands.1Mb)], 2, mean))
## [1] 0.437516

sd(apply(pi.lands.50kb[2:ncol(pi.lands.50kb)], 2, sd) / apply(pi.lands.50kb[2:ncol(pi.lands.50kb)], 2, mean))
## [1] 0.005943989

sd(apply(pi.lands.200kb[2:ncol(pi.lands.200kb)], 2, sd) / apply(pi.lands.200kb[2:ncol(pi.lands.200kb)], 2, mean))
## [1] 0.006465506

sd(apply(pi.lands.1Mb[2:ncol(pi.lands.1Mb)], 2, sd) / apply(pi.lands.1Mb[2:ncol(pi.lands.1Mb)], 2, mean))
## [1] 0.01168644

```

7 Exploring neutral evolutionary scenarios

7.1 bottleneck_r_1e-8_flat_mu

```

d <- "other_neutral_scenarios/bottleneck_r_1e-8_flat_mu/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.50kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "/sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "/rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "/rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.rho.50kb$sim, rep_tmrca.50kb$tmrca))
  names(sim.lands.50kb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
}

```

```

r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.200kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "/sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "/rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrc.200kb <- read.table(paste(d, "/rep_", i, "/sim.tmrc.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.rho.200kb$sim, rep_tmrc.200kb$tmrc))
  names(sim.lands.200kb) <- c("diversity", "rho", "tmrc")

  # centering
  sim.lands.200kb$tmrcC <- sim.lands.200kb$tmrc - mean(sim.lands.200kb$tmrc)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcC, data = sim.lands.200kb)

  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.1Mb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "/sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
}

```

```

rep_tmrcा.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrcा.1M.map", sep = ""), header = T)

sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.rho.1Mb$sim, rep_tmrcा.1Mb$tmrcा))
names(sim.lands.1Mb) <- c("diversity", "rho", "tmrcा")

# centering
sim.lands.1Mb$tmrcाC <- sim.lands.1Mb$tmrcा - mean(sim.lands.1Mb$tmrcा)
sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

m.div.1Mb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcाC, data = sim.lands.1Mb)

summary(m.div.1Mb)

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

r2.sim.avg_1 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_1) <- c("Total", "Rho", "TMRCA"))
r2.sim.avg_1$Theta <- NA
r2.sim.avg_1 <- r2.sim.avg_1[,c(1,4,2,3)]
r2.sim.avg_1$bin.size <- c(50, 200, 1000)
r2.sim.avg_1$rho <- "r = 1e-8"
r2.sim.avg_1$mu_block <- "mu = flat"

```

7.2 bottleneck_r_1e-8_mu_change_50kb

```

d <- "other_neutral_scenarios/bottleneck_r_1e-8_mu_change_50kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "/sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "/sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrcा.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrcा.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrcा.

```

```

names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

# centering
sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

m.div.50kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)

summary(m.div.50kb)

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "/sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "/sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "/rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = F)
  rep_tmrca.200kb <- read.table(paste(d, "/rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrca.200kb))
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)

  summary(m.div.200kb)
}

```

```

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb$tmrca))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

```

```

# true landscapes
r2.sim.avg_2 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_2) <- c("Total", "Theta", "Rho", "TMRCA")
r2.sim.avg_2$bin.size <- c(50, 200, 1000)
r2.sim.avg_2$rho <- "r = 1e-8"
r2.sim.avg_2$mu_block <- "avg mu block = 50 kb"

```

7.3 bottleneck_r_1e-8_mu_change_500kb

```

d <- "other_neutral_scenarios/bottleneck_r_1e-8_mu_change_500kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrc.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrc
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrc")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcC <- sim.lands.50kb$tmrc - mean(sim.lands.50kb$tmrc)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcC + thetaC:tmrcC, data = sim.lands.50kb)
  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))

```

```

row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_theta.200kb))
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)
  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb$sim))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")
}

```

```

# centering
sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

summary(m.div.1Mb)

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_3 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_3) <- c("Total", "Theta", "Rho", "TMRCA"))
r2.sim.avg_3$bin.size <- c(50, 200, 1000)
r2.sim.avg_3$rho <- "r = 1e-8"
r2.sim.avg_3$mu_block <- "avg mu block = 500 kb"

```

7.4 bottleneck_r_1e-9_flat_mu

```

d <- "other_neutral_scenarios/bottleneck_r_1e-9_flat_mu/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.50kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.rho.50kb$sim, rep_tmrca.50kb$tmrca))
  names(sim.lands.50kb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)
}
```

```

sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

m.div.50kb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.50kb)

summary(m.div.50kb)

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.200kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.rho.200kb$sim, rep_tmrca.200kb$tmrca))
  names(sim.lands.200kb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.200kb)

  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)

```

```

r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.1Mb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.rho.1Mb$sim, rep_tmrca.1Mb$tmrca))
  names(sim.lands.1Mb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm(I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_4 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.colnames(r2.sim.avg_4) <- c("Total", "Rho", "TMRCA")
r2.sim.avg_4$Theta <- NA
r2.sim.avg_4 <- r2.sim.avg_4[,c(1,4,2,3)]
r2.sim.avg_4$bin.size <- c(50, 200, 1000)
r2.sim.avg_4$rho <- "r = 1e-9"
r2.sim.avg_4$mu_block <- "mu = flat"

```

7.5 bottleneck_r_1e-9_mu_change_50kb

```
d <- "other_neutral_scenarios/bottleneck_r_1e-9_mu_change_50kb/"
```

```

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrca
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrca
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca"))
}

```

```

# centering
sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)

summary(m.div.200kb)

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb$sim))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)
}

```

```

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_5 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_5) <- c("Total", "Theta", "Rho", "TMRCA")
r2.sim.avg_5$bin.size <- c(50, 200, 1000)
r2.sim.avg_5$rho <- "r = 1e-9"
r2.sim.avg_5$mu_block <- "avg mu block = 50 kb"

```

7.6 bottleneck_r_1e-9_mu_change_500kb

```

d <- "other_neutral_scenarios/bottleneck_r_1e-9_mu_change_500kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrca
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)
  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100

```

```

r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrca.200kb))
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)
  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

```

```

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrc.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrc.1Mb))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrc.C <- sim.lands.1Mb$tmrc - mean(sim.lands.1Mb$tmrc)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrc.C + thetaC:tmrc.C, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_6 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names = TRUE)
colnames(r2.sim.avg_6) <- c("Total", "Theta", "Rho", "TMRCA")
r2.sim.avg_6$bin.size <- c(50, 200, 1000)
r2.sim.avg_6$rho <- "r = 1e-9"
r2.sim.avg_6$mu_block <- "avg mu block = 500 kb"

```

7.7 bottleneck plot

```

r2.sim.bottleneck <- rbind.data.frame(r2.sim.avg_1, r2.sim.avg_2, r2.sim.avg_3, r2.sim.avg_4, r2.sim.avg_5, r2.sim.avg_6)
r2.sim.bottleneck$mu_block = factor(r2.sim.bottleneck$mu_block, levels=c('mu = flat', 'avg mu block = 500 kb'))

molten.r2 <- melt(r2.sim.bottleneck, id.vars = c("bin.size", "rho", "mu_block"))

r2.plot_bottleneck <- ggplot(data = molten.r2, aes(x = bin.size, y = value, shape = variable))
r2.plot_bottleneck <- r2.plot_bottleneck + geom_line(data = molten.r2) + facet_grid(rho ~ mu_block)
r2.plot_bottleneck <- r2.plot_bottleneck + geom_point(aes(shape = variable), size = 4)
r2.plot_bottleneck <- r2.plot_bottleneck + scale_shape_manual(values = c(0, 1, 2, 8), name = "", labels = c("Total", expression(theta), expression(rho)))
r2.plot_bottleneck <- r2.plot_bottleneck + scale_x_continuous(breaks = c(50, 200, 1000), limits = c(40, 1200))

```

```

r2.plot_bottleneck <- r2.plot_bottleneck + scale_y_continuous(breaks = pretty_breaks())
r2.plot_bottleneck <- r2.plot_bottleneck + labs(title = NULL, x = "Bin Size (kb)", y = "Variance Explained (%)")
r2.plot_bottleneck <- r2.plot_bottleneck + theme(axis.title = element_text(size = 16), axis.text = element_text(size = 16),
                                                 strip.text.x = element_text(size = 16), strip.text.y = element_text(size = 16),
                                                 legend.text=element_text(size=16), legend.position = "bottom")

```

7.8 flat_Ne_r_1e-8_flat_mu

```

d <- "other_neutral_scenarios/flat_Ne_r_1e-8_flat_mu/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.50kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrc.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.rho.50kb$sim, rep_tmrc.50kb$tmrc))
  names(sim.lands.50kb) <- c("diversity", "rho", "tmrc")

  # centering
  sim.lands.50kb$tmrc.C <- sim.lands.50kb$tmrc - mean(sim.lands.50kb$tmrc)
  sim.lands.50kb$rho.C <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm( I(diversity * 1e+6) ~ rho.C + tmrc.C, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.200kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

```

```

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.rho.200kb$sim, rep_tmrca.200kb$tmrca))
  names(sim.lands.200kb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.200kb)

  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.1Mb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.rho.1Mb$sim, rep_tmrca.1Mb$tmrca))
  names(sim.lands.1Mb) <- c("diversity", "rho", "tmrca")

  # centering
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)
}

```

```

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_1 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_1) <- c("Total", "Rho", "TMRCA")
r2.sim.avg_1$Theta <- NA
r2.sim.avg_1 <- r2.sim.avg_1[,c(1,4,2,3)]
r2.sim.avg_1$bin.size <- c(50, 200, 1000)
r2.sim.avg_1$rho <- "r = 1e-8"
r2.sim.avg_1$mu_block <- "mu = flat"

```

7.9 flat_Ne_r_1e-8_mu_change_50kb

```

d <- "other_neutral_scenarios/flat_Ne_r_1e-8_mu_change_50kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrca))
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)
  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"

```

```

anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrc.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrc$tmrc))
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrc")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcC <- sim.lands.200kb$tmrc - mean(sim.lands.200kb$tmrc)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcC + thetaC:tmrcC, data = sim.lands.200kb)
  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")

```

```

colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrc.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrc.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrc.1Mb))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrc")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrc.1Mb <- sim.lands.1Mb$tmrc - mean(sim.lands.1Mb$tmrc)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrc.1Mb + thetaC:tmrc.1Mb, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_2 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_2) <- c("Total", "Theta", "Rho", "TMRCA"))
r2.sim.avg_2$bin.size <- c(50, 200, 1000)
r2.sim.avg_2$rho <- "r = 1e-8"
r2.sim.avg_2$mu_block <- "avg mu block = 50 kb"

```

7.10 flat_Ne_r_1e-8_mu_change_500kb

```

d <- "other_neutral_scenarios/flat_Ne_r_1e-8_mu_change_500kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

```

```

sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrc.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrc
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrc")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcC <- sim.lands.50kb$tmrc - mean(sim.lands.50kb$tmrc)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcC + thetaC:tmrcC, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRC")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrc.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrc
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrc")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcC <- sim.lands.200kb$tmrc - mean(sim.lands.200kb$tmrc)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)
}

```

```

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)

summary(m.div.200kb)

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

```

```

}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_3 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_3) <- c("Total", "Theta", "Rho", "TMRCA"))
r2.sim.avg_3$bin.size <- c(50, 200, 1000)
r2.sim.avg_3$rho <- "r = 1e-8"
r2.sim.avg_3$mu_block <- "avg mu block = 500 kb"

```

7.11 flat_Ne_r_1e-9_flat_mu

```

d <- "other_neutral_scenarios/flat_Ne_r_1e-9_flat_mu/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.50kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrc.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.rho.50kb$sim, rep_tmrc.50kb$tmrc))
  names(sim.lands.50kb) <- c("diversity", "rho", "tmrc")

  # centering
  sim.lands.50kb$tmrcC <- sim.lands.50kb$tmrc - mean(sim.lands.50kb$tmrc)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ rhoC + tmrcC, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb

```

```

r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.200kb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrc.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrc.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.rho.200kb$sim, rep_tmrc.200kb$tmrc))
  names(sim.lands.200kb) <- c("diversity", "rho", "tmrc")

  # centering
  sim.lands.200kb$tmrcC <- sim.lands.200kb$tmrc - mean(sim.lands.200kb$tmrc)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm(I(diversity * 1e+6) ~ rhoC + tmrcC, data = sim.lands.200kb)

  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 3))
row.names(r2.sim.1Mb) <- c("Total", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrc.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrc.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.rho.1Mb$sim, rep_tmrc.1Mb$tmrc))
  names(sim.lands.1Mb) <- c("diversity", "rho", "tmrc")

  # centering
  sim.lands.1Mb$tmrcC <- sim.lands.1Mb$tmrc - mean(sim.lands.1Mb$tmrc)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)
}

```

```

sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

m.div.1Mb <- lm( I(diversity * 1e+6) ~ rhoC + tmrcaC, data = sim.lands.1Mb)

summary(m.div.1Mb)

anova.diversity <- Anova(m.div.1Mb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2]) * 100
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_4 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names(r2.sim.avg_4) <- c("Total", "Rho", "TMRCA")
r2.sim.avg_4$Theta <- NA
r2.sim.avg_4 <- r2.sim.avg_4[,c(1,4,2,3)]
r2.sim.avg_4$bin.size <- c(50, 200, 1000)
r2.sim.avg_4$rho <- "r = 1e-9"
r2.sim.avg_4$mu_block <- "mu = flat"

```

7.12 flat_Ne_r_1e-9_mu_change_50kb

```

d <- "other_neutral_scenarios/flat_Ne_r_1e-9_mu_change_50kb/"

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrca
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)
}

```

```

m.div.50kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)

summary(m.div.50kb)

anova.diversity <- Anova(m.div.50kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_theta.200kb))
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
  sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
  sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

  sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

  m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)

  summary(m.div.200kb)

  anova.diversity <- Anova(m.div.200kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
  r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

```

```

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb$tmrca))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
  r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_5 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.colnames(r2.sim.avg_5) <- c("Total", "Theta", "Rho", "TMRCA")
r2.sim.avg_5$bin.size <- c(50, 200, 1000)
r2.sim.avg_5$rho <- "r = 1e-9"
r2.sim.avg_5$mu_block <- "avg mu block = 50 kb"

```

7.13 flat_Ne_r_1e-9_mu_change_500kb

```
d <- "other_neutral_scenarios/flat_Ne_r_1e-9_mu_change_500kb/"
```

```

# 50kb
r2.sim.50kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.50kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.50kb) <- reps

sim.rho.50kb <- read.table(paste(d, "sim.rho.50000.map", sep = ""), header = T)
sim.theta.50kb <- read.table(paste(d, "sim.theta.50000.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.50kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.50kb.bedgraph", sep = ""), header = T)
  rep_tmrca.50kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.50k.map", sep = ""), header = T)

  sim.lands.50kb <- as.data.frame(cbind(rep_pi.50kb$pi, sim.theta.50kb$sim, sim.rho.50kb$sim, rep_tmrca
  names(sim.lands.50kb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.50kb$thetaC <- sim.lands.50kb$theta - mean(sim.lands.50kb$theta)
  sim.lands.50kb$tmrcaC <- sim.lands.50kb$tmrca - mean(sim.lands.50kb$tmrca)
  sim.lands.50kb$rhoC <- sim.lands.50kb$rho - mean(sim.lands.50kb$rho)

  sim.lands.50kb$bin <- 1:nrow(sim.lands.50kb)

  m.div.50kb <- lm(I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.50kb)

  summary(m.div.50kb)

  anova.diversity <- Anova(m.div.50kb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)

  r2.sim.50kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]
  r2.sim.50kb[2, i] <- anova.diversity$VarExp[1] * 100
  r2.sim.50kb[3, i] <- anova.diversity$VarExp[2] * 100
  r2.sim.50kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.50kb$average <- rowMeans(r2.sim.50kb)
r2.sim.50kb <- transform(r2.sim.50kb, sd=apply(r2.sim.50kb, 1, sd, na.rm = TRUE))

# 200kb
r2.sim.200kb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.200kb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.200kb) <- reps

sim.rho.200kb <- read.table(paste(d, "sim.rho.2e+05.map", sep = ""), header = T)
sim.theta.200kb <- read.table(paste(d, "sim.theta.2e+05.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.200kb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.200kb.bedgraph", sep = ""), header = T)
  rep_tmrca.200kb <- read.table(paste(d, "rep_", i, "/sim.tmrca.200k.map", sep = ""), header = T)

  sim.lands.200kb <- as.data.frame(cbind(rep_pi.200kb$pi, sim.theta.200kb$sim, sim.rho.200kb$sim, rep_tmrca
  names(sim.lands.200kb) <- c("diversity", "theta", "rho", "tmrca"))
}

```

```

# centering
sim.lands.200kb$thetaC <- sim.lands.200kb$theta - mean(sim.lands.200kb$theta)
sim.lands.200kb$tmrcaC <- sim.lands.200kb$tmrca - mean(sim.lands.200kb$tmrca)
sim.lands.200kb$rhoC <- sim.lands.200kb$rho - mean(sim.lands.200kb$rho)

sim.lands.200kb$bin <- 1:nrow(sim.lands.200kb)

m.div.200kb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.200kb)

summary(m.div.200kb)

anova.diversity <- Anova(m.div.200kb)
apiss <- anova.diversity$"Sum Sq"
anova.diversity$VarExp <- apiss / sum(apiss)

r2.sim.200kb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3]) * 100
r2.sim.200kb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.200kb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.200kb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.200kb$average <- rowMeans(r2.sim.200kb)
r2.sim.200kb <- transform(r2.sim.200kb, sd=apply(r2.sim.200kb, 1, sd, na.rm = TRUE))

# 1Mb
r2.sim.1Mb <- as.data.frame(matrix(ncol = nreps, nrow = 4))
row.names(r2.sim.1Mb) <- c("Total", "Theta", "Rho", "TMRCA")
colnames(r2.sim.1Mb) <- reps

sim.rho.1Mb <- read.table(paste(d, "sim.rho.1e+06.map", sep = ""), header = T)
sim.theta.1Mb <- read.table(paste(d, "sim.theta.1e+06.map", sep = ""), header = T)

for(i in 1:nreps) {
  rep_pi.1Mb <- read.table(paste(d, "rep_", i, "/rep_", i, ".pi.1Mb.bedgraph", sep = ""), header = T)
  rep_tmrca.1Mb <- read.table(paste(d, "rep_", i, "/sim.tmrca.1M.map", sep = ""), header = T)

  sim.lands.1Mb <- as.data.frame(cbind(rep_pi.1Mb$pi, sim.theta.1Mb$sim, sim.rho.1Mb$sim, rep_tmrca.1Mb$sim))
  names(sim.lands.1Mb) <- c("diversity", "theta", "rho", "tmrca")

  # centering
  sim.lands.1Mb$thetaC <- sim.lands.1Mb$theta - mean(sim.lands.1Mb$theta)
  sim.lands.1Mb$tmrcaC <- sim.lands.1Mb$tmrca - mean(sim.lands.1Mb$tmrca)
  sim.lands.1Mb$rhoC <- sim.lands.1Mb$rho - mean(sim.lands.1Mb$rho)

  sim.lands.1Mb$bin <- 1:nrow(sim.lands.1Mb)

  m.div.1Mb <- lm( I(diversity * 1e+6) ~ thetaC + rhoC + tmrcaC + thetaC:tmrcaC, data = sim.lands.1Mb)

  summary(m.div.1Mb)

  anova.diversity <- Anova(m.div.1Mb)
  apiss <- anova.diversity$"Sum Sq"
  anova.diversity$VarExp <- apiss / sum(apiss)
}

```

```

r2.sim.1Mb[1, i] <- (anova.diversity$VarExp[1] + anova.diversity$VarExp[2] + anova.diversity$VarExp[3])
r2.sim.1Mb[2, i] <- anova.diversity$VarExp[1] * 100
r2.sim.1Mb[3, i] <- anova.diversity$VarExp[2] * 100
r2.sim.1Mb[4, i] <- anova.diversity$VarExp[3] * 100
}

r2.sim.1Mb$average <- rowMeans(r2.sim.1Mb)
r2.sim.1Mb <- transform(r2.sim.1Mb, sd=apply(r2.sim.1Mb, 1, sd, na.rm = TRUE))

# true landscapes
r2.sim.avg_6 <- rbind.data.frame(r2.sim.50kb$average, r2.sim.200kb$average, r2.sim.1Mb$average, make.row.names = FALSE)
colnames(r2.sim.avg_6) <- c("Total", "Theta", "Rho", "TMRCA")
r2.sim.avg_6$bin.size <- c(50, 200, 1000)
r2.sim.avg_6$rho <- "r = 1e-9"
r2.sim.avg_6$mu_block <- "avg mu block = 500 kb"

```

7.14 flat_Ne plot

```

r2.sim.flat_Ne <- rbind.data.frame(r2.sim.avg_1, r2.sim.avg_2, r2.sim.avg_3, r2.sim.avg_4, r2.sim.avg_5)
r2.sim.flat_Ne$mu_block = factor(r2.sim.flat_Ne$mu_block, levels=c('mu = flat','avg mu block = 500 kb', 'avg mu block = 100 kb'))

molten.r2 <- melt(r2.sim.flat_Ne, id.vars = c("bin.size", "rho", "mu_block"))

r2.plot_flat_Ne <- ggplot(data = molten.r2, aes(x = bin.size, y = value, shape = variable))
r2.plot_flat_Ne <- r2.plot_flat_Ne + geom_line(data = molten.r2) + facet_grid(rho ~ mu_block)
r2.plot_flat_Ne <- r2.plot_flat_Ne + geom_point(aes(shape = variable), size = 4)
r2.plot_flat_Ne <- r2.plot_flat_Ne + scale_shape_manual(values = c(0, 1, 2, 8))
r2.plot_flat_Ne <- r2.plot_flat_Ne + scale_x_continuous(breaks = c(50, 200, 1000), limits = c(40, 1200))
r2.plot_flat_Ne <- r2.plot_flat_Ne + scale_y_continuous(breaks = pretty_breaks())
r2.plot_flat_Ne <- r2.plot_flat_Ne + labs(title = NULL, x = NULL, y = "Variance Explained (%)") + theme_minimal()
r2.plot_flat_Ne <- r2.plot_flat_Ne + theme(axis.title = element_text(size = 16), axis.text = element_text(size = 16),
                                         strip.text.x = element_text(size = 16), strip.text.y = element_text(size = 16))

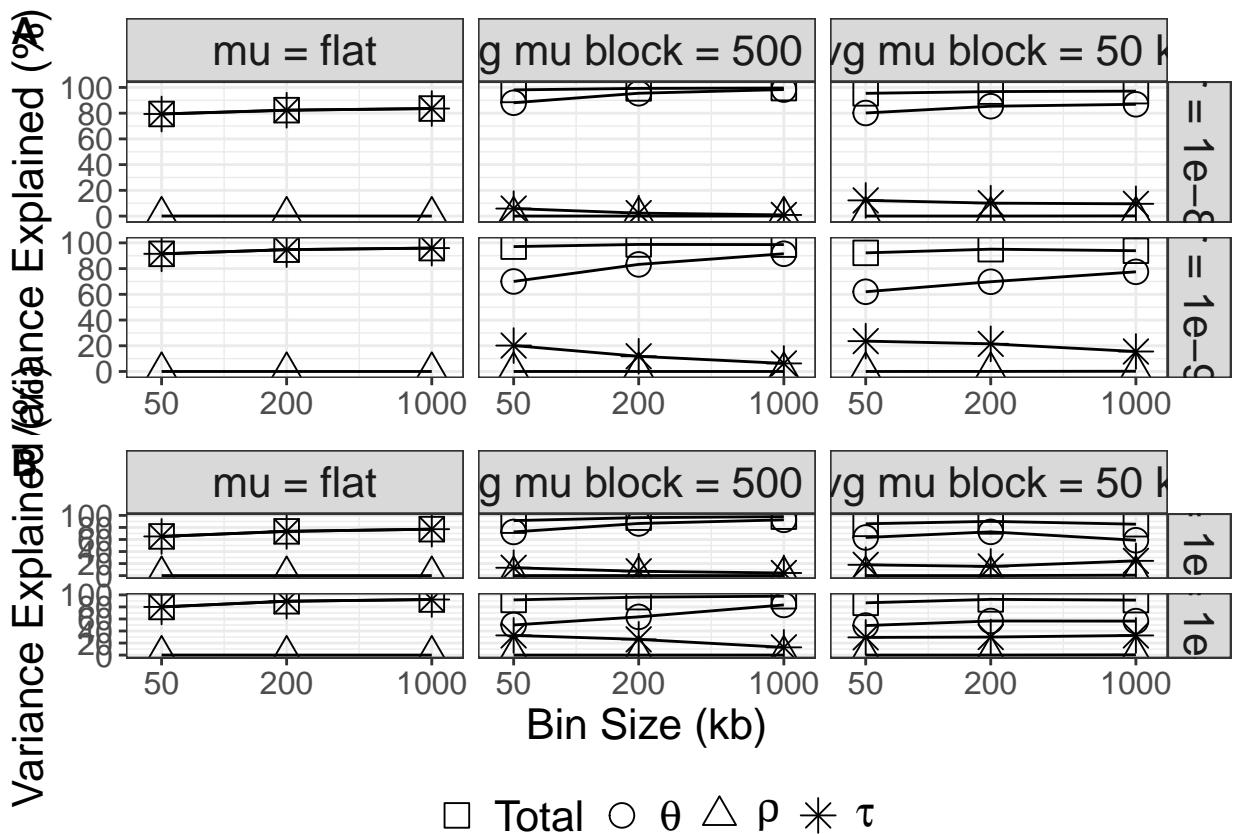
```

7.15 plots combined

```

coal.sims.plot <- plot_grid(r2.plot_flat_Ne, r2.plot_bottleneck, nrow = 2, ncol = 1, labels = "AUTO")
coal.sims.plot

```



```
save_plot("Figure5.pdf", coal.sims.plot, device = "pdf", base_width = 9, base_height = 12)
```