ms1_analyses_rf_testnewvars

Jonathan Walter, Grace Wilkinson, Rachel Fleck, Michael Pace

10/3/2019

This document organizes for openness and reproducibility analyses of the temporal coherence of interannual variation in lake primary productivity with terrestrial primary productivity in the landscape surrounding the lake.

Data import

Data produced in 'ms1_prep.Rmd' are loaded.

```
load("/Users/jonathanwalter/Box Sync/NSF EAGER Synchrony/Data/RData files/ms1_analysis_inprogress1_v108")
```

```
any(sapply(analysislakes$lakedata, function(x){any(is.infinite(x))}))
```

```
## [1] FALSE
```

```
any(sapply(analysislakes$lakedata, function(x){any(is.na(x))}))
```

```
## [1] FALSE
```

```
which(sapply(analysislakes$lakedata, function(x){any(is.na(x))}))
```

```
## named integer(0)
```

```
analysislakes$lakeinfo[which(sapply(analysislakes$lakedata, function(x){any(is.na(x))})),]
```

```
##  [1] lagoslakeid       gnis_name         nhd_lat
##  [4] nhd_long          lake_area_ha      lake_perim_meters
##  [7] nhd_ftype         nhd_fcode         hu4_zoneid
## [10] hu12_zoneid       state_zoneid      elevation_m
## [13] start             end
## <0 rows> (or 0-length row.names)
```

```
# image(accndvi)
# points(lakepts.prj[which(sapply(analysislakes$lakedata, function(x){any(is.na(x))})),])

dbuff[which(sapply(analysislakes$lakedata, function(x){any(is.na(x))}))]
```

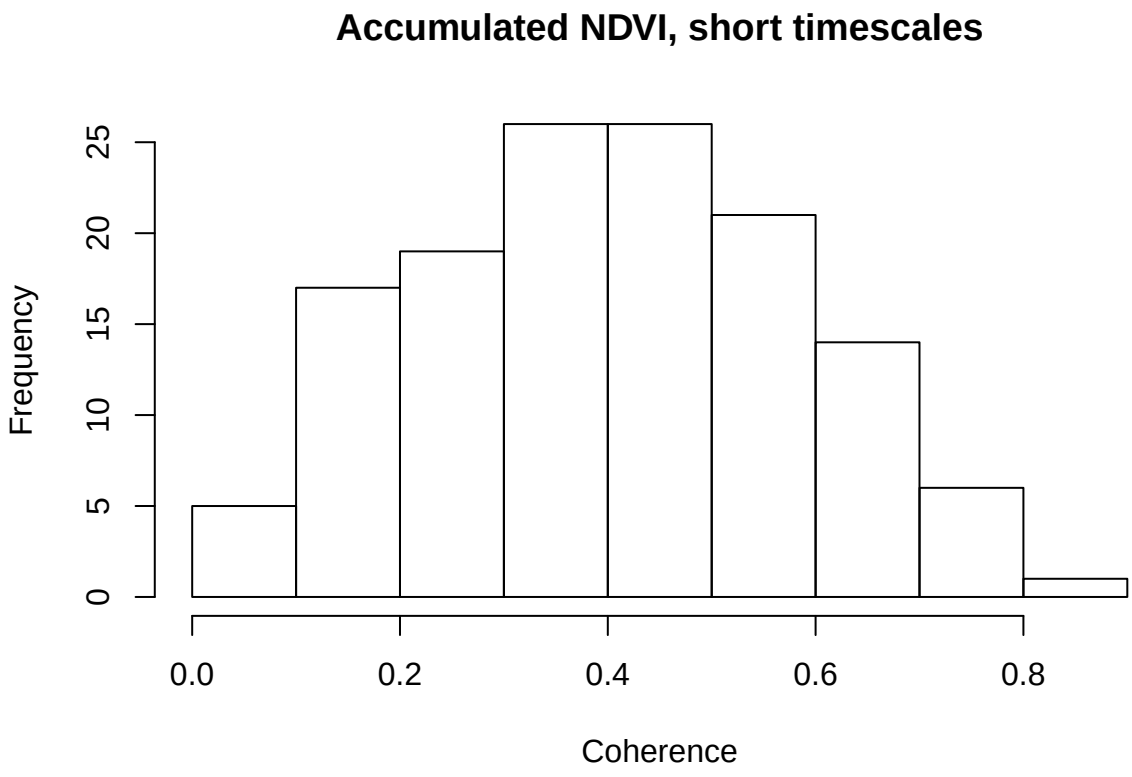
```
## numeric(0)
```

```
analysislakes$lakeinfo<-analysislakes$lakeinfo[!sapply(analysislakes$lakedata, function(x){any(is.na(x)
analysislakes$lakedata<-analysislakes$lakedata[!sapply(analysislakes$lakedata, function(x){any(is.na(x)

analysislakes$lakeinfo$tslength<-analysislakes$lakeinfo$end-analysislakes$lakeinfo$start+1
# analysislakes$lakedata<-analysislakes$lakedata[!analysislakes$lakeinfo$tslength < 20]
# analysislakes$lakeinfo<-analysislakes$lakeinfo[!analysislakes$lakeinfo$tslength < 20,]
```

```
source("~/GitHub/AquaTerrSynch/AnalysisCode/bandtest_coh.R")

tsranges<-rbind(c(2,4),c(4,Inf),c(2,Inf))

coh.chlaXaccndvi<-NULL
```

```r
#coh.chlaXmaxndvi<-NULL

for(lind in 1:length(analysislakes$lakedata)){
  lakedat.ii<-cleandat(analysislakes$lakedata[[lind]], as.numeric(colnames(analysislakes$lakedata[[lind]
  chlaXaccndvi<-coh(lakedat.ii[1,], lakedat.ii[2,], as.numeric(colnames(analysislakes$lakedata[[lind]]))
                    norm="powall", sigmethod="fast", nrand=10000)
#  chlaXmaxndvi<-coh(lakedat.ii[1,], lakedat.ii[3,], as.numeric(colnames(analysislakes$lakedata[[lind]]
#                    norm="powall", sigmethod="fast", nrand=10000)
  for(rind in 1:nrow(tsranges)){
    chlaXaccndvi<-bandtest.coh(chlaXaccndvi, tsranges[rind,])
    #chlaXmaxndvi<-bandtest.coh(chlaXmaxndvi, tsranges[rind,])
  }
  coh.chlaXaccndvi<-rbind(coh.chlaXaccndvi, c(t(as.matrix(chlaXaccndvi$bandp[,3:5]))))
#  coh.chlaXmaxndvi<-rbind(coh.chlaXmaxndvi, c(t(as.matrix(chlaXmaxndvi$bandp[,3:5]))))

}

coh.chlaXaccndvi<-as.data.frame(coh.chlaXaccndvi)
#coh.chlaXmaxndvi<-as.data.frame(coh.chlaXmaxndvi)

colnames(coh.chlaXaccndvi)<-paste0("accndvi",c("p.ts1","phi.ts1","coh.ts1","p.ts2","phi.ts2","coh.ts2",
#colnames(coh.chlaXmaxndvi)<-paste0("maxndvi",c("p.ts1","phi.ts1","coh.ts1","p.ts2","phi.ts2","coh.ts2"

coh.chlaXaccndvi$lagoslakeid<-analysislakes$lakeinfo$lagoslakeid
#coh.chlaXmaxndvi$lagoslakeid<-analysislakes$lakeinfo$lagoslakeid
```

```r
#short timescales
hist(coh.chlaXaccndvi$accndvicoh.ts1, main="Accumulated NDVI, short timescales", xlab="Coherence", ylab=
```



```
#hist(coh.chlaXmaxndvi$maxndvicoh.ts1, main="Maximum NDVI, short timescales", xlab="Coherence", ylab="F

quantile(coh.chlaXaccndvi$accndvicoh.ts1)
```

```
##         0%        25%        50%        75%       100%
## 0.03540956 0.26015941 0.40373548 0.52492077 0.81625251
```

```
#quantile(coh.chlaXmaxndvi$maxndvicoh.ts1)

alpha=0.05
sum(coh.chlaXaccndvi$accndvip.ts1<alpha)/nrow(coh.chlaXaccndvi)
```

```
## [1] 0.06666667
```

```
#sum(coh.chlaXmaxndvi$maxndvip.ts1<alpha)/nrow(coh.chlaXmaxndvi)

print(cbind(coh.chlaXaccndvi$lagoslakeid, coh.chlaXaccndvi$accndvip.ts1)[coh.chlaXaccndvi$accndvip.ts1<a
```

```
##         [,1]       [,2]
##  [1,]   5104 0.00169983
##  [2,]   5288 0.03849615
##  [3,]   6199 0.00669933
##  [4,]   6399 0.03469653
##  [5,]   6973 0.02419758
##  [6,]   7810 0.01579842
##  [7,]  79457 0.04709529
##  [8,] 136680 0.04859514
##  [9,]   5453 0.02489751
```

```
print(cbind(coh.chlaXaccndvi$lagoslakeid, coh.chlaXaccndvi$accndvip.ts2)[coh.chlaXaccndvi$accndvip.ts2<a
```

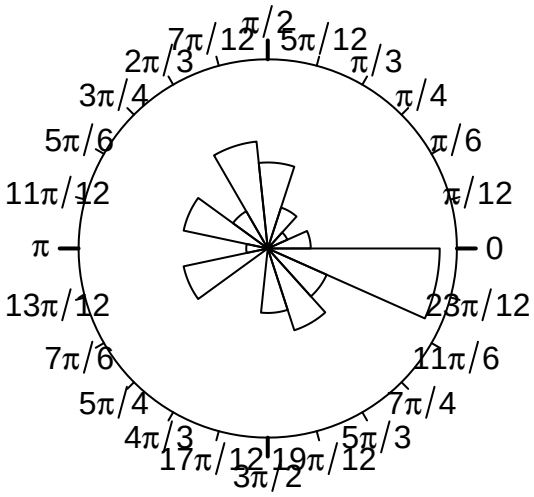
```
##        [,1]       [,2]
## [1,]    249 0.02229777
## [2,]   6301 0.02349765
## [3,]   7792 0.04729527
## [4,] 136466 0.00749925
## [5,]  14815 0.00889911
## [6,]   3280 0.03769623
## [7,]   5463 0.03249675
```

```
cor(coh.chlaXaccndvi$accndvicoh.ts1,coh.chlaXaccndvi$accndvicoh.ts2)
```

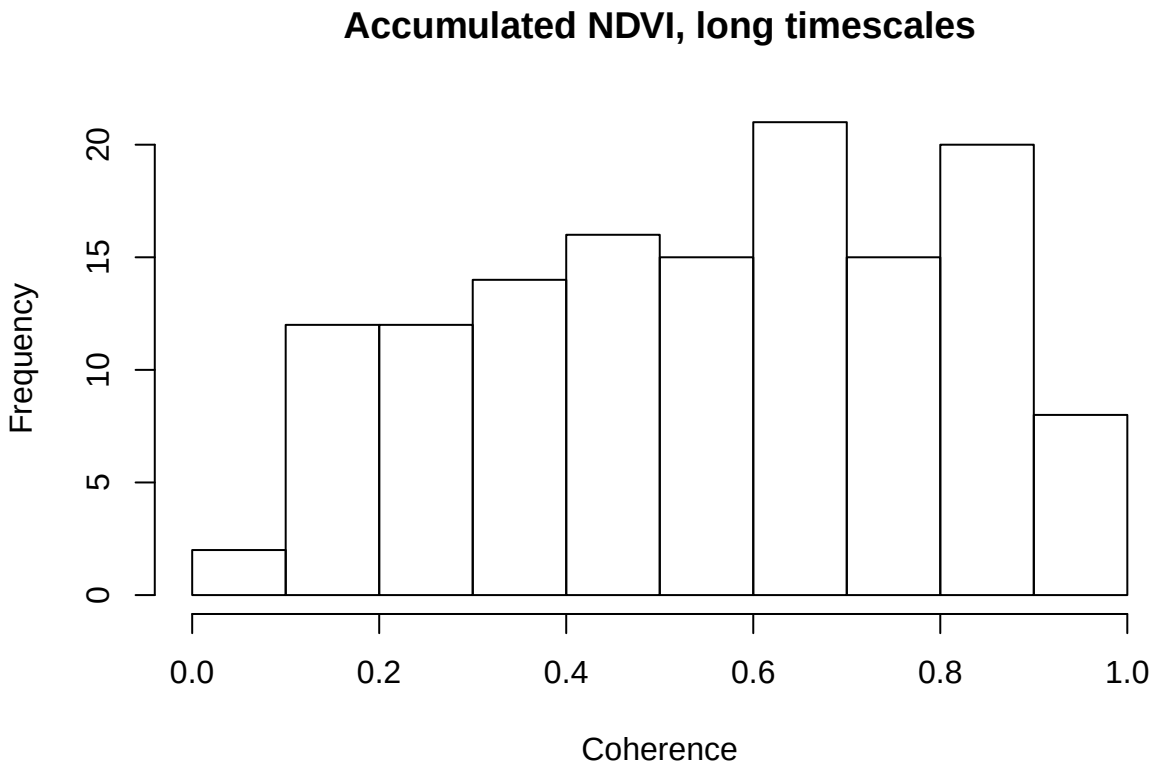
```
## [1] -0.002969988
```

```
# print(coh.chlaXaccndvi$accndviphi.ts1[coh.chlaXaccndvi$accndvip.ts1<alpha]/pi) #only pattern is that
# print(coh.chlaXmaxndvi$maxndviphi.ts1[coh.chlaXmaxndvi$maxndvip.ts1<alpha]/pi)

phicls<-c(-1,-.75,-0.25,0.25,0.75,1)

# hist(coh.chlaXaccndvi$accndviphi.ts1[coh.chlaXaccndvi$accndvip.ts1<0.2]/pi, main="Accumulated NDVI, s
rose(coh.chlaXaccndvi$accndviphi.ts1[coh.chlaXaccndvi$accndvip.ts1<0.3], unit="radian",
     breaks=seq(0,2*pi,length.out=16))
```

coh.chlaXaccndvi$accndviphi.ts1[coh.chlaXaccndvi$accndvip.ts1 <




```
#hist(coh.chlaXmaxndvi$maxndviphi.ts1[coh.chlaXmaxndvi$maxndvip.ts1<0.2]/pi, main="Maximum NDVI, short

#long timescales
hist(coh.chlaXaccndvi$accndvicoh.ts2, main="Accumulated NDVI, long timescales", xlab="Coherence", ylab=
```




```
#hist(coh.chlaXmaxndvi$maxndvicoh.ts2, main="Maximum NDVI, long timescales", xlab="Coherence", ylab="Fr

quantile(coh.chlaXaccndvi$accndvicoh.ts2)
```

```
##         0%        25%        50%        75%       100%
## 0.06700155 0.35635453 0.56072757 0.75753276 0.96052338
```

```
#quantile(coh.chlaXmaxndvi$maxndvicoh.ts2)

alpha=0.05
sum(coh.chlaXaccndvi$accndvip.ts2<alpha)/nrow(coh.chlaXaccndvi)
```

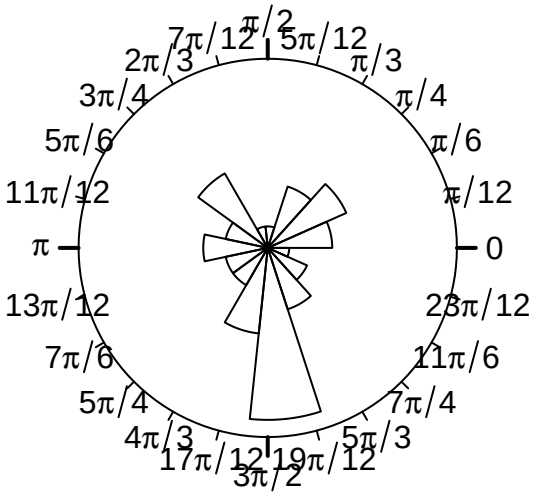
```
## [1] 0.05185185
```

```
#sum(coh.chlaXmaxndvi$maxndvip.ts2<alpha)/nrow(coh.chlaXmaxndvi)

print(coh.chlaXaccndvi$accndviphi.ts2[coh.chlaXaccndvi$accndvip.ts2<alpha]/pi)
```

```
## [1] -0.43893809  0.25315167 -0.40935196 -0.04386325 -0.65597599  0.36382168
## [7]  0.89471121
```

```
#print(coh.chlaXmaxndvi$maxndviphi.ts2[coh.chlaXmaxndvi$maxndvip.ts2<alpha]/pi)

# hist(coh.chlaXaccndvi$accndviphi.ts2[coh.chlaXaccndvi$accndvip.ts2<0.2]/pi, main="Accumulated NDVI, l
rose(coh.chlaXaccndvi$accndviphi.ts2[coh.chlaXaccndvi$accndvip.ts2<0.3], unit="radian",
     breaks=seq(0,2*pi,length.out=16))
```

coh.chlaXaccndvi$accndviphi.ts2[coh.chlaXaccndvi$accndvip.ts2 <




```
#hist(coh.chlaXmaxndvi$maxndviphi.ts1[coh.chlaXmaxndvi$maxndvicoh.ts2>0.6]/pi, main="Maximum NDVI, shor

# tiff("~/Box Sync/NSF EAGER Synchrony/Manuscripts/1_CoherenceSpatialVariation/fig2_distributions.tif",
#      res=300, width=6.5, height=6.5)
#
# par(mar=c(3,3,2,1),mgp=c(1.7,0.5,0),mfrow=c(2,2),cex.main=0.9)
#
# hist(coh.chlaXaccndvi$accndvicoh.ts1, main="Short timescale coherence", xlab="Coherence", ylab="Frequ
# text(par()$usr[1]+.05,0.95*par()$usr[4],"a)")
# hist(coh.chlaXaccndvi$accndvicoh.ts2, main="Long timescale coherence", xlab="Coherence", ylab="Freque
# text(par()$usr[1]+.05,0.95*par()$usr[4],"b)")
#
# par(mar=c(1,1,2,1))
# rose(coh.chlaXaccndvi$accndviphi.ts1[coh.chlaXaccndvi$accndvip.ts1<0.3], unit="radian", col="lightgre
#      breaks=c(0,pi/4,pi/2,3*pi/4,pi,5*pi/4,3*pi/2,7*pi/4,2*pi), main="Short timescale phases",
#        at=c(0,pi/4,pi/2,3*pi/4,pi,-3*pi/4,-pi/2,-pi/4))
```

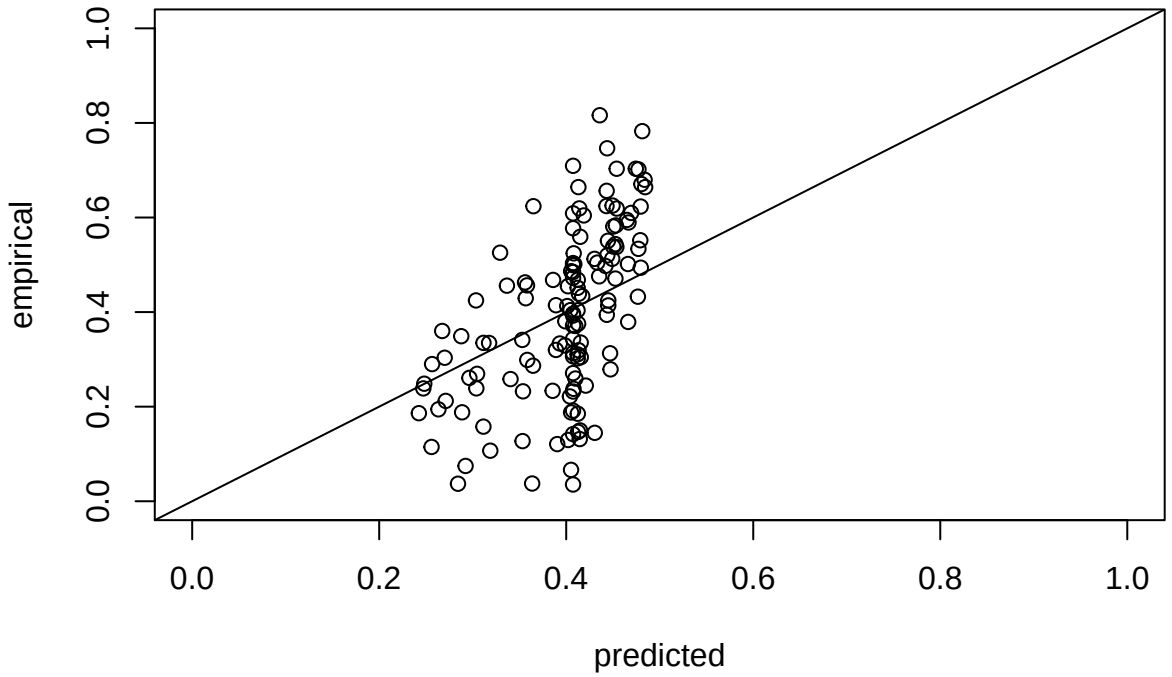
```
# text(0.9*par()$usr[1],0.95*par()$usr[4],"c)")
# rose(coh.chlaXaccndvi$accndviphi.ts2[coh.chlaXaccndvi$accndvip.ts2<0.3], unit="radian", col="lightgre
#      breaks=c(0,pi/4,pi/2,3*pi/4,pi,5*pi/4,3*pi/2,7*pi/4,2*pi), main="Long timescale phases",
#      at=c(0,pi/4,pi/2,3*pi/4,pi,-3*pi/4,-pi/2,-pi/4))
# text(0.9*par()$usr[1],0.95*par()$usr[4],"d)")
#
# dev.off()
```

```
dt<-lagosne_load("1.087.3")
dt.conn<-dt$buffer500m.conn
dt.chag<-dt$hu12.chag

predictors<-analysislakes$lakeinfo
predictors$tslength<-predictors$end-predictors$start + 1
pred.conn<-left_join(predictors, dt.conn, by="lagoslakeid")
pred.chag<-left_join(predictors, dt.chag, by="hu12_zoneid")
```

```
## Warning: Column `hu12_zoneid` joining factor and character vector, coercing
## into character vector
```

```
modvars.conn<-left_join(pred.conn, coh.chlaXaccndvi, by="lagoslakeid")
modvars.chag<-left_join(pred.chag, coh.chlaXaccndvi, by="lagoslakeid")

# modvars.accndvi.phist<-modvars.accndvi[modvars.accndvi$accndvip.ts1<0.3,]
# modvars.accndvi.philt<-modvars.accndvi[modvars.accndvi$accndvip.ts2<0.3,]
```

```
dconn.st<-modvars.conn[,c(17:26,29)]

cforest.st<-party::cforest(accndvicoh.ts1 ~ ., data=dconn.st,
                           controls=cforest_control(ntree=50000,mincriterion =  0.9))
predcoh.st<-predict(cforest.st, newdata=dconn.st,type="response")
#hist(predcoh.st)
#hist(modvars.accndvi$accndvicoh.ts1)
plot(predcoh.st, dconn.st$accndvicoh.ts1, xlab="predicted", ylab="empirical", main="Coherence, short ts
     xlim=c(0,1), ylim=c(0,1))
abline(a=0,b=1)
```




```
cor.test(predcoh.st,dconn.st$accndvicoh.ts1)
```

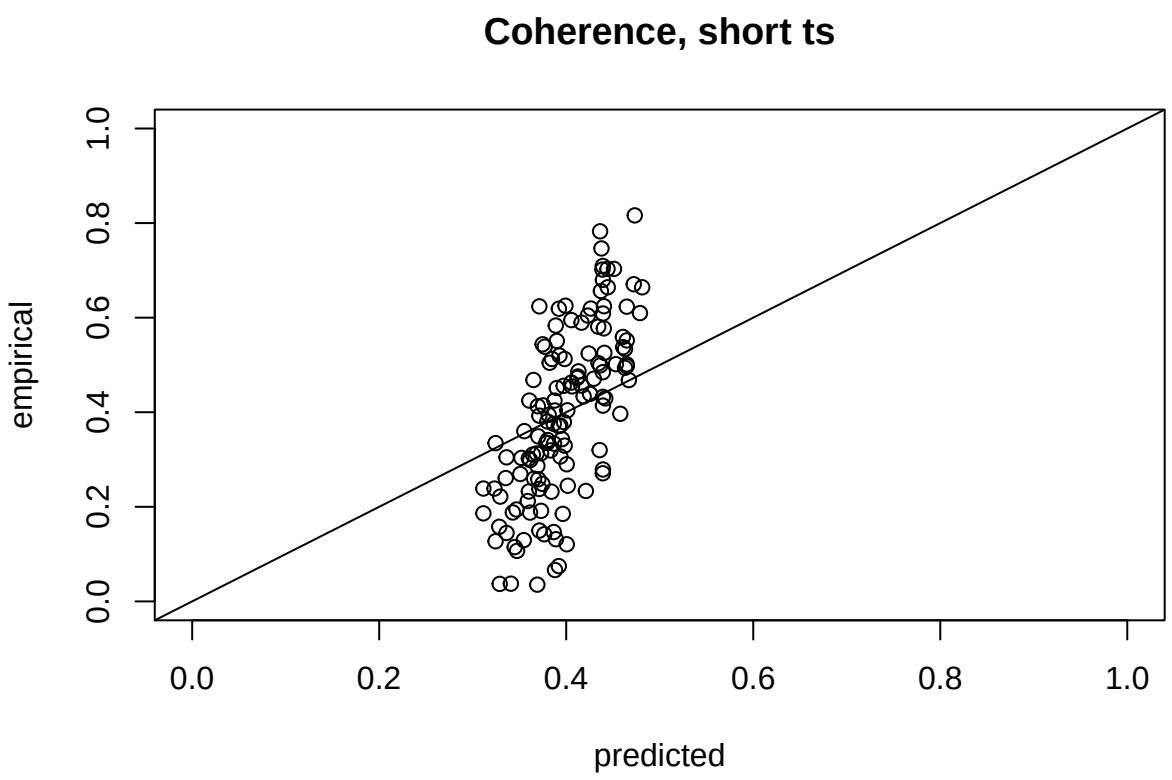
```
##
##  Pearson's product-moment correlation
##
## data:  predcoh.st and dconn.st$accndvicoh.ts1
## t = 7.9456, df = 133, p-value = 7.252e-13
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.4406307 0.6719002
## sample estimates:
##     cor
## 0.56735
```

```
varimp.coh.st<-varimp(cforest.st)
print(varimp.coh.st[order(varimp.coh.st, decreasing=T)])
```

```
##    buffer500m_streamdensity_midreaches_sum_lengthm
##                                       2.889502e-03
##     uffer500m_streamdensity_headwaters_sum_lengthm
##                                       1.755891e-03
##    buffer500m_streamdensity_streams_density_mperha
##                                       1.364898e-03
## buffer500m_streamdensity_midreaches_density_mperha
##                                       1.364607e-03
##       buffer500m_streamdensity_streams_sum_lengthm
##                                       1.326136e-03
## buffer500m_streamdensity_headwaters_density_mperha
##                                       5.429641e-04
##     buffer500m_streamdensity_rivers_density_mperha
```

```
##                                     2.491017e-04
##        buffer500m_streamdensity_rivers_sum_lengthm
##                                     6.336914e-05
##        buffer500m_canalditchdensity_density_mperha
##                                     1.562256e-05
##           buffer500m_canalditchdensity_sum_lengthm
##                                     1.349738e-05
```

```
#pdp.shoredev.coh.st<-partial(cforest.st, pred.var="shoredev", train=modvars.accndvi, type="regression"


dchag.st<-modvars.chag[,c(17:158,161)]
cforest.st<-party::cforest(accndvicoh.ts1 ~ ., data=dchag.st,
                           controls=cforest_control(ntree=50000,mincriterion =  0.9))
predcoh.st<-predict(cforest.st, newdata=dchag.st,type="response")
#hist(predcoh.st)
#hist(modvars.accndvi$accndvicoh.ts1)
plot(predcoh.st, dconn.st$accndvicoh.ts1, xlab="predicted", ylab="empirical", main="Coherence, short ts
     xlim=c(0,1), ylim=c(0,1))
abline(a=0,b=1)
```




```
cor.test(predcoh.st,dconn.st$accndvicoh.ts1)
```

```
##
##  Pearson's product-moment correlation
##
## data:  predcoh.st and dconn.st$accndvicoh.ts1
## t = 11.248, df = 133, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.6000488 0.7756707
```

```
## sample estimates:
##       cor
## 0.6982187
```

```
varimp.coh.st<-varimp(cforest.st)
print(varimp.coh.st[order(varimp.coh.st, decreasing=T)])
```

```
##    hu12_prism_ppt_30yr_normal_800mm2_annual_min
##                                    2.733220e-04
##                           hu12_baseflowindex_max
##                                    2.203866e-04
##   hu12_prism_ppt_30yr_normal_800mm2_annual_mean
##                                    1.865381e-04
##                          hu12_baseflowindex_mean
##                                    1.587517e-04
##    hu12_prism_ppt_30yr_normal_800mm2_annual_max
##                                    1.585217e-04
##              hu12_surficialgeology_lac_clay_pct
##                                    9.127801e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_max
##                                    8.109044e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_min
##                                    7.739031e-05
##  hu12_prism_tmax_30yr_normal_800mm2_annual_mean
##                                    7.355661e-05
##  hu12_prism_tmean_30yr_normal_800mm2_annual_max
##                                    6.386278e-05
##   hu12_prism_tmin_30yr_normal_800mm2_annual_std
##                                    5.856549e-05
##                         hu12_dep_totaln_1990_max
##                                    5.100724e-05
##  hu12_prism_tmean_30yr_normal_800mm2_annual_min
##                                    4.959176e-05
##                         hu12_dep_totaln_1990_std
##                                    4.784961e-05
##                            hu12_dep_so4_2005_min
##                                    4.781318e-05
##               hu12_surficialgeology_lac_clay_ha
##                                    4.684036e-05
##                           hu12_dep_no3_1990_mean
##                                    4.392393e-05
##                    hu12_groundwaterrecharge_mean
##                                    4.058358e-05
##                            hu12_dep_so4_1990_max
##                                    3.965912e-05
##                            hu12_dep_no3_1995_std
##                                    3.962367e-05
##                        hu12_dep_totaln_1990_mean
##                                    3.942147e-05
##                            hu12_dep_so4_2010_std
##                                    3.891161e-05
## hu12_prism_tmean_30yr_normal_800mm2_annual_mean
##                                    3.670768e-05
##                            hu12_dep_no3_1990_max
##                                    3.375986e-05
```

```
##                    hu12_groundwaterrecharge_max
##                                     2.999309e-05
##   hu12_prism_tmin_30yr_normal_800mm2_annual_min
##                                     2.843827e-05
##                             hu12_dep_no3_1990_std
##                                     2.671742e-05
##                             hu12_dep_no3_1990_min
##                                     2.618105e-05
##                             hu12_dep_so4_1990_std
##                                     2.599002e-05
##                            hu12_dep_so4_1990_mean
##                                     2.477123e-05
##                            hu12_dep_so4_2005_mean
##                                     2.361262e-05
##                    hu12_groundwaterrecharge_min
##                                     2.355189e-05
##                             hu12_dep_so4_1990_min
##                                     2.350386e-05
##                             hu12_dep_so4_2005_max
##                                     2.342839e-05
##                            hu12_dep_so4_2010_mean
##                                     2.330336e-05
##                            hu12_dep_so4_2000_mean
##                                     2.078349e-05
##                                   hu12_runoff_max
##                                     1.849343e-05
##  hu12_prism_tmean_30yr_normal_800mm2_annual_std
##                                     1.765086e-05
##                             hu12_dep_so4_2000_max
##                                     1.761915e-05
##                             hu12_dep_no3_2005_min
##                                     1.683413e-05
##                                   hu12_runoff_std
##                                     1.679234e-05
##                             hu12_dep_so4_1985_min
##                                     1.636301e-05
##                            hu12_dep_no3_2005_mean
##                                     1.613869e-05
##                             hu12_dep_no3_1985_max
##                                     1.611976e-05
##                            hu12_dep_so4_1995_mean
##                                     1.566758e-05
##                          hu12_dep_totaln_2005_min
##                                     1.441818e-05
##                            hu12_dep_so4_1985_mean
##                                     1.386093e-05
##  hu12_prism_tmin_30yr_normal_800mm2_annual_mean
##                                     1.343253e-05
##    hu12_prism_ppt_30yr_normal_800mm2_annual_std
##                                     1.301034e-05
##                             hu12_dep_so4_2000_min
##                                     1.270643e-05
##                             hu12_dep_no3_1985_std
##                                     1.265930e-05
```

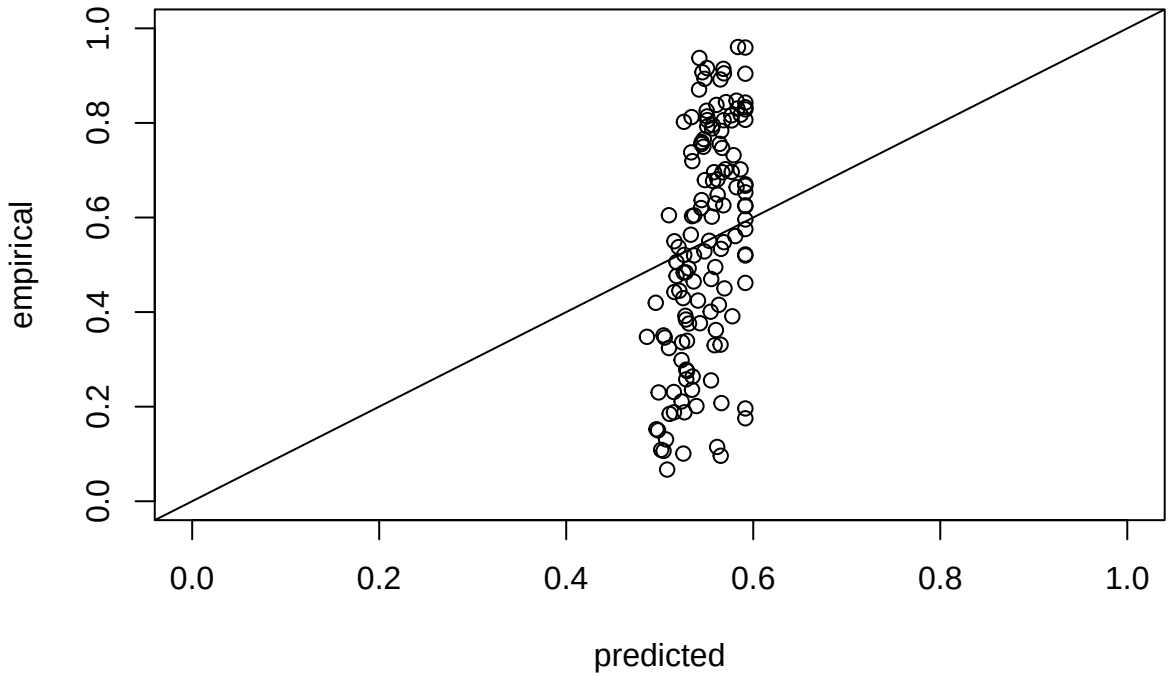
```
##                           hu12_dep_so4_1985_max
##                                    1.260231e-05
##                         hu12_dep_totaln_1990_min
##                                    1.224346e-05
##                            hu12_dep_so4_1995_min
##                                    1.176755e-05
##                         hu12_dep_totaln_2005_max
##                                    1.116423e-05
##                            hu12_dep_no3_2000_max
##                                    9.928707e-06
##                            hu12_dep_so4_1985_std
##                                    9.857007e-06
##                            hu12_dep_so4_2010_min
##                                    9.144313e-06
##   hu12_prism_tmin_30yr_normal_800mm2_annual_max
##                                    7.897817e-06
##                            hu12_dep_no3_2005_max
##                                    7.851940e-06
##                   hu12_surficialgeology_lac_pct
##                                    7.149615e-06
##                            hu12_dep_no3_2010_min
##                                    7.090686e-06
##                           hu12_dep_no3_2000_mean
##                                    6.632314e-06
##                            hu12_dep_no3_1995_max
##                                    5.535535e-06
##                           hu12_dep_no3_1995_mean
##                                    4.444238e-06
##                    hu12_surficialgeology_lac_ha
##                                    4.370994e-06
##                         hu12_dep_totaln_2005_mean
##                                    4.333418e-06
##              hu12_surficialgeology_peat_mrsh_ha
##                                    4.109888e-06
##             hu12_surficialgeology_till_sand_pct
##                                    3.865560e-06
##                            hu12_dep_so4_1995_std
##                                    3.344293e-06
##                            hu12_dep_so4_1995_max
##                                    3.201820e-06
##             hu12_surficialgeology_till_loam_pct
##                                    2.885665e-06
##                    hu12_groundwaterrecharge_std
##                                    2.341459e-06
##             hu12_surficialgeology_peat_mrsh_pct
##                                    1.797267e-06
##                                hu12_runoff_mean
##                                    1.050595e-06
##                 hu12_surficialgeology_eolian_ha
##                                    7.996186e-07
##                hu12_surficialgeology_eolian_pct
##                                    1.866326e-07
##                  hu12_surficialgeology_beach_ha
##                                    0.000000e+00
```

```
##                 hu12_surficialgeology_beach_pct
##                                    0.000000e+00
##                 hu12_surficialgeology_colluv_ha
##                                    0.000000e+00
##                hu12_surficialgeology_colluv_pct
##                                    0.000000e+00
##                   hu12_surficialgeology_grus_ha
##                                    0.000000e+00
##                  hu12_surficialgeology_grus_pct
##                                    0.000000e+00
##                  hu12_surficialgeology_other_ha
##                                    0.000000e+00
##                 hu12_surficialgeology_other_pct
##                                    0.000000e+00
##                  hu12_surficialgeology_solif_ha
##                                    0.000000e+00
##                 hu12_surficialgeology_solif_pct
##                                    0.000000e+00
##               hu12_surficialgeology_till_oth_ha
##                                    0.000000e+00
##              hu12_surficialgeology_till_oth_pct
##                                    0.000000e+00
##                                     borderhu12s
##                                    0.000000e+00
##                 hu12_surficialgeology_saprol_ha
##                                   -2.488657e-08
##              hu12_surficialgeology_till_clay_ha
##                                   -5.434593e-08
##                hu12_surficialgeology_saprol_pct
##                                   -6.943854e-08
##             hu12_surficialgeology_till_clay_pct
##                                   -7.118091e-08
##                 hu12_surficialgeology_marine_ha
##                                   -1.527904e-07
##                hu12_surficialgeology_marine_pct
##                                   -2.483517e-07
##                        hu12_dep_totaln_2000_std
##                                   -9.878704e-07
##                           hu12_dep_so4_2005_std
##                                   -1.046585e-06
##                        hu12_dep_totaln_1995_std
##                                   -1.110582e-06
##                           hu12_dep_no3_2010_std
##                                   -1.137744e-06
##                        hu12_dep_totaln_1985_std
##                                   -1.745618e-06
##                        hu12_dep_totaln_2000_max
##                                   -1.865904e-06
##                                  hu12_runoff_min
##                                   -2.136356e-06
##                        hu12_dep_totaln_2010_min
##                                   -3.570373e-06
##                        hu12_dep_totaln_1995_max
##                                   -4.339305e-06
```

```
##                          hu12_dep_no3_2010_mean
##                                    -4.402127e-06
##                   hu12_surficialgeology_solut_ha
##                                    -4.457969e-06
##                           hu12_dep_no3_2000_min
##                                    -4.782831e-06
##                           hu12_dep_no3_1995_min
##                                    -5.436043e-06
##                  hu12_surficialgeology_alluv_pct
##                                    -6.395913e-06
##                           hu12_dep_no3_1985_min
##                                    -6.753517e-06
##                        hu12_dep_totaln_2010_mean
##                                    -7.009650e-06
##                  hu12_surficialgeology_solut_pct
##                                    -7.176517e-06
##                           hu12_dep_no3_1985_mean
##                                    -7.984106e-06
##                           hu12_dep_so4_2010_max
##                                    -8.388133e-06
##                           hu12_dep_no3_2010_max
##                                    -8.442325e-06
##                 hu12_surficialgeology_gf_out_pct
##                                    -8.450748e-06
##                           hu12_dep_no3_2000_std
##                                    -8.858737e-06
##                   hu12_surficialgeology_alluv_ha
##                                    -8.942437e-06
##                           hu12_dep_so4_2000_std
##                                    -9.118814e-06
##                        hu12_dep_totaln_2000_mean
##                                    -9.157060e-06
##                         hu12_dep_totaln_2000_min
##                                    -9.989466e-06
##                hu12_surficialgeology_till_sand_ha
##                                    -1.000773e-05
##                           hu12_dep_no3_2005_std
##                                    -1.014699e-05
##                         hu12_dep_totaln_2010_max
##                                    -1.121096e-05
##                         hu12_dep_totaln_2005_std
##                                    -1.150304e-05
##                         hu12_dep_totaln_1985_max
##                                    -1.167730e-05
##                    hu12_surficialgeology_ice_pct
##                                    -1.270684e-05
##               hu12_surficialgeology_dec_resid_pct
##                                    -1.381640e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_std
##                                    -1.487727e-05
##                         hu12_dep_totaln_1995_mean
##                                    -1.489826e-05
##                         hu12_dep_totaln_1985_mean
##                                    -1.497379e-05
```

```
##                         hu12_dep_totaln_2010_std
##                                     -1.606613e-05
##                       hu12_surficialgeology_ice_ha
##                                     -1.648096e-05
##                         hu12_dep_totaln_1985_min
##                                     -1.653933e-05
##                hu12_surficialgeology_dec_resid_ha
##                                     -1.669455e-05
##              hu12_surficialgeology_open_water_pct
##                                     -2.157568e-05
##               hu12_surficialgeology_open_water_ha
##                                     -2.236351e-05
##                hu12_surficialgeology_till_loam_ha
##                                     -2.236675e-05
##                         hu12_dep_totaln_1995_min
##                                     -2.340871e-05
##                           hu12_baseflowindex_std
##                                     -2.604895e-05
##                   hu12_surficialgeology_gf_out_ha
##                                     -3.732133e-05
```

```
### long timescales
dconn.lt<-modvars.conn[,c(17:26,32)]

cforest.lt<-party::cforest(accndvicoh.ts2 ~ ., data=dconn.lt,
                           controls=cforest_control(ntree=50000,mincriterion =  0.9))
predcoh.lt<-predict(cforest.lt, newdata=dconn.lt,type="response")
#hist(predcoh.lt)
#hist(modvars.accndvi$accndvicoh.ts1)
plot(predcoh.lt, dconn.lt$accndvicoh.ts2, xlab="predicted", ylab="empirical", main="Coherence, short ts
     xlim=c(0,1), ylim=c(0,1))
abline(a=0,b=1)
```




```
cor.test(predcoh.lt,dconn.lt$accndvicoh.ts2)
```

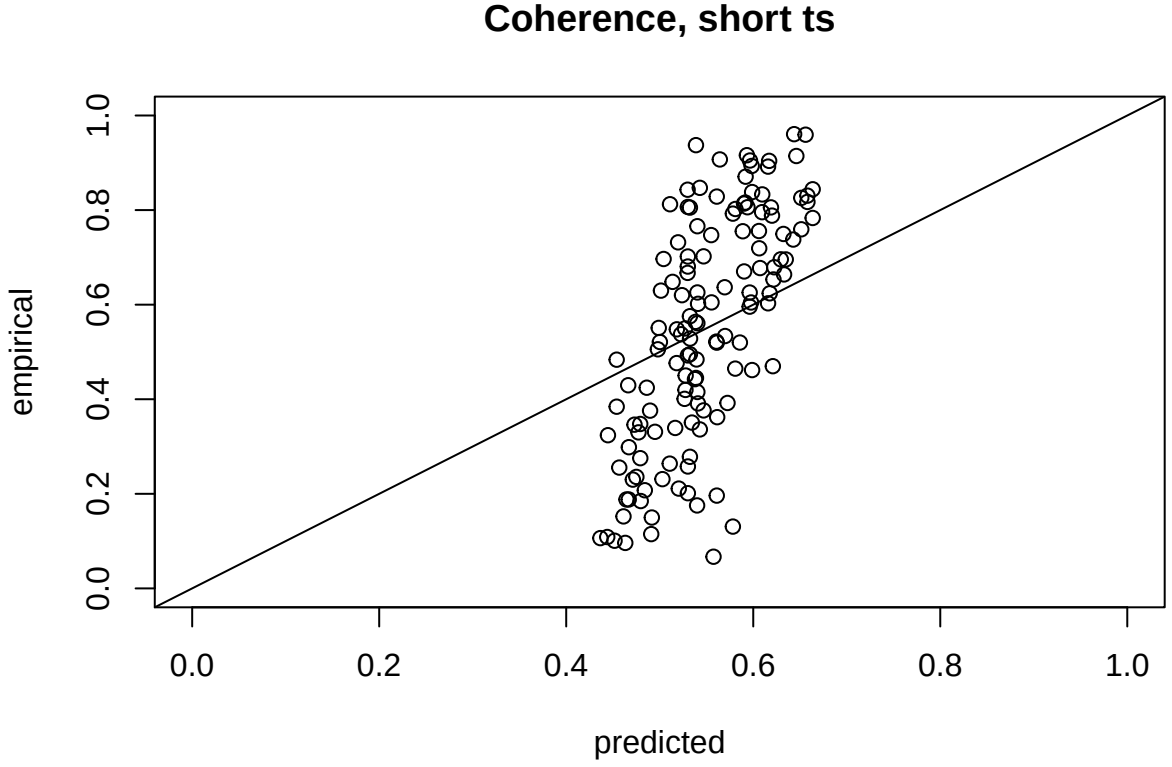
```
##
##  Pearson's product-moment correlation
##
## data:  predcoh.lt and dconn.lt$accndvicoh.ts2
## t = 7.0187, df = 133, p-value = 1.035e-10
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.3847250 0.6332238
## sample estimates:
##       cor
## 0.5198883
```

```
varimp.coh.lt<-varimp(cforest.lt)
print(varimp.coh.lt[order(varimp.coh.lt, decreasing=T)])
```

```
##    buffer500m_streamdensity_midreaches_sum_lengthm
##                                       3.266540e-04
##     buffer500m_streamdensity_rivers_density_mperha
##                                       4.710446e-05
##       buffer500m_streamdensity_streams_sum_lengthm
##                                       3.999521e-05
##        buffer500m_streamdensity_rivers_sum_lengthm
##                                      -6.931268e-06
##           buffer500m_canalditchdensity_sum_lengthm
##                                      -1.802391e-05
##     uffer500m_streamdensity_headwaters_sum_lengthm
##                                      -1.869373e-05
##        buffer500m_canalditchdensity_density_mperha
```

```
##                                     -7.386400e-05
##    buffer500m_streamdensity_streams_density_mperha
##                                     -2.096031e-04
## buffer500m_streamdensity_headwaters_density_mperha
##                                     -4.189364e-04
## buffer500m_streamdensity_midreaches_density_mperha
##                                     -6.330820e-04
```

```
#pdp.shoredev.coh.lt<-partial(cforest.lt, pred.var="shoredev", train=modvars.accndvi, type="regression"


dchag.lt<-modvars.chag[,c(17:158,164)]
cforest.lt<-party::cforest(accndvicoh.ts2 ~ ., data=dchag.lt,
                           controls=cforest_control(ntree=50000,mincriterion =  0.9))
predcoh.lt<-predict(cforest.lt, newdata=dchag.lt,type="response")
#hist(predcoh.lt)
#hist(modvars.accndvi$accndvicoh.ts1)
plot(predcoh.lt, dconn.lt$accndvicoh.ts2, xlab="predicted", ylab="empirical", main="Coherence, short ts
     xlim=c(0,1), ylim=c(0,1))
abline(a=0,b=1)
```




```
cor.test(predcoh.lt,dconn.lt$accndvicoh.ts2)
```

```
##
##  Pearson's product-moment correlation
##
## data:  predcoh.lt and dconn.lt$accndvicoh.ts2
## t = 11.172, df = 133, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.5969981 0.7737703
```

```
## sample estimates:
##       cor
## 0.6957745
```

```
varimp.coh.lt<-varimp(cforest.lt)
print(varimp.coh.lt[order(varimp.coh.lt, decreasing=T)])
```

```
##                           hu12_dep_so4_2010_max
##                                    2.270029e-04
##                          hu12_dep_so4_2010_mean
##                                    1.866036e-04
##                       hu12_dep_totaln_2005_mean
##                                    1.738299e-04
##                           hu12_dep_so4_2005_min
##                                    1.731070e-04
##                        hu12_dep_totaln_2005_max
##                                    1.644684e-04
##                          hu12_dep_so4_2005_mean
##                                    1.625744e-04
##                        hu12_dep_totaln_2000_max
##                                    1.468410e-04
##                        hu12_dep_totaln_2005_min
##                                    1.422730e-04
##                  hu12_surficialgeology_solut_ha
##                                    1.322013e-04
##                           hu12_dep_so4_2010_min
##                                    1.310577e-04
##                           hu12_dep_no3_2000_max
##                                    1.304977e-04
##                           hu12_dep_so4_2005_max
##                                    1.198706e-04
##                           hu12_dep_no3_2005_max
##                                    1.165594e-04
##                   hu12_groundwaterrecharge_mean
##                                    1.154480e-04
##                    hu12_groundwaterrecharge_min
##                                    1.148715e-04
##                           hu12_dep_no3_2000_min
##                                    1.126941e-04
##                          hu12_dep_no3_2005_mean
##                                    1.105346e-04
##                       hu12_dep_totaln_2000_mean
##                                    1.064000e-04
##                           hu12_dep_so4_2000_max
##                                    1.004871e-04
##                           hu12_dep_no3_2005_min
##                                    1.002320e-04
##                           hu12_dep_so4_2000_min
##                                    9.050711e-05
##                           hu12_dep_no3_1985_max
##                                    9.009670e-05
##                        hu12_dep_totaln_2000_min
##                                    8.583262e-05
##                          hu12_dep_no3_2000_mean
##                                    8.433392e-05
```

```
##                     hu12_groundwaterrecharge_max
##                                     8.340407e-05
##                           hu12_dep_so4_2000_mean
##                                     8.310014e-05
##                          hu12_dep_totaln_1995_max
##                                     7.771554e-05
##                           hu12_dep_so4_1985_mean
##                                     7.117043e-05
##                           hu12_dep_so4_1995_mean
##                                     6.481608e-05
##                         hu12_dep_totaln_1990_mean
##                                     6.262255e-05
##                            hu12_dep_so4_1985_max
##                                     5.561861e-05
##                           hu12_dep_so4_1995_min
##                                     5.559468e-05
##                           hu12_dep_no3_1990_mean
##                                     5.487451e-05
##                            hu12_dep_so4_2000_std
##                                     5.422891e-05
##                          hu12_dep_totaln_2010_max
##                                     5.348591e-05
##                           hu12_dep_so4_1995_max
##                                     5.157987e-05
##                           hu12_dep_no3_1995_std
##                                     5.015743e-05
##    hu12_prism_ppt_30yr_normal_800mm2_annual_min
##                                     4.995680e-05
##                          hu12_dep_totaln_2010_min
##                                     4.712719e-05
##  hu12_prism_tmean_30yr_normal_800mm2_annual_std
##                                     4.535757e-05
##                  hu12_surficialgeology_solut_pct
##                                     4.392324e-05
##                           hu12_dep_so4_1990_mean
##                                     4.095789e-05
##              hu12_surficialgeology_till_sand_pct
##                                     4.086962e-05
##                            hu12_dep_so4_1985_min
##                                     4.069925e-05
##                                  hu12_runoff_min
##                                     4.067220e-05
##                          hu12_baseflowindex_mean
##                                     3.714670e-05
##                         hu12_dep_totaln_2010_mean
##                                     3.525197e-05
##                                 hu12_runoff_mean
##                                     3.429041e-05
##                           hu12_dep_no3_1985_mean
##                                     3.403317e-05
##    hu12_prism_ppt_30yr_normal_800mm2_annual_max
##                                     3.319186e-05
##                           hu12_dep_no3_1995_mean
##                                     3.167440e-05
```

```
##                          hu12_dep_no3_1990_min
##                                    2.910421e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_std
##                                    2.876785e-05
##                        hu12_dep_totaln_1995_std
##                                    2.872147e-05
##                        hu12_dep_totaln_1990_max
##                                    2.801594e-05
##                       hu12_dep_totaln_1995_mean
##                                    2.767833e-05
##                        hu12_dep_totaln_1990_min
##                                    2.565907e-05
##              hu12_surficialgeology_lac_clay_ha
##                                    2.449120e-05
##                        hu12_dep_totaln_1985_max
##                                    2.428494e-05
##                           hu12_dep_no3_1985_min
##                                    2.290783e-05
##             hu12_surficialgeology_till_sand_ha
##                                    2.286418e-05
##                           hu12_dep_so4_1990_std
##                                    2.196221e-05
##                                 hu12_runoff_max
##                                    2.164322e-05
##                           hu12_dep_no3_2000_std
##                                    2.032450e-05
##                           hu12_dep_so4_1990_min
##                                    1.972139e-05
##                        hu12_dep_totaln_1995_min
##                                    1.967540e-05
##                           hu12_dep_so4_1990_max
##                                    1.736694e-05
##                           hu12_dep_no3_1990_max
##                                    1.695682e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_max
##                                    1.535233e-05
##            hu12_surficialgeology_till_loam_pct
##                                    1.390223e-05
##   hu12_prism_ppt_30yr_normal_800mm2_annual_mean
##                                    1.326279e-05
##                           hu12_dep_so4_1995_std
##                                    1.324961e-05
##                           hu12_dep_no3_1995_max
##                                    1.227109e-05
##   hu12_prism_tmax_30yr_normal_800mm2_annual_min
##                                    1.072329e-05
##                          hu12_baseflowindex_max
##                                    9.342304e-06
##   hu12_prism_tmin_30yr_normal_800mm2_annual_max
##                                    8.471058e-06
##                    hu12_surficialgeology_lac_pct
##                                    8.343604e-06
##                           hu12_dep_no3_1995_min
##                                    8.319875e-06
```

```
##  hu12_prism_tmean_30yr_normal_800mm2_annual_min
##                                     8.079767e-06
##                         hu12_dep_totaln_1985_mean
##                                     7.872057e-06
##  hu12_prism_tmax_30yr_normal_800mm2_annual_mean
##                                     7.553913e-06
##                            hu12_dep_no3_2010_mean
##                                     6.450727e-06
##                             hu12_dep_no3_2010_max
##                                     6.183744e-06
##                             hu12_dep_so4_2005_std
##                                     5.574836e-06
## hu12_prism_tmean_30yr_normal_800mm2_annual_mean
##                                     5.465188e-06
##                     hu12_surficialgeology_ice_pct
##                                     5.358316e-06
##                          hu12_dep_totaln_1985_min
##                                     3.673108e-06
##                      hu12_groundwaterrecharge_std
##                                     2.145433e-06
##   hu12_prism_tmin_30yr_normal_800mm2_annual_min
##                                     1.658864e-06
##                             hu12_dep_no3_1985_std
##                                     1.438117e-06
##                  hu12_surficialgeology_eolian_ha
##                                     6.756703e-07
##                 hu12_surficialgeology_saprol_pct
##                                     3.985665e-07
##                  hu12_surficialgeology_saprol_ha
##                                     7.240732e-08
##                   hu12_surficialgeology_beach_ha
##                                     0.000000e+00
##                  hu12_surficialgeology_beach_pct
##                                     0.000000e+00
##                  hu12_surficialgeology_colluv_ha
##                                     0.000000e+00
##                 hu12_surficialgeology_colluv_pct
##                                     0.000000e+00
##                    hu12_surficialgeology_grus_ha
##                                     0.000000e+00
##                   hu12_surficialgeology_grus_pct
##                                     0.000000e+00
##                   hu12_surficialgeology_other_ha
##                                     0.000000e+00
##                  hu12_surficialgeology_other_pct
##                                     0.000000e+00
##                   hu12_surficialgeology_solif_ha
##                                     0.000000e+00
##                  hu12_surficialgeology_solif_pct
##                                     0.000000e+00
##                hu12_surficialgeology_till_oth_ha
##                                     0.000000e+00
##               hu12_surficialgeology_till_oth_pct
##                                     0.000000e+00
```

```
##                                     borderhu12s
##                                    0.000000e+00
##             hu12_surficialgeology_till_clay_pct
##                                    -2.843244e-08
##              hu12_surficialgeology_till_clay_ha
##                                    -4.789520e-07
##                hu12_surficialgeology_eolian_pct
##                                    -5.932782e-07
##              hu12_surficialgeology_peat_mrsh_ha
##                                    -1.071480e-06
##                   hu12_surficialgeology_lac_ha
##                                    -1.076702e-06
##  hu12_prism_tmin_30yr_normal_800mm2_annual_mean
##                                    -1.098767e-06
##             hu12_surficialgeology_peat_mrsh_pct
##                                    -2.243079e-06
##  hu12_prism_tmean_30yr_normal_800mm2_annual_max
##                                    -2.494125e-06
##                            hu12_dep_so4_1985_std
##                                    -3.729963e-06
##                            hu12_dep_no3_1990_std
##                                    -5.222988e-06
##                         hu12_dep_totaln_1985_std
##                                    -7.496778e-06
##                hu12_surficialgeology_marine_pct
##                                    -8.741320e-06
##              hu12_surficialgeology_lac_clay_pct
##                                    -8.846688e-06
##                            hu12_dep_no3_2005_std
##                                    -9.147676e-06
##                            hu12_dep_no3_2010_min
##                                    -9.929998e-06
##                 hu12_surficialgeology_marine_ha
##                                    -1.076002e-05
##                    hu12_surficialgeology_ice_ha
##                                    -1.225756e-05
##    hu12_prism_ppt_30yr_normal_800mm2_annual_std
##                                    -1.359695e-05
##             hu12_surficialgeology_open_water_ha
##                                    -1.611547e-05
##                         hu12_dep_totaln_2005_std
##                                    -1.635018e-05
##                                   hu12_runoff_std
##                                    -2.115076e-05
##            hu12_surficialgeology_open_water_pct
##                                    -2.192301e-05
##                         hu12_dep_totaln_1990_std
##                                    -2.222919e-05
##                hu12_surficialgeology_alluv_pct
##                                    -2.226153e-05
##             hu12_surficialgeology_dec_resid_pct
##                                    -2.556376e-05
##                            hu12_dep_so4_2010_std
##                                    -2.821682e-05
```

```
##              hu12_surficialgeology_dec_resid_ha
##                                   -2.938220e-05
##                         hu12_dep_totaln_2000_std
##                                   -3.183426e-05
##              hu12_surficialgeology_till_loam_ha
##                                   -3.224909e-05
##                  hu12_surficialgeology_alluv_ha
##                                   -3.767473e-05
##                         hu12_dep_totaln_2010_std
##                                   -3.804034e-05
##                            hu12_dep_no3_2010_std
##                                   -3.940065e-05
##   hu12_prism_tmin_30yr_normal_800mm2_annual_std
##                                   -5.243331e-05
##                 hu12_surficialgeology_gf_out_ha
##                                   -8.152187e-05
##                hu12_surficialgeology_gf_out_pct
##                                   -8.193563e-05
##                           hu12_baseflowindex_std
##                                   -1.305068e-04
```

```
# cforest.lt<-party::cforest(accndvicoh.ts2 ~ shoredev + lake_area_ha + maxdepth + pct.ag + chla + tsi.
#                            + cv.accndvi+ pct.wetlands + doc + prcp.normal,
#                      data=modvars.accndvi, controls=cforest_control(ntree=50000,mincriterion = 0.9))
# predcoh.lt<-predict(cforest.lt, newdata=modvars.accndvi)
# # hist(predcoh.lt)
# # hist(modvars.accndvi$accndvicoh.ts2)
# plot(predcoh.lt, modvars.accndvi$accndvicoh.ts2, xlab="predicted", ylab="empirical", main="Coherence,
#      xlim=c(0,1), ylim=c(0,1))
# abline(a=0,b=1)
# cor.test(predcoh.lt,modvars.accndvi$accndvicoh.ts2)
# varimp.coh.lt<-varimp(cforest.lt)
# print(varimp.coh.lt[order(varimp.coh.lt, decreasing=T)])
#
#
# #pdp.wetlands.coh.lt<-partial(cforest.lt, pred.var="pct.wetlands", train=modvars.accndvi, type="regre
#
```