

First Analyses for Isotopes February '18

Joan

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R Markdown

This R Markdown document evaluates stable isotopes from sugar pine needles collected in August, 2017

First look at data

```
library(ggplot2)
##read in data
isotopes = read.csv("2018_IsotopeData.csv", header = T)

head(isotopes)

##   SampleID TreeName Year Treatment Pair      Batch PerN mgNcapsule
## 1 SB1_2017      SB1 2017          N    1 NCS_171212a 1.07         88
## 2 SB1_2016      SB1 2016          N    1 NCS_171212a 1.28        106
## 3 SB1_2015      SB1 2015          N    1 NCS_171212a 1.22        100
## 4 SB1_2014      SB1 2014          N    1 NCS_171212a 1.23        104
## 5 SB1_2013      SB1 2013          N    1 NCS_171212a 1.17         95
## 6 SB1_2012      SB1 2012          N    1 NCS_171212a 0.84         69
##   d15Npermil  PerC mgCcapsule d13Cpermil PerS mgScapsule d34Spermil
## 1      -2.39 48.61         4.00     -29.02 0.13          9      8.04
## 2      -3.40 51.02         4.22     -29.30 0.13         10      6.06
## 3      -3.36 51.58         4.23     -29.26 0.13         10      5.79
## 4      -3.47 51.26         4.33     -29.03 0.12         10      5.66
## 5      -3.66 51.11         4.16     -29.17 0.12          8      4.78
## 6      -3.28 50.56         4.13     -29.05 0.12          7      4.47

names(isotopes)[1:15]=tolower(names(isotopes[1:15]))

summary(lm(d13cpermil~year+treatment, data=isotopes))

##
## Call:
## lm(formula = d13cpermil ~ year + treatment, data = isotopes)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.69252 -0.70648 -0.05875  0.76502  2.03104
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -341.83812   107.74539   -3.173  0.001876 **
## year           0.15602    0.05348    2.917  0.004148 **
## treatmentN    -0.62754    0.18212   -3.446  0.000762 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.061 on 133 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.1348, Adjusted R-squared:  0.1218
## F-statistic: 10.36 on 2 and 133 DF,  p-value: 6.566e-05
```

```
summary(lm(d15npermil~year+treatment, data=isotopes))
```

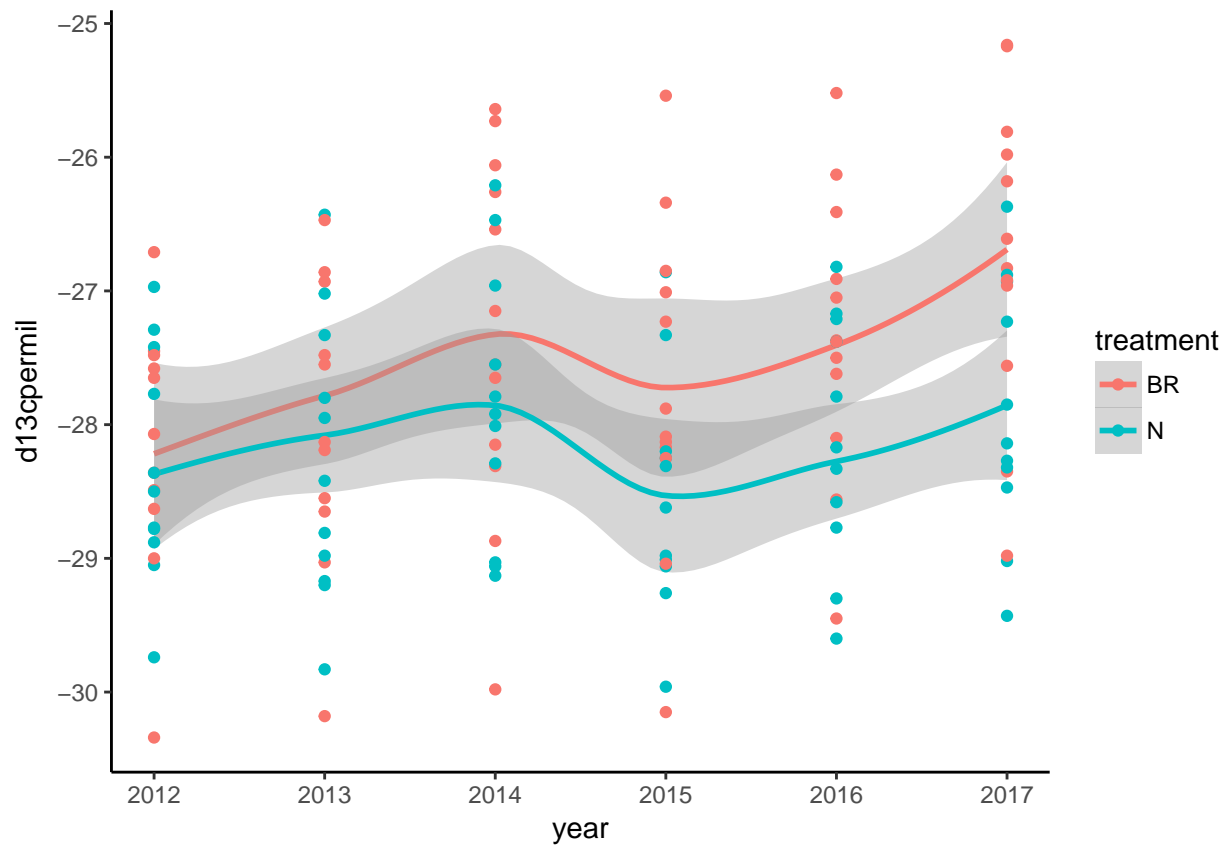
```
##
## Call:
## lm(formula = d15npermil ~ year + treatment, data = isotopes)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.5408 -0.9522 -0.2441  0.7018  2.8680
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -344.23208   138.39426   -2.487   0.0141 *
## year          0.16875     0.06870    2.457   0.0153 *
## treatmentN   -0.08544     0.23392   -0.365   0.7155
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.363 on 133 degrees of freedom
## (2 observations deleted due to missingness)
## Multiple R-squared:  0.04454,    Adjusted R-squared:  0.03017
## F-statistic:   3.1 on 2 and 133 DF,  p-value: 0.04833
```

```
ggplot(isotopes, aes(year, d13cpermil, color=treatment))+
  geom_smooth()+
  geom_point()+
  theme_classic()
```

```
## `geom_smooth()` using method = 'loess'
```

```
## Warning: Removed 2 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 2 rows containing missing values (geom_point).
```

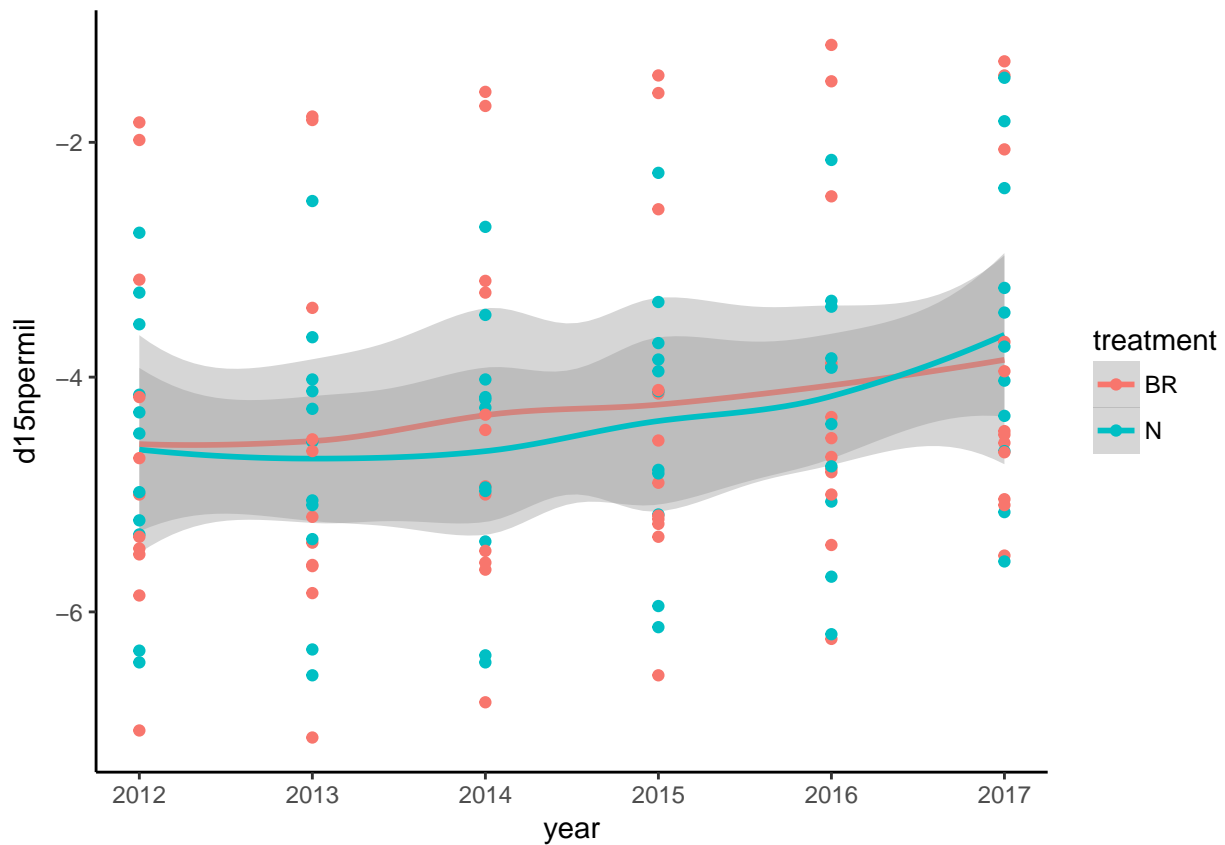


```
ggplot(isotopes, aes(year, d15npermil, color=treatment))+
  geom_smooth()+
  geom_point()+
  theme_classic()
```

```
## `geom_smooth()` using method = 'loess'
```

```
## Warning: Removed 2 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 2 rows containing missing values (geom_point).
```



```
ggplot(isotopes, aes(year, d34spermil, color=treatment))+
  geom_smooth()+
  geom_point()+
  theme_classic()
```

```
## `geom_smooth()` using method = 'loess'
```

```
## Warning: Removed 132 rows containing non-finite values (stat_smooth).
```

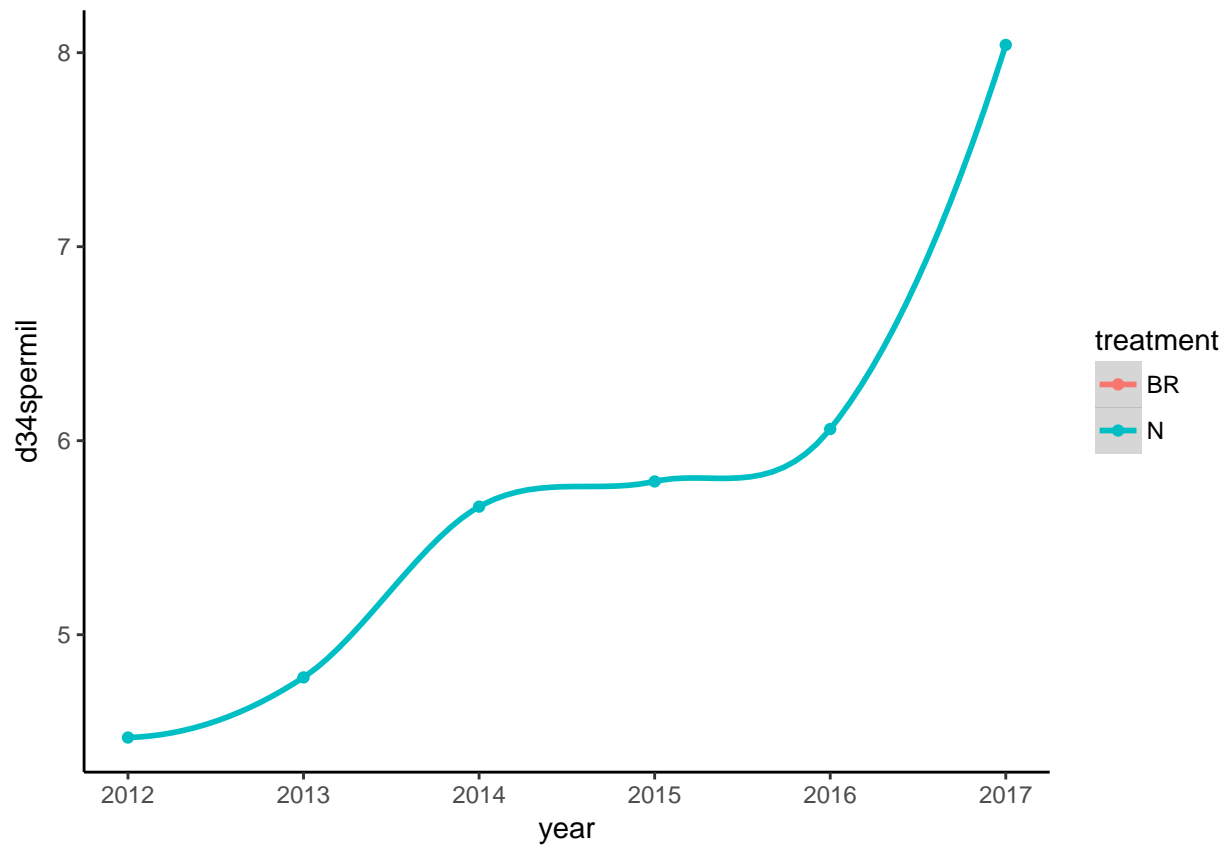
```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : Chernobyl! trL>n 6
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =
## parametric, : Chernobyl! trL>n 6
```

```
## Warning in sqrt(sum.squares/one.delta): NaNs produced
```

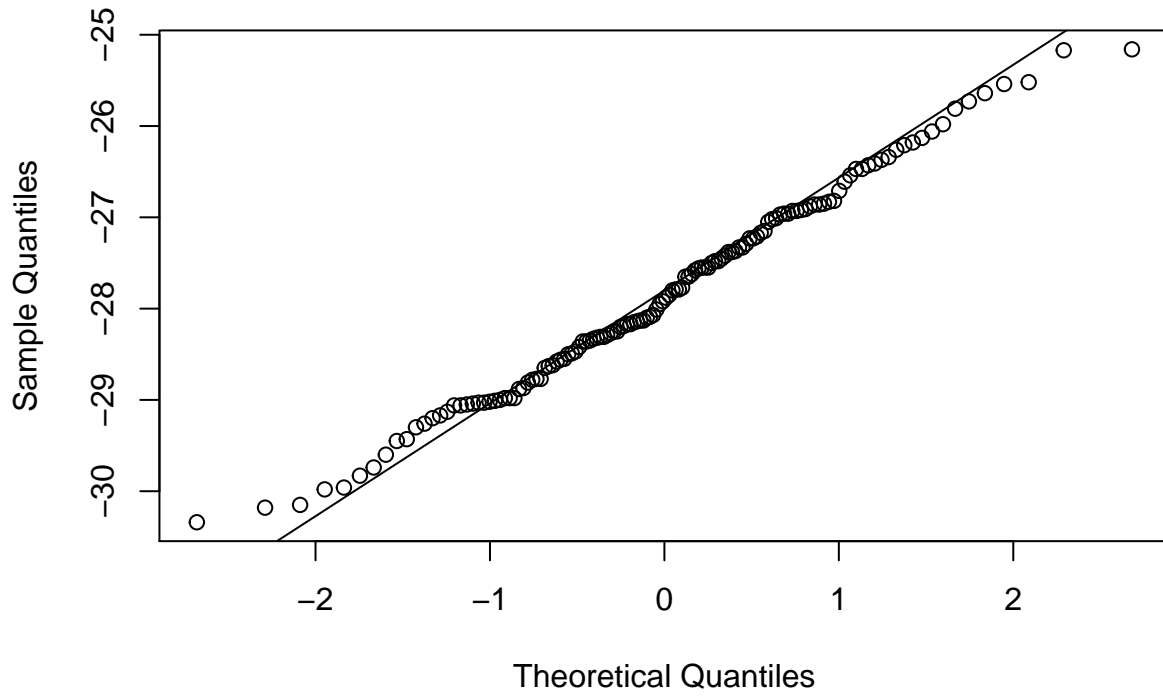
```
## Warning in stats::qt(level/2 + 0.5, pred$df): NaNs produced
```

```
## Warning: Removed 132 rows containing missing values (geom_point).
```



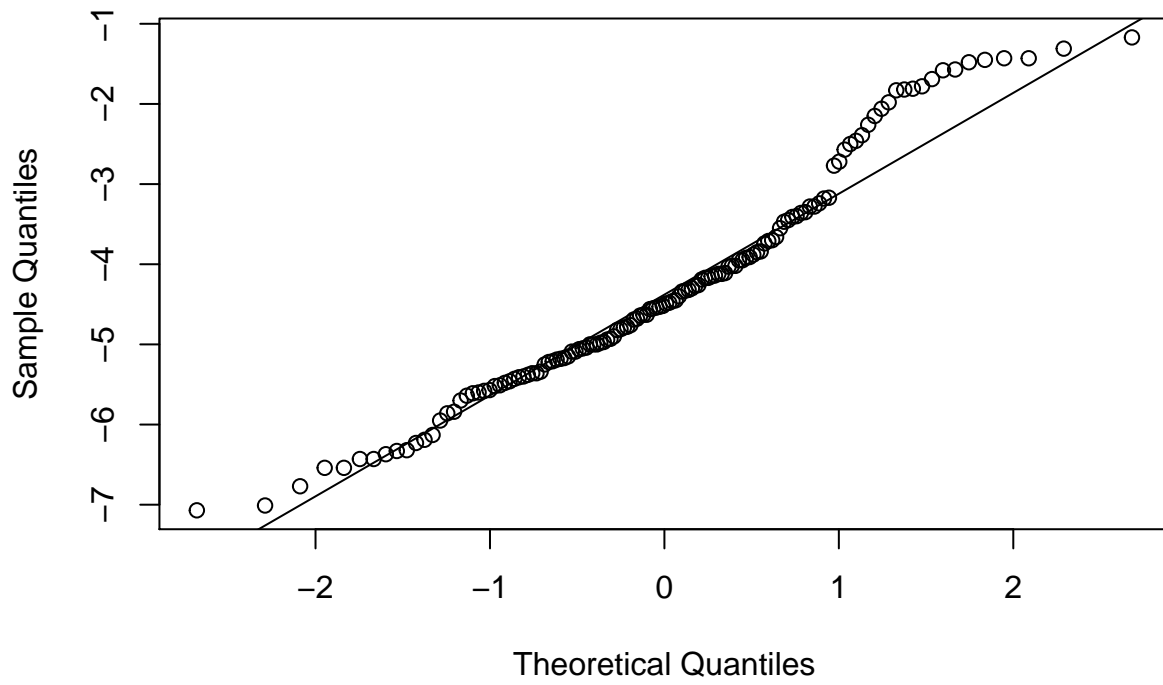
```
#c data normal? - yes!  
qqnorm(isotopes$d13cpermil)  
qqline(isotopes$d13cpermil)
```

Normal Q-Q Plot



```
#n data normal? - pretty good  
qqnorm(isotopes$d15npermil)  
qqline(isotopes$d15npermil)
```

Normal Q-Q Plot



```

##are the independent variables (year+treatment) multicollinear?
summary(lm(year~treatment, data=isotopes)) ## nope

##
## Call:
## lm(formula = year ~ treatment, data = isotopes)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
##     -2.5     -1.5      0.0      1.5      2.5
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.014e+03  2.027e-01   9936  <2e-16 ***
## treatmentN  -2.600e-14  2.932e-01      0      1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.72 on 136 degrees of freedom
## Multiple R-squared:  6.294e-27, Adjusted R-squared:  -0.007353
## F-statistic: 8.56e-25 on 1 and 136 DF,  p-value: 1
##DEALING WITH PAIRED, REPEATED MEASURES
##violation=non-independent variables - we sampled the same individual for six years

##since these are repeat measures (one individual for 6 years) so we use a Two-Way ANOVA with Repeated Measures
##and add an error term, which controls for the between-pair variation
##We can also control for autocorrelation adding in year as an independent variable into the anova

summary(lm(d13cpmil~year+treatment, data=isotopes))

##
## Call:
## lm(formula = d13cpmil ~ year + treatment, data = isotopes)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.69252 -0.70648 -0.05875  0.76502  2.03104
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -341.83812   107.74539   -3.173  0.001876 **
## year          0.15602    0.05348    2.917  0.004148 **
## treatmentN   -0.62754    0.18212   -3.446  0.000762 ***
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summary(aov(d13cpmil~year+treatment+Error(pair/(year+treatment)), data=isotopes))

```

```
##
## Error: pair
##      Df Sum Sq Mean Sq
## year  1  10.72   10.72
##
## Error: pair:year
##      Df Sum Sq Mean Sq
## year  1  0.5826   0.5826
##
## Error: pair:treatment
##      Df Sum Sq Mean Sq
## year  1  0.7957   0.7957
##
## Error: Within
##      Df Sum Sq Mean Sq F value    Pr(>F)
## year      1    9.96    9.957    9.579 0.002410 **
## treatment  1   15.98   15.984   15.378 0.000142 ***
## Residuals 130 135.12    1.039
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(aov(d13cpmil~year+treatment, data=isotopes))
```

```
##      Df Sum Sq Mean Sq F value    Pr(>F)
## year      1    9.97    9.972    8.853 0.003476 **
## treatment  1   13.37   13.374   11.874 0.000762 ***
## Residuals 133 149.81    1.126
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 2 observations deleted due to missingness
```

```
summary(lm(d15npermil~year+treatment, data=isotopes))
```

```
##
## Call:
## lm(formula = d15npermil ~ year + treatment, data = isotopes)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.5408 -0.9522 -0.2441  0.7018  2.8680
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## Coefficients:
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## (Intercept) -344.23208   138.39426  -2.487   0.0141 *
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## F-statistic:  3.1 on 2 and 133 DF,  p-value: 0.04833
```

```
summary(aov(d15npermil~year+treatment+Error(pair/(year+treatment)), data=isotopes))
```



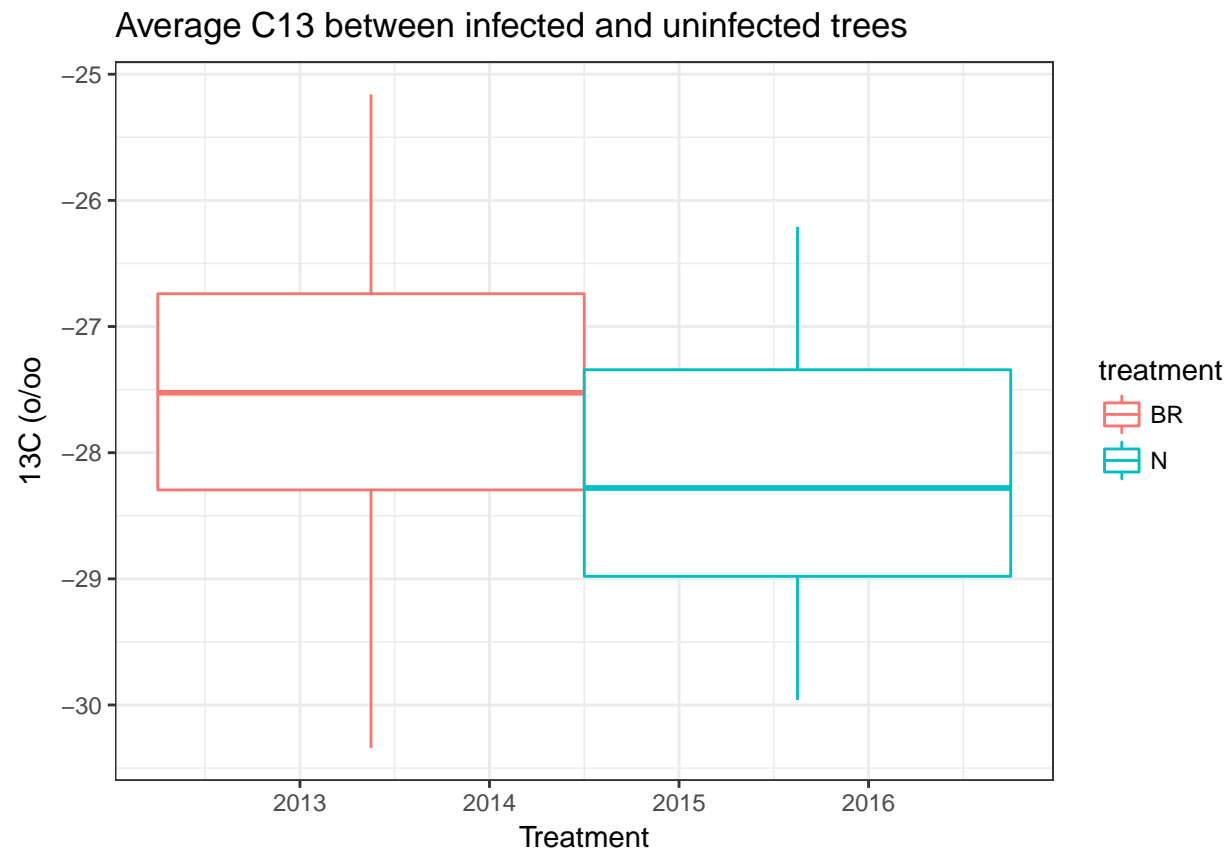
```
##
## Error: pair
##      Df Sum Sq Mean Sq
## year  1  12.47   12.47
##
## Error: pair:year
##      Df Sum Sq Mean Sq
## year  1   2.759   2.759
##
## Error: pair:treatment
##      Df Sum Sq Mean Sq
## year  1  13.54   13.54
##
## Error: Within
##      Df Sum Sq Mean Sq F value Pr(>F)
## year      1   8.22   8.215   5.003 0.0270 *
## treatment  1   8.20   8.199   4.993 0.0272 *
## Residuals 130 213.49   1.642
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

summary(aov(d15npermil~year+treatment, data=isotopes))

##      Df Sum Sq Mean Sq F value Pr(>F)
## year      1  11.27   11.273   6.066 0.0151 *
## treatment  1   0.25   0.248   0.133 0.7155
## Residuals 133 247.16   1.858
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 2 observations deleted due to missingness

##boxplots
ggplot(isotopes, aes(x=year, y=d13cpermil, color=treatment))+
  geom_boxplot(position = "dodge")+
  labs(title="Average C13 between infected and uninfected trees", x="Treatment", y="13C (o/oo")+
  theme_bw()

## Warning: Removed 2 rows containing non-finite values (stat_boxplot).
```



```
ggplot(isotopes, aes(x=year, y=d15npermil, color=treatment))+
  geom_boxplot(position = "dodge")+
  labs(title="Average N between infected and uninfected trees", x="Treatment", y="N (o/oo) ") +
  theme_bw()
```

Warning: Removed 2 rows containing non-finite values (stat_boxplot).

