Comparison of treatments - CH4, NH3, CO2

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Purpose

Compare different slurry handling systems in terms of methane emission.

Prep

```
rm(list = ls())

source('../functions/rbindf.R')
source('../functions/dfcombos.R')
source('../functions/ggsave2x.R')

library('DescTools')
library('dplyr')
```

```
##
## Vedhæfter pakke: 'dplyr'

## De følgende objekter er maskerede fra 'package:stats':
##
##     filter, lag

## De følgende objekter er maskerede fra 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library('tidyr')
library('readxl')
library('multcomp')
```

```
## Indlæser krævet pakke: mvtnorm

## Indlæser krævet pakke: survival

## Indlæser krævet pakke: TH.data
```

```
## Indlæser krævet pakke: MASS

##
## Vedhæfter pakke: 'MASS'

## Det følgende objekt er maskeret fra 'package:dplyr':
##
##     select

##
## Vedhæfter pakke: 'TH.data'

## Det følgende objekt er maskeret fra 'package:MASS':
##
##     geyser
```

```
library('ggplot2')
library('FSA')
```

Measurement data

Get stacked data with high-resolution measurements. Calculate mean emission rate by period.

```
dat <- read.csv('../data/dat_stacked.csv')

emis_dat <- summarise(group_by(dat, period, treatment),
                      mean_CH4_barn = mean(CH4_rate/pigs, na.rm = T),
                      mean_CH4_slurry = mean(CH4_emis_rate/pigs, na.rm = T),
                      mean_NH3_barn = mean(NH3_emis_rate/pigs, na.rm = T),
                      mean_CO2_barn = mean(CO2E, na.rm = T),
                      mean_CO2_slurry = mean(CO2_emis_rate, na.rm = T))
```

```
## `summarise()` has grouped output by 'period'. You can override using the `.groups` argument.
```

```
emis_dat$treatment <- factor(emis_dat$treatment)
```

Analysis

Loop through all variables, fit models, print results. Crude and a lot of pages. . .

```
for (y in c('mean_CH4_barn', 'mean_CH4_slurry', 'mean_NH3_barn', 'mean_CO2_barn', 'mean_CO2_slurry')) {
  cat('\n')
  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('\n')

  emis_dat$y <- emis_dat[, y, drop = TRUE]
```

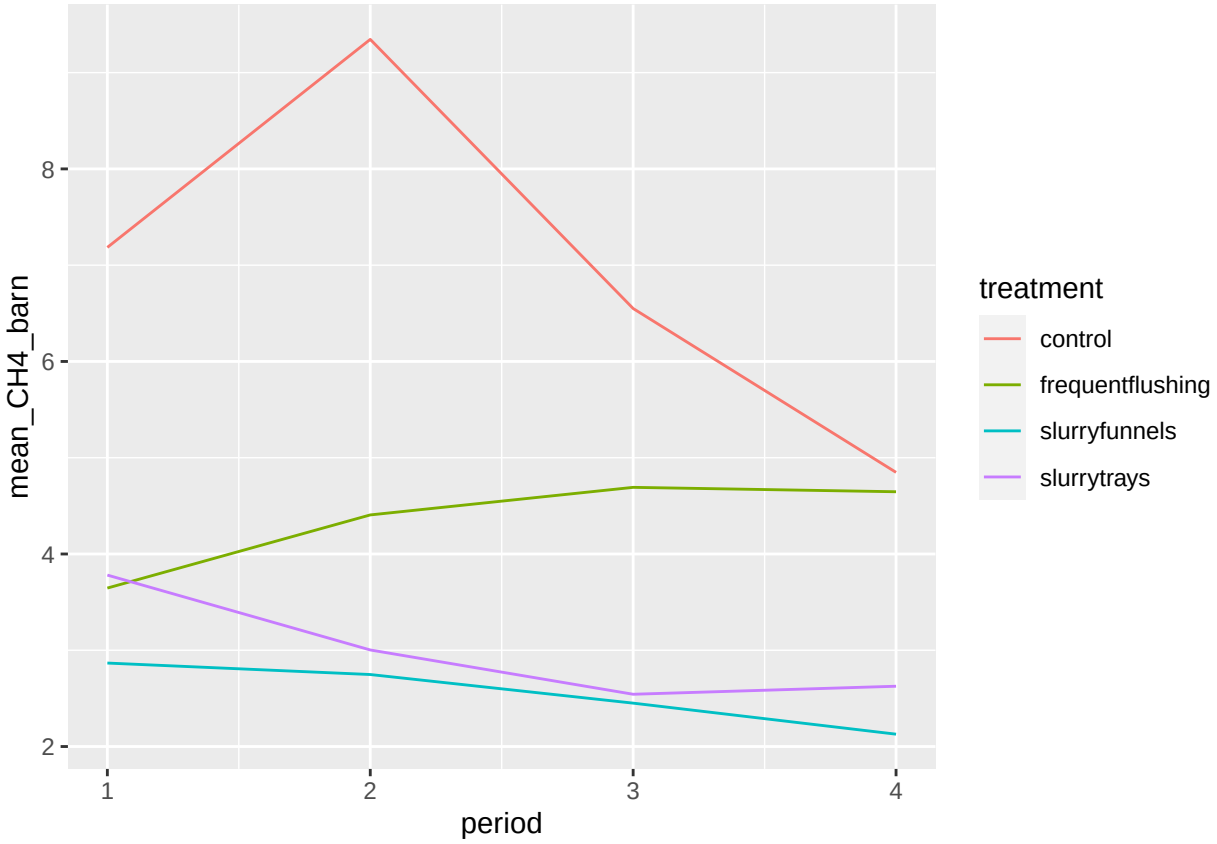
```r
p1 <- ggplot(emis_dat, aes(period, y, colour = treatment)) +
  geom_line() +
  labs(y = y)

p2 <- ggplot(emis_dat, aes(treatment, y)) +
  geom_boxplot()

print(p1)
print(p2)

m1 <- aov(y ~ factor(period) + treatment, data = emis_dat)
d1 <- glht(m1, linfct = mcp(treatment = "Dunnett"))

m2 <- aov(log10(y) ~ factor(period) + treatment, data = emis_dat)
d2 <- glht(m2, linfct = mcp(treatment = "Dunnett"))

m3 <- aov(log10(y) ~ treatment, data = emis_dat)
d3 <- glht(m3, linfct = mcp(treatment = "Dunnett"))

cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Non-transformed aov summary:\n')
print(summary(m1))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Non-transformed lm summary:\n')
print(summary.lm(m1))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Non-transformed Dunnett s test:\n')
print(summary(d1))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Non-transformed confidence intervals:\n')
print(confint(m1))

cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed aov summary:\n')
print(summary(m2))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed lm summary:\n')
print(summary.lm(m2))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed Dunnetts test:\n')
print(summary(d2))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed confidence intervals:\n')
print(100 * (10^confint(m2) - 1))

cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed aov summary without period:\n')
print(summary(m3))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed lm summary without period:\n')
print(summary.lm(m3))
cat('\n', rep(c(y, '\n'), 4), '\n')
cat('Transformed Dunnetts test without period:\n')
```

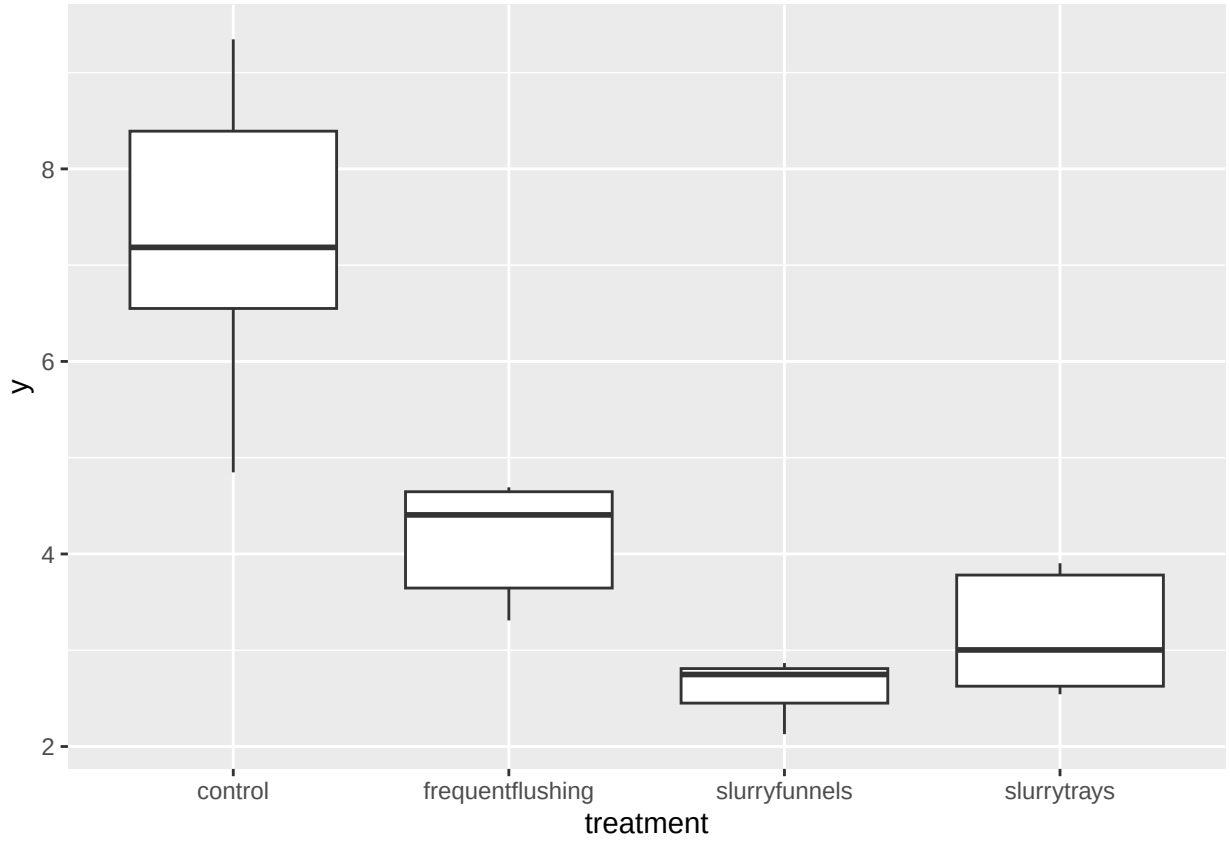
```
  print(summary(d3))
  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Transformed confidence intervals without period:\n')
  print(100 * (10^confint(m3) - 1))

  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Transformed relative reduction (coef):\n')
  print(round(100 * (10^coef(m2)[-1:-2] - 1), 1))

  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Transformed relative reduction without period (coef):\n')
  print(round(100 * (10^coef(m3)[-1] - 1), 1))

  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Non-transformed diagnostic plots:\n')
  plot(m1, ask = FALSE)

  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Transformed diagnostic plots:\n')
  plot(m2, ask = FALSE)

  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('Transformed diagnostic plots without period:\n')
  plot(m3, ask = FALSE)


  cat('\n', rep(c(y, '\n'), 4), '\n')
  cat('\n\n')
  cat('\n', rep(paste('end', y), 3), '\n')
  cat('\n', rep(paste('end', y), 3), '\n')
  cat('\n', rep(paste('end', y), 3), '\n')
  cat('\n')

}
```

```
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
```

```
##
```

```
## Warning: Removed 4 rows containing missing values (‘geom_line()‘).
```






```
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Non-transformed aov summary:
##                Df Sum Sq Mean Sq F value   Pr(>F)
## factor(period)  3   3.64   1.214   1.254 0.346848
## treatment       3  47.83  15.943  16.465 0.000536 ***
## Residuals       9   8.71   0.968
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Non-transformed lm summary:
##
## Call:
## aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
```

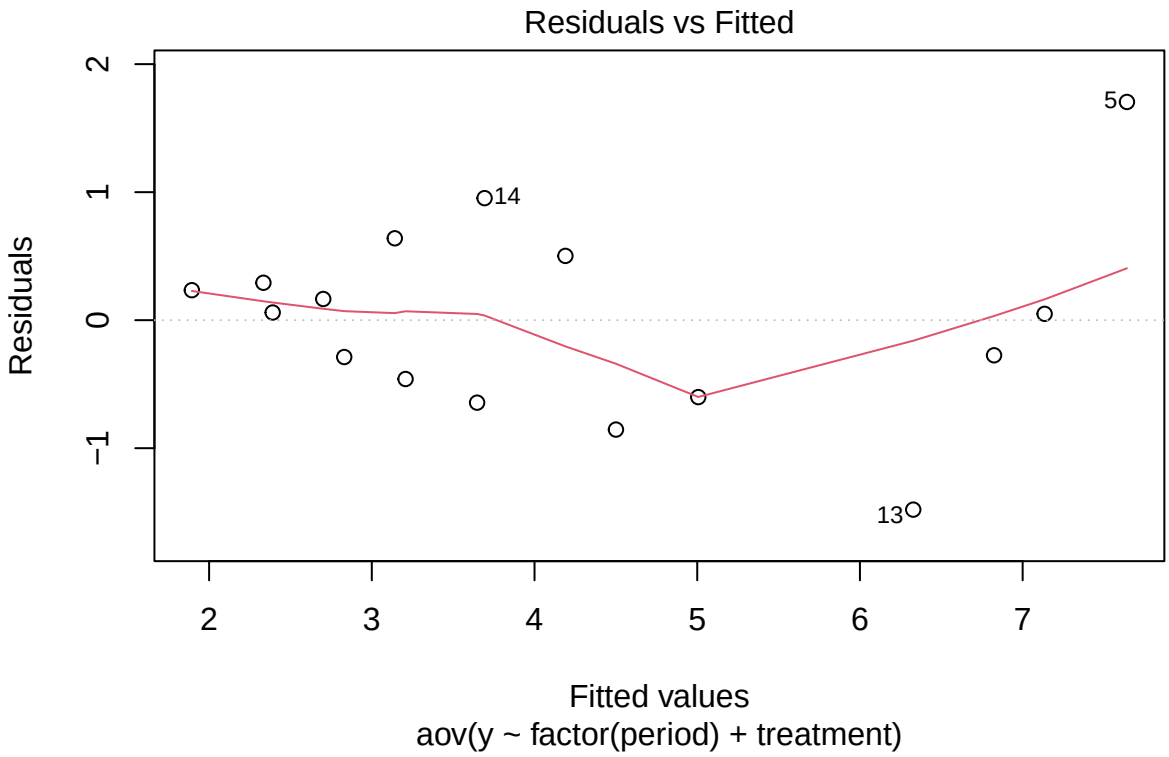
```
##      Min       1Q   Median       3Q      Max
## -1.47980 -0.49486  0.05473  0.34478  1.70454
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 7.1351     0.6509  10.963 1.66e-06 ***
## factor(period)2             0.5059     0.6958   0.727 0.485635
## factor(period)3            -0.3107     0.6958  -0.447 0.665718
## factor(period)4            -0.8075     0.6958  -1.161 0.275692
## treatmentfrequentflushing  -2.6345     0.6958  -3.786 0.004307 **
## treatmentslurryfunnels     -4.4337     0.6958  -6.372 0.000129 ***
## treatmentslurrytrays       -3.9939     0.6958  -5.740 0.000280 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.984 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.8552, Adjusted R-squared:  0.7587
## F-statistic:  8.86 on 6 and 9 DF,  p-value: 0.002325
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Non-transformed Dunnett s test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  -2.6345     0.6958  -3.786   0.0108 *
## slurryfunnels - control == 0     -4.4337     0.6958  -6.372   <0.001 ***
## slurrytrays - control == 0       -3.9939     0.6958  -5.740   <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Non-transformed confidence intervals:
##                                2.5 %     97.5 %
## (Intercept)                5.662801  8.6074933
## factor(period)2           -1.068075  2.0799333
```

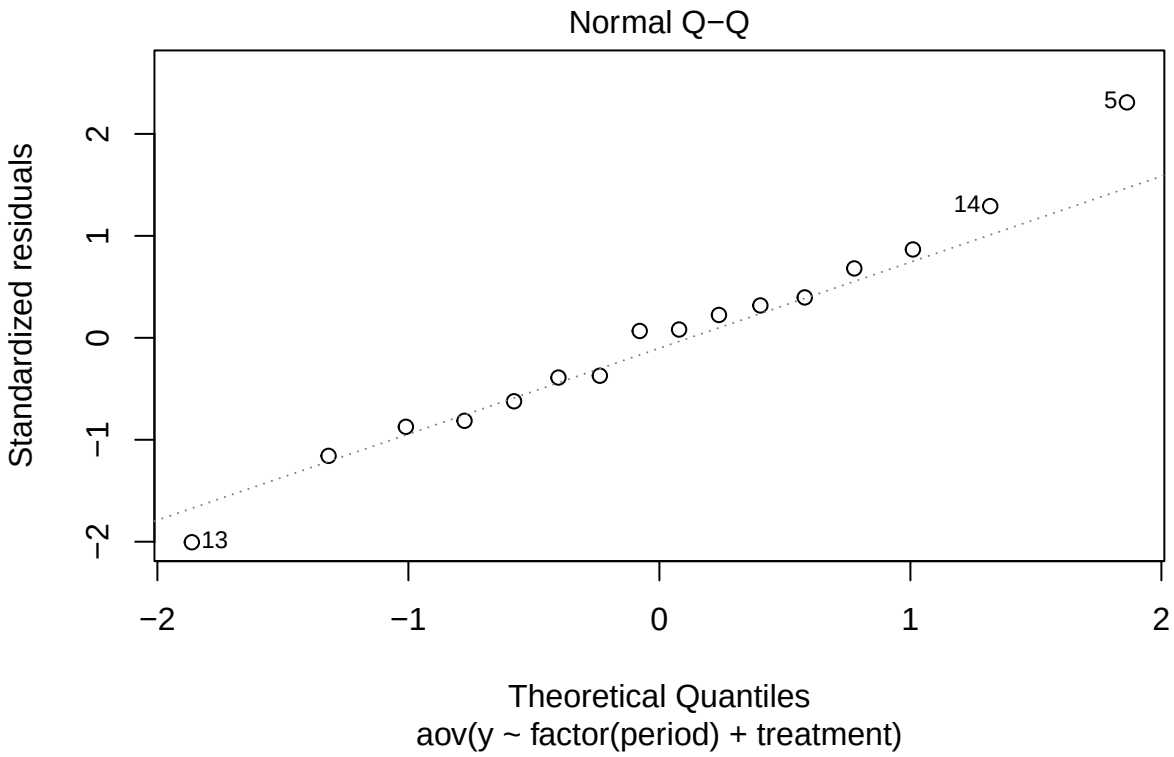
```
## factor(period)3           -1.884746  1.2632625
## factor(period)4           -2.381496  0.7665122
## treatmentfrequentflushing -4.208553 -1.0605448
## treatmentslurryfunnels    -6.007728 -2.8597196
## treatmentslurrytrays      -5.567873 -2.4198645
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed aov summary:
##                Df Sum Sq Mean Sq F value   Pr(>F)
## factor(period)  3 0.0276 0.00919   1.649    0.246
## treatment       3 0.4397 0.14657  26.295 8.71e-05 ***
## Residuals       9 0.0502 0.00557
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed lm summary:
##
## Call:
## aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.102154 -0.039526 -0.002392  0.032105  0.091454
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 0.86010    0.04938  17.417 3.06e-08 ***
## factor(period)2             0.01949    0.05279   0.369  0.72057
## factor(period)3            -0.04276    0.05279  -0.810  0.43886
## factor(period)4            -0.08831    0.05279  -1.673  0.12869
## treatmentfrequentflushing -0.19613    0.05279  -3.715  0.00481 **
## treatmentslurryfunnels    -0.42879    0.05279  -8.122 1.96e-05 ***
## treatmentslurrytrays      -0.36226    0.05279  -6.862 7.37e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.07466 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.9031, Adjusted R-squared:  0.8384
## F-statistic: 13.97 on 6 and 9 DF,  p-value: 0.0004169
##
##
##  mean_CH4_barn
##  mean_CH4_barn
```

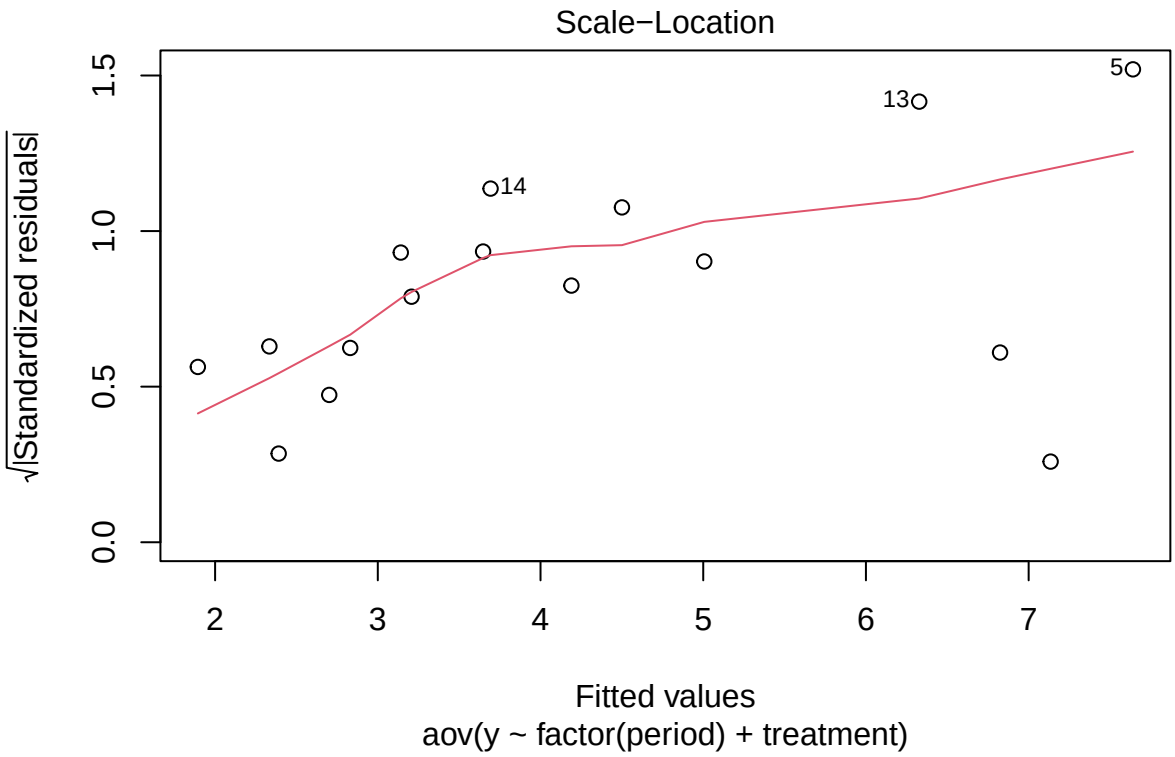
```
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed Dunnetts test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0 -0.19613    0.05279  -3.715   0.0127 *
## slurryfunnels - control == 0    -0.42879    0.05279  -8.122   <0.001 ***
## slurrytrays - control == 0      -0.36226    0.05279  -6.862   <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed confidence intervals:
##                                 2.5 %     97.5 %
## (Intercept)                460.25781 837.156194
## factor(period)2            -20.55591  37.693033
## factor(period)3            -31.16405  19.306934
## factor(period)4            -38.01840   7.426925
## treatmentfrequentflushing -51.64433 -16.189624
## treatmentslurryfunnels    -71.69999 -50.950230
## treatmentslurrytrays      -67.01512 -42.830377
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed aov summary without period:
##             Df Sum Sq Mean Sq F value  Pr(>F)
## treatment    3 0.5453  0.1818   26.75 1.8e-06 ***
## Residuals   16 0.1087  0.0068
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
```

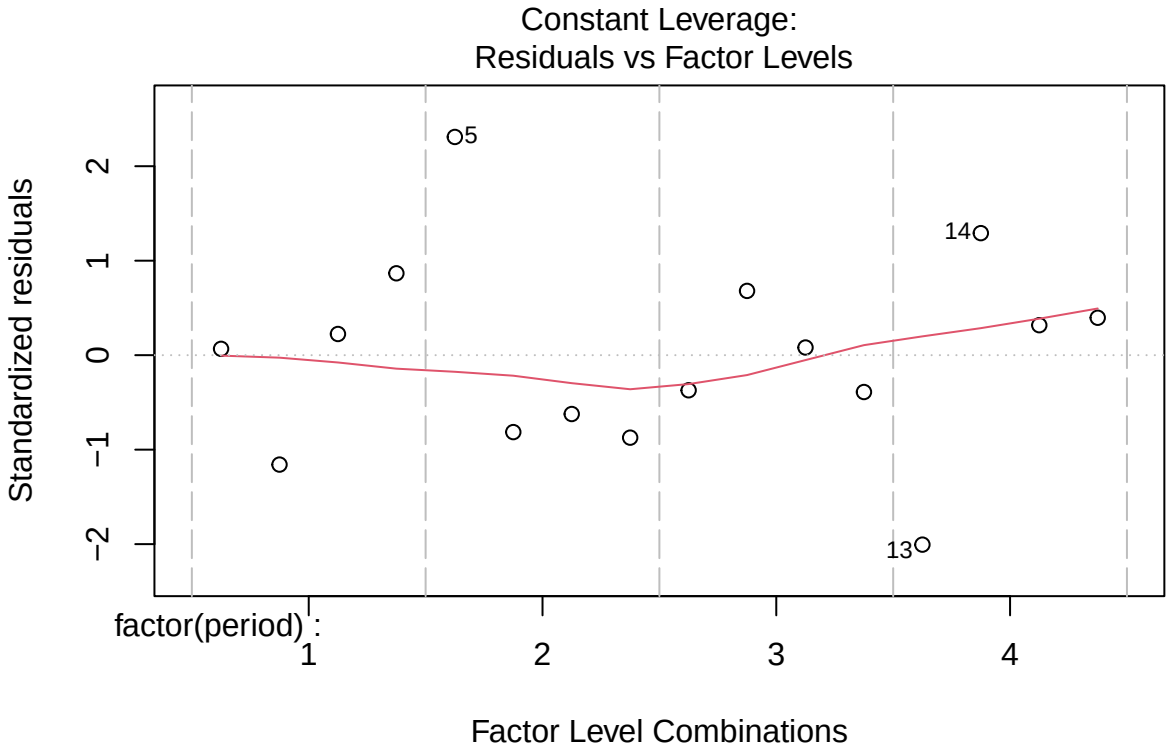
```
## Transformed lm summary without period:
##
## Call:
## aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.16498 -0.05698  0.01621  0.05536  0.12008
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 0.85053    0.03687  23.071 1.05e-13 ***
## treatmentfrequentflushing -0.23772    0.05214  -4.559 0.000322 ***
## treatmentslurryfunnels    -0.43808    0.05214  -8.403 2.92e-07 ***
## treatmentslurrytrays      -0.35629    0.05214  -6.834 4.02e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08244 on 16 degrees of freedom
## Multiple R-squared:  0.8338, Adjusted R-squared:  0.8026
## F-statistic: 26.75 on 3 and 16 DF,  p-value: 1.798e-06
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed Dunnetts test without period:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0 -0.23772    0.05214  -4.559   <0.001 ***
## slurryfunnels - control == 0    -0.43808    0.05214  -8.403   <0.001 ***
## slurrytrays - control == 0      -0.35629    0.05214  -6.834   <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed confidence intervals without period:
##                                2.5 %    97.5 %
```

```
## (Intercept)               492.07950 748.56706
## treatmentfrequentflushing -55.15044 -25.38803
## treatmentslurryfunnels    -71.72555 -52.96247
## treatmentslurrytrays      -65.86590 -43.21434
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed relative reduction (coef):
##           factor(period)3           factor(period)4 treatmentfrequentflushing    treatmentslurryfunne
##                      -9.4                     -18.4                      -36.3                      -6
##      treatmentslurrytrays
##                     -56.6
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed relative reduction without period (coef):
## treatmentfrequentflushing    treatmentslurryfunnels      treatmentslurrytrays
##                     -42.2                     -63.5                      -56.0
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Non-transformed diagnostic plots:
```

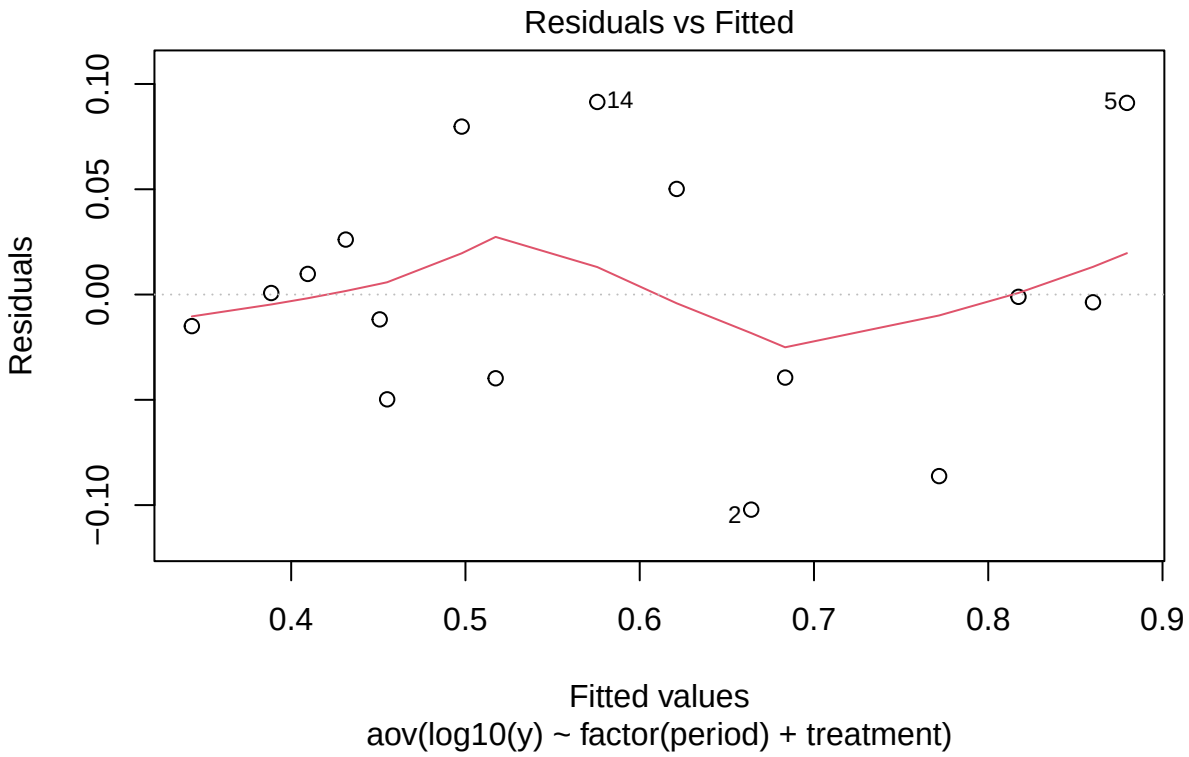

Residuals vs Fitted
Residuals
Fitted values
aov(y ~ factor(period) + treatment)
5
14
13

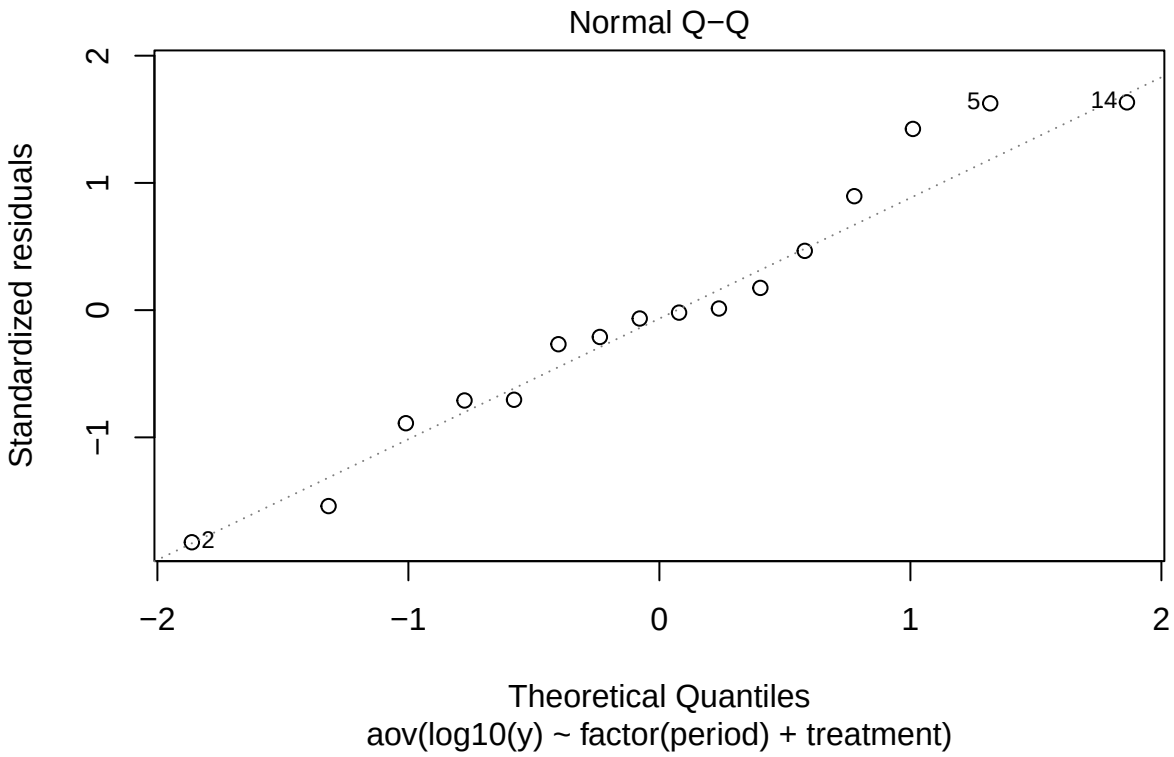

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(y ~ factor(period) + treatment)
5
14
13
−2
−1
0
1
2

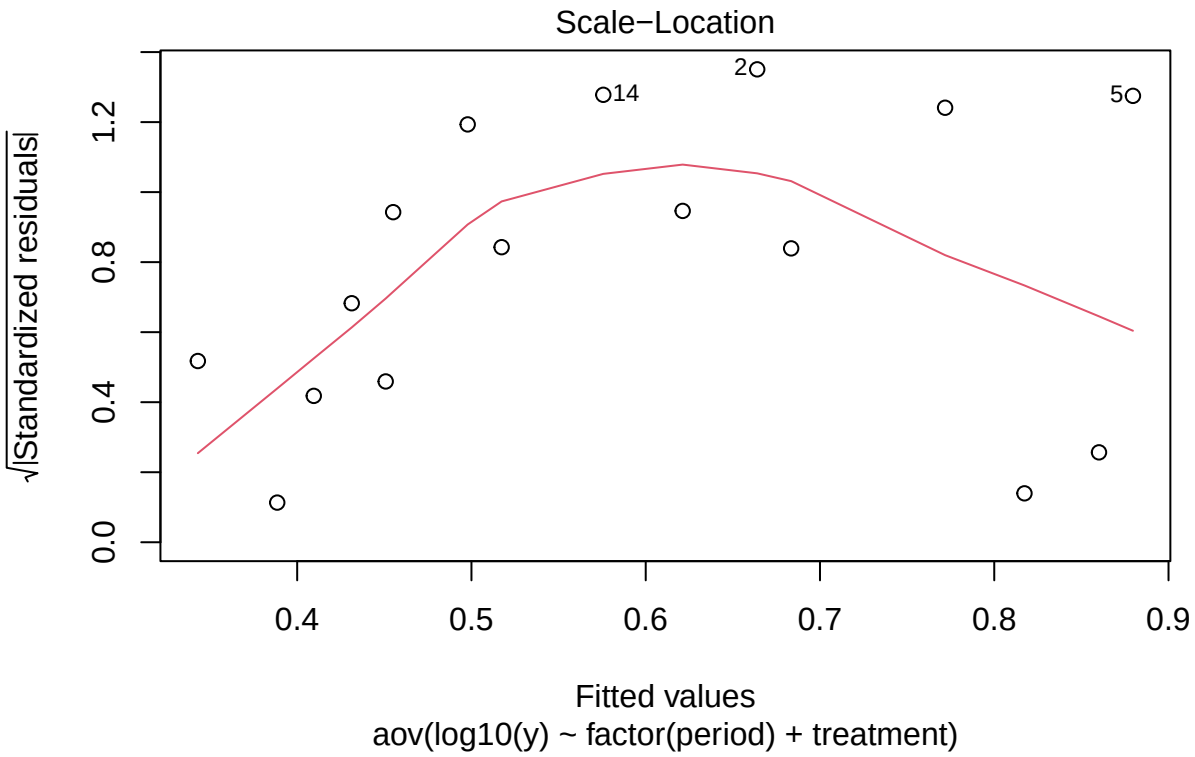

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
2
3
4
5
6
7
5
13
14
Fitted values
aov(y ~ factor(period) + treatment)

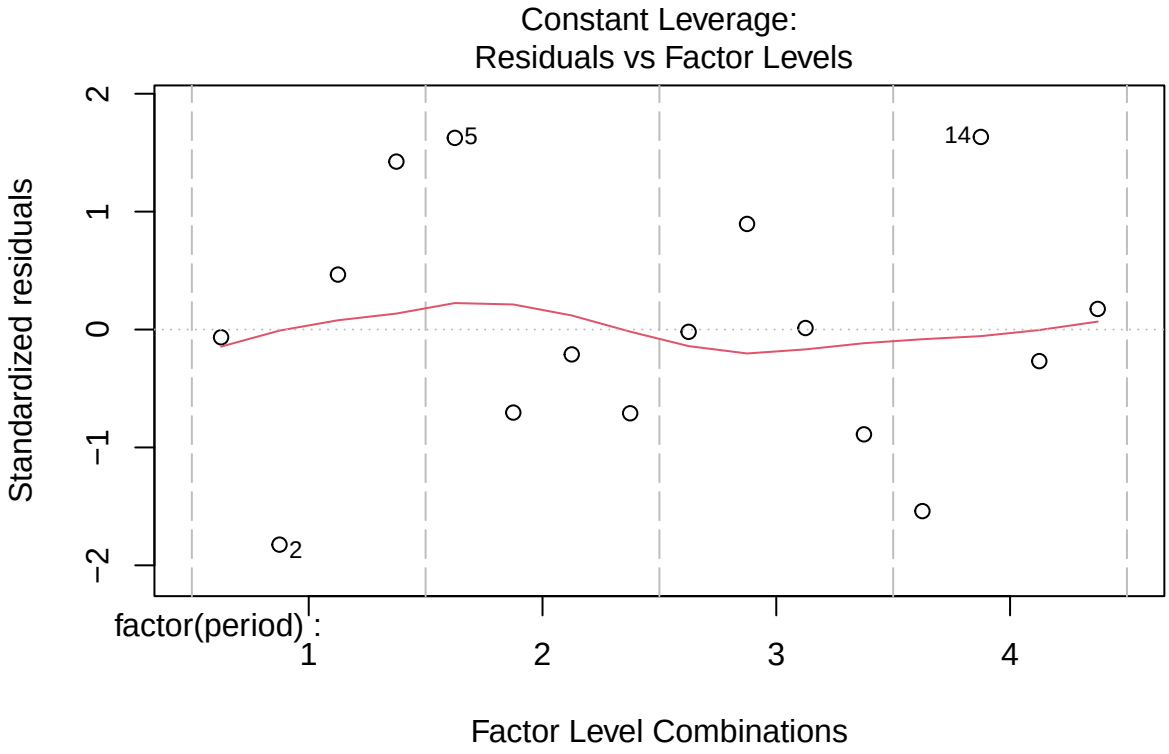



```
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed diagnostic plots:
```

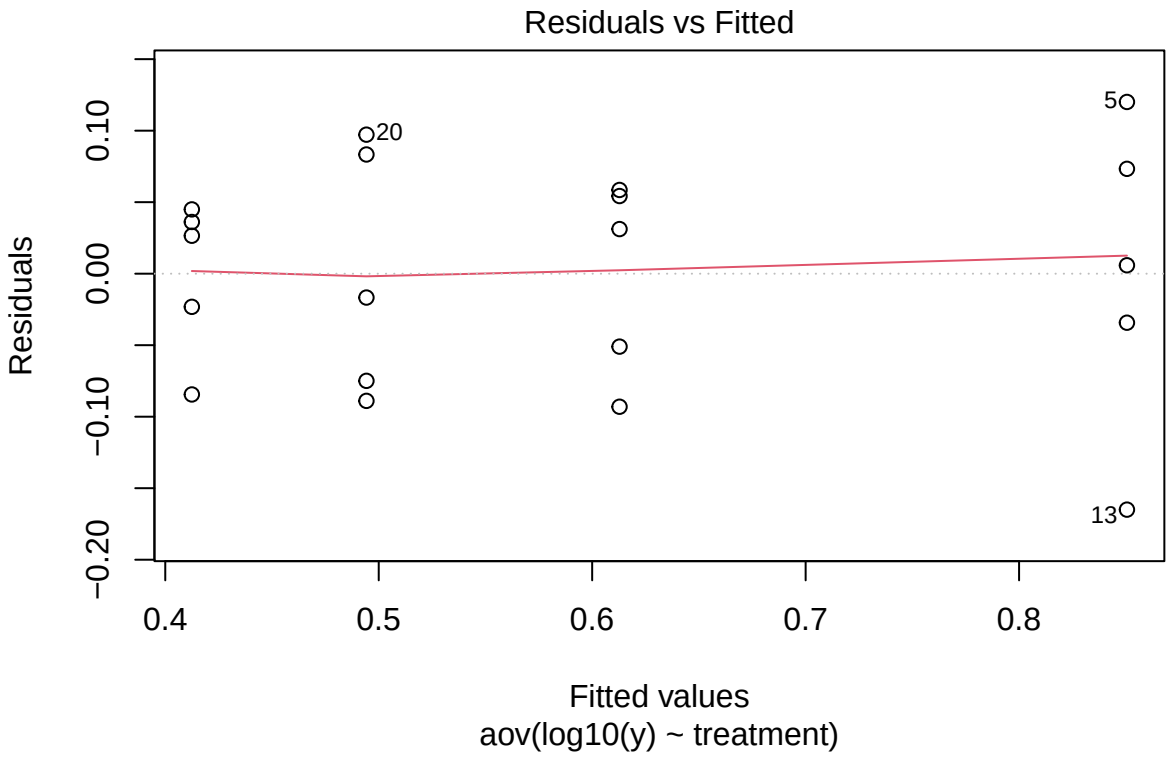

Residuals vs Fitted
Residuals
0.10
0.05
0.00
−0.10
14
5
2
0.4
0.5
0.6
0.7
0.8
0.9
Fitted values
aov(log10(y) ~ factor(period) + treatment)

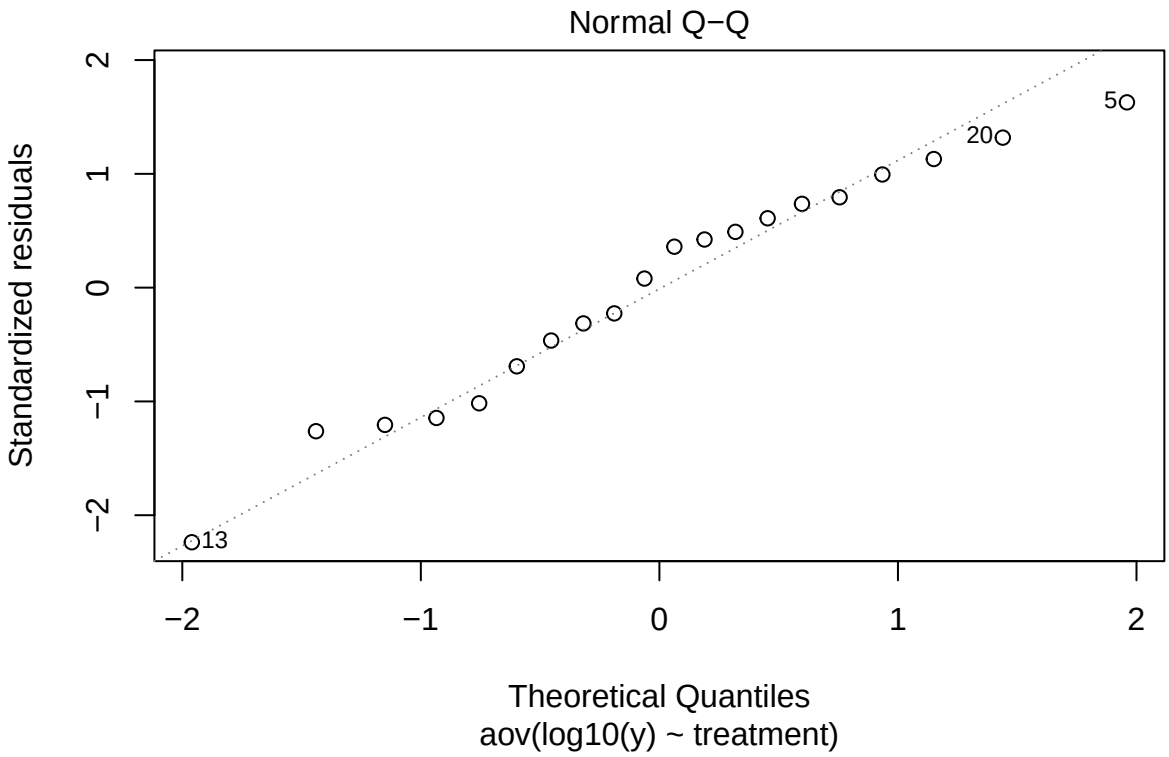

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ factor(period) + treatment)
2
5
14
−2
−1
0
1
2

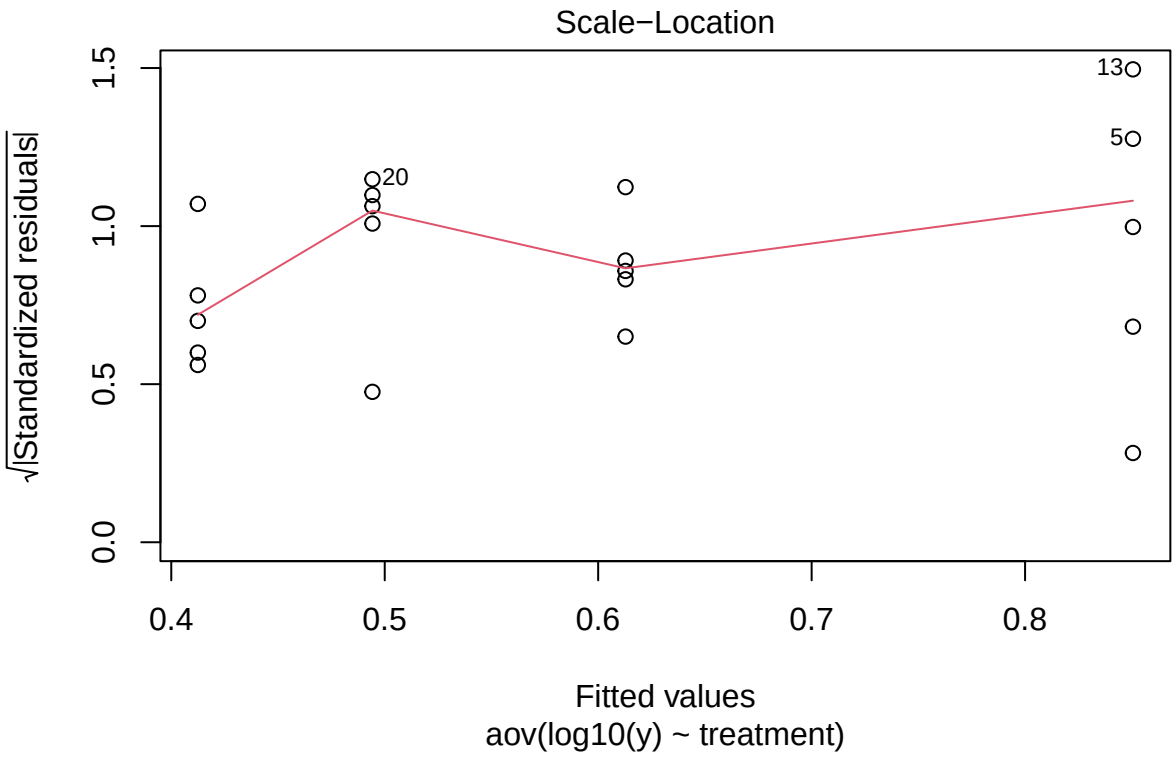

Scale−Location
√|Standardized residuals|
0.0
0.4
0.8
1.2
0.4
0.5
0.6
0.7
0.8
0.9
14
2
5
Fitted values
aov(log10(y) ~ factor(period) + treatment)

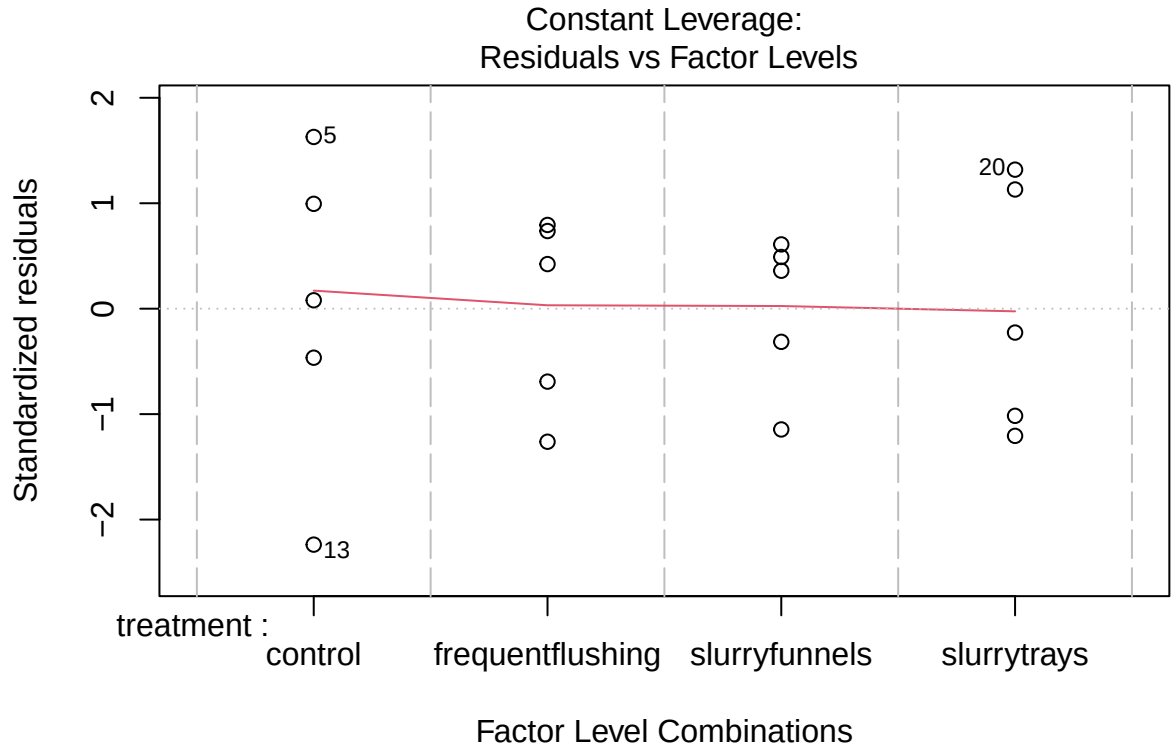



```
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
## Transformed diagnostic plots without period:
```


Residuals vs Fitted
Residuals
0.10
0.00
−0.10
−0.20
20
5
13
0.4
0.5
0.6
0.7
0.8
Fitted values
aov(log10(y) ~ treatment)


Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ treatment)
13
20
5
−2
−1
0
1
2

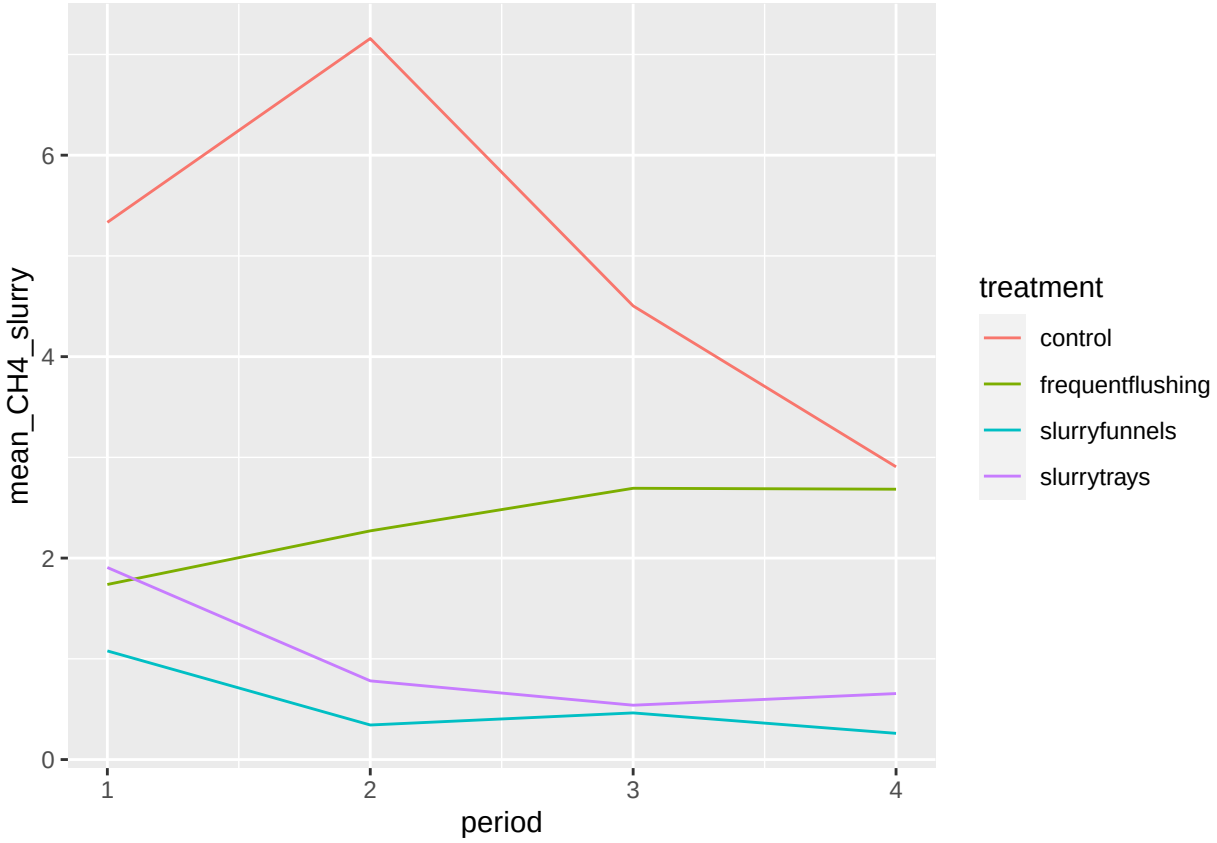

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
0.4
0.5
0.6
0.7
0.8
13
5
20
Fitted values
aov(log10(y) ~ treatment)

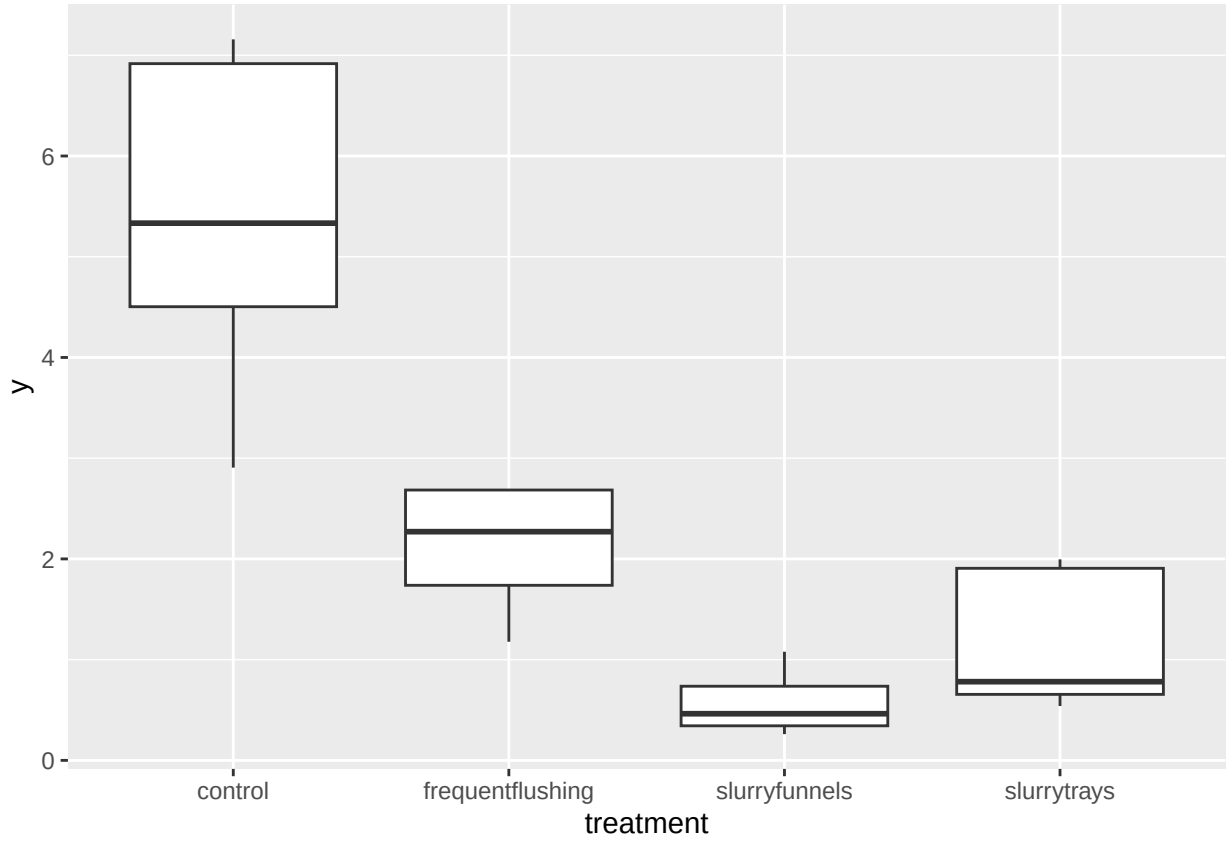



```
##
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##  mean_CH4_barn
##
##
##
##
##  end mean_CH4_barn end mean_CH4_barn end mean_CH4_barn
##
##  end mean_CH4_barn end mean_CH4_barn end mean_CH4_barn
##
##  end mean_CH4_barn end mean_CH4_barn end mean_CH4_barn
##
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
```

```
##  mean_CH4_slurry
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
```

```
## Warning: Removed 4 rows containing missing values (‘geom_line()‘).
```






```
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Non-transformed aov summary:
##                Df Sum Sq Mean Sq F value   Pr(>F)
## factor(period)  3   2.57   0.856   0.851 0.500103
## treatment       3  48.01  16.004  15.918 0.000608 ***
## Residuals       9   9.05   1.005
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Non-transformed lm summary:
##
## Call:
## aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
```

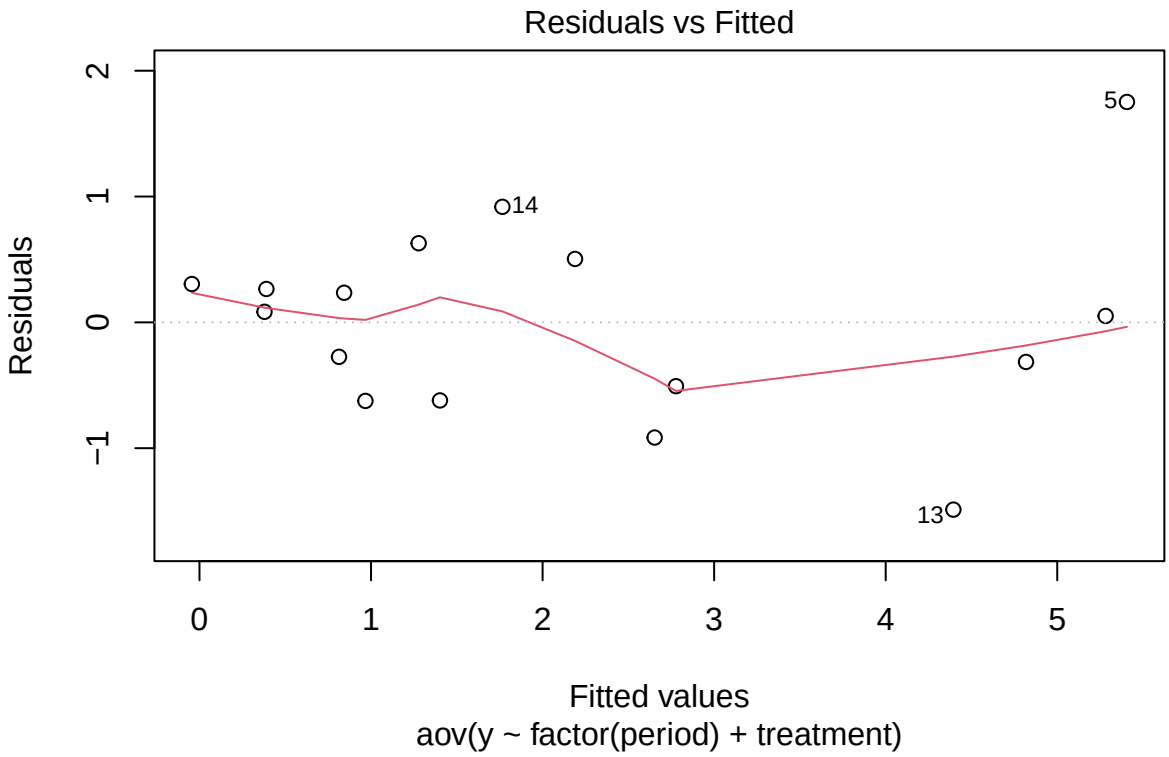
```
##      Min       1Q   Median       3Q      Max
## -1.48831 -0.53546  0.06752  0.35460  1.75175
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 5.2822     0.6632   7.964 2.29e-05 ***
## factor(period)2             0.1242     0.7090   0.175 0.864819
## factor(period)3            -0.4641     0.7090  -0.655 0.529080
## factor(period)4            -0.8877     0.7090  -1.252 0.242140
## treatmentfrequentflushing  -2.6289     0.7090  -3.708 0.004861 **
## treatmentslurryfunnels     -4.4391     0.7090  -6.261 0.000148 ***
## treatmentslurrytrays       -4.0046     0.7090  -5.648 0.000314 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.003 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.8483, Adjusted R-squared:  0.7471
## F-statistic: 8.385 on 6 and 9 DF,  p-value: 0.002834
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Non-transformed Dunnett s test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                 Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0   -2.629      0.709  -3.708   0.0124 *
## slurryfunnels - control == 0      -4.439      0.709  -6.261   <0.001 ***
## slurrytrays - control == 0        -4.005      0.709  -5.648   <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Non-transformed confidence intervals:
##                               2.5 %    97.5 %
## (Intercept)                3.781902  6.782514
## factor(period)2           -1.479693  1.728097
```

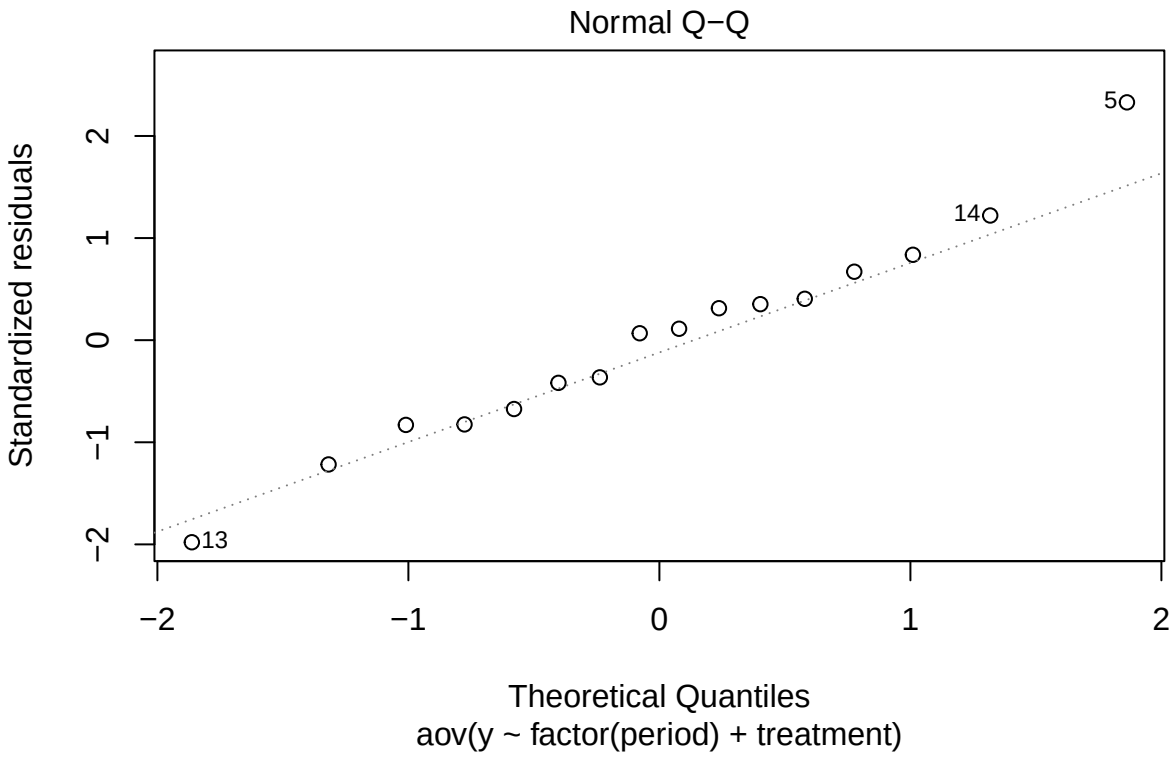
```
## factor(period)3           -2.068034  1.139756
## factor(period)4           -2.491553  0.716237
## treatmentfrequentflushing -4.232826 -1.025037
## treatmentslurryfunnels    -6.043017 -2.835227
## treatmentslurrytrays      -5.608542 -2.400753
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed aov summary:
##                Df Sum Sq Mean Sq F value   Pr(>F)
## factor(period)  3 0.1753  0.0584   1.645 0.247169
## treatment       3 2.4274  0.8091  22.784 0.000154 ***
## Residuals       9 0.3196  0.0355
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed lm summary:
##
## Call:
## aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.286000 -0.112487  0.001559  0.122449  0.208276
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  0.8369     0.1246   6.714 8.71e-05 ***
## factor(period)2             -0.1602     0.1333  -1.202 0.259872
## factor(period)3             -0.1996     0.1333  -1.498 0.168306
## factor(period)4             -0.2891     0.1333  -2.169 0.058165 .
## treatmentfrequentflushing   -0.3109     0.1333  -2.333 0.044532 *
## treatmentslurryfunnels      -1.0124     0.1333  -7.597 3.34e-05 ***
## treatmentslurrytrays        -0.7443     0.1333  -5.586 0.000341 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1885 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.8906, Adjusted R-squared:  0.8177
## F-statistic: 12.21 on 6 and 9 DF,  p-value: 0.0007015
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
```

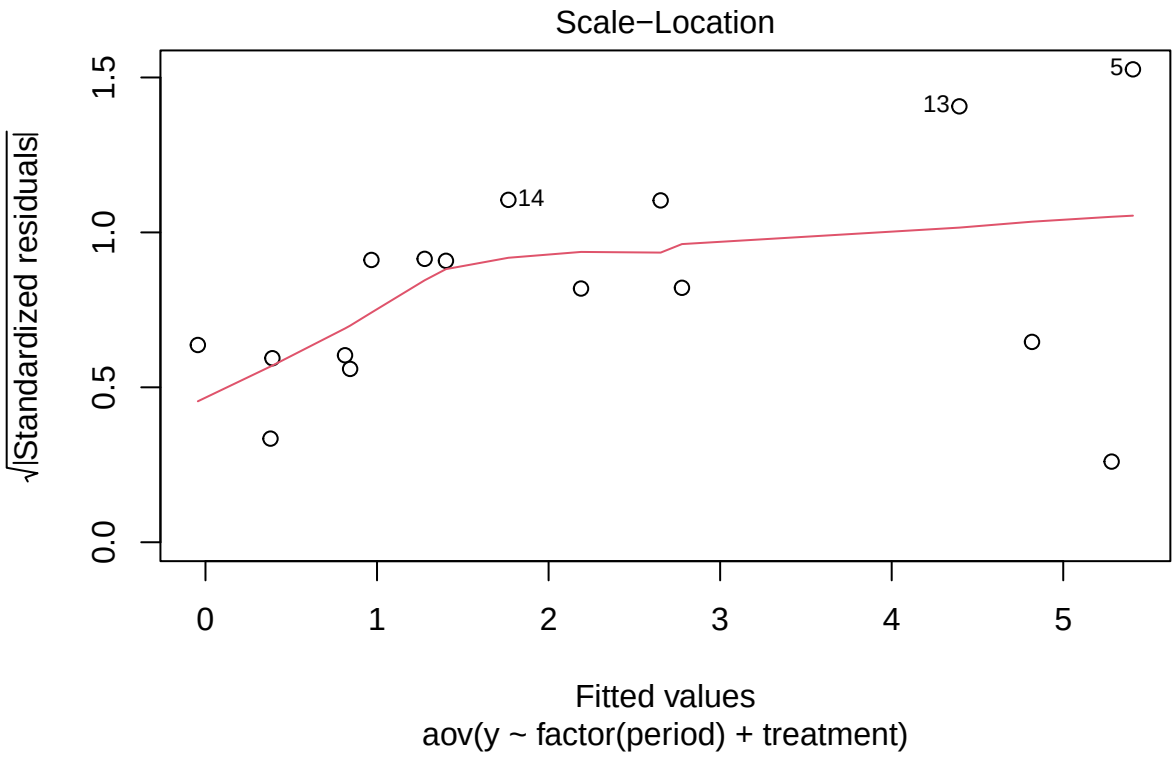
```
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed Dunnetts test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                 Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  -0.3109     0.1333  -2.333  0.10580
## slurryfunnels - control == 0     -1.0124     0.1333  -7.597  < 0.001 ***
## slurrytrays - control == 0       -0.7443     0.1333  -5.586  0.00101 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed confidence intervals:
##                               2.5 %      97.5 %
## (Intercept)               258.87112 1214.877580
## factor(period)2           -65.45962   38.424082
## factor(period)3           -68.45616   26.415147
## factor(period)4           -74.32746    2.885281
## treatmentfrequentflushing -75.58357   -2.148700
## treatmentslurryfunnels    -95.14531  -80.544331
## treatmentslurrytrays      -90.99974  -63.930547
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed aov summary without period:
##             Df Sum Sq Mean Sq F value   Pr(>F)
## treatment    3 2.7619  0.9206   20.23 1.08e-05 ***
## Residuals   16 0.7281  0.0455
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
```

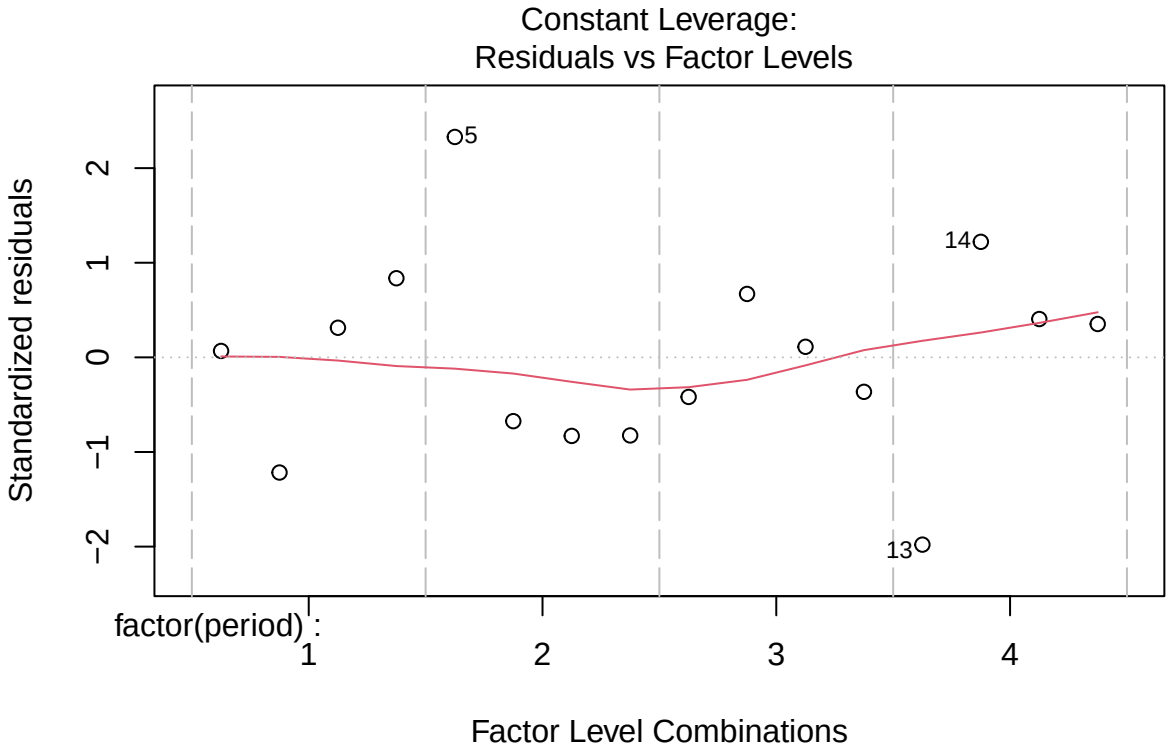
```
## Transformed lm summary without period:
##
## Call:
## aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.28793 -0.17282 -0.00916  0.13592  0.32960
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 0.7077     0.0954   7.418 1.46e-06 ***
## treatmentfrequentflushing  -0.4025     0.1349  -2.983  0.00878 **
## treatmentslurryfunnels     -1.0045     0.1349  -7.446 1.39e-06 ***
## treatmentslurrytrays       -0.7034     0.1349  -5.214 8.53e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2133 on 16 degrees of freedom
## Multiple R-squared:  0.7914, Adjusted R-squared:  0.7523
## F-statistic: 20.23 on 3 and 16 DF,  p-value: 1.081e-05
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed Dunnetts test without period:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  -0.4025     0.1349  -2.983   0.0228 *
## slurryfunnels - control == 0     -1.0045     0.1349  -7.446   <0.001 ***
## slurrytrays - control == 0       -0.7034     0.1349  -5.214   <0.001 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed confidence intervals without period:
##                                2.5 %    97.5 %
```

```
## (Intercept)               220.24458 712.75325
## treatmentfrequentflushing -79.51100 -23.52181
## treatmentslurryfunnels    -94.87767 -80.88014
## treatmentslurrytrays      -89.75360 -61.75381
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed relative reduction (coef):
##           factor(period)3           factor(period)4 treatmentfrequentflushing    treatmentslurryfunne
##                     -36.9                     -48.6                     -51.1                      -9
##      treatmentslurrytrays
##                     -82.0
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed relative reduction without period (coef):
## treatmentfrequentflushing    treatmentslurryfunnels      treatmentslurrytrays
##                     -60.4                     -90.1                     -80.2
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Non-transformed diagnostic plots:
```

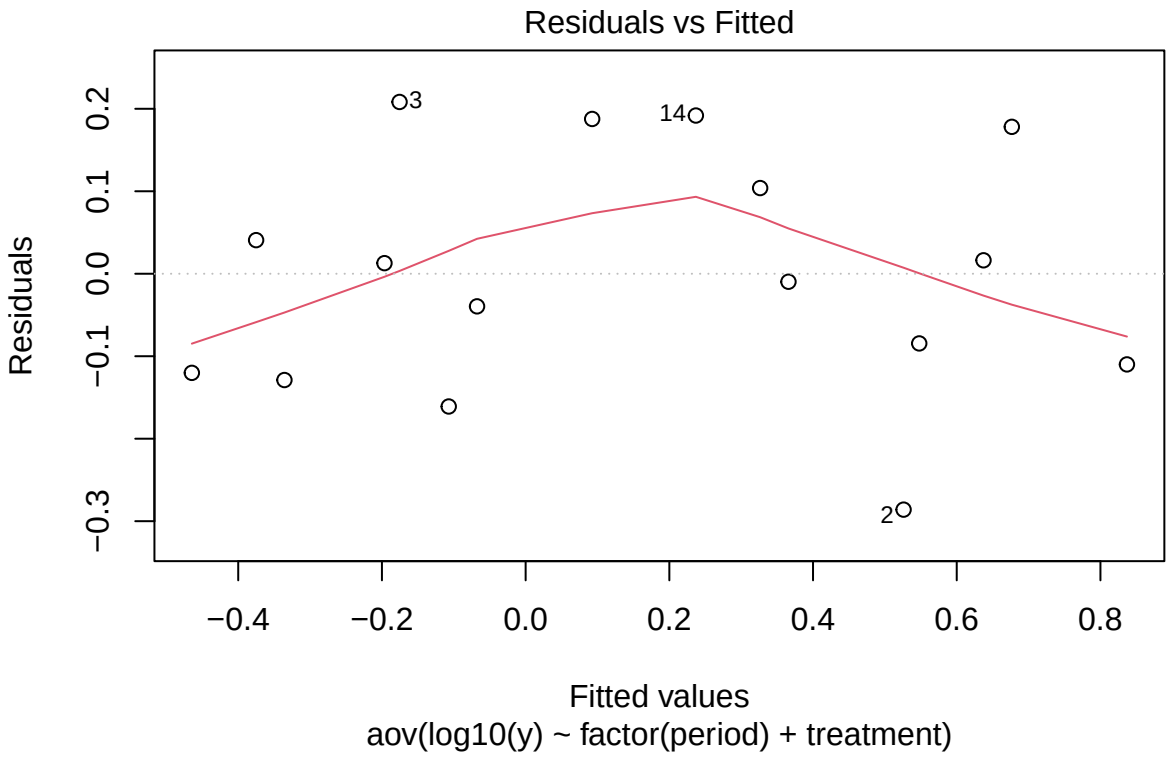

Residuals vs Fitted
Residuals
2
1
0
−1
0
1
2
3
4
5
14
5
13
Fitted values
aov(y ~ factor(period) + treatment)

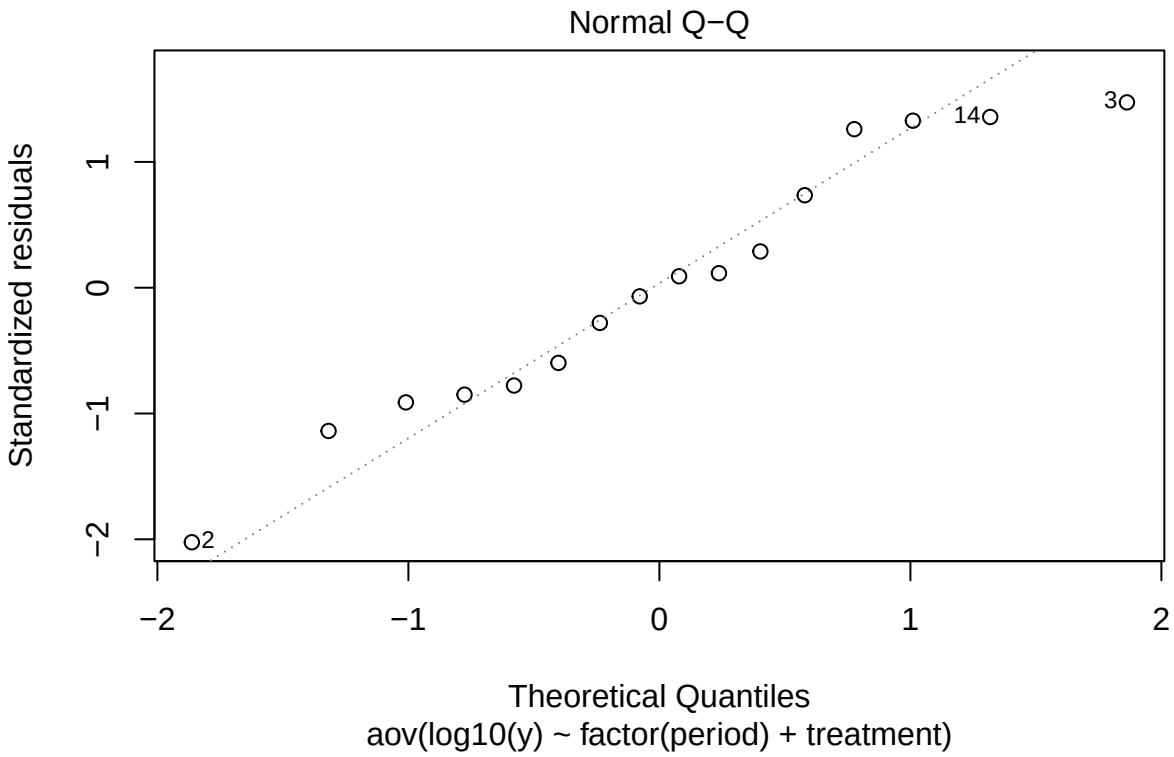

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(y ~ factor(period) + treatment)
5
14
13
−2
−1
0
1
2

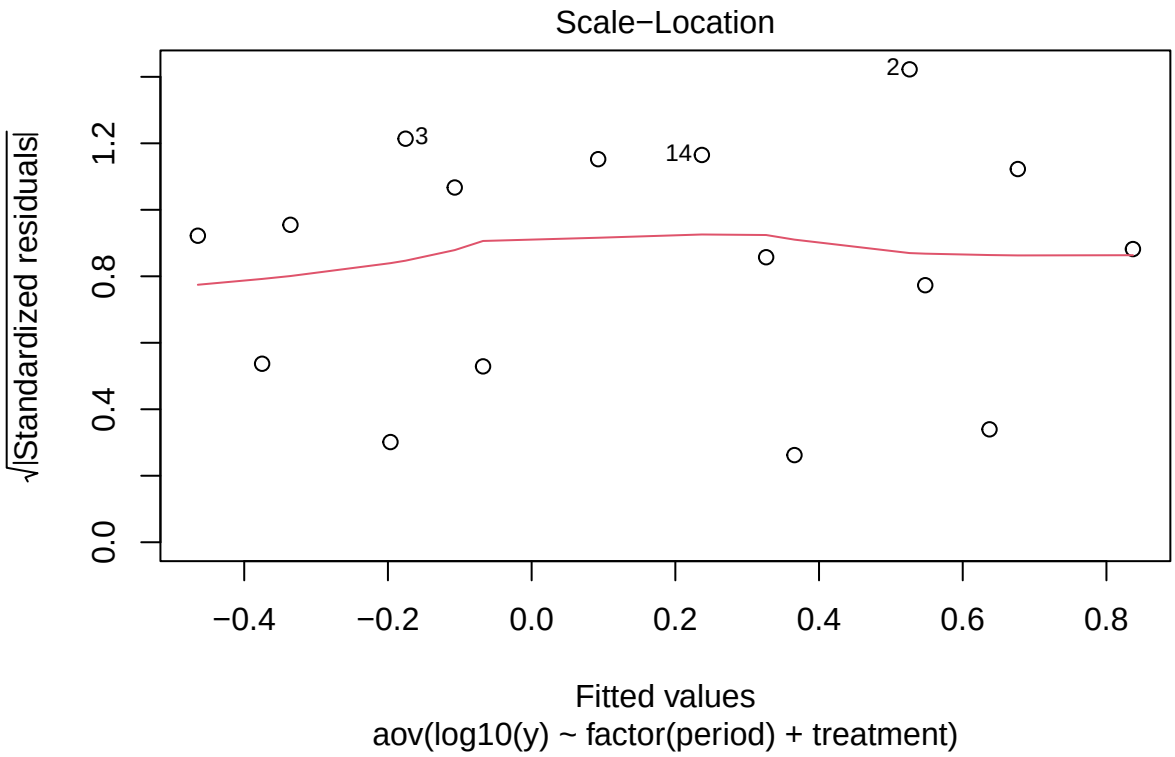

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
0
1
2
3
4
5
5
13
14
Fitted values
aov(y ~ factor(period) + treatment)

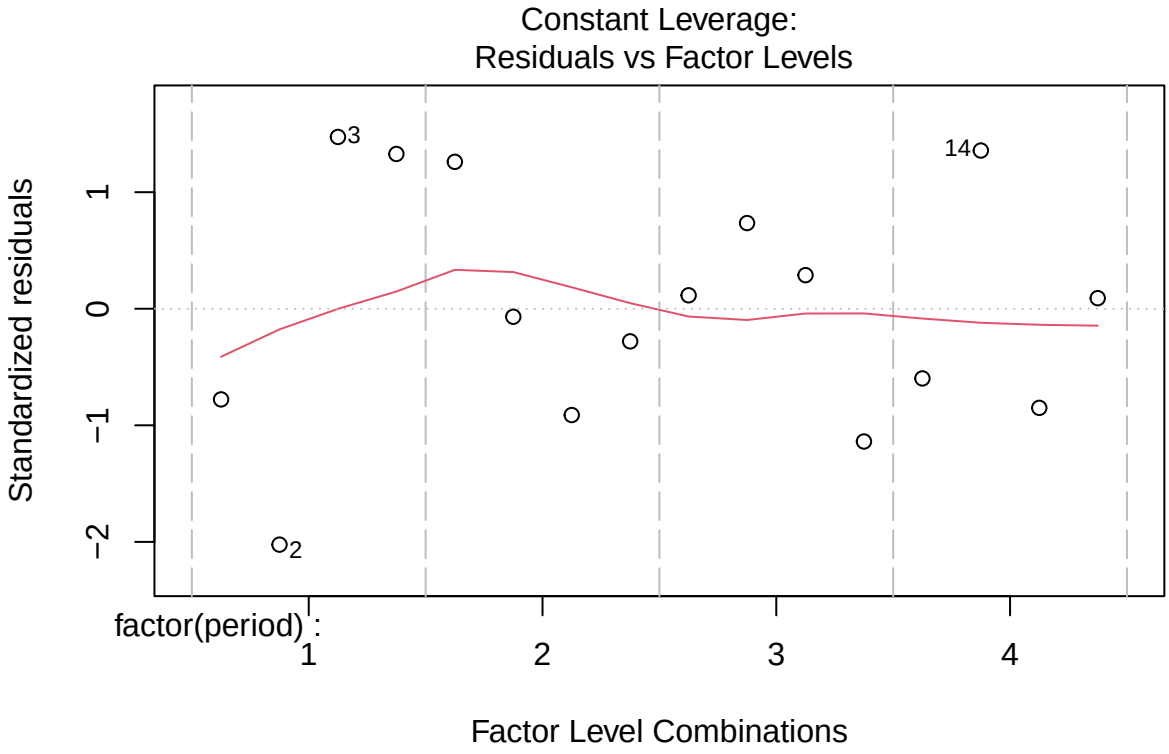



```
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed diagnostic plots:
```

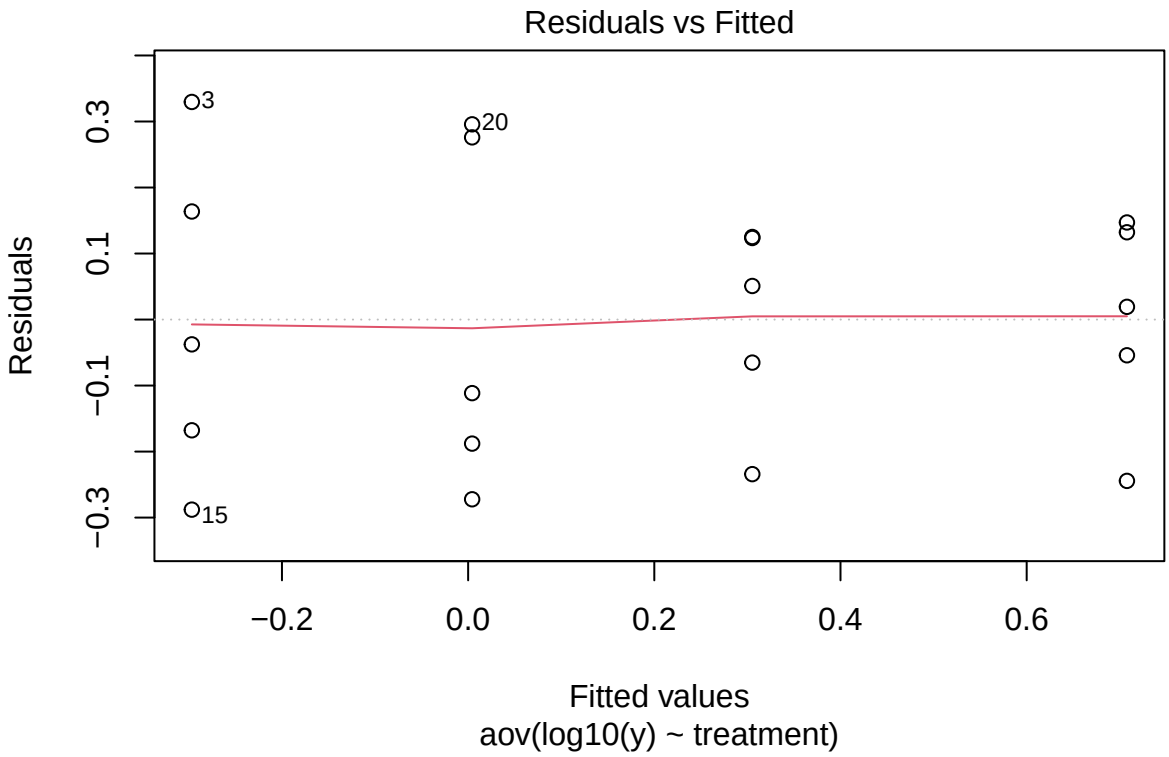

Residuals vs Fitted
Residuals
0.2
0.1
0.0
−0.1
−0.3
3
14
2
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
Fitted values
aov(log10(y) ~ factor(period) + treatment)

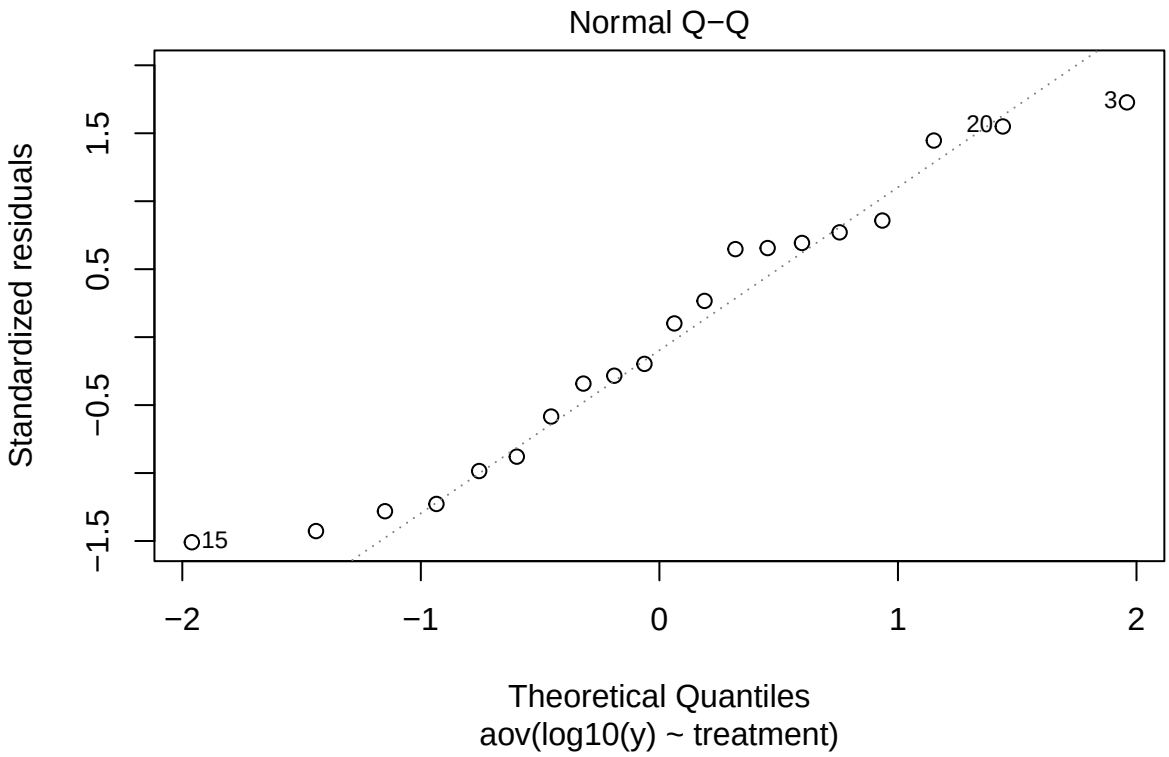

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ factor(period) + treatment)
2
14
3
−2
−1
0
1
2

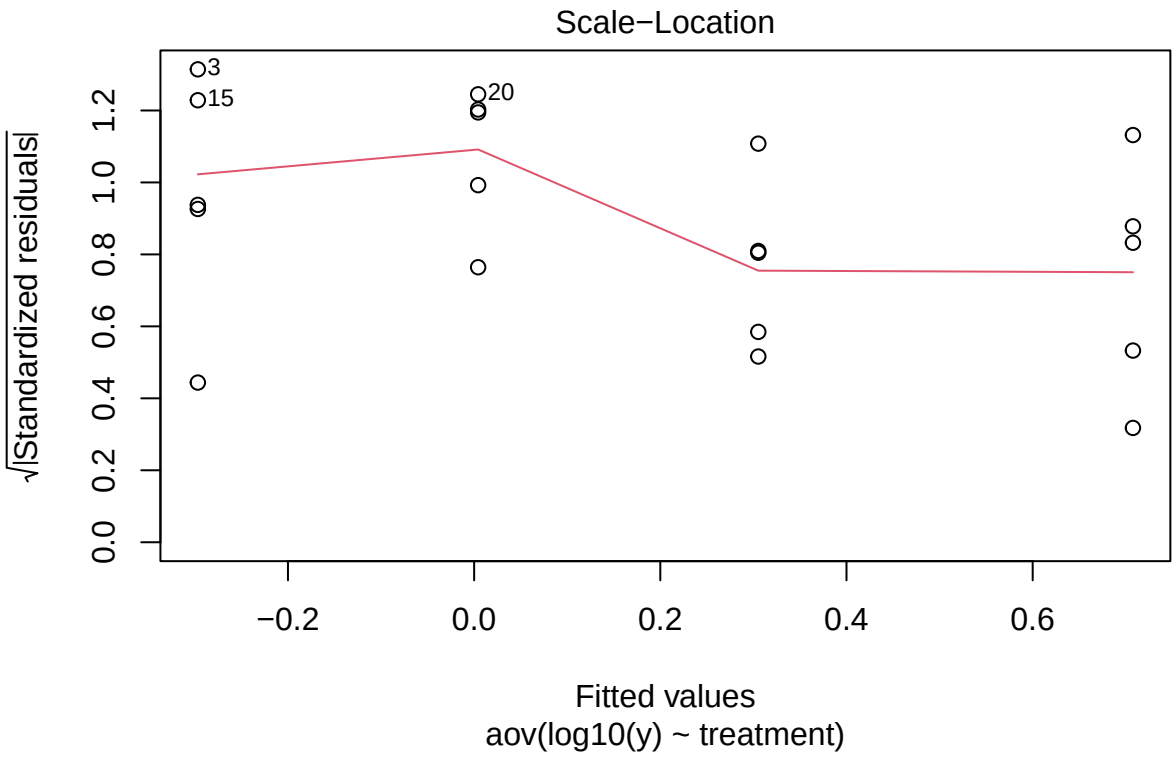

Scale−Location
√|Standardized residuals|
0.0
0.4
0.8
1.2
2
3
14
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
Fitted values
aov(log10(y) ~ factor(period) + treatment)

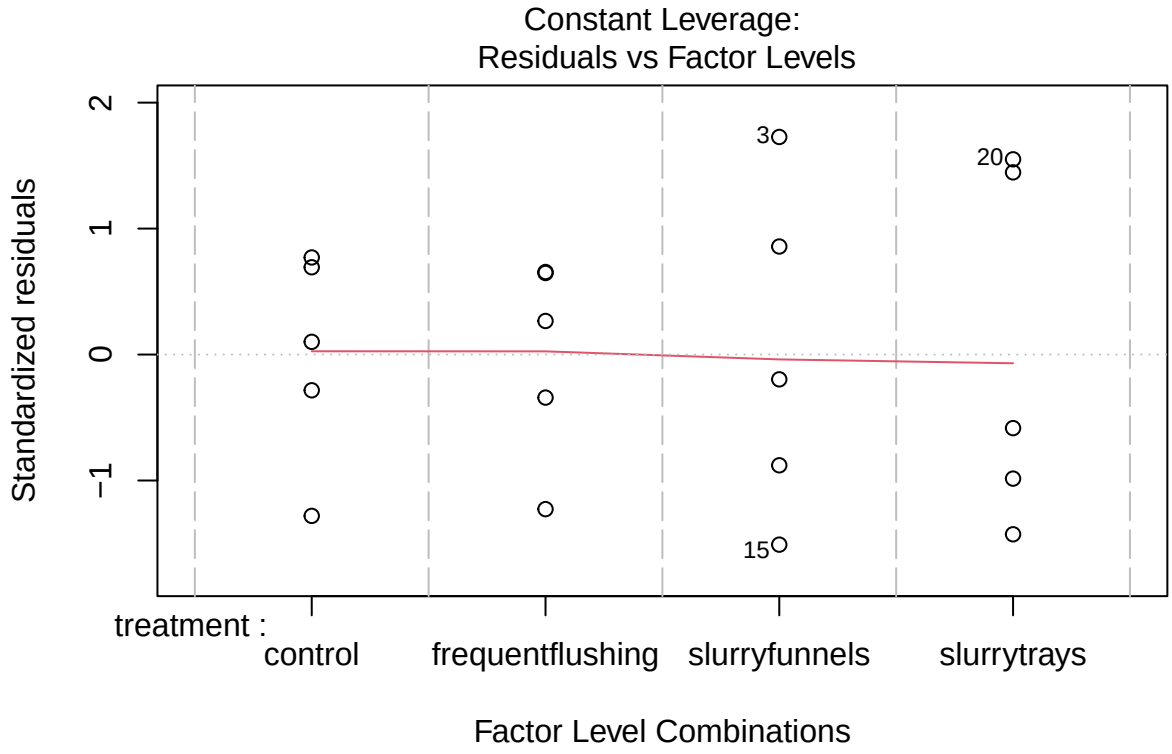



```
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
## Transformed diagnostic plots without period:
```


Residuals vs Fitted
Residuals
0.3
0.1
−0.1
−0.3
3
20
15
−0.2
0.0
0.2
0.4
0.6
Fitted values
aov(log10(y) ~ treatment)


Normal Q−Q
Standardized residuals
−1.5
−0.5
0.5
1.5
15
20
3
−2
−1
0
1
2
Theoretical Quantiles
aov(log10(y) ~ treatment)

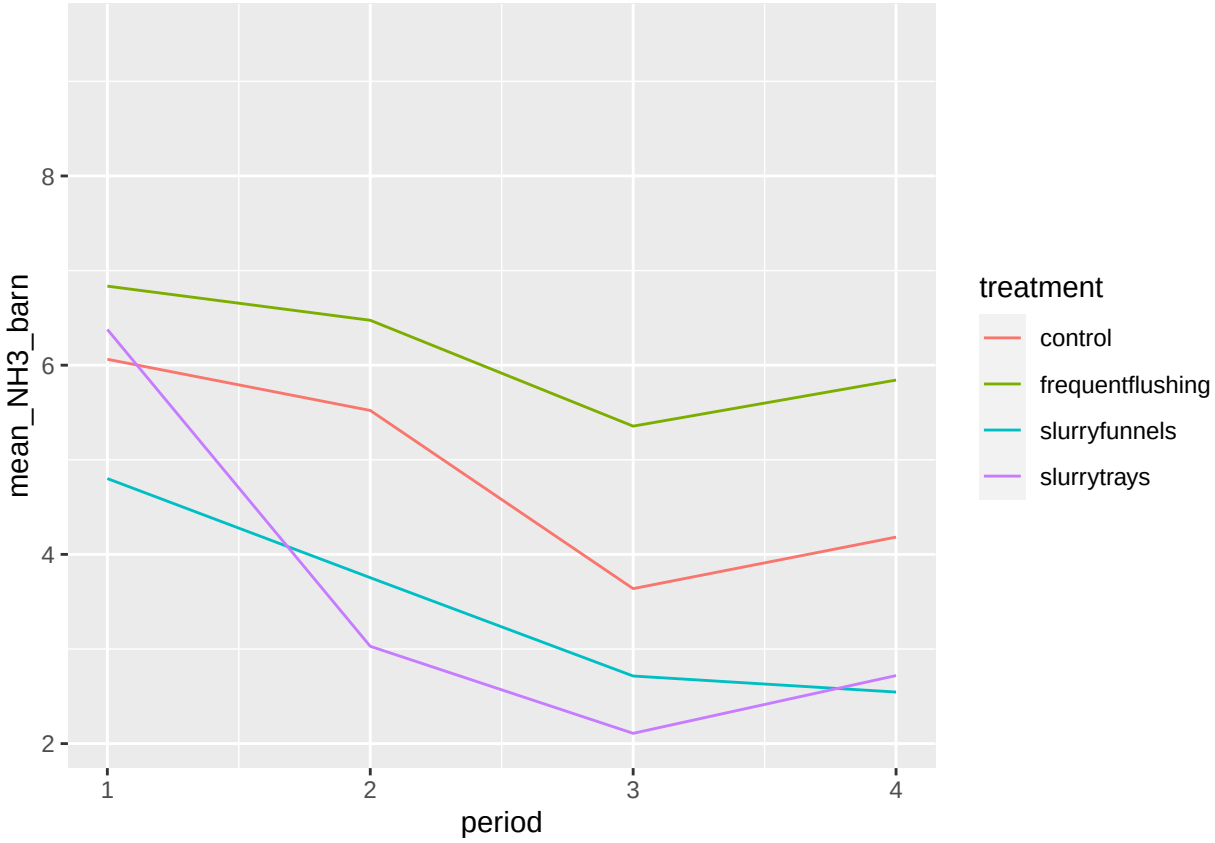

Scale−Location
√|Standardized residuals|
0.0
0.2
0.4
0.6
0.8
1.0
1.2
3
15
20
−0.2
0.0
0.2
0.4
0.6
Fitted values
aov(log10(y) ~ treatment)

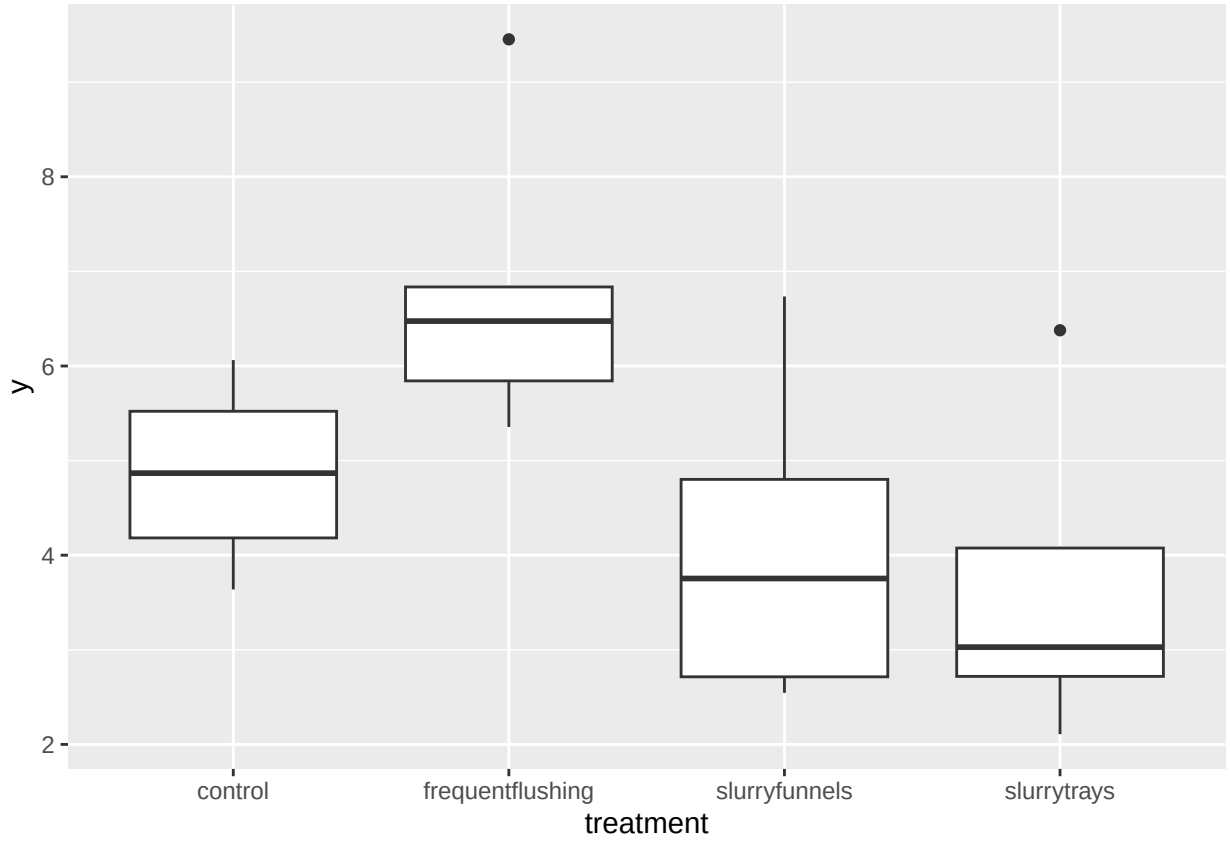



```
##
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##  mean_CH4_slurry
##
##
##
##
##  end mean_CH4_slurry end mean_CH4_slurry end mean_CH4_slurry
##
##  end mean_CH4_slurry end mean_CH4_slurry end mean_CH4_slurry
##
##  end mean_CH4_slurry end mean_CH4_slurry end mean_CH4_slurry
##
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
```

```
##  mean_NH3_barn
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
```

```
## Warning: Removed 4 rows containing missing values (‘geom_line()‘).
```






```
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Non-transformed aov summary:
##                Df Sum Sq Mean Sq F value   Pr(>F)
## factor(period)  3 15.595   5.198   12.15 0.001622 **
## treatment       3 19.007   6.336   14.80 0.000795 ***
## Residuals       9  3.852   0.428
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Non-transformed lm summary:
##
## Call:
## aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
```

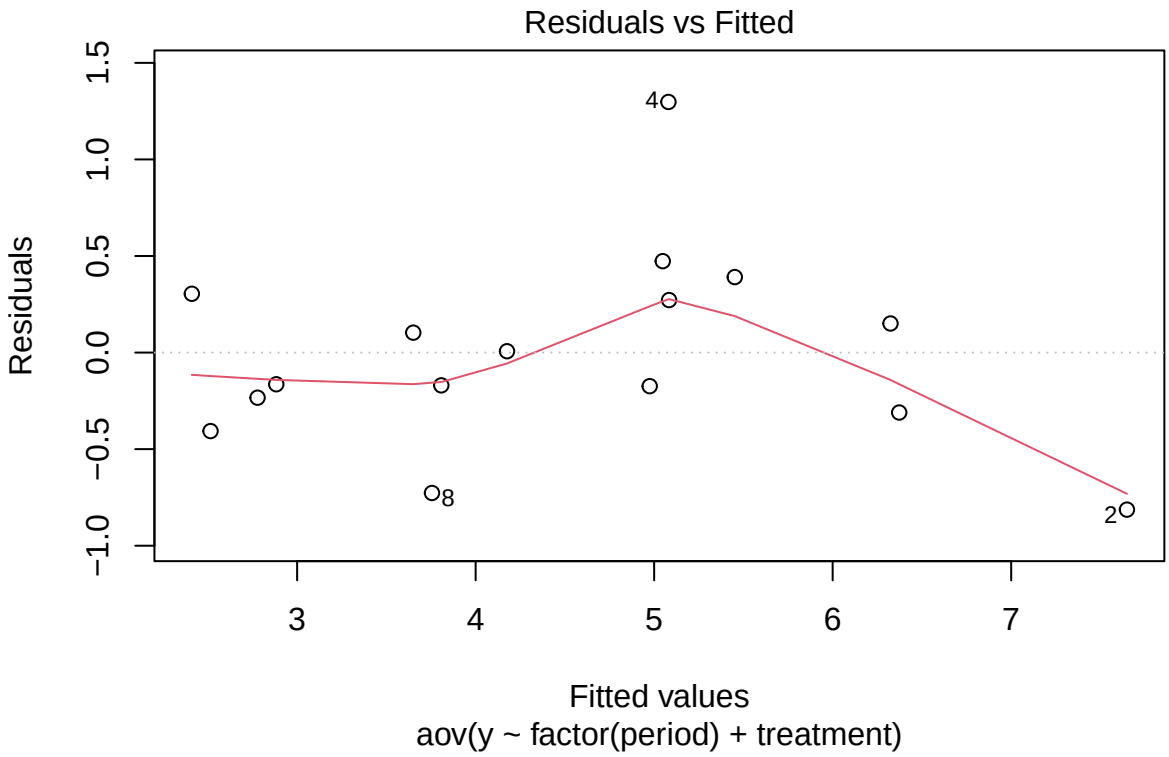
```
##      Min       1Q   Median       3Q      Max
## -0.81318 -0.25284 -0.07859  0.28003  1.29752
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 6.3727     0.4327  14.727 1.32e-07 ***
## factor(period)2            -1.3246     0.4626  -2.863 0.018678 *
## factor(period)3            -2.5650     0.4626  -5.545 0.000359 ***
## factor(period)4            -2.1969     0.4626  -4.749 0.001046 **
## treatmentfrequentflushing   1.2758     0.4626   2.758 0.022187 *
## treatmentslurryfunnels     -1.3975     0.4626  -3.021 0.014456 *
## treatmentslurrytrays       -1.2927     0.4626  -2.794 0.020901 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.6542 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.8998, Adjusted R-squared:  0.833
## F-statistic: 13.47 on 6 and 9 DF,  p-value: 0.0004802
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Non-transformed Dunnett s test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                 Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0   1.2758     0.4626   2.758   0.0544 .
## slurryfunnels - control == 0     -1.3975     0.4626  -3.021   0.0359 *
## slurrytrays - control == 0       -1.2927     0.4626  -2.794   0.0511 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Non-transformed confidence intervals:
##                                 2.5 %     97.5 %
## (Intercept)                5.3938497  7.3516478
## factor(period)2           -2.3710978 -0.2781235
```

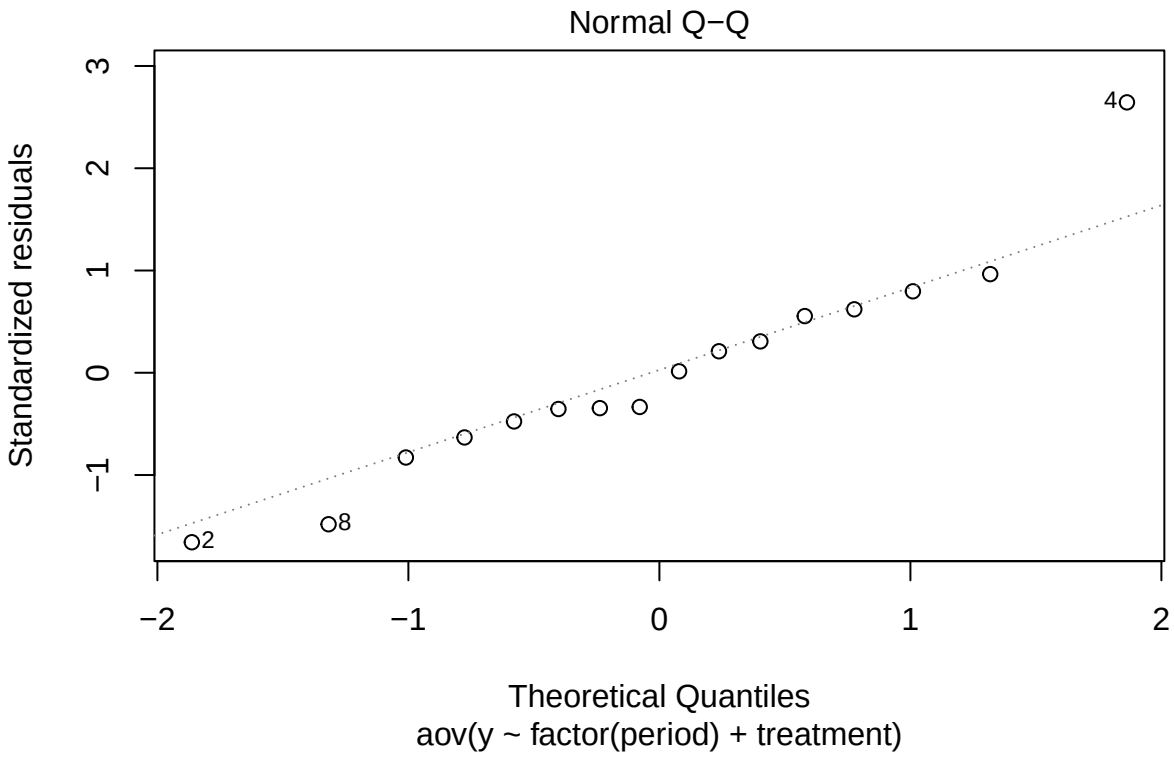
```
## factor(period)3           -3.6115274 -1.5185532
## factor(period)4           -3.2433721 -1.1503978
## treatmentfrequentflushing  0.2293446  2.3223188
## treatmentslurryfunnels    -2.4440163 -0.3510421
## treatmentslurrytrays      -2.3392145 -0.2462402
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed aov summary:
##                Df  Sum Sq Mean Sq F value  Pr(>F)
## factor(period)  3 0.16370 0.05457   9.378 0.00393 **
## treatment       3 0.20644 0.06881  11.826 0.00178 **
## Residuals       9 0.05237 0.00582
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 4 observations deleted due to missingness
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed lm summary:
##
## Call:
## aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.102192 -0.047033  0.001905  0.026331  0.141972
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 0.82837    0.05045  16.418 5.14e-08 ***
## factor(period)2            -0.12362    0.05394  -2.292 0.047632 *
## factor(period)3            -0.26402    0.05394  -4.895 0.000854 ***
## factor(period)4            -0.21883    0.05394  -4.057 0.002855 **
## treatmentfrequentflushing  0.10859    0.05394   2.013 0.074939 .
## treatmentslurryfunnels    -0.15296    0.05394  -2.836 0.019534 *
## treatmentslurrytrays      -0.16569    0.05394  -3.072 0.013315 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.07628 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.8761, Adjusted R-squared:  0.7934
## F-statistic:  10.6 on 6 and 9 DF,  p-value: 0.0012
##
##
##  mean_NH3_barn
##  mean_NH3_barn
```

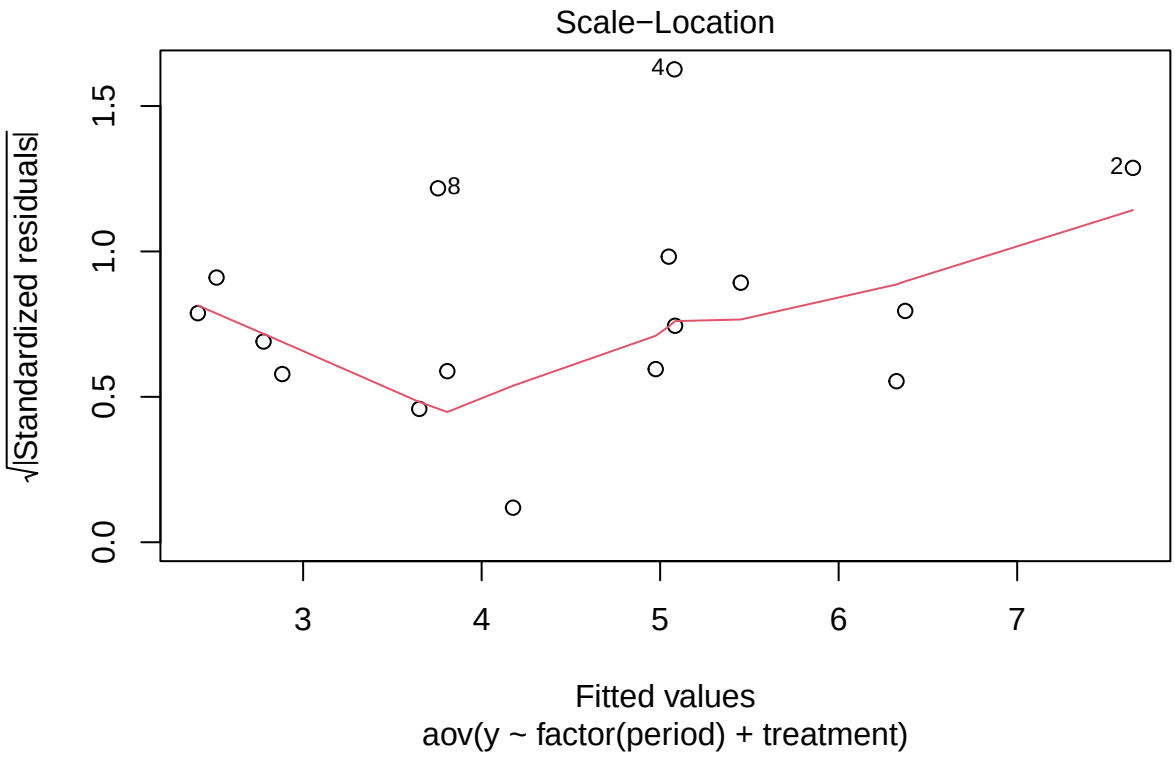
```
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed Dunnetts test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  0.10859    0.05394   2.013   0.1722
## slurryfunnels - control == 0    -0.15296    0.05394  -2.836   0.0482 *
## slurrytrays - control == 0      -0.16569    0.05394  -3.072   0.0333 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed confidence intervals:
##                                 2.5 %      97.5 %
## (Intercept)               417.885107 775.9997438
## factor(period)2           -43.197430  -0.3678552
## factor(period)3           -58.888805 -27.8906482
## factor(period)4           -54.379605 -19.9814771
## treatmentfrequentflushing  -3.044583  70.0605452
## treatmentslurryfunnels    -46.908681  -6.8774180
## treatmentslurrytrays      -48.441838  -9.5665878
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed aov summary without period:
##             Df Sum Sq Mean Sq F value Pr(>F)
## treatment    3 0.2463 0.08211   4.016 0.0262 *
## Residuals   16 0.3271 0.02045
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
```

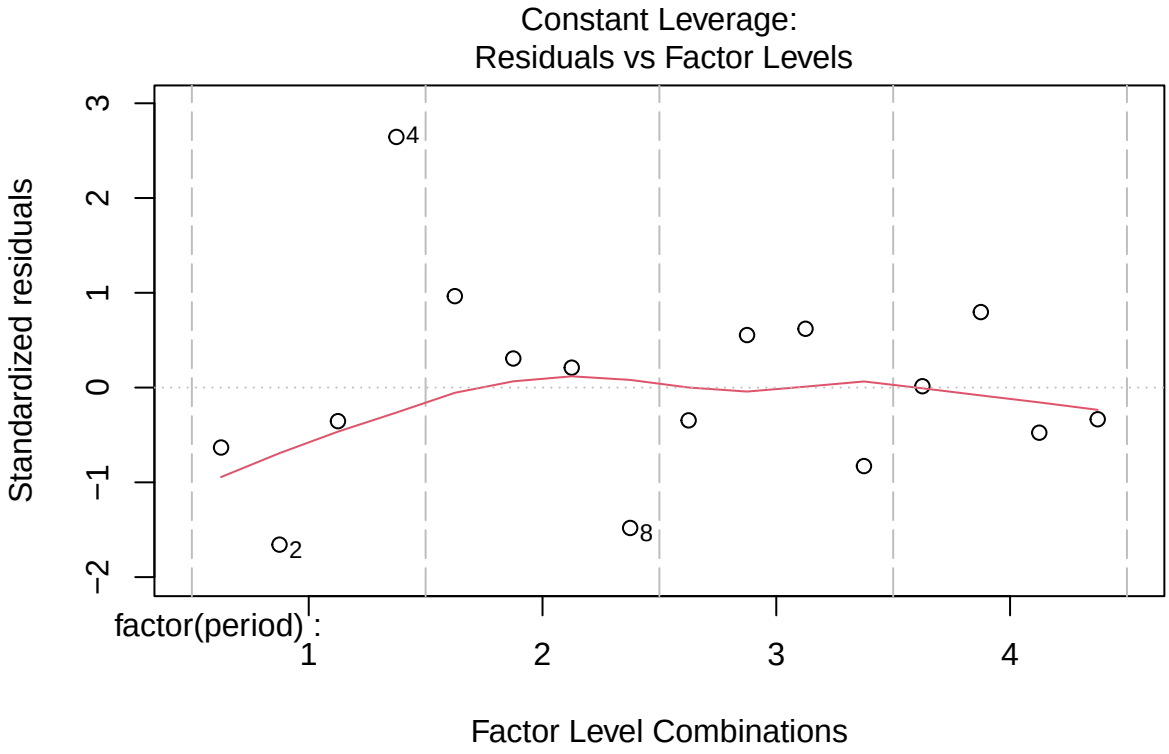
```
## Transformed lm summary without period:
##
## Call:
## aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.20693 -0.09506 -0.01121  0.08364  0.27376
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 0.67886    0.06395  10.616 1.19e-08 ***
## treatmentfrequentflushing  0.14452    0.09044   1.598    0.130
## treatmentslurryfunnels    -0.09416    0.09044  -1.041    0.313
## treatmentslurrytrays      -0.14797    0.09044  -1.636    0.121
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.143 on 16 degrees of freedom
## Multiple R-squared:  0.4295, Adjusted R-squared:  0.3226
## F-statistic: 4.016 on 3 and 16 DF,  p-value: 0.02625
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed Dunnetts test without period:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  0.14452    0.09044   1.598    0.290
## slurryfunnels - control == 0    -0.09416    0.09044  -1.041    0.607
## slurrytrays - control == 0      -0.14797    0.09044  -1.636    0.274
## (Adjusted p values reported -- single-step method)
##
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed confidence intervals without period:
##                                2.5 %    97.5 %
## (Intercept)               249.37949 552.26685
## treatmentfrequentflushing -10.29766 116.88850
```

```
## treatmentslurryfunnels    -48.22489  25.18542
## treatmentslurrytrays      -54.25835  10.59731
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed relative reduction (coef):
##           factor(period)3           factor(period)4 treatmentfrequentflushing    treatmentslurryfunne
##                     -45.6                     -39.6                      28.4                      -2
##      treatmentslurrytrays
##                     -31.7
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed relative reduction without period (coef):
## treatmentfrequentflushing    treatmentslurryfunnels      treatmentslurrytrays
##                      39.5                     -19.5                     -28.9
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Non-transformed diagnostic plots:
```

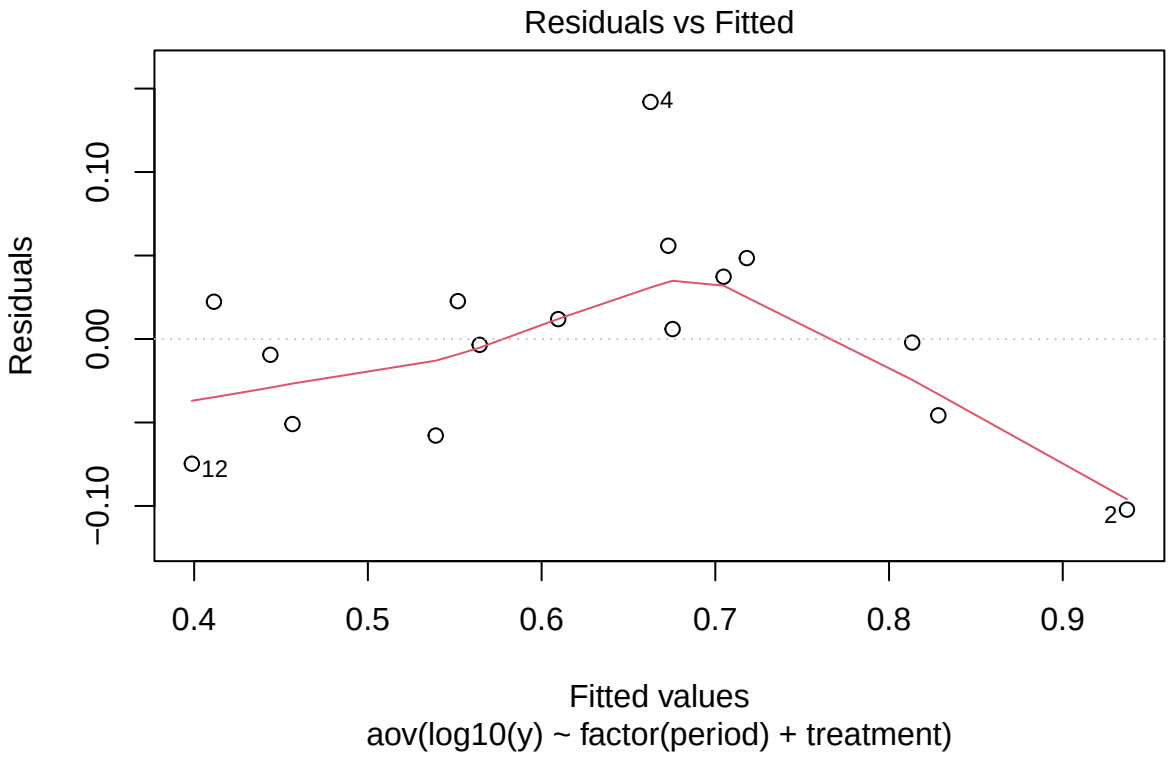

Residuals vs Fitted
Residuals
1.5
1.0
0.5
0.0
−0.5
−1.0
4
8
2
3
4
5
6
7
Fitted values
aov(y ~ factor(period) + treatment)

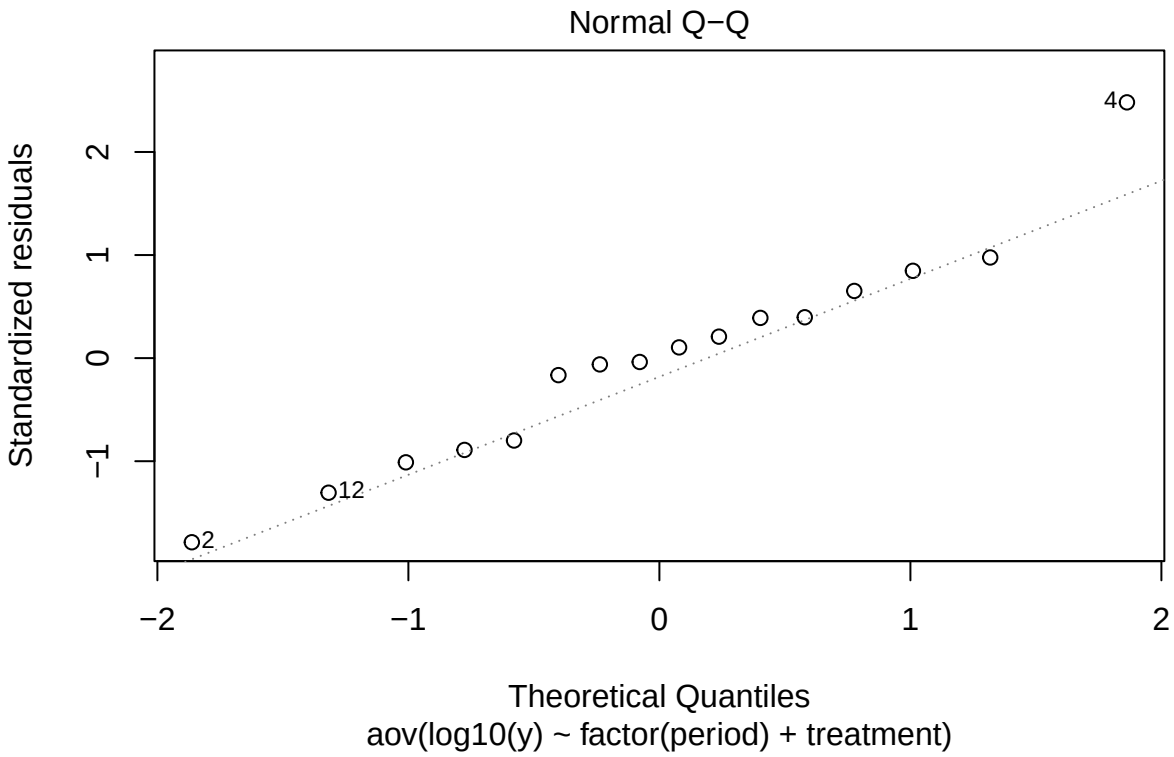

Normal Q−Q
Standardized residuals
3
2
1
0
−1
4
8
2
−2
−1
0
1
2
Theoretical Quantiles
aov(y ~ factor(period) + treatment)

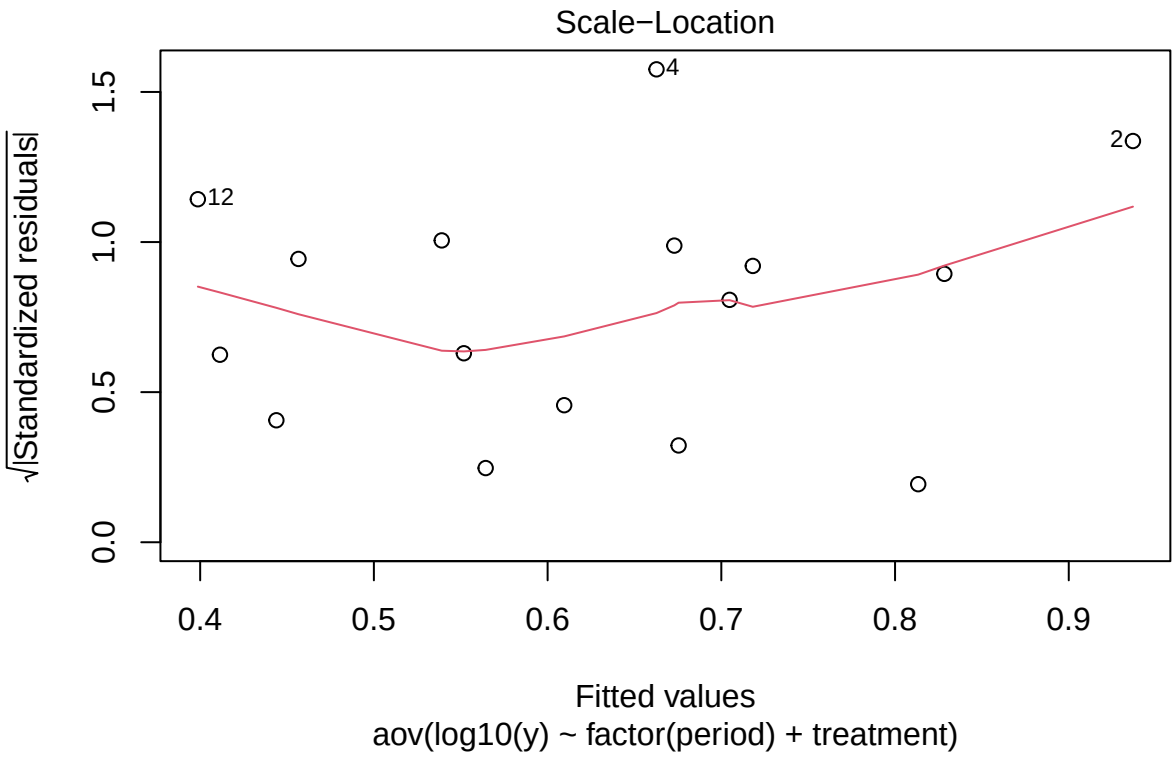

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
3
4
5
6
7
4
8
2
Fitted values
aov(y ~ factor(period) + treatment)

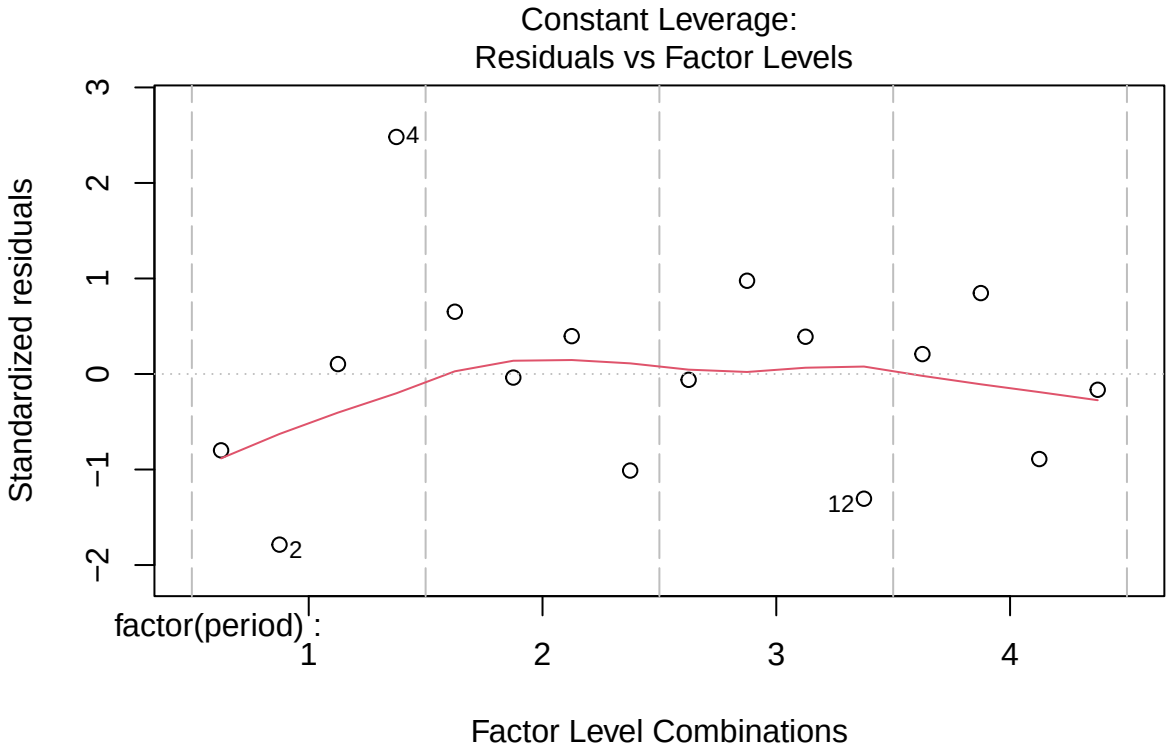



```
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed diagnostic plots:
```

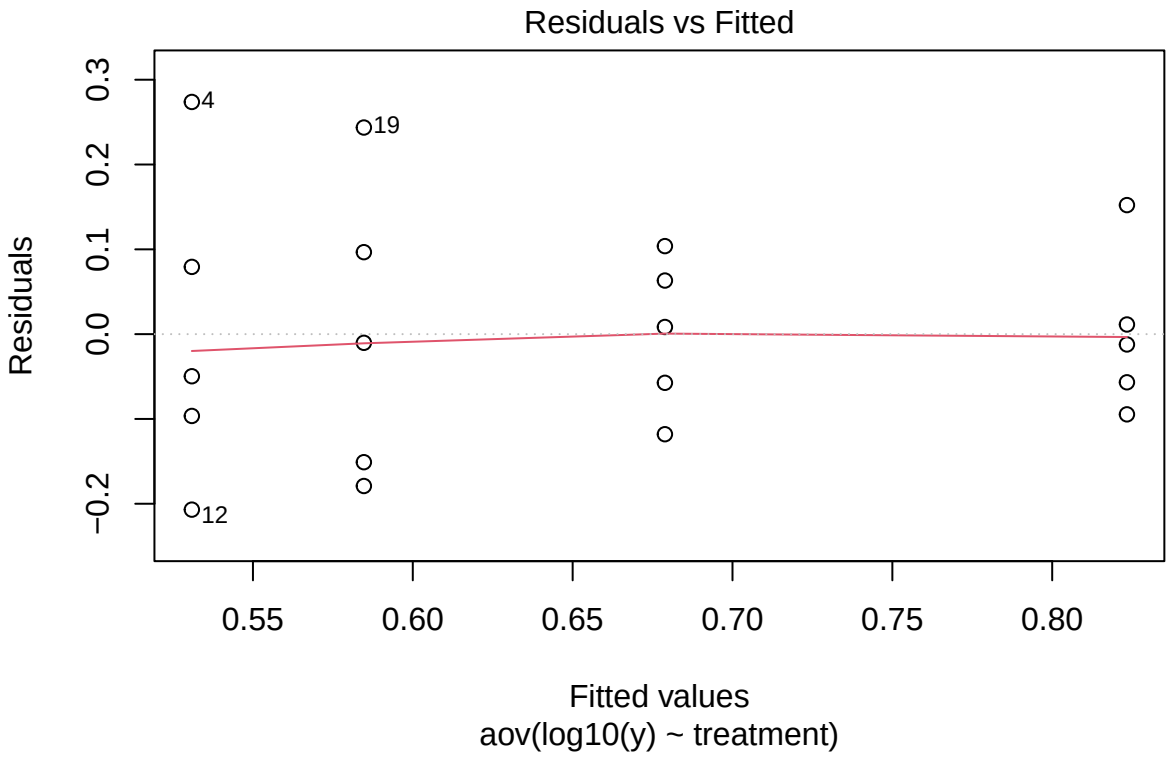

Residuals vs Fitted
Residuals
0.10
0.00
−0.10
4
12
2
0.4
0.5
0.6
0.7
0.8
0.9
Fitted values
aov(log10(y) ~ factor(period) + treatment)

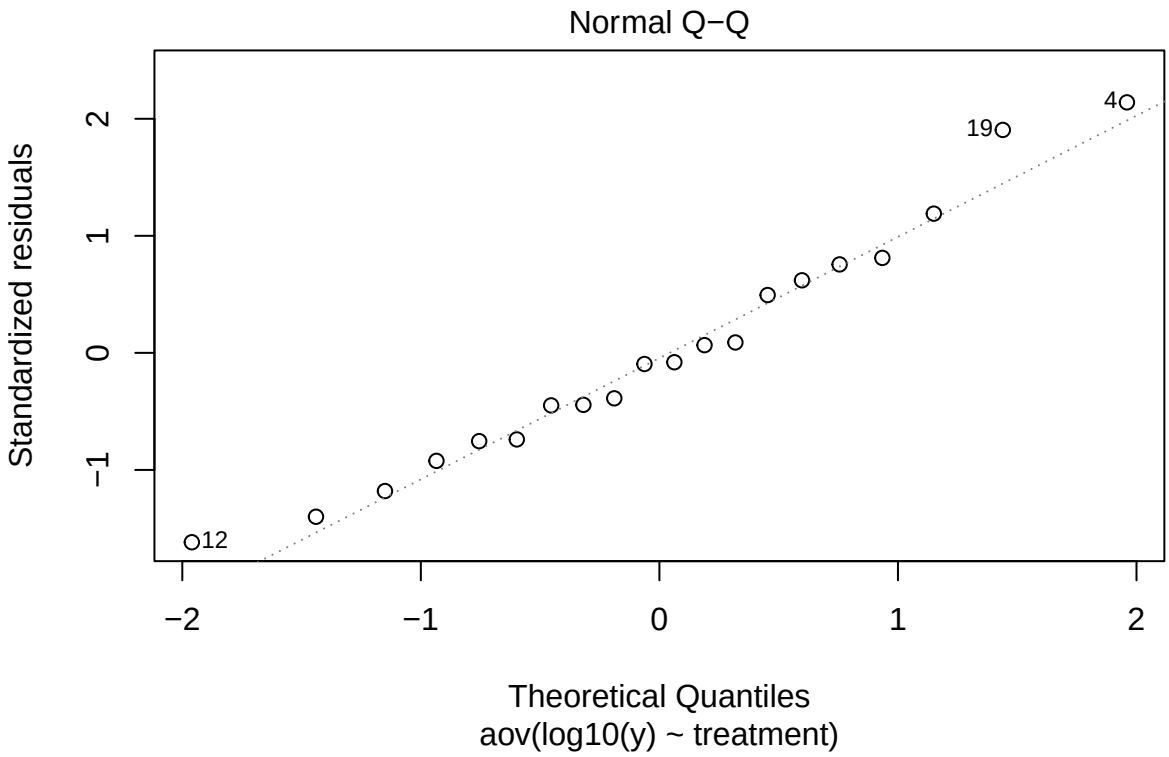

Normal Q−Q
Standardized residuals
−1
0
1
2
4
12
2
−2
−1
0
1
2
Theoretical Quantiles
aov(log10(y) ~ factor(period) + treatment)

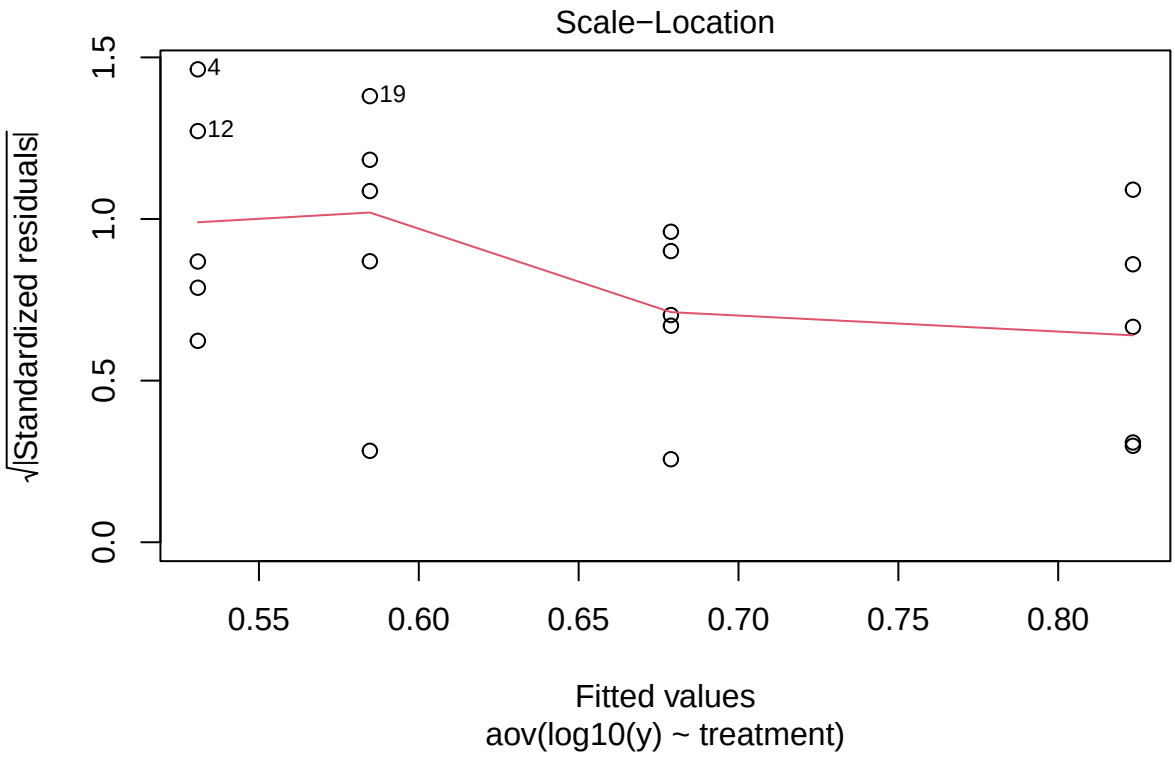

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
0.4
0.5
0.6
0.7
0.8
0.9
4
2
12
Fitted values
aov(log10(y) ~ factor(period) + treatment)

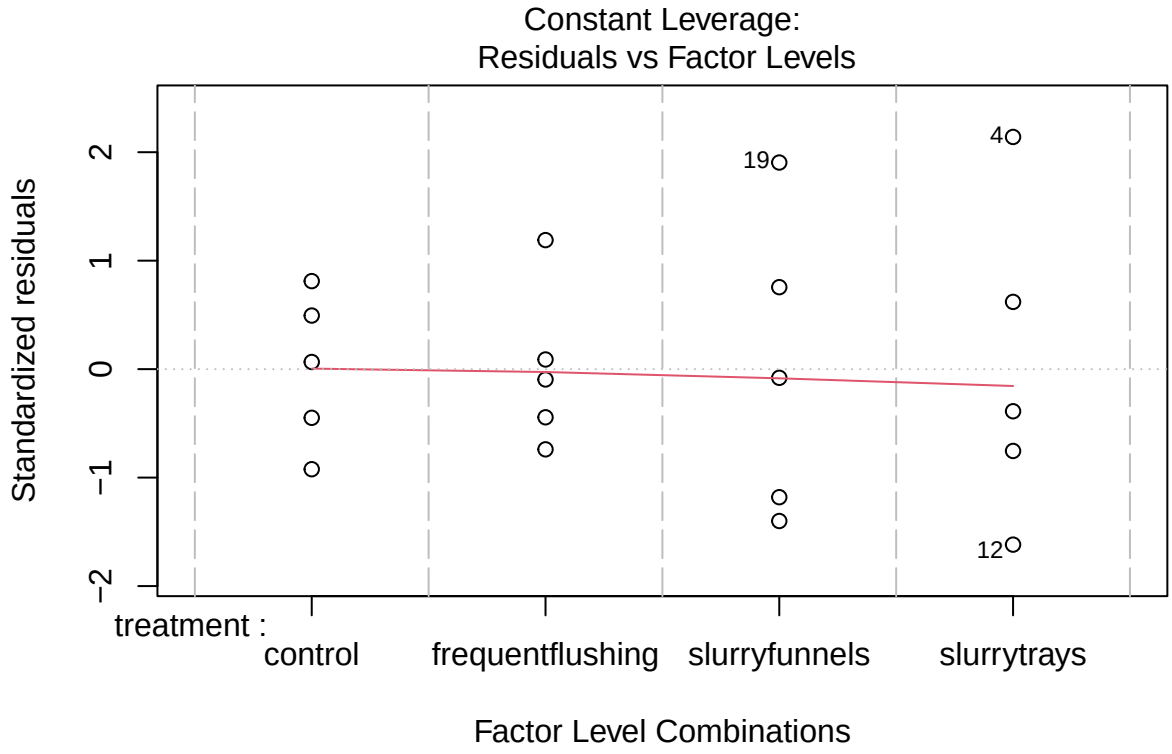



```
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
## Transformed diagnostic plots without period:
```


Residuals vs Fitted
Residuals
0.3
0.2
0.1
0.0
−0.2
4
19
12
0.55
0.60
0.65
0.70
0.75
0.80
Fitted values
aov(log10(y) ~ treatment)


Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ treatment)
12
19
4
−2
−1
0
1
2

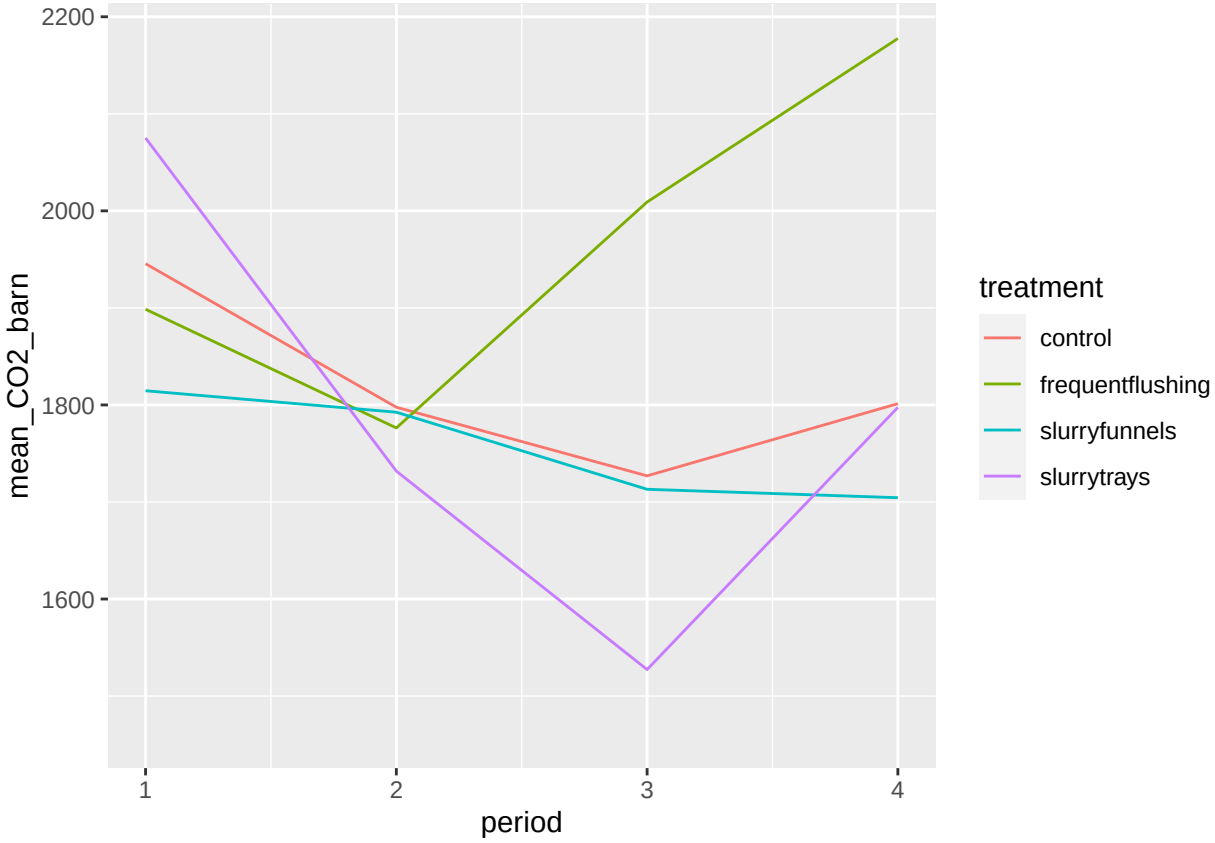

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
4
19
12
0.55
0.60
0.65
0.70
0.75
0.80
Fitted values
aov(log10(y) ~ treatment)

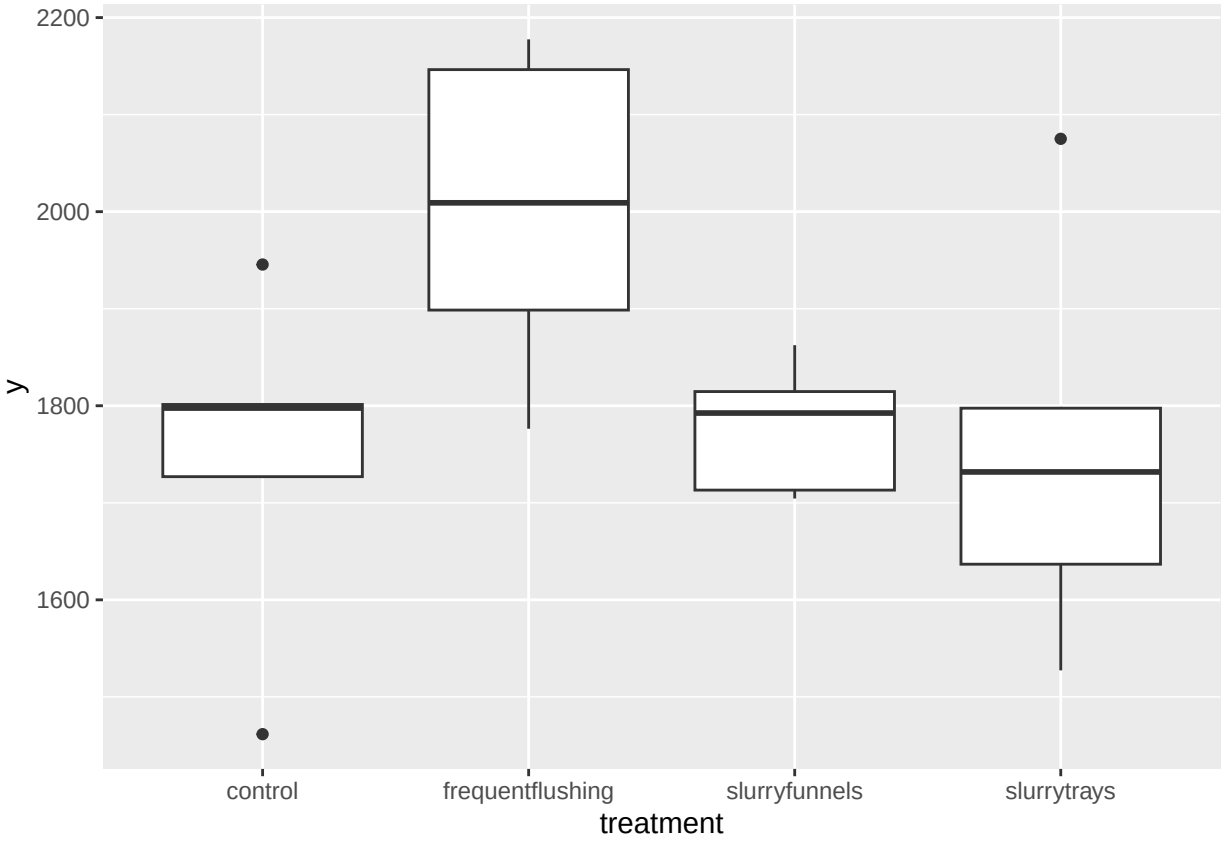



```
##
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##  mean_NH3_barn
##
##
##
##
##  end mean_NH3_barn end mean_NH3_barn end mean_NH3_barn
##
##  end mean_NH3_barn end mean_NH3_barn end mean_NH3_barn
##
##  end mean_NH3_barn end mean_NH3_barn end mean_NH3_barn
##
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
```

```
##  mean_CO2_barn
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
```

```
## Warning: Removed 4 rows containing missing values (‘geom_line()‘).
```






```
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Non-transformed aov summary:
##                Df Sum Sq Mean Sq F value Pr(>F)
## factor(period)  3  91073   30358   1.484  0.284
## treatment       3 104609   34870   1.704  0.235
## Residuals       9 184138   20460
## 4 observations deleted due to missingness
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Non-transformed lm summary:
##
## Call:
## aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -169.693  -64.957    0.219   55.650  189.299
```

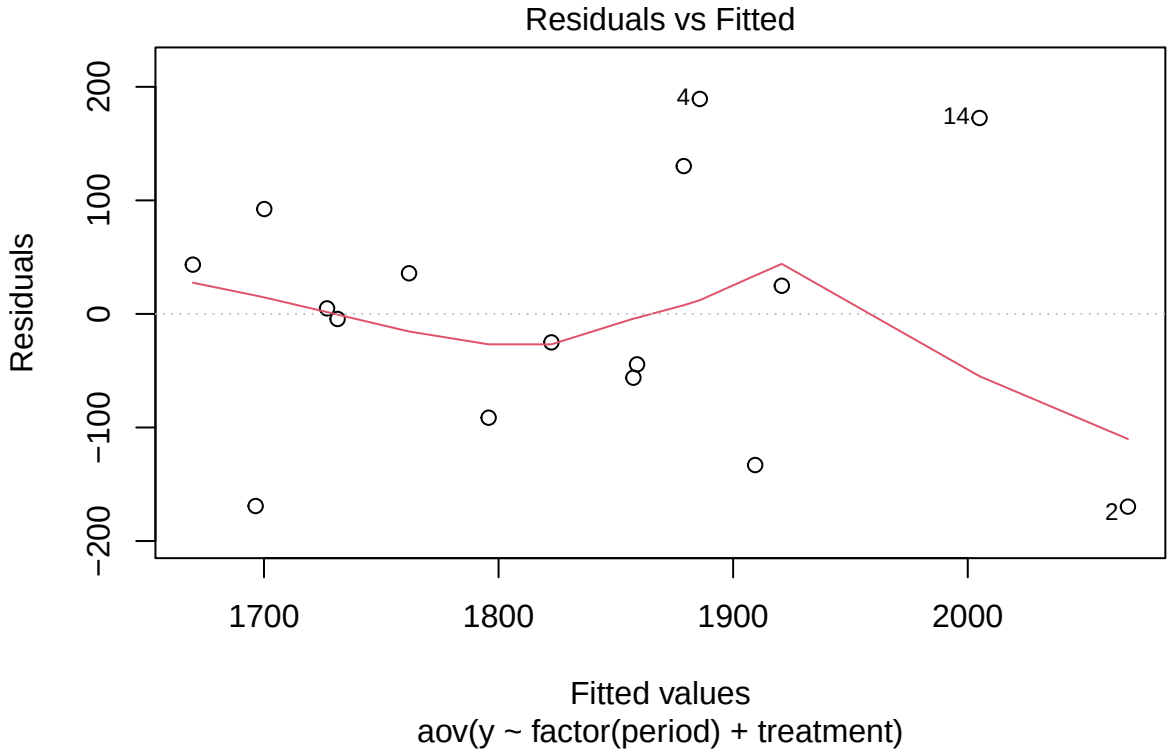
```
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 1920.74      94.61  20.302 7.96e-09 ***
## factor(period)2             -158.90     101.14  -1.571    0.151
## factor(period)3             -189.35     101.14  -1.872    0.094 .
## factor(period)4              -63.27     101.14  -0.626    0.547
## treatmentfrequentflushing    147.55     101.14   1.459    0.179
## treatmentslurryfunnels       -61.71     101.14  -0.610    0.557
## treatmentslurrytrays         -34.94     101.14  -0.345    0.738
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 143 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.5152, Adjusted R-squared:  0.192
## F-statistic: 1.594 on 6 and 9 DF,  p-value: 0.254
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Non-transformed Dunnett s test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0   147.55     101.14   1.459    0.377
## slurryfunnels - control == 0      -61.71     101.14  -0.610    0.874
## slurrytrays - control == 0        -34.94     101.14  -0.345    0.972
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Non-transformed confidence intervals:
##                                 2.5 %     97.5 %
## (Intercept)                1706.71426 2134.76165
## factor(period)2            -387.70010   69.90180
## factor(period)3            -418.14799   39.45391
## factor(period)4            -292.06627  165.53563
## treatmentfrequentflushing   -81.25136  376.35055
## treatmentslurryfunnels     -290.50893  167.09298
```

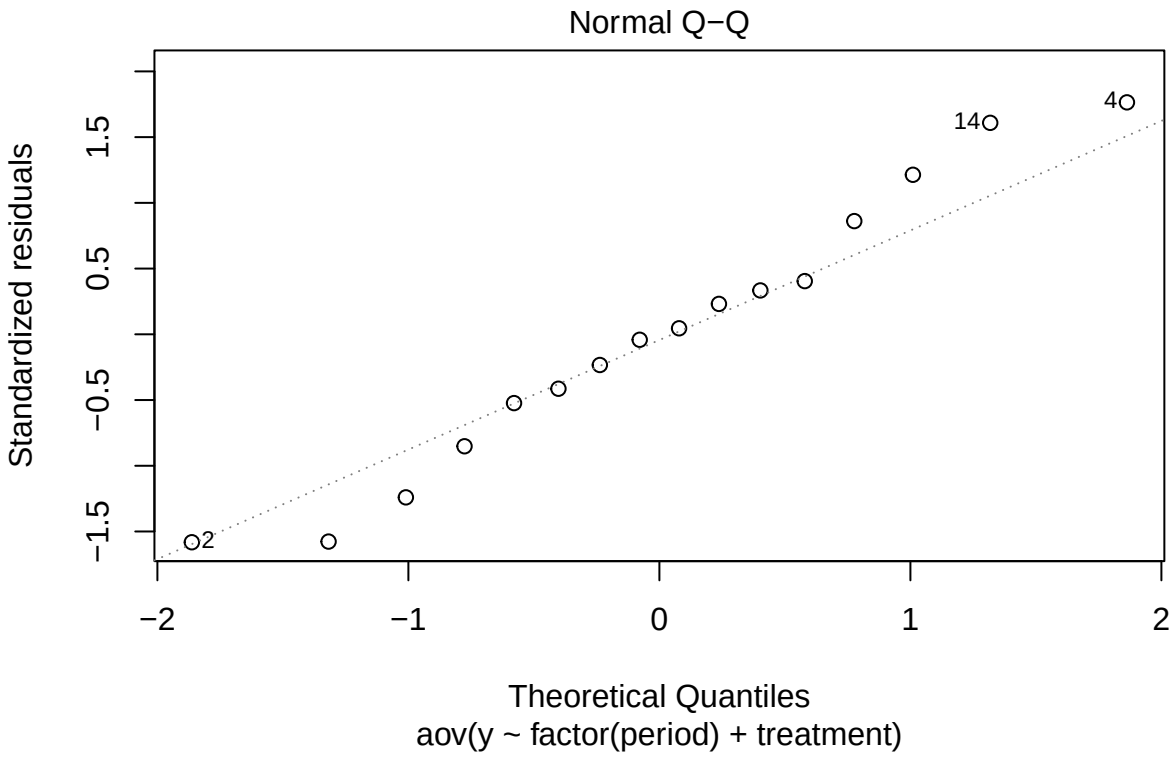
```
## treatmentslurrytrays      -263.74554  193.85636
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed aov summary:
##                Df   Sum Sq  Mean Sq F value Pr(>F)
## factor(period)  3 0.005206 0.001736   1.563  0.265
## treatment       3 0.005640 0.001880   1.693  0.237
## Residuals       9 0.009993 0.001110
## 4 observations deleted due to missingness
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed lm summary:
##
## Call:
## aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.043025 -0.014750  0.000852  0.013497  0.043762
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                 3.28390    0.02204 148.994   <2e-16 ***
## factor(period)2            -0.03678    0.02356  -1.561   0.1530
## factor(period)3            -0.04633    0.02356  -1.966   0.0808 .
## factor(period)4            -0.01587    0.02356  -0.674   0.5174
## treatmentfrequentflushing  0.03308    0.02356   1.404   0.1939
## treatmentslurryfunnels     -0.01475    0.02356  -0.626   0.5468
## treatmentslurrytrays       -0.01062    0.02356  -0.451   0.6628
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03332 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.5205, Adjusted R-squared:  0.2008
## F-statistic: 1.628 on 6 and 9 DF,  p-value: 0.2451
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed Dunnetts test:
##
##   Simultaneous Tests for General Linear Hypotheses
```

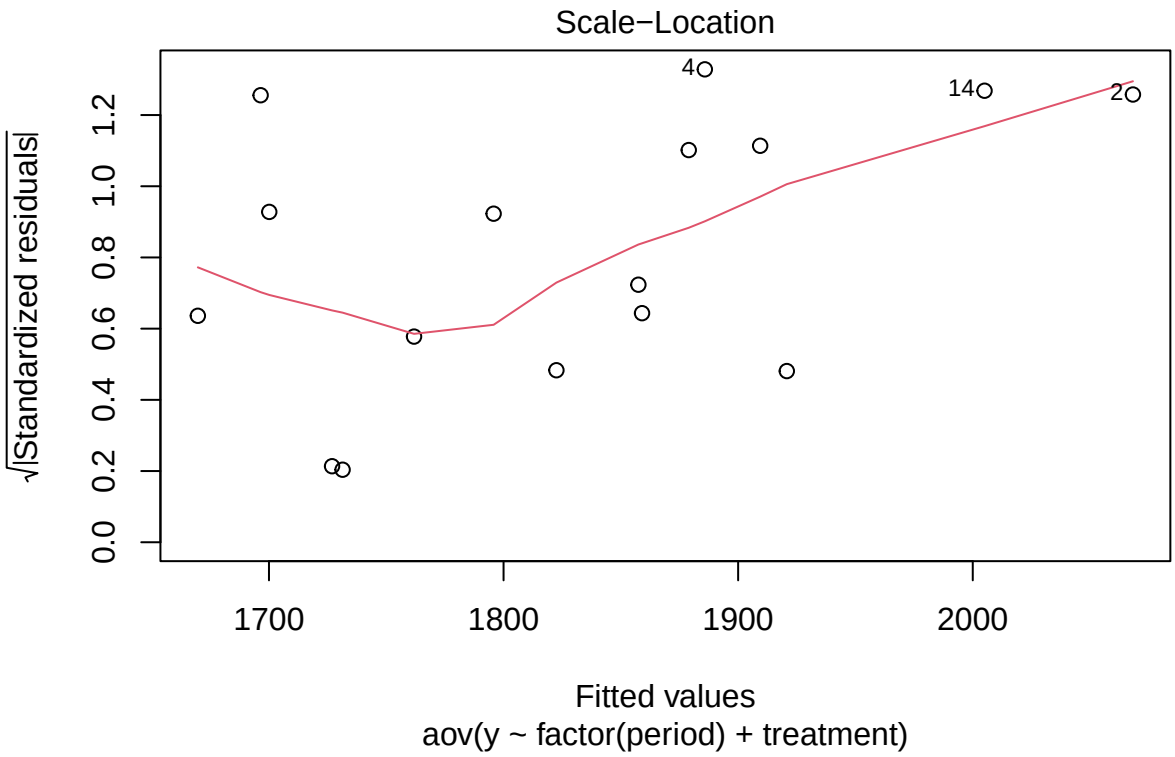
```
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  0.03308    0.02356   1.404    0.405
## slurryfunnels - control == 0    -0.01475    0.02356  -0.626    0.866
## slurrytrays - control == 0      -0.01062    0.02356  -0.451    0.941
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed confidence intervals:
##                                    2.5 %       97.5 %
## (Intercept)               171310.927768 2.155536e+05
## factor(period)2              -18.732086 3.877700e+00
## factor(period)3              -20.499137 1.619034e+00
## factor(period)4              -14.724380 9.000402e+00
## treatmentfrequentflushing     -4.549047 2.200665e+01
## treatmentslurryfunnels       -14.504227 9.281805e+00
## treatmentslurrytrays         -13.687076 1.032630e+01
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed aov summary without period:
##             Df  Sum Sq  Mean Sq F value Pr(>F)
## treatment    3 0.01214 0.004048   2.586 0.0892 .
## Residuals   16 0.02505 0.001566
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed lm summary without period:
##
## Call:
## aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.075466 -0.018899  0.003403  0.016614  0.075419
```

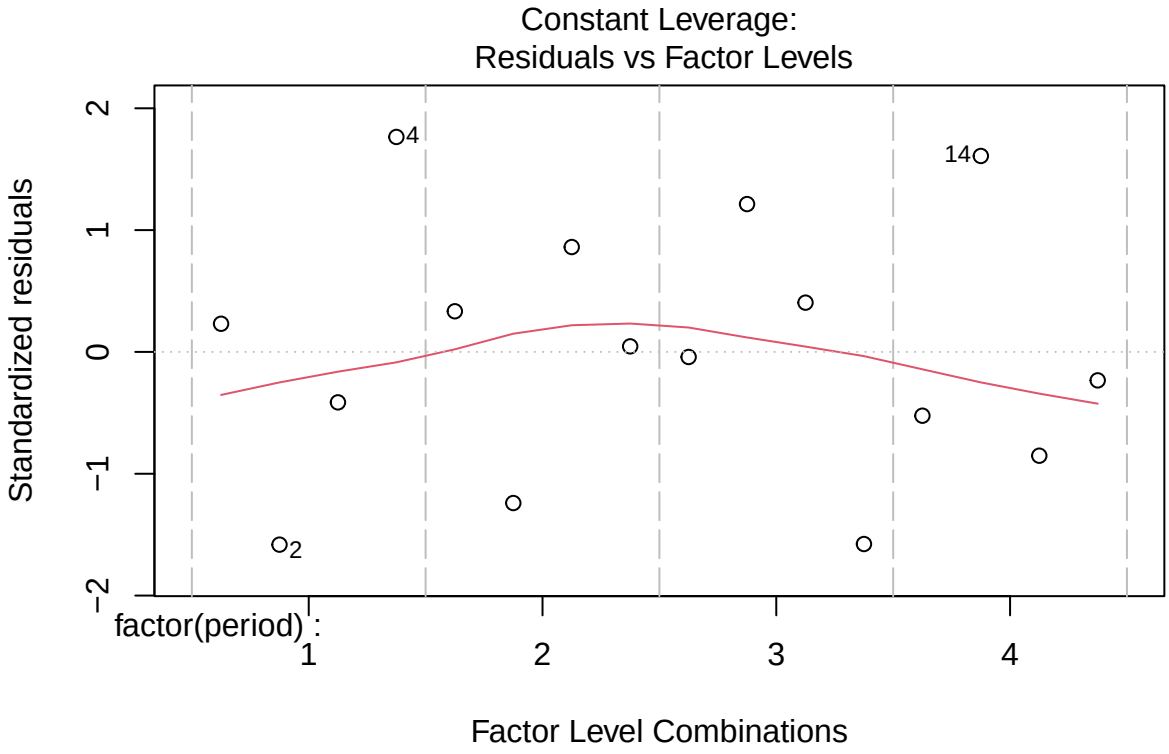
```
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)               3.240286   0.017695 183.122   <2e-16 ***
## treatmentfrequentflushing 0.059843   0.025024   2.391   0.0294 *
## treatmentslurryfunnels    0.009248   0.025024   0.370   0.7165
## treatmentslurrytrays      0.001332   0.025024   0.053   0.9582
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03957 on 16 degrees of freedom
## Multiple R-squared:  0.3265, Adjusted R-squared:  0.2002
## F-statistic: 2.586 on 3 and 16 DF,  p-value: 0.08925
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed Dunnetts test without period:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                 Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0 0.059843   0.025024   2.391   0.0734 .
## slurryfunnels - control == 0    0.009248   0.025024   0.370   0.9662
## slurrytrays - control == 0      0.001332   0.025024   0.053   0.9999
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed confidence intervals without period:
##                                   2.5 %       97.5 %
## (Intercept)               159405.319099 189482.09677
## treatmentfrequentflushing      1.576805     29.68564
## treatmentslurryfunnels        -9.593489     15.42425
## treatmentslurrytrays         -11.226517     13.33932
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
```

```
##  mean_CO2_barn
##
## Transformed relative reduction (coef):
##           factor(period)3           factor(period)4 treatmentfrequentflushing    treatmentslurryfunne
##                     -10.1                      -3.6                       7.9                      -3
##      treatmentslurrytrays
##                     -2.4
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed relative reduction without period (coef):
## treatmentfrequentflushing    treatmentslurryfunnels      treatmentslurrytrays
##                      14.8                       2.2                       0.3
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Non-transformed diagnostic plots:
```

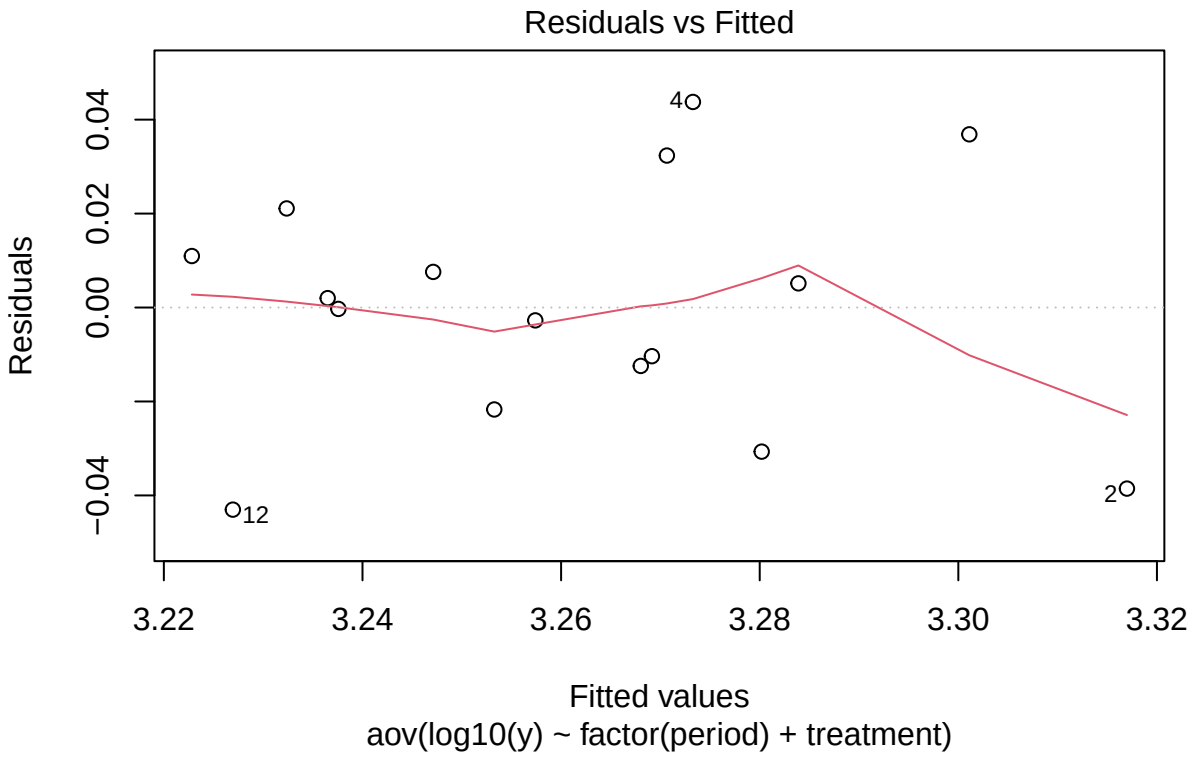


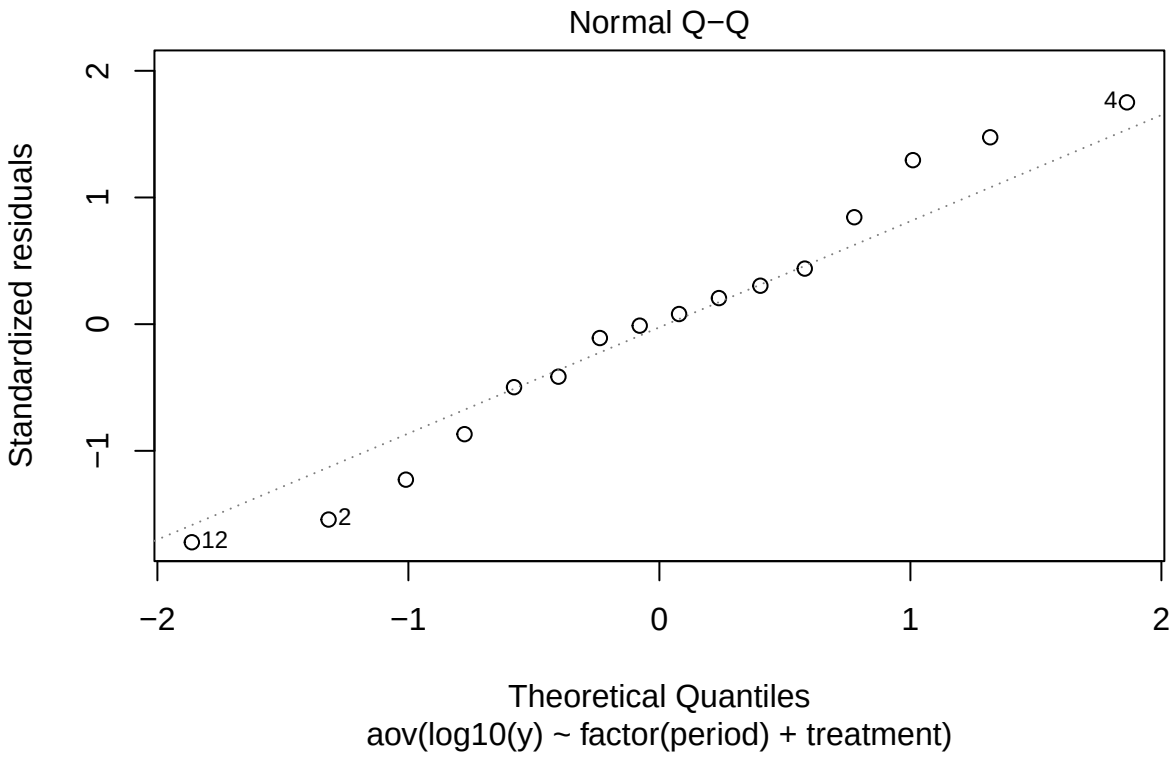

Normal Q−Q
Standardized residuals
−1.5
−0.5
0.5
1.5
2
14
4
−2
−1
0
1
2
Theoretical Quantiles
aov(y ~ factor(period) + treatment)

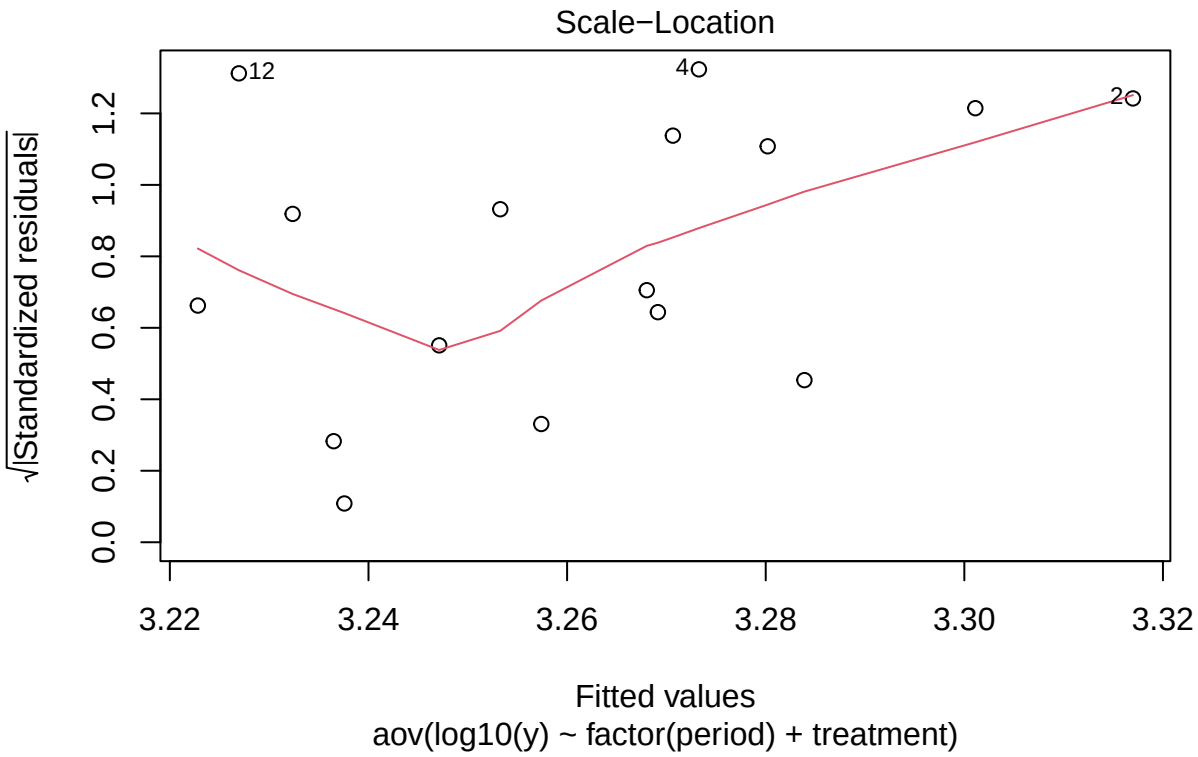

Scale−Location
√|Standardized residuals|
0.0
0.2
0.4
0.6
0.8
1.0
1.2
4
14
2
1700
1800
1900
2000
Fitted values
aov(y ~ factor(period) + treatment)

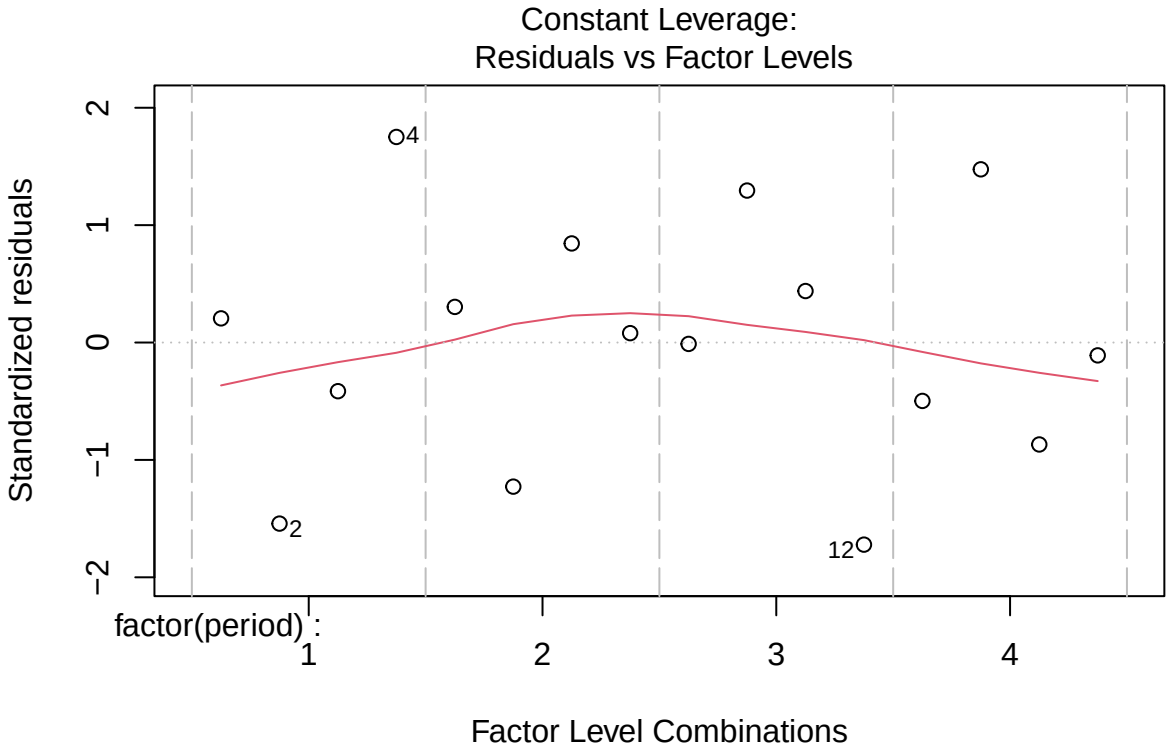



```
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed diagnostic plots:
```

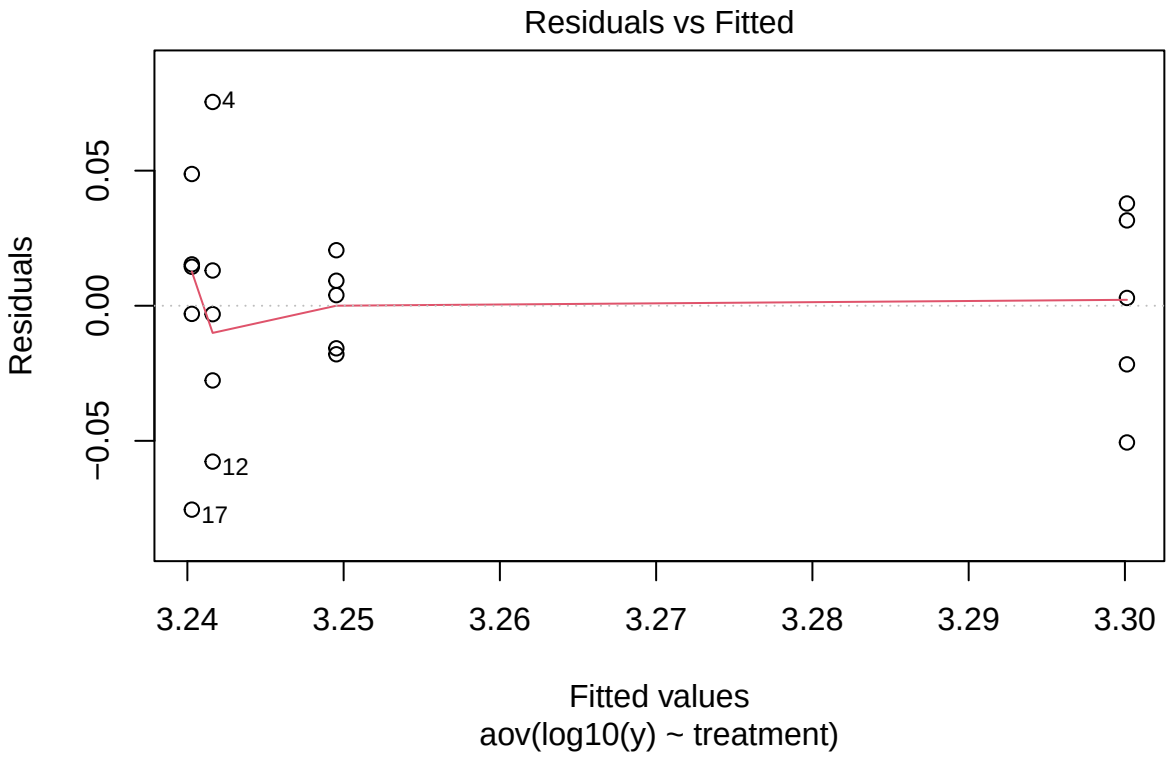

Residuals vs Fitted
Residuals
0.04
0.02
0.00
−0.04
4
12
2
3.22
3.24
3.26
3.28
3.30
3.32
Fitted values
aov(log10(y) ~ factor(period) + treatment)

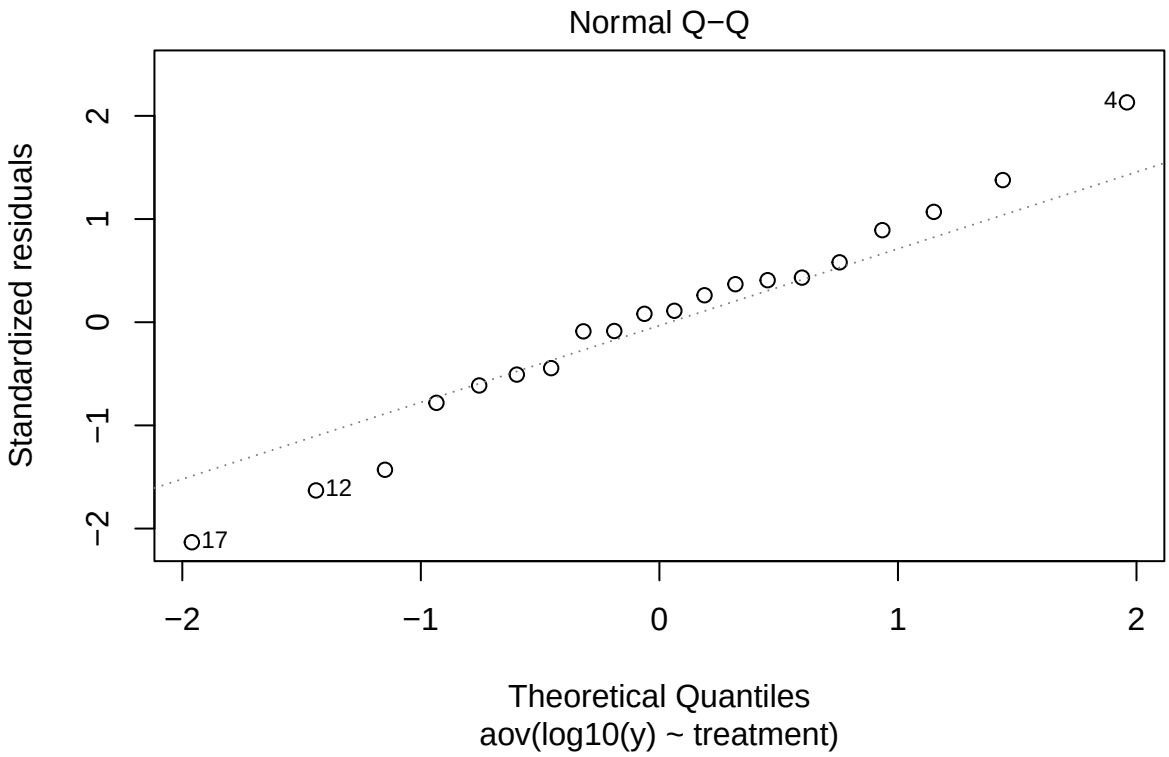

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ factor(period) + treatment)
12
2
4

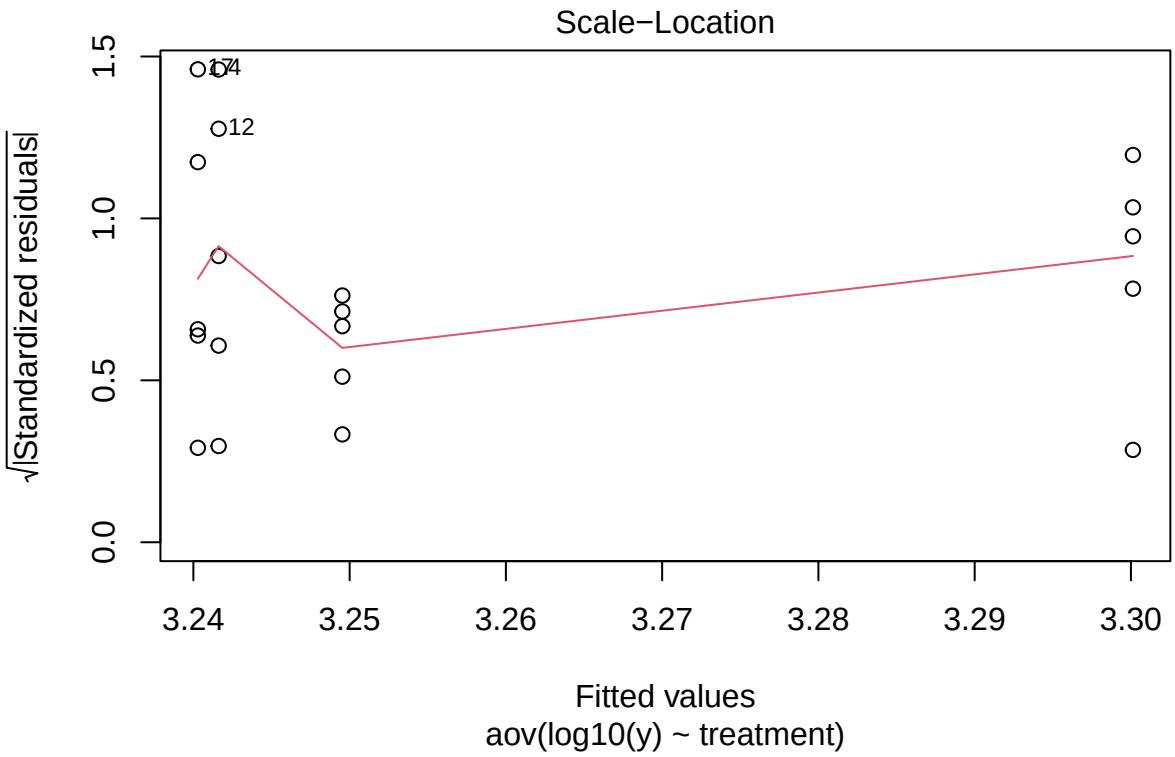

Scale−Location
√|Standardized residuals|
0.0
0.2
0.4
0.6
0.8
1.0
1.2
12
4
2
3.22
3.24
3.26
3.28
3.30
3.32
Fitted values
aov(log10(y) ~ factor(period) + treatment)

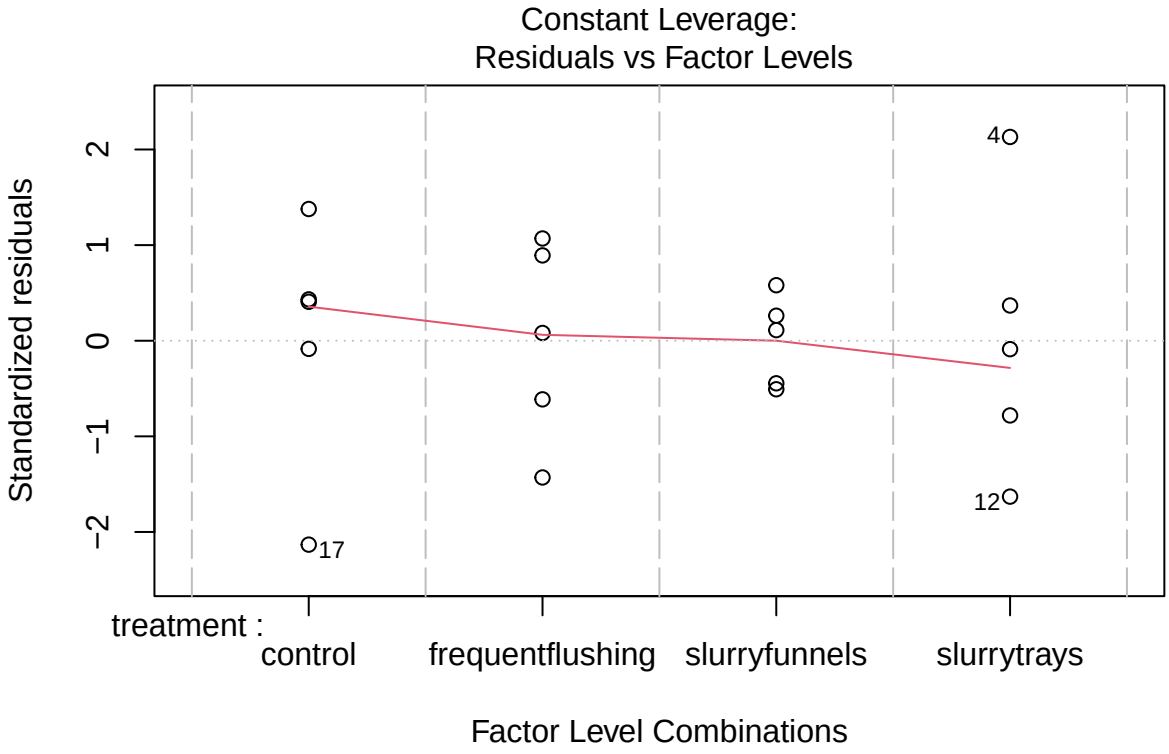



```
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
## Transformed diagnostic plots without period:
```


Residuals vs Fitted
Residuals
0.05
0.00
−0.05
4
12
17
3.24
3.25
3.26
3.27
3.28
3.29
3.30
Fitted values
aov(log10(y) ~ treatment)


Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ treatment)
4
12
17
−2
−1
0
1
2

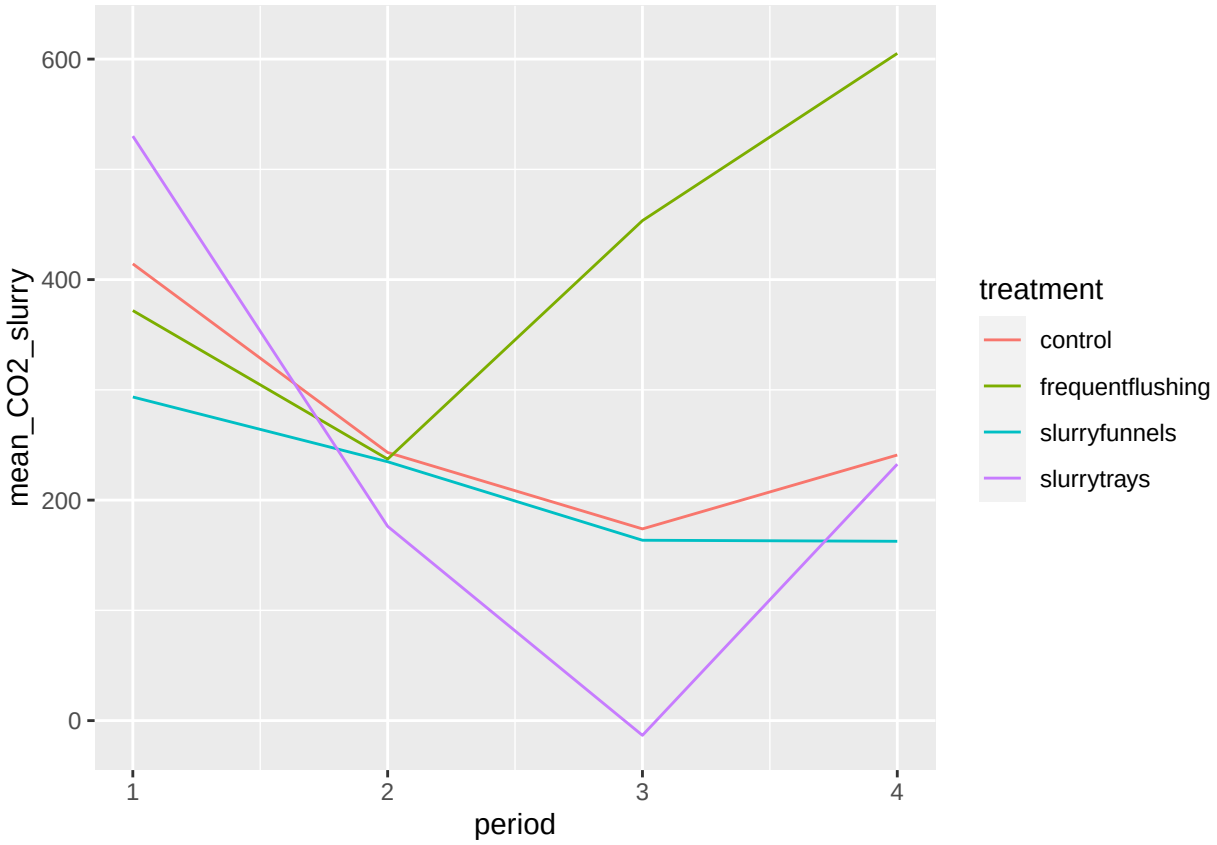

Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
3.24
3.25
3.26
3.27
3.28
3.29
3.30
Fitted values
aov(log10(y) ~ treatment)




```
##
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##  mean_CO2_barn
##
##
##
##
##  end mean_CO2_barn end mean_CO2_barn end mean_CO2_barn
##
##  end mean_CO2_barn end mean_CO2_barn end mean_CO2_barn
##
##  end mean_CO2_barn end mean_CO2_barn end mean_CO2_barn
##
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
```

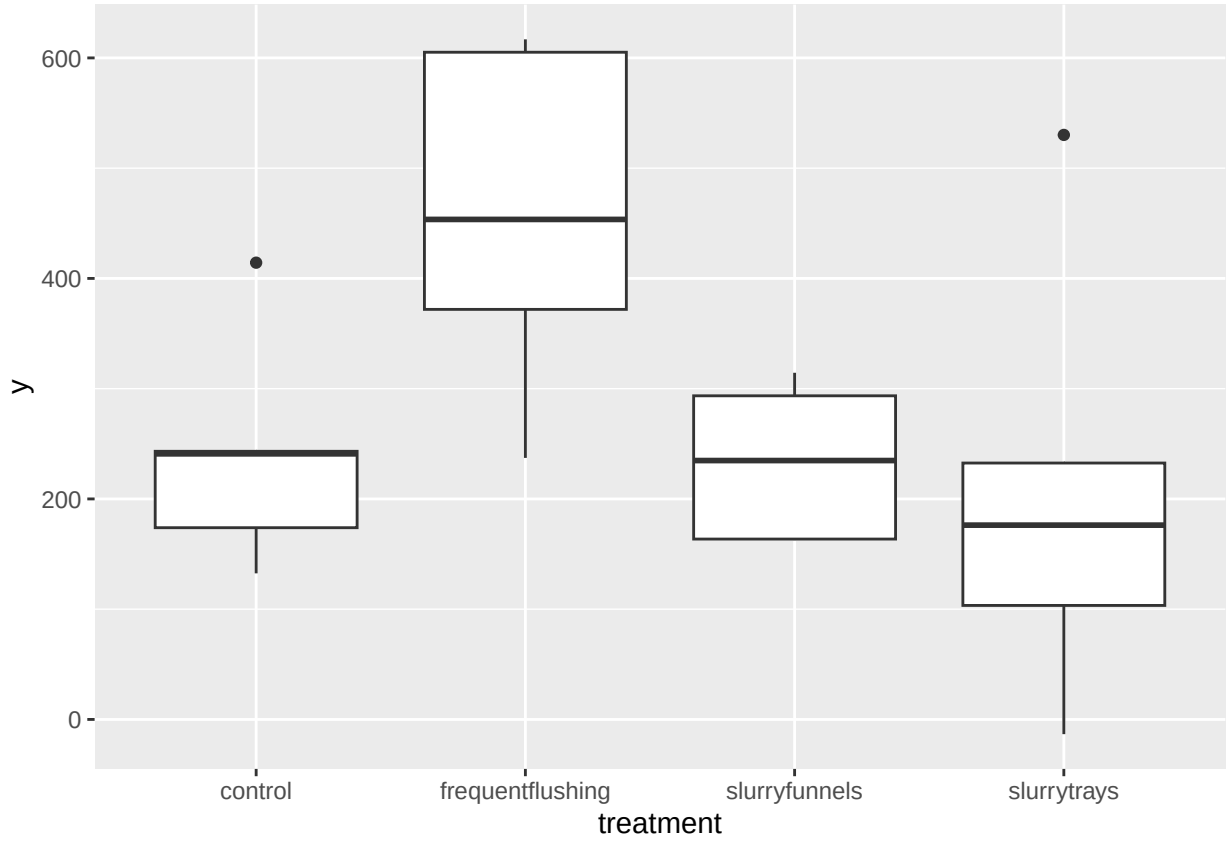
```
##  mean_CO2_slurry
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
```

```
## Warning: Removed 4 rows containing missing values (‘geom_line()‘).
```




```
## Warning in eval(predvars, data, env): NaNs produced
```

```
## Warning in eval(predvars, data, env): NaNs produced
```




```
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Non-transformed aov summary:
##                Df Sum Sq Mean Sq F value Pr(>F)
## factor(period)  3 105940   35313   1.975  0.188
## treatment       3 102555   34185   1.912  0.198
## Residuals       9 160891   17877
## 4 observations deleted due to missingness
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Non-transformed lm summary:
##
## Call:
## aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -164.986  -60.929   -0.789   48.737  178.799
```

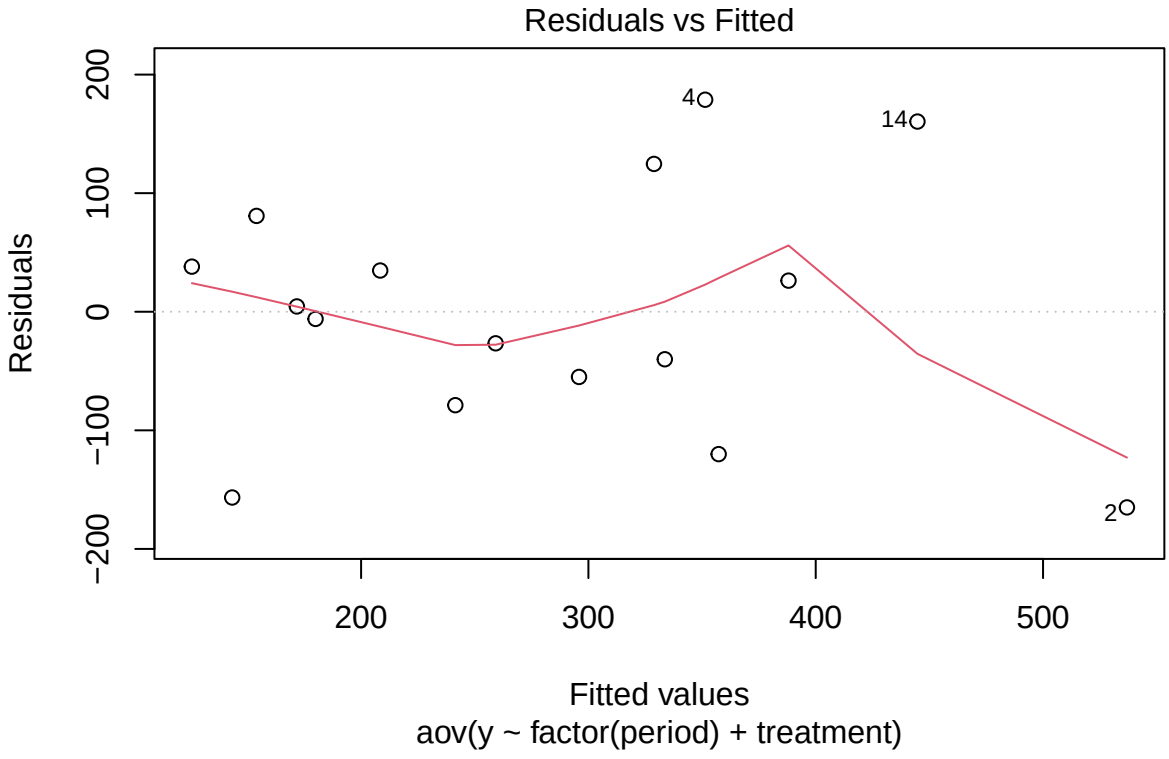
```
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  388.03      88.44   4.388  0.00175 **
## factor(period)2             -179.62      94.54  -1.900  0.08991 .
## factor(period)3             -208.07      94.54  -2.201  0.05527 .
## factor(period)4              -92.16      94.54  -0.975  0.35513
## treatmentfrequentflushing    148.88      94.54   1.575  0.14976
## treatmentslurryfunnels       -54.42      94.54  -0.576  0.57896
## treatmentslurrytrays         -36.68      94.54  -0.388  0.70709
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 133.7 on 9 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.5644, Adjusted R-squared:  0.2741
## F-statistic: 1.944 on 6 and 9 DF,  p-value: 0.1777
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Non-transformed Dunnett s test:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = y ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0   148.88      94.54   1.575    0.323
## slurryfunnels - control == 0      -54.42      94.54  -0.576    0.890
## slurrytrays - control == 0        -36.68      94.54  -0.388    0.961
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Non-transformed confidence intervals:
##                                 2.5 %     97.5 %
## (Intercept)                187.97226 588.088953
## factor(period)2           -393.48755  34.255190
## factor(period)3           -421.93793   5.804805
## factor(period)4           -306.03106 121.711681
## treatmentfrequentflushing  -64.98727 362.755463
## treatmentslurryfunnels    -268.29474 159.448001
```

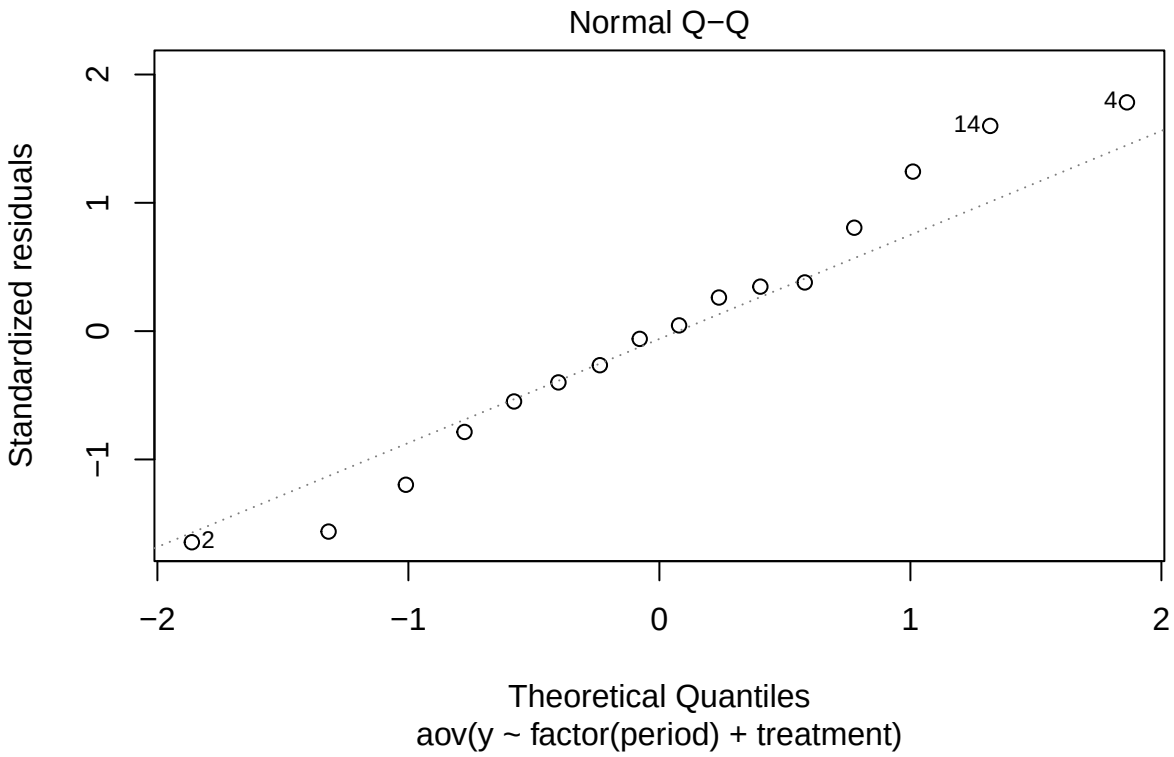
```
## treatmentslurrytrays      -250.54674 177.195999
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed aov summary:
##                Df Sum Sq Mean Sq F value Pr(>F)
## factor(period)  3 0.1472 0.04908   2.132  0.174
## treatment       3 0.1642 0.05473   2.377  0.146
## Residuals       8 0.1842 0.02302
## 5 observations deleted due to missingness
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed lm summary:
##
## Call:
## aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.18531 -0.09133 -0.02469  0.10005  0.18567
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2.56610    0.10115  25.370 6.24e-09 ***
## factor(period)2           -0.25049    0.10728  -2.335   0.0478 *
## factor(period)3           -0.22894    0.11861  -1.930   0.0897 .
## factor(period)4           -0.15958    0.10728  -1.487   0.1752
## treatmentfrequentflushing  0.18967    0.10728   1.768   0.1151
## treatmentslurryfunnels    -0.09050    0.10728  -0.844   0.4234
## treatmentslurrytrays       0.01625    0.11861   0.137   0.8944
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1517 on 8 degrees of freedom
##   (5 observations deleted due to missingness)
## Multiple R-squared:  0.6284, Adjusted R-squared:  0.3497
## F-statistic: 2.255 on 6 and 8 DF,  p-value: 0.1423
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed Dunnetts test:
##
##   Simultaneous Tests for General Linear Hypotheses
```

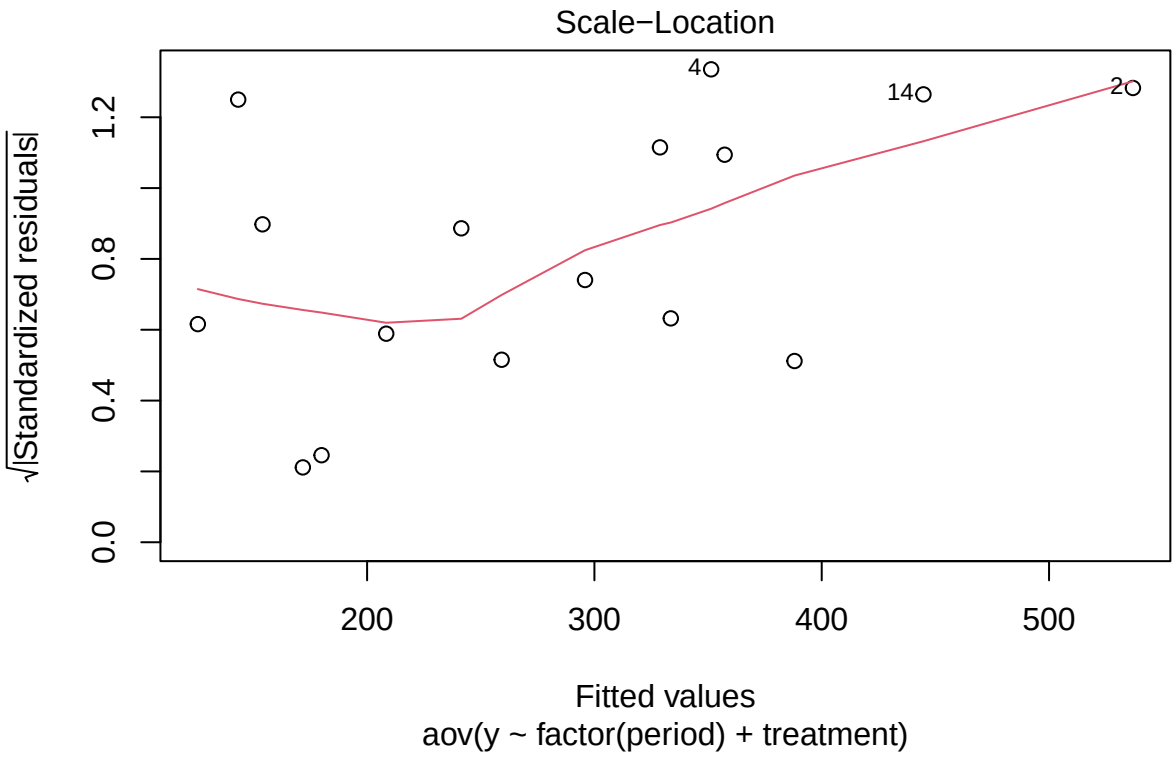
```
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ factor(period) + treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  0.18967    0.10728   1.768    0.257
## slurryfunnels - control == 0    -0.09050    0.10728  -0.844    0.747
## slurrytrays - control == 0       0.01625    0.11861   0.137    0.998
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed confidence intervals:
##                                   2.5 %        97.5 %
## (Intercept)                21420.44490 62901.3733373
## factor(period)2              -68.22298    -0.7090115
## factor(period)3              -68.55520    10.8069761
## factor(period)4              -60.82376    22.4107039
## treatmentfrequentflushing    -12.44678   173.5701917
## treatmentslurryfunnels       -54.06948    43.5152359
## treatmentslurrytrays         -44.69744    94.8783290
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed aov summary without period:
##             Df Sum Sq Mean Sq F value Pr(>F)
## treatment    3 0.3055  0.1018   2.578 0.0924 .
## Residuals   15 0.5925  0.0395
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 1 observation deleted due to missingness
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed lm summary without period:
##
## Call:
## aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

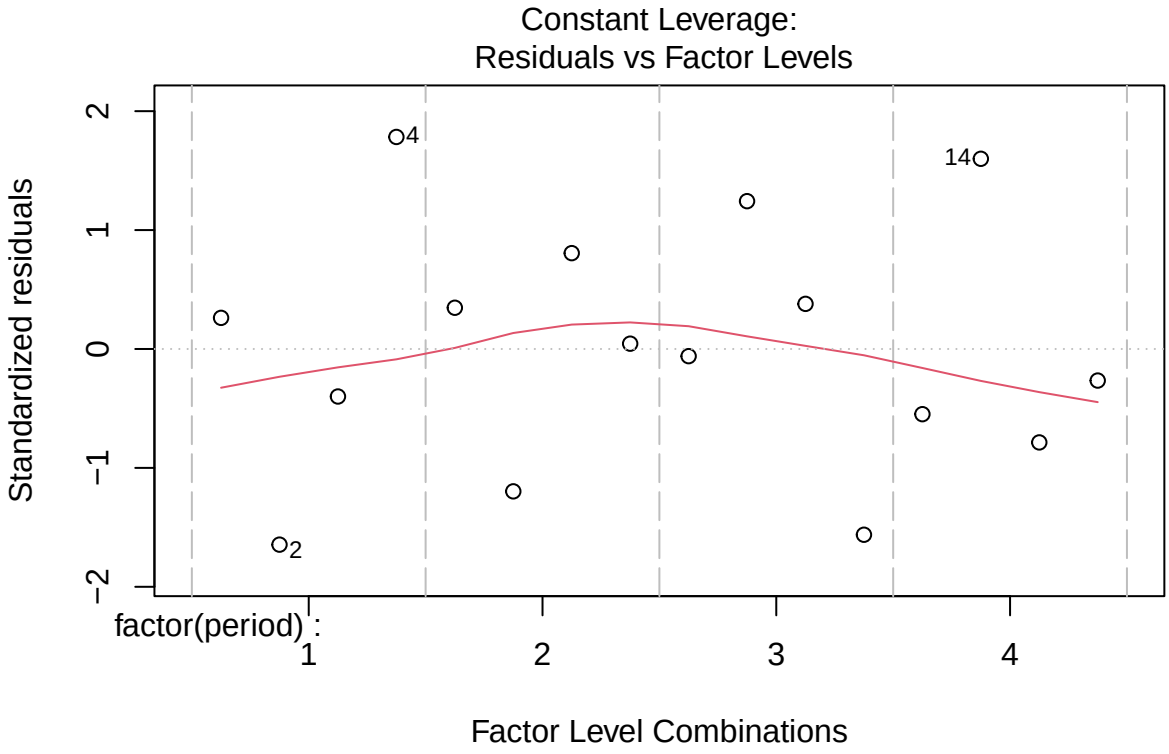
```
## -0.32338 -0.12382  0.02174  0.13041  0.38653
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                2.349517   0.088884  26.433 5.37e-14 ***
## treatmentfrequentflushing  0.285333   0.125701   2.270   0.0384 *
## treatmentslurryfunnels     0.002664   0.125701   0.021   0.9834
## treatmentslurrytrays      -0.011646   0.133327  -0.087   0.9315
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1988 on 15 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.3402, Adjusted R-squared:  0.2082
## F-statistic: 2.578 on 3 and 15 DF,  p-value: 0.0924
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed Dunnetts test without period:
##
##   Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Dunnett Contrasts
##
##
## Fit: aov(formula = log10(y) ~ treatment, data = emis_dat)
##
## Linear Hypotheses:
##                                  Estimate Std. Error t value Pr(>|t|)
## frequentflushing - control == 0  0.285333   0.125701   2.270   0.0953 .
## slurryfunnels - control == 0     0.002664   0.125701   0.021   1.0000
## slurrytrays - control == 0      -0.011646   0.133327  -0.087   0.9995
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
##
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed confidence intervals without period:
##                                  2.5 %      97.5 %
## (Intercept)                14356.553890 34491.53020
## treatmentfrequentflushing      4.089393   257.48602
## treatmentslurryfunnels       -45.707728    86.46211
## treatmentslurrytrays         -49.397113    87.29785
##
##  mean_CO2_slurry
```

```
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed relative reduction (coef):
##           factor(period)3           factor(period)4 treatmentfrequentflushing    treatmentslurryfunne
##                     -41.0                     -30.7                      54.8                     -18
##      treatmentslurrytrays
##                       3.8
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed relative reduction without period (coef):
## treatmentfrequentflushing    treatmentslurryfunnels      treatmentslurrytrays
##                      92.9                       0.6                      -2.6
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Non-transformed diagnostic plots:
```

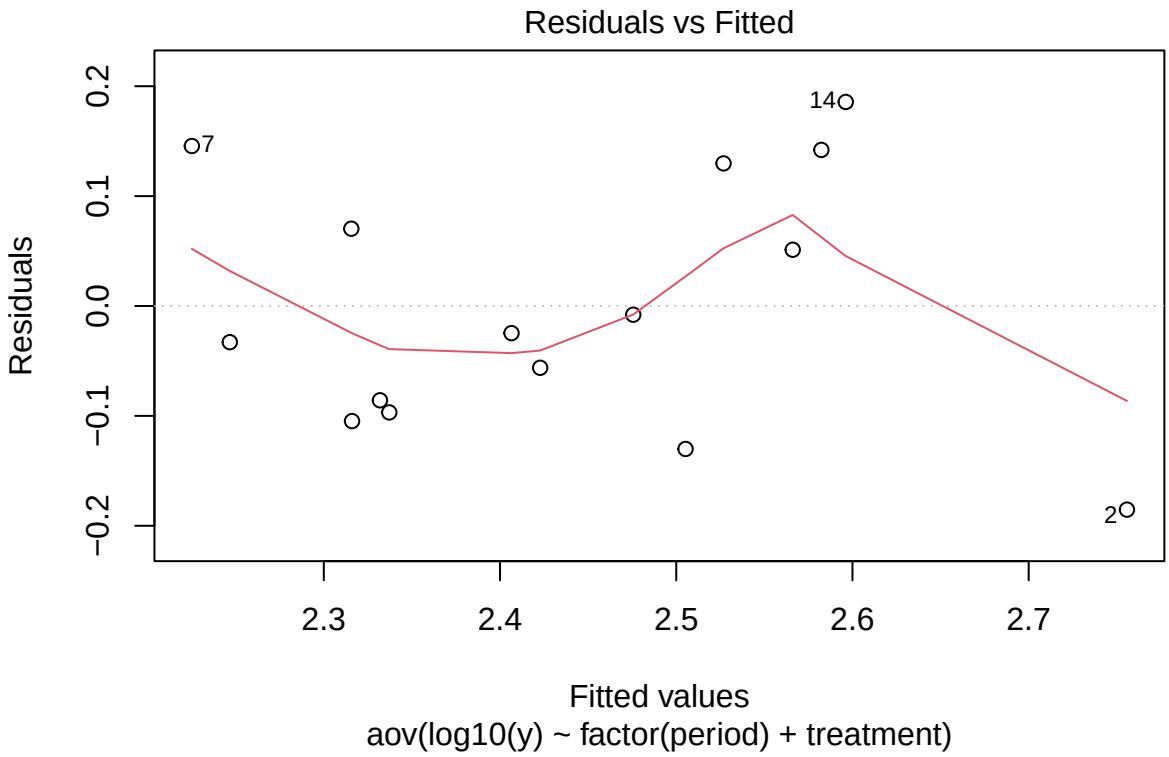


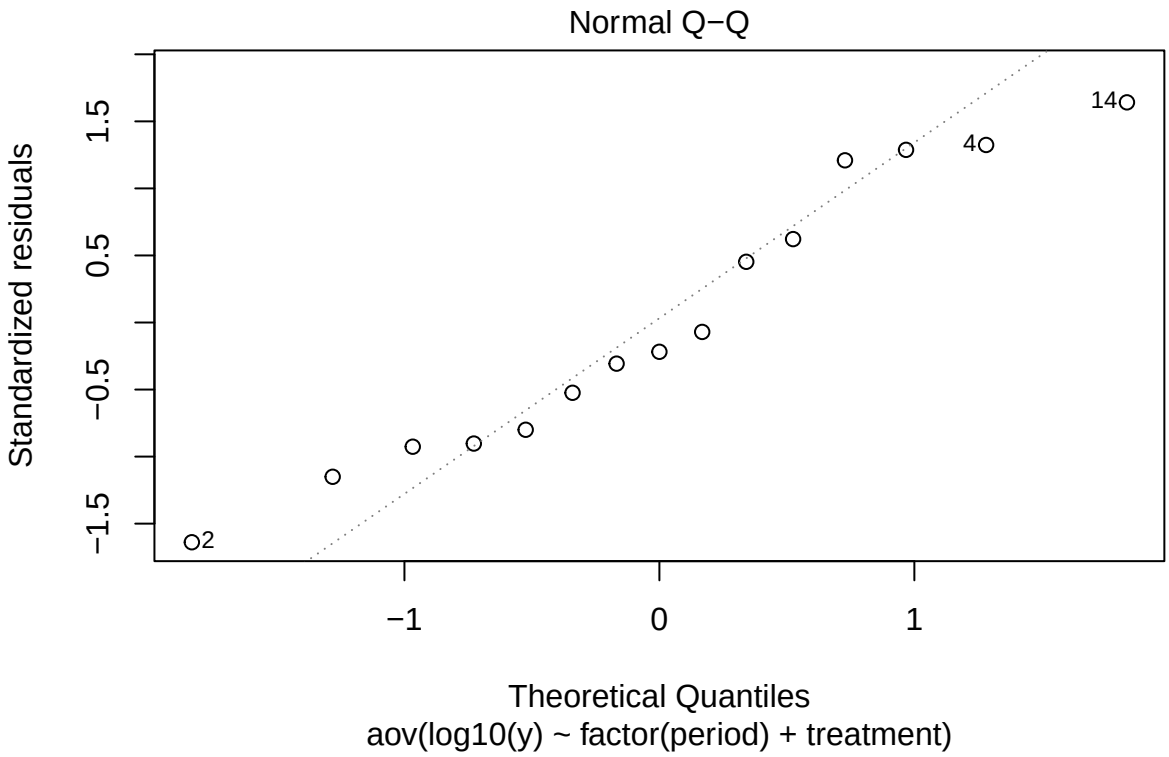

Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(y ~ factor(period) + treatment)
2
14
4
−2
−1
0
1
2

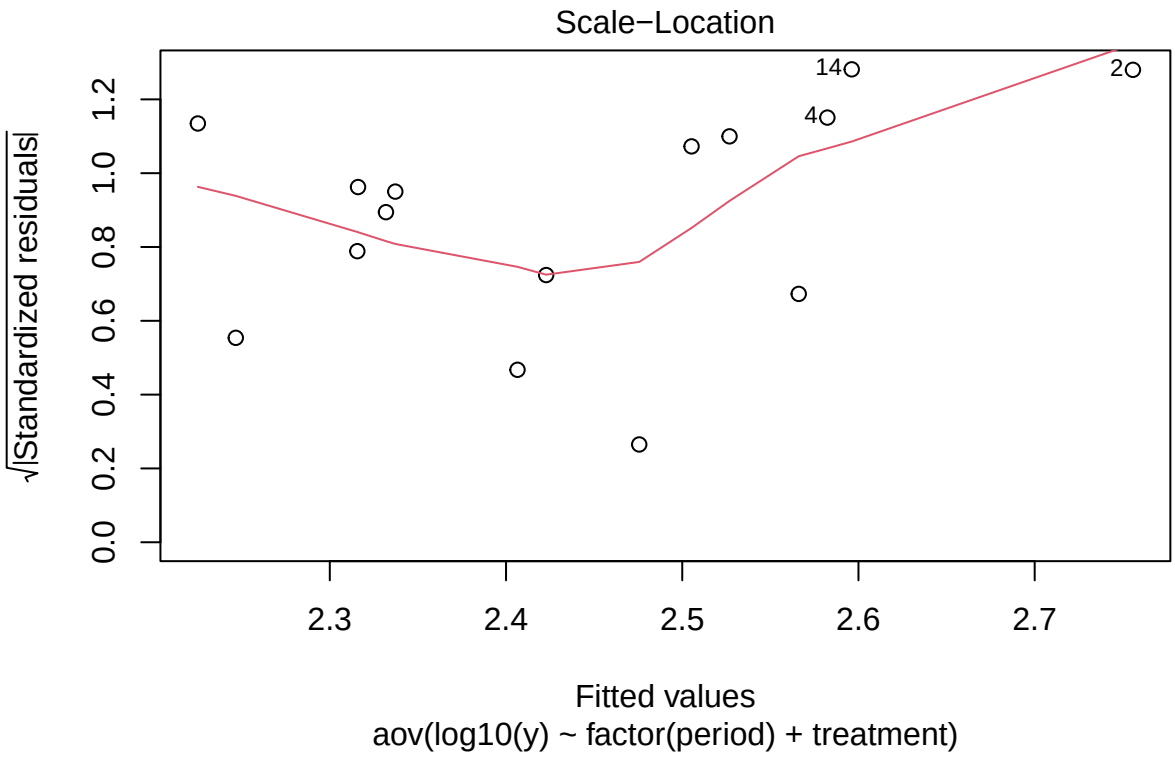

Scale−Location
√|Standardized residuals|
0.0
0.4
0.8
1.2
200
300
400
500
4
14
2
Fitted values
aov(y ~ factor(period) + treatment)

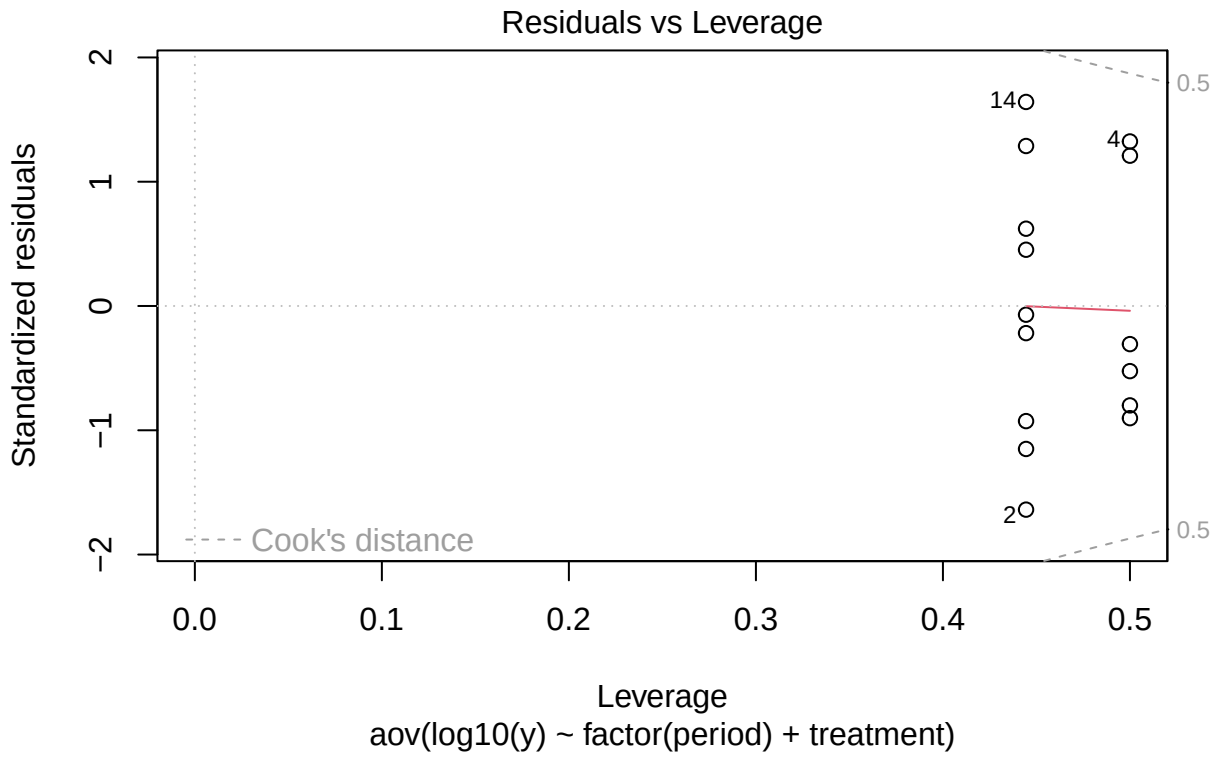



```
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed diagnostic plots:
```

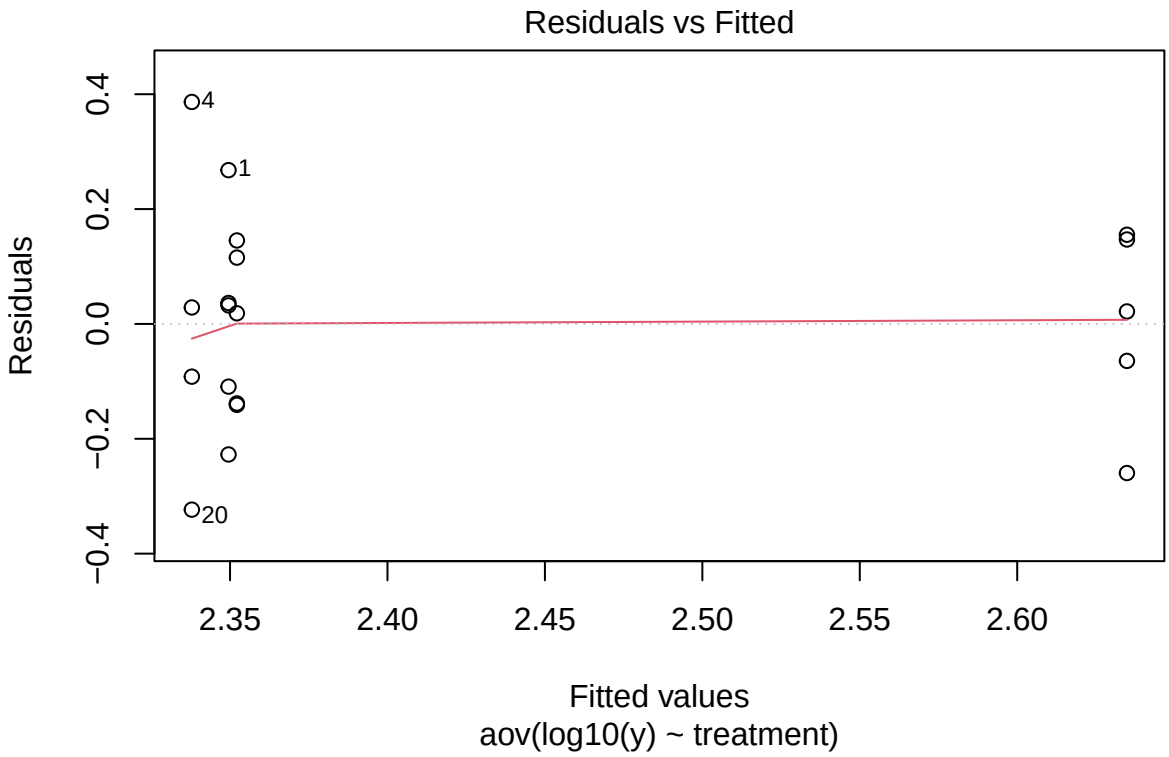

Residuals vs Fitted
Residuals
0.2
0.1
0.0
−0.1
−0.2
7
14
2
2.3
2.4
2.5
2.6
2.7
Fitted values
aov(log10(y) ~ factor(period) + treatment)

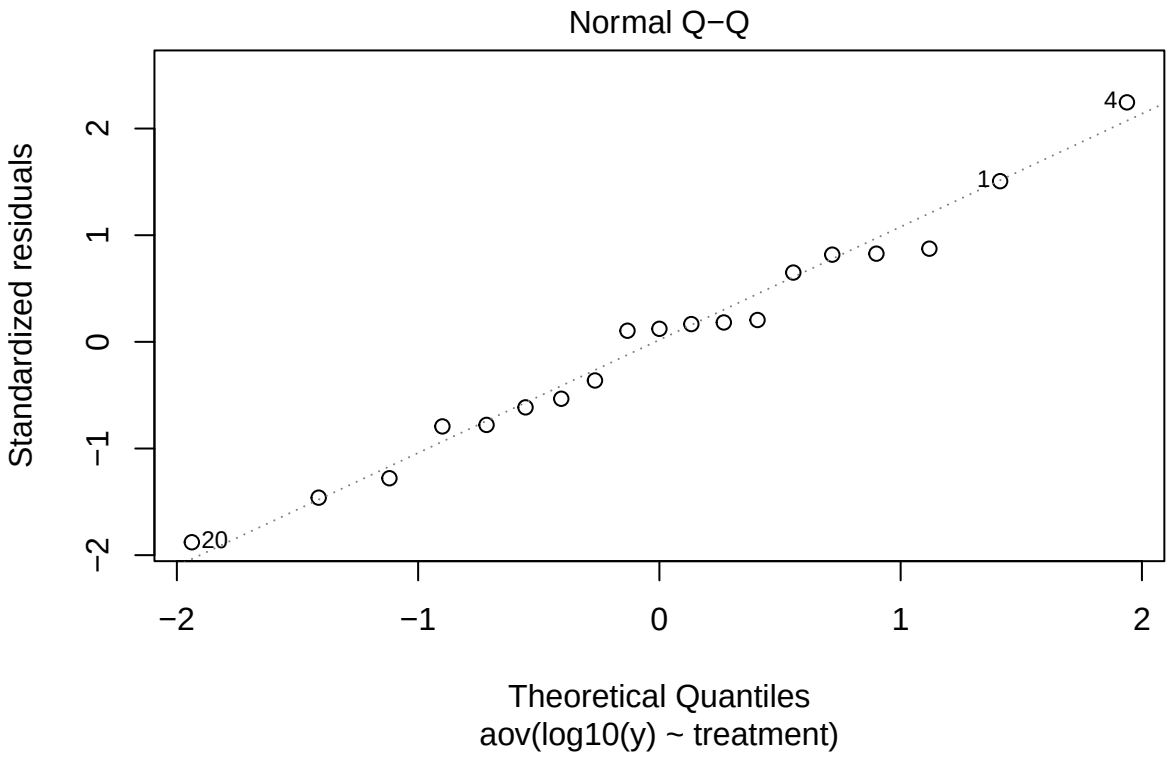

Normal Q−Q
Standardized residuals
1.5
0.5
−0.5
−1.5
2
14
4
−1
0
1
Theoretical Quantiles
aov(log10(y) ~ factor(period) + treatment)

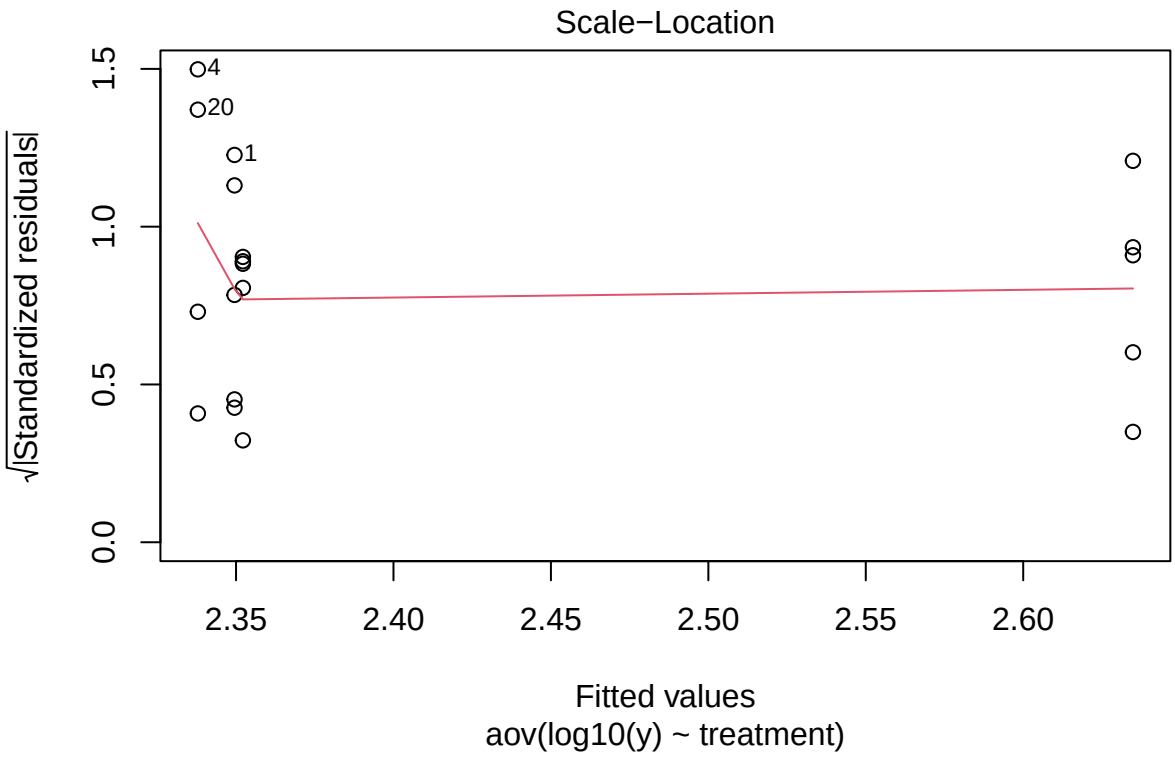

Scale−Location
√|Standardized residuals|
0.0
0.2
0.4
0.6
0.8
1.0
1.2
14
4
2
2.3
2.4
2.5
2.6
2.7
Fitted values
aov(log10(y) ~ factor(period) + treatment)

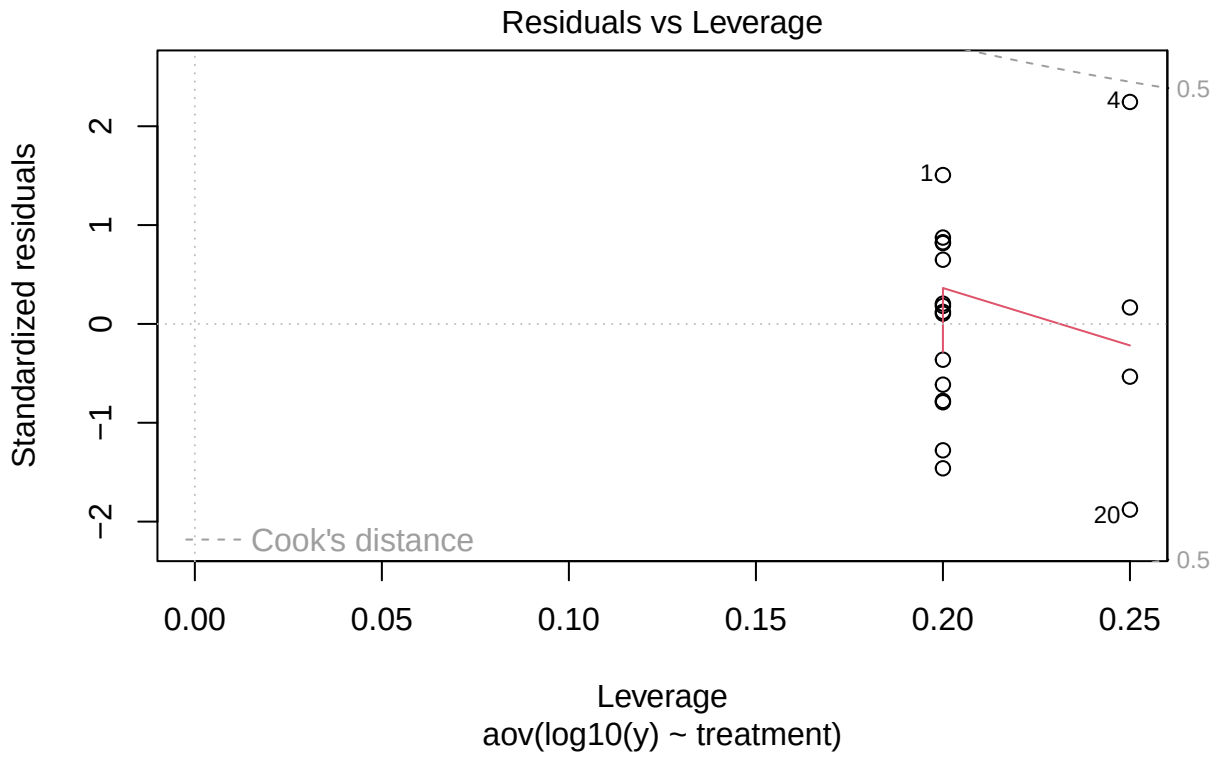



```
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
## Transformed diagnostic plots without period:
```


Residuals vs Fitted
Residuals
0.4
0.2
0.0
−0.2
−0.4
4
1
20
2.35
2.40
2.45
2.50
2.55
2.60
Fitted values
aov(log10(y) ~ treatment)


Normal Q−Q
Standardized residuals
Theoretical Quantiles
aov(log10(y) ~ treatment)
20
1
4
−2
−1
0
1
2


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
4
20
1
2.35
2.40
2.45
2.50
2.55
2.60
Fitted values
aov(log10(y) ~ treatment)




```
##
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##  mean_CO2_slurry
##
##
##
##
##  end mean_CO2_slurry end mean_CO2_slurry end mean_CO2_slurry
##
##  end mean_CO2_slurry end mean_CO2_slurry end mean_CO2_slurry
##
##  end mean_CO2_slurry end mean_CO2_slurry end mean_CO2_slurry
```