

Buoy

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Import data

The first step is to download the data from 2000 to 2019 on the NDBC. in these data, the variable types are not exactly the same from year to year, we need to delete some columns, such as the variable tide and the duplicate variable mm. Then, we connect the year's data together to get a data frame that contains all the data.

```
library(data.table)
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.3.0 --

## v ggplot2 3.3.2      v purrr  0.3.4
## v tibble  3.0.3      v dplyr  1.0.2
## v tidyr   1.1.2      v stringr 1.4.0
## v readr   1.3.1      v forcats 0.5.0

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::between()   masks data.table::between()
## x dplyr::filter()    masks stats::filter()
## x dplyr::first()     masks data.table::first()
## x dplyr::lag()       masks stats::lag()
## x dplyr::last()      masks data.table::last()
## x purrr::transpose() masks data.table::transpose()

library(lubridate)

##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:data.table':
##
##     hour, isoweek, mday, minute, month, quarter, second, wday, week,
##     yday, year

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union

setwd("D:\\Documents\\R Project\\615\\buoy project\\data")

#2000
Buoy2000<-read.csv("buoy2000.txt",sep=" ",header = T)
Buoy2000$TIDE<-0
Buoy2000$mm<-0
colnames(Buoy2000)[1]<-"X.YY"
```

```

colnames(Buoy2000)[5]<-"WDIR"
colnames(Buoy2000)[12]<-"PRES"

#2001
Buoy2001<-read.csv("buoy2001.txt",sep=" ",header = T)
Buoy2001$mm<-0
colnames(Buoy2001)[1]<-"X.YY"
colnames(Buoy2001)[5]<-"WDIR"
colnames(Buoy2001)[12]<-"PRES"

#2002
Buoy2002<-read.csv("buoy2002.txt",sep=" ",header = T)
Buoy2002$mm<-0
colnames(Buoy2002)[1]<-"X.YY"
colnames(Buoy2002)[5]<-"WDIR"
colnames(Buoy2002)[12]<-"PRES"

#2003
Buoy2003<-read.csv("buoy2003.txt",sep=" ",header = T)
Buoy2003$mm<-0
colnames(Buoy2003)[1]<-"X.YY"
colnames(Buoy2003)[5]<-"WDIR"
colnames(Buoy2003)[12]<-"PRES"

#2004
Buoy2004<-read.csv("buoy2004.txt",sep=" ",header = T)
Buoy2004$mm<-0
colnames(Buoy2004)[1]<-"X.YY"
colnames(Buoy2004)[5]<-"WDIR"
colnames(Buoy2004)[12]<-"PRES"

#2005
Buoy2005<-read.csv("buoy2005.txt",sep=" ",header = T)
mm2005<-Buoy2005$mm
Buoy2005$mm<-NULL
Buoy2005$mm<-mm2005
colnames(Buoy2005)[1]<-"X.YY"
colnames(Buoy2005)[5]<-"WDIR"
colnames(Buoy2005)[12]<-"PRES"

#2006
Buoy2006<-read.csv("buoy2006.txt",sep=" ",header = T)
mm2006<-Buoy2006$mm
Buoy2006$mm<-NULL
Buoy2006$mm<-mm2006
colnames(Buoy2006)[1]<-"X.YY"
colnames(Buoy2006)[5]<-"WDIR"
colnames(Buoy2006)[12]<-"PRES"

#2007
Buoy2007<-read.csv("buoy2007.txt",sep=" ",header = T)
mm2007<-Buoy2007$mm

```

```

Buoy2007$mm<-NULL
Buoy2007$mm<-mm2007
Buoy2007 = Buoy2007[-c(1),]

#2008
Buoy2008<-read.csv("buoy2008.txt",sep="",header = T)
mm2008<-Buoy2008$mm
Buoy2008$mm<-NULL
Buoy2008$mm<-mm2008
Buoy2008 = Buoy2008[-c(1),]

#2009
Buoy2009<-read.csv("buoy2009.txt",sep="",header = T)
mm2009<-Buoy2009$mm
Buoy2009$mm<-NULL
Buoy2009$mm<-mm2009
Buoy2009 = Buoy2009[-c(1),]

#2010
Buoy2010<-read.csv("buoy2010.txt",sep="",header = T)
mm2010<-Buoy2010$mm
Buoy2010$mm<-NULL
Buoy2010$mm<-mm2010
Buoy2010 = Buoy2010[-c(1),]

#2011
Buoy2011<-read.csv("buoy2011.txt",sep="",header = T)
mm2011<-Buoy2011$mm
Buoy2011$mm<-NULL
Buoy2011$mm<-mm2011
Buoy2011 = Buoy2011[-c(1),]

#2012
Buoy2012<-read.csv("buoy2012.txt",sep="",header = T)
mm2012<-Buoy2012$mm
Buoy2012$mm<-NULL
Buoy2012$mm<-mm2012
Buoy2012 = Buoy2012[-c(1),]

#2013
Buoy2013<-read.csv("buoy2013.txt",sep="",header = T)
mm2013<-Buoy2013$mm
Buoy2013$mm<-NULL
Buoy2013$mm<-mm2013
Buoy2013 = Buoy2013[-c(1),]

#2014
Buoy2014<-read.csv("buoy2014.txt",sep="",header = T)
mm2014<-Buoy2014$mm
Buoy2014$mm<-NULL
Buoy2014$mm<-mm2014
Buoy2014 = Buoy2014[-c(1),]

```

```

#2015
Buoy2015<-read.csv("buoy2015.txt",sep=" ",header = T)
mm2015<-Buoy2015$mm
Buoy2015$mm<-NULL
Buoy2015$mm<-mm2015
Buoy2015 = Buoy2015[-c(1),]

#2016
Buoy2016<-read.csv("buoy2016.txt",sep=" ",header = T)
mm2016<-Buoy2016$mm
Buoy2016$mm<-NULL
Buoy2016$mm<-mm2016
Buoy2016 = Buoy2016[-c(1),]

#2017
Buoy2017<-read.csv("buoy2017.txt",sep=" ",header = T)
mm2017<-Buoy2017$mm
Buoy2017$mm<-NULL
Buoy2017$mm<-mm2017
Buoy2017 = Buoy2017[-c(1),]

#2018
Buoy2018<-read.csv("buoy2018.txt",sep=" ",header = T)
mm2018<-Buoy2018$mm
Buoy2018$mm<-NULL
Buoy2018$mm<-mm2018
Buoy2018 = Buoy2018[-c(1),]

#2019
Buoy2019<-read.csv("buoy2019.txt",sep=" ",header = T)
mm2019<-Buoy2019$mm
Buoy2019$mm<-NULL
Buoy2019$mm<-mm2019
Buoy2019 = Buoy2019[-c(1),]

#Combine
Buoy<-rbind(Buoy2000,Buoy2001,Buoy2002,Buoy2003,Buoy2004,Buoy2005,Buoy2006,Buoy2007,Buoy2008,Buoy2009,B

```

There are some outliers, like temperatures above 50 degrees and some observations of 999. These are obviously not practical. Therefore, we only choose the observations meeting our requirements to create a new date set.

```

Buoy[Buoy==99|Buoy==999|Buoy==9999]<-0

Buoy <- Buoy [, -11]
Buoy <- Buoy [, -15:-17]

#remove outliers
a <- Buoy %>% select(X.YY, MM, DD, hh)

a2 <- as.data.frame(lapply(a,as.numeric))

```

```

D_date<- make_datetime(year=a2$X.YY, month=a2$MM, day=a2$DD, hour=a2$hh)
Buoy$D_date <- D_date
cols <- colnames(Buoy)
new_cols <- c(cols[1], cols[length(cols)], cols[2:(length(cols) - 1)])
Buoy <- Buoy[, new_cols]
Buoy <- Buoy[,c(-1,-3:-5)]
Buoy <- filter(Buoy, DEWP < 999 & ATMP < 50 & WTMP < 50)
Buoy$D_date <- as.POSIXct(Buoy$D_date)
Buoy[,2:11]<-lapply(Buoy[,2:11],as.numeric)

save(Buoy, file = "Buoy.Rdata")

```

We think it is possible to compare the change in temperature according to the average monthly and yearly temperature. In this step, we reorder the data by date, month and year and calculate the mean value of these data, because in this way, We can use the average daily temperature to conclude the temperature trend, and the average monthly temperature and the average annual temperature can eliminate the influence of seasons and extreme weather on the results.

```

Buoy <- filter(Buoy, DEWP < 999 & ATMP < 50 & WTMP < 50)
Buoy$D_date <- as.POSIXct(Buoy$D_date)
Buoy[,2:11]<-lapply(Buoy[,2:11],as.numeric)

Buoy2 <- Buoy %>% group_by(date(D_date)) %>% summarize(mean(WDIR),mean(WSPD),mean(GST),mean(WVHT),mean(
## `summarise()` ungrouping output (override with `.groups` argument)
Buoy3 <- Buoy %>% group_by(year(D_date),month(D_date)) %>% summarize(mean(WDIR),mean(WSPD),mean(GST),me
## `summarise()` regrouping output by 'year(D_date)' (override with `.groups` argument)
Buoy4 <- Buoy %>% group_by(year(D_date)) %>% summarize(mean(WDIR),mean(WSPD),mean(GST),mean(WVHT),mean(
## `summarise()` ungrouping output (override with `.groups` argument)
b <- Buoy3 %>% select(`year(D_date)`, `month(D_date)`)
b2 <- as.data.frame(lapply(b,as.numeric))
year_month <- make_date(year = b$`year(D_date)`,month = b$`month(D_date)`)
Buoy3$year_month<-year_month

```

#ATMP As the simple regression model, we can find that for each year of time increase, the predicted annual increase in air temperature is 0.099, which means that the global warming is indeed happening. And we find that the relationship between averaged wind speed over the an eight-minute period and the dominant wave period is not obvious so we delete these two variable. The two factors that best reflect change are the gust speed(GST) and the wind speed (WSPD).

#WTMP In this model, we can find that for each year of time increase, the predicted annual increase in sea surface temperature is 0.1155, which also indicates that the global warming is indeed happening. And we find that the relationship between averaged wind speed over the an eight minute period, wind direction, and the dominant wave period is not obvious so we delete these three variable. The two factors that best reflect change is the wind speed (WSPD).

```

#ATMP
fit_in <- lm (Buoy4$`mean(ATMP)` ~ Buoy4$`year(D_date)`)

```

```
fit_year <- lm ( Buoy4$`mean(ATMP)` ~ Buoy4$`mean(WDIR)` + Buoy4$`mean(WSPD)` + Buoy4$`mean(GST)` + Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)` )
fit_month <- lm ( Buoy3$`mean(ATMP)` ~ Buoy3$`mean(WDIR)` + Buoy3$`mean(WSPD)` + Buoy3$`mean(GST)` + Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)` )
fit_day <- lm ( Buoy2$`mean(ATMP)` ~ Buoy2$`mean(WDIR)` + Buoy2$`mean(WSPD)` + Buoy2$`mean(GST)` + Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)` )
```

```
print(fit_in)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(ATMP)` ~ Buoy4$`year(D_date)` )
##
## Coefficients:
##      (Intercept)  Buoy4$`year(D_date)`
##      -186.68592           0.09854
```

```
print(fit_year)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(ATMP)` ~ Buoy4$`mean(WDIR)` + Buoy4$`mean(WSPD)` + Buoy4$`mean(GST)` + Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)` ,
##     data = Buoy4)
##
## Coefficients:
##      (Intercept)  Buoy4$`mean(WDIR)`  Buoy4$`mean(WSPD)`  Buoy4$`mean(GST)`
##      61.098170      0.002227      20.970441      -21.752416
## Buoy4$`mean(WVHT)`  Buoy4$`mean(APD)`
##      4.936915      -5.054957
```

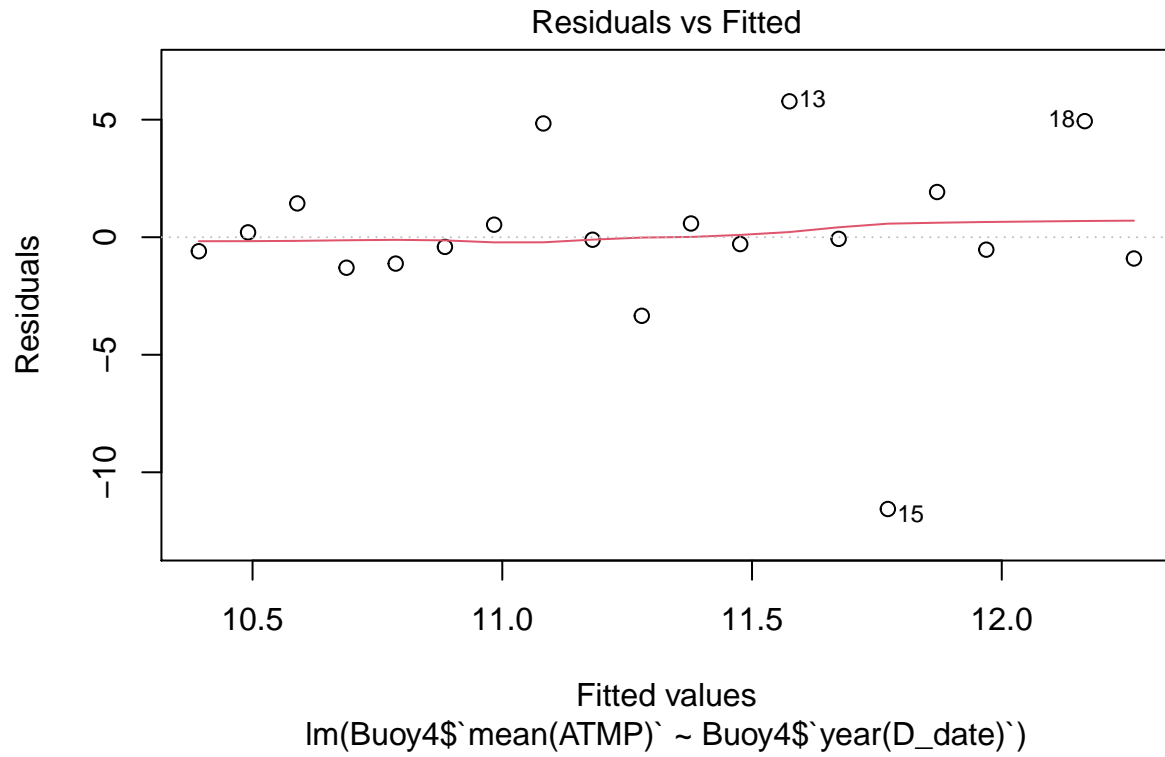
```
print(fit_month)
```

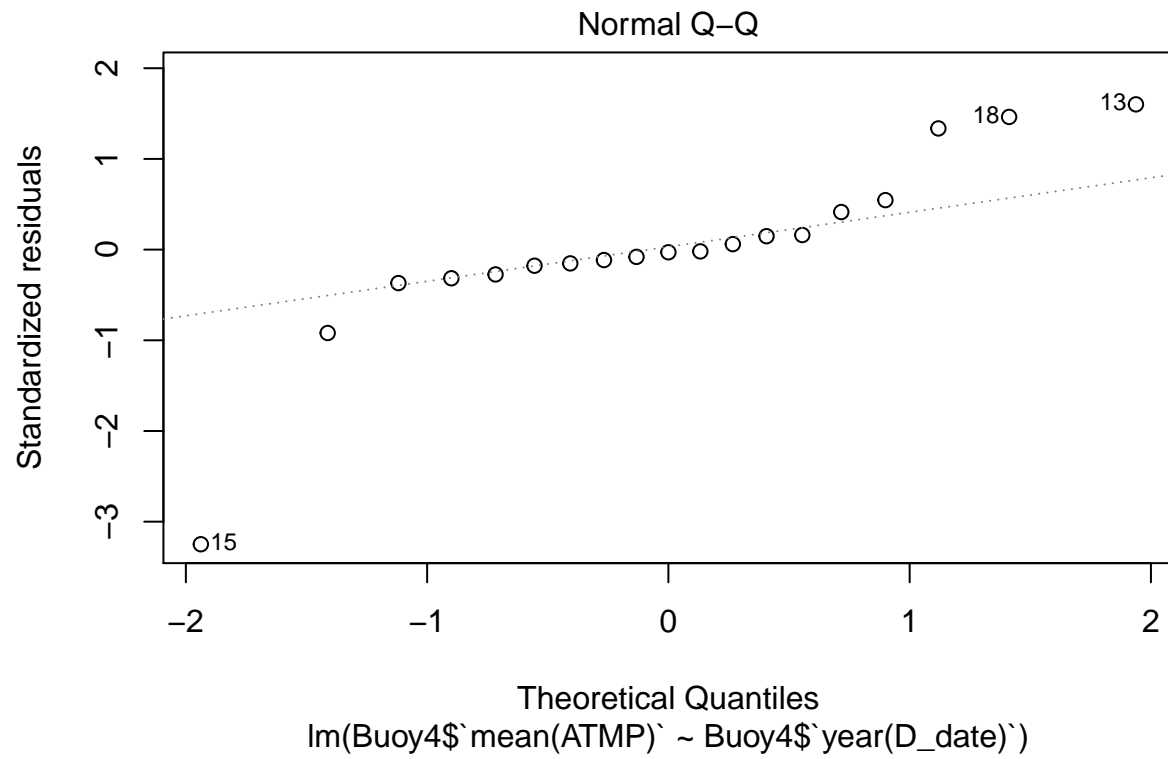
```
##
## Call:
## lm(formula = Buoy3$`mean(ATMP)` ~ Buoy3$`mean(WDIR)` + Buoy3$`mean(WSPD)` + Buoy3$`mean(GST)` + Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)` ,
##     data = Buoy3)
##
## Coefficients:
##      (Intercept)  Buoy3$`mean(WDIR)`  Buoy3$`mean(WSPD)`  Buoy3$`mean(GST)`
##      2.13912      0.01572      14.44603      -13.35200
## Buoy3$`mean(WVHT)`  Buoy3$`mean(APD)`
##      -3.64985      3.86742
```

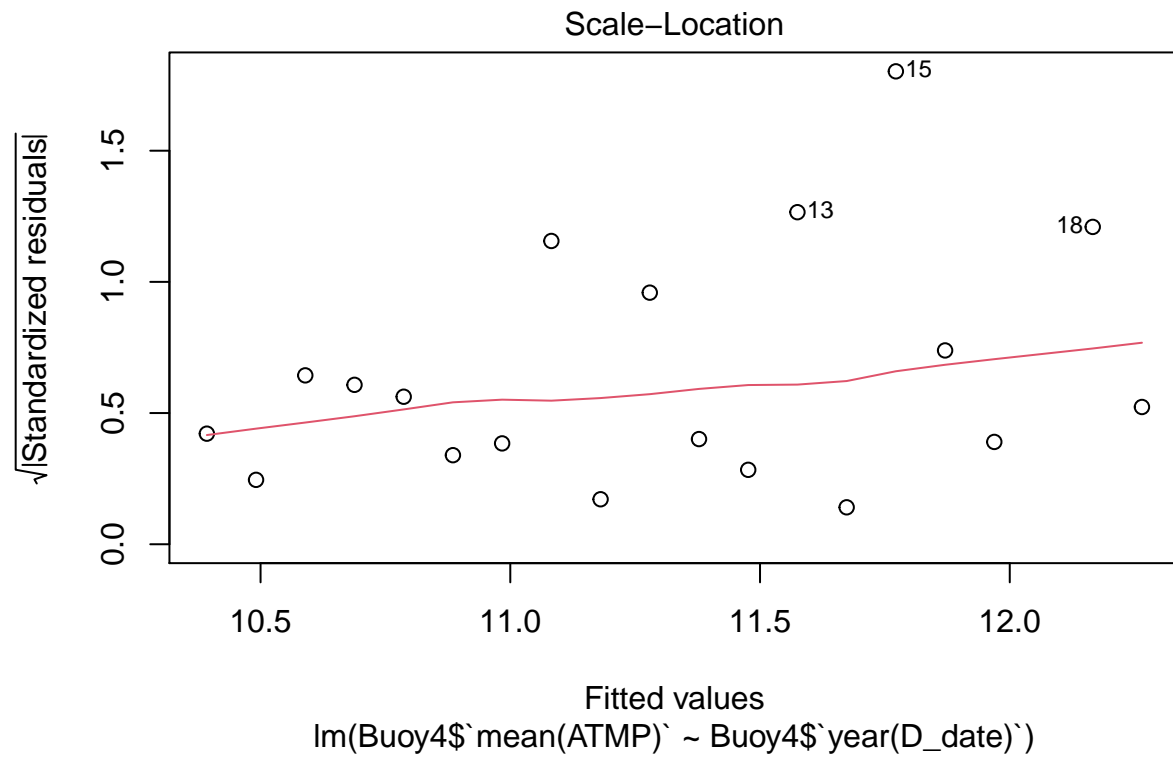
```
print(fit_day)
```

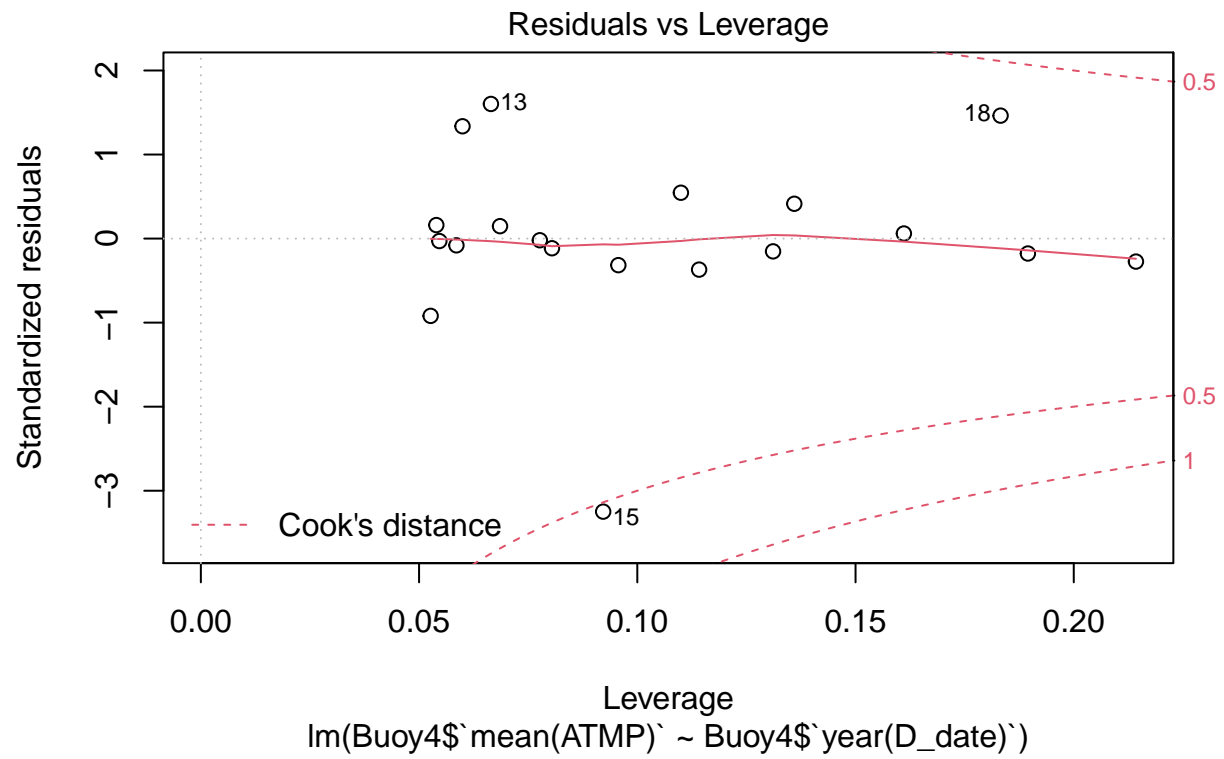
```
##
## Call:
## lm(formula = Buoy2$`mean(ATMP)` ~ Buoy2$`mean(WDIR)` + Buoy2$`mean(WSPD)` + Buoy2$`mean(GST)` + Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)` ,
##     data = Buoy2)
##
## Coefficients:
##      (Intercept)  Buoy2$`mean(WDIR)`  Buoy2$`mean(WSPD)`  Buoy2$`mean(GST)`
##      13.918794      -0.006175      2.642824      -3.149606
## Buoy2$`mean(WVHT)`  Buoy2$`mean(APD)`
##      -1.164670      1.202390
```

```
plot(fit_in)
```

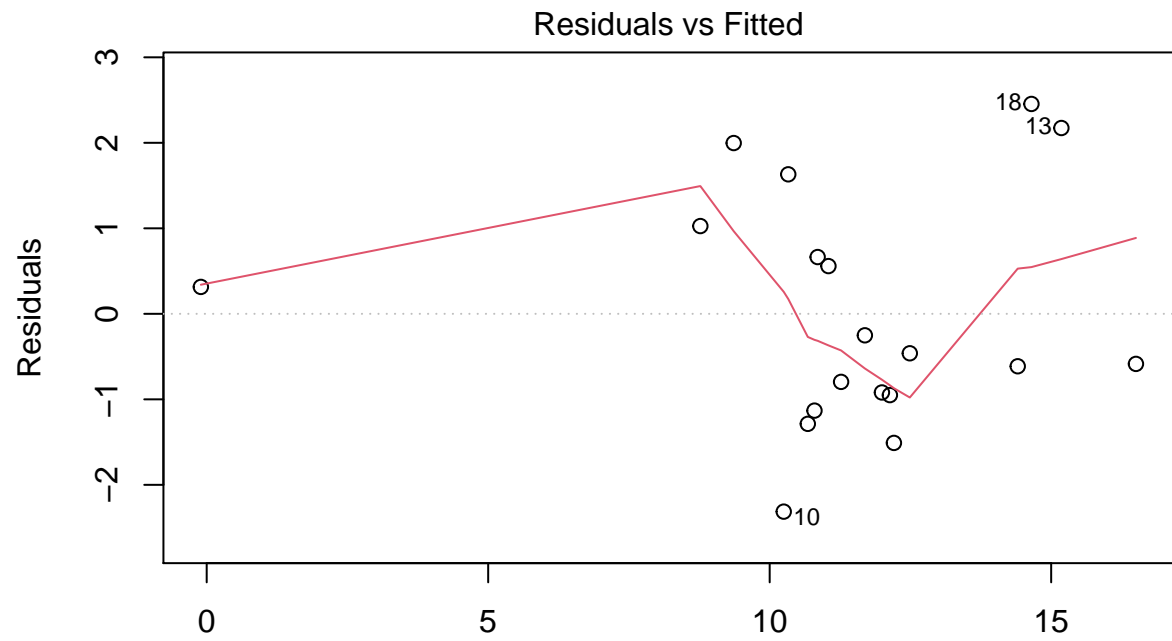




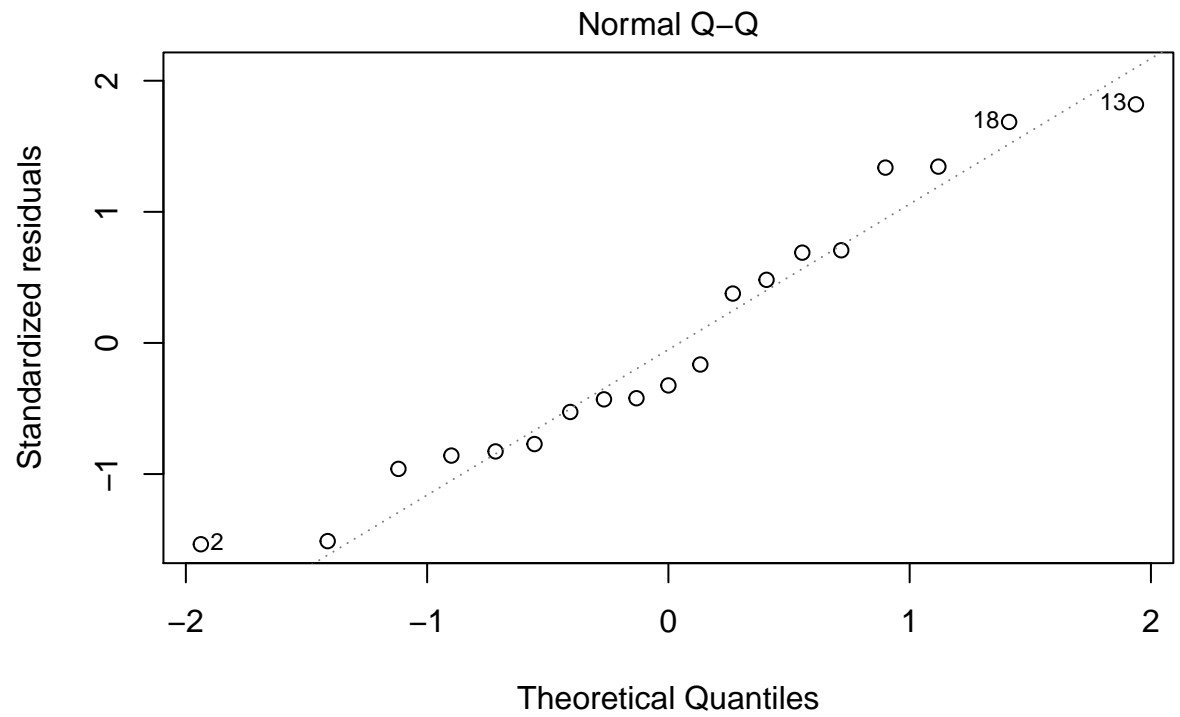




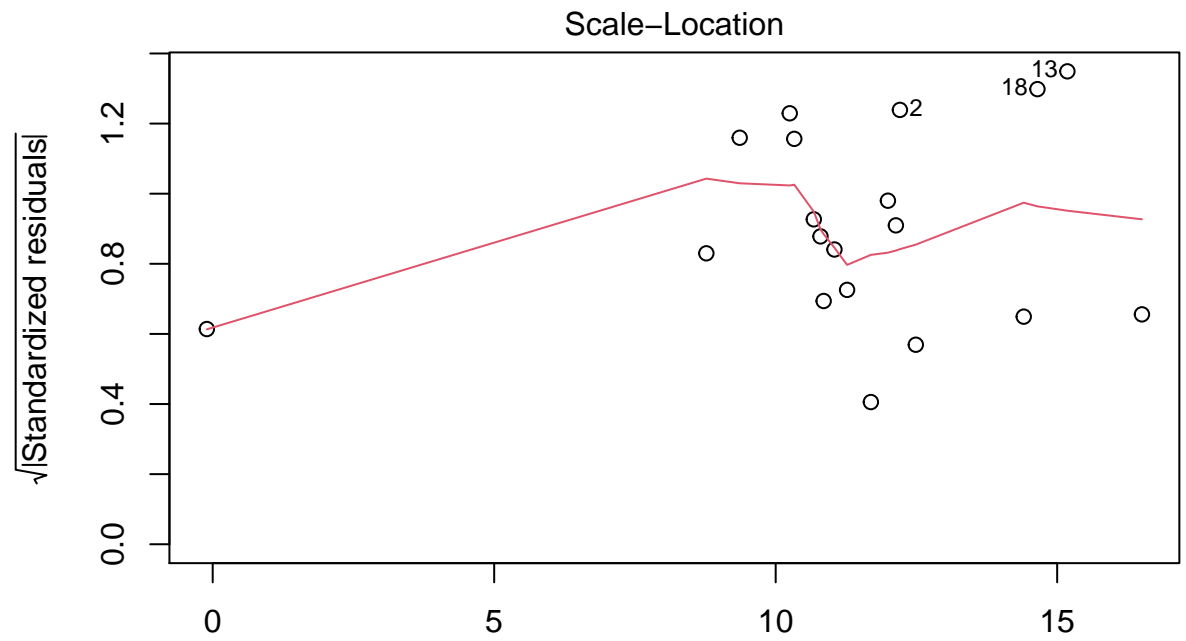
```
plot(fit_year)
```



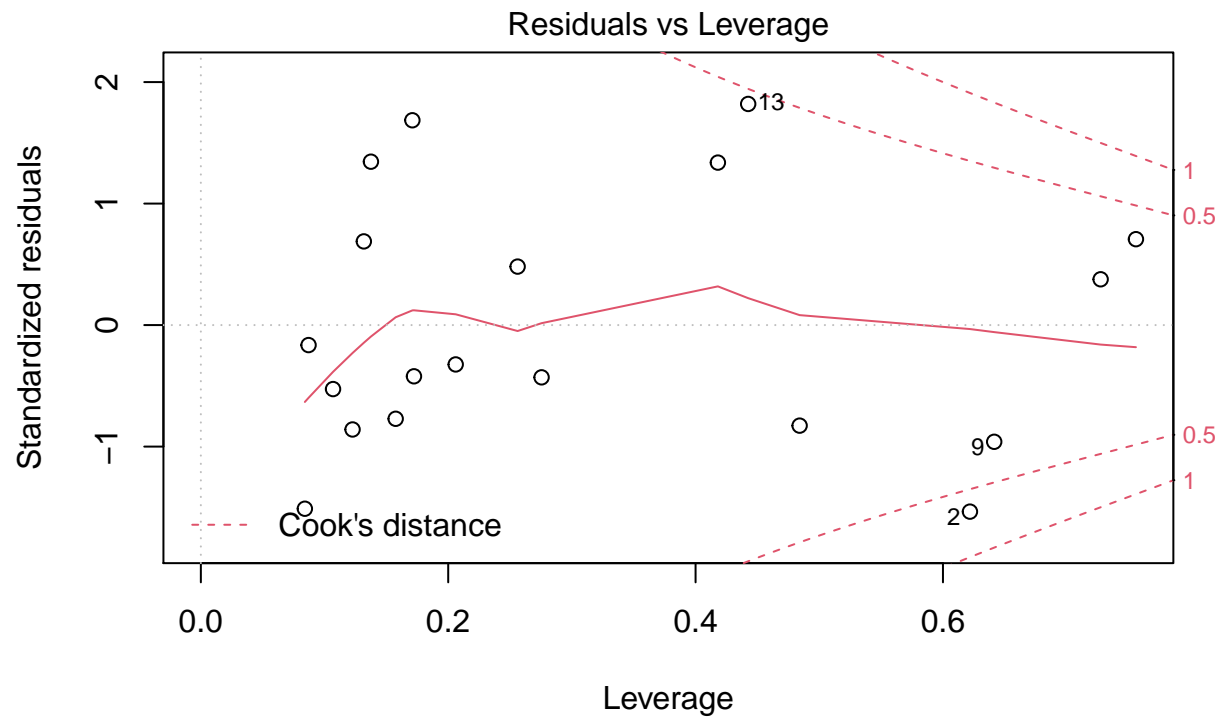
Fitted values
 $\ln(\text{Buoy4\$`mean(ATMP)`} \sim \text{Buoy4\$`mean(WDIR)`} + \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`r}$



$\ln(\text{Buoy4\$`mean(ATMP)`} \sim \text{Buoy4\$`mean(WDIR)`} + \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`r}$

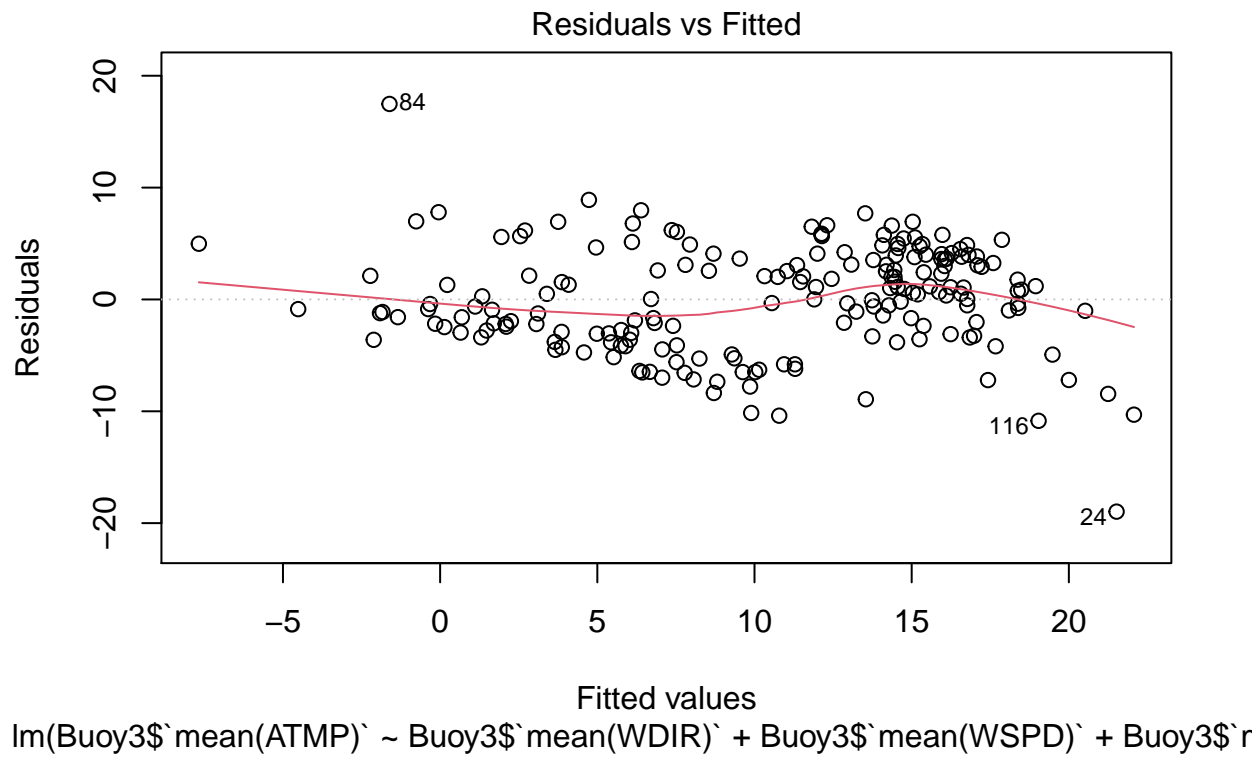


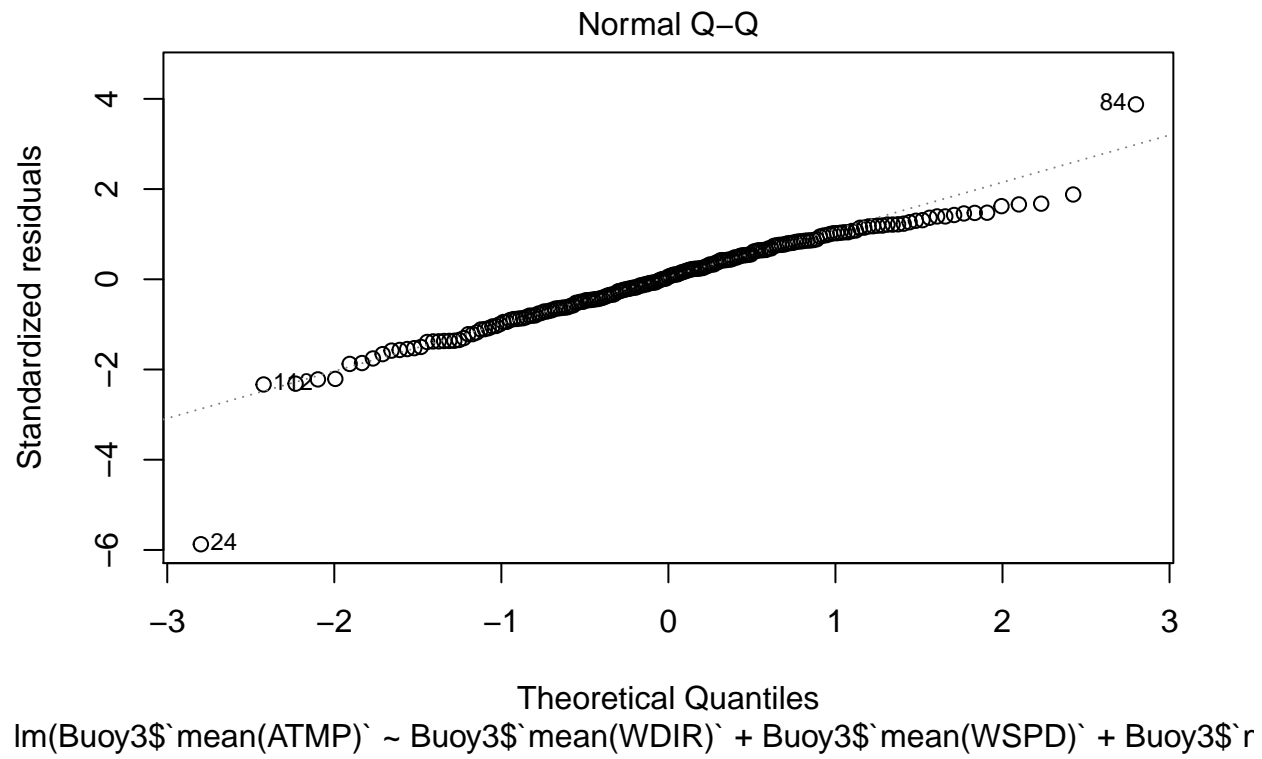
Fitted values
 $\text{lm}(\text{Buoy4\$`mean(ATMP)`} \sim \text{Buoy4\$`mean(WDIR)`} + \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`r`})$

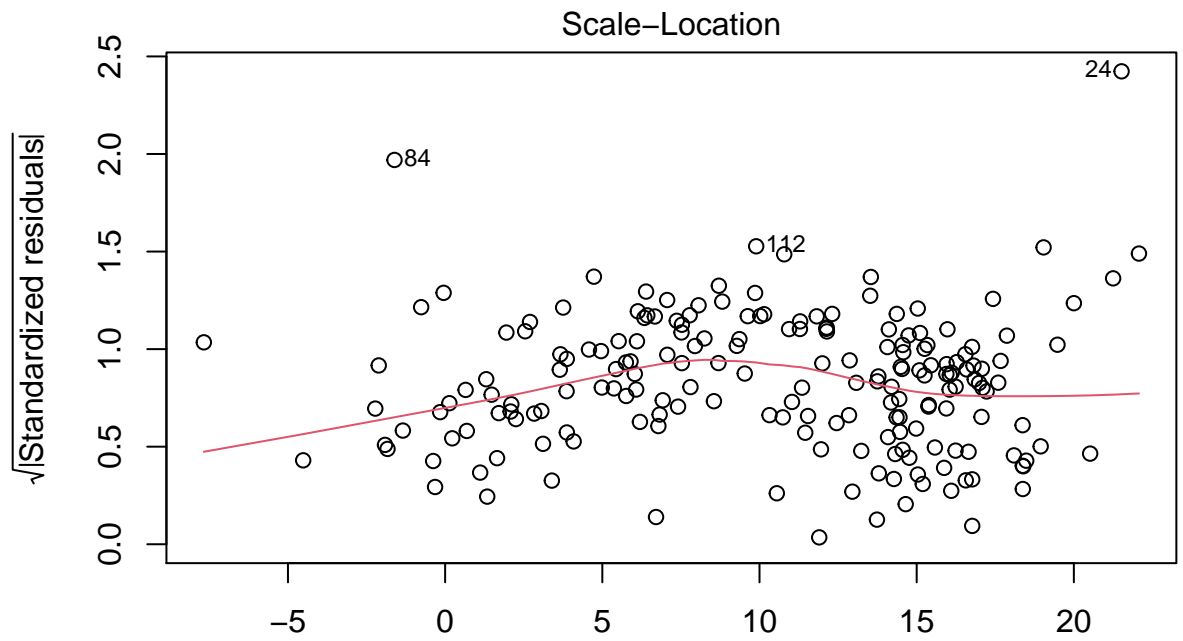


$\text{lm}(\text{Buoy4\$`mean(ATMP)`} \sim \text{Buoy4\$`mean(WDIR)`} + \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`r`})$

```
plot(fit_month)
```

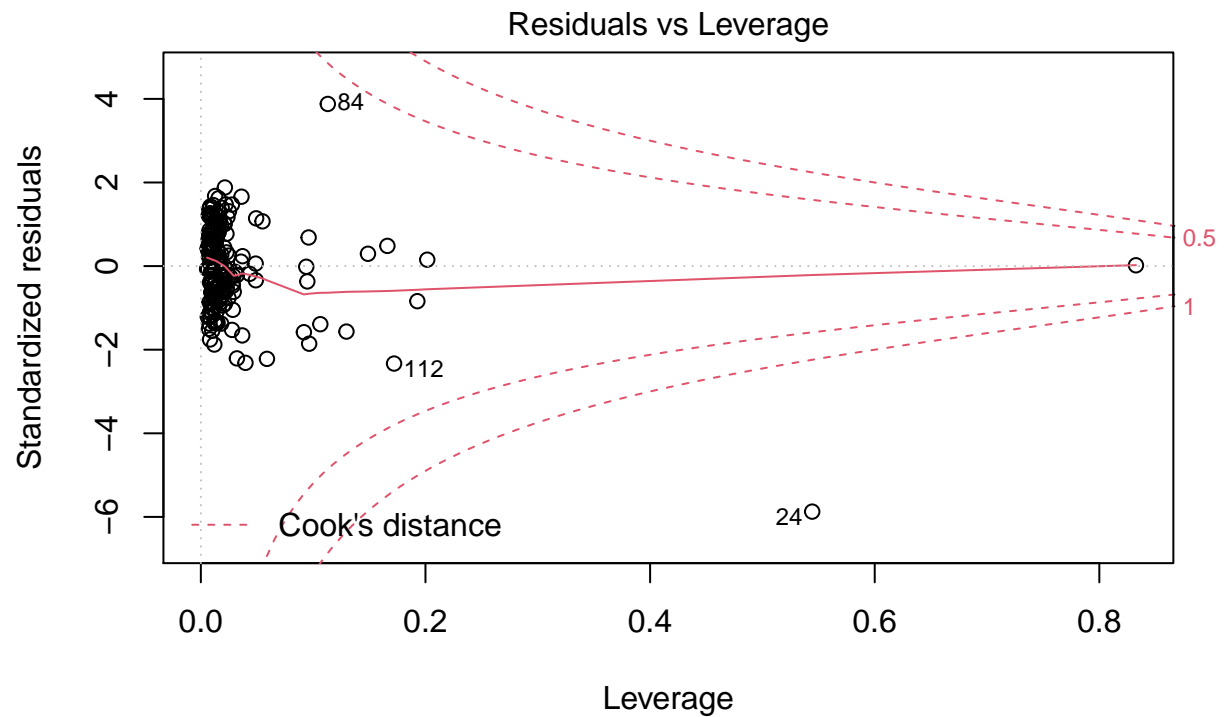






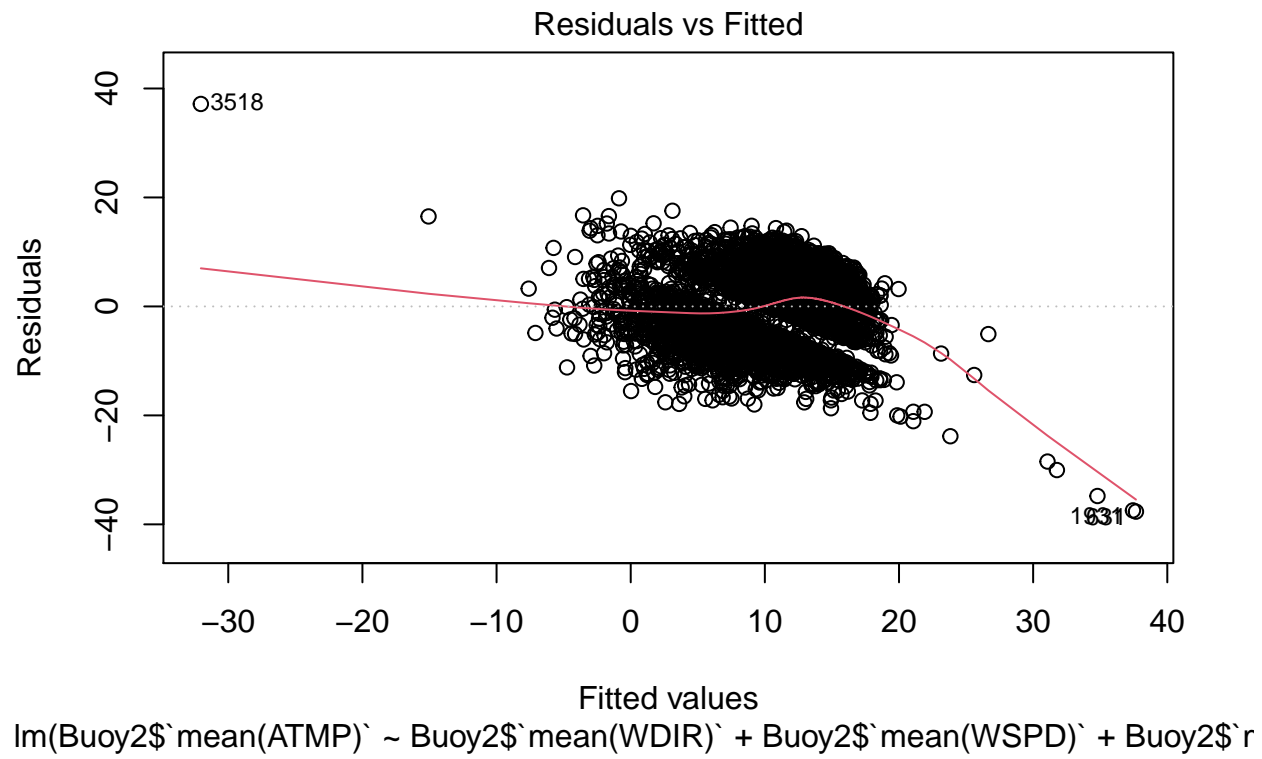
Fitted values

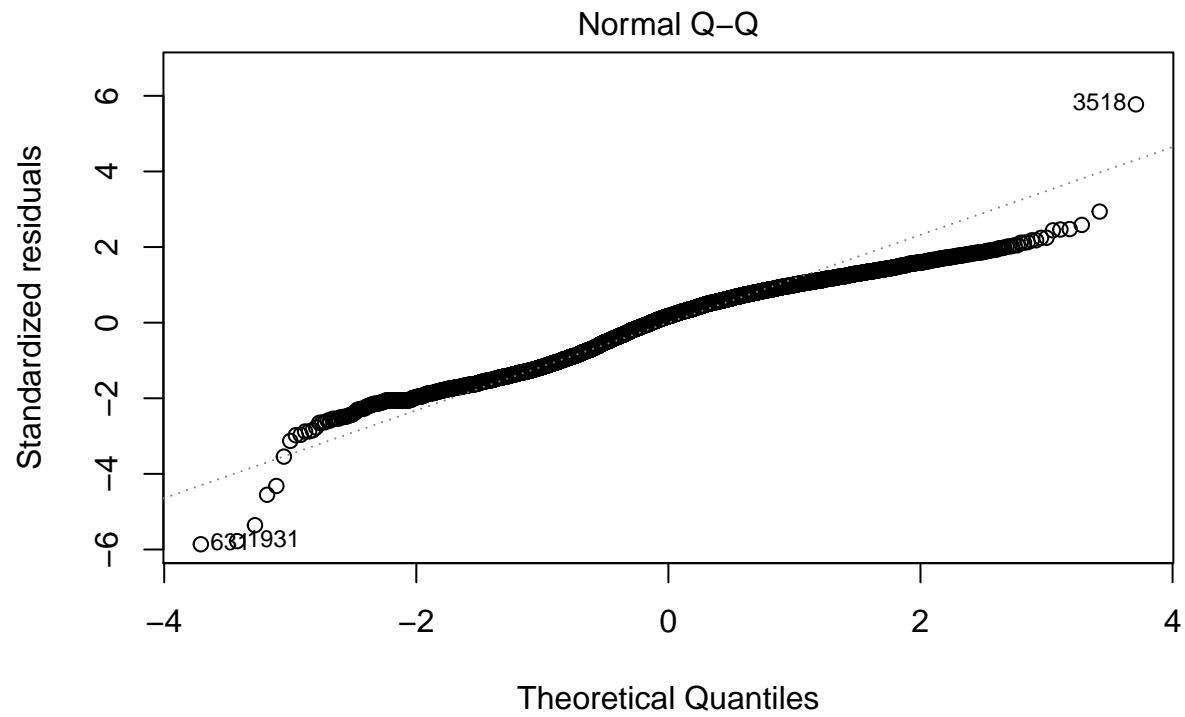
$\text{lm}(\text{Buoy3\$`mean(ATMP)`} \sim \text{Buoy3\$`mean(WDIR)`} + \text{Buoy3\$`mean(WSPD)`} + \text{Buoy3\$`r`})$



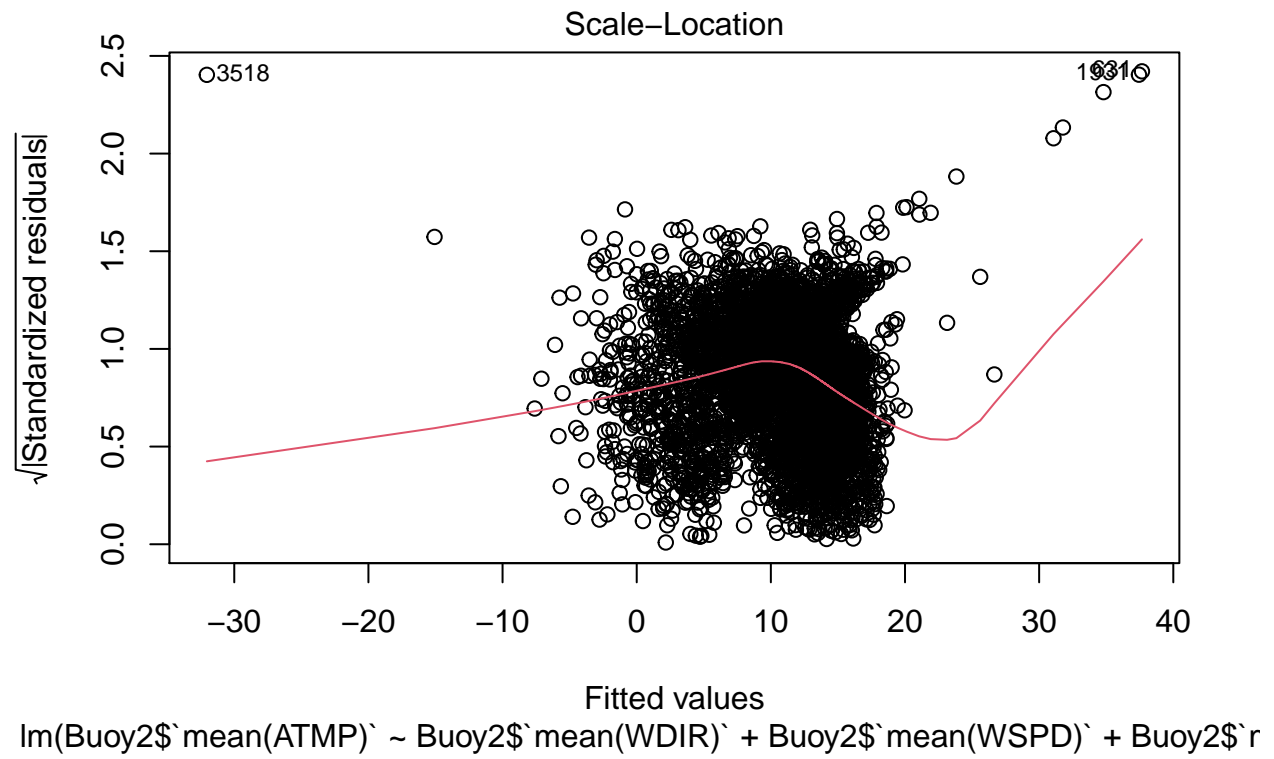
$\text{lm}(\text{Buoy3\$`mean(ATMP)`} \sim \text{Buoy3\$`mean(WDIR)`} + \text{Buoy3\$`mean(WSPD)`} + \text{Buoy3\$`r`})$

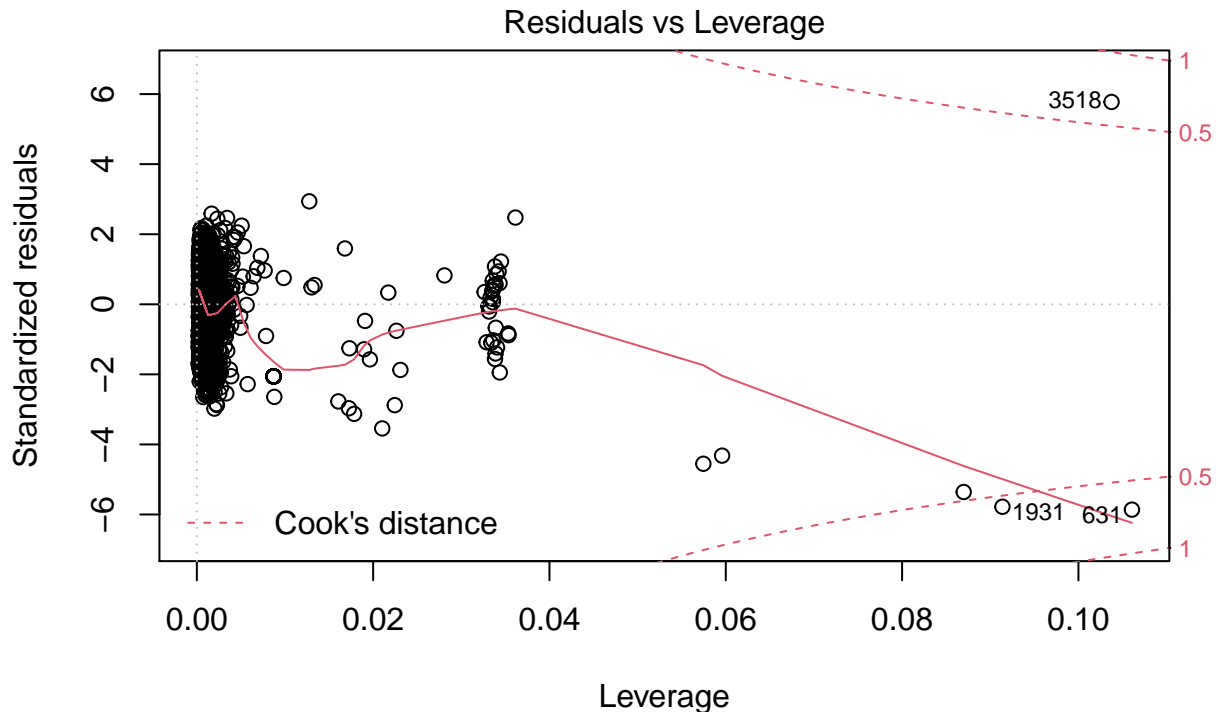
```
plot(fit_day)
```





$\ln(\text{Buoy2\$`mean(ATMP)`} \sim \text{Buoy2\$`mean(WDIR)`} + \text{Buoy2\$`mean(WSPD)`} + \text{Buoy2\$`r`}$





```
lm(Buoy2$`mean(ATMP)` ~ Buoy2$`mean(WDIR)` + Buoy2$`mean(WSPD)` + Buoy2$`r
```

```
summary(fit_in)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(ATMP)` ~ Buoy4$`year(D_date)` )
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -11.5612  -0.7517  -0.1068   1.0110   5.7799
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -186.68592    304.87564  -0.612   0.548
## Buoy4$`year(D_date)`    0.09854     0.15175   0.649   0.525
##
## Residual standard error: 3.735 on 17 degrees of freedom
## Multiple R-squared:  0.0242, Adjusted R-squared:  -0.0332
## F-statistic: 0.4217 on 1 and 17 DF, p-value: 0.5248
```

```
summary(fit_year)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(ATMP)` ~ Buoy4$`mean(WDIR)` + Buoy4$`mean(WSPD)` +
##     Buoy4$`mean(GST)` + Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)` ,
##     data = Buoy4)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.3133 -0.9351 -0.4616  0.8453  2.4544
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    61.098170   19.284352   3.168  0.00741 **
## Buoy4$`mean(WDIR)`    0.002227    0.024630    0.090  0.92932
## Buoy4$`mean(WSPD)`   20.970441   12.552585    1.671  0.11869
## Buoy4$`mean(GST)`   -21.752416    9.381993   -2.319  0.03735 *
## Buoy4$`mean(WVHT)`    4.936915    2.805382    1.760  0.10194
## Buoy4$`mean(APD)`   -5.054957    2.972266   -1.701  0.11278
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.599 on 13 degrees of freedom
## Multiple R-squared:  0.8632, Adjusted R-squared:  0.8106
## F-statistic: 16.4 on 5 and 13 DF,  p-value: 3.255e-05
```

```
summary(fit_month)
```

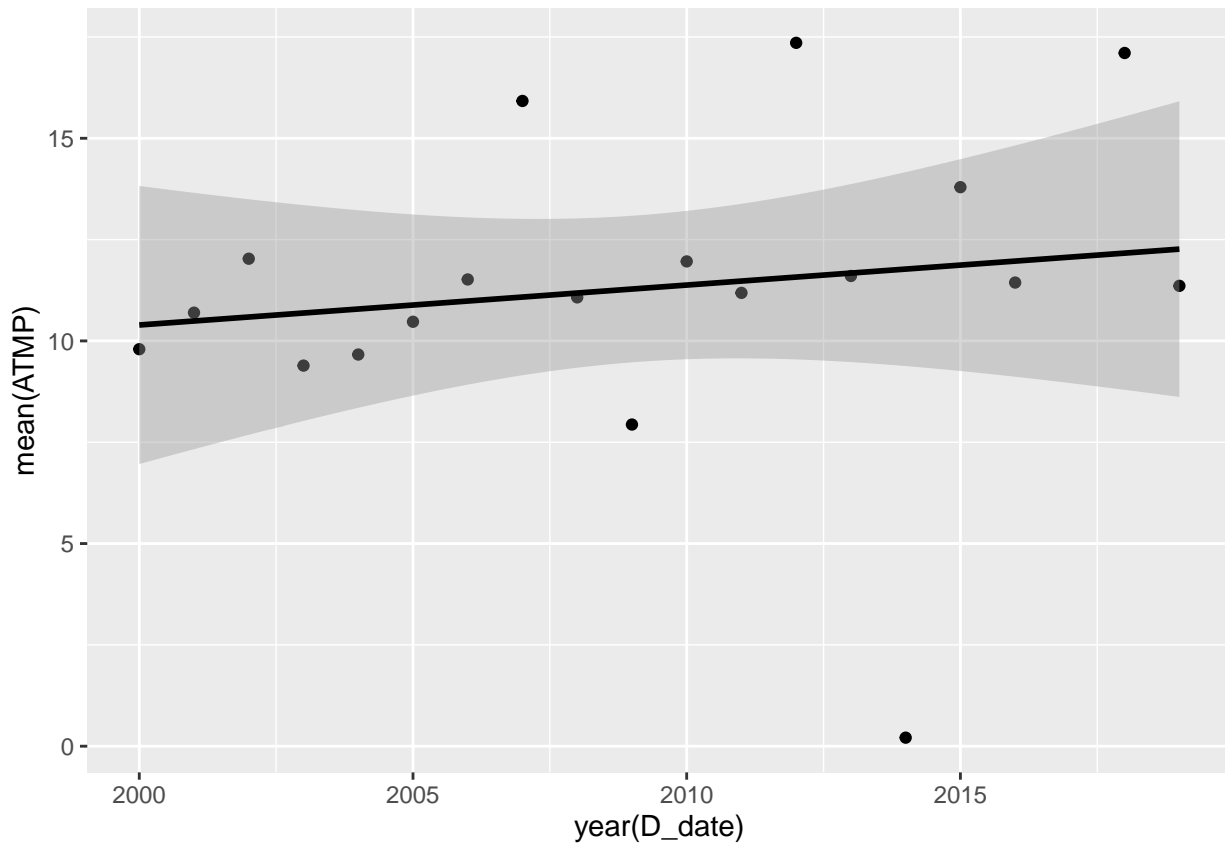
```
##
## Call:
## lm(formula = Buoy3$`mean(ATMP)` ~ Buoy3$`mean(WDIR)` + Buoy3$`mean(WSPD)` +
##      Buoy3$`mean(GST)` + Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)` ,
##      data = Buoy3)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -18.9708  -3.0833   0.2779   3.6329  17.4774
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.139121   4.983003   0.429  0.6682
## Buoy3$`mean(WDIR)`    0.015718   0.008287   1.897  0.0594 .
## Buoy3$`mean(WSPD)`   14.446028   2.514120   5.746 3.61e-08 ***
## Buoy3$`mean(GST)`  -13.352001   1.921131  -6.950 5.75e-11 ***
## Buoy3$`mean(WVHT)`   -3.649850   0.787801  -4.633 6.70e-06 ***
## Buoy3$`mean(APD)`    3.867423   0.829642   4.662 5.92e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.785 on 189 degrees of freedom
## Multiple R-squared:  0.6345, Adjusted R-squared:  0.6248
## F-statistic: 65.62 on 5 and 189 DF,  p-value: < 2.2e-16
```

```
summary(fit_day)
```

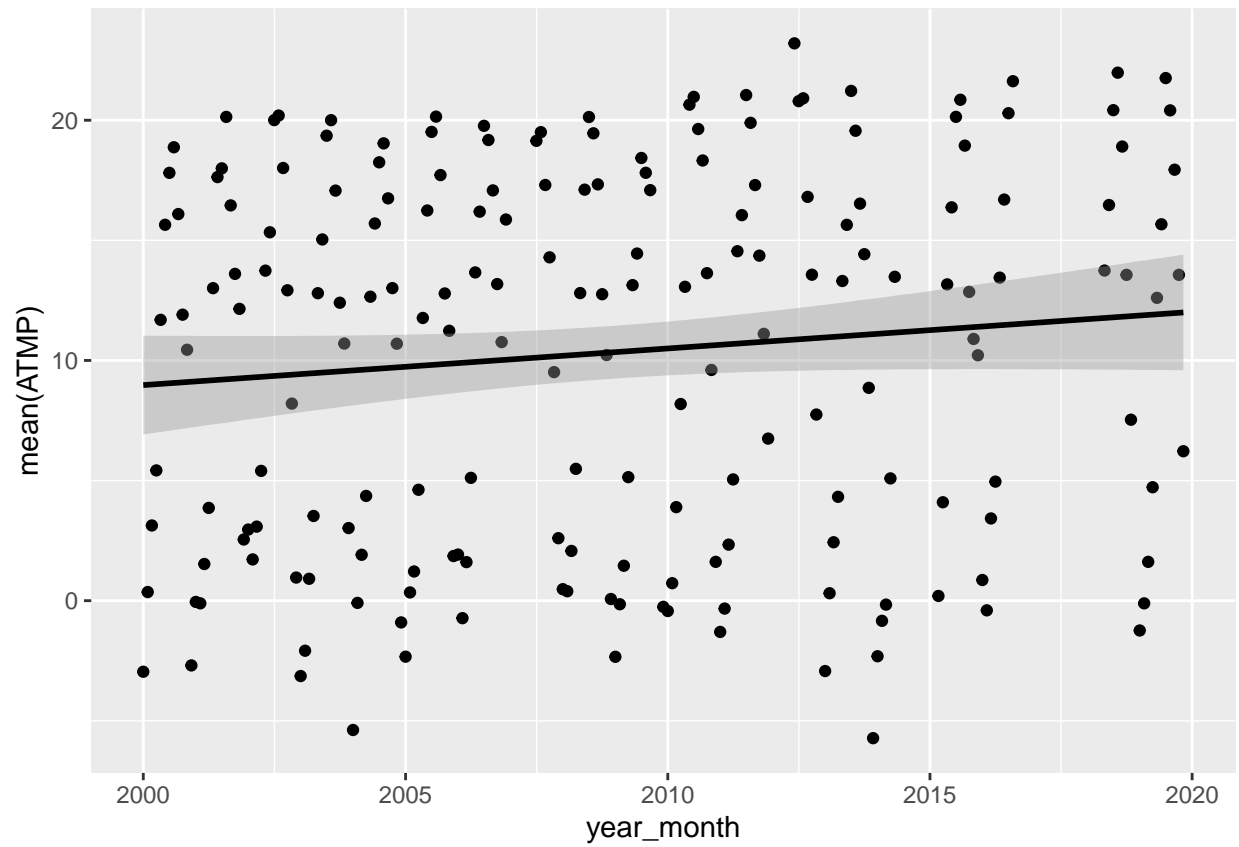
```
##
## Call:
## lm(formula = Buoy2$`mean(ATMP)` ~ Buoy2$`mean(WDIR)` + Buoy2$`mean(WSPD)` +
##      Buoy2$`mean(GST)` + Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)` ,
##      data = Buoy2)
##
## Residuals:
```

```
##      Min      1Q  Median      3Q      Max
## -37.663 -5.304   1.159   5.332  37.159
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    13.918794   0.634095   21.951 < 2e-16 ***
## Buoy2$`mean(WDIR)` -0.006175   0.001278  -4.832 1.39e-06 ***
## Buoy2$`mean(WSPD)`  2.642824   0.240083   11.008 < 2e-16 ***
## Buoy2$`mean(GST)`  -3.149606   0.189065  -16.659 < 2e-16 ***
## Buoy2$`mean(WVHT)` -1.164670   0.106278  -10.959 < 2e-16 ***
## Buoy2$`mean(APD)`   1.202390   0.110128   10.918 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.797 on 4809 degrees of freedom
## Multiple R-squared:  0.3128, Adjusted R-squared:  0.3121
## F-statistic: 437.9 on 5 and 4809 DF,  p-value: < 2.2e-16
```

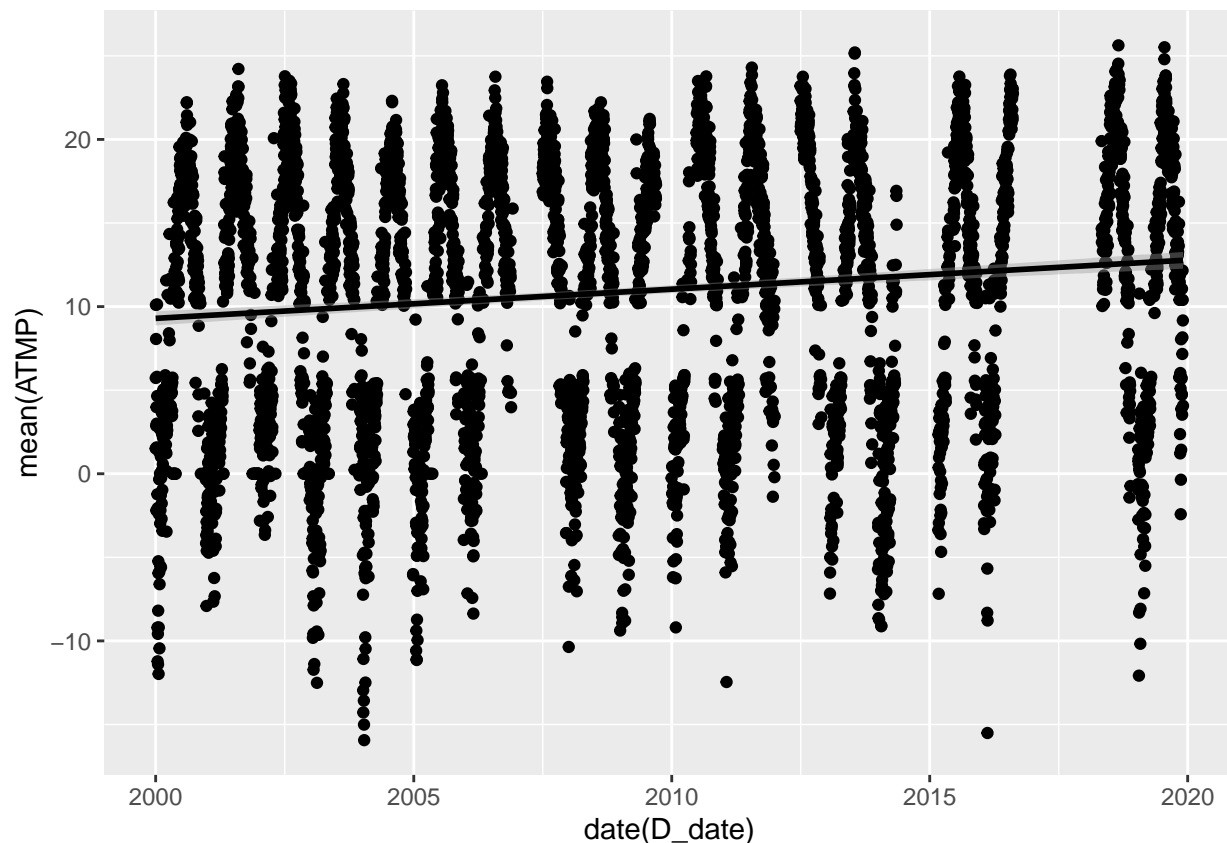
```
ggplot(mapping = aes(x= `year(D_date)`, y= `mean(ATMP)`),data = Buoy4)+ geom_point() + geom_smooth(method =
```



```
ggplot(mapping = aes(x= year_month, y= `mean(ATMP)`),data = Buoy3)+ geom_point() + geom_smooth(method =
```

```
ggplot(mapping = aes(x= `date(D_date)`, y= `mean(ATMP)`), data = Buoy2) + geom_point() + geom_smooth(method = "lm")
```



```
#WTMP
fit_in_1 <- lm (Buoy4$`mean(WTMP)` ~ Buoy4$`year(D_date)` )
fit_year_1 <- lm ( Buoy4$`mean(WTMP)` ~ Buoy4$`mean(WSPD)`+Buoy4$`mean(GST)` + Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)` , data = Buoy4)
fit_month_1 <- lm ( Buoy3$`mean(WTMP)` ~ Buoy3$`mean(WSPD)`+Buoy3$`mean(GST)` + Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)` , data = Buoy3)
fit_day_1 <- lm ( Buoy2$`mean(WTMP)` ~ Buoy2$`mean(WSPD)`+Buoy2$`mean(GST)` + Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)` , data = Buoy2)

print(fit_in_1)

##
## Call:
## lm(formula = Buoy4$`mean(WTMP)` ~ Buoy4$`year(D_date)` )
##
## Coefficients:
##      (Intercept)  Buoy4$`year(D_date)`
##      -219.9554          0.1155

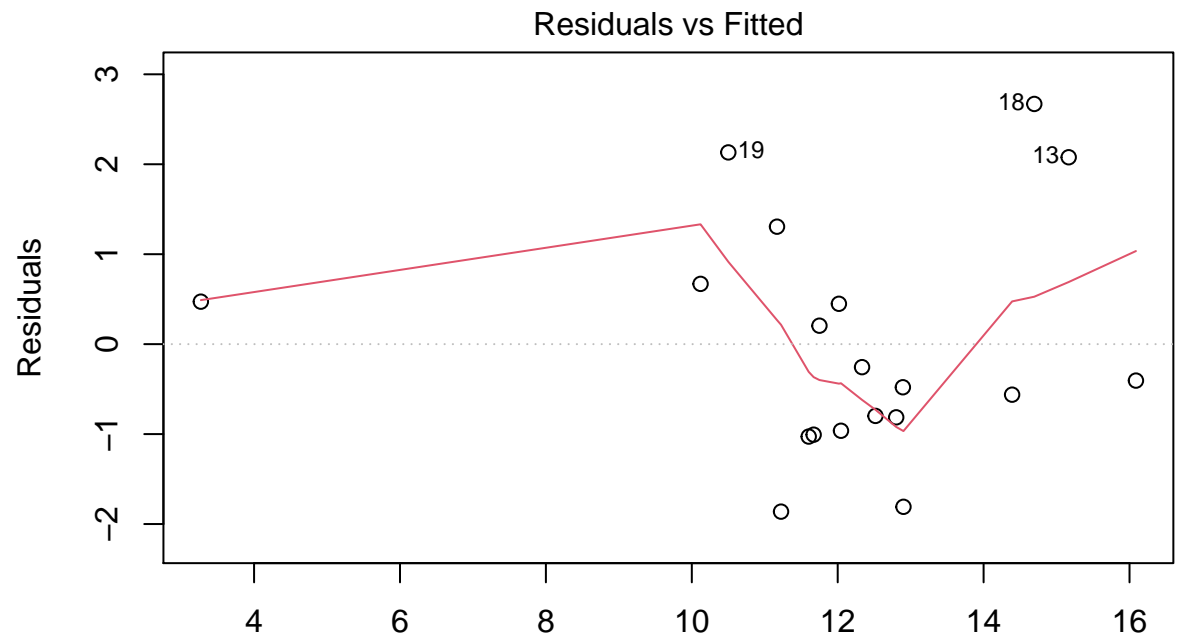
print(fit_year_1)

##
## Call:
## lm(formula = Buoy4$`mean(WTMP)` ~ Buoy4$`mean(WSPD)` + Buoy4$`mean(GST)` + Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)` , data = Buoy4)
##
## Coefficients:
##      (Intercept)  Buoy4$`mean(WSPD)`  Buoy4$`mean(GST)`  Buoy4$`mean(WVHT)`
##      50.880      14.629      -15.603      3.709
##  Buoy4$`mean(APD)`
```

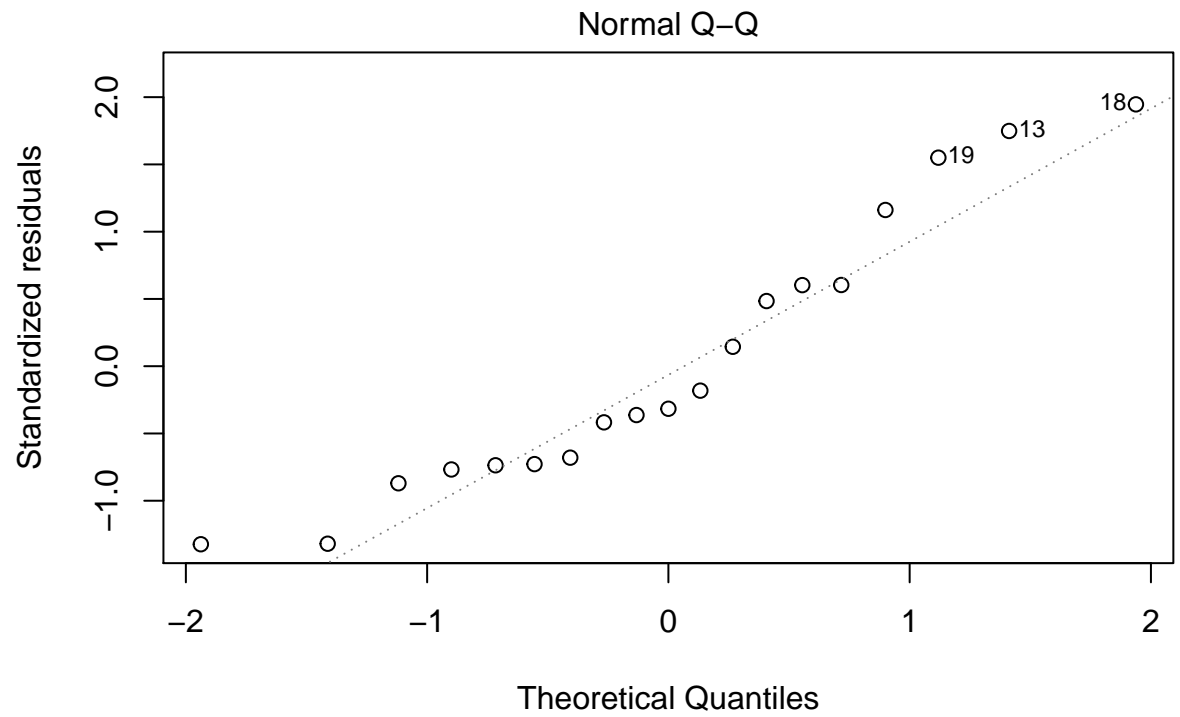
```
## -3.758
print(fit_month_1)

##
## Call:
## lm(formula = Buoy3$`mean(WTMP)` ~ Buoy3$`mean(WSPD)` + Buoy3$`mean(GST)` +
##     Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)`, data = Buoy3)
##
## Coefficients:
##      (Intercept)  Buoy3$`mean(WSPD)`  Buoy3$`mean(GST)`  Buoy3$`mean(WVHT)`
##           10.434           5.525           -5.700           -2.126
##  Buoy3$`mean(APD)`
##           2.208
print(fit_day_1)

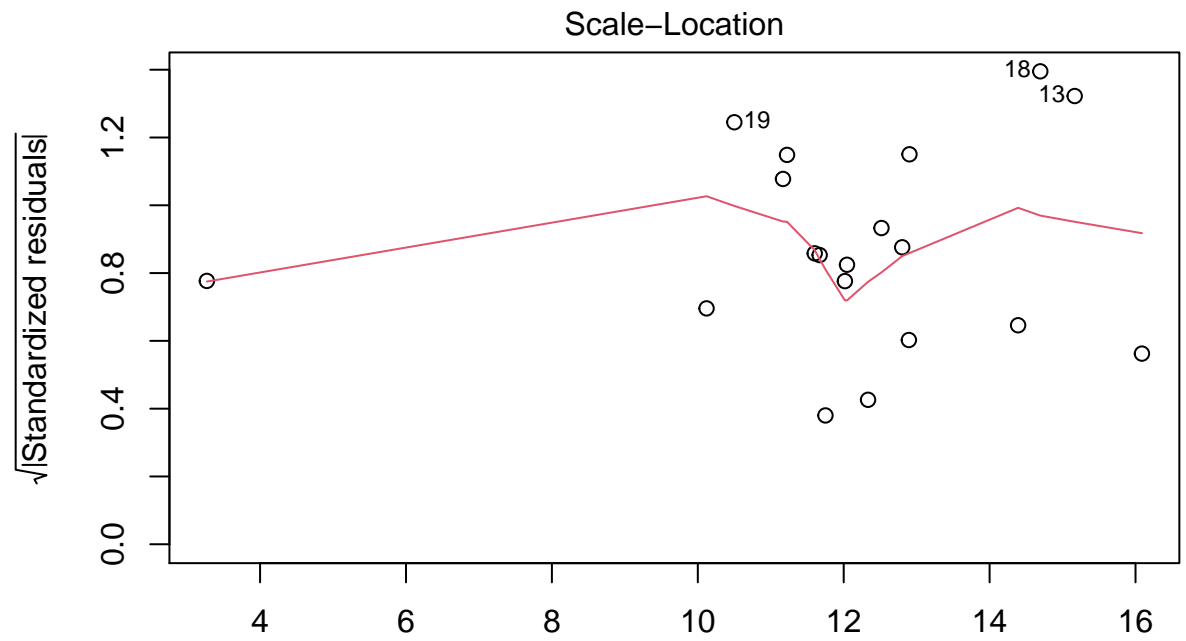
##
## Call:
## lm(formula = Buoy2$`mean(WTMP)` ~ Buoy2$`mean(WSPD)` + Buoy2$`mean(GST)` +
##     Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)`, data = Buoy2)
##
## Coefficients:
##      (Intercept)  Buoy2$`mean(WSPD)`  Buoy2$`mean(GST)`  Buoy2$`mean(WVHT)`
##           12.1822           0.9419           -1.3968           -0.8853
##  Buoy2$`mean(APD)`
##           0.9104
plot(fit_year_1)
```



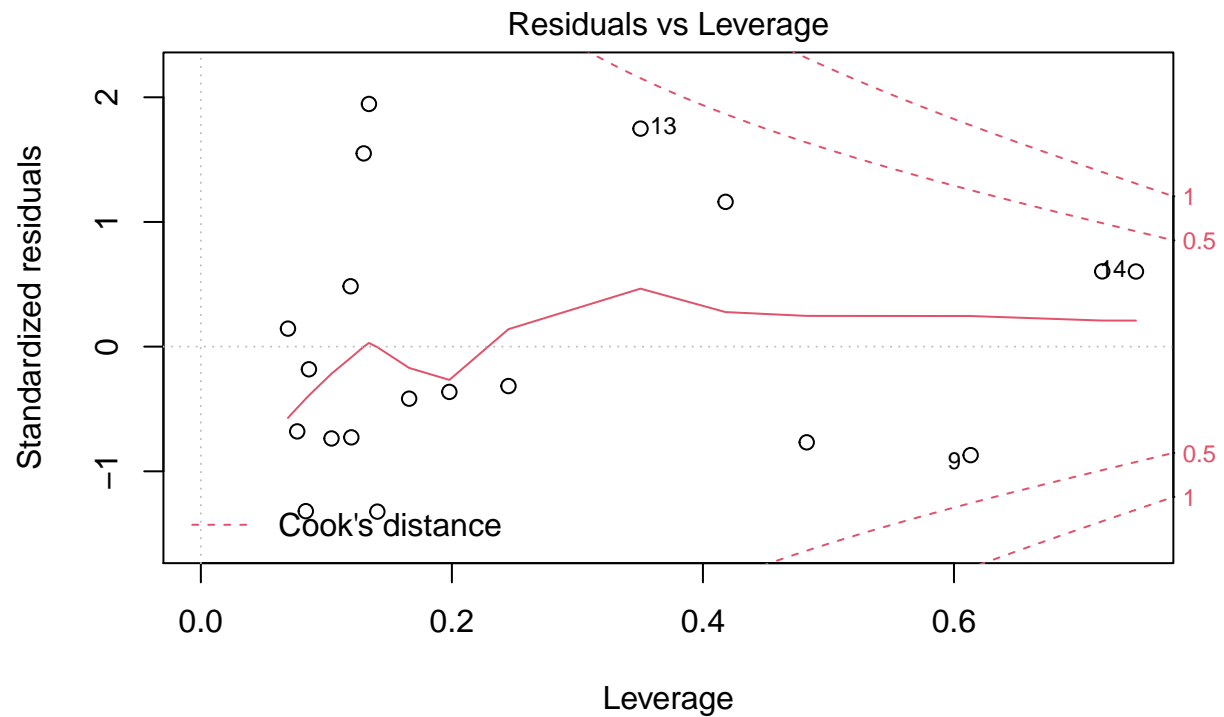
Fitted values
 $\text{lm}(\text{Buoy4\$`mean(WTMP)`} \sim \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`mean(GST)`} + \text{Buoy4\$`m`})$



$\text{lm}(\text{Buoy4\$`mean(WTMP)`} \sim \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`mean(GST)`} + \text{Buoy4\$`m`})$

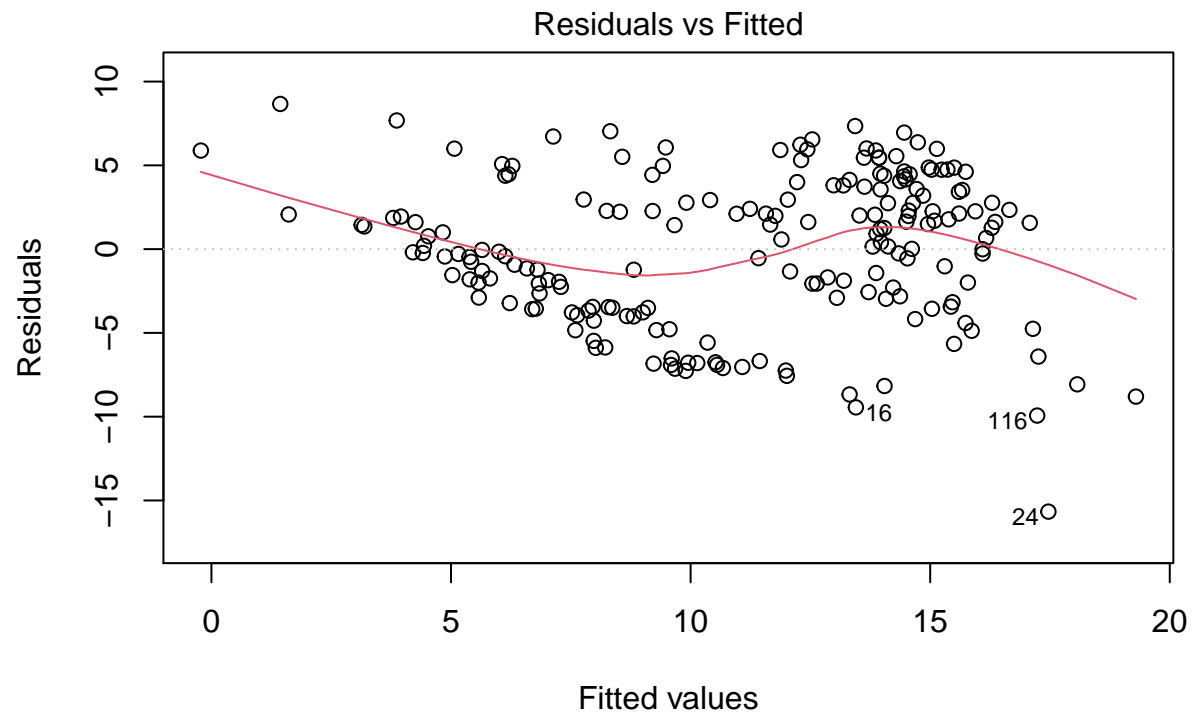


Fitted values
 $\text{lm}(\text{Buoy4\$`mean(WTMP)`} \sim \text{Buoy4\$`mean(WSPD)`} + \text{Buoy4\$`mean(GST)`} + \text{Buoy4\$`m`})$

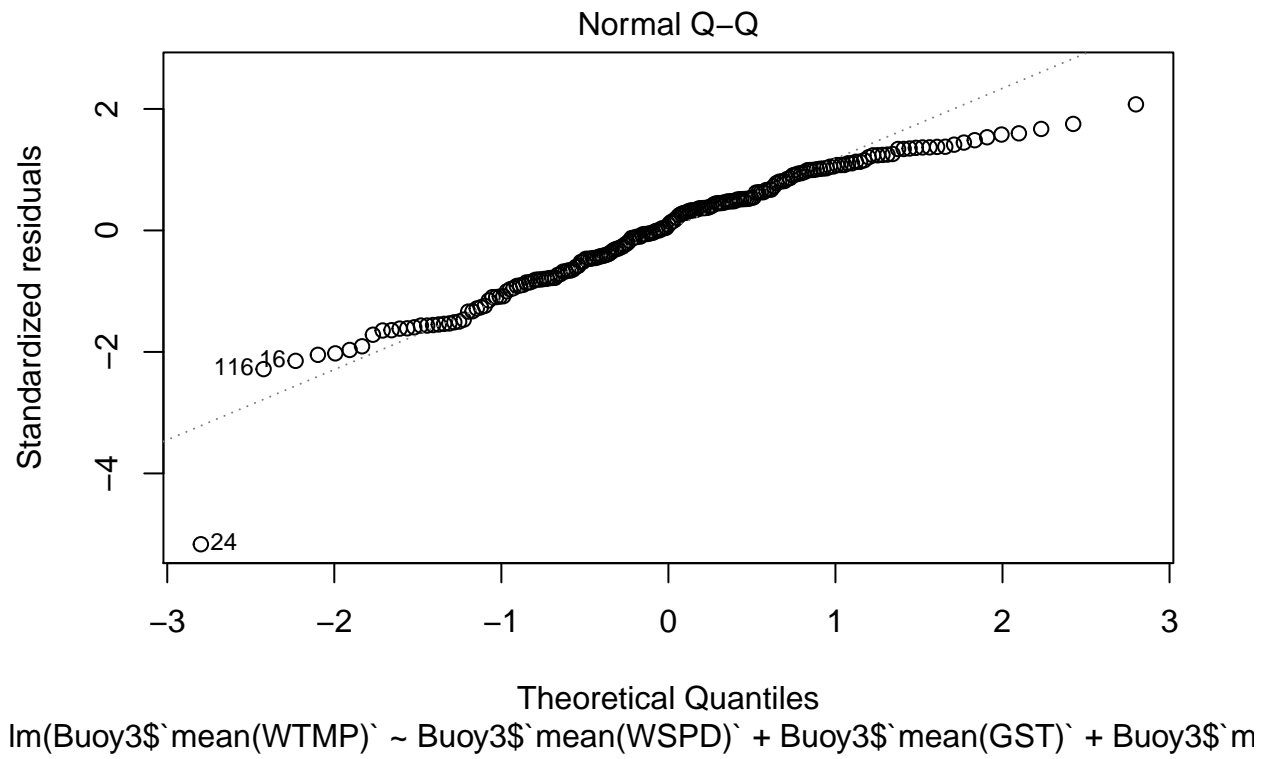


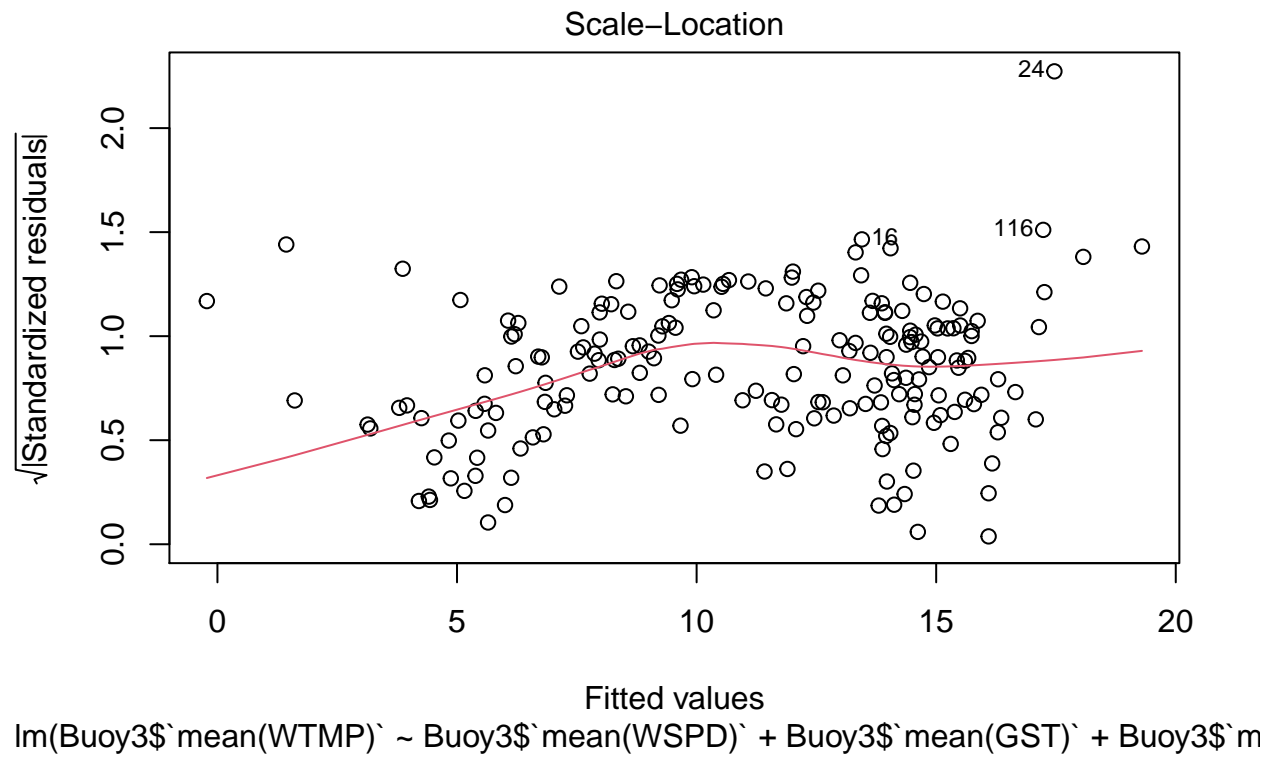
$\text{lm}(\text{Buoy4\$mean(WTMP)} \sim \text{Buoy4\$mean(WSPD)} + \text{Buoy4\$mean(GST)} + \text{Buoy4\m

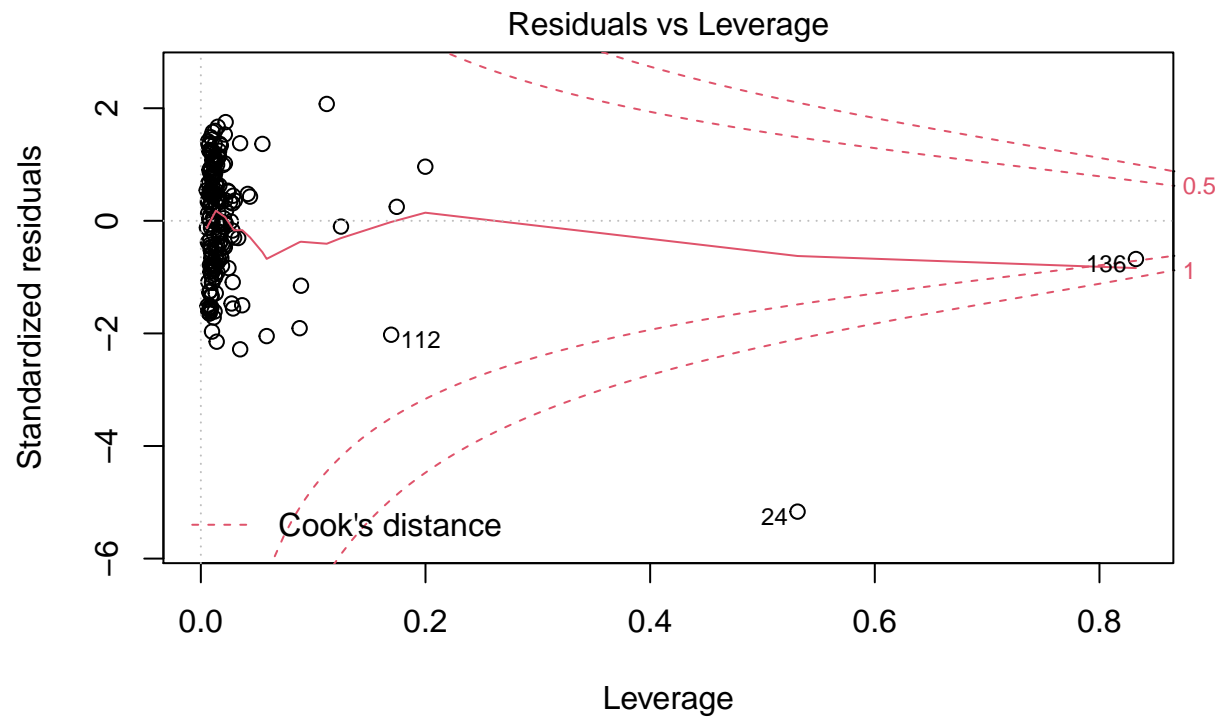
`plot(fit_month_1)`



$\text{lm}(\text{Buoy3\$`mean(WTMP)`} \sim \text{Buoy3\$`mean(WSPD)`} + \text{Buoy3\$`mean(GST)`} + \text{Buoy3\$`m`})$

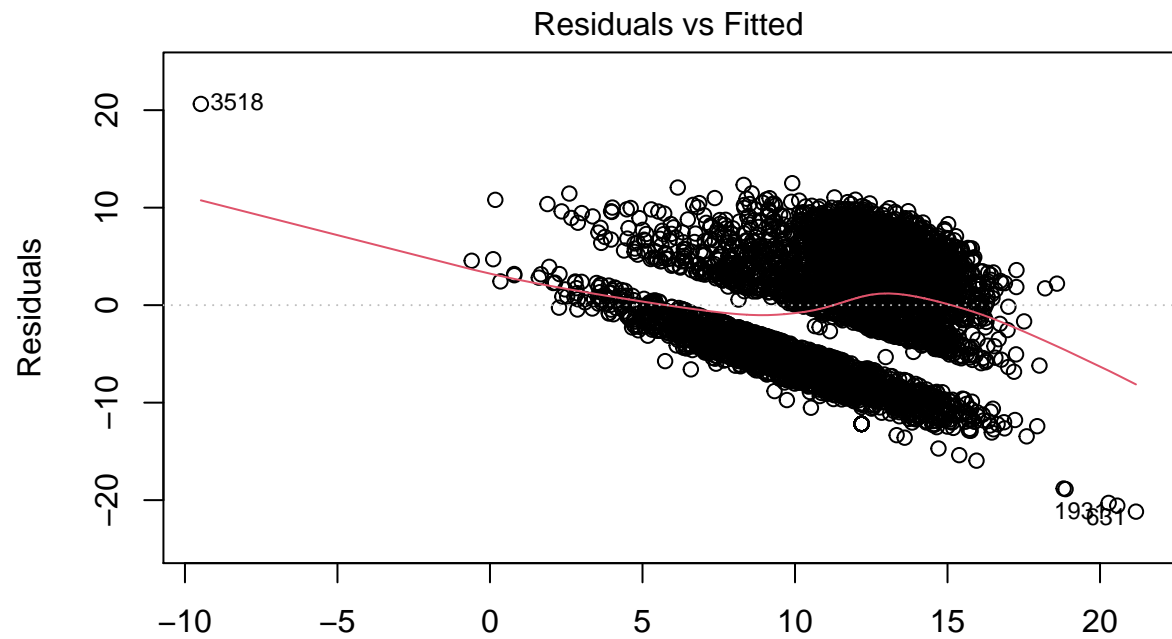




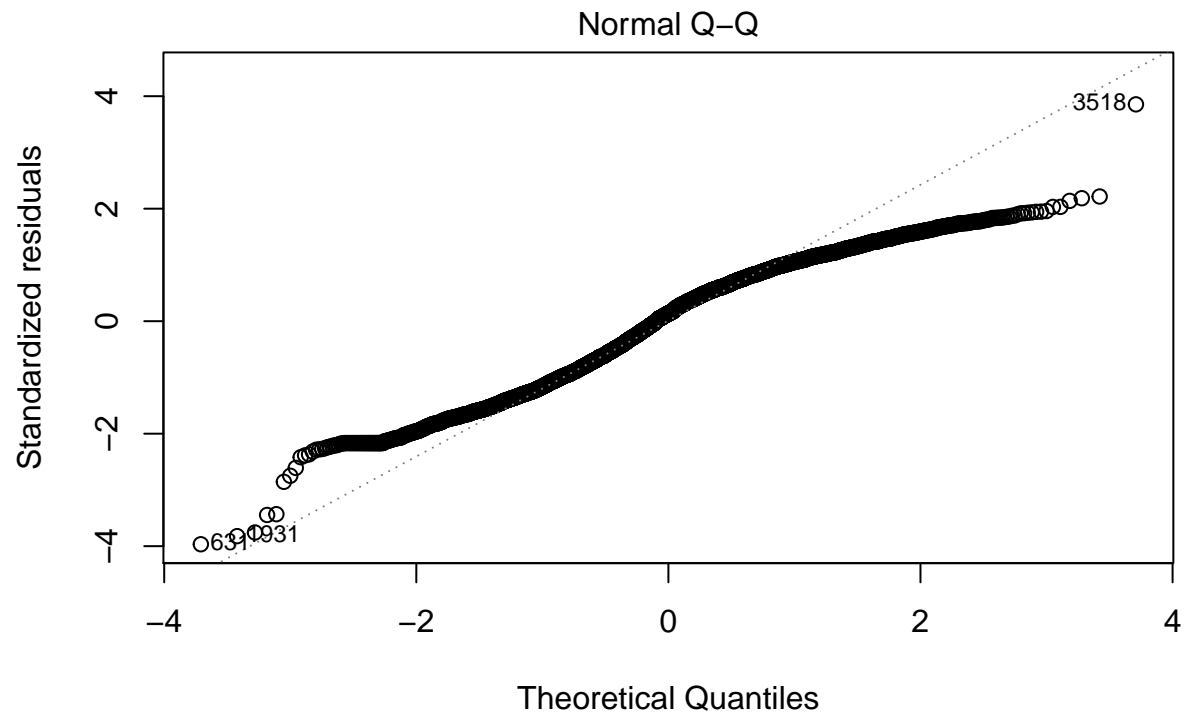


$\text{lm}(\text{Buoy3\$`mean(WTMP)`} \sim \text{Buoy3\$`mean(WSPD)`} + \text{Buoy3\$`mean(GST)`} + \text{Buoy3\$`m`})$

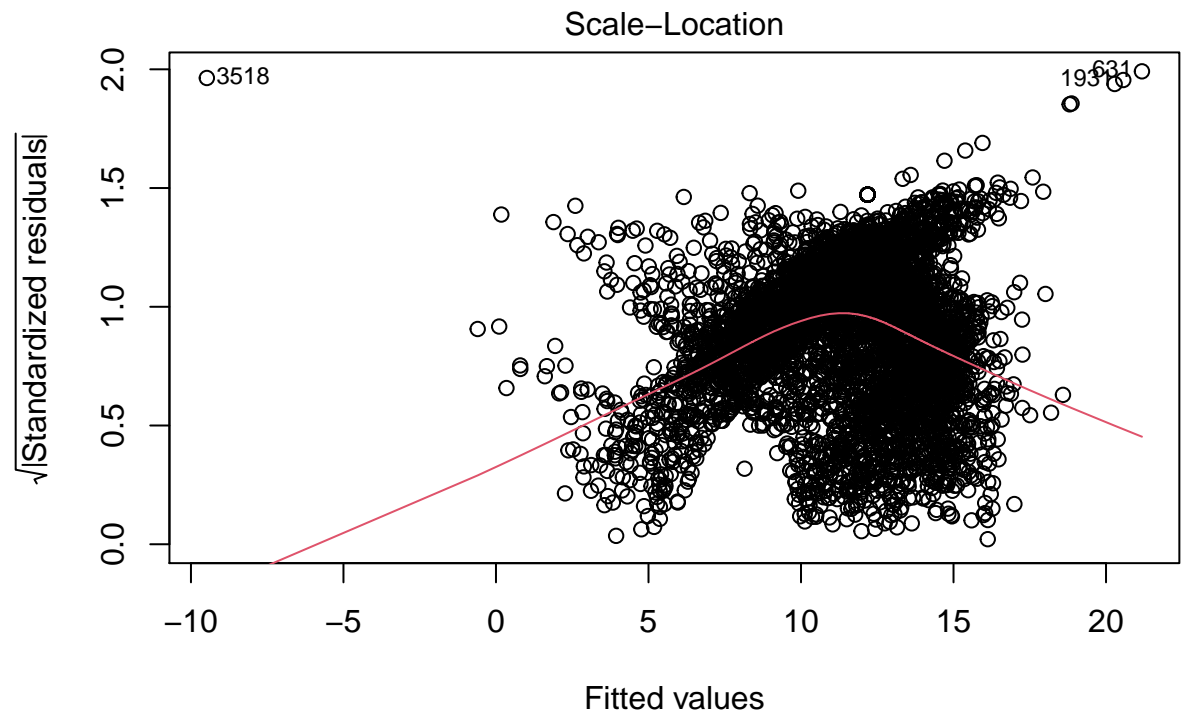
`plot(fit_day_1)`



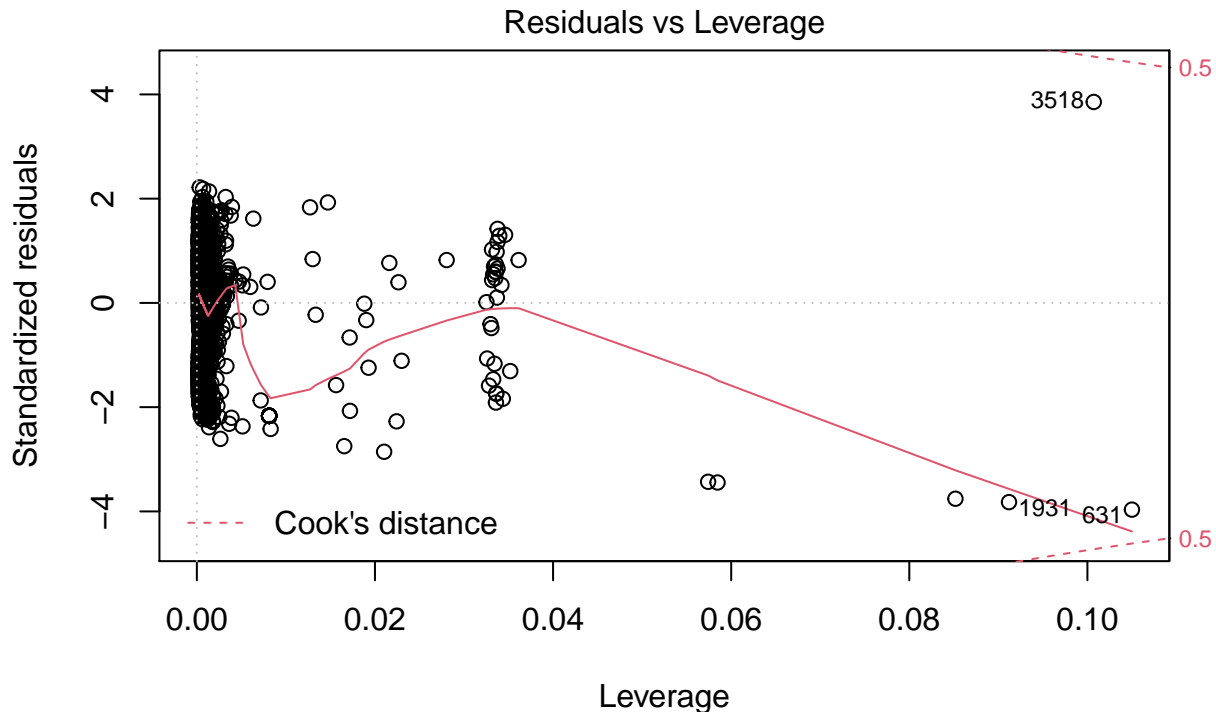
Fitted values
 $\text{lm}(\text{Buoy2\$`mean(WTMP)`} \sim \text{Buoy2\$`mean(WSPD)`} + \text{Buoy2\$`mean(GST)`} + \text{Buoy2\$`m`})$



$\text{lm}(\text{Buoy2\$`mean(WTMP)`} \sim \text{Buoy2\$`mean(WSPD)`} + \text{Buoy2\$`mean(GST)`} + \text{Buoy2\$`m`})$



$\text{lm}(\text{Buoy2\$`mean(WTMP)`} \sim \text{Buoy2\$`mean(WSPD)`} + \text{Buoy2\$`mean(GST)`} + \text{Buoy2\$`m`})$



```
lm(Buoy2$`mean(WTMP)` ~ Buoy2$`mean(WSPD)` + Buoy2$`mean(GST)` + Buoy2$`m
```

```
summary(fit_in_1)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(WTMP)` ~ Buoy4$`year(D_date)` )
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.8836 -0.6753 -0.2132  0.6987  4.8491
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -219.9554    241.0469   -0.913   0.374
## Buoy4$`year(D_date)`    0.1155     0.1200    0.963   0.349
##
## Residual standard error: 2.953 on 17 degrees of freedom
## Multiple R-squared:  0.05168,    Adjusted R-squared:  -0.004101
## F-statistic: 0.9265 on 1 and 17 DF,  p-value: 0.3493
```

```
summary(fit_year_1)
```

```
##
## Call:
## lm(formula = Buoy4$`mean(WTMP)` ~ Buoy4$`mean(WSPD)` + Buoy4$`mean(GST)` +
##     Buoy4$`mean(WVHT)` + Buoy4$`mean(APD)`, data = Buoy4)
##
## Residuals:
```

```
##      Min      1Q  Median      3Q      Max
## -1.8620 -0.8884 -0.4051  0.5711  2.6702
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      50.880      17.319   2.938  0.0108 *
## Buoy4$`mean(WSPD)`  14.629      11.515   1.270  0.2246
## Buoy4$`mean(GST)` -15.603       8.620  -1.810  0.0918 .
## Buoy4$`mean(WVHT)`   3.709       2.547   1.456  0.1674
## Buoy4$`mean(APD)`  -3.758       2.712  -1.386  0.1875
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.474 on 14 degrees of freedom
## Multiple R-squared:  0.8054, Adjusted R-squared:  0.7498
## F-statistic: 14.49 on 4 and 14 DF,  p-value: 7.012e-05
```

```
summary(fit_month_1)
```

```
##
## Call:
## lm(formula = Buoy3$`mean(WTMP)` ~ Buoy3$`mean(WSPD)` + Buoy3$`mean(GST)` +
##     Buoy3$`mean(WVHT)` + Buoy3$`mean(APD)`, data = Buoy3)
##
## Residuals:
##      Min      1Q  Median      3Q      Max
## -15.6670  -3.3264   0.4011   3.5464   8.6637
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      10.4339      4.3943   2.374  0.01857 *
## Buoy3$`mean(WSPD)`   5.5248      2.3091   2.393  0.01770 *
## Buoy3$`mean(GST)`  -5.7000      1.7544  -3.249  0.00137 **
## Buoy3$`mean(WVHT)` -2.1256      0.7252  -2.931  0.00379 **
## Buoy3$`mean(APD)`   2.2083      0.7638   2.891  0.00429 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.43 on 190 degrees of freedom
## Multiple R-squared:  0.4636, Adjusted R-squared:  0.4523
## F-statistic: 41.06 on 4 and 190 DF,  p-value: < 2.2e-16
```

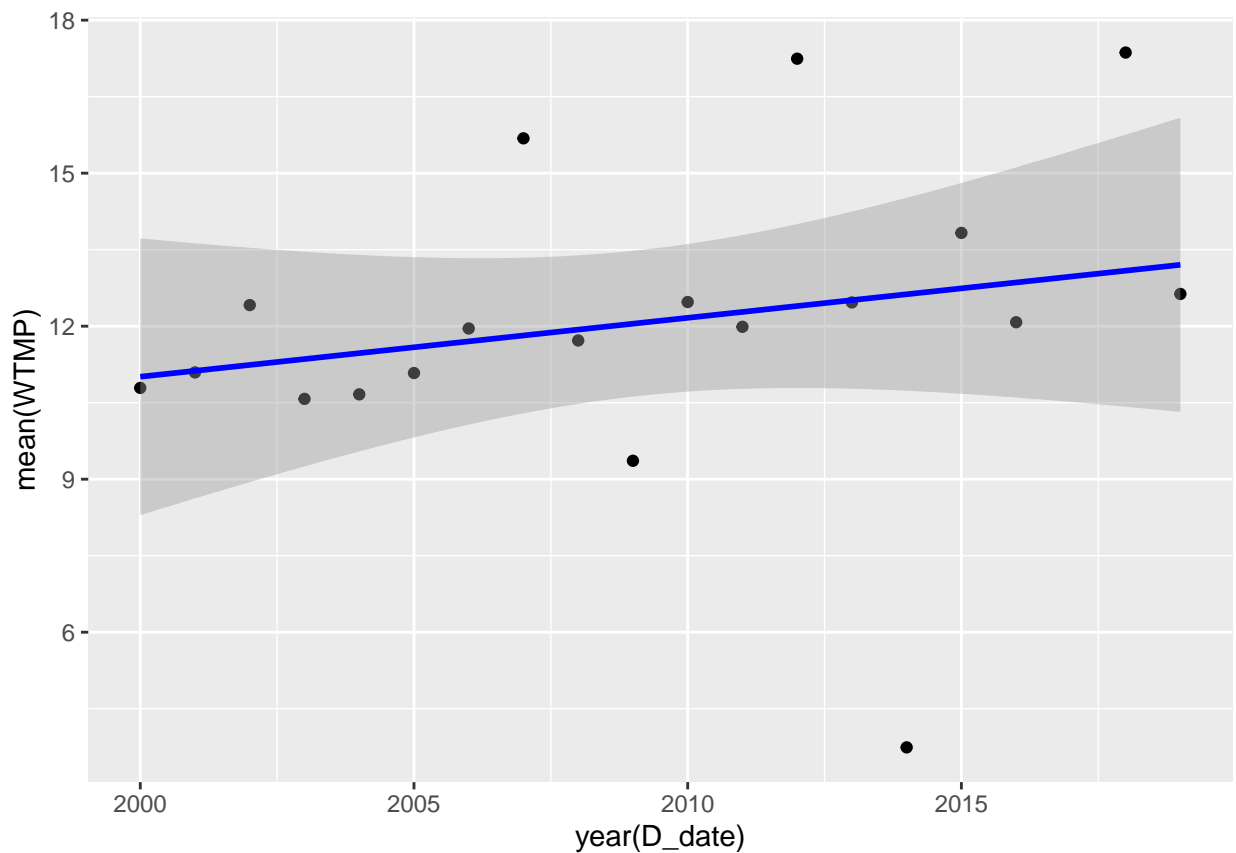
```
summary(fit_day_1)
```

```
##
## Call:
## lm(formula = Buoy2$`mean(WTMP)` ~ Buoy2$`mean(WSPD)` + Buoy2$`mean(GST)` +
##     Buoy2$`mean(WVHT)` + Buoy2$`mean(APD)`, data = Buoy2)
##
## Residuals:
##      Min      1Q  Median      3Q      Max
## -21.1775  -4.5423   0.7824   4.6511  20.6362
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
```

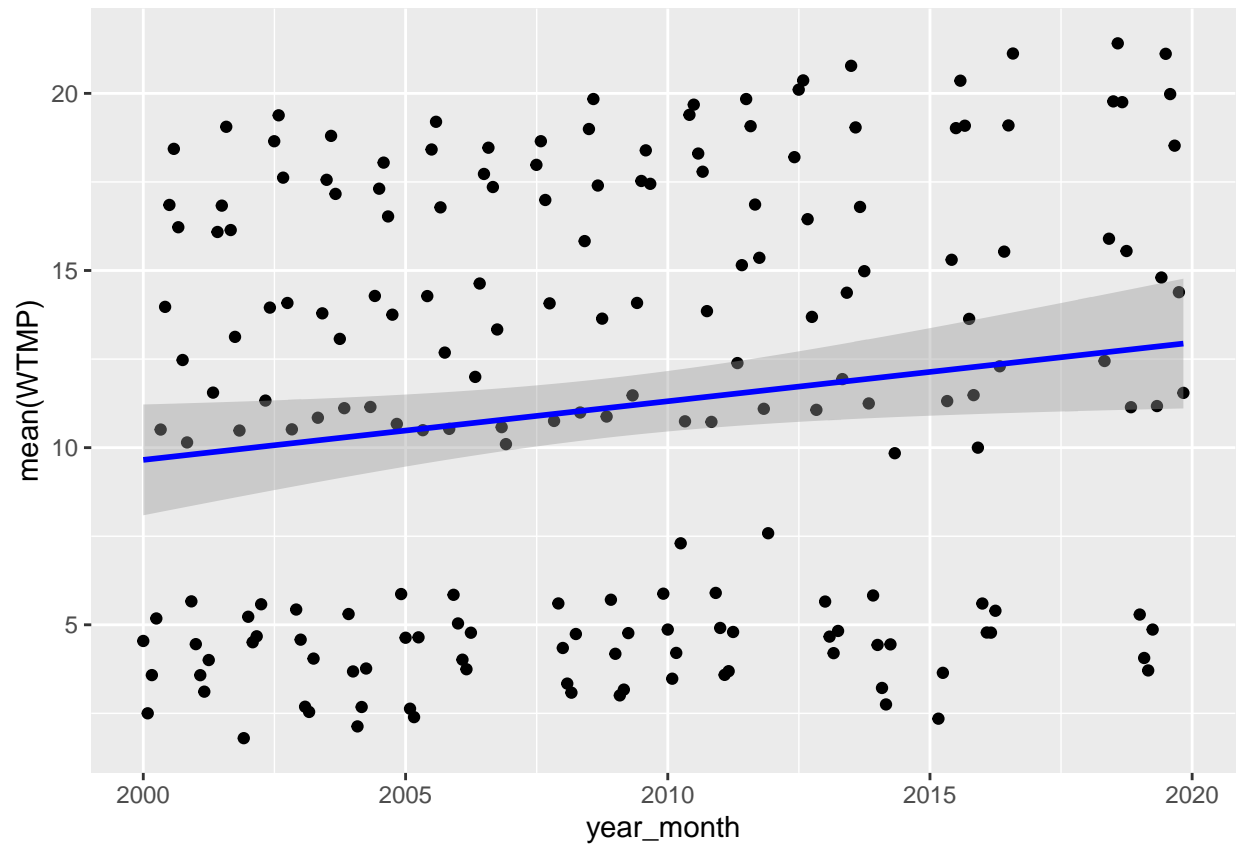


```
## (Intercept)      12.18223    0.50858   23.953   < 2e-16 ***
## Buoy2$`mean(WSPD)` 0.94192    0.19928    4.727   2.35e-06 ***
## Buoy2$`mean(GST)` -1.39681    0.15657   -8.921   < 2e-16 ***
## Buoy2$`mean(WVHT)` -0.88526    0.08814  -10.044   < 2e-16 ***
## Buoy2$`mean(APD)`  0.91045    0.09135    9.967   < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.645 on 4810 degrees of freedom
## Multiple R-squared:  0.1989, Adjusted R-squared:  0.1983
## F-statistic: 298.6 on 4 and 4810 DF,  p-value: < 2.2e-16
```

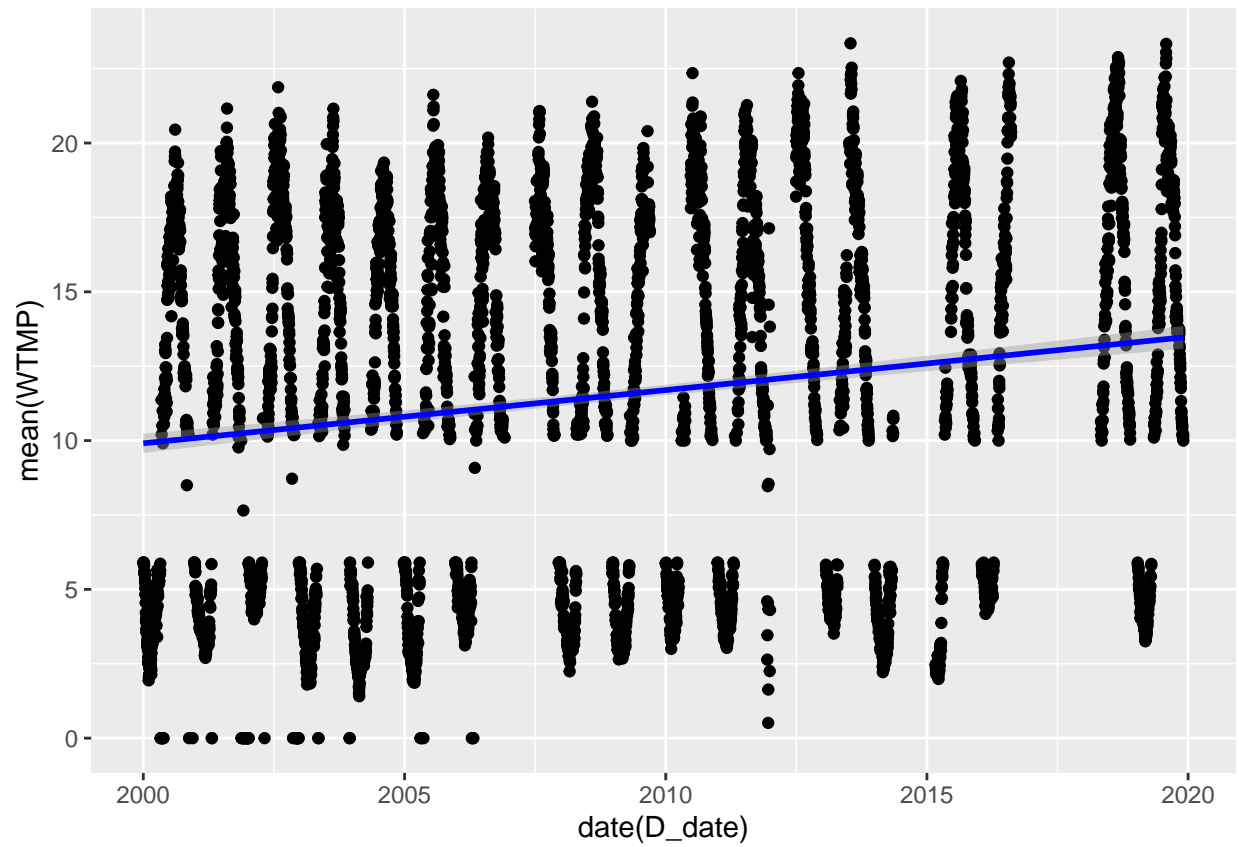
```
ggplot(mapping = aes(x= `year(D_date)`, y= `mean(WTMP)`),data = Buoy4)+ geom_point() + geom_smooth(meth
```



```
ggplot(mapping = aes(x= year_month, y= `mean(WTMP)`),data = Buoy3)+ geom_point() + geom_smooth(method =
```



```
ggplot(mapping = aes(x= `date(D_date)`, y= `mean(WTMP)`), data = Buoy2) + geom_point() + geom_smooth(meth
```



```
##reference packages(data.table) packages(lubridate) packages(tidyverse)
```