

# R Notebook

This is an R Markdown (<http://rmarkdown.rstudio.com>) Notebook. When you execute code within the notebook, the results appear beneath the code.

Try executing this chunk by clicking the *Run* button within the chunk or by placing your cursor inside it and pressing *Cmd+Shift+Enter*.

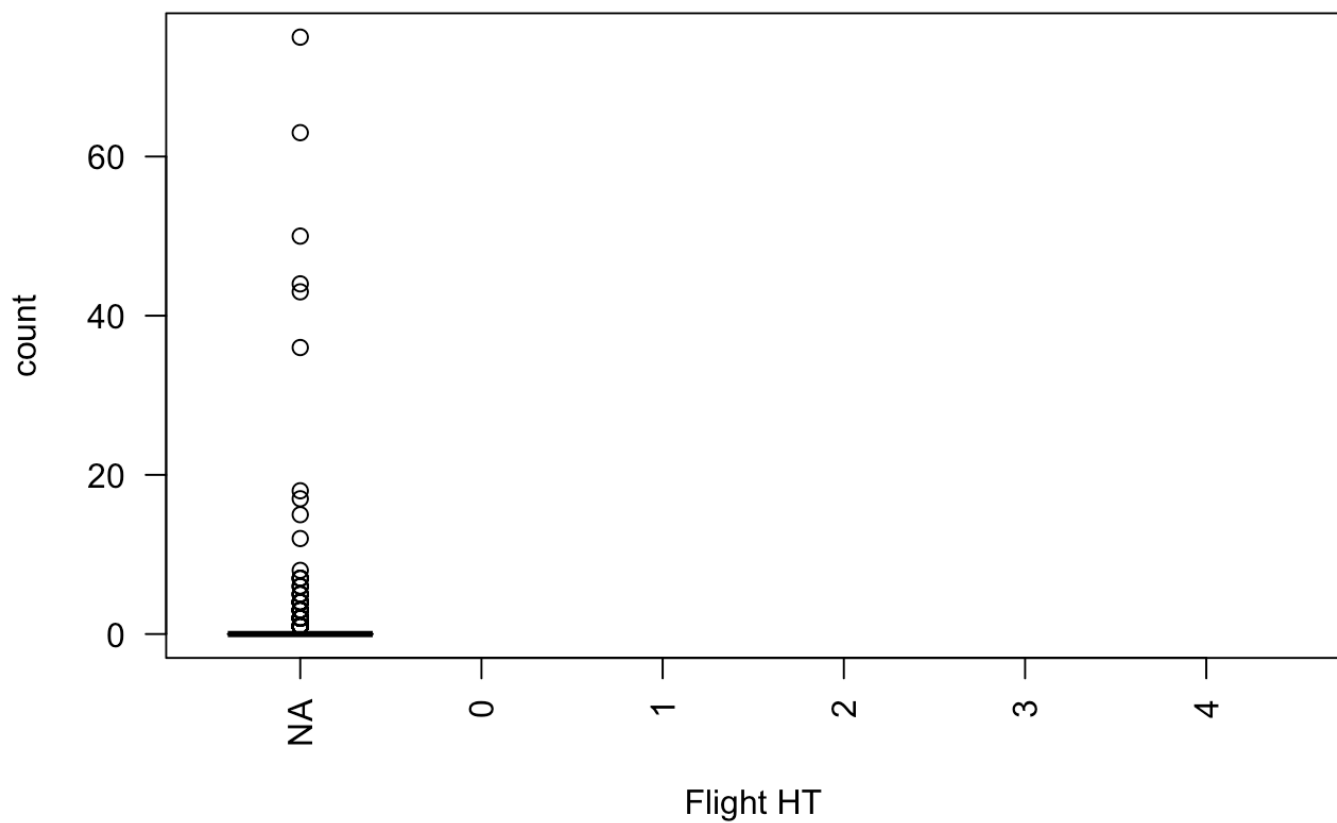
```
library(readxl)
df <- read_excel("HMworkingdatav2.xlsx")
```

```
# just for convince
names(df)[names(df) == 'Wind Spd'] <- 'Wind.Spd'
names(df)[names(df) == 'Wind Spd2'] <- 'Windspd'
names(df)[names(df) == 'Cloud Cover'] <- 'Cloudcover'
names(df)[names(df) == 'Wind Dir'] <- 'Winddir'
names(df)[names(df) == 'Flight DIR'] <- 'Flightdir'
names(df)[names(df) == 'Flight HT'] <- 'Flightht'
names(df)[names(df) == 'Observer 1'] <- 'Observer1'
names(df)[names(df) == 'Observer2.new'] <- 'Observer2'
names(df)[names(df) == 'Observer 3'] <- 'Observer3'
names(df)[names(df) == 'Observer 4'] <- 'Observer4'
# check property
data <- as.data.frame(df)
str(data)
```

```
## 'data.frame':      1319 obs. of  46 variables:
## $ Date              : POSIXct, format: "2018-02-13 11:30:00" "2018-02-13 12:00:00"
## ...
## $ Month             : chr  "02" "02" "02" "02" ...
## $ Year              : chr  "2018" "2018" "2018" "2018" ...
## $ Start             : chr  "11:30" "12:00" "13:00" "14:00" ...
## $ End              : chr  "12:00" "13:00" "14:00" "15:00" ...
## $ Duration          : num  30 60 60 60 30 60 60 60 45 30 ...
## $ Observer          : num  90 180 180 180 60 120 180 180 90 30 ...
## $ BV               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ TV               : num  0 0 0 1 0 0 0 0 0 0 ...
## $ OS               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ BE               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ NH               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ SS               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ CH               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ NG               : num  0 1 0 0 0 0 0 0 0 0 ...
## $ RS               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ BW               : num  0 0 0 0 0 0 0 0 0 0 ...
## $ RT               : num  1 2 2 0 2 1 1 0 0 0 ...
## $ RL               : num  0 0 0 0 0 0 0 0 0 0 ...
```

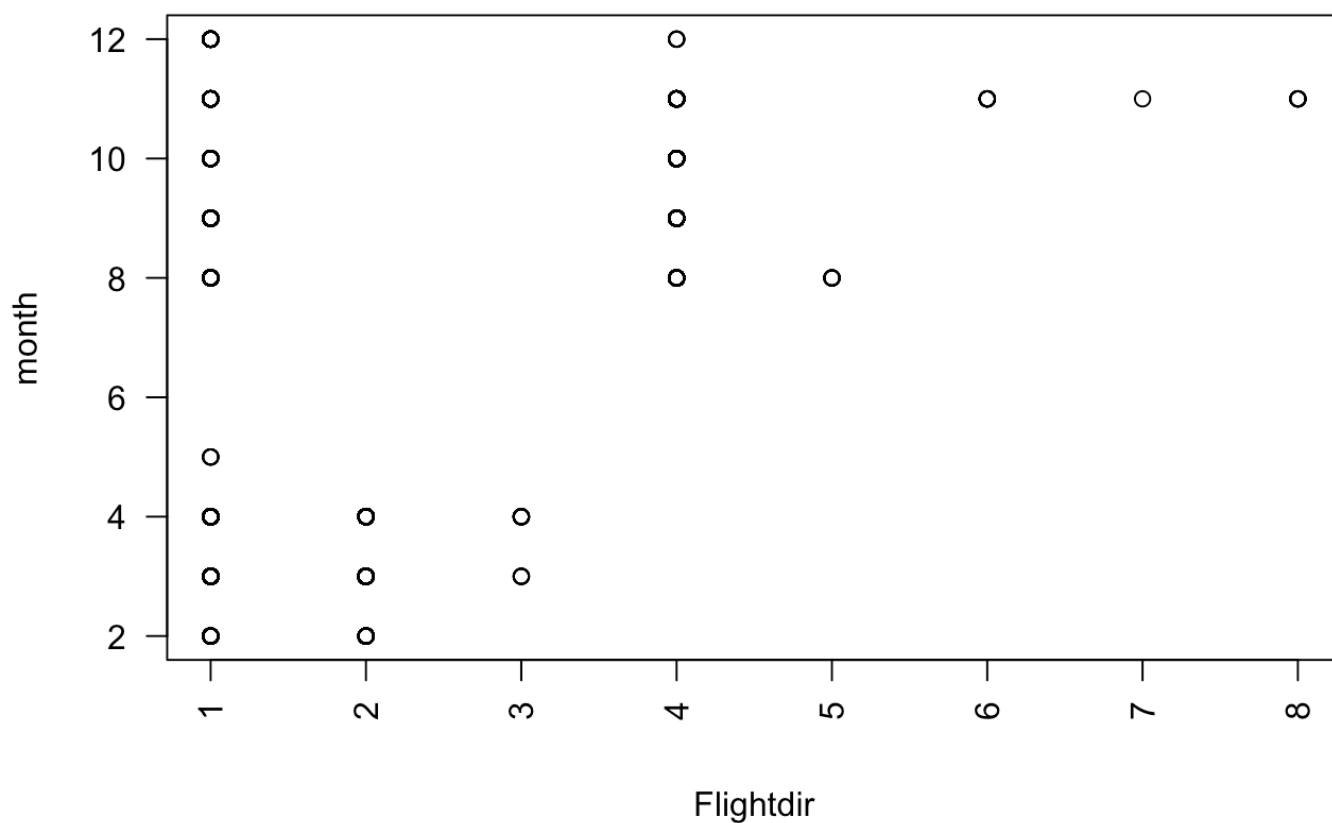
```
## $ GE : num 1 0 1 0 0 0 0 0 0 0 ...
## $ AK : num 0 0 0 0 0 0 0 0 0 0 ...
## $ ML : num 0 0 0 0 0 0 0 0 0 0 ...
## $ PG : num 0 0 0 0 0 0 0 0 0 0 ...
## $ UA : num 0 0 0 0 0 0 0 0 0 0 ...
## $ UB : num 0 0 0 0 0 0 0 0 0 0 ...
## $ UF : num 0 0 0 0 0 0 0 0 0 0 ...
## $ UE : num 0 0 0 0 0 0 0 0 0 0 ...
## $ UR : num 0 0 0 0 0 0 0 0 0 0 ...
## $ TOTAL : num 2 3 3 1 2 1 1 0 0 0 ...
## $ Wind.Spd : chr "3: 12-19 km/h (8-12 mph)" "3: 12-19 km/h (8-12 mph)" "
3: 12-19 km/h (8-12 mph)" "3: 12-19 km/h (8-12 mph)" ...
## $ Windspd : chr "3" "3" "3" "3" ...
## $ Winddir : chr "SE" "SE" "SE" "SE" ...
## $ Temp : num -2 -2 0 1 -4 -4 -3 -4 -4 1.6 ...
## $ Humidity : num 0 0 0 0 0 0 0 0 0 93 ...
## $ BARO : num 0 0 0 0 0 ...
## $ Cloudcover : num 20 20 20 25 100 85 100 100 100 100 ...
## $ Visibility : chr "25" "25" "25" "25" ...
## $ Precipitation : chr "0: None" "0: None" "0: None" "0: None" ...
## $ Precipitation2: chr "0" "0" "0" "0" ...
## $ Flightdir : chr "N" "N" "N" "N" ...
## $ Flight HT : chr "2: Unaided eye" "2: Unaided eye" "2: Unaided eye" "2:
Unaided eye" ...
## $ Counter : chr "4" "4" "4" "4" ...
## $ Observer1 : chr "36" "36" "36" "36" ...
## $ Observer2 : chr "30" "30" "30" "30" ...
## $ Observer3 : chr "NA" "NA" "NA" "NA" ...
## $ Observer4 : chr "NA" "NA" "NA" "NA" ...
```

```
# measure the relation between total and flight height
# check the importance of a factor variable
library(faraway)
data$`Flight HT` <-factor(data$`Flight HT`,levels=c("NA","0","1","2","3","4"))
plot(TOTAL ~ `Flight HT`, data, las=2, ylab="count")
```



```
# measure the relation between flight direction and month
```

```
data$Flightdir <- factor(data$Flightdir, levels=c("NA", "N", "NNE", "S", "SE", "SSW", "SW",  
"W"))  
plot(Month ~ Flightdir, data, las=2, ylab="month")
```



```
# change attribute
data$Windspd <- as.numeric(as.character(data$Windspd))
data$Visibility <- as.numeric(as.character(data$Visibility))
```

```
## Warning: 强制改变过程中产生了NA
```

```
data$Precipitation2 <- as.numeric(as.character(data$Precipitation2))
```

```
## Warning: 强制改变过程中产生了NA
```

```
data$Counter <- as.numeric(as.character(data$Counter))
```

```
## Warning: 强制改变过程中产生了NA
```

```
data$Observer1 <- as.numeric(as.character(data$Observer1))
```

```
## Warning: 强制改变过程中产生了NA
```

```
data$Observer2 <- as.numeric(as.character(data$Observer2))
```

```
## Warning: 强制改变过程中产生了NA
```

```
data$Observer3 <- as.numeric(as.character(data$Observer3))
```

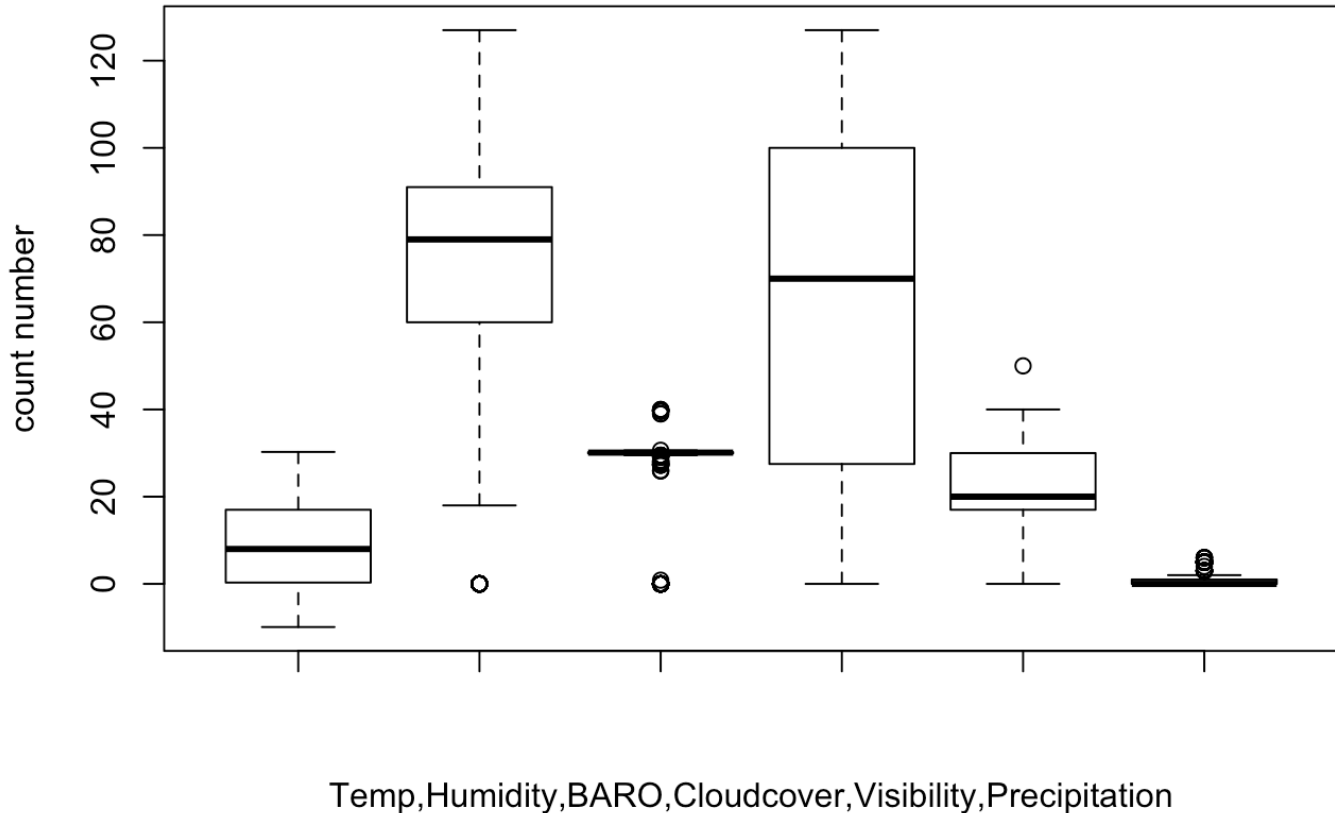
```
## Warning: 强制改变过程中产生了NA
```

```
data$Observer4 <- as.numeric(as.character(data$Observer4))
```

```
## Warning: 强制改变过程中产生了NA
```

```
# Outliers find
```

```
boxplot(data$Temp,data$Humidity,data$BARO,data$Cloudcover,data$Visibility,data$Precipitation2,xlab="Temp,Humidity,BARO,Cloudcover,Visibility,Precipitation",ylab="count number",title="Outliers find")
```



[illegible]

|    |      |       |       |       |       |       |       |       |       |       |       |       |       |
|----|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ## | [1]  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 27.42 | 27.43 | 27.40 |
| ## | [13] | 27.36 | 0.00  | 0.00  | 0.00  | 27.57 | 27.57 | 27.25 | 27.26 | 27.24 | 27.25 | 0.00  | 0.00  |
| ## | [25] | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| ## | [37] | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| ## | [49] | 0.00  | 0.00  | 27.92 | 27.98 | 27.99 | 28.01 | 28.21 | 28.37 | 29.02 | 29.28 | 30.64 | 0.85  |
| ## | [61] | 29.50 | 29.33 | 29.07 | 25.94 | 25.94 | 25.94 | 0.00  | 39.77 | 39.77 | 39.77 | 39.76 | 39.73 |
| ## | [73] | 39.70 | 39.66 | 39.62 | 39.60 | 0.00  | 0.00  | 0.00  | 39.97 | 39.97 | 39.99 | 39.00 | 39.01 |
| ## | [85] | 0.00  | 0.00  | 0.00  | 0.00  | 29.44 | 29.37 | 29.36 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| ## | [97] | 0.00  | 0.00  | 0.00  | 0.00  | 29.44 | 29.46 | 29.46 | 29.48 | 29.47 | 29.47 | 29.47 |       |

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

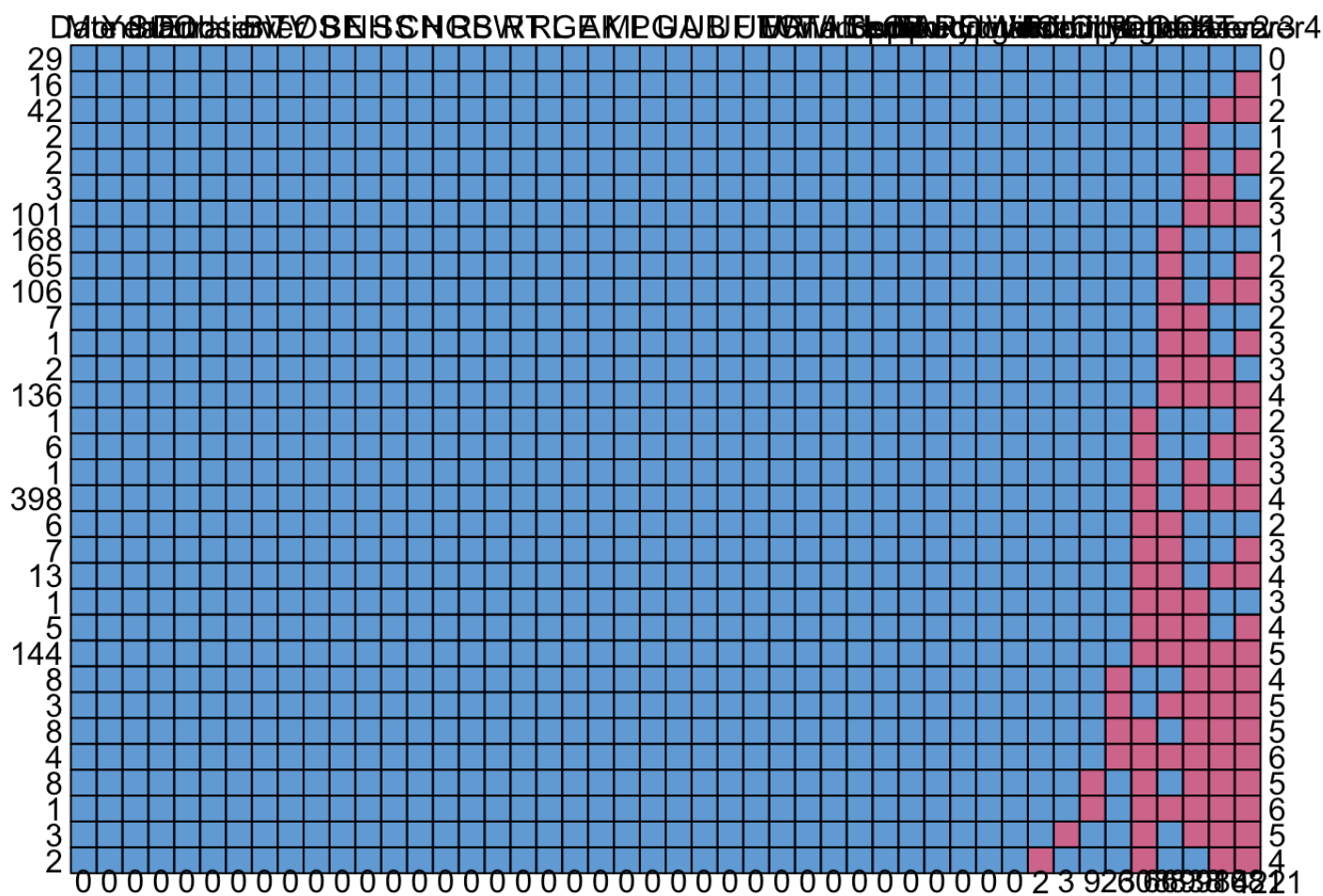
```
#check missing value
library(mice)
```

```
##
## Attaching package: 'mice'
```

```
## The following object is masked from 'package:faraway':
##
##     mammalsleep
```

```
## The following objects are masked from 'package:base':
##
##     cbind, rbind
```

```
md.pattern(newdata3)
```



```
##      Date Month Year Start End Duration Observer BV TV OS BE NH SS CH NG RS BW
## 29      1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 16      1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 42      1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 2       1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 2       1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 3       1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 101     1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 168     1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 65      1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
## 106     1      1    1      1  1          1      1  1  1  1  1  1  1  1  1  1
```

|    |     |    |    |    |    |    |    |    |    |    |    |    |       |          |         |      |          |      |   |
|----|-----|----|----|----|----|----|----|----|----|----|----|----|-------|----------|---------|------|----------|------|---|
| ## | 7   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 2   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 136 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 6   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 398 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 6   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 7   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 13  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 5   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 144 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 8   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 3   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 8   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 4   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 8   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 3   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 2   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## |     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0        | 0       | 0    | 0        | 0    | 0 |
| ## |     | RT | RL | GE | AK | ML | PG | UA | UB | UF | UE | UR | TOTAL | Wind.Spd | Windspd | Temp | Humidity | BARO |   |
| ## | 29  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 16  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 42  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 2   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 2   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 3   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 101 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 168 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 65  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 106 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 7   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 2   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 136 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 6   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 398 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 6   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 7   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 13  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 5   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 144 | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 8   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |
| ## | 3   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1        | 1       | 1    | 1        | 1    | 1 |



|    |     |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|----|-----|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ## | 8   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 4   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 8   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 1   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 3   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## | 2   | 1  | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ## |     | 0  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ## |     | Cloudcover Precipitation Flightdir Winddir Visibility Counter    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| ## | 29  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 16  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 42  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 3   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 101 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 168 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 65  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 106 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 7   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 1   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 136 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 1   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 6   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 1   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 398 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 6   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 7   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 13  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 1   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 5   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 144 |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 8   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 3   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 8   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 4   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |
| ## | 8   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 0 |   | 0 |
| ## | 1   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 0 |   | 0 |
| ## | 3   |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 0 |   | 1 |   | 1 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 0 |   | 1 |   | 1 |   | 1 |
| ## |     |  | 0 |   |   |   | 0 |   | 0 |   | 2 |   | 3 |   | 9 |   |   |
| ## |     | Precipitation2 Observer1 Flight HT Observer2 Observer3 Observer4 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| ## | 29  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 1 |   | 0 |
| ## | 16  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 1 |   | 0 |   | 1 |
| ## | 42  |  | 1 |   |   |   | 1 |   | 1 |   | 1 |   | 0 |   | 0 |   | 2 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 0 |   | 1 |   | 1 |   | 1 |
| ## | 2   |  | 1 |   |   |   | 1 |   | 1 |   | 0 |   | 1 |   | 0 |   | 2 |
| ## | 3   |  | 1 |   |   |   | 1 |   | 1 |   | 0 |   | 0 |   | 1 |   | 2 |
| ## | 101 |  | 1 |   |   |   | 1 |   | 1 |   | 0 |   | 0 |   | 0 |   | 3 |
| ## | 168 |  | 1 |   |   |   | 1 |   | 0 |   | 1 |   | 1 |   | 1 |   | 1 |

|        |    |     |     |     |     |      |      |
|--------|----|-----|-----|-----|-----|------|------|
| ## 65  | 1  | 1   | 0   | 1   | 1   | 0    | 2    |
| ## 106 | 1  | 1   | 0   | 1   | 0   | 0    | 3    |
| ## 7   | 1  | 1   | 0   | 0   | 1   | 1    | 2    |
| ## 1   | 1  | 1   | 0   | 0   | 1   | 0    | 3    |
| ## 2   | 1  | 1   | 0   | 0   | 0   | 1    | 3    |
| ## 136 | 1  | 1   | 0   | 0   | 0   | 0    | 4    |
| ## 1   | 1  | 0   | 1   | 1   | 1   | 0    | 2    |
| ## 6   | 1  | 0   | 1   | 1   | 0   | 0    | 3    |
| ## 1   | 1  | 0   | 1   | 0   | 1   | 0    | 3    |
| ## 398 | 1  | 0   | 1   | 0   | 0   | 0    | 4    |
| ## 6   | 1  | 0   | 0   | 1   | 1   | 1    | 2    |
| ## 7   | 1  | 0   | 0   | 1   | 1   | 0    | 3    |
| ## 13  | 1  | 0   | 0   | 1   | 0   | 0    | 4    |
| ## 1   | 1  | 0   | 0   | 0   | 1   | 1    | 3    |
| ## 5   | 1  | 0   | 0   | 0   | 1   | 0    | 4    |
| ## 144 | 1  | 0   | 0   | 0   | 0   | 0    | 5    |
| ## 8   | 0  | 1   | 1   | 0   | 0   | 0    | 4    |
| ## 3   | 0  | 1   | 0   | 0   | 0   | 0    | 5    |
| ## 8   | 0  | 0   | 1   | 0   | 0   | 0    | 5    |
| ## 4   | 0  | 0   | 0   | 0   | 0   | 0    | 6    |
| ## 8   | 1  | 0   | 1   | 0   | 0   | 0    | 5    |
| ## 1   | 1  | 0   | 0   | 0   | 0   | 0    | 6    |
| ## 3   | 1  | 0   | 1   | 0   | 0   | 0    | 5    |
| ## 2   | 1  | 0   | 1   | 1   | 0   | 0    | 4    |
| ##     | 23 | 608 | 669 | 838 | 988 | 1081 | 4221 |

```
# why NA? analysis
df1 <- subset(newdata3,is.na(Winddir))
df2 <- subset(newdata3,is.na(Visibility))

df3 <- subset(newdata3,is.na(Precipitation2))

df4 <- subset(newdata3,is.na(Counter))
df_NA <- rbind(df1,df2,df3,df4)
```

```
# check the NA of Observers
sum(is.na(newdata3$Observer1))
```

```
## [1] 608
```

```
sum(is.na(newdata3$Observer2))
```

```
## [1] 838
```

```
sum(is.na(newdata3$Observer3))
```

```
## [1] 988
```

```
sum(is.na(newdata3$Observer4))
```

```
## [1] 1081
```

```
# delete inconsistent Counter and Observer data
newdata3['Counter_NA'] = as.integer(is.na(newdata3[, "Counter"]))
newdata3['Observer1_NA'] <- as.integer(is.na(newdata3[, "Observer1"]))

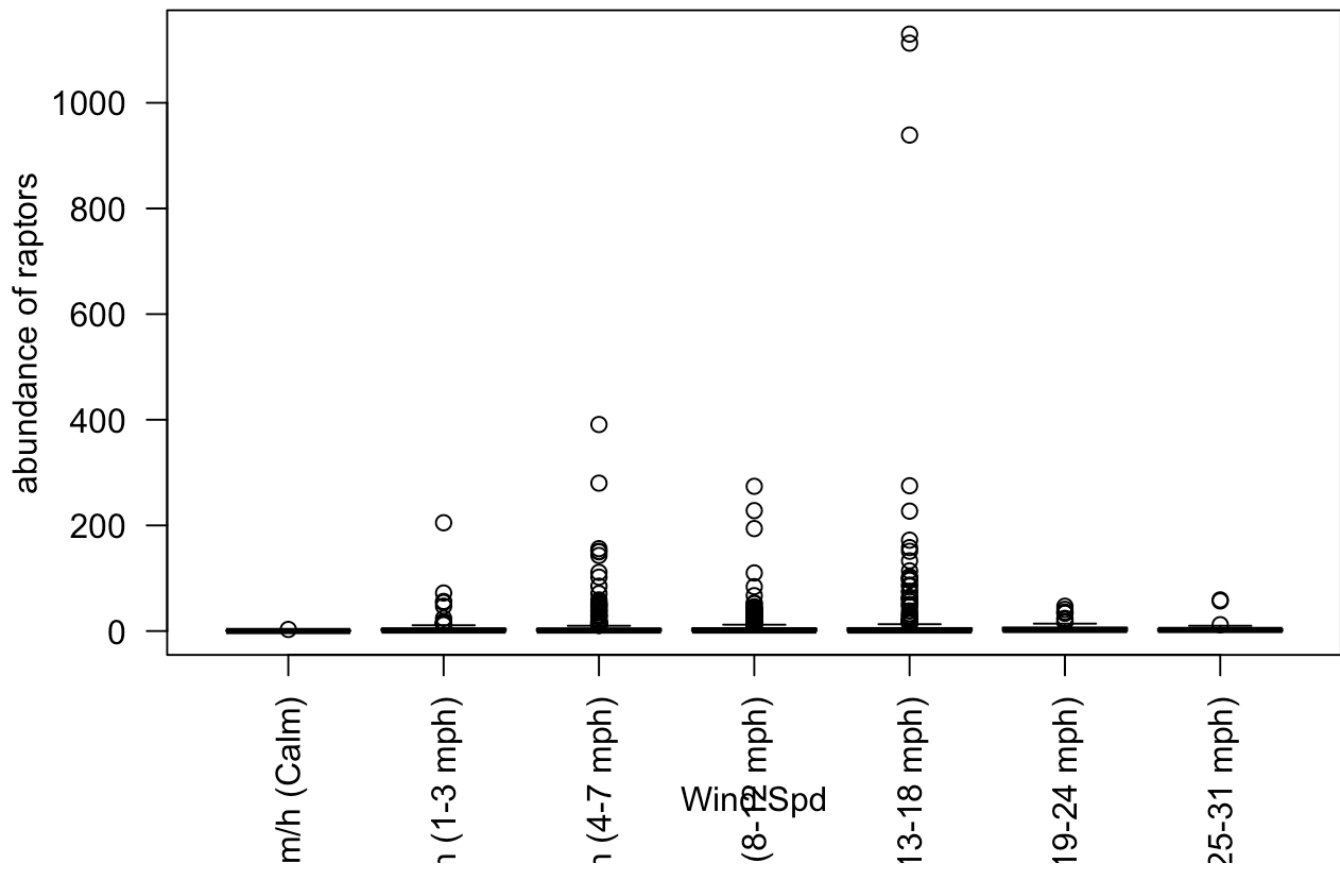
newdata3['Observer2_NA'] <- as.integer(is.na(newdata3[, "Observer2"]))
newdata3['Observer3_NA'] <- as.integer(is.na(newdata3[, "Observer3"]))
newdata3['Observer4_NA'] <- as.integer(is.na(newdata3[, "Observer4"]))
newdata3['Observer_num_real'] <- newdata3['Observer']/newdata3['Duration']-1

newdata3['Observer_num_record'] <- 4 - (newdata3['Observer1_NA'] +newdata3['Observer2_NA'] +newdata3['Observer3_NA'] +newdata3['Observer4_NA'])

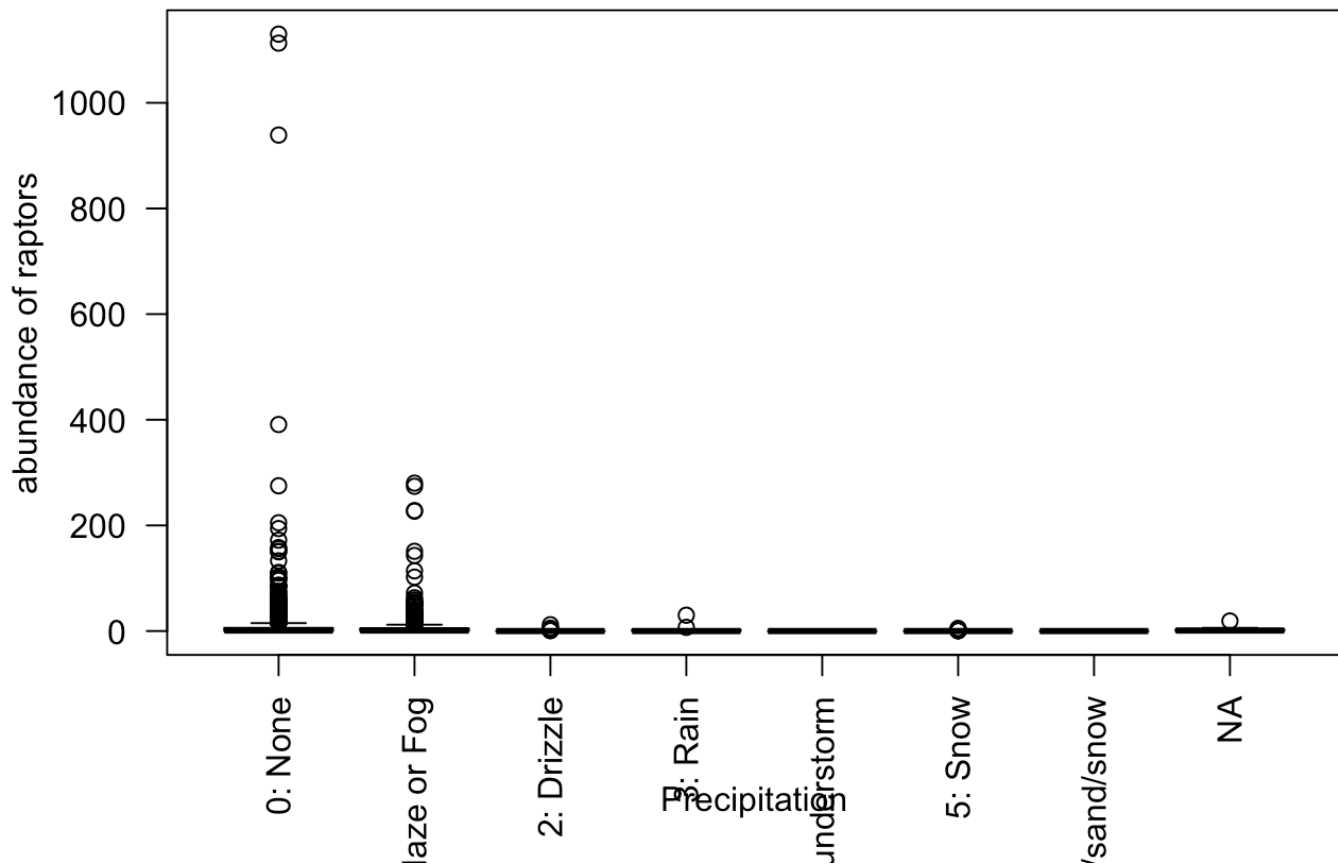
data_new1 <- newdata3[newdata3$Observer_num_real == newdata3$Observer_num_record,]
```

```
# true Observer number count add
data_new1 <- transform(data_new1, Observernumber=Observer/Duration-1)
#df5 <- subset(newdata3, newdata3$Observer_num_real < newdata3$Observer_num_real/n
newdata3$Observer_num_real > newdata3$Observer_num_real)
```

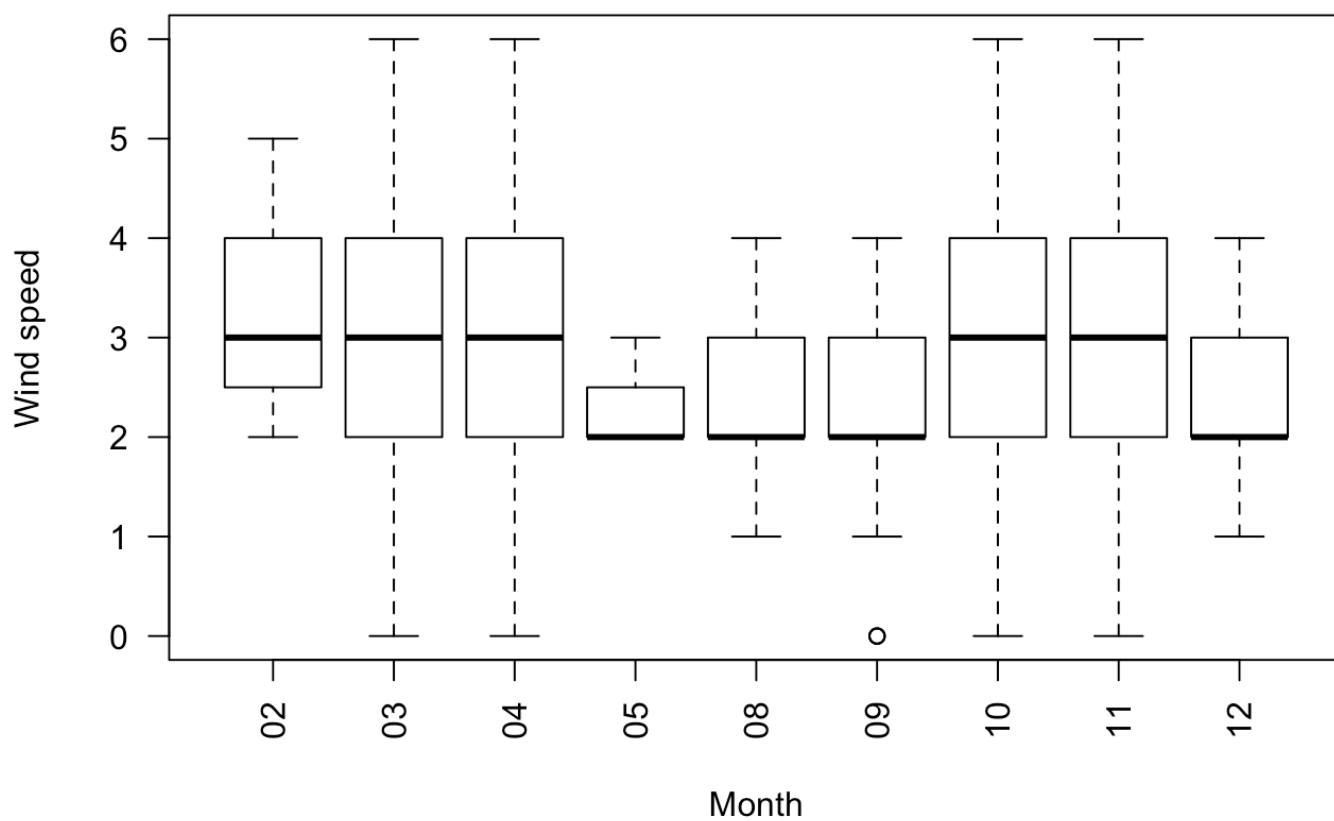
```
# check the relation of total and levels of Wind speed and precipitation
data_new1$Wind.Spd <- factor(data_new1$Wind.Spd)
data_new1$Precipitation <- factor(data_new1$Precipitation)
plot(TOTAL ~ Wind.Spd, data_new1, las=2, ylab="abundance of raptors")
```



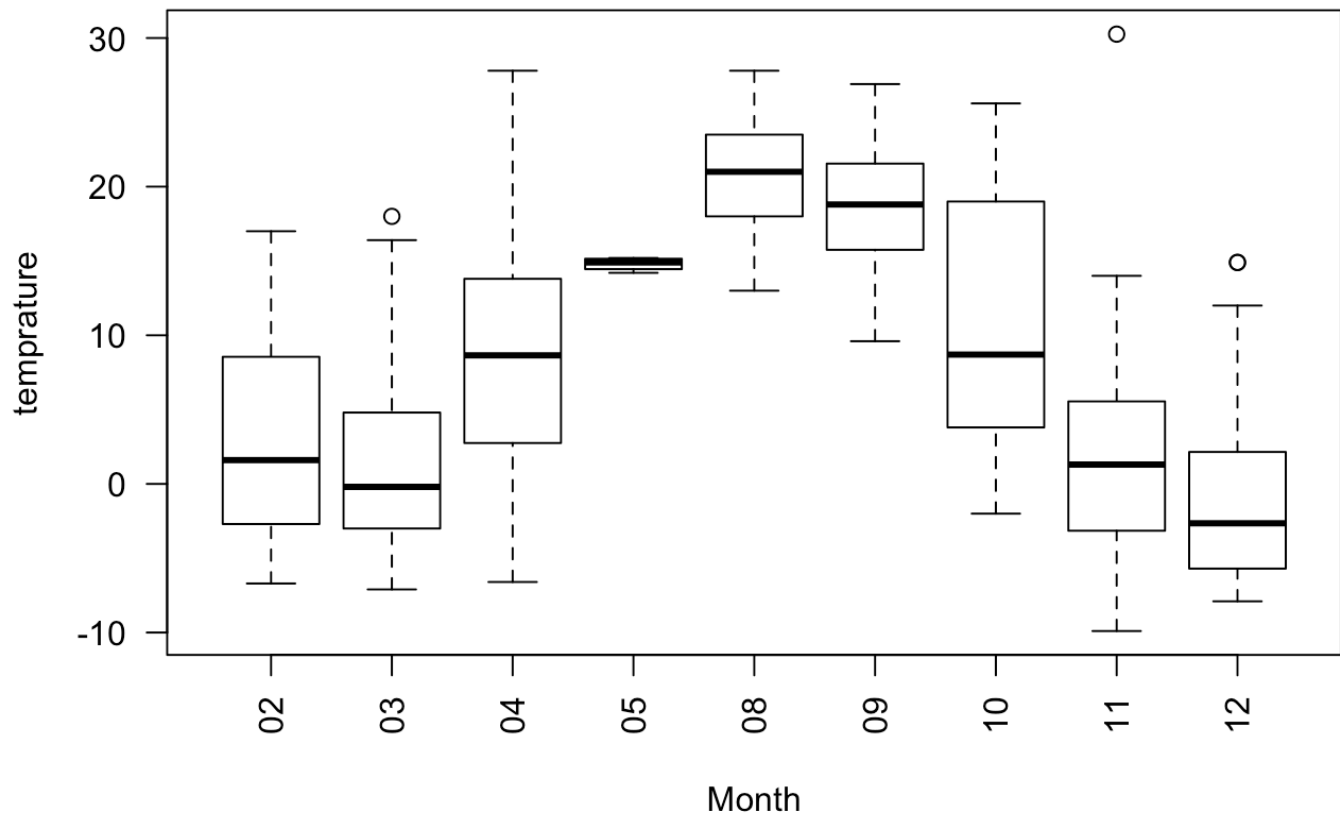
```
plot(TOTAL ~ Precipitation, data_new1, las=2, ylab="abundance of raptors")
```



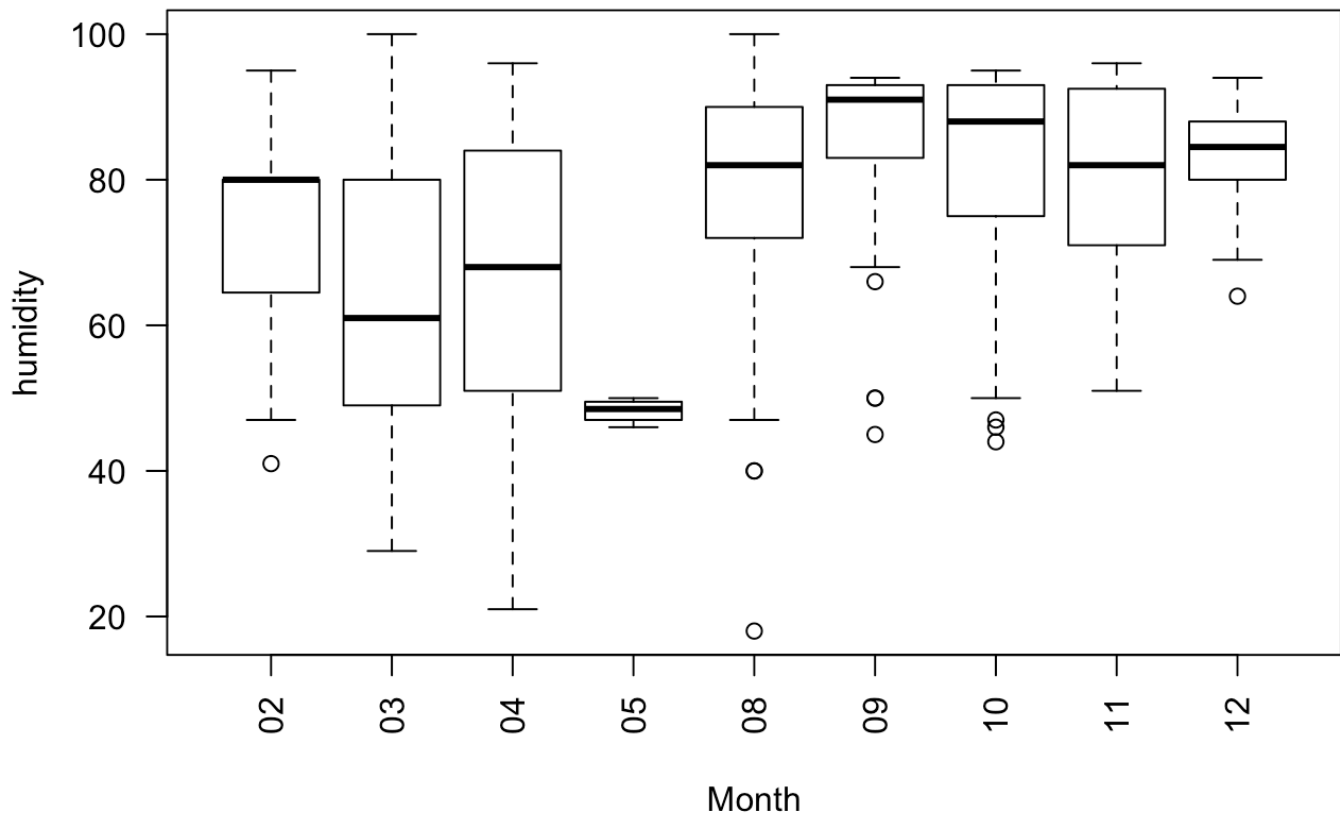
```
# check the relation of month and different weather factors
data_new1$Month <- factor(data_new1$Month)
plot(Windspd ~ Month, data_new1, las=2, ylab="Wind speed")
```



```
plot(Temp~ Month, data_new1, las=2,ylab="temprature")
```

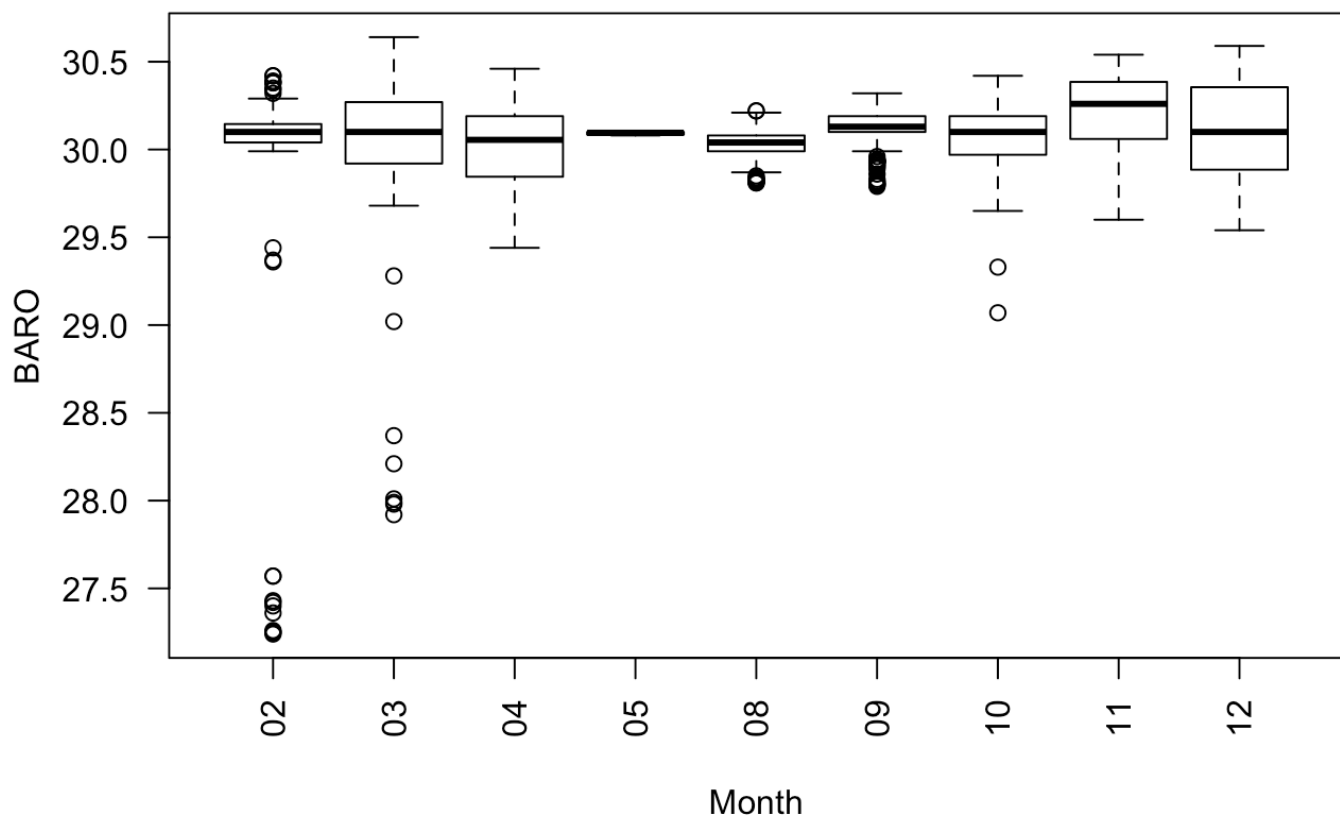


```
plot(Humidity ~ Month, data_new1, las=2, ylab="humidity")
```

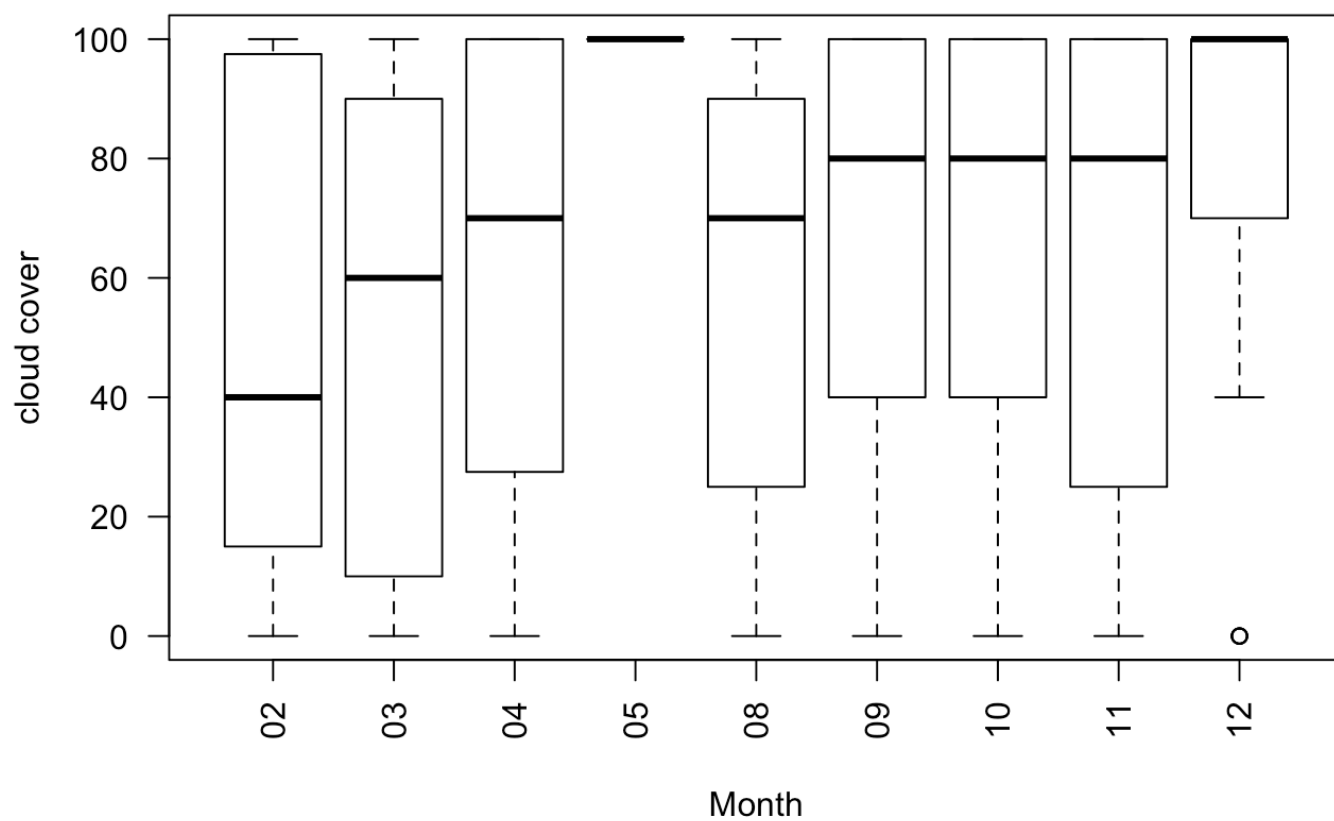


```
plot(BARO ~ Month, data_new1, las=2, ylab="BARO")
```

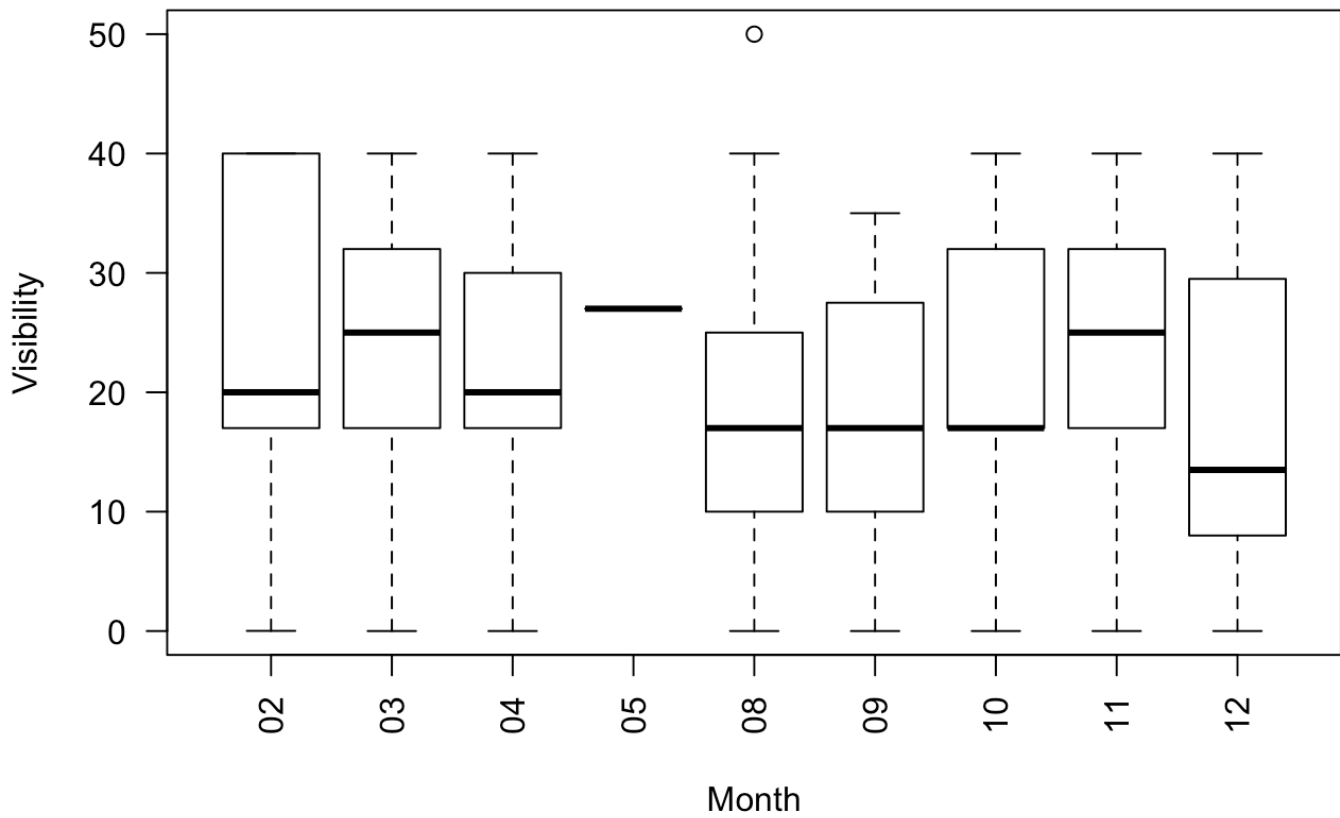




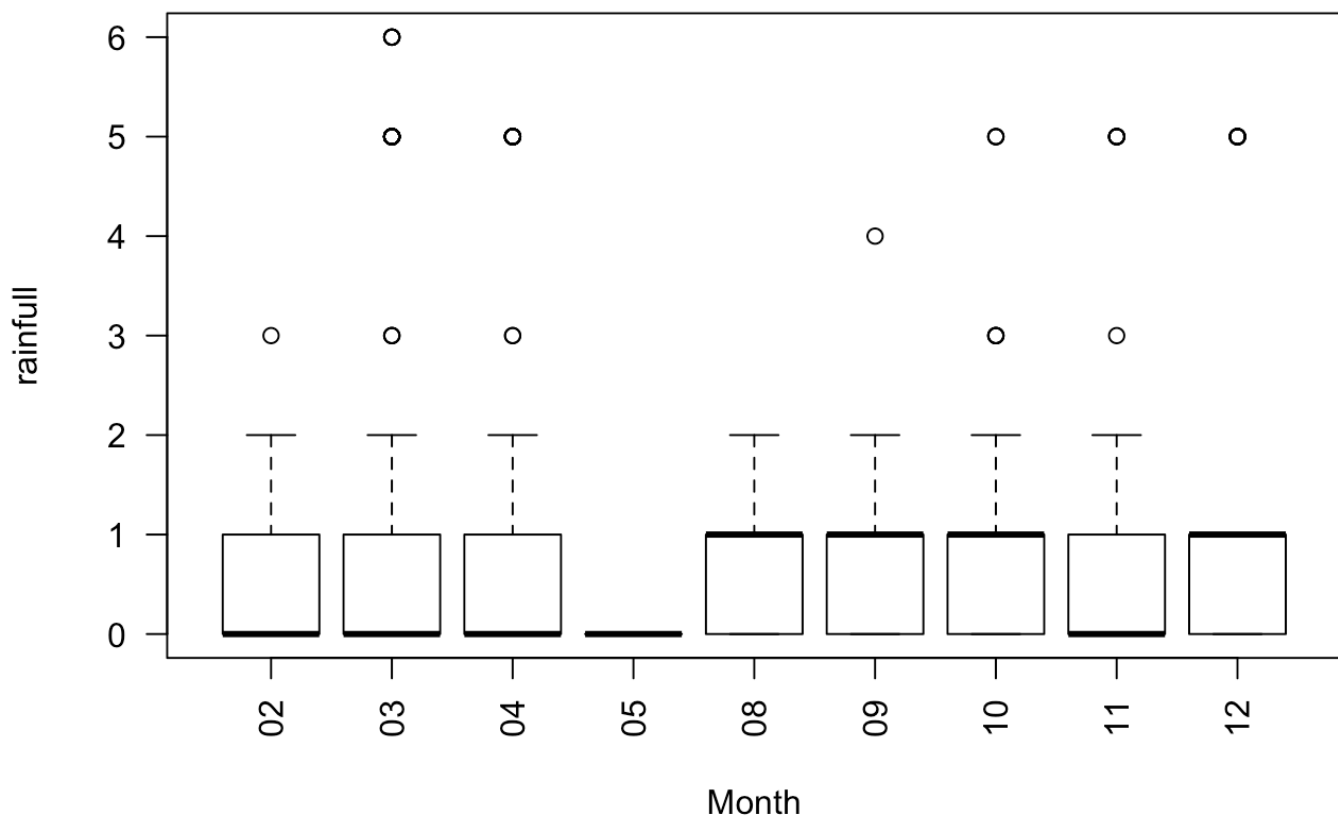
```
# BARO may not a factor to affect total  
plot(Cloudcover~ Month, data_new1, las=2,ylab="cloud cover")
```



```
plot(Visibility ~ Month, data_new1, las=2, ylab="Visibility")
```



```
plot(Precipitation2~ Month, data_new1, las=2,ylab="rainfull")
```



```
data_new2 <- subset(data_new1,select=c(TOTAL,Windspd,Temp,Humidity,BARO,Cloudcover  
,Visibility,Precipitation2))  
data_new2 <- na.omit(data_new2)  
cor(data_new2)
```

```
##              TOTAL      Windspd      Temp      Humidity      BARO
## TOTAL      1.00000000  0.058824121  0.129698512  0.08201676  0.036780172
## Windspd    0.05882412  1.000000000 -0.177427171 -0.07793613  0.007570259
## Temp       0.12969851 -0.177427171  1.000000000  0.06372075 -0.097134313
## Humidity   0.08201676 -0.077936135  0.063720750  1.000000000 -0.006131850
## BARO       0.03678017  0.007570259 -0.097134313 -0.00613185  1.000000000
## Cloudcover 0.05604067 -0.069044444  0.005016783  0.37943289 -0.088319580
## Visibility 0.03819370  0.141848840 -0.073279068 -0.47657992  0.149106753
## Precipitation2 -0.06716413  0.005552244 -0.178804212  0.26571736 -0.035394818
##           Cloudcover  Visibility  Precipitation2
## TOTAL      0.056040672  0.03819370  -0.067164133
## Windspd    -0.069044444  0.14184884  0.005552244
## Temp       0.005016783 -0.07327907  -0.178804212
## Humidity   0.379432888 -0.47657992  0.265717362
## BARO      -0.088319580  0.14910675  -0.035394818
## Cloudcover 1.000000000 -0.35270581  0.267579035
## Visibility -0.352705809  1.00000000  -0.453675143
## Precipitation2 0.267579035 -0.45367514  1.000000000
```

```
lm_weather<-lm(TOTAL~Windspd+Temp+Humidity+BARO+Cloudcover+Visibility+Precipitation2,data_new2)
library(car)
```

```
## Warning: package 'car' was built under R version 3.6.2
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 3.6.2
```

```
## Registered S3 methods overwritten by 'car':
```

```
##   method                      from
## influence.merMod              lme4
## cooks.distance.influence.merMod lme4
## dfbeta.influence.merMod       lme4
## dfbetas.influence.merMod      lme4
```

```
##
## Attaching package: 'car'
```

```
## The following objects are masked from 'package:faraway':
##
##   logit, vif
```

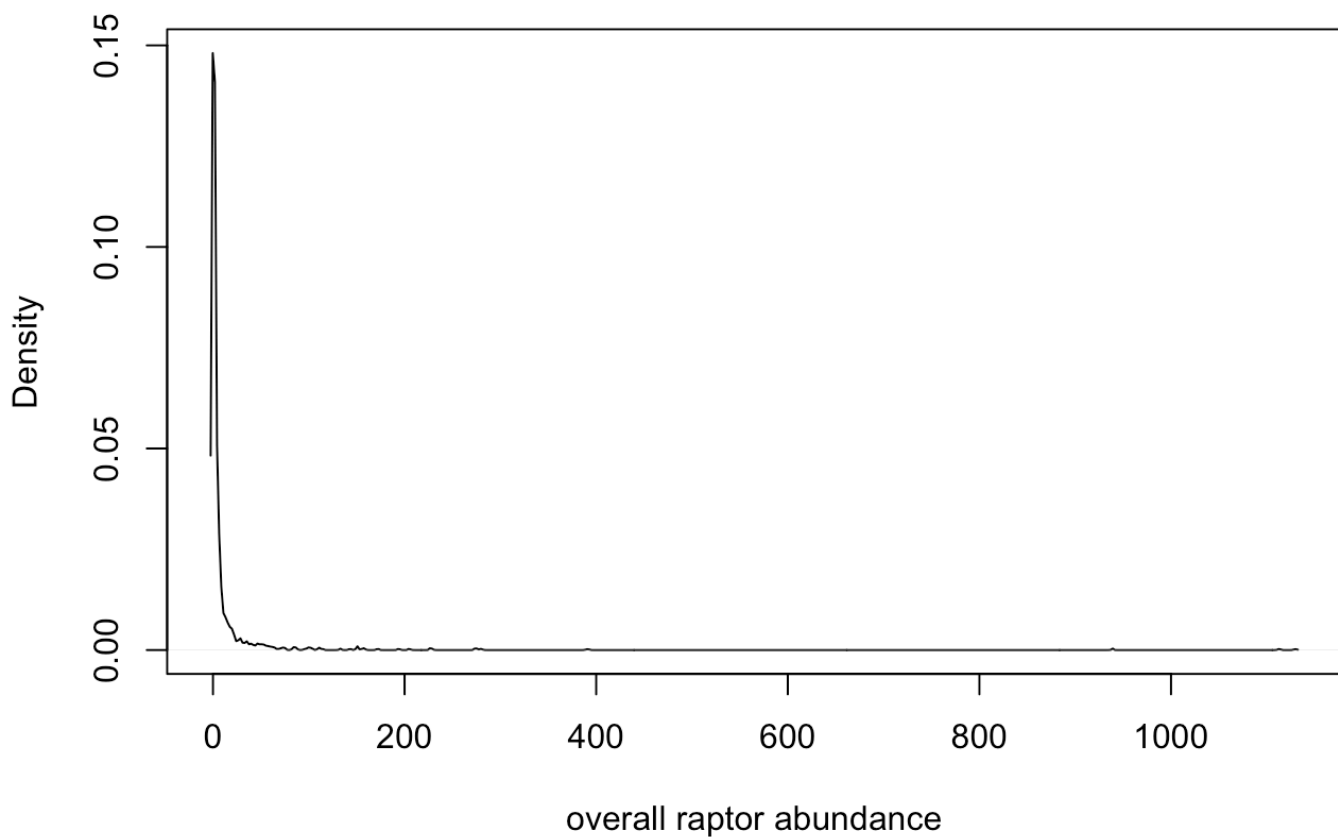
```
vif(lm_weather)
```

```
##      Windspd      Temp      Humidity      BARO      Cloudcover
##      1.054330      1.103728      1.401530      1.042404      1.246132
##      Visibility Precipitation2
##      1.643425      1.362756
```

```
data_new3 <- subset(data_new1,select=c(TOTAL,Duration,Wind.Spd,Windspd,Winddir,Temp,Humidity,BARO,Cloudcover,Visibility,Precipitation,Precipitation2,Counter,Observernumber))
data_new3 <- na.omit(data_new3)
data_new3 <- subset(data_new3,Precipitation!="NA")
```

```
#data normal?
plot(density(data_new3$TOTAL),xlab = "overall raptor abundance")
```

**density.default(x = data\_new3\$TOTAL)**



```
data_new3$Wind.Spd <- as.factor(data_new3$Wind.Spd)
data_new3$Winddir <- as.factor(data_new3$Winddir)
data_new3$Precipitation <- as.factor(data_new3$Precipitation)
data_new3$Duration <- as.factor(data_new3$Duration)
data_new3$Counter <- as.factor(data_new3$Counter)
data_new3$Observernumber<- as.factor(data_new3$Observernumber)
data_new3 <- na.omit(data_new3)
```

```
library(glmmTMB)
```

```
## Warning in checkMatrixPackageVersion(): Package version inconsistency detected.
## TMB was built with Matrix version 1.2.18
## Current Matrix version is 1.2.17
## Please re-install 'TMB' from source using install.packages('TMB', type = 'source') or ask CRAN for a binary version of 'TMB' matching CRAN's 'Matrix' package
```

```
library(mgcv)
```

```
## Loading required package: nlme
```

```
## This is mgcv 1.8-28. For overview type 'help("mgcv-package")'.
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.6.2
```

```
theme_set(theme_bw())
library(nlme)
library(ggstance)
```

```
## Warning: package 'ggstance' was built under R version 3.6.2
```

```
##
## Attaching package: 'ggstance'
```

```
## The following objects are masked from 'package:ggplot2':
##
##      geom_errorbarh, GeomErrorbarh
```

```
# full model poisson
modell <- gam(TOTAL ~ Wind.Spd+Windspd+ Winddir+ Temp + Humidity + BARO + Cloudcover + Visibility+ Precipitation+Precipitation2+ s(Counter, bs = "re") + s(Observernumber, bs = "re"), data=data_new3, family = poisson, method = "REML")
summary(modell)
```

```
##
## Family: poisson
## Link function: log
##
## Formula:
## TOTAL ~ Wind.Spd + Windspd + Winddir + Temp + Humidity + BARO +
##      Cloudcover + Visibility + Precipitation + Precipitation2 +
##      s(Counter, bs = "re") + s(Observernumber, bs = "re")
##
## Parametric coefficients:
##
```

|                                      | Estimate   | Std. Error | z value |
|--------------------------------------|------------|------------|---------|
| ## (Intercept)                       | -2.975e+01 | 2.431e+00  | -12.239 |
| ## Wind.Spd1: 1-5 km/h (1-3 mph)     | 1.043e+00  | 7.250e-01  | 1.438   |
| ## Wind.Spd2: 6-11 km/h (4-7 mph)    | 1.193e+00  | 5.796e-01  | 2.058   |
| ## Wind.Spd3: 12-19 km/h (8-12 mph)  | 9.797e-01  | 4.370e-01  | 2.242   |
| ## Wind.Spd4: 20-28 km/h (13-18 mph) | 1.664e+00  | 2.958e-01  | 5.625   |
| ## Wind.Spd5: 29-38 km/h (19-24 mph) | 3.582e-01  | 1.673e-01  | 2.142   |
| ## Wind.Spd6: 39-49 km/h (25-31 mph) | 0.000e+00  | 0.000e+00  | NA      |
| ## Windspd                           | 1.391e-01  | 1.455e-01  | 0.956   |
| ## WinddirENE                        | 3.707e+00  | 2.611e-01  | 14.196  |
| ## WinddirESE                        | 2.122e+00  | 8.626e-02  | 24.604  |
| ## WinddirN                          | -4.448e-01 | 5.096e-01  | -0.873  |
| ## WinddirNA                         | -3.450e-02 | 7.137e-01  | -0.048  |
| ## WinddirNE                         | -5.605e+01 | 6.711e+07  | 0.000   |
| ## WinddirNNW                        | 7.048e-01  | 2.063e-01  | 3.416   |
| ## WinddirNW                         | 1.911e+00  | 9.004e-02  | 21.228  |
| ## Winddirs                          | 1.554e+00  | 1.716e-01  | 9.057   |
| ## WinddirSE                         | 1.357e+00  | 8.605e-02  | 15.766  |
| ## WinddirSSE                        | 2.101e-01  | 1.085e-01  | 1.937   |
| ## WinddirSSW                        | 2.766e+00  | 1.653e-01  | 16.735  |
| ## WinddirSW                         | 1.129e+00  | 1.085e-01  | 10.408  |
| ## WinddirVariable                   | 5.761e-01  | 1.489e-01  | 3.869   |
| ## WinddirW                          | 1.385e+00  | 9.241e-02  | 14.989  |
| ## WinddirWNW                        | 1.422e+00  | 1.036e-01  | 13.727  |
| ## WinddirWSW                        | 1.396e+00  | 1.461e-01  | 9.556   |
| ## Temp                              | 4.201e-02  | 1.786e-03  | 23.529  |
| ## Humidity                          | 2.197e-02  | 8.809e-04  | 24.937  |
| ## BARO                              | 8.584e-01  | 7.213e-02  | 11.901  |
| ## Cloudcover                        | 6.770e-03  | 3.620e-04  | 18.699  |
| ## Visibility                        | 7.400e-03  | 1.287e-03  | 5.749   |
| ## Precipitation1: Haze or Fog       | 5.393e+01  | 5.002e+06  | 0.000   |
| ## Precipitation2: Drizzle           | 1.066e+02  | 1.000e+07  | 0.000   |
| ## Precipitation3: Rain              | 1.645e+02  | 1.501e+07  | 0.000   |



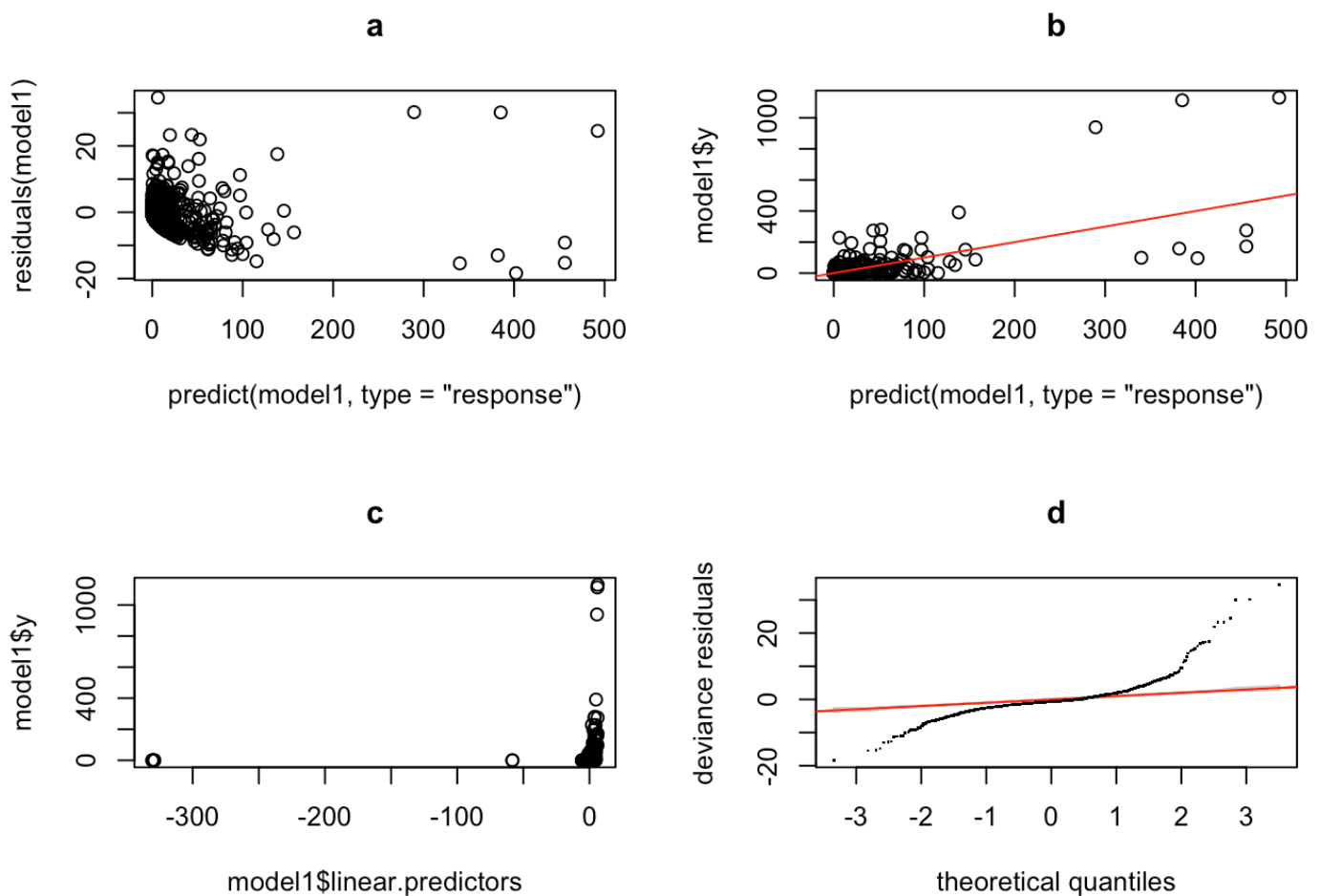
```

## Precipitation4: Thunderstorm      2.174e+02  9.699e+07  0.000
## Precipitation5: Snow              2.719e+02  2.501e+07  0.000
## Precipitation6: Wind-driven dust/sand/snow  0.000e+00  0.000e+00    NA
## Precipitation2                    -5.491e+01  5.002e+06  0.000
##                                Pr(>|z|)
## (Intercept)                      < 2e-16 ***
## Wind.Spd1: 1-5 km/h (1-3 mph)      0.150409
## Wind.Spd2: 6-11 km/h (4-7 mph)     0.039604 *
## Wind.Spd3: 12-19 km/h (8-12 mph)   0.024959 *
## Wind.Spd4: 20-28 km/h (13-18 mph)  1.85e-08 ***
## Wind.Spd5: 29-38 km/h (19-24 mph)  0.032229 *
## Wind.Spd6: 39-49 km/h (25-31 mph)   NA
## Windspd                           0.339146
## WinddirENE                        < 2e-16 ***
## WinddirESE                        < 2e-16 ***
## WinddirN                          0.382710
## WinddirNA                         0.961447
## WinddirNE                         0.999999
## WinddirNNW                       0.000636 ***
## WinddirNW                        < 2e-16 ***
## WinddirS                         < 2e-16 ***
## WinddirSE                        < 2e-16 ***
## WinddirSSE                       0.052756 .
## WinddirSSW                       < 2e-16 ***
## WinddirSW                        < 2e-16 ***
## WinddirVariable                  0.000109 ***
## WinddirW                        < 2e-16 ***
## WinddirWNW                      < 2e-16 ***
## WinddirWSW                      < 2e-16 ***
## Temp                            < 2e-16 ***
## Humidity                        < 2e-16 ***
## BARO                           < 2e-16 ***
## Cloudcover                      < 2e-16 ***
## Visibility                      8.99e-09 ***
## Precipitation1: Haze or Fog       0.999991
## Precipitation2: Drizzle           0.999991
## Precipitation3: Rain              0.999991
## Precipitation4: Thunderstorm      0.999998
## Precipitation5: Snow              0.999991
## Precipitation6: Wind-driven dust/sand/snow NA
## Precipitation2                   0.999991
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                                edf Ref.df Chi.sq p-value
## s(Counter)                   13.673    15   3905 <2e-16 ***
## s(Observernumber)            3.997     4   9553 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```
##
## Rank: 55/57
## R-sq.(adj) = 0.451   Deviance explained = 66.8%
## -REML = 11161   Scale est. = 1           n = 1211
```

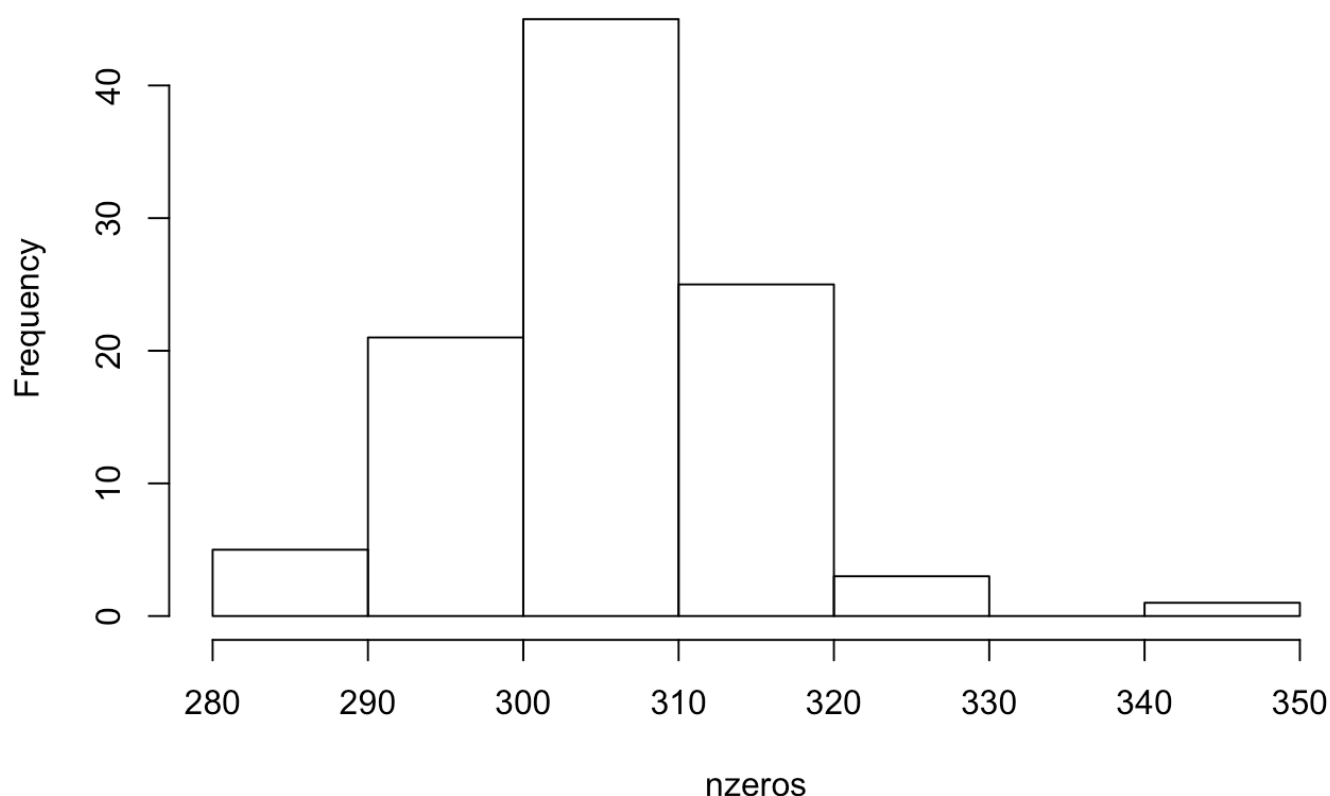
```
par(mfrow=c(2,2))
plot(predict(model1,type="response"),residuals(model1), main="a")
plot(predict(model1,type="response"),model1$y, main="b");abline(0,1,col=2)
plot(model1$linear.predictors,model1$y, main="c")
qq.gam(model1,rep=20,level=1, main="d")
```



```
# checking zero inflation
nzeros<-numeric()

for (i in 1:100){
  simcounts<-rpois(n=length(model1$residuals),lambda=predict(model1,type="response"))
  nzeros<-c(nzeros, sum(simcounts==0))
}
hist(nzeros); mean(nzeros); sum(data_new3$TOTAL==0)
```

## Histogram of nzeros



```
## [1] 306.62
```

```
## [1] 533
```

```
# NB
```

```
model2 <- gam(TOTAL ~ Wind.Spd+Windspd+ Winddir+ Temp + Humidity + BARO + Cloudcover + Visibility+ Precipitation+Precipitation2+ s(Counter, bs = "re") + s(Observernumber, bs = "re"),data=data_new3, family = nb, method = "ML")
```

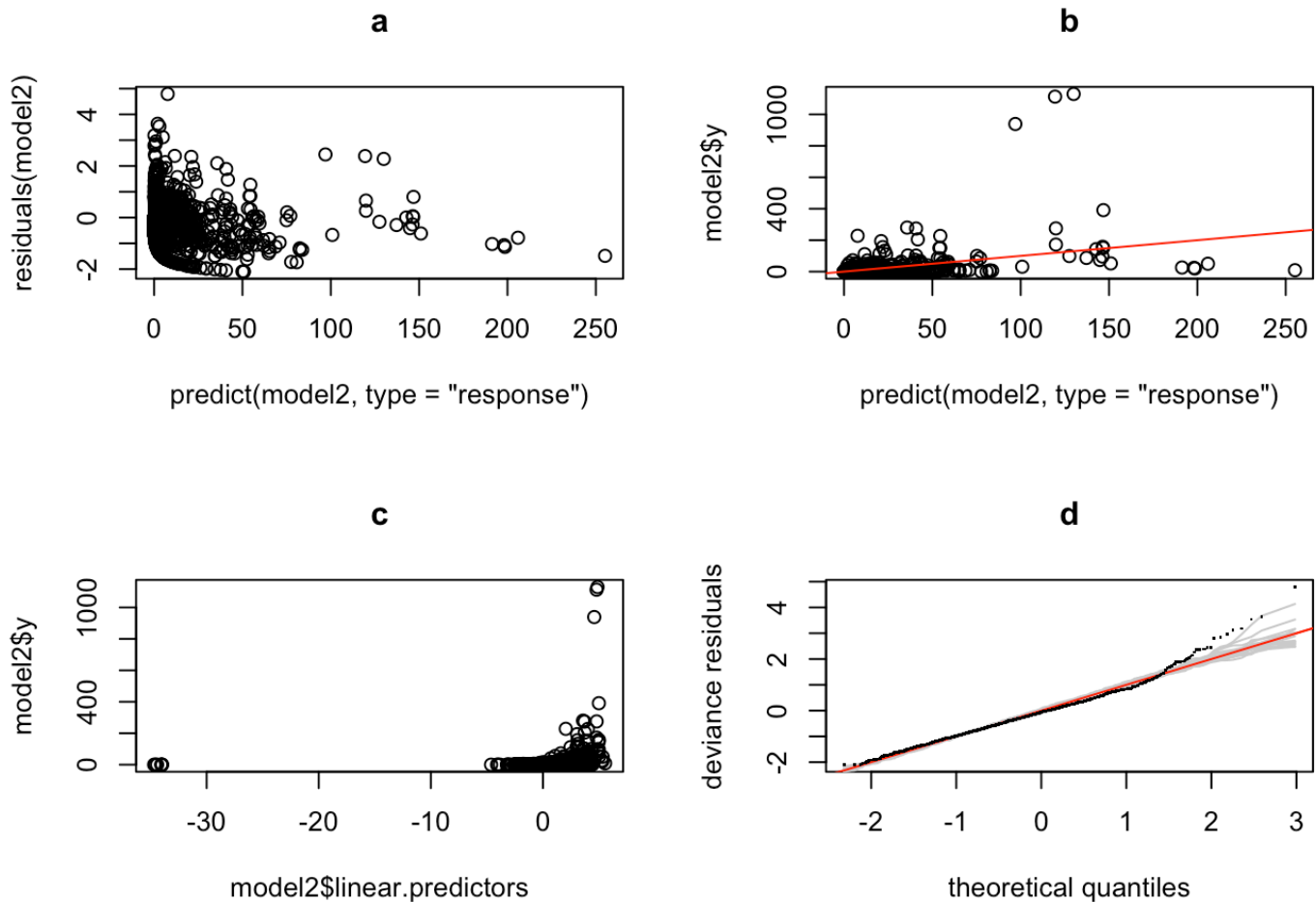
```
summary(model2)
```

```
##
## Family: Negative Binomial(0.468)
## Link function: log
##
## Formula:
## TOTAL ~ Wind.Spd + Windspd + Winddir + Temp + Humidity + BARO +
## Cloudcover + Visibility + Precipitation + Precipitation2 +
## s(Counter, bs = "re") + s(Observernumber, bs = "re")
##
```

```
## Parametric coefficients:
##
## (Intercept) -9.358e+00 6.334e+00 -1.477
## Wind.Spd1: 1-5 km/h (1-3 mph) -1.093e+00 1.538e+00 -0.711
## Wind.Spd2: 6-11 km/h (4-7 mph) -6.628e-01 1.228e+00 -0.540
## Wind.Spd3: 12-19 km/h (8-12 mph) -5.316e-01 9.431e-01 -0.564
## Wind.Spd4: 20-28 km/h (13-18 mph) -2.011e-02 6.754e-01 -0.030
## Wind.Spd5: 29-38 km/h (19-24 mph) -2.912e-01 4.855e-01 -0.600
## Wind.Spd6: 39-49 km/h (25-31 mph) 0.000e+00 0.000e+00 NA
## Windspeed -2.126e-01 3.115e-01 -0.683
## WinddirENE 1.989e+00 8.304e-01 2.395
## WinddirESE 1.232e+00 3.159e-01 3.901
## WinddirN -1.704e+00 7.786e-01 -2.188
## WinddirNA -1.360e+00 1.658e+00 -0.820
## WinddirNE -3.284e+01 2.463e+07 0.000
## WinddirNNW 9.344e-02 4.526e-01 0.206
## WinddirNW 5.368e-01 3.162e-01 1.698
## WinddirS 3.025e-01 5.128e-01 0.590
## WinddirSE 7.124e-01 2.939e-01 2.424
## WinddirSSE -1.009e-01 3.582e-01 -0.282
## WinddirSSW 8.760e-01 7.929e-01 1.105
## WinddirSW -5.764e-02 3.551e-01 -0.162
## WinddirVariable -2.164e-02 4.844e-01 -0.045
## WinddirW 1.942e-02 3.006e-01 0.065
## WinddirWNW 4.017e-01 3.364e-01 1.194
## WinddirWSW -4.741e-01 4.497e-01 -1.054
## Temp 5.152e-02 6.554e-03 7.861
## Humidity 1.352e-02 3.547e-03 3.813
## BARO 3.217e-01 1.997e-01 1.611
## Cloudcover -1.859e-03 1.559e-03 -1.192
## Visibility 2.610e-02 6.558e-03 3.980
## Precipitation1: Haze or Fog 5.268e+00 2.076e+06 0.000
## Precipitation2: Drizzle 9.047e+00 4.153e+06 0.000
## Precipitation3: Rain 1.741e+01 6.229e+06 0.000
## Precipitation4: Thunderstorm 1.720e+01 3.581e+07 0.000
## Precipitation5: Snow 2.663e+01 1.038e+07 0.000
## Precipitation6: Wind-driven dust/sand/snow 0.000e+00 0.000e+00 NA
## Precipitation2 -5.530e+00 2.076e+06 0.000
##
## Pr(>|z|)
## (Intercept) 0.139580
## Wind.Spd1: 1-5 km/h (1-3 mph) 0.477259
## Wind.Spd2: 6-11 km/h (4-7 mph) 0.589467
## Wind.Spd3: 12-19 km/h (8-12 mph) 0.572987
## Wind.Spd4: 20-28 km/h (13-18 mph) 0.976254
## Wind.Spd5: 29-38 km/h (19-24 mph) 0.548629
## Wind.Spd6: 39-49 km/h (25-31 mph) NA
## Windspeed 0.494799
## WinddirENE 0.016598 *
## WinddirESE 9.59e-05 ***
## WinddirN 0.028665 *
```

```
## WinddirNA 0.412247
## WinddirNE 0.999999
## WinddirNNW 0.836418
## WinddirNW 0.089561 .
## WinddirS 0.555187
## WinddirSE 0.015367 *
## WinddirSSE 0.778202
## WinddirSSW 0.269214
## WinddirSW 0.871064
## WinddirVariable 0.964367
## WinddirW 0.948486
## WinddirWNW 0.232491
## WinddirWSW 0.291779
## Temp 3.81e-15 ***
## Humidity 0.000137 ***
## BARO 0.107164
## Cloudcover 0.233128
## Visibility 6.89e-05 ***
## Precipitation1: Haze or Fog 0.999998
## Precipitation2: Drizzle 0.999998
## Precipitation3: Rain 0.999998
## Precipitation4: Thunderstorm 1.000000
## Precipitation5: Snow 0.999998
## Precipitation6: Wind-driven dust/sand/snow NA
## Precipitation2 0.999998
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq p-value
## s(Counter)      10.531      15  106.8 <2e-16 ***
## s(Observernumber) 3.936       4  361.0 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Rank: 55/57
## R-sq.(adj) =  0.146   Deviance explained = 55.3%
## -ML = 2772.5   Scale est. = 1         n = 1211
```

```
par(mfrow=c(2,2))
plot(predict(model2,type="response"),residuals(model2), main="a")
plot(predict(model2,type="response"),model2$y, main="b");abline(0,1,col=2)
plot(model2$linear.predictors,model2$y, main="c")
qq.gam(model2,rep=20,level=1, main="d")
```



```
model3 <- gam(TOTAL ~ Temp+Humidity+ Visibility+s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=data_new3, family = nb, method = "ML")

model4 <- gam(TOTAL ~ Temp+Humidity+ Visibility+Precipitation2+s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=data_new3, family = nb, method = "ML")

model5 <- gam(TOTAL ~ Windspd + Temp+ Humidity+ Visibility+ Precipitation2 +s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=data_new3, family = nb, method = "ML")

model6 <- gam(TOTAL ~ Windspd+Temp + Humidity+ Visibility+Precipitation +s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=data_new3, family = nb, method = "ML")

AIC(model3,model4,model5,model6)
```

|        | df<br><dbl> | AIC<br><dbl> |
|--------|-------------|--------------|
| model3 | 20.97271    | 5639.881     |
| model4 | 22.17618    | 5624.659     |
| model5 | 23.21975    | 5623.041     |

model6

28.46857

5611.901

4 rows

```
model7 <- gam(TOTAL ~ Temp + Humidity+ Visibility +Precipitation2+s(Counter, bs =
"re")+s(Observernumber, bs = "re")+s(Duration,bs="re"),data=data_new3, family = nb
, method = "ML")
summary(model7)
```

```
##
## Family: Negative Binomial(0.433)
## Link function: log
##
## Formula:
## TOTAL ~ Temp + Humidity + Visibility + Precipitation2 + s(Counter,
##      bs = "re") + s(Observernumber, bs = "re") + s(Duration, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.057564   1.014961  -2.027 0.042638 *
## Temp          0.042758   0.006116   6.991 2.73e-12 ***
## Humidity      0.016720   0.003433   4.871 1.11e-06 ***
## Visibility    0.027783   0.006094   4.559 5.14e-06 ***
## Precipitation2 -0.279226   0.075783  -3.685 0.000229 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq p-value
## s(Counter)      11.143    15 158.60 2.50e-07 ***
## s(Observernumber)  3.957     4 739.50 < 2e-16 ***
## s(Duration)       1.850     3  73.67 1.06e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0853   Deviance explained = 52.9%
## -ML =      2804   Scale est. = 1          n = 1211
```

AIC(model7)

## [1] 5581.403

```
model8 <- glmmTMB(TOTAL ~ Temp + Humidity+ Visibility+Precipitation +(1|Counter)+
(1|Observernumber)+(1|Duration), data=data_new3, family = nbinom2())
summary(model8)
```

```
## Family: nbinom2 ( log )
## Formula:
## TOTAL ~ Temp + Humidity + Visibility + Precipitation + (1 | Counter) +
## (1 | Observernumber) + (1 | Duration)
## Data: data_new3
##
##      AIC      BIC   logLik deviance df.resid
##  5614.4   5685.8  -2793.2   5586.4     1197
##
## Random effects:
##
## Conditional model:
##      Groups      Name      Variance Std.Dev.
## Counter      (Intercept) 0.7333   0.8563
## Observernumber (Intercept) 1.4175   1.1906
## Duration      (Intercept) 1.5774   1.2560
## Number of obs: 1211, groups: Counter, 16; Observernumber, 5; Duration, 4
##
## Overdispersion parameter for nbinom2 family (): 0.444
##
## Conditional model:
##                                     Estimate Std. Error z value
## (Intercept)                       -2.020e+00  1.176e+00  -1.718
## Temp                               4.427e-02  7.098e-03   6.236
## Humidity                           1.660e-02  3.437e-03   4.829
## Visibility                          2.468e-02  6.895e-03   3.579
## Precipitation1: Haze or Fog         -5.384e-01  1.375e-01  -3.915
## Precipitation2: Drizzle             -2.100e+00  4.829e-01  -4.349
## Precipitation3: Rain                 3.752e-01  6.037e-01   0.621
## Precipitation4: Thunderstorm        -2.367e+01  2.623e+04  -0.001
## Precipitation5: Snow                -1.097e+00  4.147e-01  -2.646
## Precipitation6: Wind-driven dust/sand/snow -1.480e+01  1.583e+03  -0.009
##                                     Pr(>|z|)
## (Intercept)                        0.085797 .
## Temp                               4.48e-10 ***
## Humidity                           1.37e-06 ***
## Visibility                          0.000345 ***
## Precipitation1: Haze or Fog         9.05e-05 ***
## Precipitation2: Drizzle             1.37e-05 ***
## Precipitation3: Rain                0.534315
## Precipitation4: Thunderstorm        0.999280
## Precipitation5: Snow                0.008142 **
## Precipitation6: Wind-driven dust/sand/snow 0.992541
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

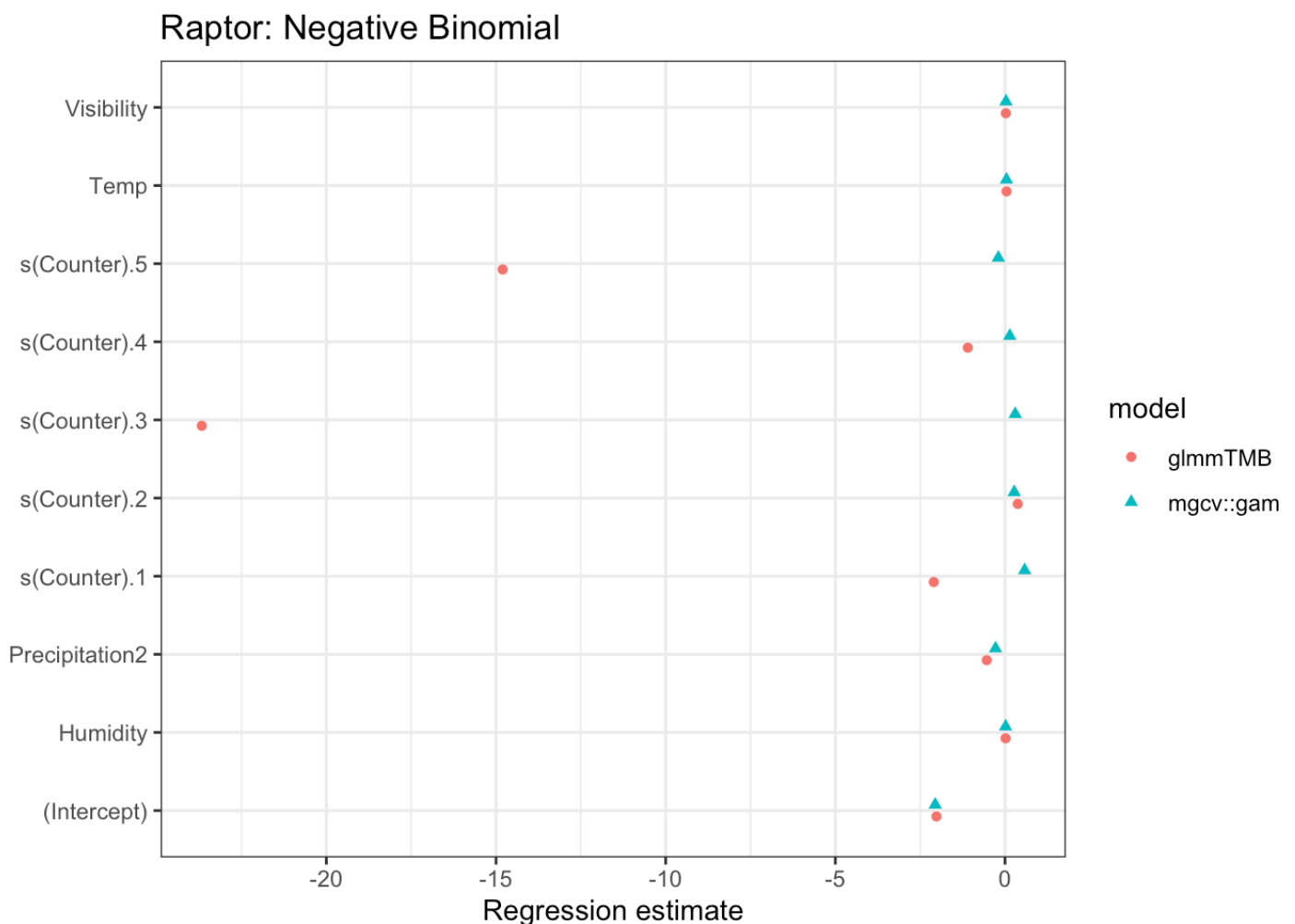
```
gam.vcomp(model7)
```



```
##
## Standard deviations and 0.95 confidence intervals:
##
##               std.dev      lower      upper
## s(Counter)      0.7759687 0.4470282 1.346956
## s(Observernumber) 1.1890881 0.6142445 2.301902
## s(Duration)     1.2412105 0.3758303 4.099200
##
## Rank: 3/3
```

```
nb2.coefs <- data.frame(estimate = c(coef(summary(model8))$cond[, "Estimate"], coef(model7)[c(1:10)]), model = rep(c("glmmTMB", "mgcv::gam"), each = 10), term = rep(names(coef(model7)[c(1:10)]), 2))
#nb2.coefs <- data.frame(estimate = coef(summary(model8))$cond[, "Estimate"])

ggplot(nb2.coefs, aes(x = estimate, y = term, colour = model, shape = model)) + geom_point(position = position_dodgev(height = 0.3)) + labs(y = NULL, x = "Regression estimate", title = "Raptor: Negative Binomial")
```



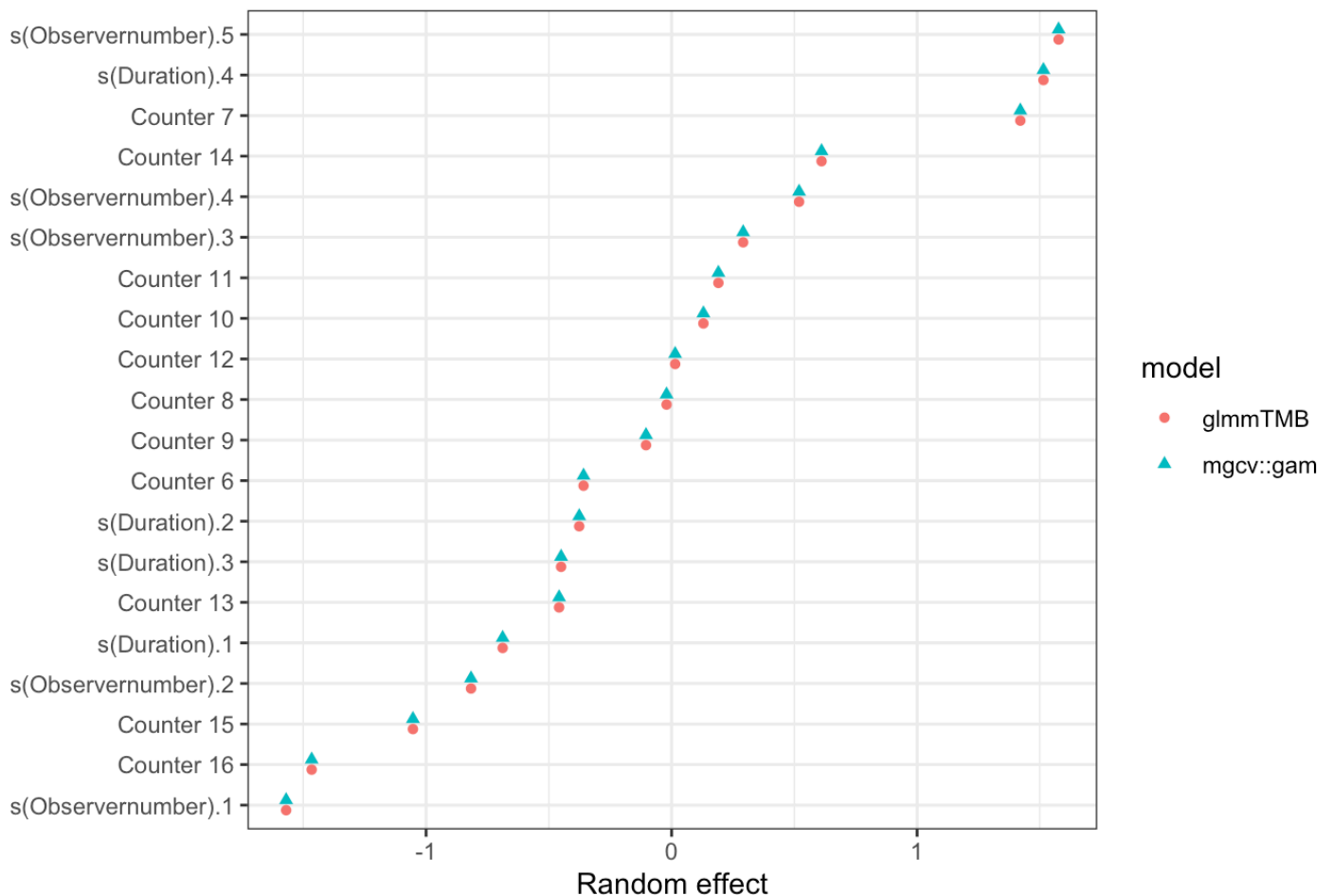
```

nbgam2.r <- coef(model7)[-c(1:10)]
nbm2.r <- ranef(model8)$cond$site[,1]
nms <- sub("s\\(Counter\\)\\. ", "Counter ", names(nbgam2.r))
ranefs <- data.frame(ranef = c(unname(nbgam2.r), nbm2.r),
                    model = rep(c("glmmTMB", "mgcv::gam"), each = length(nbgam2.r)
)),
                    Counter = rep(nms, 2))
ranefs <- transform(ranefs, Counter = factor(Counter, nms[order(nbgam2.r)]))

ggplot(ranefs, aes(x = ranef, y = Counter, colour = model, shape = model)) +
  geom_point(position = position_dodgev(height = 0.5)) +
  labs(y = NULL,
       x = "Random effect",
       title = "Raptor: Negative Binomial")

```

### Raptor: Negative Binomial



```

# standard errors of the coefficients
diag(vcov(model7))

```

```
##      (Intercept)          Temp      Humidity      Visibility
##      1.030146e+00      3.741094e-05      1.178484e-05      3.714191e-05
##      Precipitation2      s(Counter).1      s(Counter).2      s(Counter).3
##      5.743061e-03      2.613438e-01      5.927435e-02      6.598796e-02
##      s(Counter).4      s(Counter).5      s(Counter).6      s(Counter).7
##      3.727522e-01      8.323649e-02      1.019559e-01      6.890266e-02
##      s(Counter).8      s(Counter).9      s(Counter).10      s(Counter).11
##      3.664589e-01      6.573884e-02      5.281866e-01      1.782918e-01
##      s(Counter).12      s(Counter).13      s(Counter).14      s(Counter).15
##      6.311199e-02      1.305296e-01      9.566382e-02      3.111935e-01
##      s(Counter).16      s(Observernumber).1      s(Observernumber).2      s(Observernumber).3
##      1.720053e-01      2.917458e-01      2.926096e-01      2.951887e-01
##      s(Observernumber).4      s(Observernumber).5      s(Duration).1      s(Duration).2
##      3.012903e-01      2.935527e-01      1.016198e+00      5.974836e-01
##      s(Duration).3      s(Duration).4
##      1.119084e+00      5.790732e-01
```

```
# 95% confidence interval of the coefficients
confint(model8)
```

```
##      2.5 %      97.5 %
## cond.(Intercept)      -4.325544e+00      2.845688e-01
## cond.Temp      3.035414e-02      5.817911e-02
## cond.Humidity      9.861038e-03      2.333496e-02
## cond.Visibility      1.116345e-02      3.819096e-02
## cond.Precipitation1: Haze or Fog      -8.078853e-01      -2.688234e-01
## cond.Precipitation2: Drizzle      -3.046617e+00      -1.153739e+00
## cond.Precipitation3: Rain      -8.080765e-01      1.558398e+00
## cond.Precipitation4: Thunderstorm      -5.144161e+04      5.139427e+04
## cond.Precipitation5: Snow      -1.910120e+00      -2.845443e-01
## cond.Precipitation6: Wind-driven dust/sand/snow      -3.118350e+03      3.088744e+03
## Counter.cond.Std.Dev.(Intercept)      5.022943e-01      1.459815e+00
## Observernumber.cond.Std.Dev.(Intercept)      6.146643e-01      2.306095e+00
## Duration.cond.Std.Dev.(Intercept)      3.803467e-01      4.147305e+00
##      Estimate
## cond.(Intercept)      -2.02048733
## cond.Temp      0.04426663
## cond.Humidity      0.01659800
## cond.Visibility      0.02467721
## cond.Precipitation1: Haze or Fog      -0.53835433
## cond.Precipitation2: Drizzle      -2.10017792
## cond.Precipitation3: Rain      0.37516090
## cond.Precipitation4: Thunderstorm      -23.67070647
## cond.Precipitation5: Snow      -1.09733236
## cond.Precipitation6: Wind-driven dust/sand/snow      -14.80337832
## Counter.cond.Std.Dev.(Intercept)      0.85630410
## Observernumber.cond.Std.Dev.(Intercept)      1.19057716
## Duration.cond.Std.Dev.(Intercept)      1.25595128
```

```
data_new4 <- subset(data_new1,select=c(BV,TV,OS,BE,NH,SS,CH,NG,RS,BW,RT,RL,GE,AK,ML,PG,UA,UB,UF,UE,UR,Duration,Wind.Spd,Windspd,Winddir,Temp,Humidity,BARO,Cloudcover,Visibility,Precipitation,Precipitation2,Counter,Observernumber))
```

```
data_new4$Wind.Spd <- as.factor(data_new4$Wind.Spd)
data_new4$Winddir <- as.factor(data_new4$Winddir)
data_new4$Precipitation <- as.factor(data_new4$Precipitation)

data_new4$Counter <- as.factor(data_new4$Counter)
data_new4$Observernumber<- as.factor(data_new4$Observernumber)
data_new4 <- na.omit(data_new4)
data_new4 <-transform(data_new4,Eagles=BE+GE+UE+OS)
data_new4 <-transform(data_new4,Hawks=SS+CH+NG+RS+BW+RT+RL+UA+NH)
data_new4 <-transform(data_new4,Falcons=PG+UF+ML+AK)
data_new4 <-transform(data_new4,Buzzards=BV+TV+UB)
```

```
m1 <- gam(BV ~ Temp+s(Observernumber, bs = "re"),data=data_new4, family = nb, method = "ML")
summary(m1)
```

```
##
## Family: Negative Binomial(0.018)
## Link function: log
##
## Formula:
## BV ~ Temp + s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -5.61465    0.78042  -7.194 6.27e-13 ***
## Temp        0.14244    0.04182   3.406 0.00066 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq p-value
## s(Observernumber) 1.804      4  4.68 0.0371 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.028   Deviance explained =   33%
## -ML = 111.31   Scale est. = 1           n = 1211
```

```
m2 <- gam(TV ~ Visibility+s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=
data_new4, family = nb, method = "ML")
summary(m2)
```

```
##
## Family: Negative Binomial(0.071)
## Link function: log
##
## Formula:
## TV ~ Visibility + s(Counter, bs = "re") + s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.14397    0.48260  -4.443 8.89e-06 ***
## Visibility   0.06290    0.01226   5.133 2.86e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      6.010     15  18.48  0.00121 **
## s(Observernumber) 3.344      4  35.22 4.29e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0822   Deviance explained = 23.7%
## -ML = 749.61   Scale est. = 1           n = 1211
```

```
m3 <- gam(OS ~ Temp +s(Counter, bs = "re")+s(Observernumber, bs = "re"),data=data_
new4, family = nb, method = "ML")
summary(m3)
```

```
##
## Family: Negative Binomial(0.263)
## Link function: log
##
## Formula:
## OS ~ Temp + s(Counter, bs = "re") + s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.85200    0.45326  -6.292 3.13e-10 ***
## Temp         0.05830    0.01385   4.210 2.55e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      3.486     15  5.882    0.12
## s(Observernumber) 3.643      4 57.385 1.84e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.076   Deviance explained = 27.1%
## -ML = 399.1   Scale est. = 1           n = 1211
```

```
m4 <- gam(UR ~ Temp + Humidity+s(Counter, bs = "re")+s(Observernumber, bs = "re"),
data=data_new4, family = nb, method = "ML")
summary(m4)
```

```
##
## Family: Negative Binomial(0.334)
## Link function: log
##
## Formula:
## UR ~ Temp + Humidity + s(Counter, bs = "re") + s(Observernumber,
##       bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.797220   0.626829  -2.867  0.00414 **
## Temp         0.040535   0.013931   2.910  0.00362 **
## Humidity     -0.019950   0.006597  -3.024  0.00249 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      7.09     15  39.36 7.26e-07 ***
## s(Observernumber) 3.38      4  37.75 2.35e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0681   Deviance explained = 25.3%
## -ML = 344.79   Scale est. = 1           n = 1211
```

```
# larger size, more powerful build, and heavier head and bill
m5 <- gam(Eagles ~ Windspd+ s(Counter, bs = "re") +s(Counter,bs="re") +s(Observer
rnumber, bs = "re"),data=data_new4, family = nb,method = "ML")
summary(m5)
```

```
##
## Family: Negative Binomial(0.525)
## Link function: log
##
## Formula:
## Eagles ~ Windspd + s(Counter, bs = "re") + s(Counter, bs = "re") +
##       s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.35004    0.51563  -2.618 0.008839 **
## Windspd      0.21960    0.05696   3.855 0.000116 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      6.489    15  37.13 4.02e-05 ***
## s(Observernumber) 3.917     4 297.99 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.22   Deviance explained = 37.6%
## -ML = 1000.6   Scale est. = 1           n = 1211
```

```
# long tails and high visual acuity
m6 <- gam(Hawks~Temp + Humidity +Visibility+ Precipitation2+ s(Counter, bs = "re")
+ s(Observernumber, bs = "re"),data=data_new4, family = nb,method = "ML")
summary(m6)
```



```
##
## Family: Negative Binomial(0.334)
## Link function: log
##
## Formula:
## Hawks ~ Temp + Humidity + Visibility + Precipitation2 + s(Counter,
##      bs = "re") + s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.855885   0.748674  -2.479 0.013179 *
## Temp          0.057854   0.007026   8.234 < 2e-16 ***
## Humidity      0.020403   0.003955   5.159 2.49e-07 ***
## Visibility    0.033416   0.007064   4.731 2.24e-06 ***
## Precipitation2 -0.328429   0.091547  -3.588 0.000334 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      11.470     15  211.5 1.95e-11 ***
## s(Observernumber) 3.947      4  700.6 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0619   Deviance explained = 52.3%
## -ML = 2433.7   Scale est. = 1           n = 1211
```

```
# have thin, pointed wings, which allow them to dive at extremely high speeds.
m7 <- gam(Falcons~ Windspd+ Temp + Precipitation2+ s(Counter, bs = "re") + s(Observernumber, bs = "re"),data=data_new4, family = nb,method = "ML")
summary(m7)
```

```
##
## Family: Negative Binomial(0.648)
## Link function: log
##
## Formula:
## Falcons ~ Windspd + Temp + Precipitation2 + s(Counter, bs = "re") +
##       s(Observernumber, bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -3.70043    0.65441  -5.655 1.56e-08 ***
## Windspd        0.32766    0.09679   3.385 0.000711 ***
## Temp           0.05618    0.01322   4.250 2.14e-05 ***
## Precipitation2 -1.19007    0.25749  -4.622 3.81e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      7.489    15  39.49 3.93e-06 ***
## s(Observernumber) 3.735     4  75.76 3.09e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.206   Deviance explained = 41.6%
## -ML = 393.28   Scale est. = 1           n = 1211
```

```
m8 <- gam(Buzzards~ Visibility+ s(Counter, bs = "re") + s(Observernumber, bs = "re"),
data=data_new4, family = nb,method = "ML")
summary(m8)
```

```
##
## Family: Negative Binomial(0.096)
## Link function: log
##
## Formula:
## Buzzards ~ Visibility + s(Counter, bs = "re") + s(Observernumber,
##      bs = "re")
##
## Parametric coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.80597    0.45662  -3.955 7.65e-05 ***
## Visibility   0.05428    0.01068   5.085 3.68e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df Chi.sq  p-value
## s(Counter)      6.234     15  20.90 0.000513 ***
## s(Observernumber) 3.509      4  50.95  3.4e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0965   Deviance explained = 23.9%
## -ML = 857.55   Scale est. = 1           n = 1211
```

```
#car包有多个函数，可以判断误差的独立性，线性，同方差性
#library(car)
#durbinWatsonTest(fit)
#crPlots(fit)
#ncvTest(fit)
#spreadLevelPlot(fit)
```

```
#检验多重共线性，根号下vif>2则表明有多重共线性
#sqrt(vif(fit))
#都小于2所以不存在多重共线性
```

```
#library('VIM')
#aggr(data,prop=TRUE,numbers=TRUE)
```

Add a new chunk by clicking the *Insert Chunk* button on the toolbar or by pressing *Cmd+Option+I*.

When you save the notebook, an HTML file containing the code and output will be saved alongside it (click the *Preview* button or press *Cmd+Shift+K* to preview the HTML file).

The preview shows you a rendered HTML copy of the contents of the editor. Consequently, unlike *Knit*, *Preview* does not run any R code chunks. Instead, the output of the chunk when it was last run in the editor is displayed.