Ejercicio 2.3: Detección y tratamiento de datos atípicos univariante y bivariante

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Lectura Fichero de datos

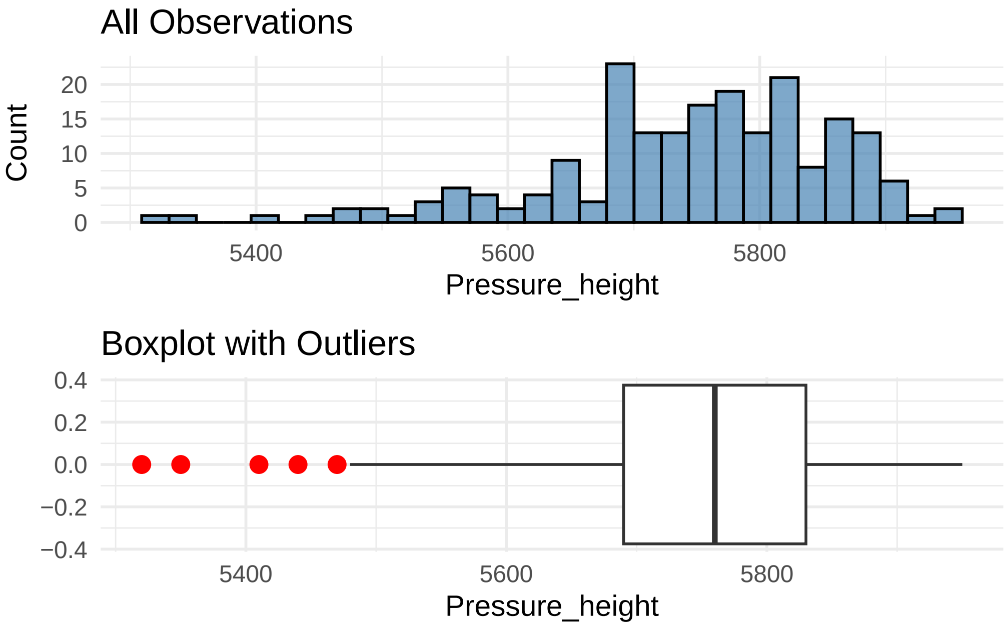
```r
data <- read.csv("ozone.csv")  # import data
data$Month<-as.factor(data$Month)
data$Day_of_month<-as.factor(data$Day_of_month)
data$Day_of_week<-as.factor(data$Day_of_week)
```

Uso de la función outliers() y extreme()

```r
source("Funciones_propias.R")
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

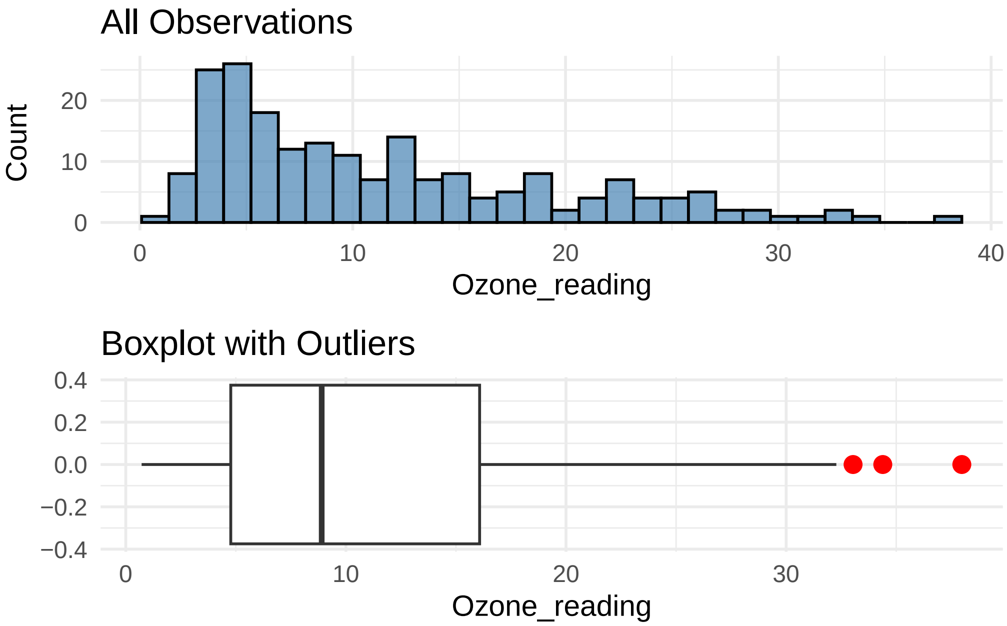
```r
outliers(data,"Pressure_height")
```



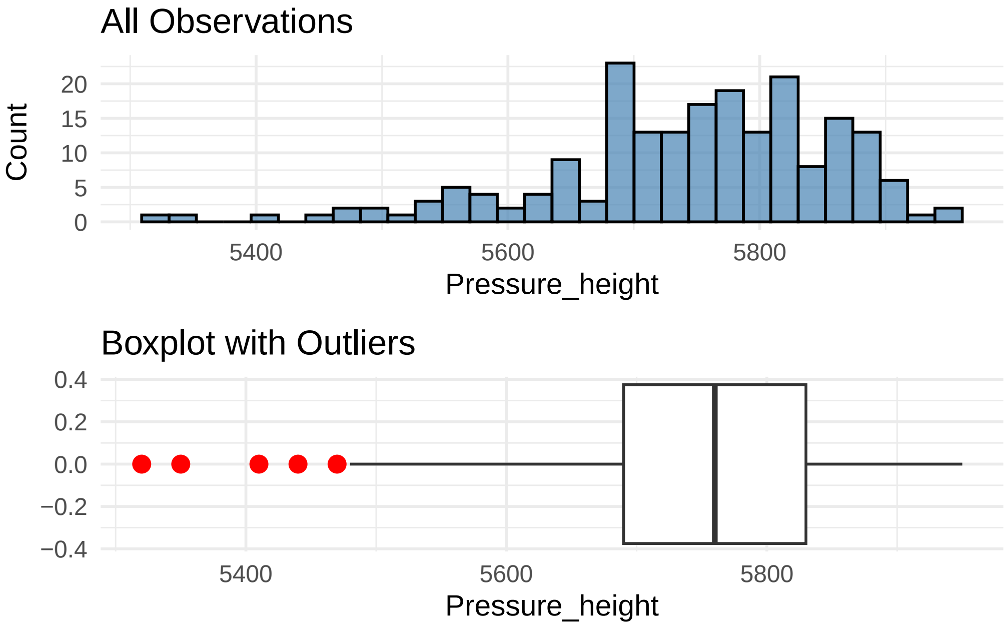
```
 Outliers identified in Pressure_height :  5 outliers
 Proportion (%) of outliers: 2.46 %
```

```
[1] 5410 5350 5470 5320 5440
```

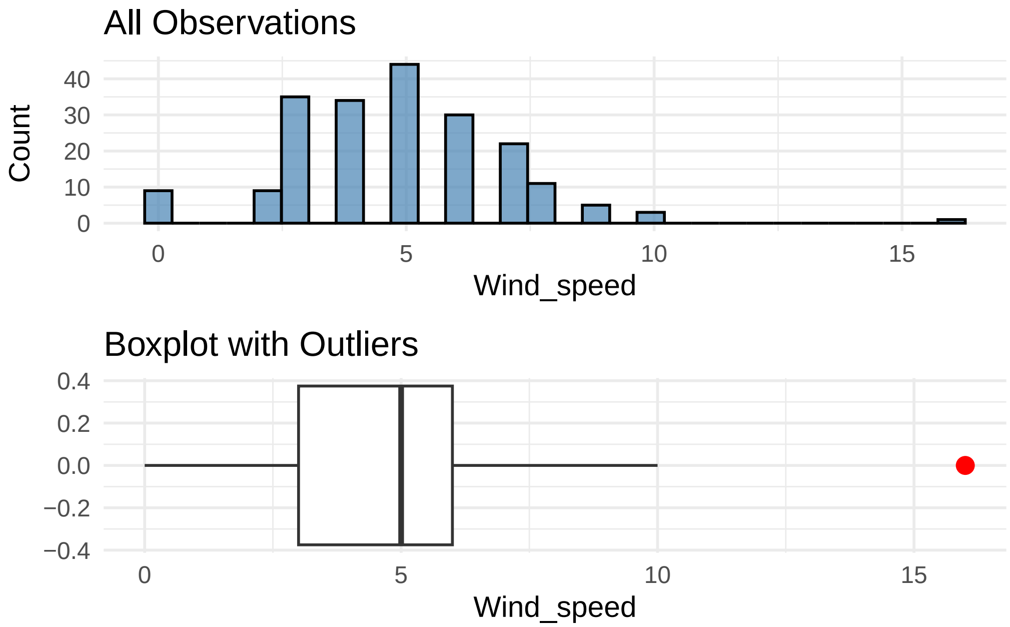
```r
# Aplicar la función a múltiples variables numéricas o enteras
numeric_integer_vars <- names(which(sapply(data, is.numeric) | sapply(data, is.integer)))
# Aplicar la función 'outliers' a cada una de las variables numéricas
outliers_results <- lapply(numeric_integer_vars, function(var) {
  outliers(data, var)  # Llamar a la función pasando el nombre de la variable
})
```



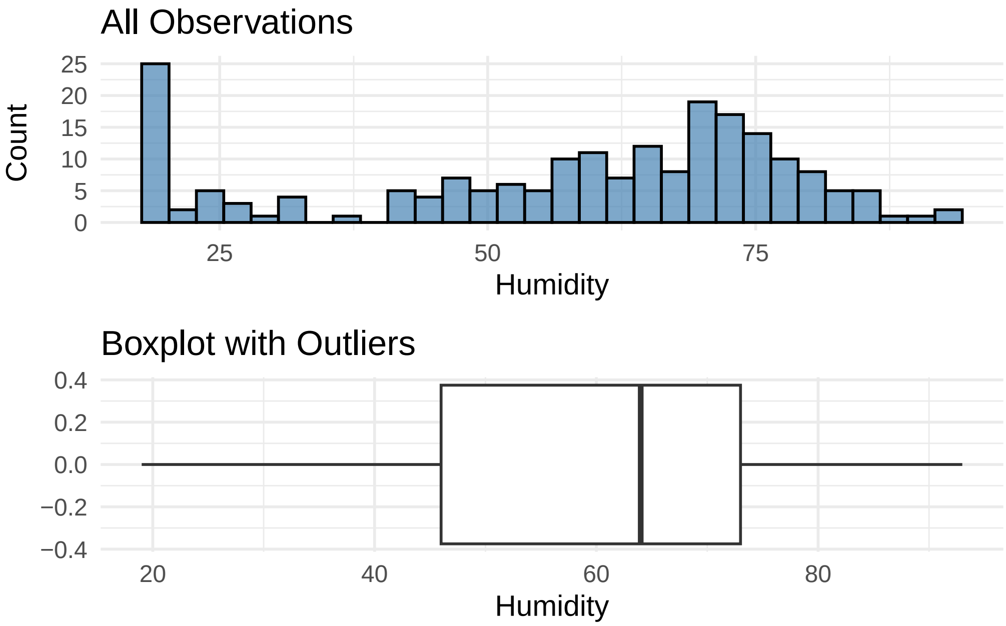
```
Outliers identified in Ozone_reading :  3 outliers
Proportion (%) of outliers: 1.48 %
```



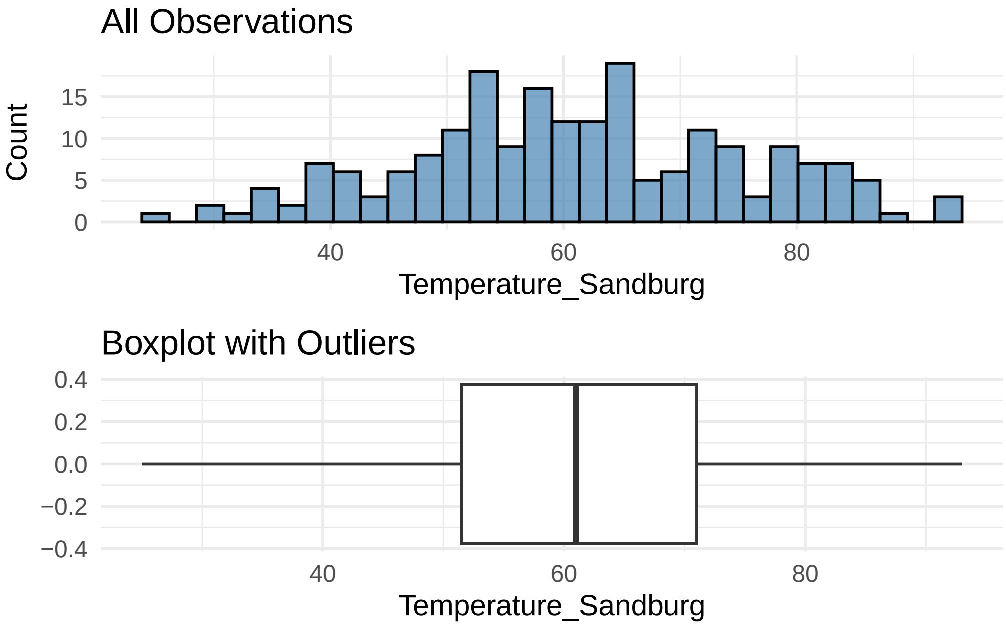
```
Outliers identified in Pressure_height :  5 outliers
Proportion (%) of outliers: 2.46 %
```



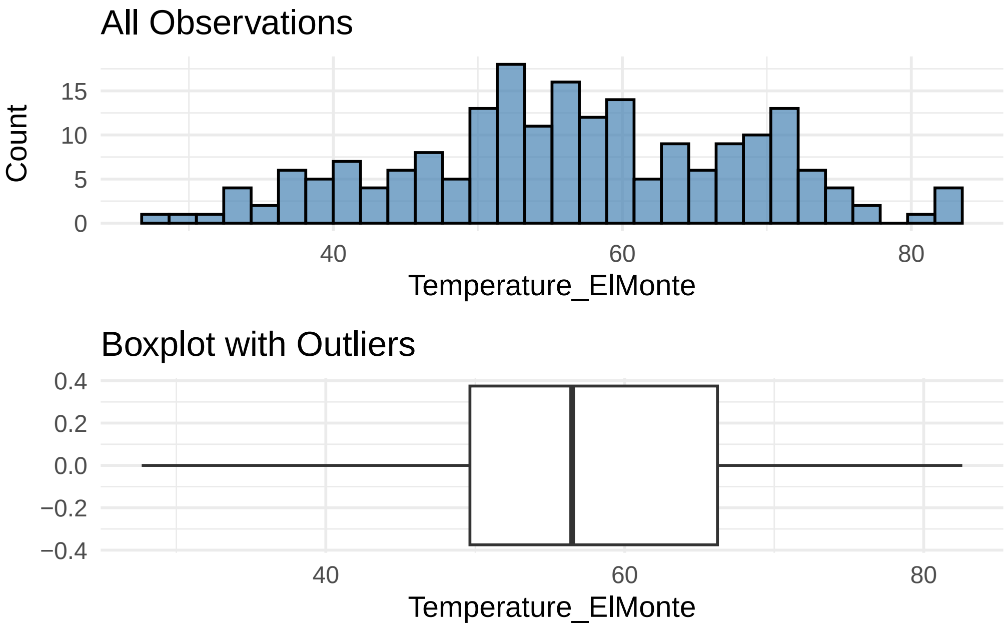
```
Outliers identified in Wind_speed :  1 outliers
Proportion (%) of outliers: 0.49 %
```



```
Outliers identified in Humidity :  0 outliers
Proportion (%) of outliers: 0 %
```



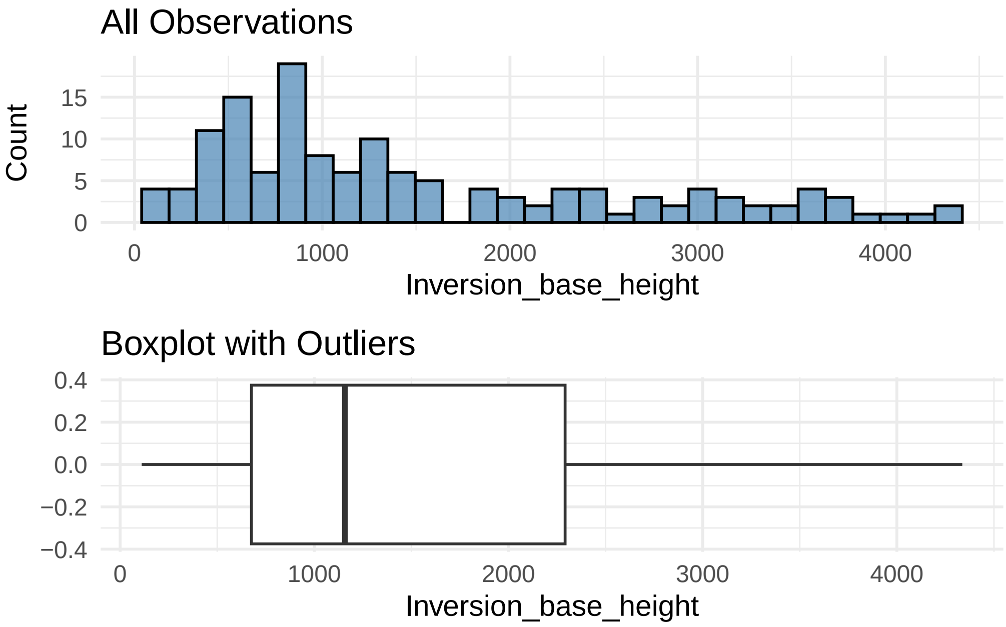
```
Outliers identified in Temperature_Sandburg :  0 outliers
Proportion (%) of outliers: 0 %
```



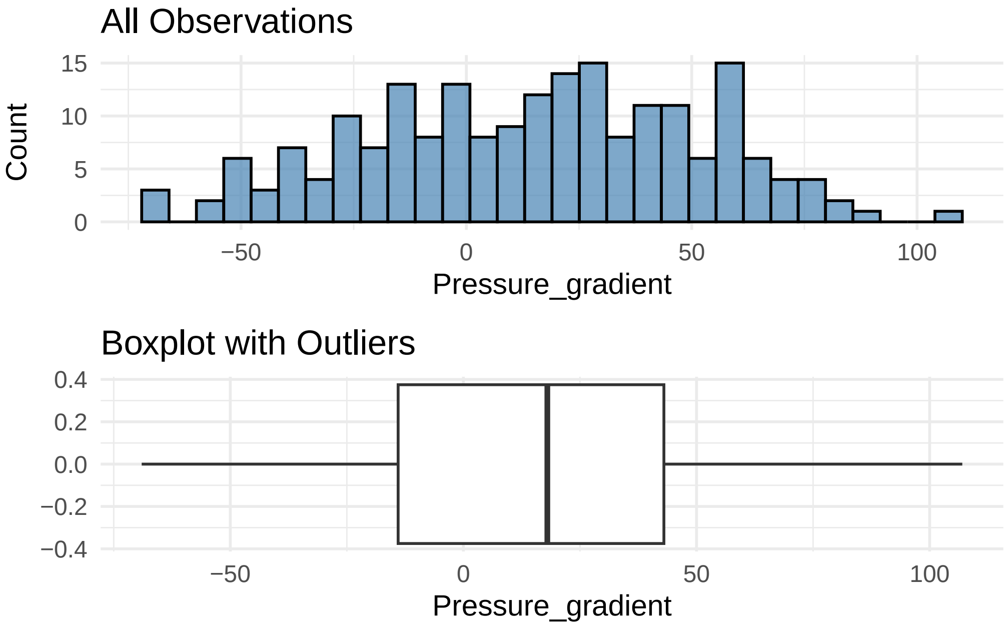
```
Outliers identified in Temperature_ElMonte :  0 outliers
Proportion (%) of outliers: 0 %
```

```
Warning: Removed 63 rows containing non-finite outside the scale range
(`stat_bin()`).
```

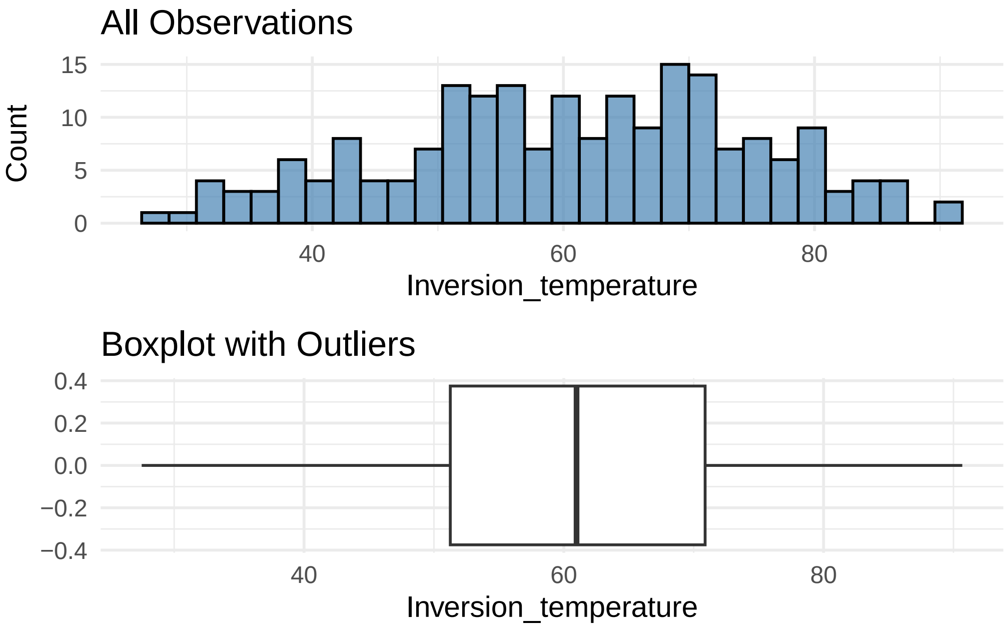
```
Warning: Removed 63 rows containing non-finite outside the scale range
(`stat_boxplot()`).
```



```
Outliers identified in Inversion_base_height :  0 outliers
Proportion (%) of outliers: 0 %
```



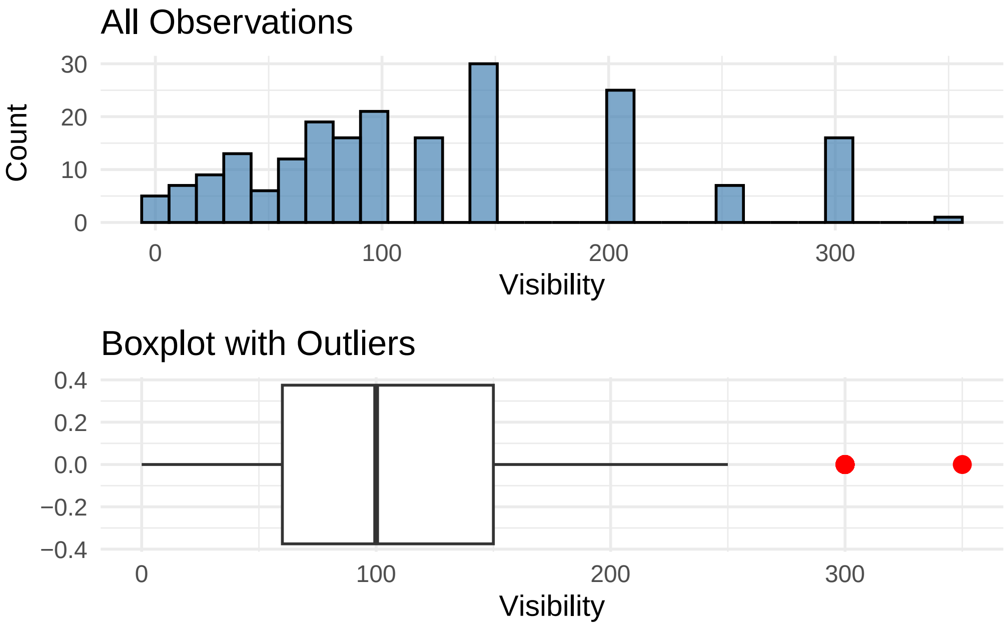
```
Outliers identified in Pressure_gradient :  0 outliers
Proportion (%) of outliers: 0 %
```



All Observations

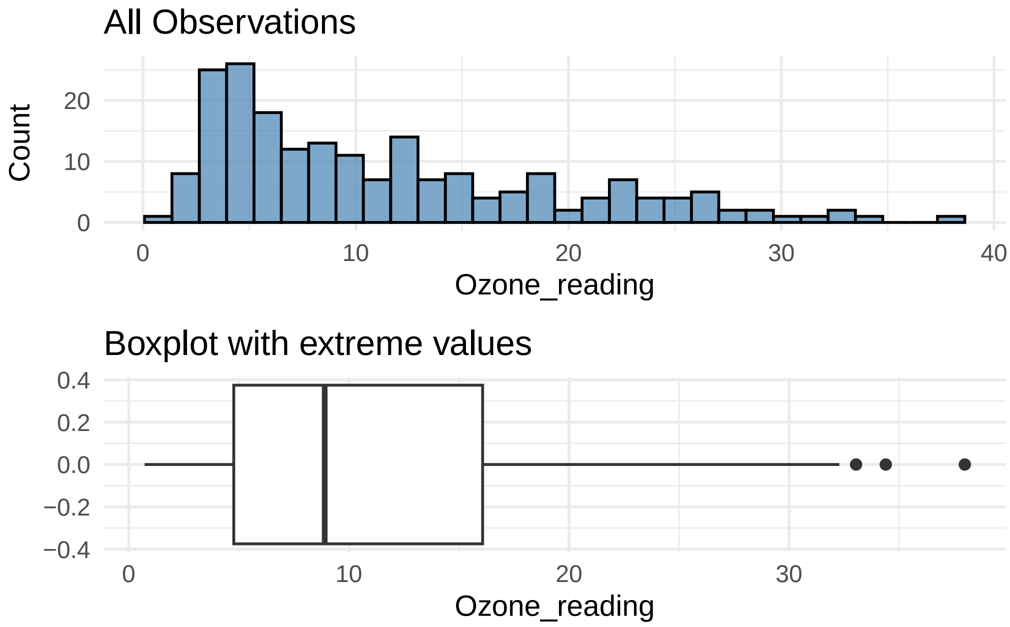
Boxplot with Outliers

```
Outliers identified in Inversion_temperature :  0 outliers
Proportion (%) of outliers: 0 %
```

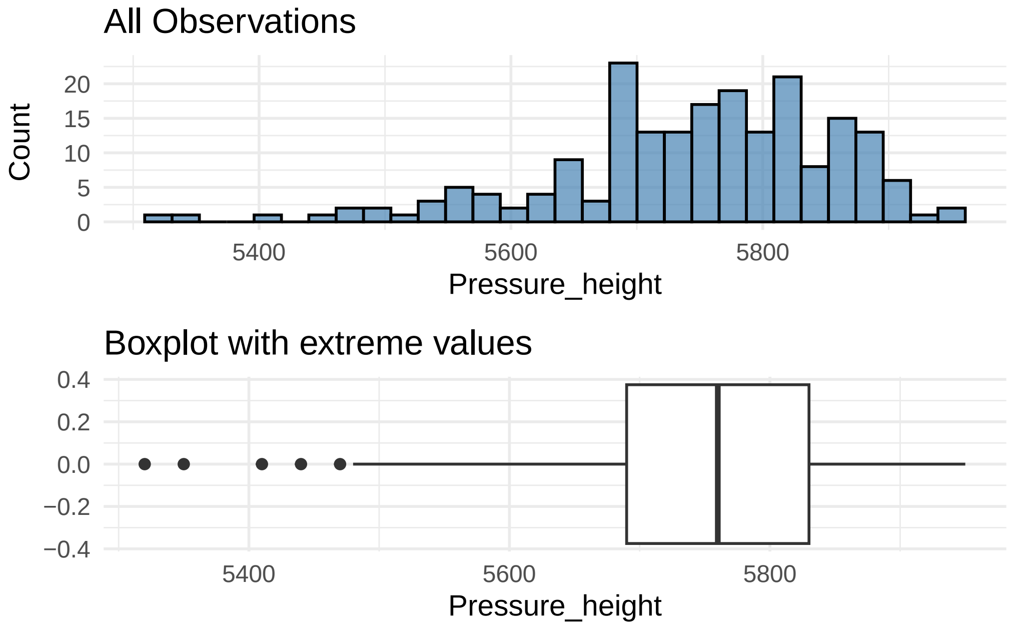


```
 Outliers identified in Visibility :  17 outliers
 Proportion (%) of outliers: 8.37 %
```

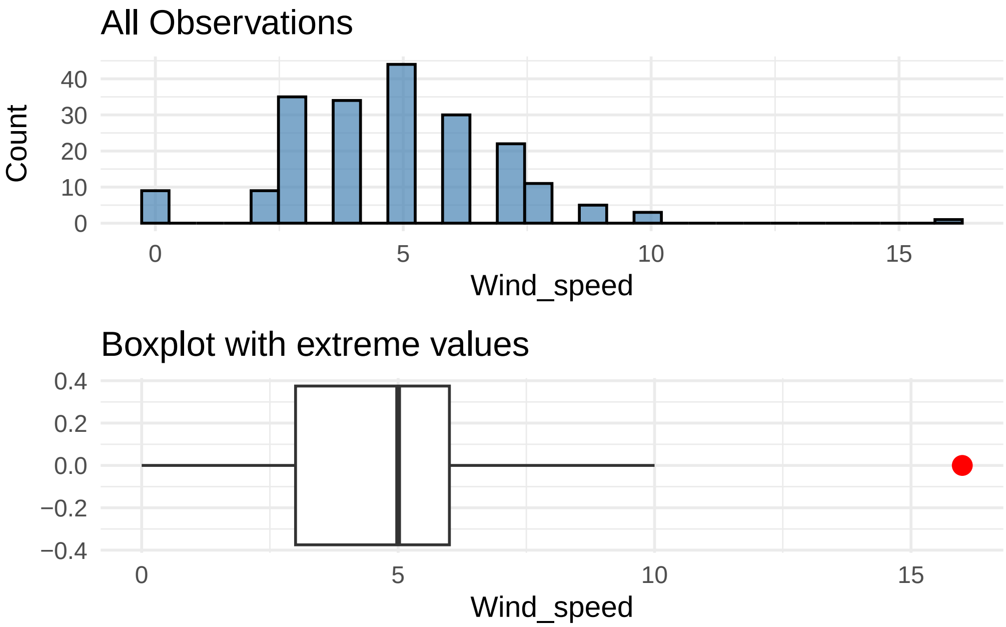
```
extreme_results <- lapply(numeric_integer_vars, function(var) {
  extreme(data, var)  # Llamar a la función pasando el nombre de la variable
})
```



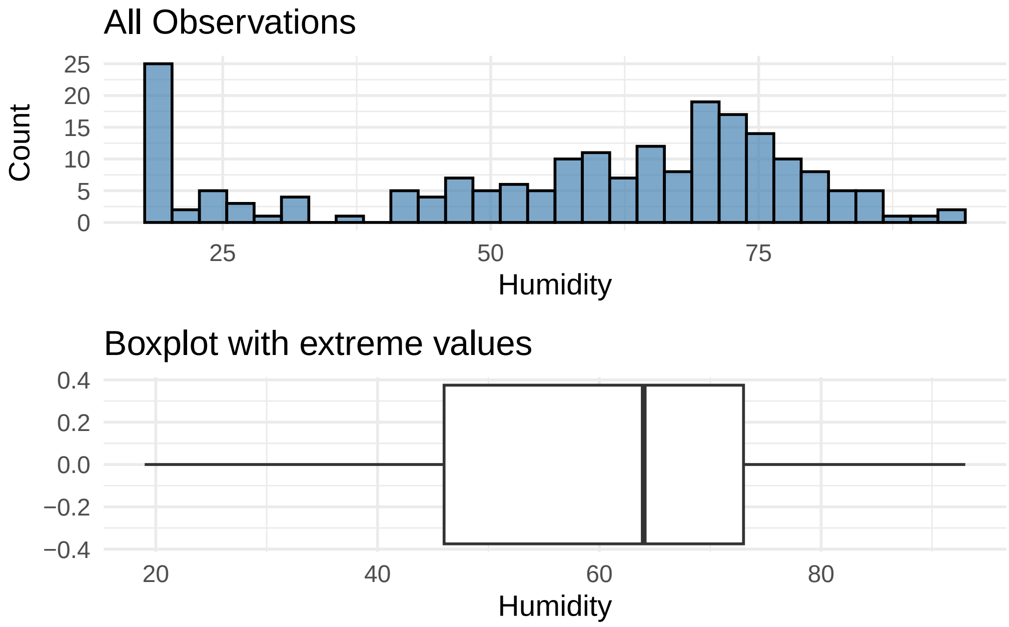
```
Outliers identified in Ozone_reading :  0 extreme values
Proportion (%) of extreme values: 0 %
```



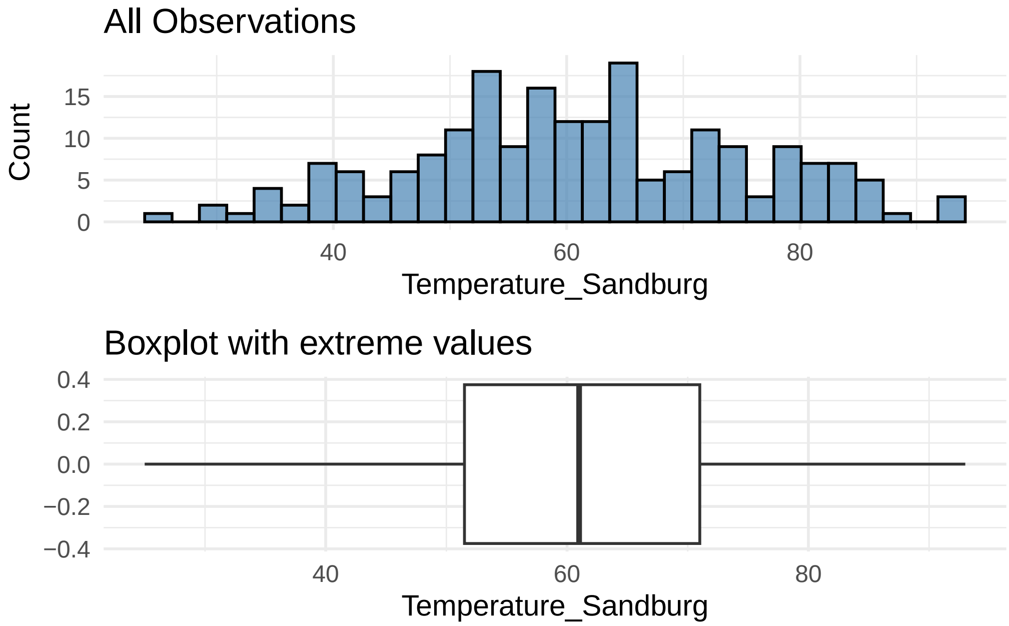
```
Outliers identified in Pressure_height :  0 extreme values
Proportion (%) of extreme values: 0 %
```



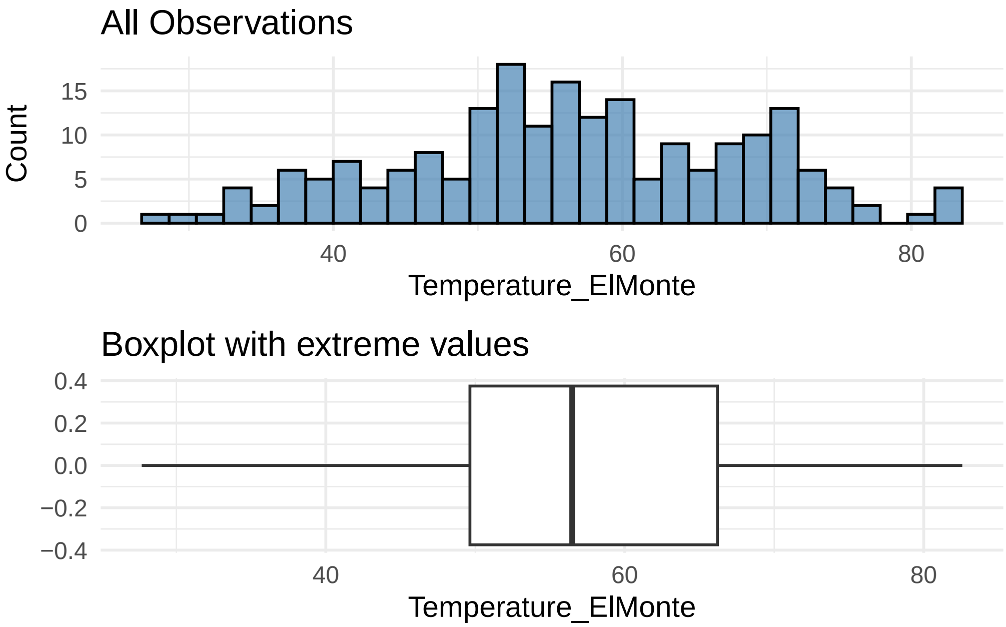
```
Outliers identified in Wind_speed :  1 extreme values
Proportion (%) of extreme values: 0.49 %
```



```
Outliers identified in Humidity :  0 extreme values
Proportion (%) of extreme values: 0 %
```



```
 Outliers identified in Temperature_Sandburg :  0 extreme values
 Proportion (%) of extreme values: 0 %
```



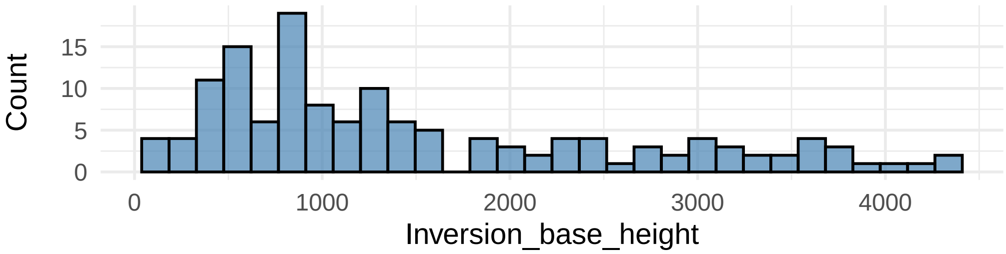
All Observations

Boxplot with extreme values

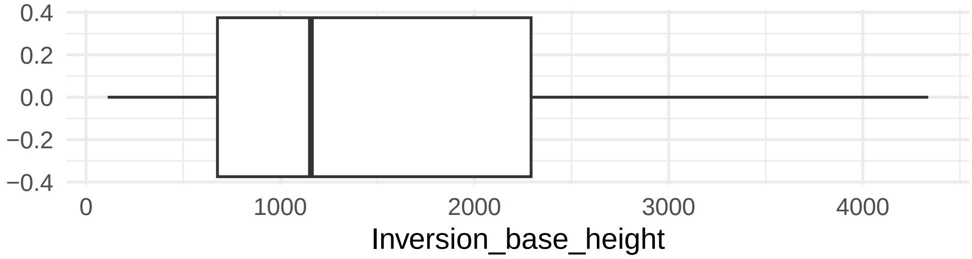
```
 Outliers identified in Temperature_ElMonte :  0 extreme values
 Proportion (%) of extreme values: 0 %
```

```
Warning: Removed 63 rows containing non-finite outside the scale range (`stat_bin()`).
Removed 63 rows containing non-finite outside the scale range
(`stat_boxplot()`).
```

All Observations

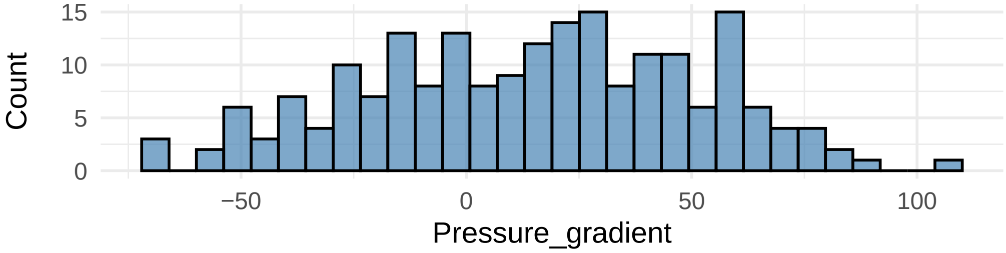


Boxplot with extreme values

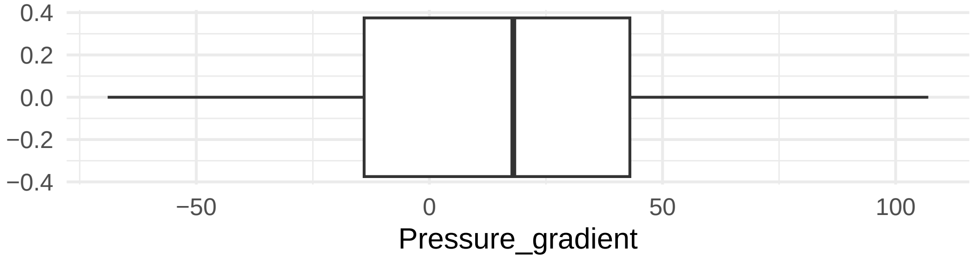


```
Outliers identified in Inversion_base_height :  0 extreme values
Proportion (%) of extreme values: 0 %
```

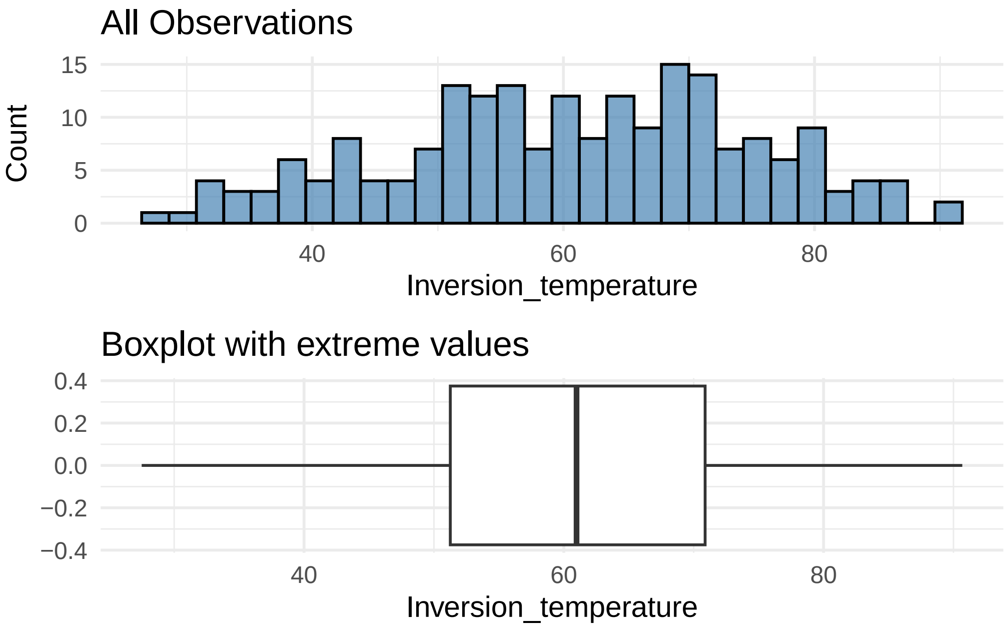
All Observations



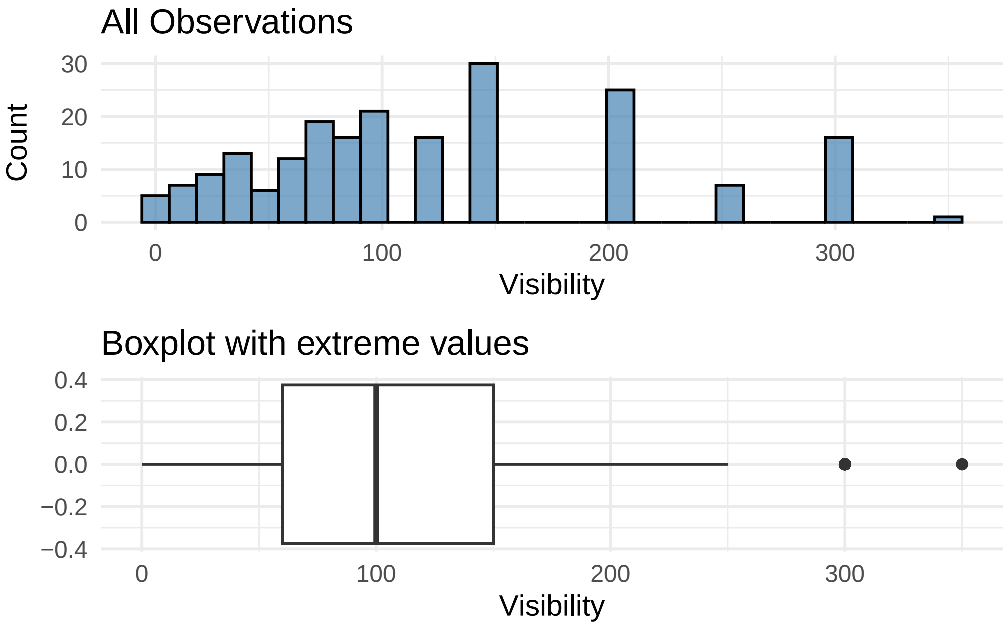
Boxplot with extreme values



```
Outliers identified in Pressure_gradient :  0 extreme values
Proportion (%) of extreme values: 0 %
```



```
Outliers identified in Inversion_temperature :  0 extreme values
Proportion (%) of extreme values: 0 %
```



```
Outliers identified in Visibility :  0 extreme values
Proportion (%) of extreme values: 0 %
```

Las variables con datos atípicos son:

`Pressure_heigth` (2.46%): valores muy pequeños que parecen parte de una distribución asimétrica

`Ozone_reading` (1.48%): valores muy grandes que parecen parte de una distribución asimétrica

`Wind_speed` (0.49%): Valor que es también extremo y que se sale completamente de la distrinbución

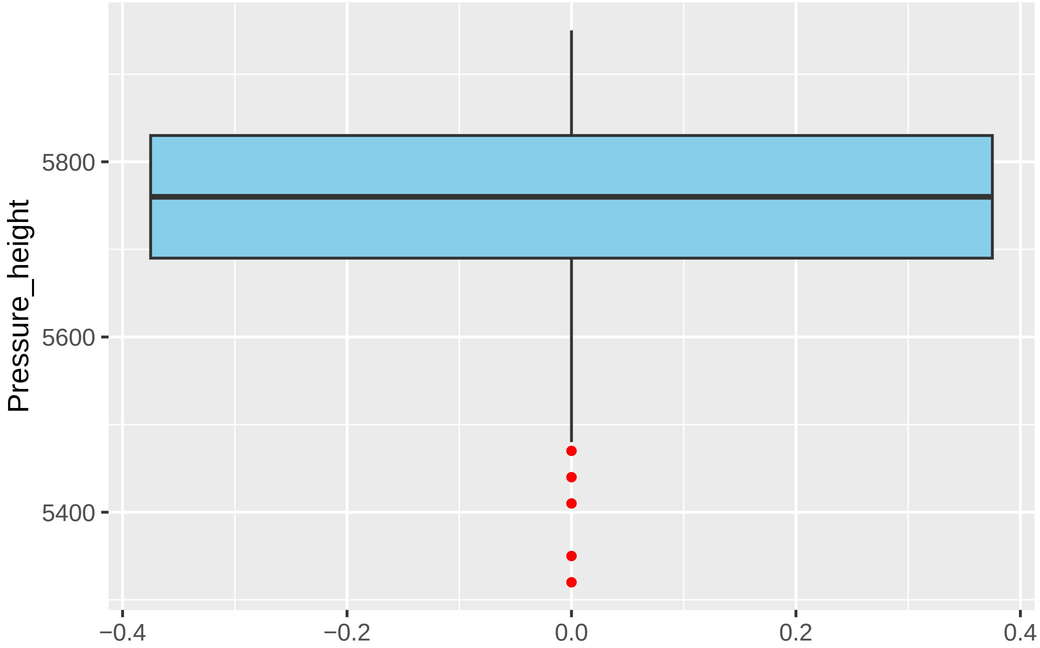
`Visibility` (8.37%): Valores que corresponden a los mismos valores de 300 y 350 que parecen claramente parte de la variable. Además es un número muy elevado como para ser dato atípico.

De todos los outliers el único que se ve como extremo es un valor en `Wind_speed`

Vamos por tanto a realizar el estudio bivariante de `Pressure_height, Ozone_reading y Wind_speed`

Estudio de la variable Pressure_height

```
##### Pressure heigth #####
ggplot(data, aes(y = Pressure_height)) +
  geom_boxplot(fill = "skyblue", outlier.color = "red", outlier.shape = 16)
```



```
###Los valores atípicos son:
outlier_values <- boxplot.stats(data$Pressure_height)$out  # outlier values.
out_ind <- which(data$Ozone_reading %in% c(outlier_values))
data[out_ind,]
```

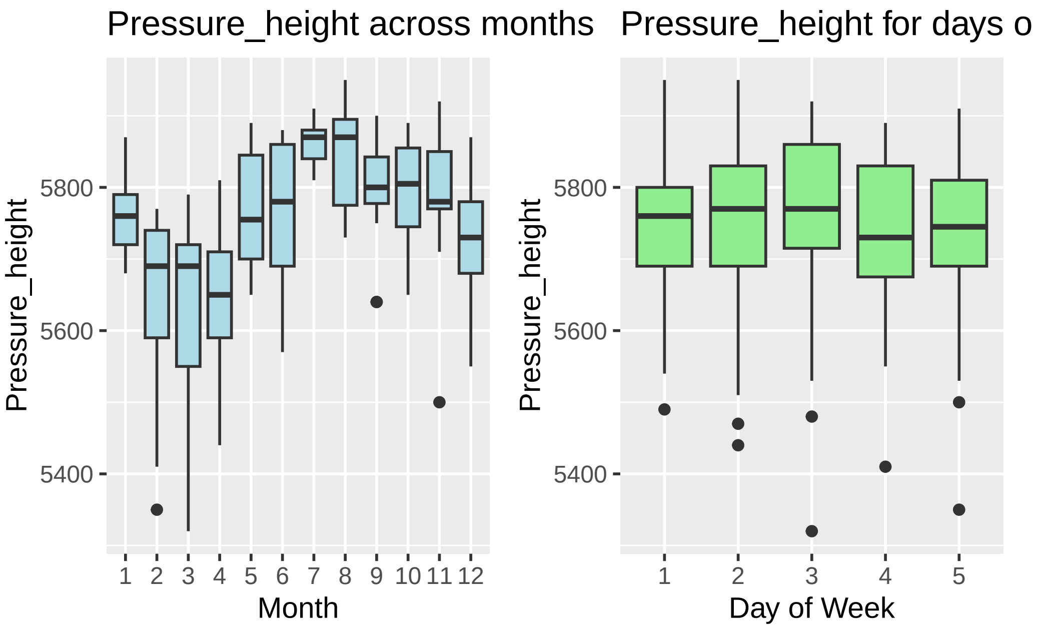
```
 [1] Month                 Day_of_month          Day_of_week
 [4] Ozone_reading         Pressure_height       Wind_speed
 [7] Humidity              Temperature_Sandburg  Temperature_ElMonte
[10] Inversion_base_height Pressure_gradient     Inversion_temperature
[13] Visibility
<0 rows> (or 0-length row.names)
```

```
###Los valores extremos son:
extreme_values <- boxplot.stats(data$Pressure_height,coef=3)$out  # extreme values.
```

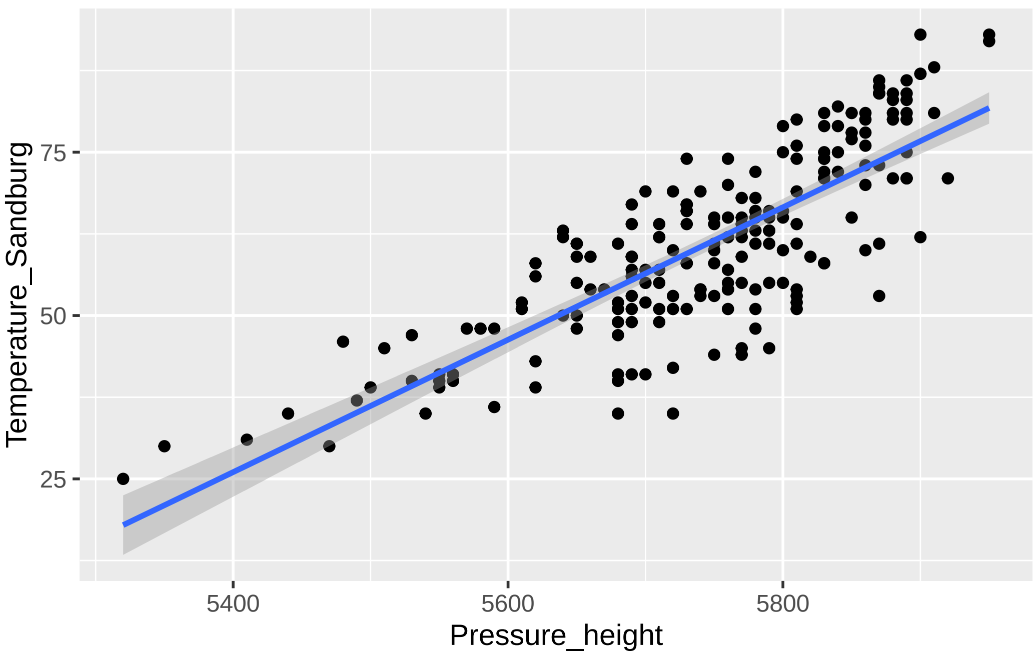
```r
ext_ind <- which(data$Pressure_height %in% c(extreme_values))
data[ext_ind,]
```

```
 [1] Month                 Day_of_month          Day_of_week
 [4] Ozone_reading         Pressure_height       Wind_speed
 [7] Humidity              Temperature_Sandburg  Temperature_ElMonte
[10] Inversion_base_height Pressure_gradient     Inversion_temperature
[13] Visibility
<0 rows> (or 0-length row.names)
```

```r
library(patchwork)  # Para combinar gráficos fácilmente

# Gráfico 1: Pressure Height por mes
p1 <- ggplot(data, aes(x = as.factor(Month), y = Pressure_height)) +
  geom_boxplot(fill = "lightblue") +
  labs(title = "Pressure_height across months", x = "Month", y = "Pressure_height")

# Gráfico 2: Pressure Height por día de la semana
p2 <- ggplot(data, aes(x = as.factor(Day_of_week), y = Pressure_height)) +
  geom_boxplot(fill = "lightgreen") +
  labs(title = "Pressure_height for days of week", x = "Day of Week", y = "Pressure_height")

# Combinar ambos gráficos en una fila
p1 + p2
```



```r
ggp <- ggplot(data,aes(Pressure_height, Temperature_Sandburg)) + geom_point()
ggp + stat_smooth(method = "lm",
                  formula = y ~ x,
                  geom = "smooth")
```



```
summary(lm(data$Pressure_height~data$Temperature_Sandburg))
```

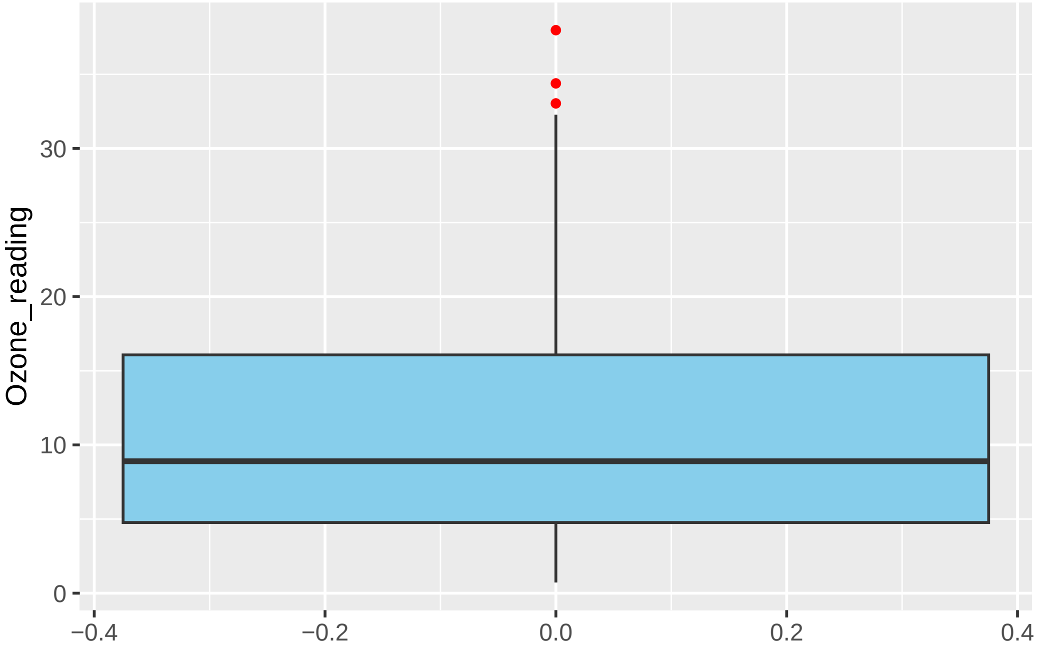
```
Call:
lm(formula = data$Pressure_height ~ data$Temperature_Sandburg)

Residuals:
     Min       1Q   Median       3Q      Max 
-196.559  -41.846    1.171   39.099  175.891 

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)    
(Intercept)               5354.1021    20.8228  257.13   <2e-16 ***
data$Temperature_Sandburg    6.4152     0.3319   19.33   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 67.02 on 201 degrees of freedom
Multiple R-squared:  0.6502,    Adjusted R-squared:  0.6484 
F-statistic: 373.6 on 1 and 201 DF,  p-value: < 2.2e-16
```

Esta variable está claramente asociada con los meses del año, perteneciendo los valores más altos de esta variable a los meses de verano. Además vemos una clara asoaciación con la variable de temperatura.

CONCLUSIÓN: No borramos estos valores atípicos porque son parte de una asociación,

Estudio de la variable Ozone Reading

```
##### OZONE READING #####
ggplot(data, aes(y = Ozone_reading)) +
  geom_boxplot(fill = "skyblue", outlier.color = "red", outlier.shape = 16)
```



```
###Los valores atípicos son:
outlier_values <- boxplot.stats(data$Ozone_reading)$out  # outlier values.
out_ind <- which(data$Ozone_reading %in% c(outlier_values))
data[out_ind,]
```

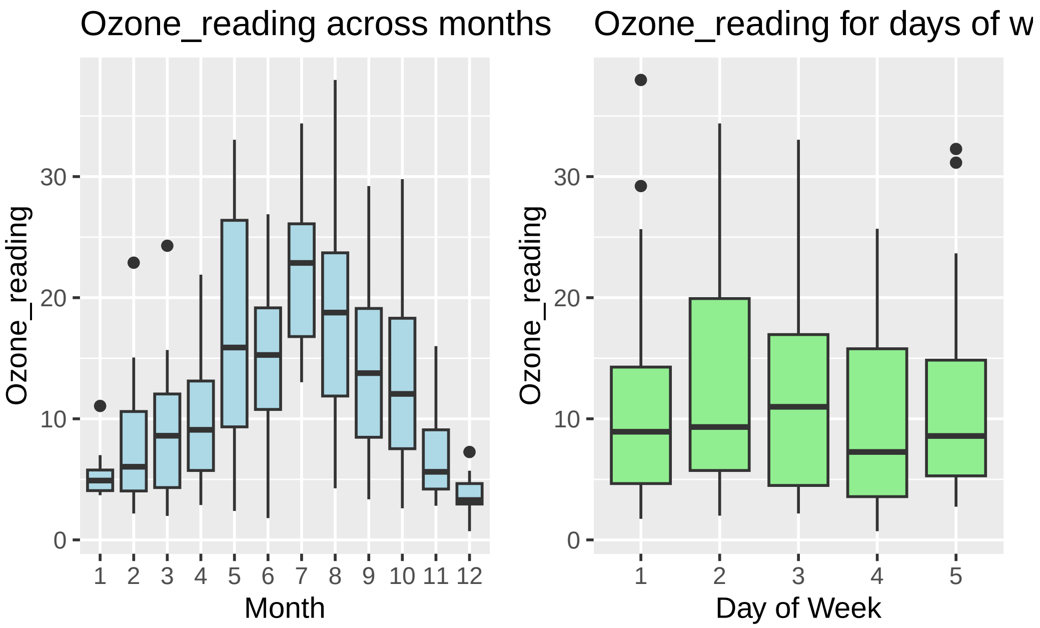
```
    Month Day_of_month Day_of_week Ozone_reading Pressure_height Wind_speed
82      5           12           3         33.04            5880          3
104     7            6           2         34.39            5900          6
130     8           30           1         37.98            5950          5
```

```
    Humidity Temperature_Sandburg Temperature_ElMonte Inversion_base_height
82        80                   80               73.04                   436
104       86                   87               81.68                   990
130       62                   92               82.40                   557
    Pressure_gradient Inversion_temperature Visibility
82                  0                 86.36         40
104                22                 85.10         40
130                 0                 90.68         70
```

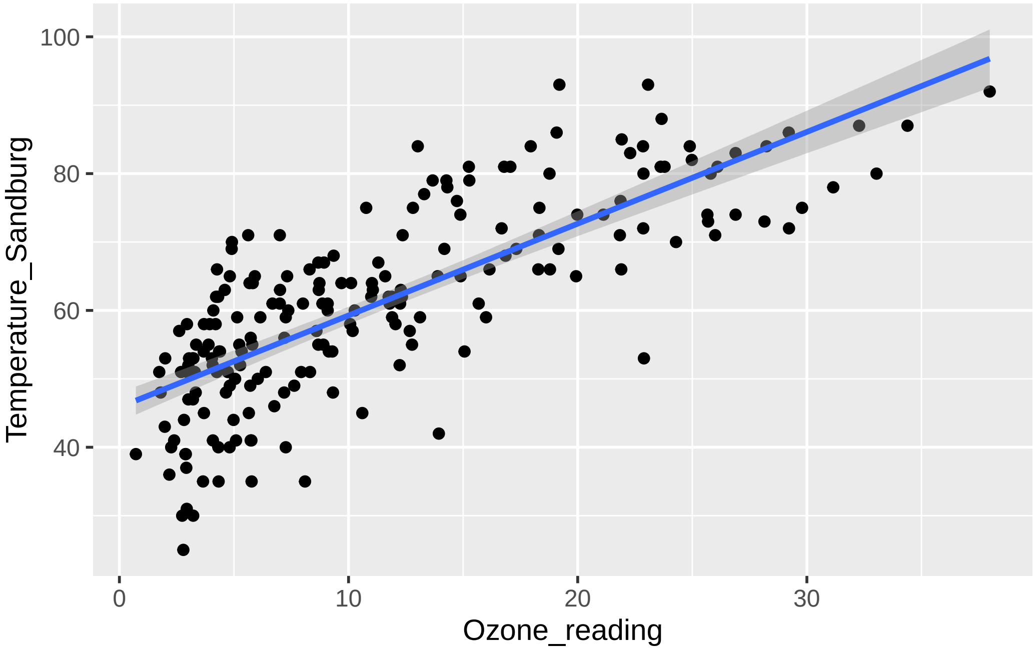
```
###Los valores extremos son:
extreme_values <- boxplot.stats(data$Ozone_reading,coef=3)$out  # extreme values.
ext_ind <- which(data$Ozone_reading %in% c(extreme_values))
data[ext_ind,]
```

```
 [1] Month                 Day_of_month          Day_of_week
 [4] Ozone_reading         Pressure_height       Wind_speed
 [7] Humidity              Temperature_Sandburg  Temperature_ElMonte
[10] Inversion_base_height Pressure_gradient     Inversion_temperature
[13] Visibility
<0 rows> (or 0-length row.names)
```

```
library(patchwork)  # Para combinar gráficos fácilmente

# Gráfico 1: Ozone_reading por mes
p1 <- ggplot(data, aes(x = as.factor(Month), y = Ozone_reading)) +
  geom_boxplot(fill = "lightblue") +
  labs(title = "Ozone_reading across months", x = "Month", y = "Ozone_reading")

# Gráfico 2: Ozone_reading por día de la semana
p2 <- ggplot(data, aes(x = as.factor(Day_of_week), y = Ozone_reading)) +
  geom_boxplot(fill = "lightgreen") +
  labs(title = "Ozone_reading for days of week", x = "Day of Week", y = "Ozone_reading")

# Combinar ambos gráficos en una fila
p1 + p2
```



```
ggp <- ggplot(data,aes(Ozone_reading, Temperature_Sandburg)) + geom_point()
ggp + stat_smooth(method = "lm",
                  formula = y ~ x,
                  geom = "smooth")
```



```
summary(lm(data$Ozone_reading~data$Temperature_Sandburg))
```

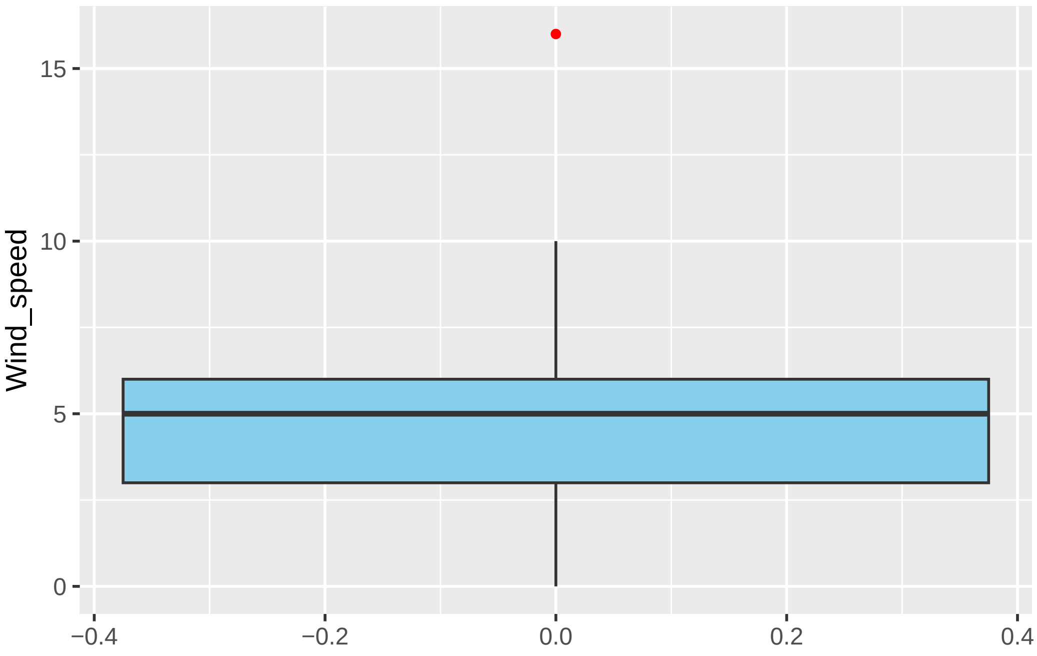
```
Call:
lm(formula = data$Ozone_reading ~ data$Temperature_Sandburg)

Residuals:
     Min       1Q   Median       3Q      Max 
-10.4273  -3.8316  -0.4737   3.2197  15.1344 

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)    
(Intercept)               -15.88133    1.61779  -9.817   <2e-16 ***
data$Temperature_Sandburg   0.44598    0.02579  17.294   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.207 on 201 degrees of freedom
Multiple R-squared:  0.5981,	Adjusted R-squared:  0.5961 
F-statistic: 299.1 on 1 and 201 DF,  p-value: < 2.2e-16
```

De la misma forma que la variable anterior, esta variable está claramente asociada con los meses del año, perteneciendo los valores más altos de esta variable a los meses de verano. Además vemos una clara asoaciación con la variable de temperatura.

CONCLUSIÓN: No borramos estos valores atípicos porque son parte de una asociación

Estudio de la variable WIND SPEED

```
ggplot(data, aes(y = Wind_speed)) +
  geom_boxplot(fill = "skyblue", outlier.color = "red", outlier.shape = 16)
```



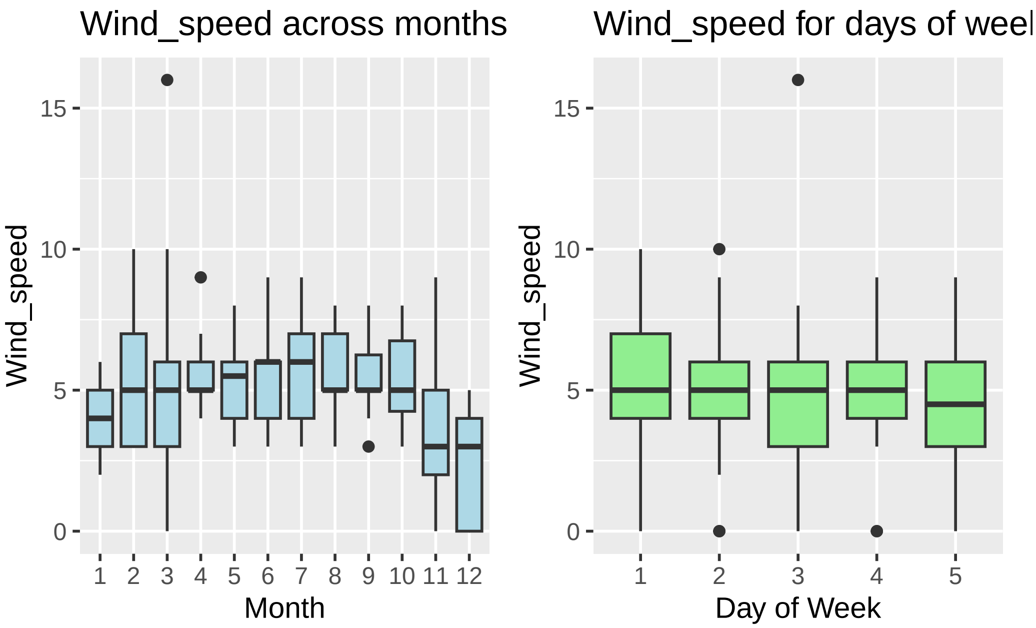
```
###Los valores atípicos son:
outlier_values <- boxplot.stats(data$Wind_speed)$out  # outlier values.
out_ind <- which(data$Wind_speed %in% c(outlier_values))
data[out_ind,]
```

```
   Month Day_of_month Day_of_week Ozone_reading Pressure_height Wind_speed
37     3            3           3          2.79            5320         16
   Humidity Temperature_Sandburg Temperature_ElMonte Inversion_base_height
37       45                   25               27.68                    NA
   Pressure_gradient Inversion_temperature Visibility
37                39                  27.5        200
```

```
###Los valores extremos son:
extreme_values <- boxplot.stats(data$Wind_speed,coef=3)$out  # extreme values.
ext_ind <- which(data$Wind_speed %in% c(extreme_values))
data[ext_ind,]
```

```
   Month Day_of_month Day_of_week Ozone_reading Pressure_height Wind_speed
37     3            3           3          2.79            5320         16
   Humidity Temperature_Sandburg Temperature_ElMonte Inversion_base_height
37       45                   25               27.68                    NA
   Pressure_gradient Inversion_temperature Visibility
37                39                  27.5        200
```

```
library(patchwork)  # Para combinar gráficos fácilmente

# Gráfico 1: Pressure Height por mes
p1 <- ggplot(data, aes(x = as.factor(Month), y = Wind_speed)) +
  geom_boxplot(fill = "lightblue") +
  labs(title = "Wind_speed across months", x = "Month", y = "Wind_speed")

# Gráfico 2: Pressure Height por día de la semana
p2 <- ggplot(data, aes(x = as.factor(Day_of_week), y = Wind_speed)) +
  geom_boxplot(fill = "lightgreen") +
  labs(title = "Wind_speed for days of week", x = "Day of Week", y = "Wind_speed")

# Combinar ambos gráficos en una fila
p1 + p2
```



Wind_speed across months

Wind_speed for days of weel

En este caso vemos que el outlier de `wind_speed` no está asoiciado con las variables de interés y además es un extremo.

CONCLUSIÓN: Este outlier no tiene ninguna asociación aparente, por tanto este dato missing si lo quitamos

```
outlier_values <- boxplot.stats(data$Wind_speed)$out  # outlier values.
out_ind <- which(data$Wind_speed %in% c(outlier_values))
data[out_ind,"Wind_speed"]<-NA
```