EDA

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Data Exploratory Analysis

hurrican703.csv collected the track data of 703 hurricanes in the North Atlantic area since 1950. For all the storms, their location (longitude & latitude) and maximum wind speed were recorded every 6 hours. The data includes the following variables

1. **ID**: ID of the hurricans
2. **Season**: In which the hurricane occurred
3. **Month**: In which the hurricane occurred
4. **Nature**: Nature of the hurricane

- ET: Extra Tropical
- DS: Disturbance
- NR: Not Rated
- SS: Sub Tropical
- TS: Tropical Storm

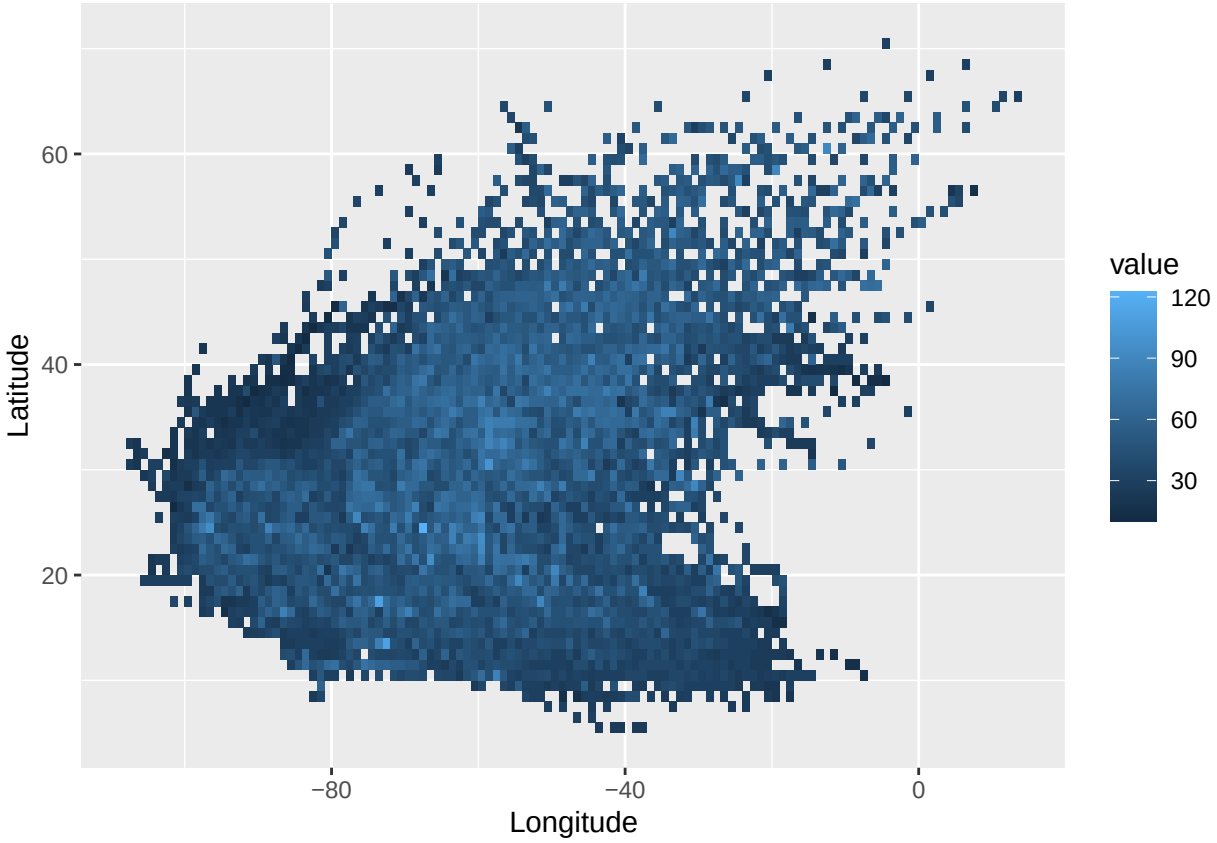
5. **time**: dates and time of the record
6. **Latitude** and **Longitude**: The location of a hurricane check point
7. **Wind.kt** Maximum wind speed (in Knot) at each check point

```
# library all packages that we need at the beginning
library(tidyverse)
library(dplyr)
library(readxl)
library(car)
library(gtsummary)
library(corrplot)
library(caret)
library(patchwork)
```

Summary table and Plot for hurricane data

```
library(ggplot2)
dt = read.csv("hurrican703.csv")
ggplot(data=dt, aes(x = Longitude, y = Latitude)) +
  stat_summary_2d(data = dt, aes(x = Longitude, y = Latitude, z = dt$Wind.kt),
                  fun = median, binwidth = c(1, 1), show.legend = TRUE)
```

```
## Warning: Use of ‘dt$Wind.kt‘ is discouraged.
## i Use ‘Wind.kt‘ instead.
```




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

```
##
## Attaching package: 'data.table'

## The following objects are masked from 'package:dplyr':
##
##     between, first, last

## The following object is masked from 'package:purrr':
##
##     transpose
```

```
dt <- as.data.table(dt)
summary(dt)
```

```
##       ID                Season        Month              Nature
##  Length:22038       Min.   :1950   Length:22038       Length:22038
##  Class :character   1st Qu.:1969   Class :character   Class :character
##  Mode  :character   Median :1989   Mode  :character   Mode  :character
##                     Mean   :1986
##                     3rd Qu.:2003
##                     Max.   :2013
##      time              Latitude       Longitude          Wind.kt
##  Length:22038       Min.   : 5.00   Min.   :-107.70   Min.   : 10.00
##  Class :character   1st Qu.:18.70   1st Qu.: -78.70   1st Qu.: 30.00
##  Mode  :character   Median :26.50   Median : -64.05   Median : 45.00
##                     Mean   :26.99   Mean   : -62.91   Mean   : 52.28
##                     3rd Qu.:33.60   3rd Qu.: -48.60   3rd Qu.: 65.00
##                     Max.   :70.70   Max.   :  13.50   Max.   :165.00
```

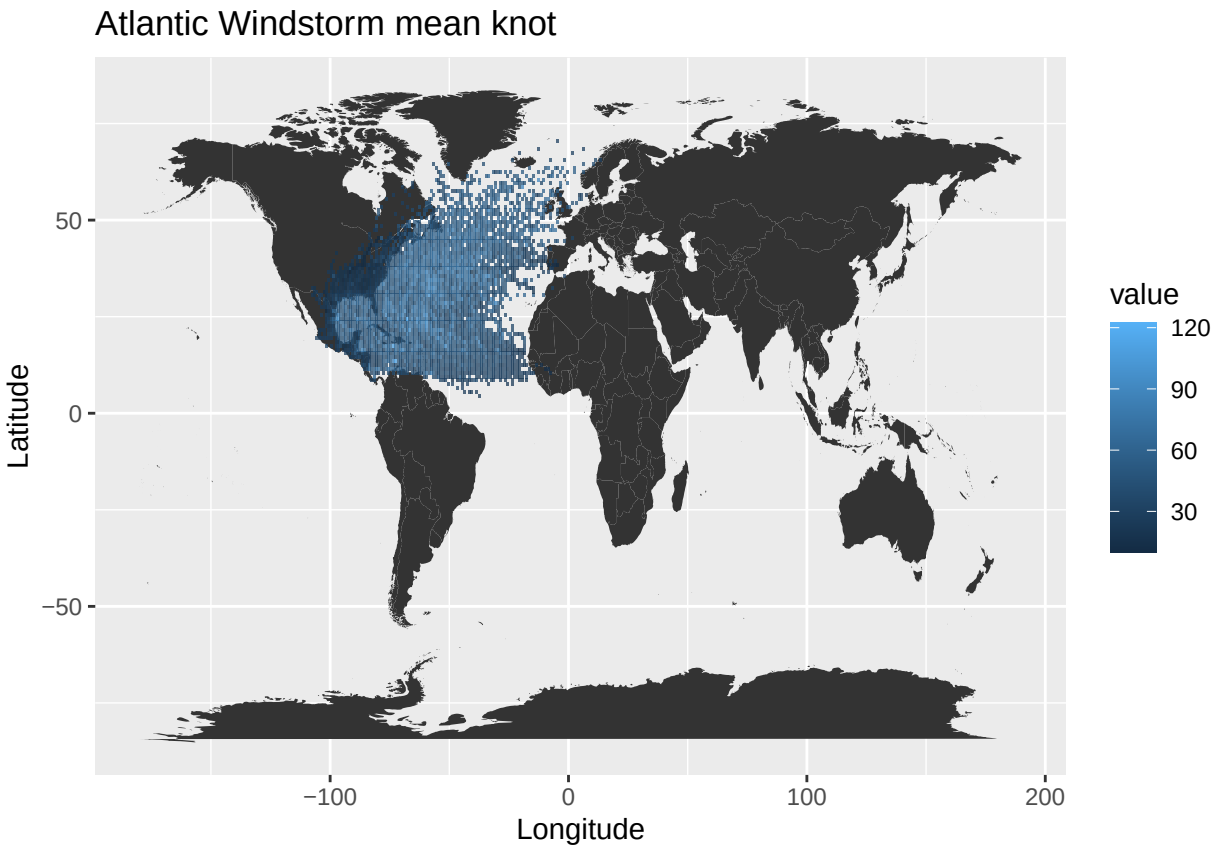
Hurricane data on World Map

```
library(maps)
```

```
##
## Attaching package: 'maps'
```

```
## The following object is masked from 'package:purrr':
##
##     map
```

```
map <- ggplot(data = dt, aes(x = Longitude, y = Latitude)) +
  geom_polygon(data = map_data(map = 'world'),
               aes(x = long, y = lat, group = group))
map1 <- map +
  stat_summary_2d(data = dt, aes(x = Longitude, y = Latitude, z = dt$Wind.kt),
                  fun = median, binwidth = c(1, 1),
                  show.legend = TRUE, alpha = 0.75) +
  ggtitle(paste0("Atlantic Windstorm mean knot"))
map1
```



Track of Each Hurricane on Map

```
map <- ggplot(dt, aes(x = Longitude, y = Latitude, group = ID)) +
  geom_polygon(data = map_data("world"),
               aes(x = long, y = lat, group = group),
               fill = "gray25", colour = "gray10", size = 0.2) +
  geom_path(data = dt, aes(group = ID, colour = Wind.kt), size = 0.5) +
  xlim(-138, -20) + ylim(3, 55) +
  labs(x = "", y = "", colour = "Wind \n(knots)") +
  theme(panel.background = element_rect(fill = "gray10", colour = "gray30"),
        axis.text.x = element_blank(), axis.text.y = element_blank(),
        axis.ticks = element_blank(), panel.grid.major = element_blank(),
        panel.grid.minor = element_blank())
```

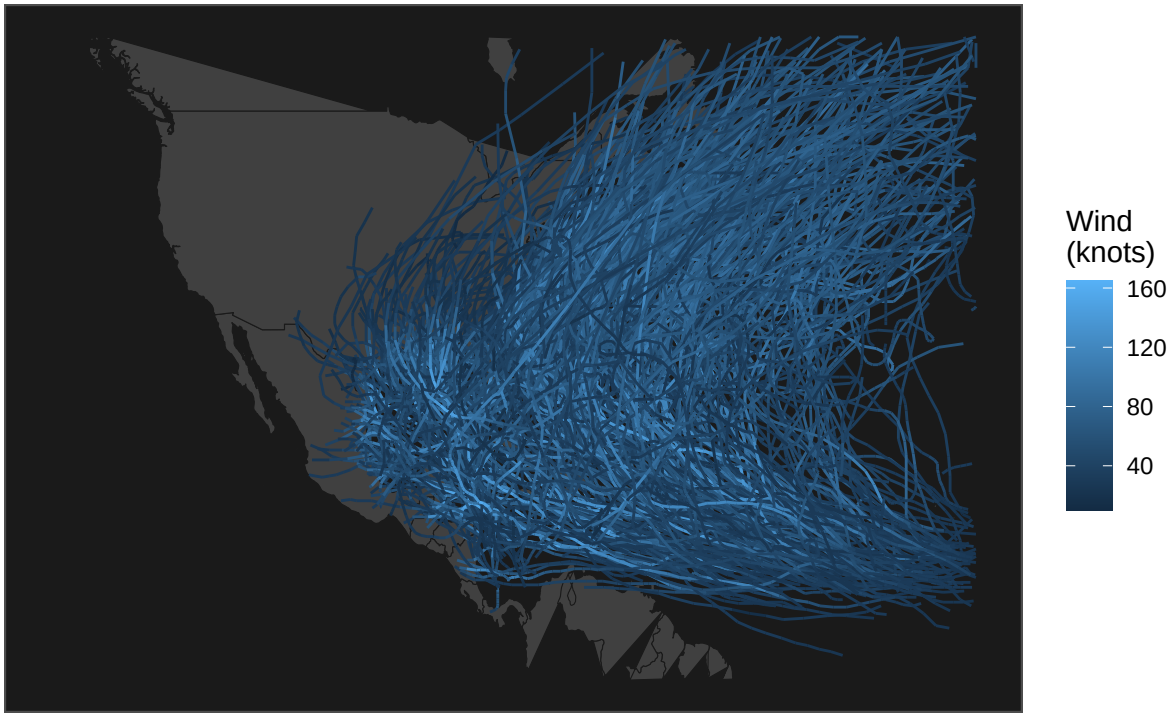
```
## Warning: Using ‘size‘ aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use ‘linewidth‘ instead.
```

```
seasonrange <- paste(range(dt[, Season]), collapse=" - ")

map + ggtitle(paste("Atlantic named Windstorm Trajectories (",
                    seasonrange, ")\n"))
```

```
## Warning: Removed 522 rows containing missing values (‘geom_path()‘).
```

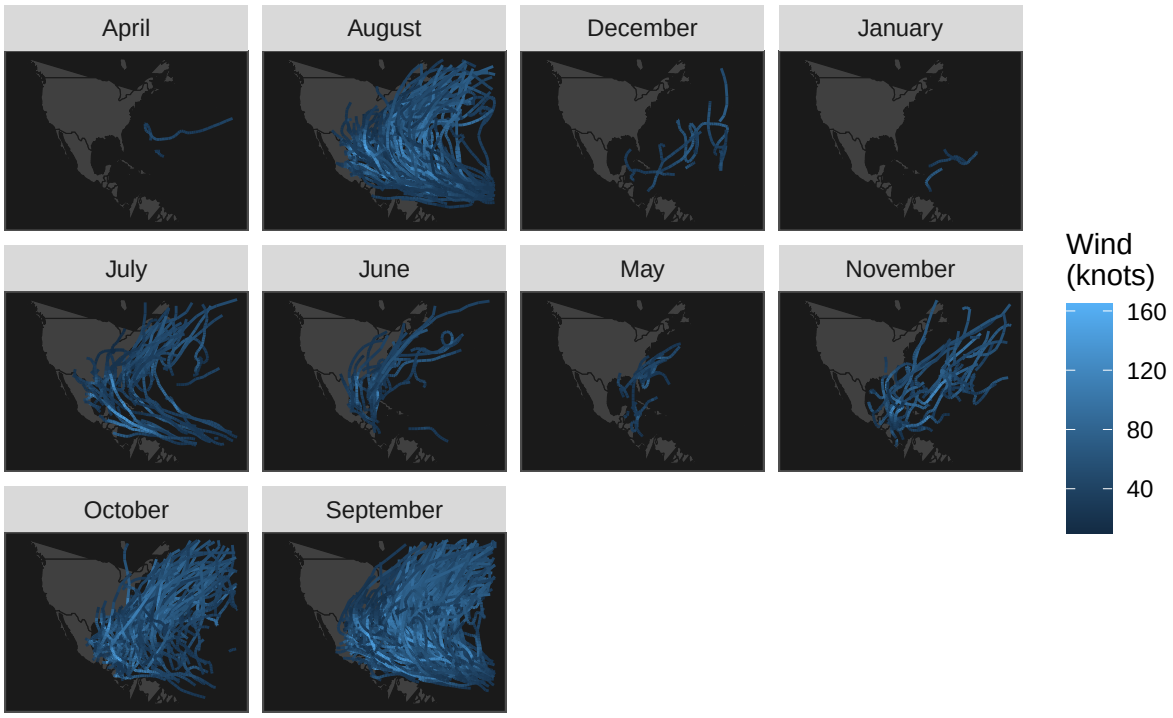
Atlantic named Windstorm Trajectories (1950 − 2013)



Track of Each Hurricane by Month on Map

```
mapMonth <- map + facet_wrap(~ Month) +
  ggtitle(paste("Atlantic named Windstorm Trajectories by Month (",
                seasonrange, ")\n"))
mapMonth
```

```
## Warning: Removed 522 rows containing missing values (‘geom_path()‘).
```

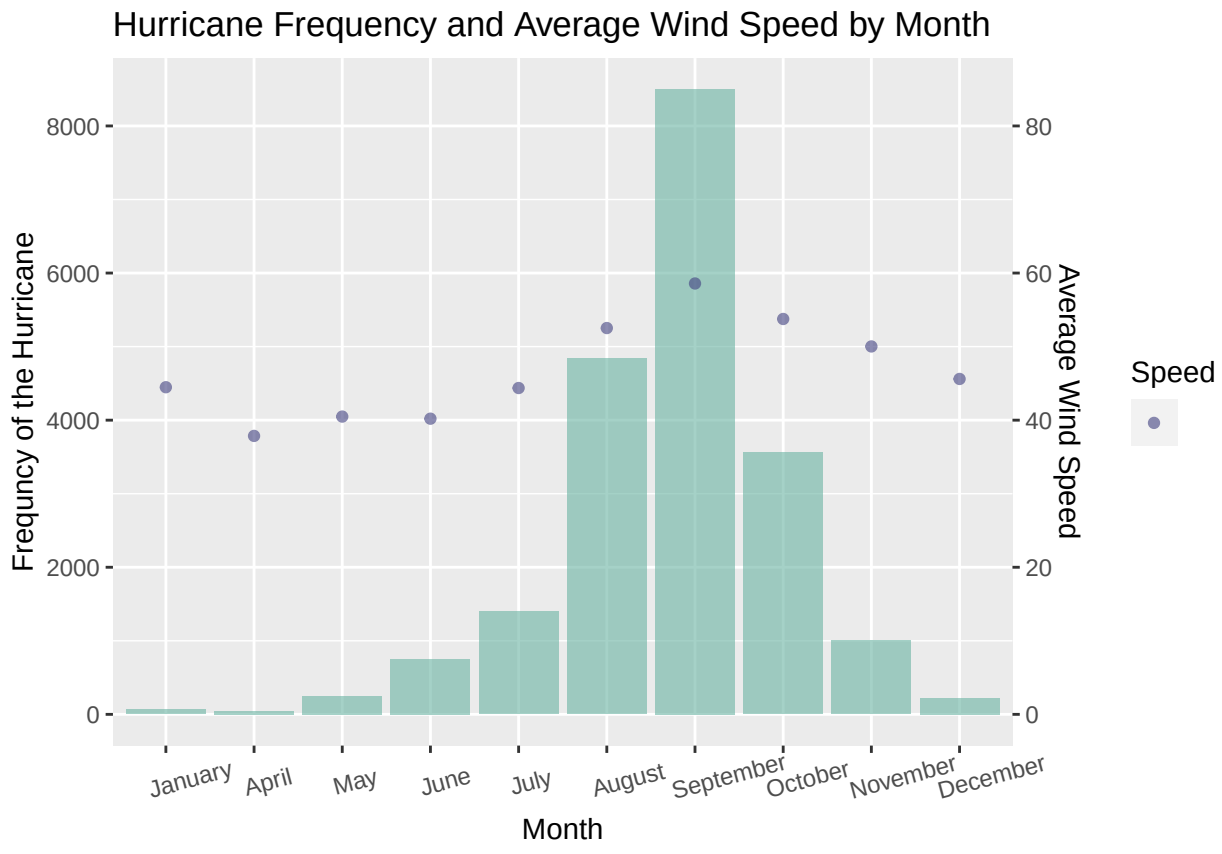


Tidy Data and Preprocessing for MCMC

```
# read in data from CSV file
hurricane <- read.csv("hurrican703.csv")
# tidy data on date
hurricane <- as_tibble(hurricane) %>%
  separate(time, into = c("Date", "Hour"), sep = " ") %>%
  mutate(Hour = ifelse(Hour == "00:00:00)", 0,
                       ifelse(Hour == "06:00:00)", 6,
                              ifelse(Hour == "12:00:00)", 12, 18))),
         Date = str_remove(Date, "\\("),
         Date = yday(Date),
         Month = factor(Month,levels = month.name))
# tidy data on latitude longitude wind_kt
hurricane <- hurricane %>%
  group_by(ID) %>%
  mutate(Lat_change =  Latitude - lag(Latitude, 1),
         Long_change = Longitude - lag(Longitude, 1),
         Wind_change = lag(Wind.kt, 1) - lag(Wind.kt, 2),
         Wind_prev = lag(Wind.kt, 1)) %>%
  na.omit()
# save(hurricane, file = "hurricane.RData")
```

Exploratory Plots of Hurricane in each

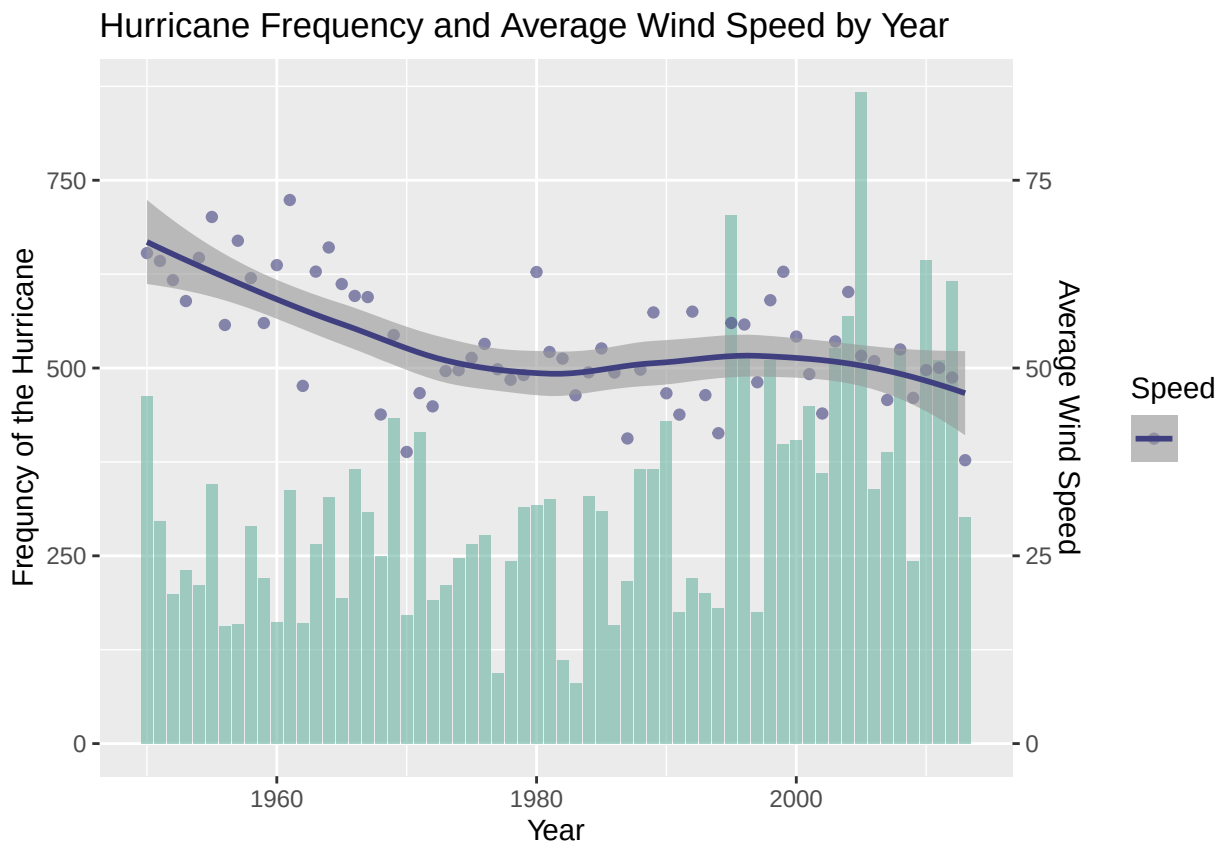
```
map2 <- hurricane %>%
  group_by(Month) %>%
  summarise(count = n(),
            Ave.Speed = mean(Wind.kt)) %>%
  ggplot(aes(x = Month)) +
  geom_col(aes(y = count), fill = "#69b3a2", alpha = 0.6) +
  geom_point(aes(y = Ave.Speed*100, color = " "), alpha = 0.6) +
  scale_y_continuous(
    name = "Frequncy of the Hurricane",
    sec.axis = sec_axis(~.*0.01, name = "Average Wind Speed")) +
  scale_color_manual(name = "Speed",
                     values = c(" " = "#404080")) +
  labs(title = "Hurricane Frequency and Average Wind Speed by Month") +
  theme(axis.text.x = element_text(angle = 15, vjust = 0.5, hjust = 0.2))
map2
```



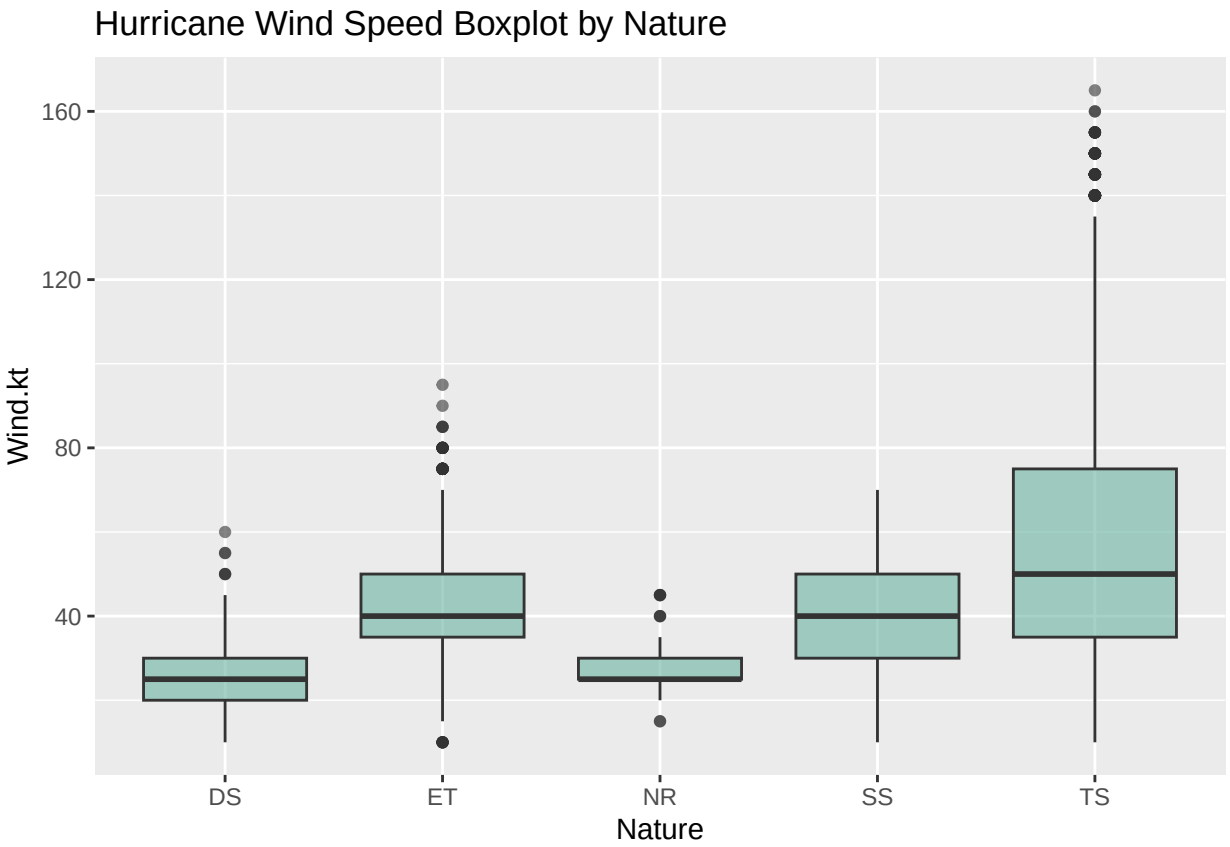

```
map3 <- hurricane %>%
  group_by(Season) %>%
  summarise(count = n(),
            Ave.Speed = mean(Wind.kt)) %>%
  ggplot(aes(x = Season)) +
  geom_col(aes(y = count), fill = "#69b3a2", alpha = 0.6) +
```

```
  geom_point(aes(y = Ave.Speed*10, color = " "), alpha = 0.6) +
  geom_smooth(aes(y = Ave.Speed*10, color = " "), alpha = 0.6) +
  scale_y_continuous(
    name = "Frequncy of the Hurricane",
    sec.axis = sec_axis(~.*0.1, name = "Average Wind Speed")) +
  scale_color_manual(name = "Speed",
                     values = c(" " = "#404080")) +
  labs(title = "Hurricane Frequency and Average Wind Speed by Year",
       x = "Year")
map3
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```




```
map4 <- hurricane %>%
  group_by(Nature) %>%
  ggplot(aes(x = Nature, y = Wind.kt)) +
  geom_boxplot(fill = "#69b3a2", alpha = 0.6) +
  labs(title = "Hurricane Wind Speed Boxplot by Nature",
       x = "Nature")
map4
```


Hurricane Wind Speed Boxplot by Nature
Wind.kt
160
120
80
40
DS
ET
NR
SS
TS
Nature