Understanding Tropical Cyclones with Historical Storm Data

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Tropical Cyclones

A **tropical cyclone** is the generic term for a non-frontal synoptic scale low-pressure system over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation (Holland 1993).

Saffir-Simpson Hurricane Scale for Tropical Cyclones

A tropical cyclone can be classified based on **maximum sustained wind speeds** (MWS) using the **Saffir-Simpson hurricane scale (SSHS)**:

- Category one: MWS is in [33, 43) (m/s).
- Category two: MWS is in [43, 50) (m/s).
- Category three: MWS is in [50, 58) (m/s).
- Category four: MWS is in [58, 70) (m/s).
- Category five: MWS is greater than 70 m/s.

One knot is 0.514 m/s.

Tropical Cyclone Hazards

Video Time

IBTrACS Data

The International Best Track Archieve for Climate Stewardship (IBTrACS) project:

- contains the most complete global set of historical tropical cyclones;
- combines information from numerous tropical cyclone datasets;
- simplifies inter-agency comparisons by providing storm data from multiple sources in one place;
- combines recent and historical storm data in one dataset.

Read IBTrACS Data into R

```r
library(ncdf4)
storms = nc_open("IBTrACS.since1980.v04r00.nc")
name = ncvar_get(storms, "name")
season = ncvar_get(storms, "season")
count = as.numeric(table(season))
year = as.numeric(names(table(season)))
Lat = ncvar_get(storms, "lat")
Lon = ncvar_get(storms, "lon")

## Maximum sustained wind speed
mws = ncvar_get(storms, "wmo_wind") * 0.514   # kt to m/s
## Minimum central pressure
mcp = ncvar_get(storms, "wmo_pres")
```
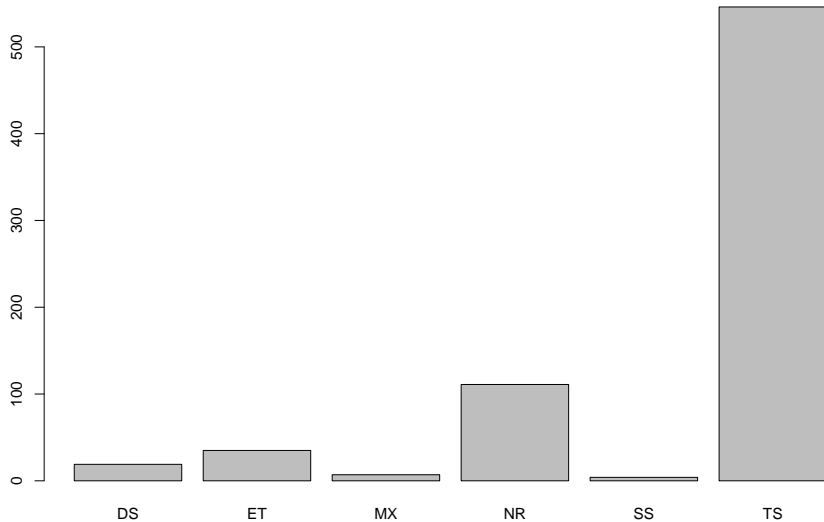
Storm Counts
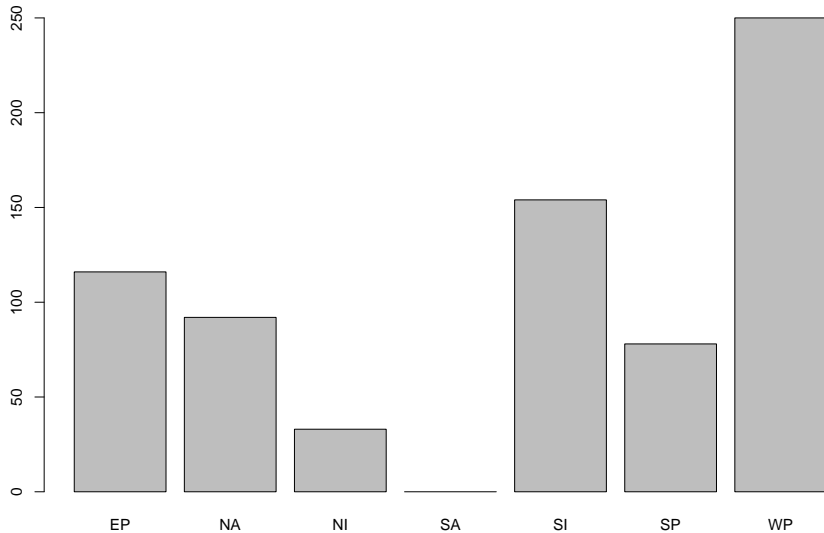
- How to model storm counts per year?
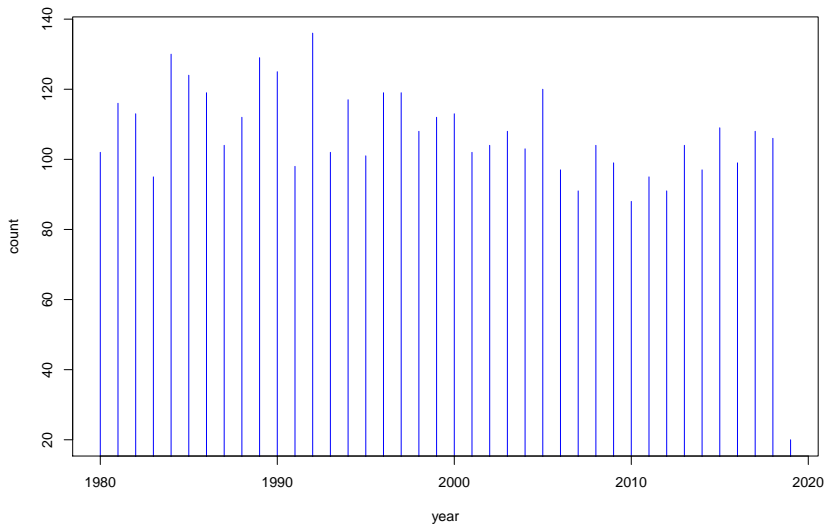
# Storm Types

Storm per Basin

Maximum Sustained Wind Speed

The maximum sustained wind speeds for tropical cyclones are the highest surface winds occuring within the circulation of the system.

- spatial resolution: $0.1°$ (~10km)
- temporal resolution: 6 hours
- coverage: $70°$ N to $70°$ S and $180°$ W to $180°$ E, 1841-present

Global Map of MWS: 1980 - 2019

Maximum sustained wind speed
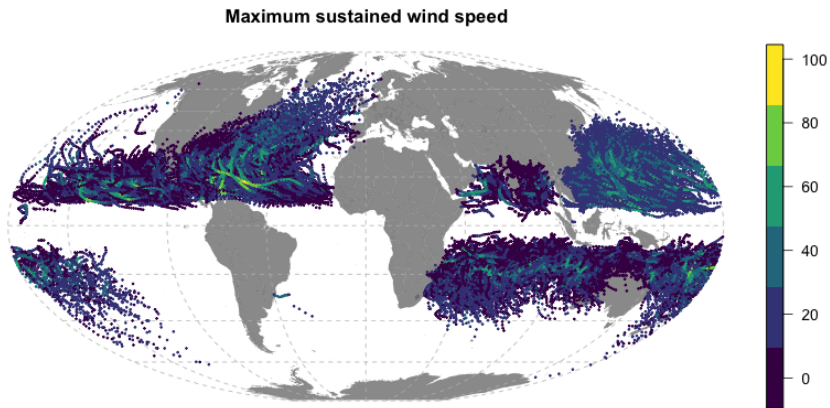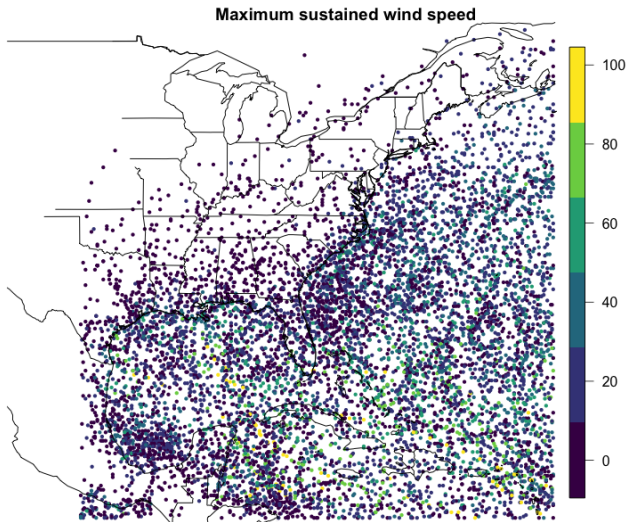
Global Map of SSHS: 1980 - 2019

Saffir-Simpson hurricane scale
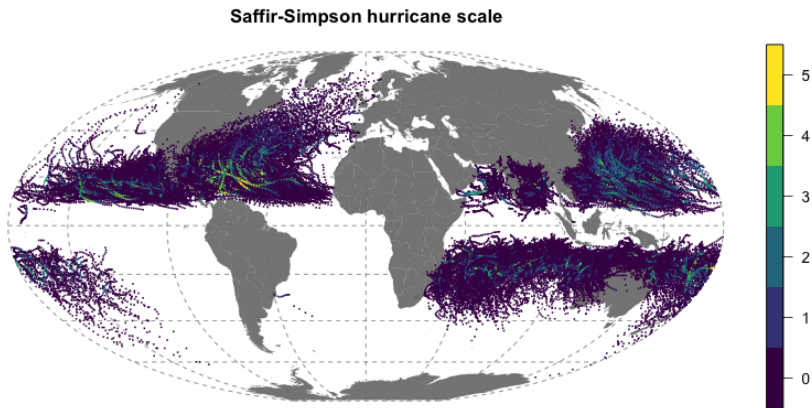
MWS in North Atlantic: 1980 - 2019

- ► How to model the spatial/spatio-temporal distribution of the MWS?

Maximum sustained wind speed

SSHS in North Atlantic: 1980 - 2019

Saffir-Simpson hurricane scale
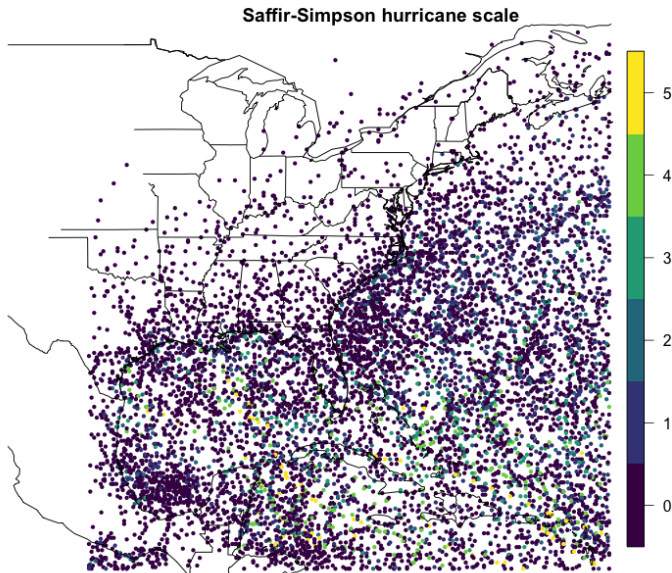
Scientific Questions

- How do we model the number of storms per year?
- How do we model the distribution of the MWS?
- How do we predict the MWS for a new storm given historical data?