P8160 - Project 3
Baysian modeling of hurrican trajectories

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Motivation

Climate researchers are interested in modeling the hurricane trajectories to forcase the windspeed.

Data

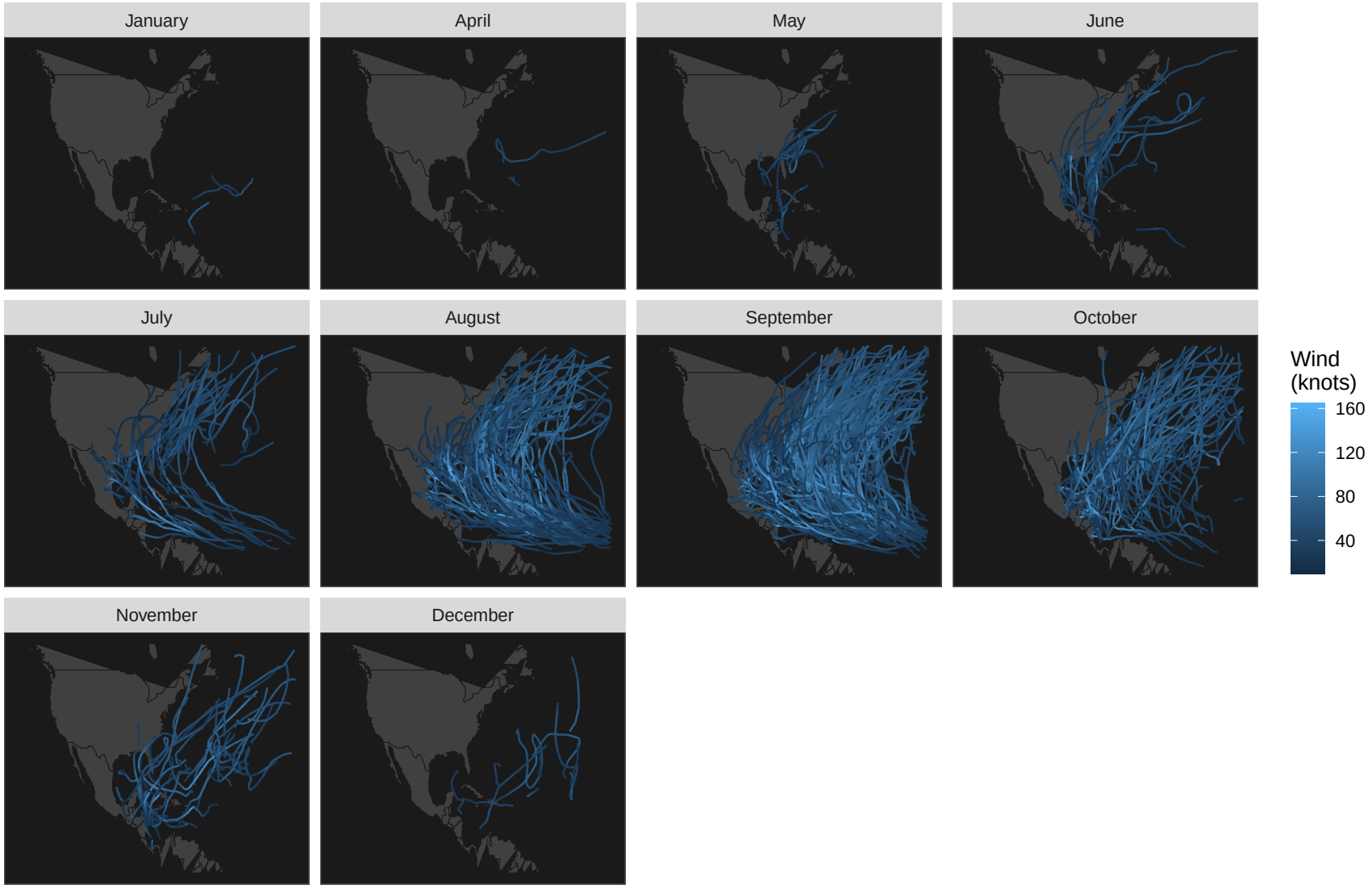
- **ID**: ID of hurricanes
- **Year**: In which the hurricane occurred
- **Month**: In which the hurricane occurred
- **Nature**: Nature of the hurricane
  - ET: Extra Tropical
  - DS: Disturbance
  - NR: Not Rated
  - SS: Sub Tropical
  - TS: Tropical Storm
- **Time**: dates and time of the record
- **Latitude** and **Longitude**: The location of a hurricane check point
- **Wind.kt**: Maximum wind speed (in Knot) at each check point

Overview

- Exploration into the Data
- Bayesian modeling of hurricane wind speed
  - Model Equation
  - Posterior Derivation
  - MCMC Algorithm
- How Month, Year, and the Nature of the hurricane affect wind speed
  - Explore seasonal differences
  - Explore if wind speeds is increasing over years
- Exploring wind speeds impact on death and damages
  - As well as the characteristic of a hurricane associated with damages and deaths

Data

Atlantic named Windstorm Trajectories by Month (1950 − 2013)



Data Cleaning

- We are only concerned about observations that occurred on 6 hour intervals. hour 0, 6, 12, and 18.
- In addition we will exclude all hurricane IDs that have less then 7 observations.

Through this process we remove 460 observations so we are left with 21578 observations and 681 unique hurricanes.

Bayesian Model for Hurricane Trajectories

To model the wind speed of the i^{th} hurricane at time t we will use

$$Y_i(t+6) = \beta_{0,i} + \beta_{1,i} Y_i(t) + \beta_{2,i} \Delta_{i,1}(t) + \beta_{3,i} \Delta_{i,2}(t) + \beta_{4,i} \Delta_{i,3}(t) + \epsilon_i(t)$$

Where

- $\Delta_{i,1}(t)$, $\Delta_{i,2}(t)$ and $\Delta_{i,3}(t)$ are changes in latitude longitude and wind speed respectively between $t-6$ and t
- $\epsilon_i(t) \sim N(0, \sigma^2)$ independent across t
- Let $\beta_i = (\beta_{0,i}, \beta_{1,i}, \beta_{2,i}, \beta_{3,i}, \beta_{4,i}) \sim \mathcal{N}(\mu, \Sigma)$ be multivariate normal distribution where $\mu \in \mathbb{R}^d$ and $\Sigma \in \mathbb{R}^{d \times d}$.

Prior Distributions:

- For σ^2 we assume $\pi(\sigma^2) \propto \frac{1}{\sigma^2}$
- For μ we assume $\pi(\mu) \propto 1$
- For Σ we assume $\pi\left(\Sigma^{-1}\right) \propto |\Sigma|^{-(d+1)} \exp\left\{-\frac{1}{2}\Sigma^{-1}\right\}$

Goal: Estimate $\Theta = (\mu^T, \sigma^2, \Sigma)$

Posterior Calculation

MCMC Algorithm

Initial Starting Values

MCMC Model Convergence

MCMC Model Convergence

Beta Estimates

Understanding Seasonal differnces in Hurricane Wind Speed

Exploring if wind speeds has increased over the years

Hurricane Deaths

Hurricane Damages

Conclusions