Second Midterm Project Proposal

What is the topic of your project?
Modeling Hurricanes Through Various Extreme Value Frameworks.
As fossil fuel emissions continue to warm the Earth, scientists predict that the intensity of hurricanes will increase (in terms of rainfall rate and wind speeds). We hope to evaluate this forecast using the extreme value frameworks presented in class.

What question would you like to answer?
How has climate change affected hurricane intensity?

Who are your group members?
Abigail Kinaro (new member)
Kent Codding
Max Bahar

What methods or ideas will you use? (If you are working on one of the three code-base-focused projects, explain what features you will need to build or use to instantiate your idea.)
We have some potential ideas to explore in our project:
- For our models, we will use maximum rainfall rates, maximum wind speeds, and minimum central pressures (which is inversely proportional to hurricane strength) obtained from the following datasets: [HURDAT2](#) and [IBTrACS](#).
- We can fit the distribution of these extreme values to the Gumbel, Frechet, and Weibull distributions (based on the Fisher–Tippett–Gnedenko theorem).
- As an alternative/extension, we could look at the Pareto distribution (or Generalized Pareto distribution) to examine hurricanes that exceed a certain threshold value by utilizing the [Saffir-Simpson Hurricane Wind Scale](#).
- To correlate hurricanes with climate change, we could utilize linear regression to see if variables such as time or CO2 concentration accurately predicts the extreme values of hurricanes. If we use the Pareto distribution (or Generalized Pareto distribution), we could use a logistic regression to see if climate variables could predict the odds of a hurricane being at least a category 3/4/5.
- Finally, we hope to examine the behavior of the maxima (and minima in the case of central pressure) over time. Specifically, are hurricanes in more recent years getting stronger? And are hurricanes in more recent years intensifying at a faster rate?

Do you have questions about how to start that we can help with?
From our list of potential ideas above, do you have a recommendation on which ones to use for this project?
Do you have any other ideas on how we can do more to relate hurricanes to climate change?

Should we still contribute to the Covid code base even though this project is not necessarily epidemiological?

Modeling Extreme Values in the Anthropocene

Project Directions

Fit to existing distributions
- Gumbel distribution
- Frechet distribution
- Weibull distribution
- Fisher–Tippett–Gnedenko theorem
- Pareto distribution (data over a certain threshold)

Relationship to other measures
- Logistic regression (correlate with other things)

Time period between events
- Monte carlo from distribution
- Fit to more recent data and compare with historical data

Hurricanes

Info:
- Climate change effects:
  - Warm ocean surface fuels hurricanes.
  - High moisture content in the air (warmer air can hold more moisture)
    - => Not more frequent BUT higher intensity, stronger wind speeds, more rainfall
- Sources:
  - https://science.nasa.gov/earth/climate-change/a-force-of-nature-hurricanes-in-a-changing-climate/
  - https://www.woodwellclimate.org/how-climate-change-is-affecting-hurricanes/
  - https://www.edf.org/climate/how-climate-change-makes-hurricanes-more-destructive

Data:
- HURDAT2 (https://www.nhc.noaa.gov/data/)
  - Atlantic (1851-2023) + Northeast and North Central Pacific (1949-2023).
  - Six-hourly information on the location, maximum winds, central pressure, and (beginning in 2004) size of all known tropical cyclones and subtropical cyclones.
  - CSV format, seems like a pain to clean (documentation).
  - The hurdat2parser or tropycal Python modules might make formatting this data more manageable.
- IBTrACS (https://www.ncei.noaa.gov/products/international-best-track-archive)
  - Most complete global collection of tropical cyclones.
  - CSV and Shapefile formats (documentation).
    - Shapefile formats useful for visualization purposes for report
  - The tropycal Python module also supports this data source or we can use this Python ibtracs API.