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Projecting Weather-Driven Power Outages across the Continental United States

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CLIMATE X

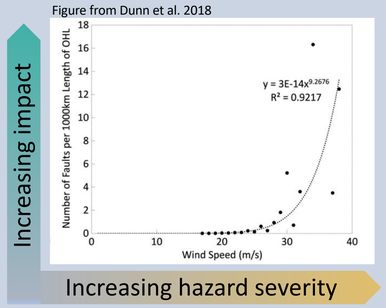
BACKGROUND

Weather is the number one cause of major power outages in the United States (Kenward & Raja 2014) (Mukherjee et al. 2018)

Wind is a common point of failure for transmission lines, from hazards including synoptic system sustained wind gusts, thunderstorm winds, downbursts, and tornadoes

This research builds off previous work, which quantifies limits of the power grid, to understand how weather-related outages will evolve under future climate scenarios and how these outages will impact the power grid's ability to meet demand

Figure from Dunn et al. 2018

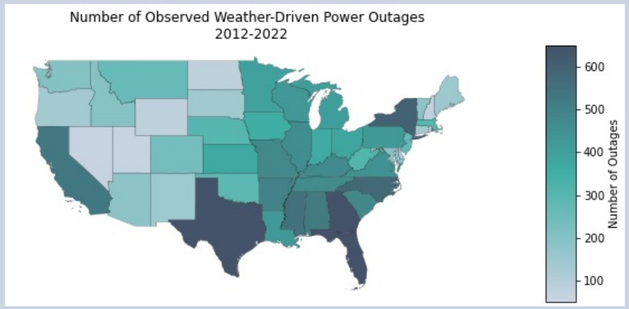


Fragility curve: measures the probability of reaching a certain damage state as a function of environmental change

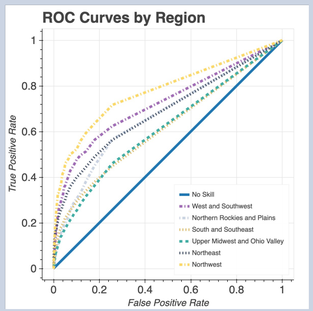
KEY QUESTIONS

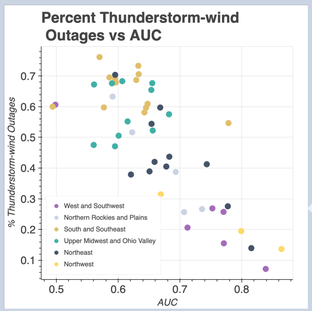
- How accurately can established fragility curves be applied to new locations in order to predict wind based transmission outages?
- How will climate change impact the locations and frequency of these outages?
- How will future weather-related outages impact the grid's ability to meet demand?

RESULTS



Largest number of observed weather-driven outages:
Texas (836), Georgia (721), Florida (710), and New York (601)





Receiver operating characteristic curve (ROC curve): how well a classification model performs; greater area under the curve (AUC) indicates a more accurate classifier

Fragility curve predicted more accurately in the **Northwest** and **South + Southwest** (AUC: 0.778, 0.724) than the **Upper Midwest + Ohio Valley** and **South + Southeast** (0.616, 0.617)

States with a higher percentage of thunderstorm-wind outages had ROC curves with less skill than states with a lower percentage of thunderstorm-wind outages (corr: -0.790)

KEY TAKEAWAYS

1. The Dunn 2018 curve was able to predict wind transmission outages in the US with more skill than a random classifier
2. Localized thunderstorm-winds may not be reflected in ERA5 wind data, leading to lower skill when predicting weather-driven outages

NEXT STEPS

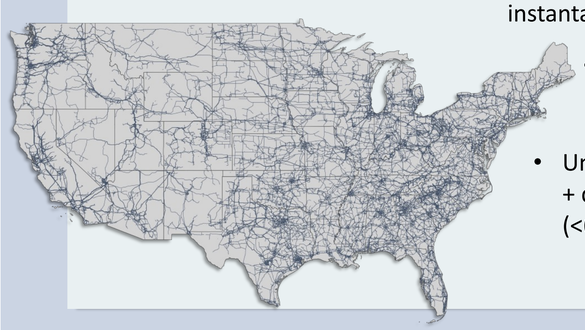
- Incorporate convective parameters into the prediction process to better account for thunderstorm-wind outages
- Use regional climate model wind outputs to project the future locations of weather-driven power outages

METHODS

Predicted Outages

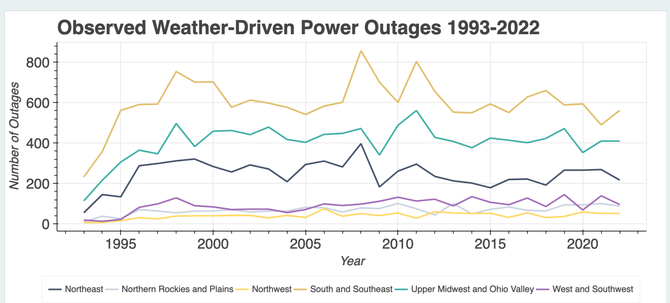
1 Apply fragility curve to historic wind data to estimate past outages

- Maximum daily ERA5 instantaneous wind gust
- Scaled to state level
- Underground lines + distribution lines (<69 kV) removed



Observed Outages

2 Filter National Oceanic and Atmospheric Administration (NOAA) storm events database by instances of power outage reports



Comparison

3 Use threshold tuning to determine the number of *predicted* outages needed to reach an *observed* outage in order to compare results

- **False negatives**: fragility curve did not predict an observed outage
- **False positives**: fragility curve predicted an outage that was not observed