

# EXTREME WEATHER DRIVERS DURING POWER OUTAGES IN THE UNITED STATES



Nicole D. Jackson, Ph.D.  
Climate Change Security Center

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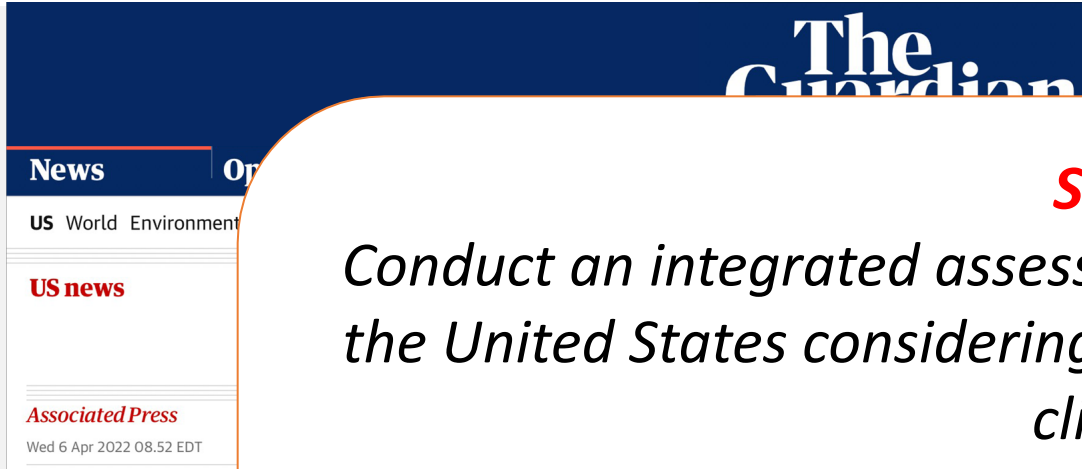
- Jean-Paul Watson



- Ali Ghassemian

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# Large-scale power outages often co-occur with severe weather events in the United States

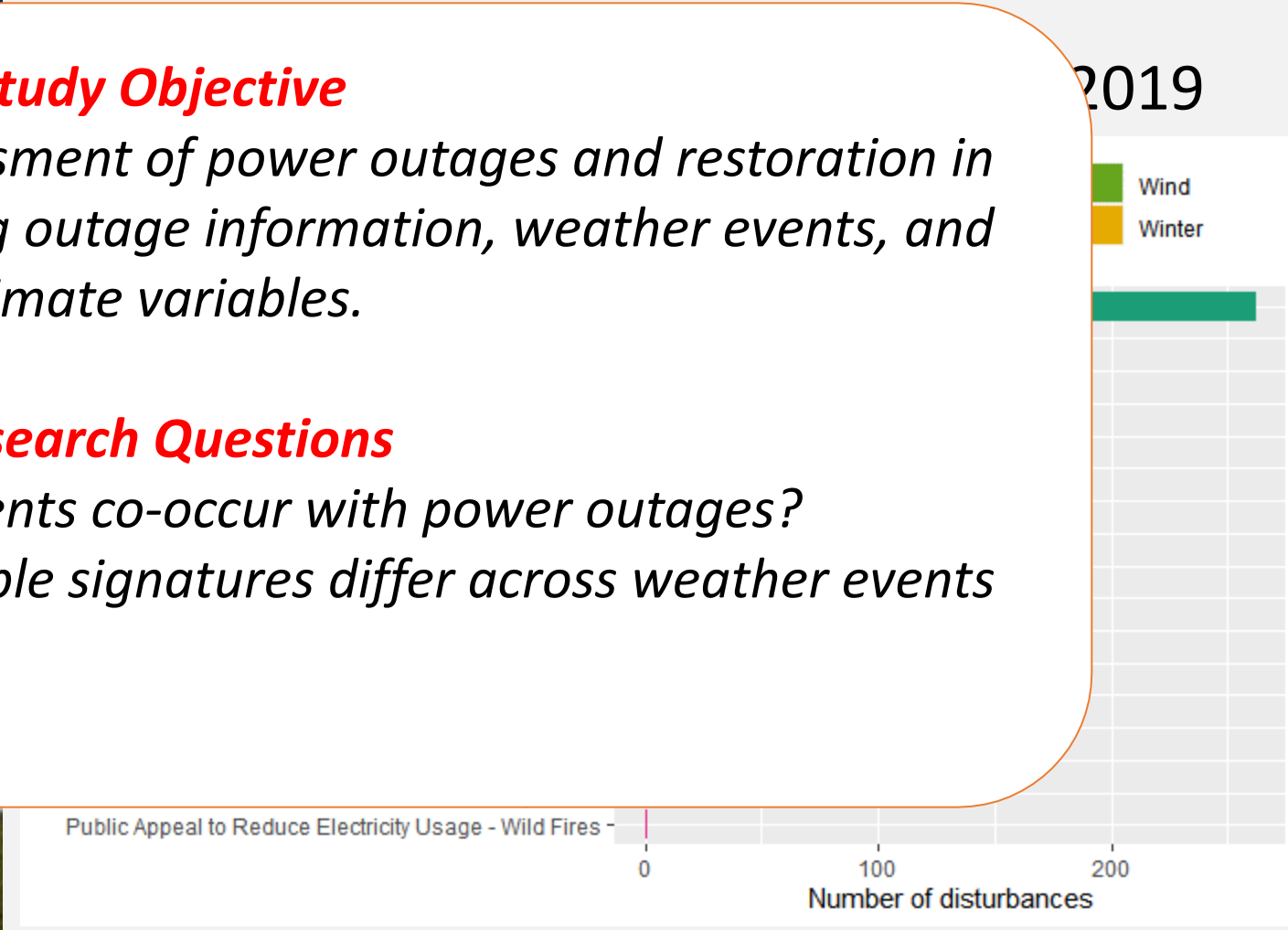
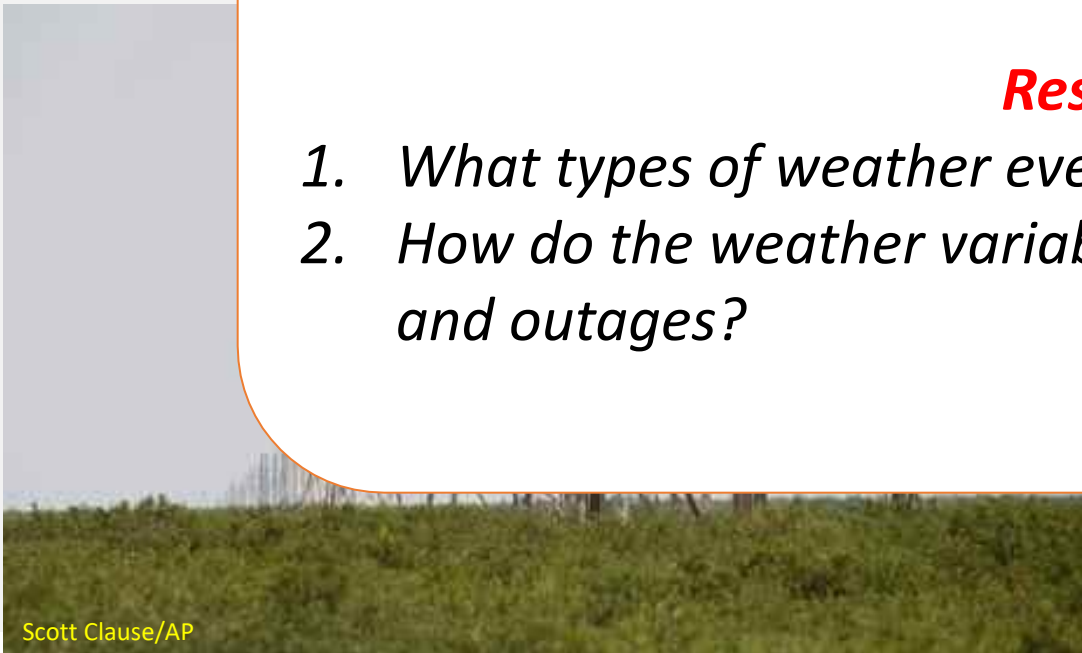


## **Study Objective**

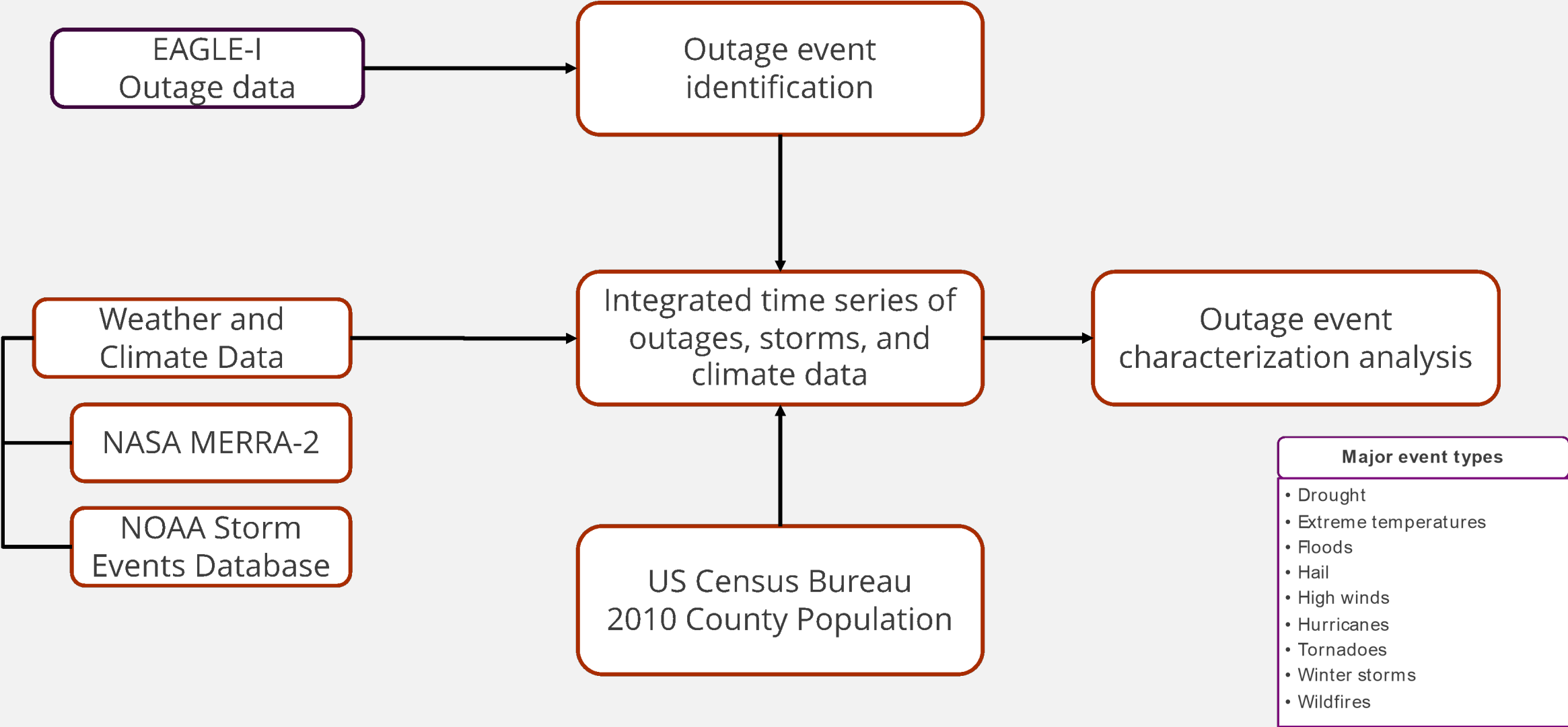
*Conduct an integrated assessment of power outages and restoration in the United States considering outage information, weather events, and climate variables.*

## **Research Questions**

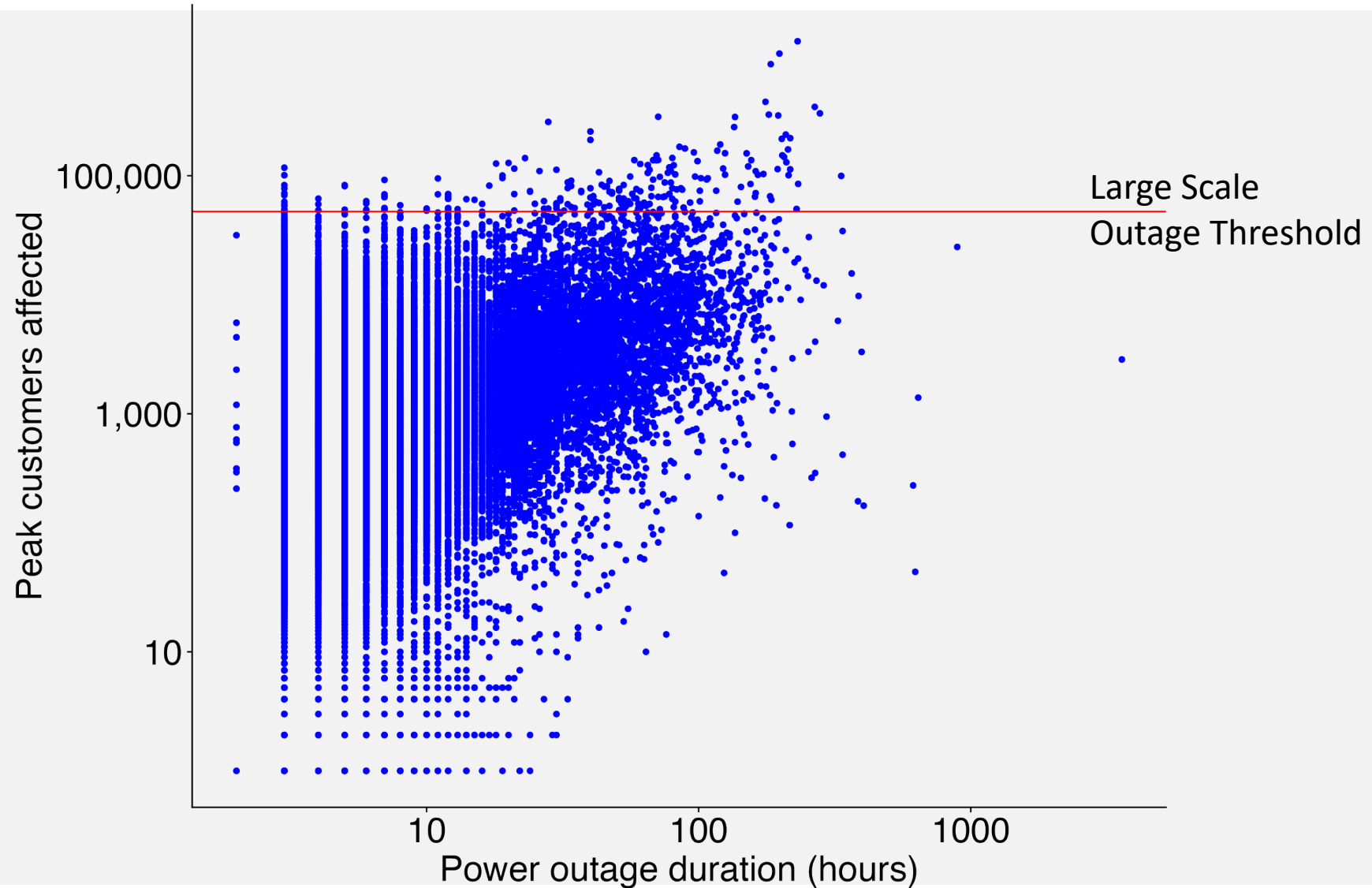
- 1. What types of weather events co-occur with power outages?*
- 2. How do the weather variable signatures differ across weather events and outages?*



# Integrated assessment relies on multiple datasets to characterize weather during outages and restorations



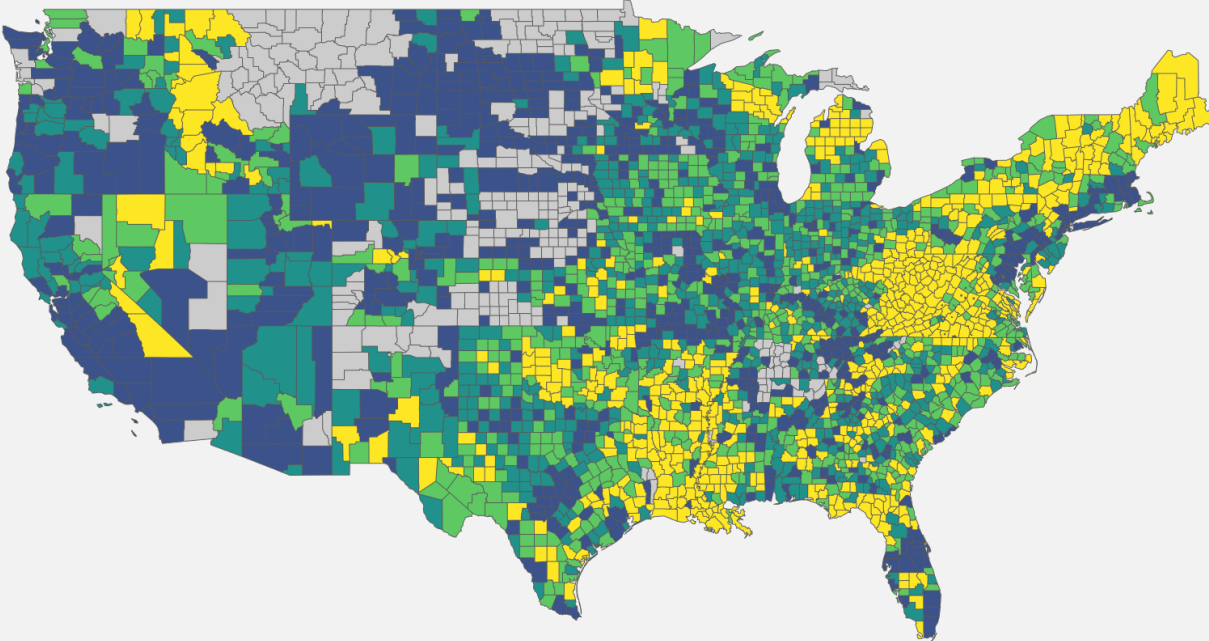
# Nearly 158,000 county-level power outage events occurred between November 2014 and October 2019



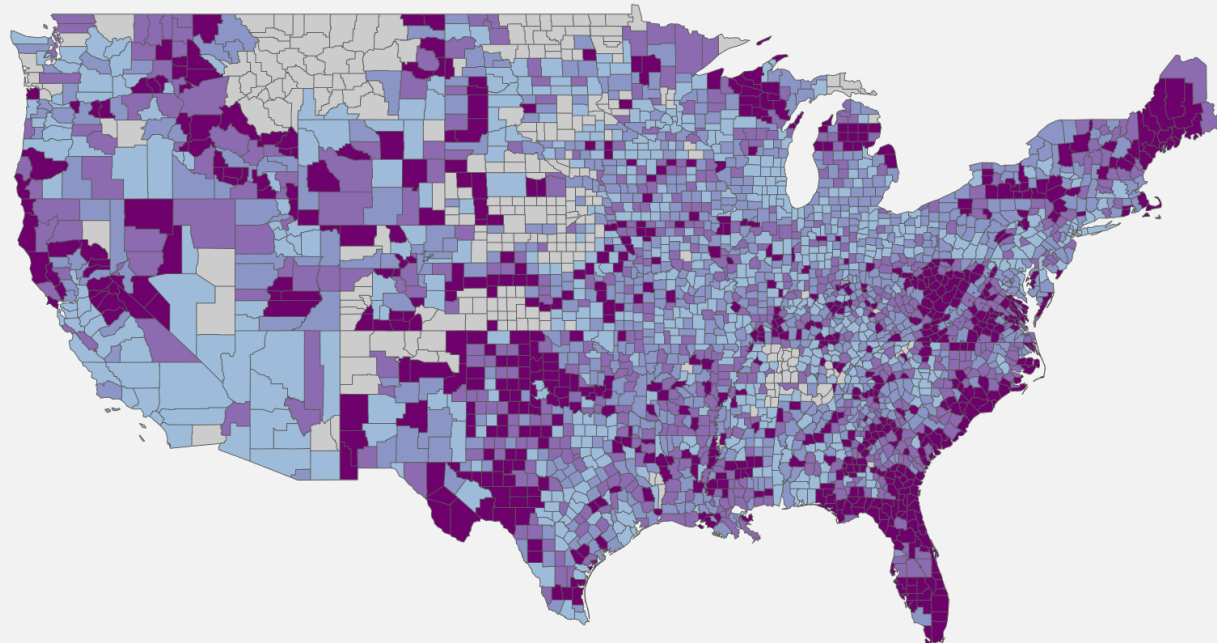
Note: data plotted on log-log scale

# Observed spatial pattern of power outage events for November 2014 – October 2019 depends on metric

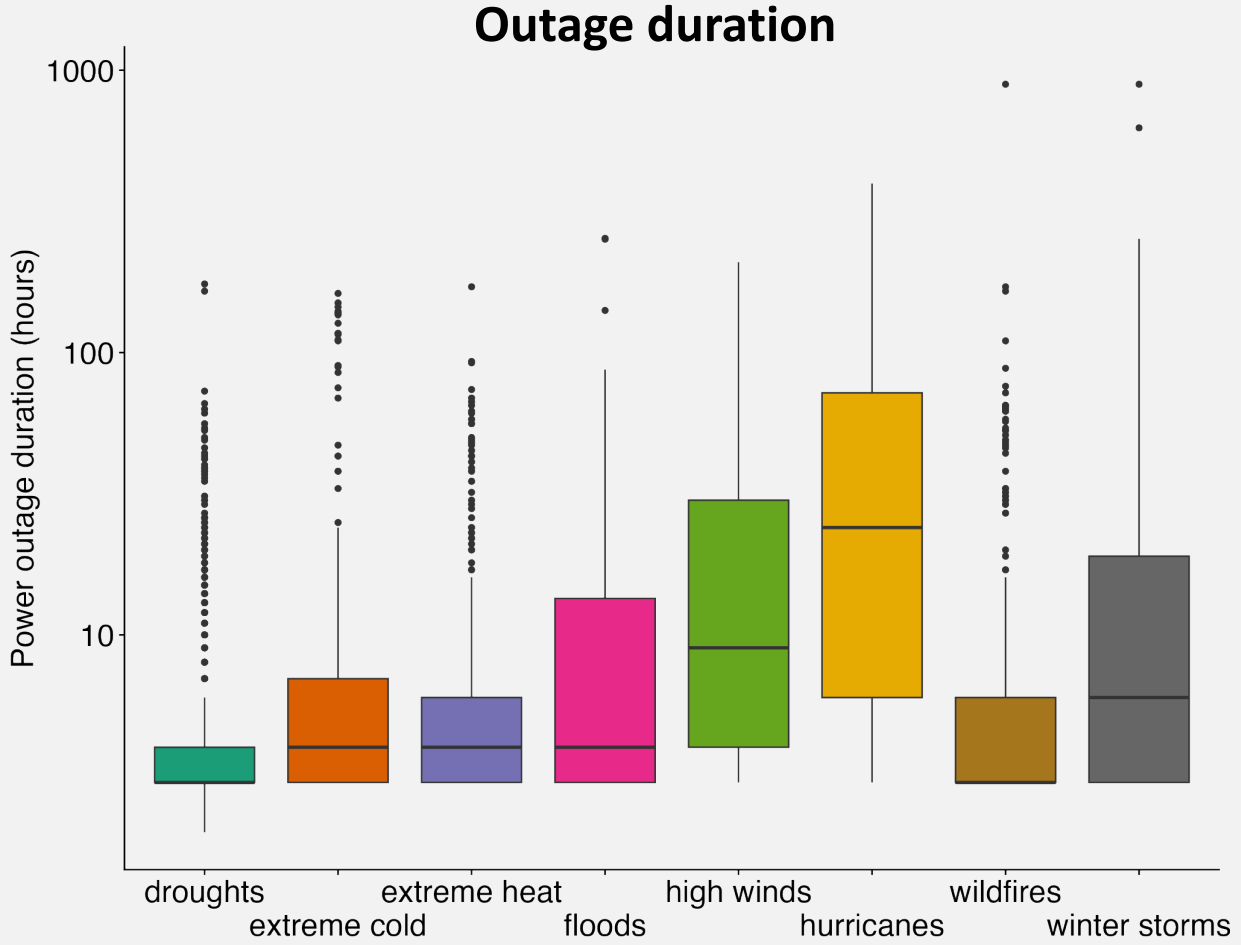
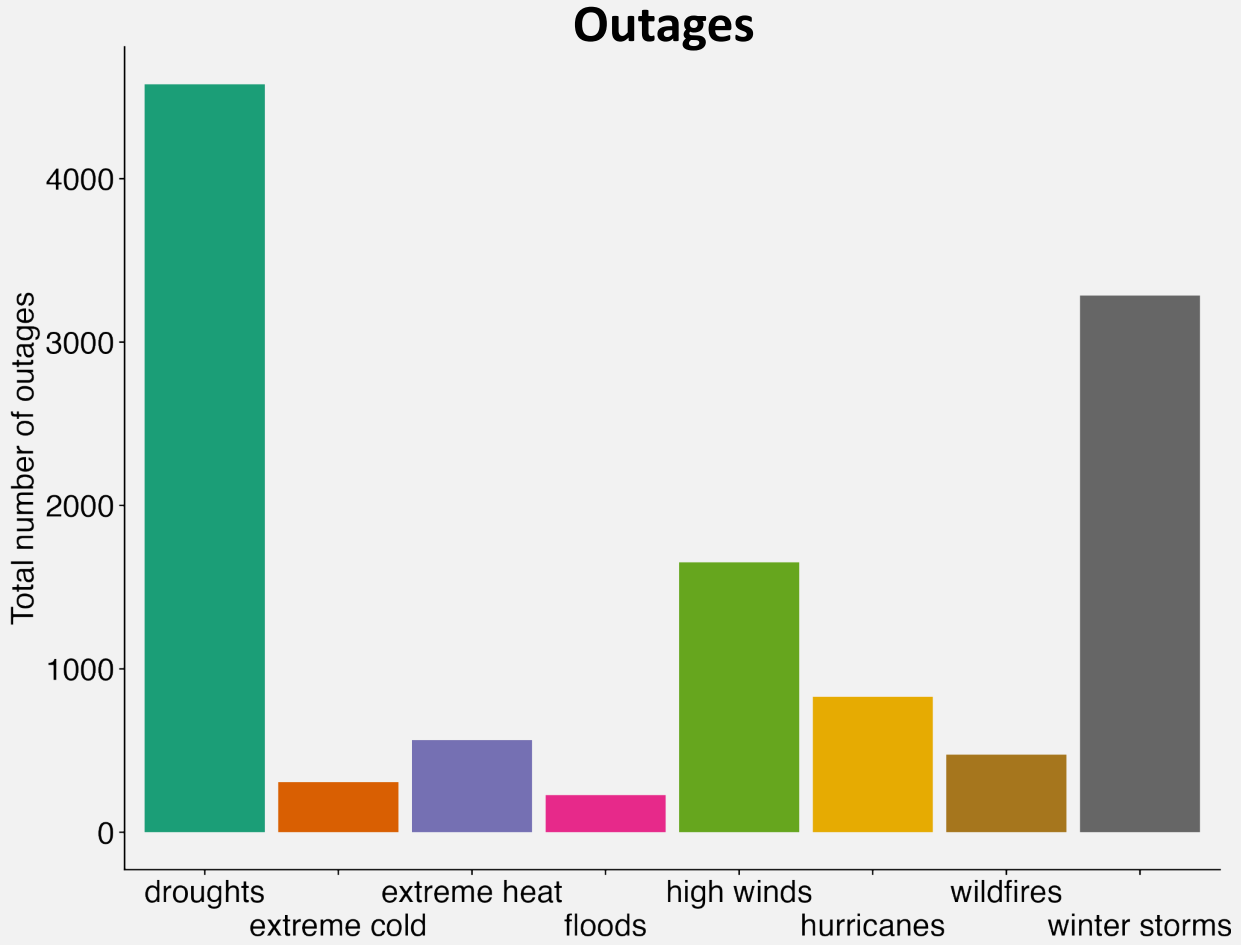
Number of outages



Peak customers affected (%)



# Droughts, winter storms co-occur most often with outages but hurricanes have longest durations



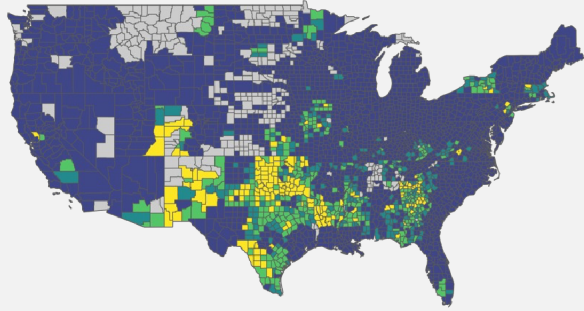


# Regional variations in co-occurrence of power outages with grouped NOAA storm event categories

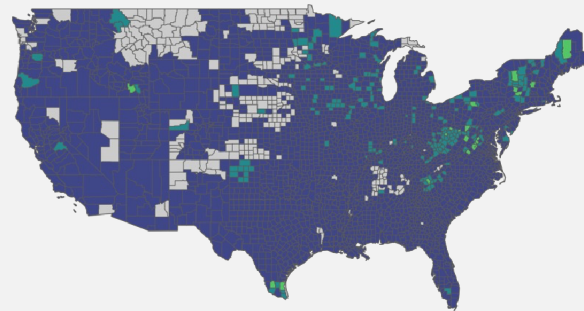
Number of outages co-occurring with storm event



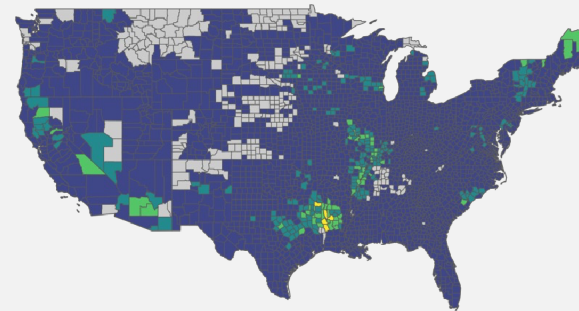
**Drought**



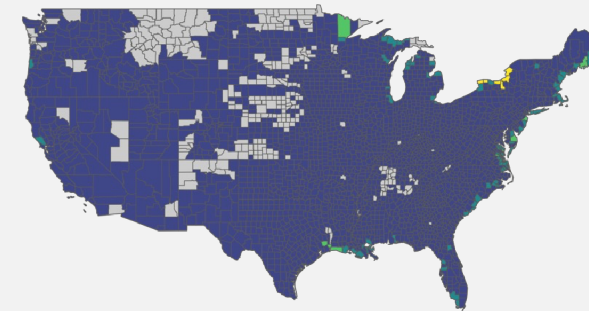
**Extreme Cold**



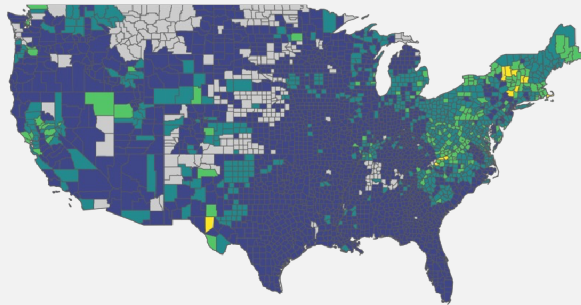
**Extreme Heat**



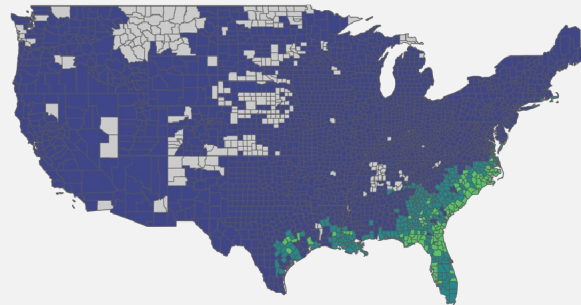
**Floods**



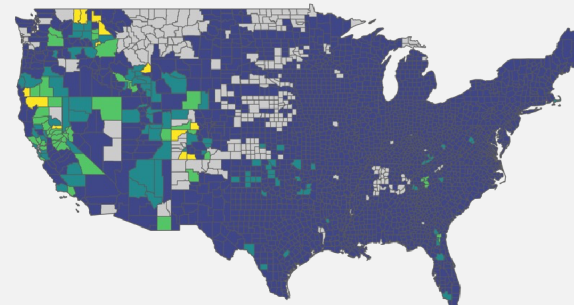
**High Winds**



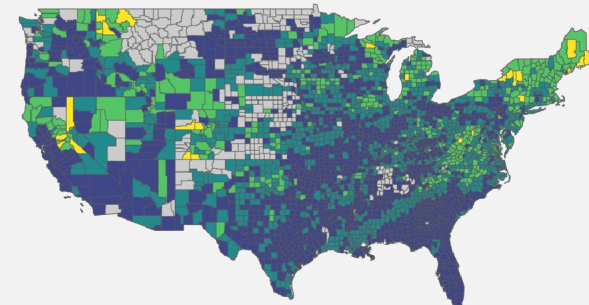
**Hurricanes**



**Wildfires**

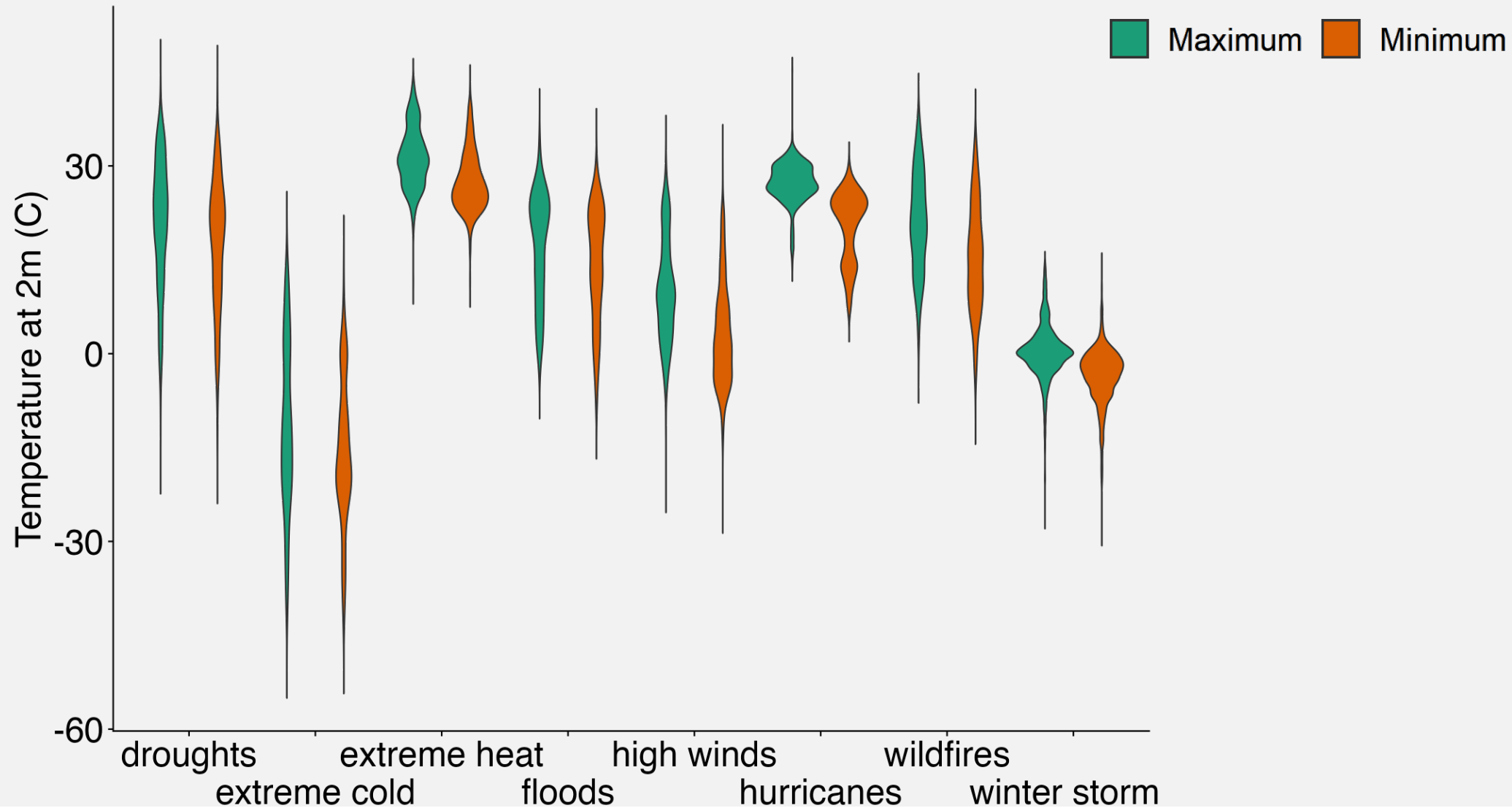


**Winter Storms**

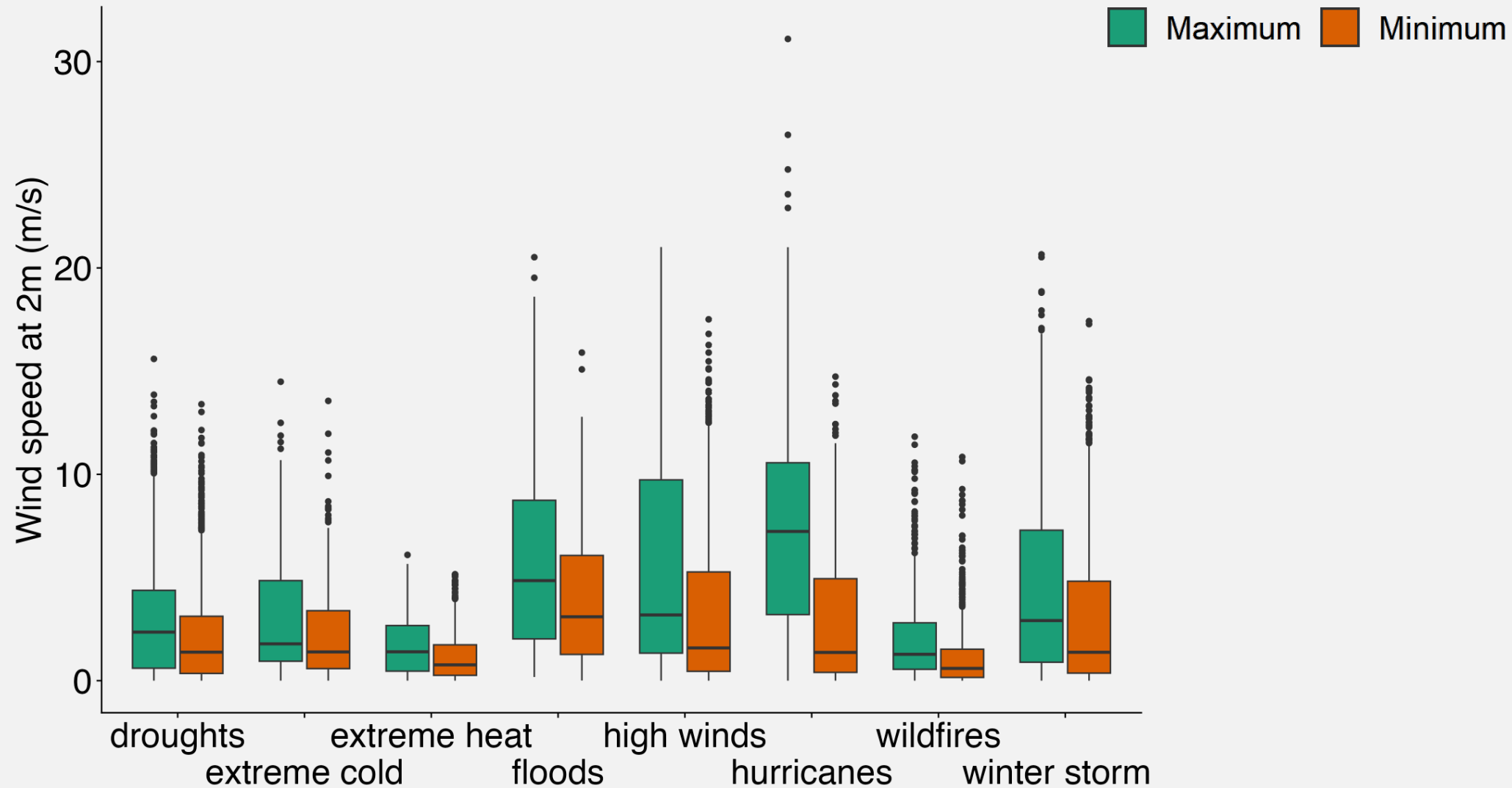




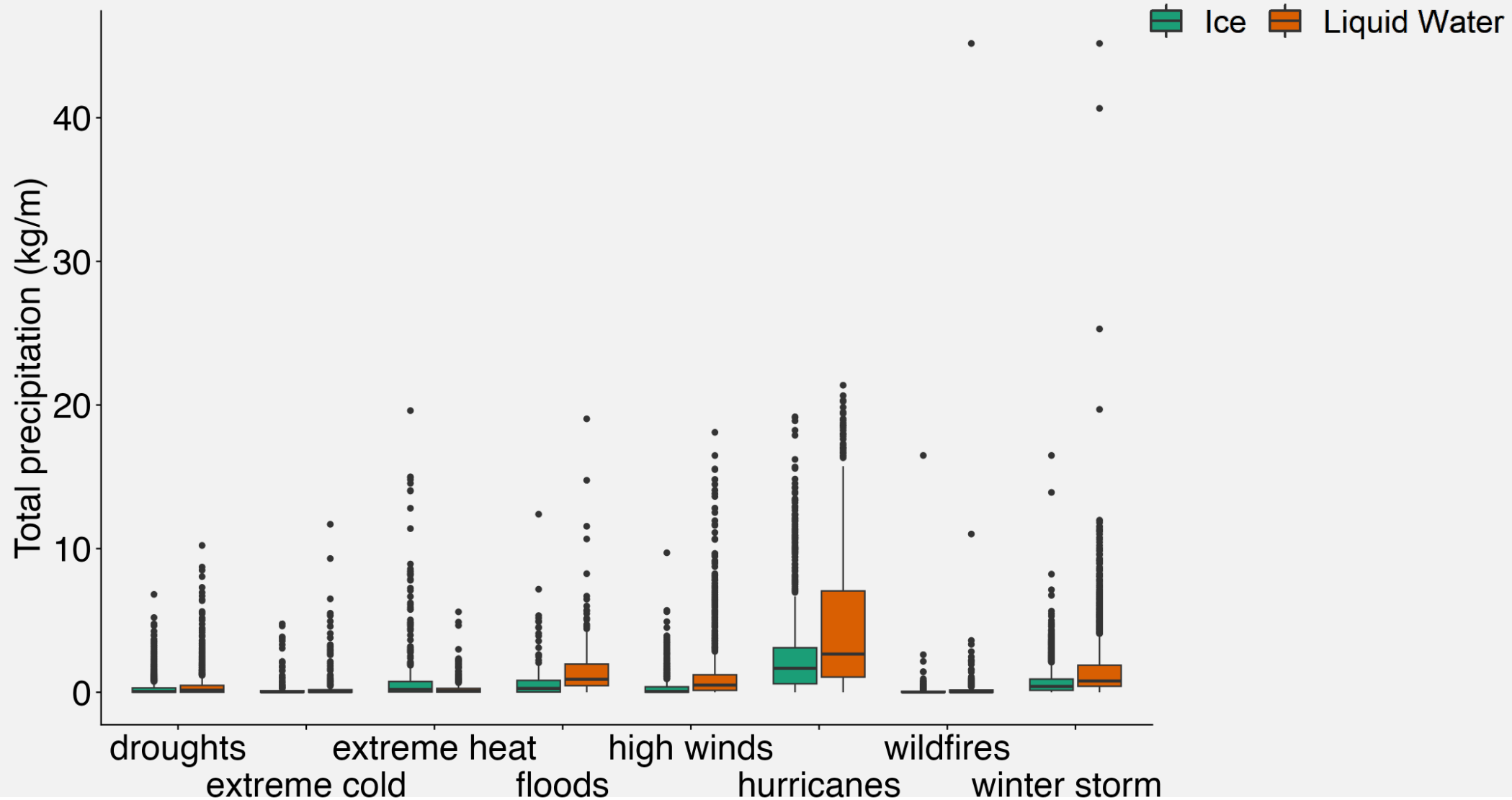
# Maximum and minimum temperatures demonstrate wide variability across storm event types



# Hurricanes have highest recorded wind speeds during outages but other events have long wind speed tails



# Hurricanes, winter storms, and floods show highest levels of precipitation during outages



# In conclusion, limited overlap between outages and NOAA storm events with long tails in weather variables

- Data fusion of county-level outage data, storm events information, and re-analysis climate data
- Limited co-occurrence of outages with official storm events
- Observed variability in temperatures, wind speed, and precipitation across storm events during outages

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## Future work directions

- Historical climate variables extremes
- Predictive model of event-specific power restoration

