1. BACKGROUND AND MOTIVATION

- Almost $2.57 trillion economic loss due to weather-related events.
- Major reason of socioeconomic losses → high-impact low-probability events.
- 90% of those events are hurricanes → severe storms and tropical cyclones.
- Challenges → spatiotemporal (varying in space and in time) impact and uncertainty due to hurricanes and storm surges.
- Need of a framework to analyze the uncertain impacts of these events to proactively plan the available resources.

2. HURRICANE MODELING

- Almost $2.57 trillion economic loss due to weather-related events.
- Major reason of socioeconomic losses → high-impact low-probability events.
- 90% of those events are hurricanes → severe storms and tropical cyclones.
- Challenges → spatiotemporal (varying in space and in time) impact and uncertainty due to hurricanes and storm surges.
- Need of a framework to analyze the uncertain impacts of these events to proactively plan the available resources.

The Costliest Hurricanes to Insurers

- Highest insured losses caused by hurricanes in the United States (in billion U.S. dollars)
- When occurred → In 2022 dollars

- Hurricane Katrina: $207 billion
- Hurricane Sandy: $65 billion
- Hurricane Ike: $29 billion
- Hurricane Harvey: $125 billion
- Hurricane Michael: $20 billion
- Hurricane Andrew: $26.5 billion

The map shows the distribution of insured losses caused by hurricanes in the United States, with Hurricane Katrina being the costliest event.

3. STORM SURGE MODELING

- Storm surge modeling approach:
  - Monte-Carlo simulation to identify failed lines.
  - Evaluating line status for next trial.
  - Calculating time-varying loss.
  - Identifying vulnerable areas and providing hardening techniques to prevent damage or accelerate restoration.

4. HURRICANE, STORM SURGE GENERATION AND IMPACT ASSESSMENT

- Hurricane within cone of uncertainty
- Storm surges MEOWs in SLOSH basins
- Power grid model
- Line fragility
- Substation fragility
- Monte-Carlo simulation to identify failed lines
- Calculating time-varying loss
- Power grid fragility

5. SPATIOTEMPORAL HURRICANE SCENARIOS

- Time-varying impact of hurricane & flood
- Monte-Carlo simulation converges in 800 trials.
- The inundation scenarios for each B and each hurricane tracks ζ are equally probable.
- Loss is high around landfall and saturates when moving inland.

6. TIME-VARYING IMPACT OF HURRICANE & FLOOD

- Calculating time-varying loss

7. CONCLUSION AND FUTURE WORK

- Simulations showed that storm surges could flood the coastal substations to incur an additional loss in the system.
- The suggested method can assist system operators in order to identify vulnerable areas and provide hardening techniques to prevent certain damage or accelerate restoration.
- A future extension of this research is to create a risk-map by identifying vulnerable locations and power system components based on hurricane and storm surge disasters for a power grid.

REFERENCES

4. NOAA, Sea, Lake, & Overland Surges from Hurricanes (SLOSH)