

MODELING TROPICAL CYCLONE RAINFALL



An open-source climatology software tool to estimate extreme rainfall driven by tropical cyclones along the U.S. Coasts

WHY NOW?

Tropical cyclones, or hurricanes, are among the most destructive natural hazards, with much of their destruction stemming from intense rainfall and flooding. Accurately estimating rainfall induced by tropical cyclones is of critical importance for assessing current and future weather risks. This study addresses the urgent need for precise rainfall modeling to help protect vulnerable communities and infrastructure.

WHAT WE DID

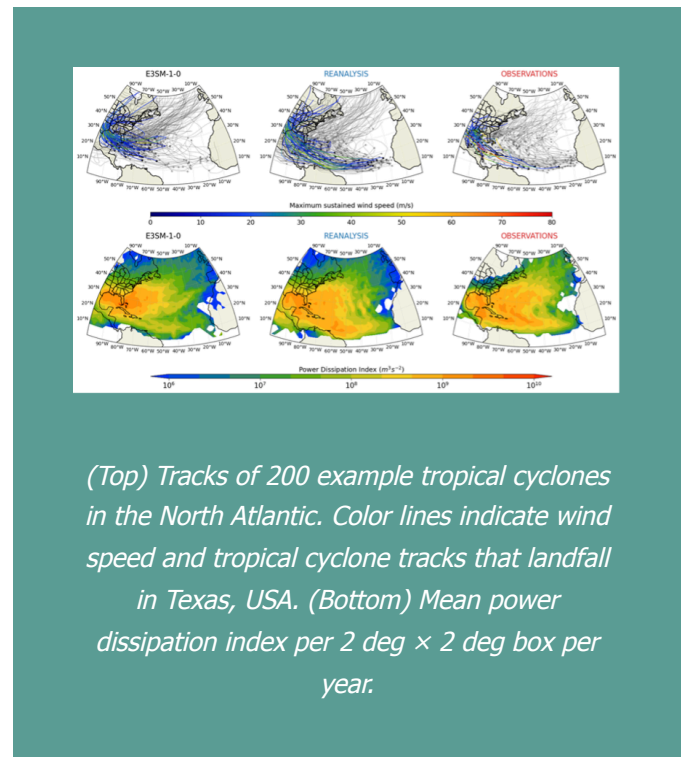
The SETx-UIFL developed a novel, user-friendly tool designed for multiscale analysis of tropical cyclone-driven rainfall. The core methodology uses tropical cyclone intensity modeling to generate artificial hurricane tracks from large Earth system models that fit the weather-patterns and conditions of Southeast Texas. This approach offers a highly efficient alternative to traditional models, enabling the production of statistically robust rainfall probability distributions essential for precise risk assessment.

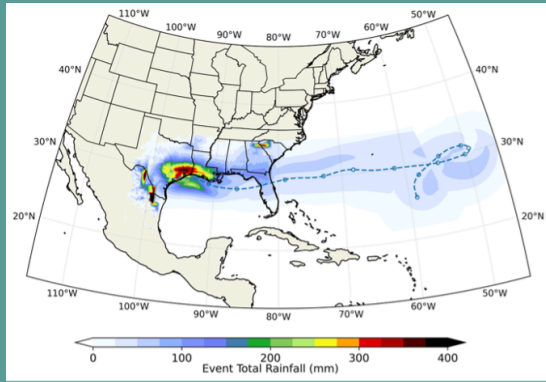
FINDINGS

This study introduces a computationally efficient method for simulating tropical cyclone rainfall, overcoming the bottlenecks of traditional Earth system model downscaling. Key results include:

- Large-Scale Ensemble Generation:** The model can generate large numbers (~1,000s–10,000s) of synthetic tropical cyclones, enabling the estimation of statistically robust rainfall distributions.
- High Efficiency:** This work significantly reduces the computational cost of tropical cyclone rainfall downscaling.
- Scalable Risk Assessment:** This framework offers a practical solution for quantifying robust rainfall distributions, directly supporting flood risk analysis and climate impact assessments.

Using DOE's E3SM model outputs, our model shows that hurricane activity is likely to increase in SETx, thereby elevating the risk of coastal and inland flooding, storm surge impacts, infrastructure damage, and associated economic losses.





Spatial distribution of total rainfall generated for a particular tropical cyclone track that makes landfall on Texas, USA.

MORE ABOUT SETX-UIFL

The Southeast Texas Urban Integrated Field Lab (SETx-UIFL) is one of four projects funded in 2022 by the U.S. Department of Energy to study how climate, environment, and urban changes affect cities. A team of over 80 researchers from UT, Lamar University, Texas A&M, Prairie View A&M, Oak Ridge National Lab, and Los Alamos National Lab has collected data and conducted modeling across hazards including flooding, hurricanes, heat stress, and air quality. Our Why: Southeast Texas faces numerous hazards, yet smaller communities like this one have often felt forgotten compared to larger cities. The SETx-UIFL was designed to explore the complex dynamics of disaster vulnerability for this economically and culturally vibrant region. We believe Southeast Texas is a bellwether for the entire Gulf Coast, and an exemplar for strategies that protect people and places. We hope this effort supports your path toward lasting resilience.



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