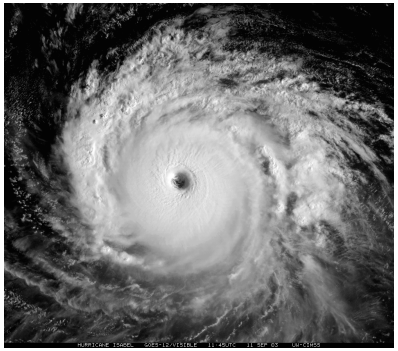


Stony Brook University

Quantifying the contribution of various storm-types to extreme precipitation

Kevin A. Reed

School of Marine and Atmospheric Sciences

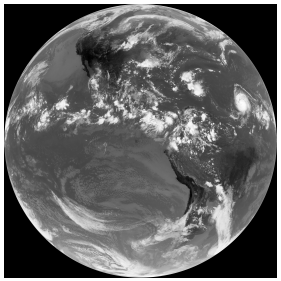
Stony Brook University, Stony Brook, New York

Collaborators:

Erica Bower[1], Alyssa M. Stansfield[1], John Landy[1], and Angeline Pendergrass[2]

[1]Stony Brook University, Stony Brook, NY

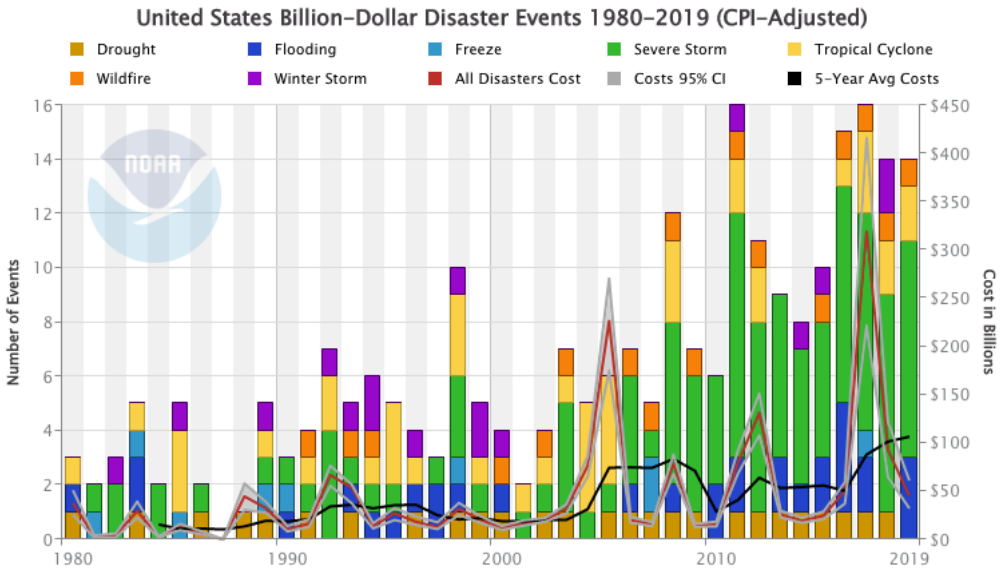
[2]National Center for Atmospheric Research, Boulder, CO



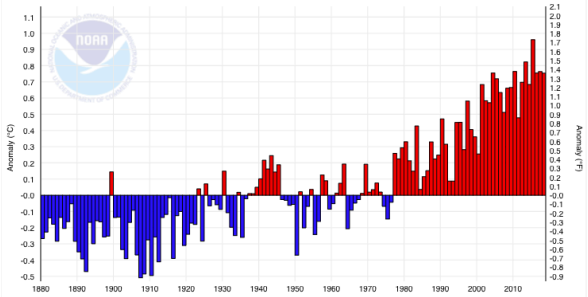
Motivation

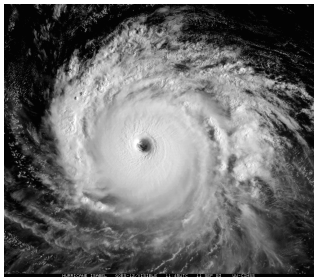
U.S. National Climate Assessment:

"*Changes in **extreme weather events** are the primary way that most people experience climate change. Human-induced climate change has already increased the number and strength of some of these extreme events.*"



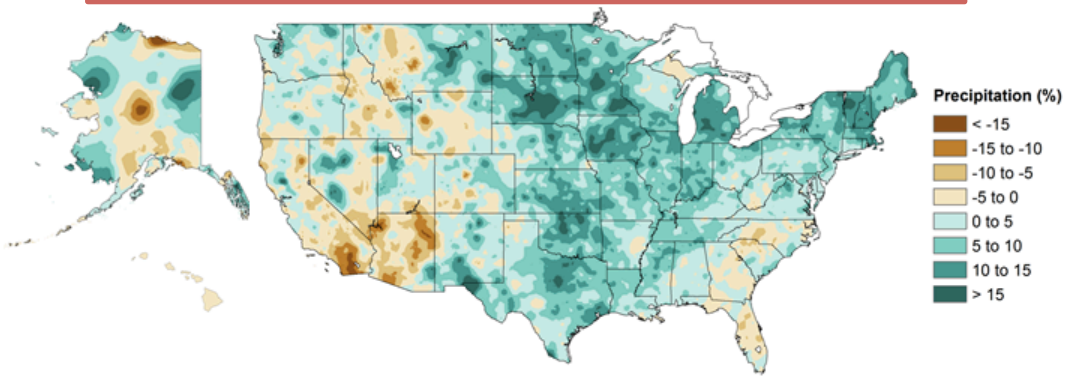
Increasing Surface Temperature

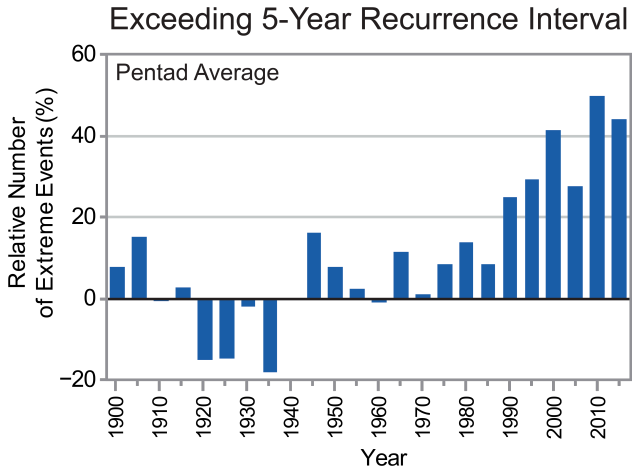




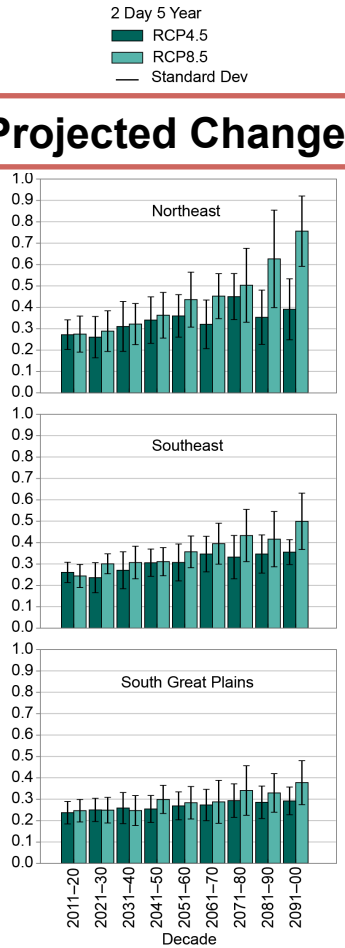
Changes in Rainfall

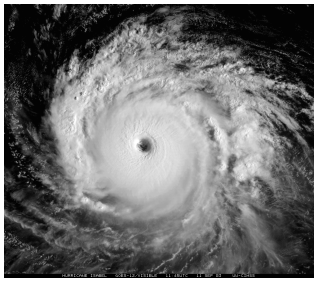
Historical Changes Regionally





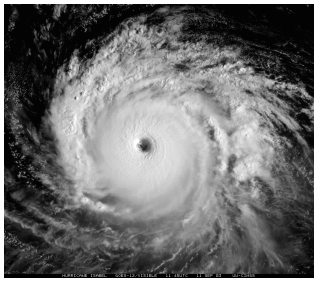
Projected Changes





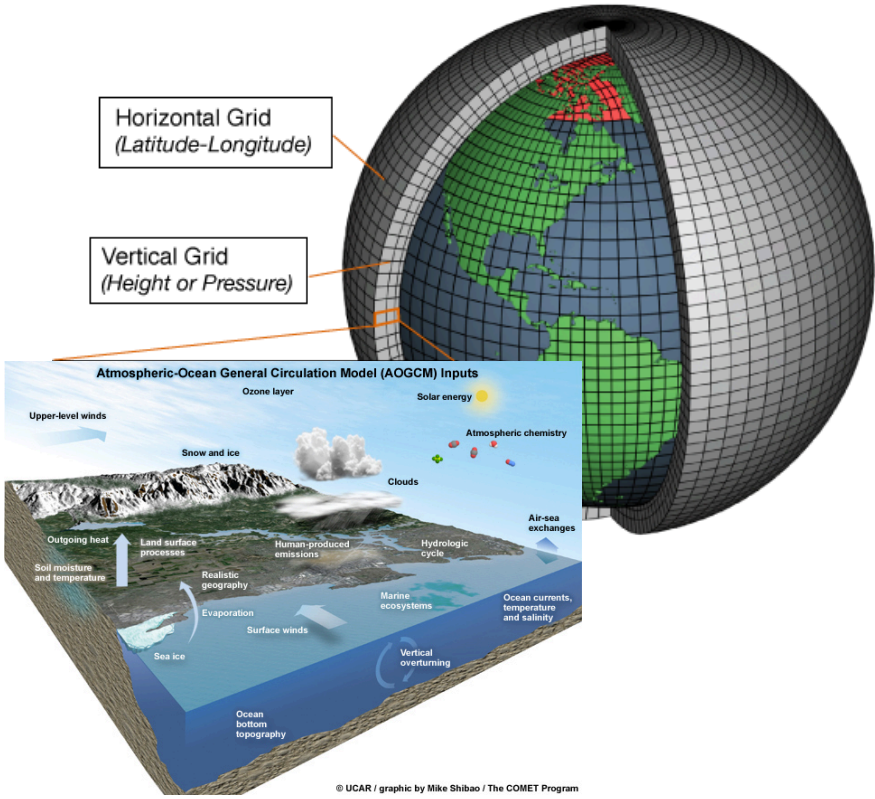
Motivation

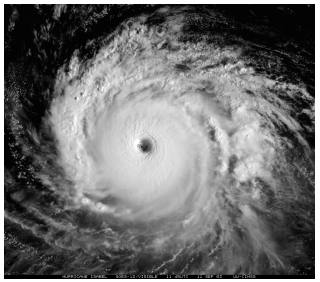
- We are entering an era where the numerical tools typically used to assess **long-term climate change** are approaching those now used for **short-term weather prediction**.
- Advanced climate modeling has improved our ability to investigate trends in **extreme weather events** and to project **regional impacts** of climate change using a **hazard approach**.
- *But*, we need **new tools and datasets** to evaluate these climate models.



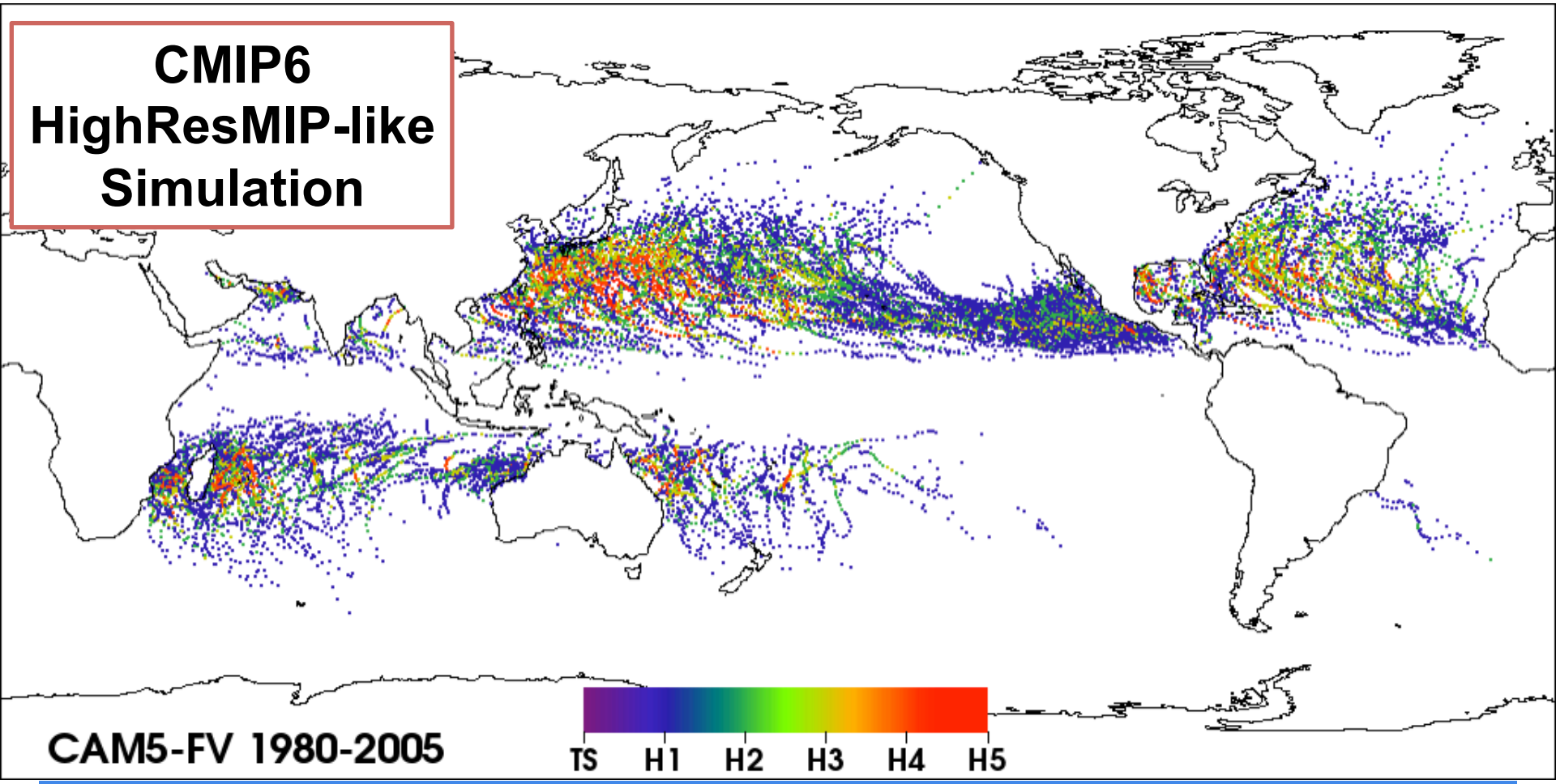
Model Approach

- National Center for Atmospheric Research's (NCAR) Community Atmosphere Model version 5 (CAM 5).
- Performed with 30 vertical levels is used at the horizontal resolutions of ~25 km.
- Full CAM 5 physics with Atmospheric Model Intercomparison Project (AMIP) protocols (with prescribed aerosol forcing).
- Observed ozone, CO_2, solar forcing, etc. for 1980-2015.
- RCP settings for future scenarios 2070-2100.
- Individual storms are tracked using TempestExtremes (github.com/ClimateGlobalChange/tempestextremes)

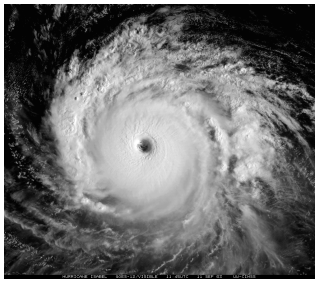




CAM5 at ~25 km Storm Tracks

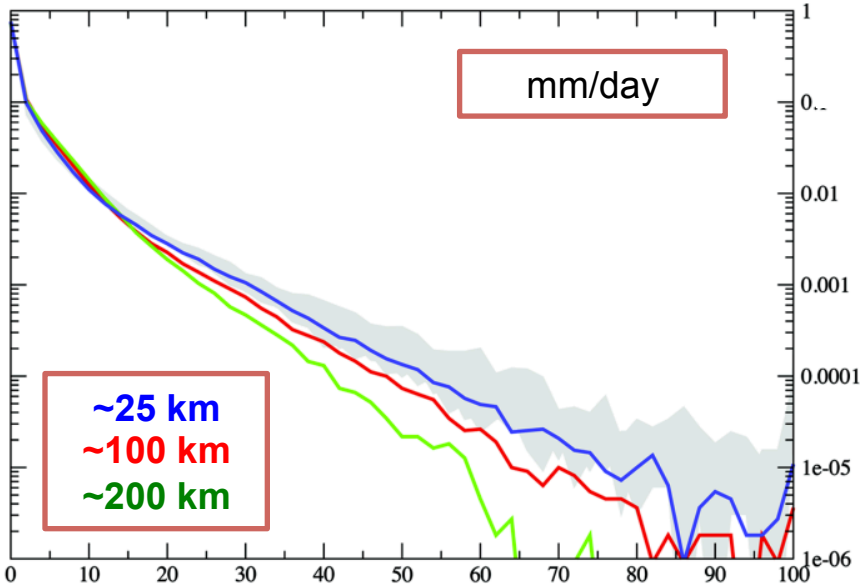


[Wehner et al. 2014, JAMES]

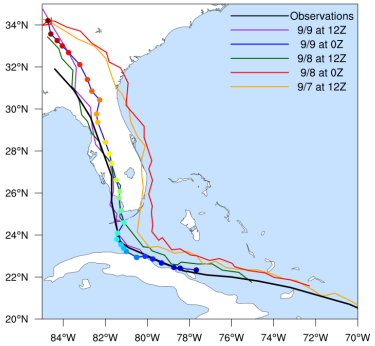


Observed vs. CAM5 US Precipitation Distribution

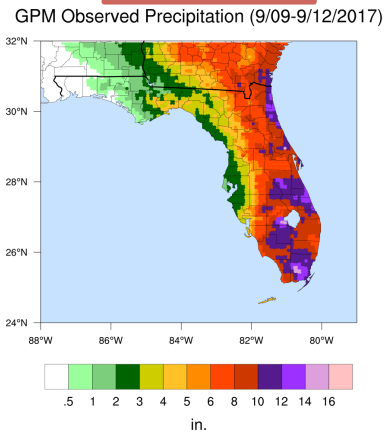
Full Probability Distribution Function for US:

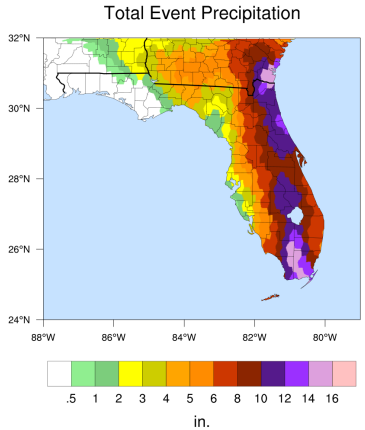


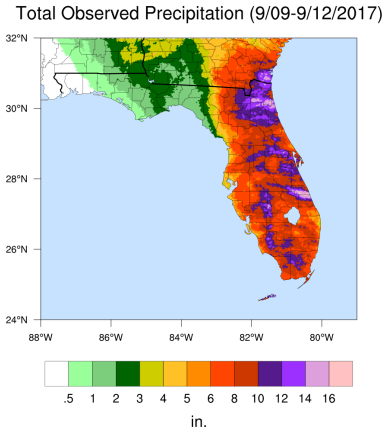
CAM5

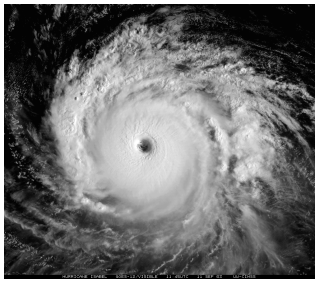


Obs.

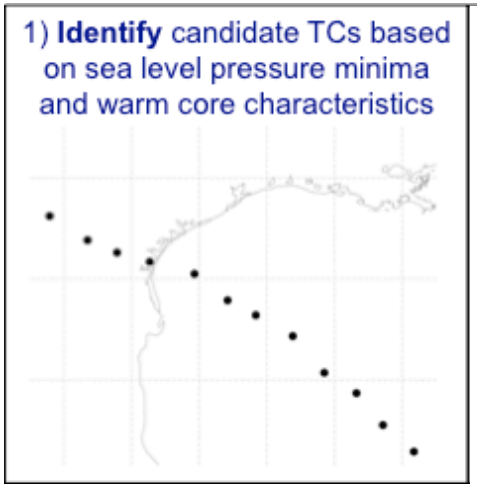


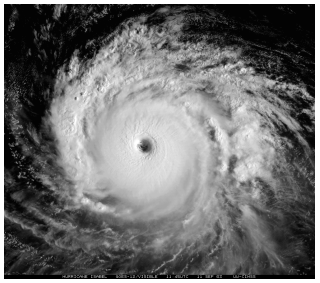




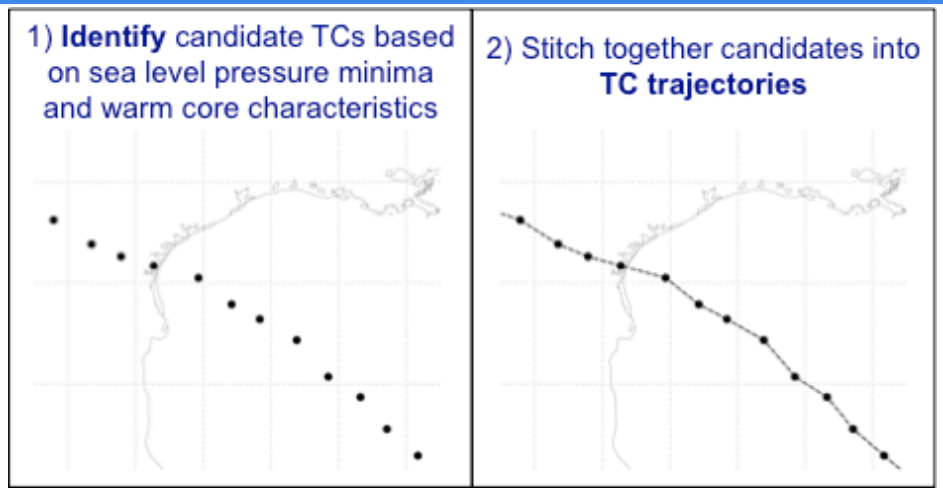


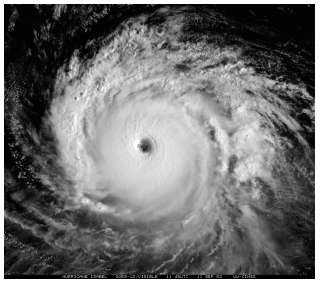
Building TC Rainfall Metric in TempestExtremes



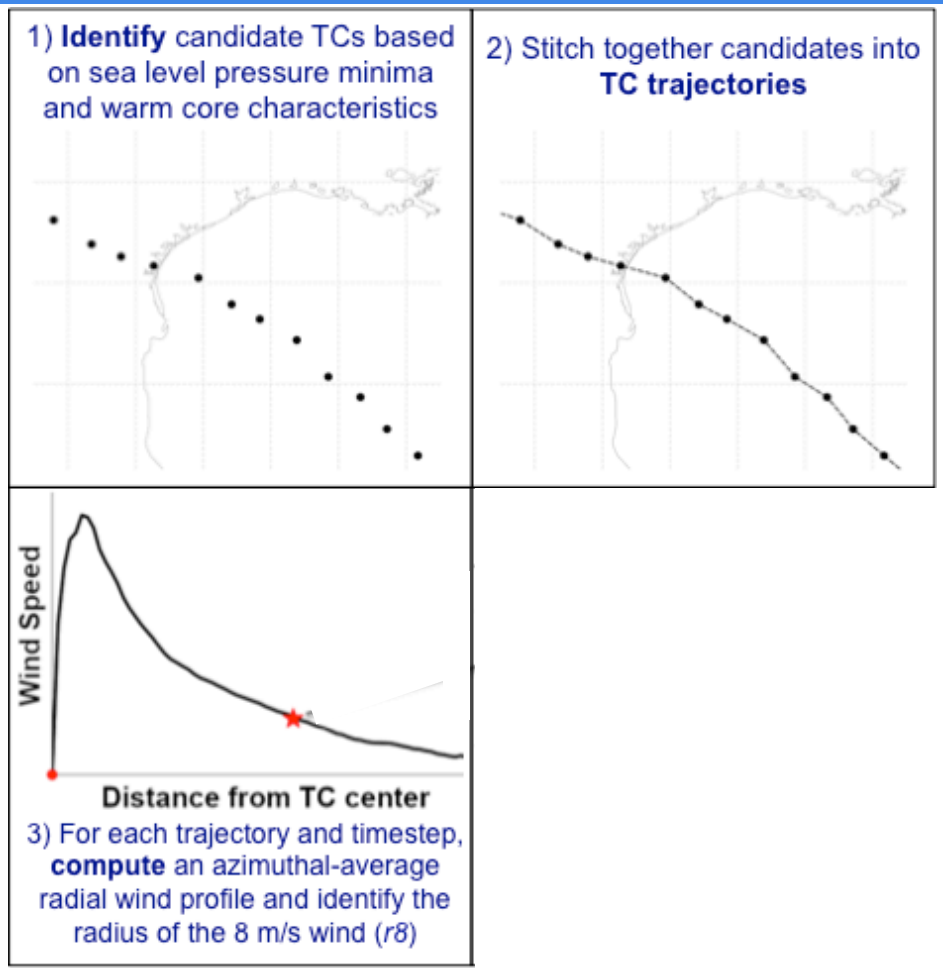


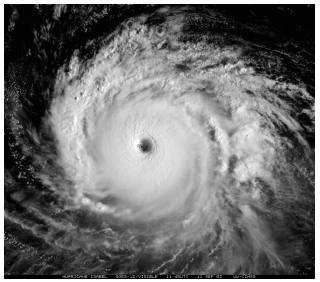
Building TC Rainfall Metric in TempestExtremes



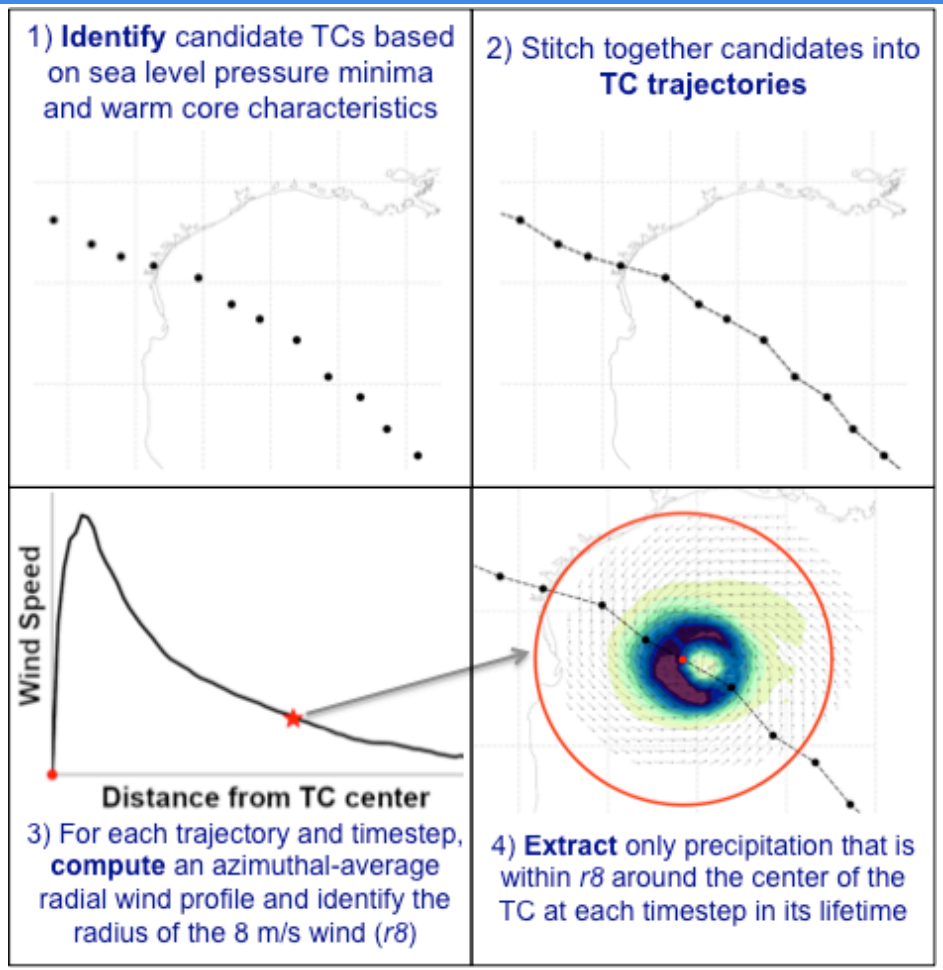


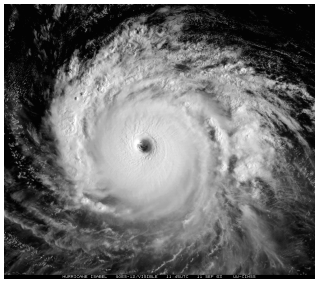
Building TC Rainfall Metric in TempestExtremes





Building TC Rainfall Metric in TempestExtremes



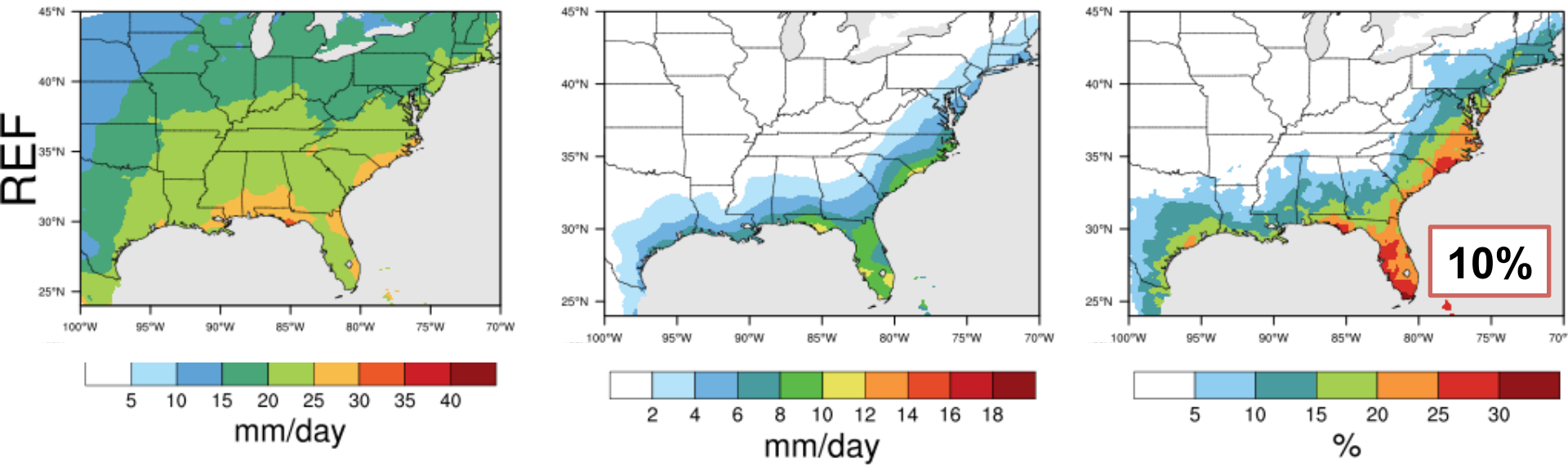


Exploring TC Extreme Precip.: CAM5 – High-Res ~25 km

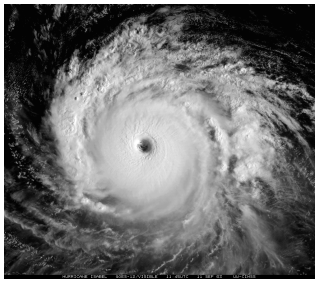
Annual Maximum 5-day Accumulated Precipitation (Rx5day)

TC-contributed Rx5day

% of Rx5day Events from TCs

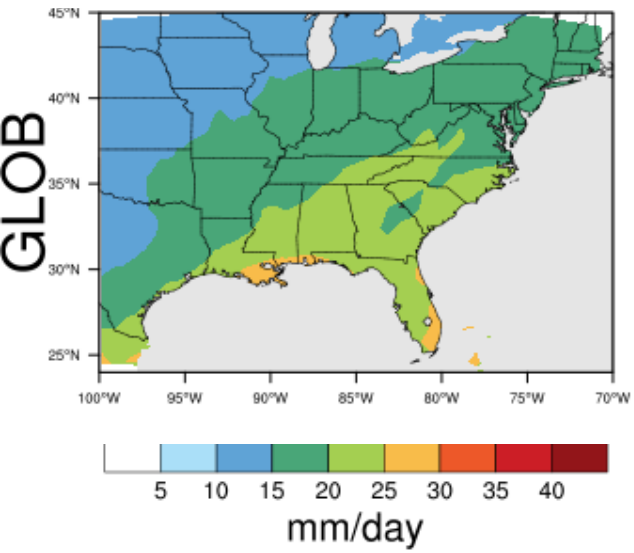


Tropical cyclone **contribute to extreme precipitation near coastlines**.

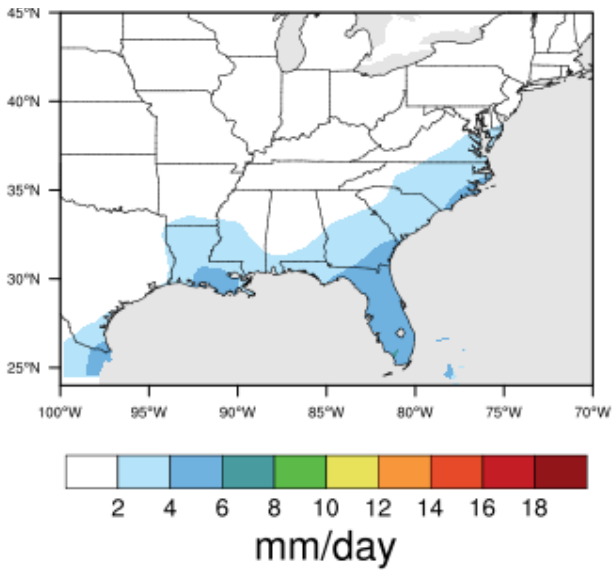


Exploring TC Extreme Precip.: CAM5 – Standard ~100 km

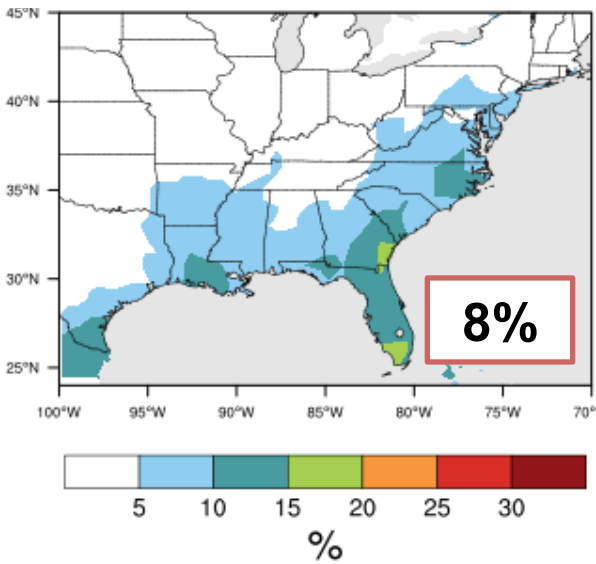
Annual Maximum 5-day Accumulated Precipitation (Rx5day)



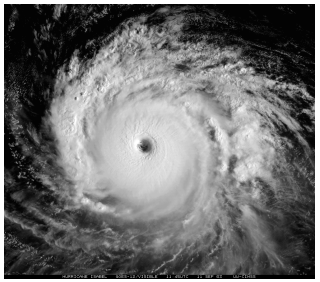
TC-contributed Rx5day



% of Rx5day Events from TCs



And are significantly lower at **conventional climate model** resolution.

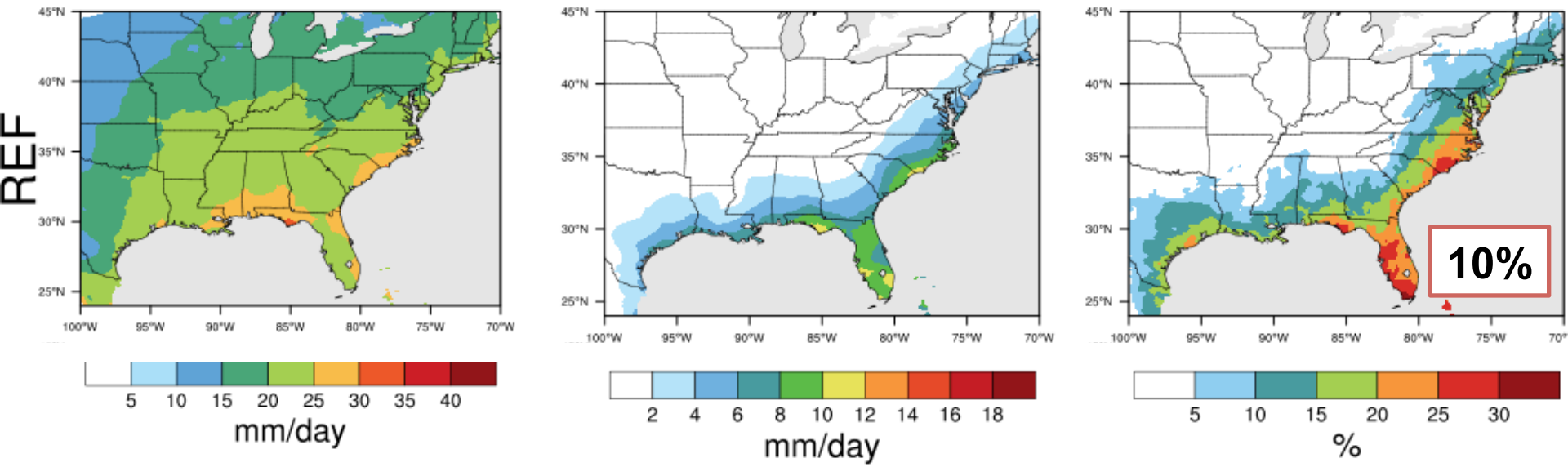


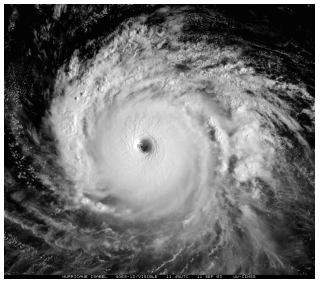
Exploring TC Extreme Precip.: CAM5 – High-Res ~25 km

Annual Maximum 5-day Accumulated Precipitation (Rx5day)

TC-contributed Rx5day

% of Rx5day Events from TCs



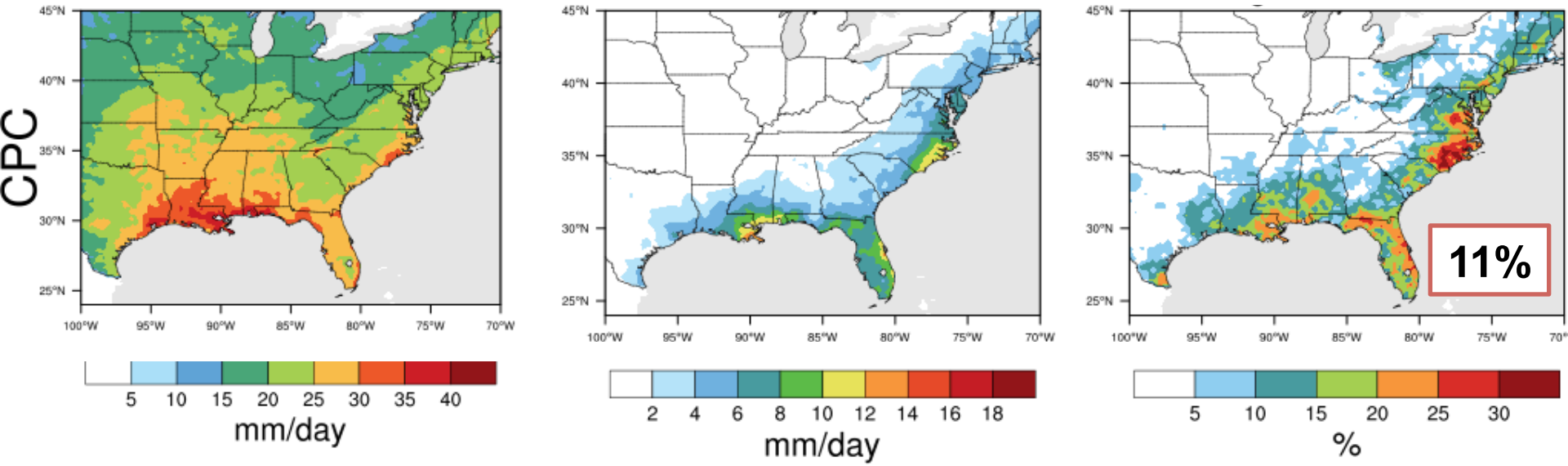


Exploring TC Extreme Precip.: CAM5 – Observed (CPC)

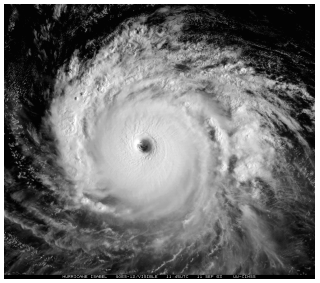
Annual Maximum 5-day Accumulated Precipitation (Rx5day)

TC-contributed Rx5day

% of Rx5day Events from TCs



High-resolution CAM5 values of Rx5day is reduced and but is comparable to observations for TC events.



Extending Rainfall Metric for TC Lifetime in TempestExtremes

Total IMERG Precip.

↓

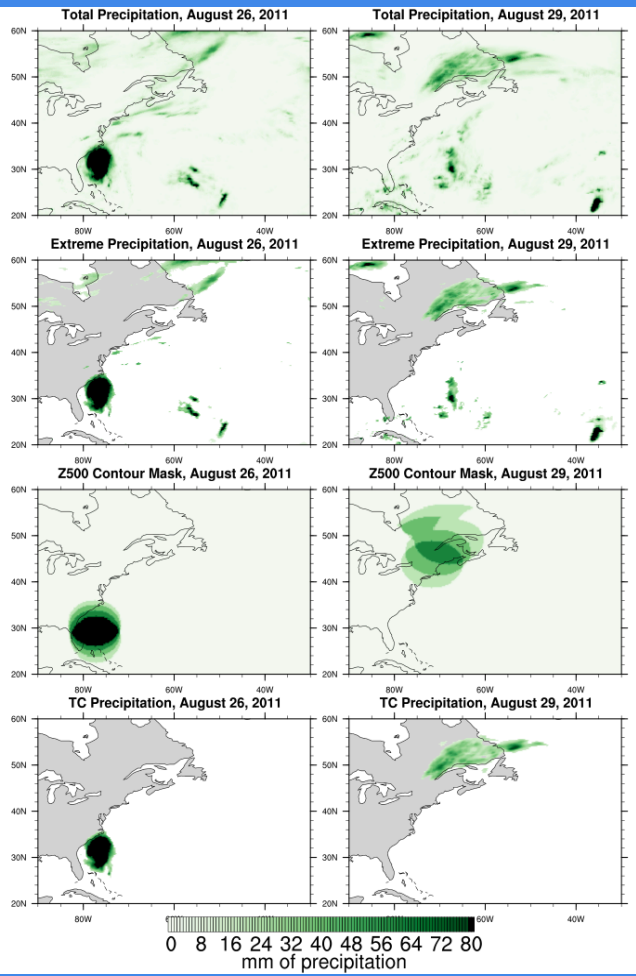
95th Percentile Precip.

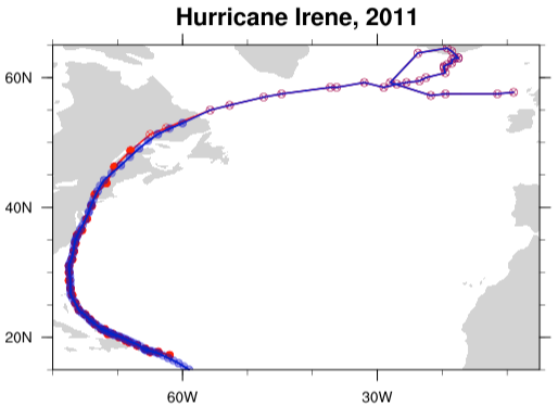
↓

Storm Mask

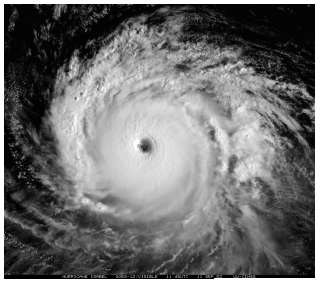
↓

Strom Precip.

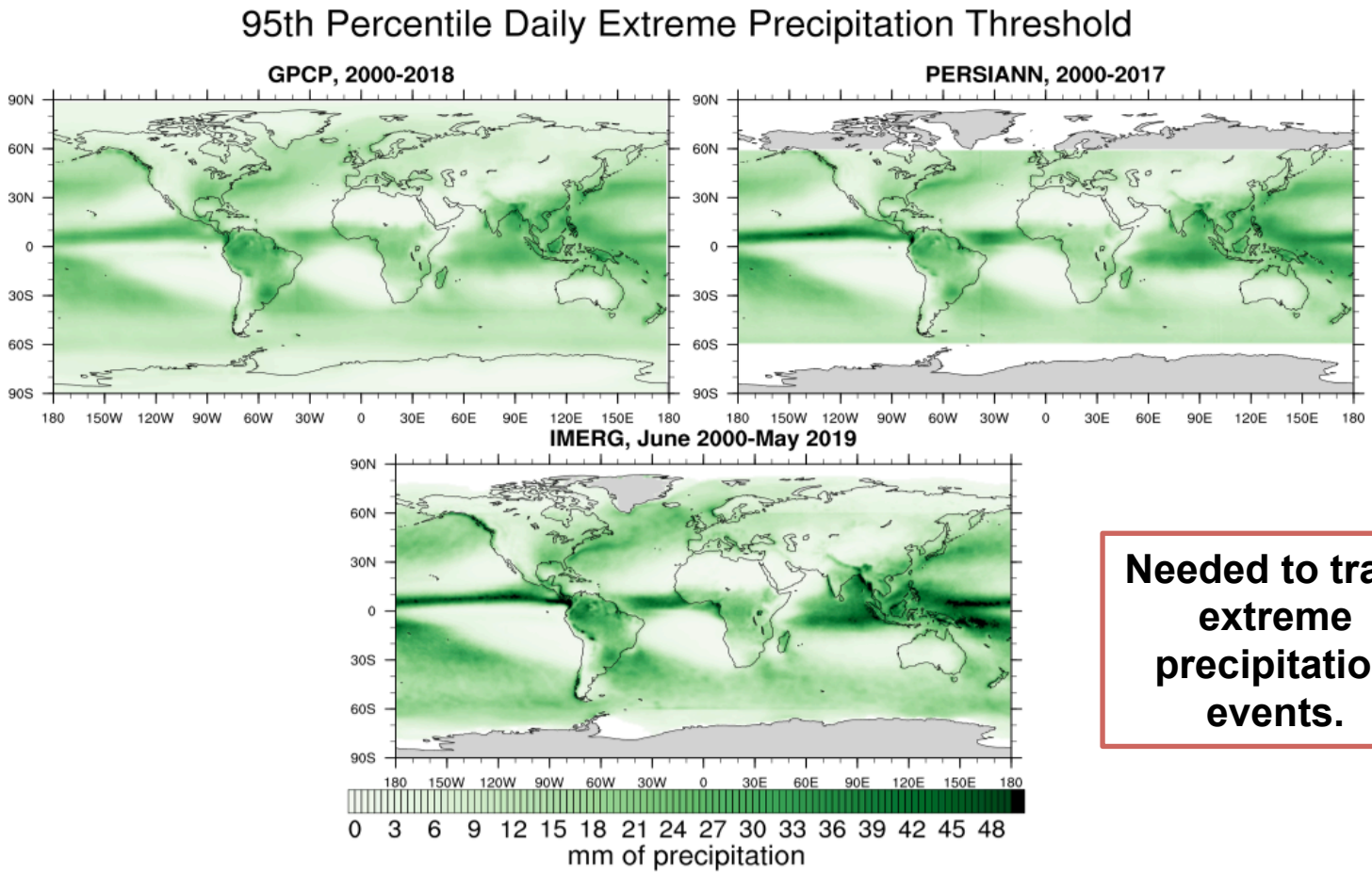




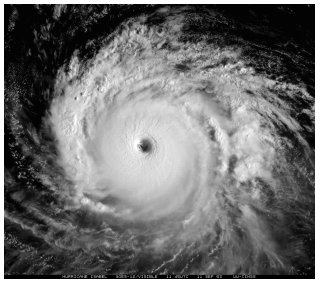
Note, we use Z500 to mask the storm throughout its lifetime.



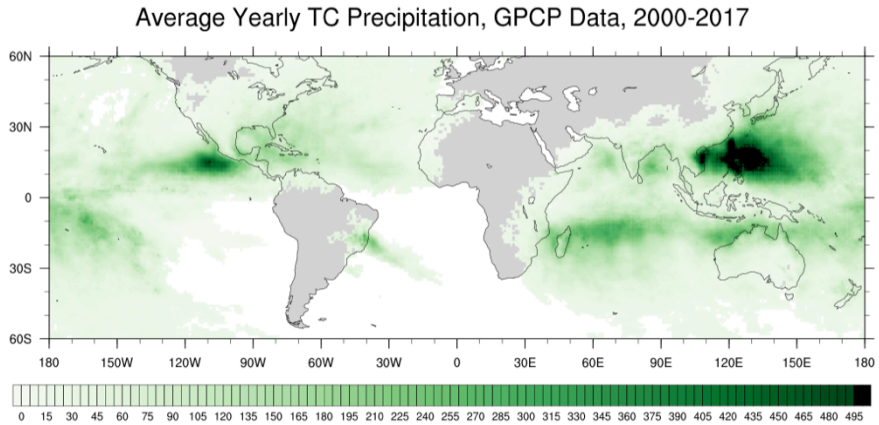
Comparison: Extreme Precip.

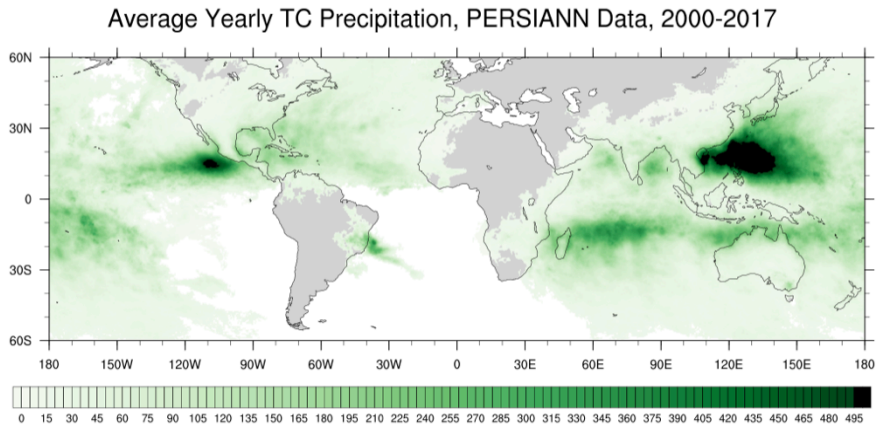


Needed to track extreme precipitation events.

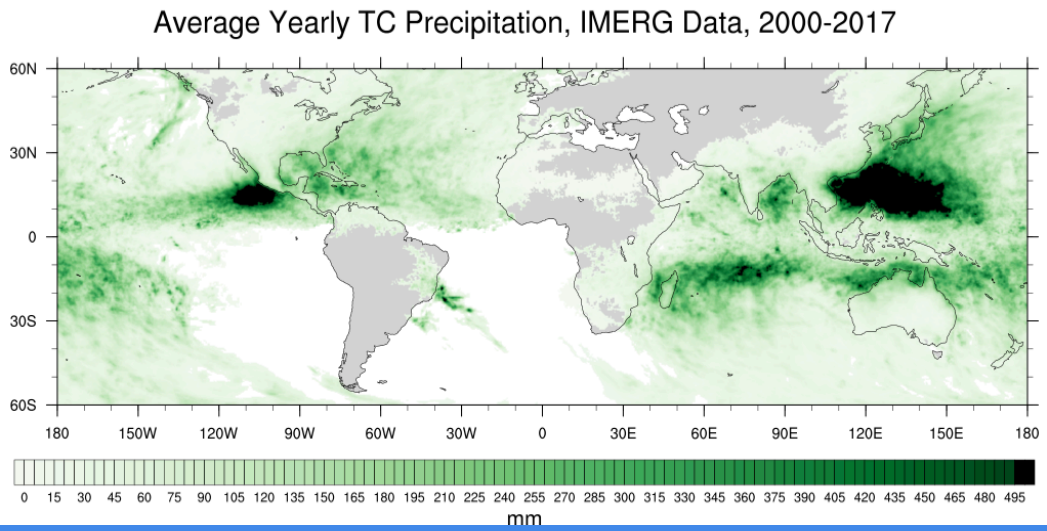


Comparison: TC Precip.

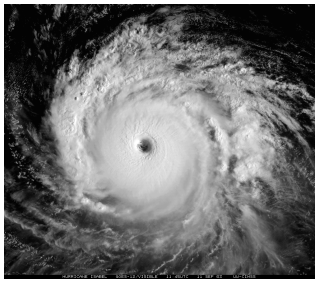




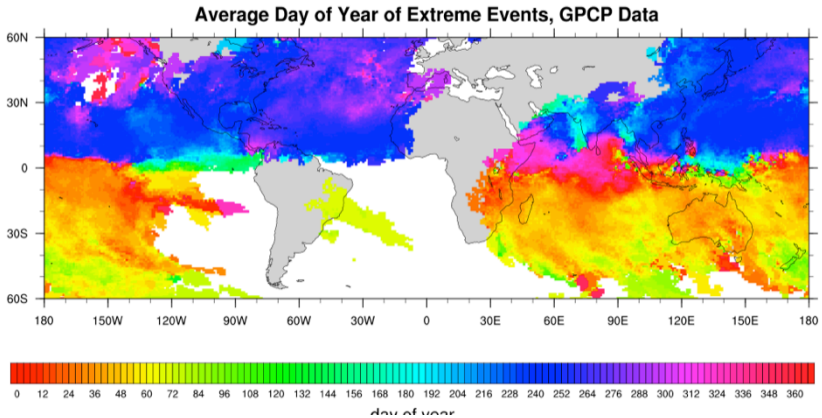
Some **consistency** across the datasets.

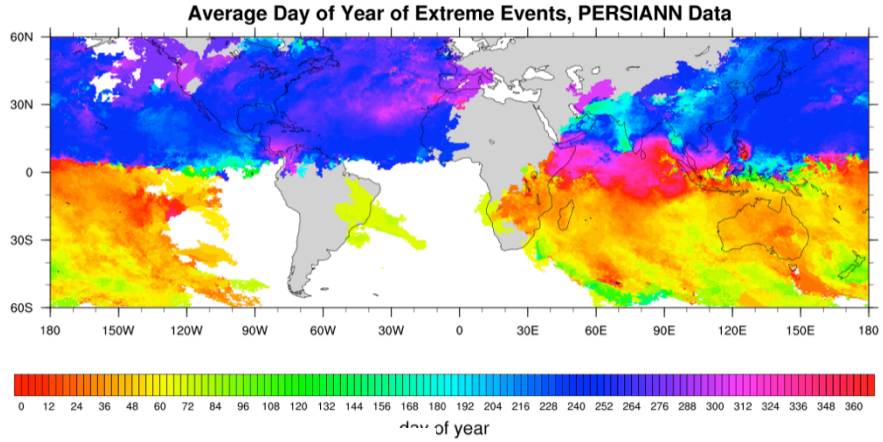


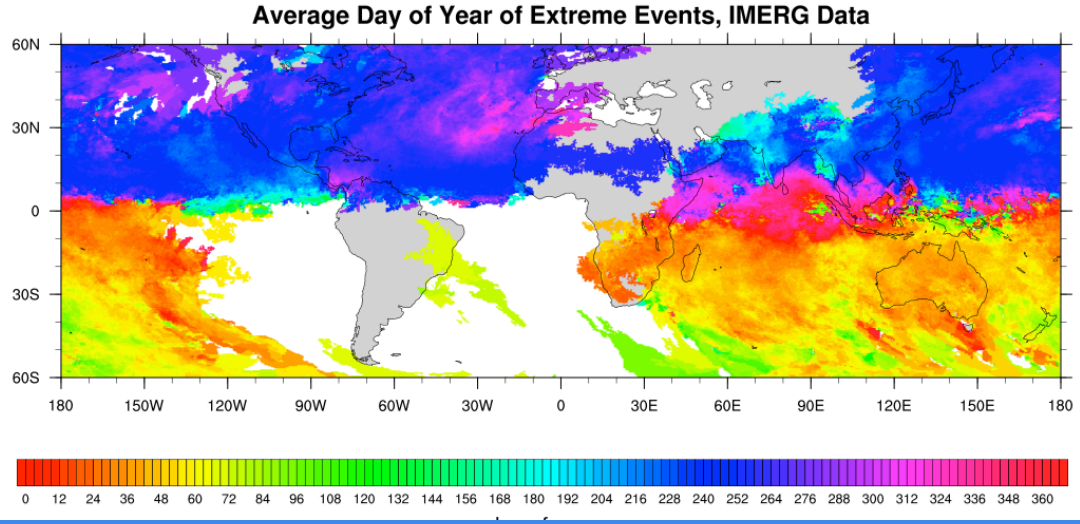
Larger precip. magnitudes in IMERG.



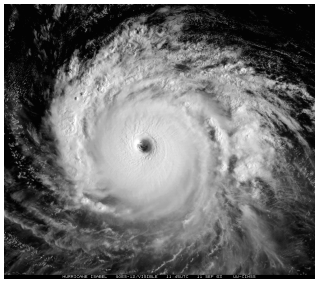
Comparison: TC Precip. Timing



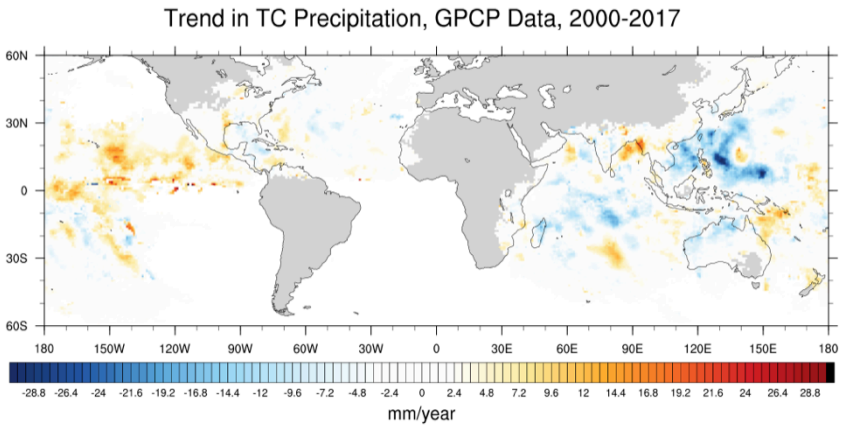


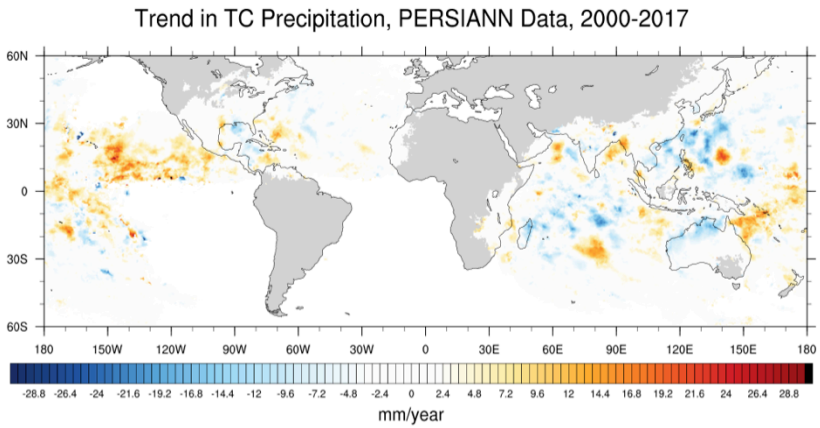


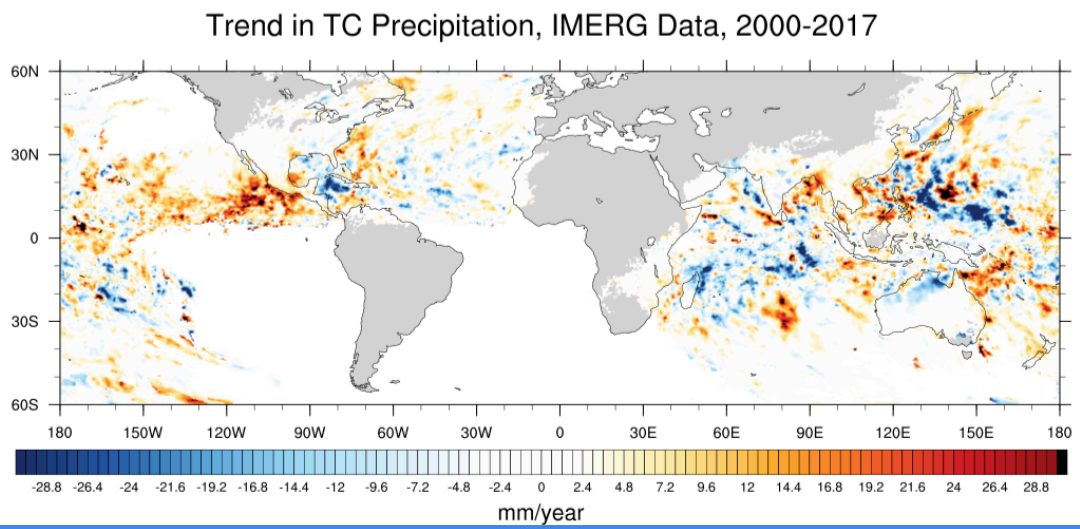
Consistency across the datasets, with some **late-season differences**.



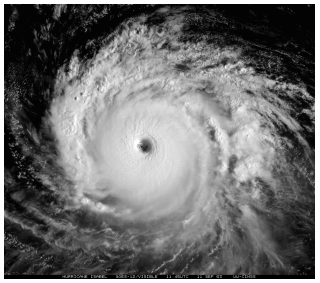
Comparison: TC Precip. Trends







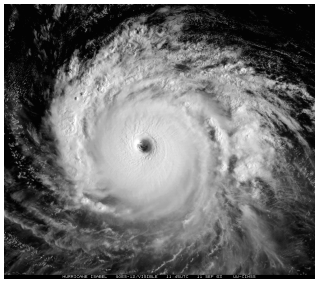
Preliminary Work!



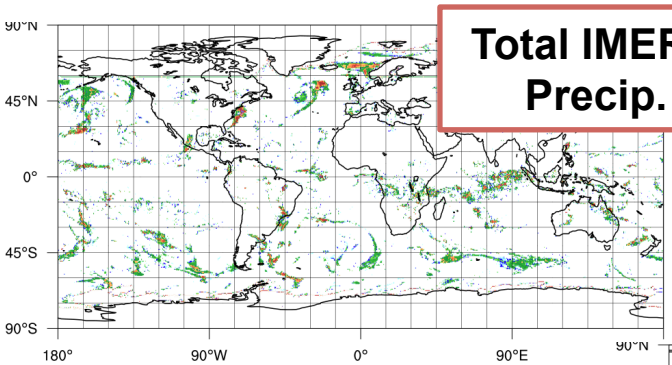
Other Storm Types

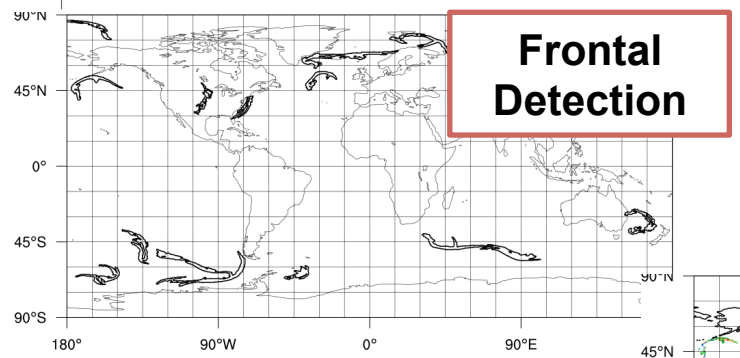
To understand changes in extreme precipitation in the future, we need to understand the changes in the events responsible for extreme precipitation:

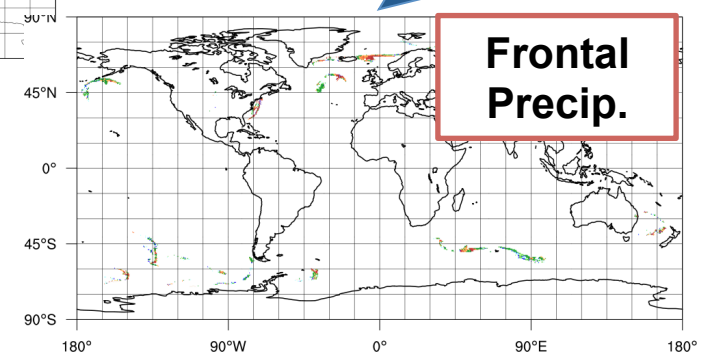
kevin.a.reed@stonybrook.edu

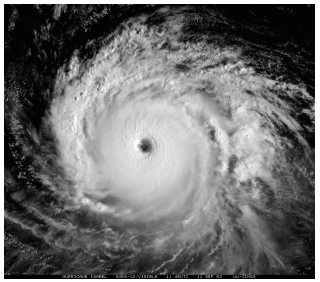


Extending Rainfall Metric for Fronts in TempestExtremes



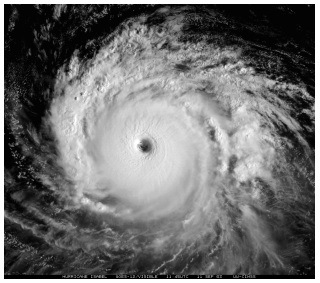






Final Thoughts

- Working to **characterize the link between convective storm-types and extreme precipitation** in IMERG.
- Building the Extreme PreCIpitation, ORganization of Convection and Aggregation (**EPIC ORCA**) algorithm into the open-source **TempestExtremes** toolkit.
- This Framework will then be used to **evaluate the skill of various climate models** (CMIP6 HighResMIP) to simulate extreme precipitation from different storm-types.
- This work is crucial to **interpret future projections** of extreme precipitation.



Thanks!

Available @ https://github.com/ClimateGlobalChange/tempestextremes

kevin.a.reed@stonybrook.edu

[Grant: 80NSSC19K0717]