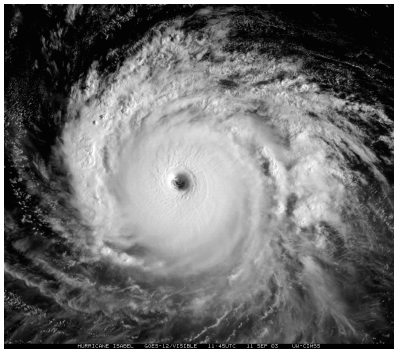

Stony Brook University

High-resolution climate modeling: A tool to study extreme weather on decadal timescales

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Collaborators…

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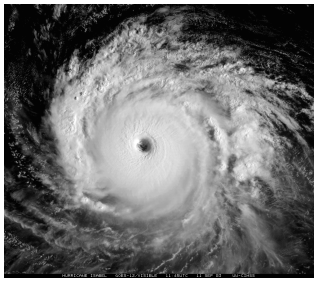
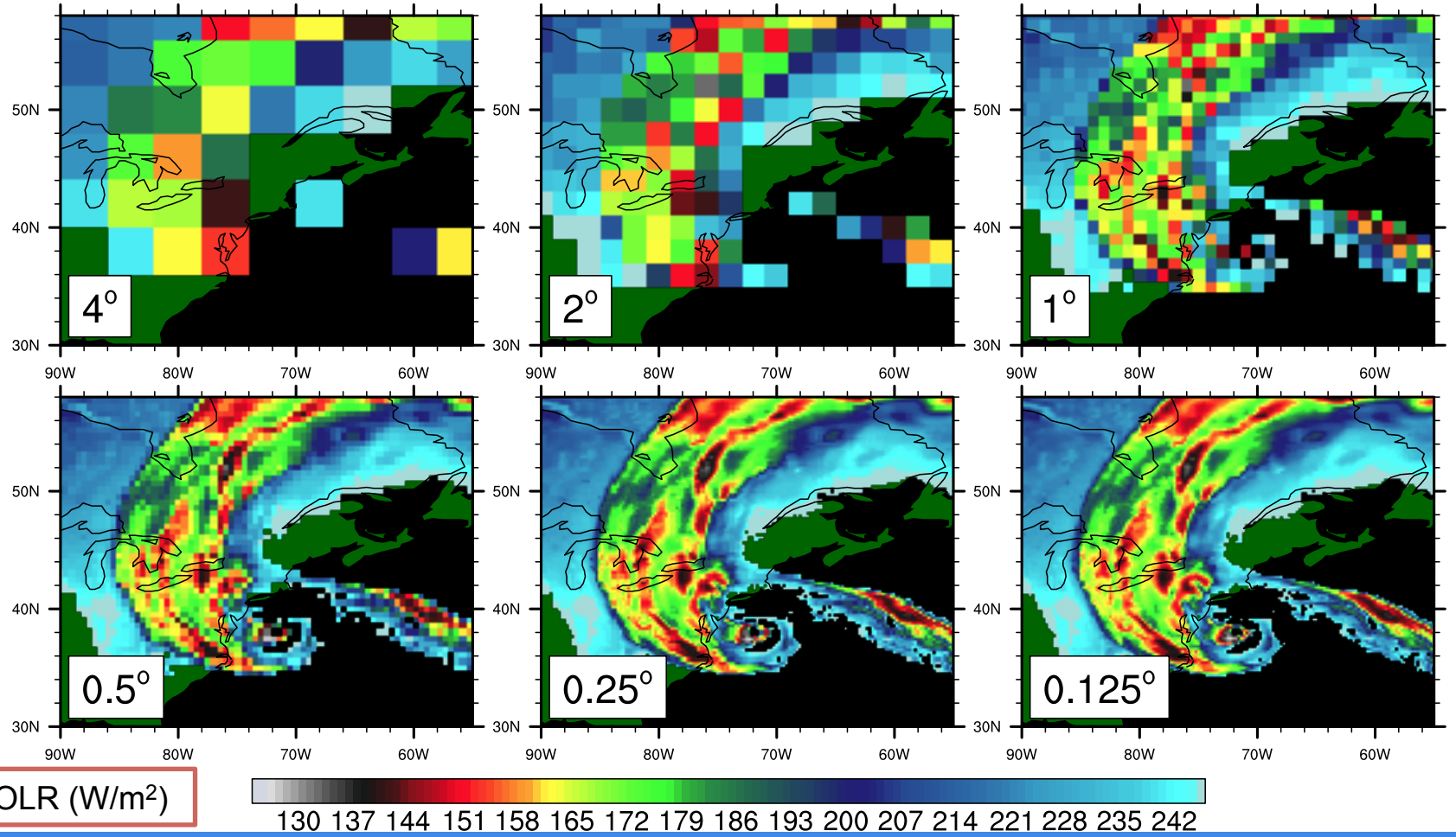
[1]*Stony Brook University, Stony Brook, NY, USA*

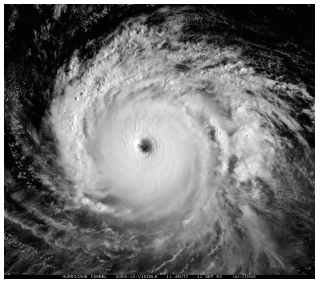
[2]*Lawrence Berkeley National Laboratory, Berkeley, CA, USA*

[3]*National Center for Atmospheric Research, Boulder, CO, USA*

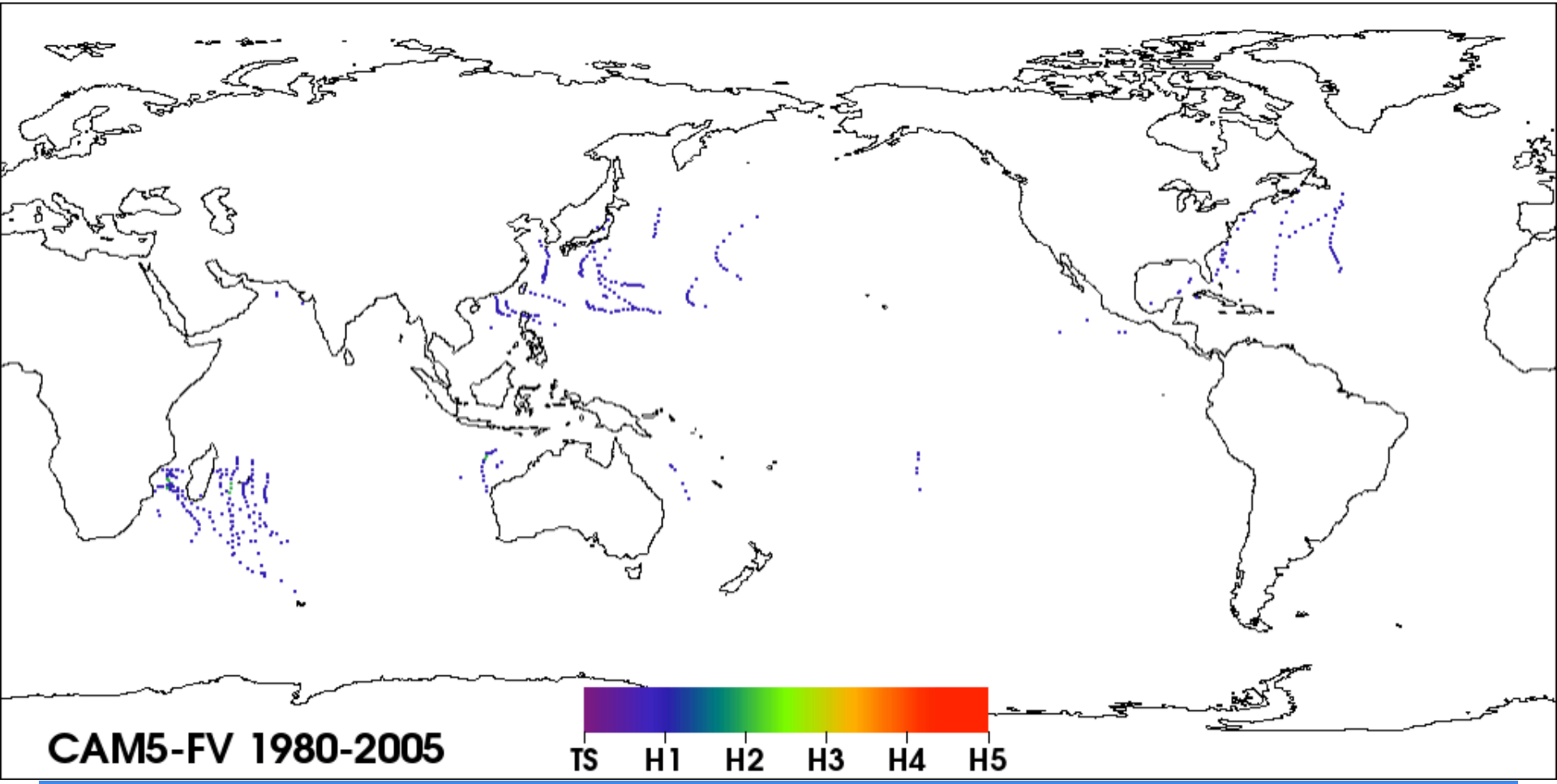


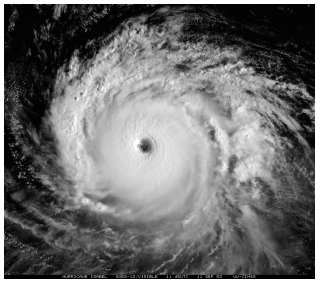
High-Resolution Climate Modeling: Spatial Scale of Sandy



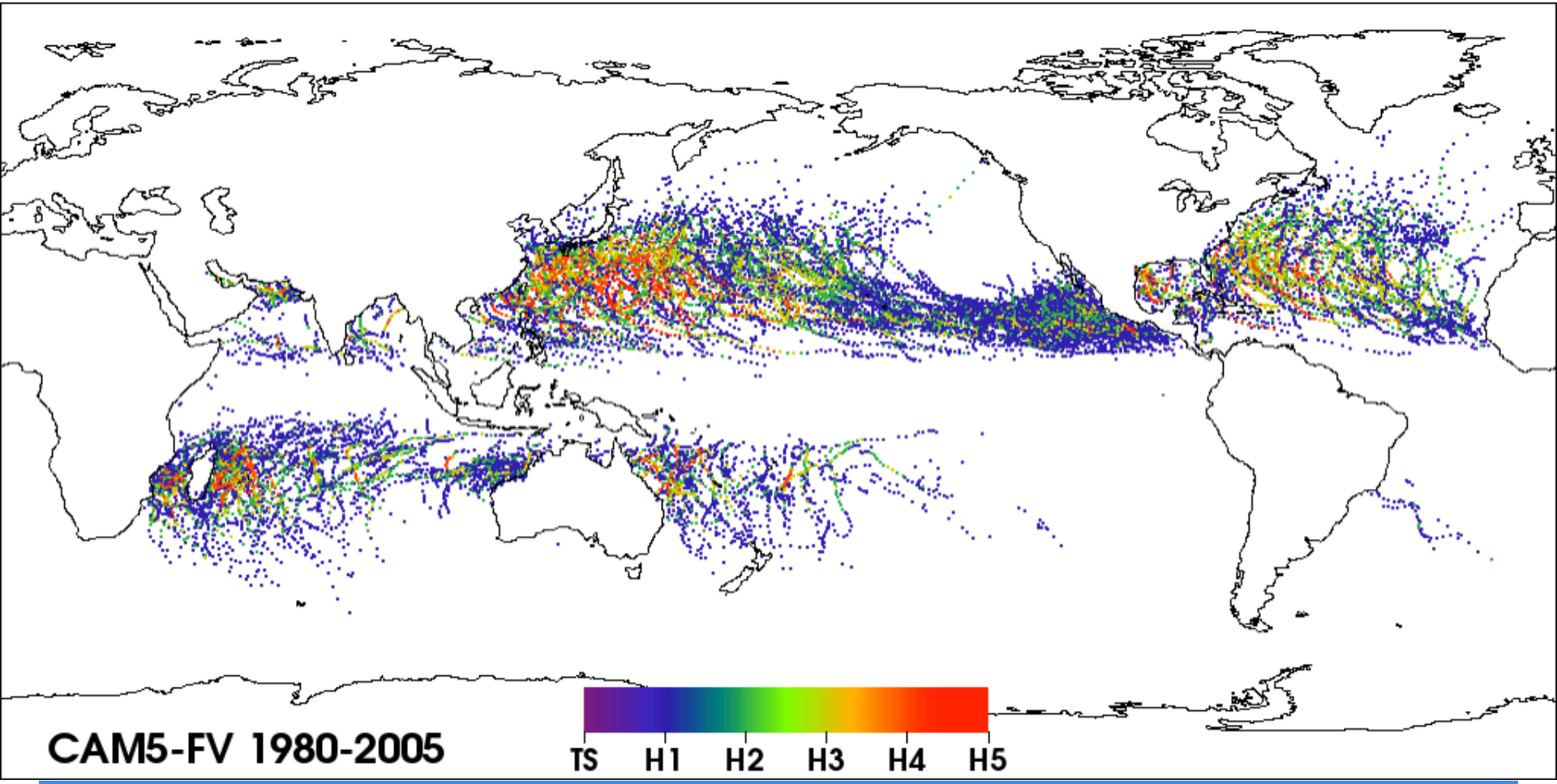


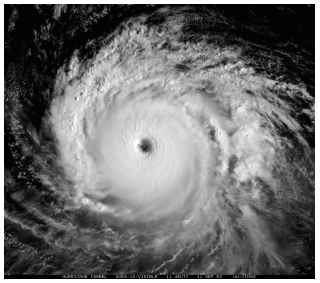
CAM5 - 100 km
Storm Tracks - AMIP



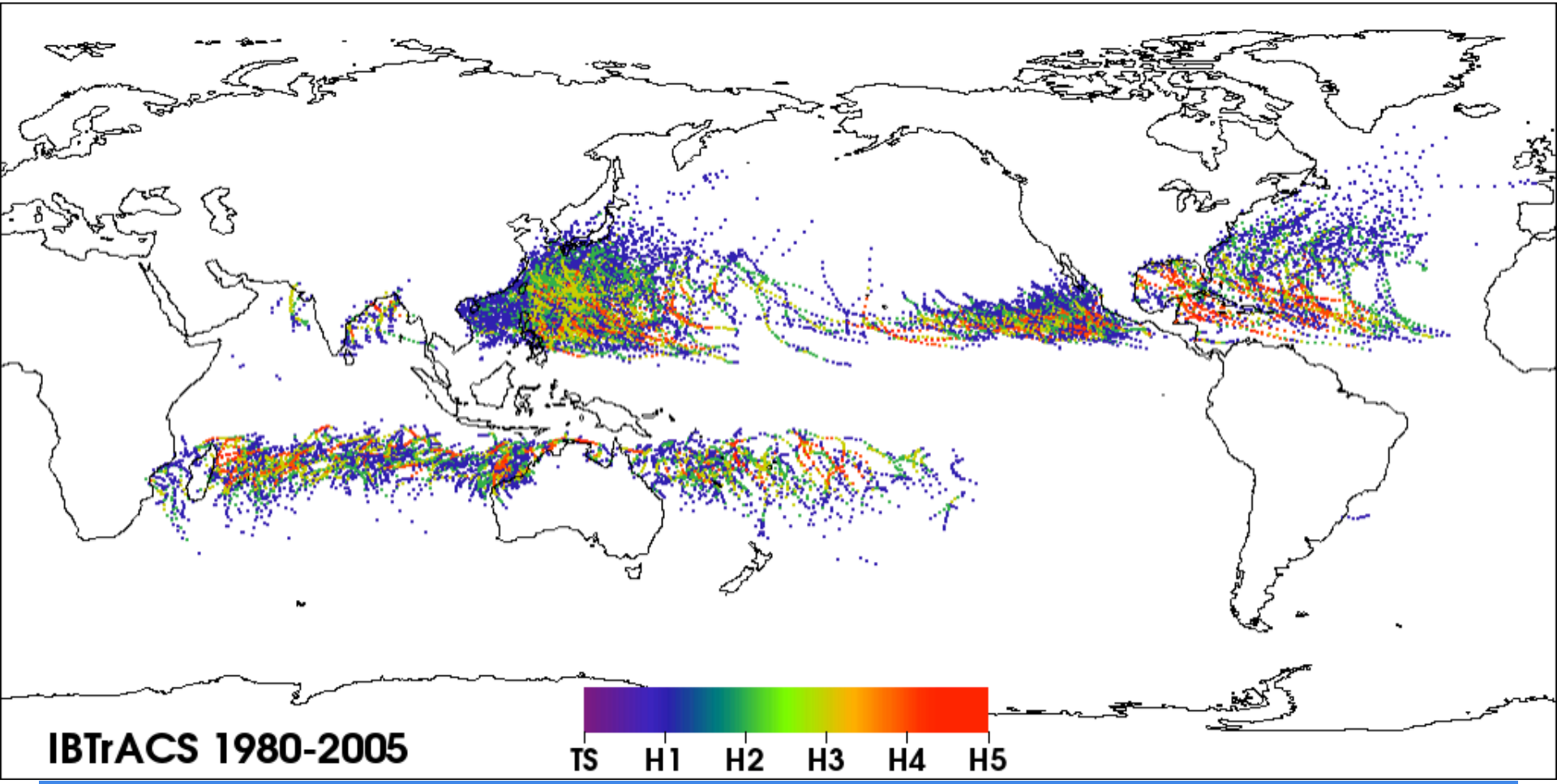


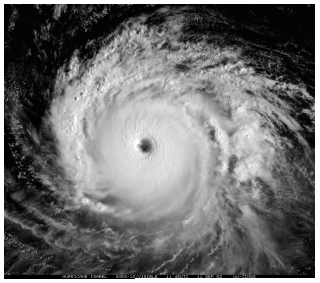
CAM5 - 25 km
Storm Tracks - AMIP



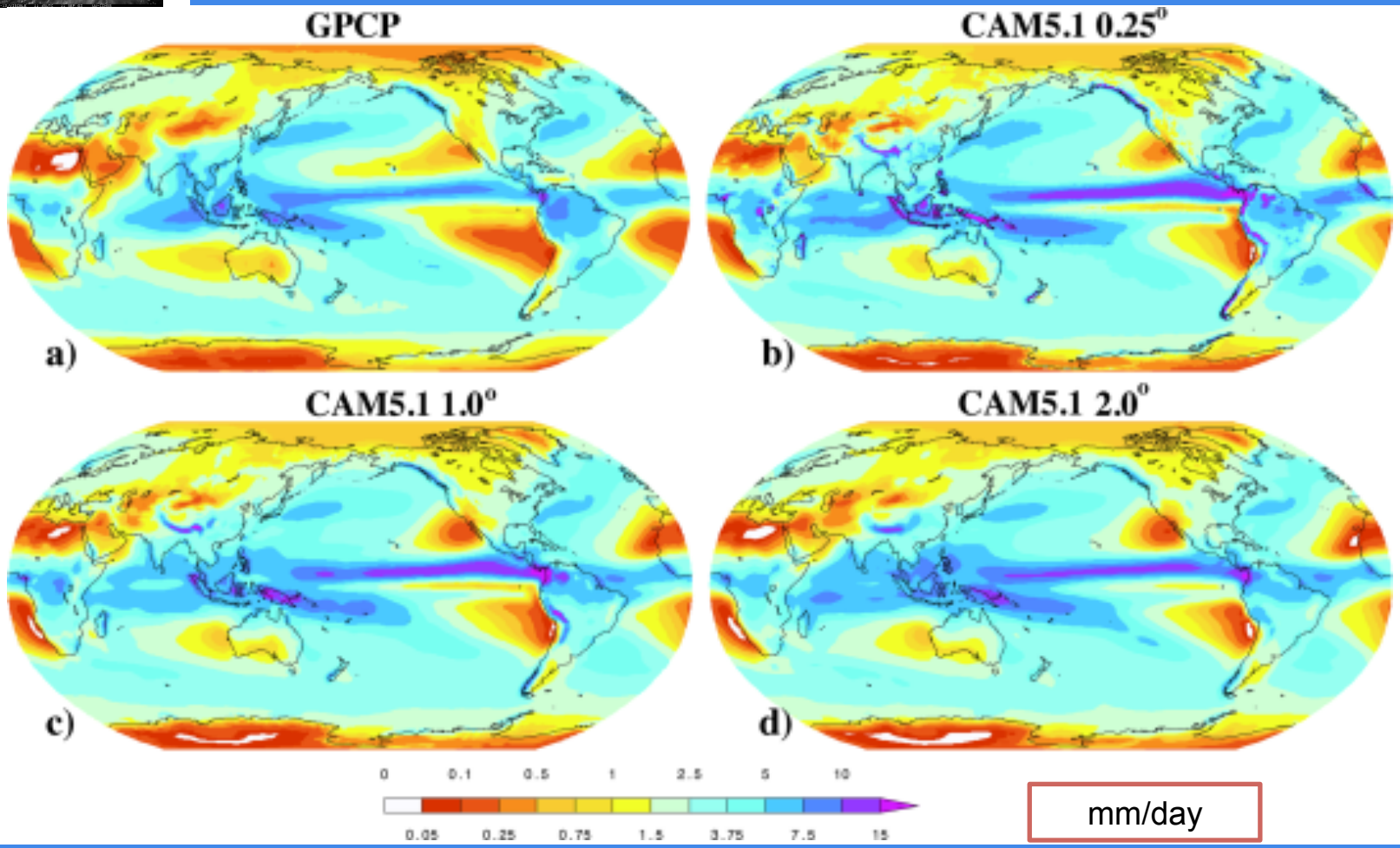


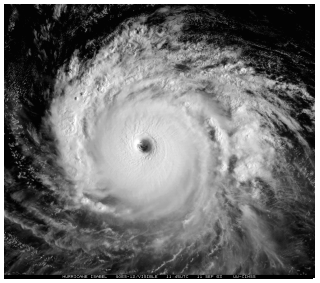
Observed Storm Tracks



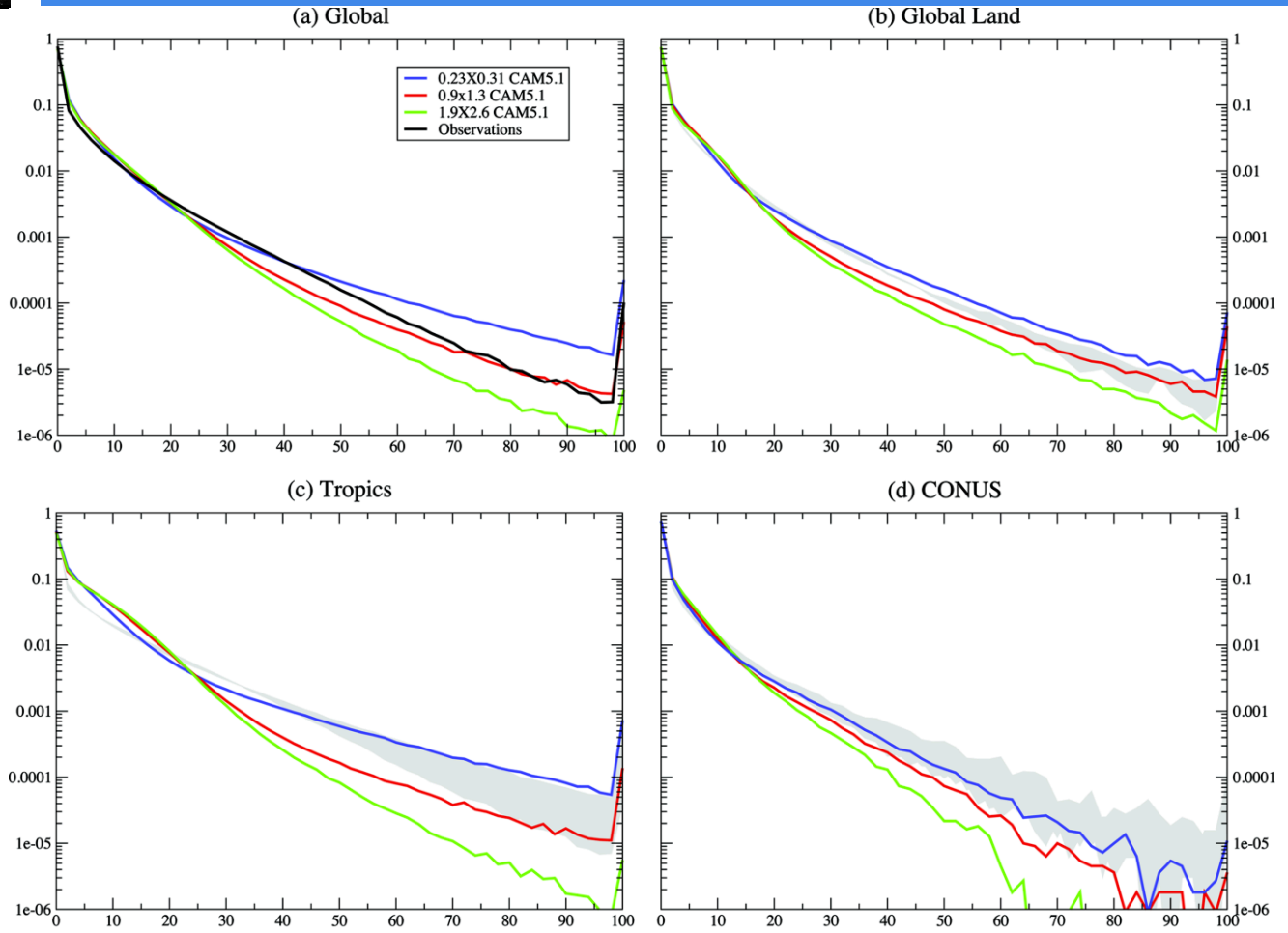


Observed vs. CAM5 Annual Mean Precipitation

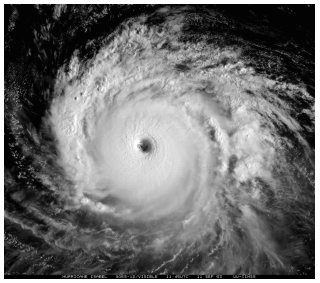




Observed vs. CAM5 Precipitation Distribution

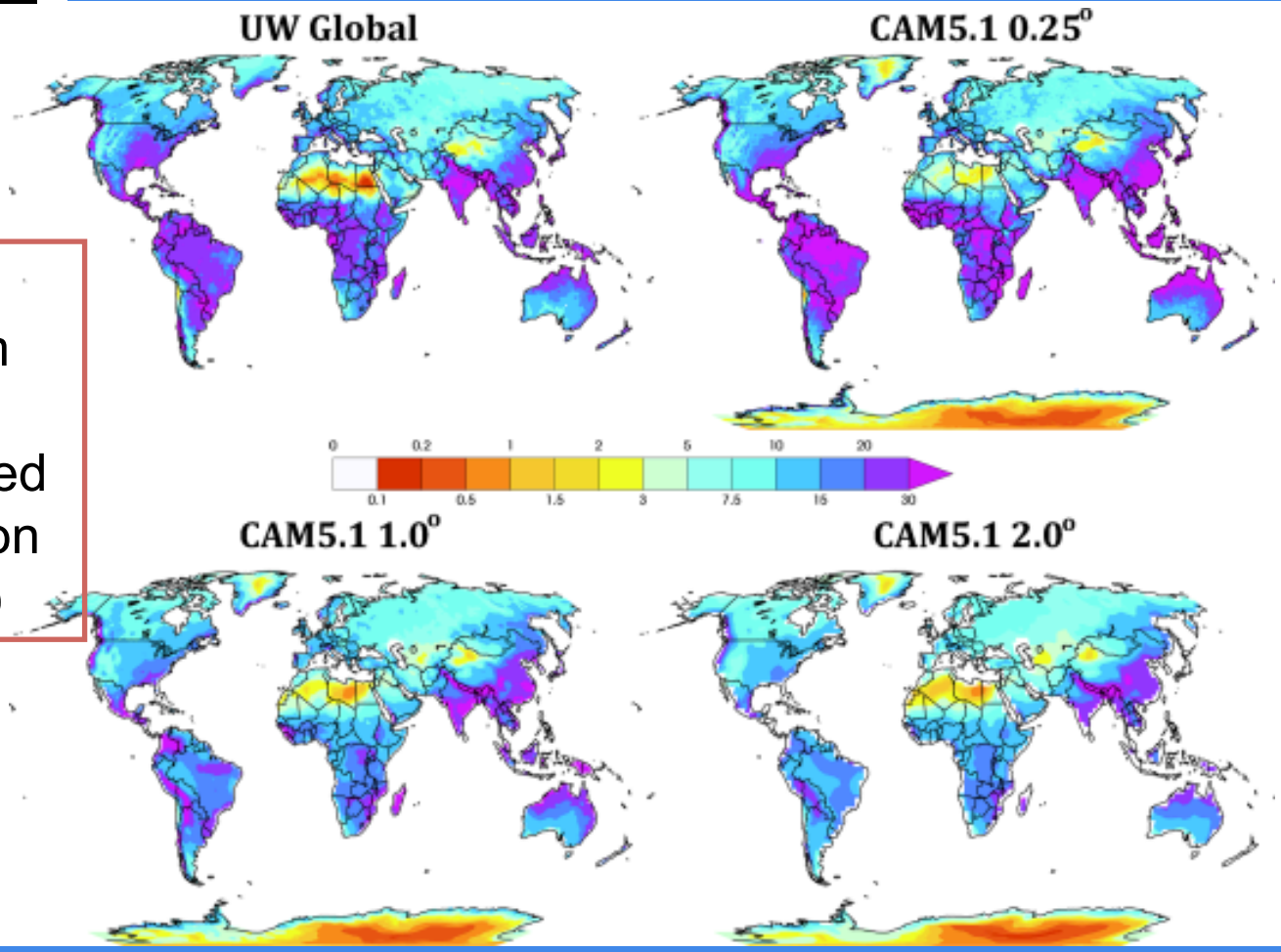


mm/day

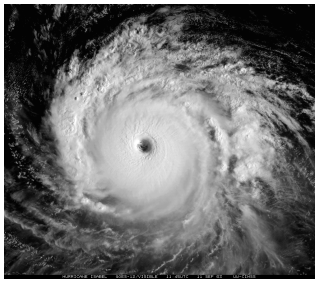


Observed vs. CAM5 Extreme Precipitation

Annual Maximum 5-day Accumulated Precipitation (Rx5day)

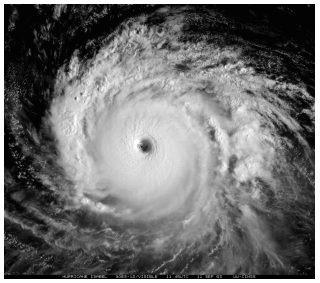


mm/day

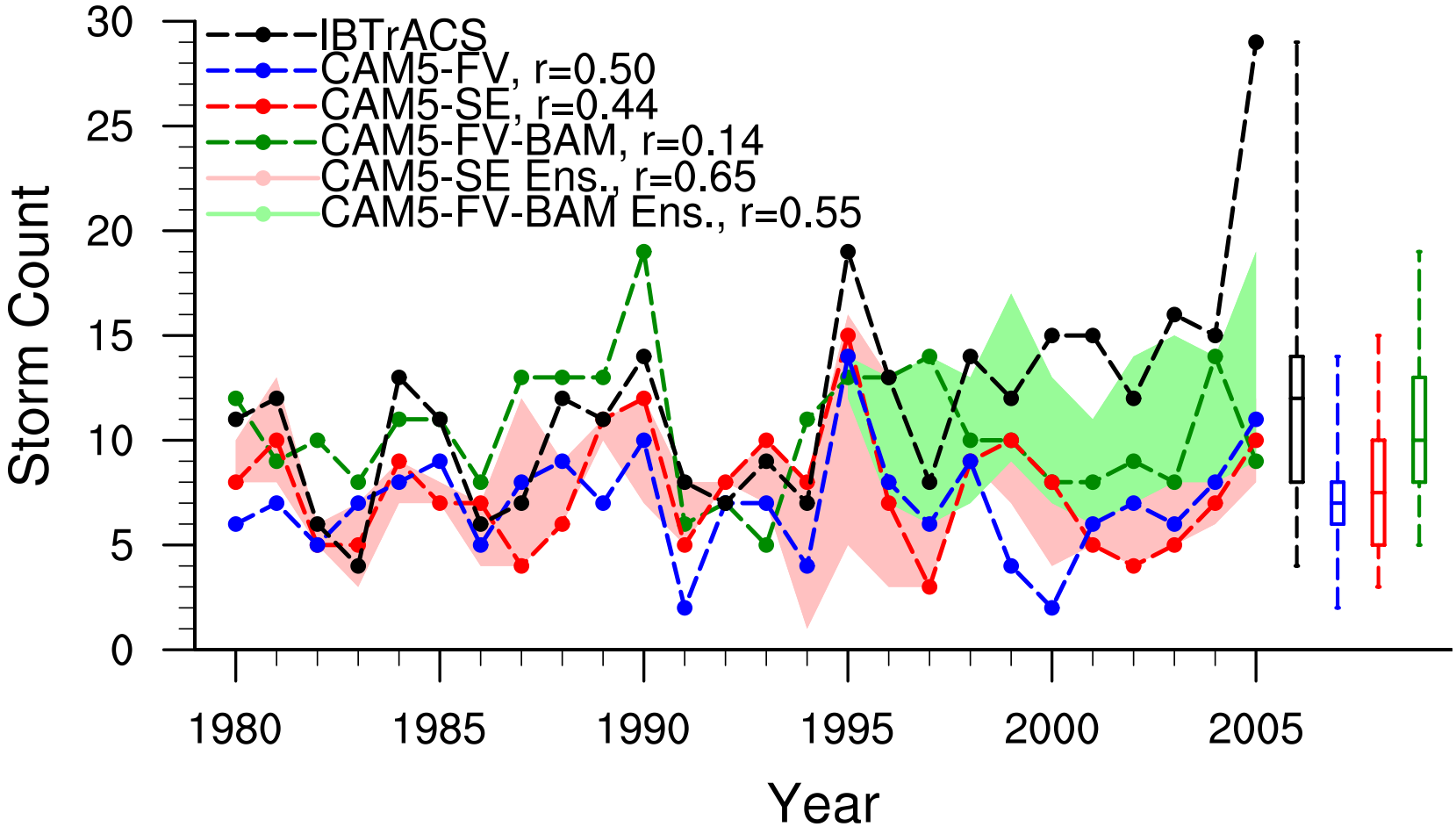


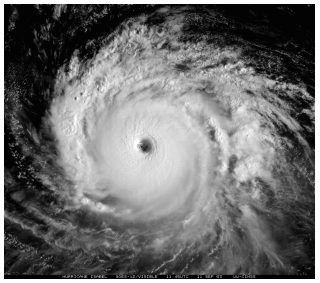
General Design of Decadal Simulations

- National Center for Atmospheric Research's (NCAR) Community Atmosphere Model version 5 (CAM 5).
- General, two dynamical core options, FV or SE with 30 vertical levels is used at the horizontal resolution of:
  - $\Delta x = 0.25°$; ne=120; ~25 km
  - See *Reed et al. (2015)* for dynamical core impact on tropical cyclones.
- Full physics with Atmospheric Model Intercomparison Project (AMIP) protocols for 1980-2005 (thru 2012 in some cases). Then 2070-2100 for RCP8.5 climate.
- Prescribed observed (or projected) SSTs, ozone, CO_2, solar forcing, etc.
- The impact of aerosol model and airborne dust is explored.

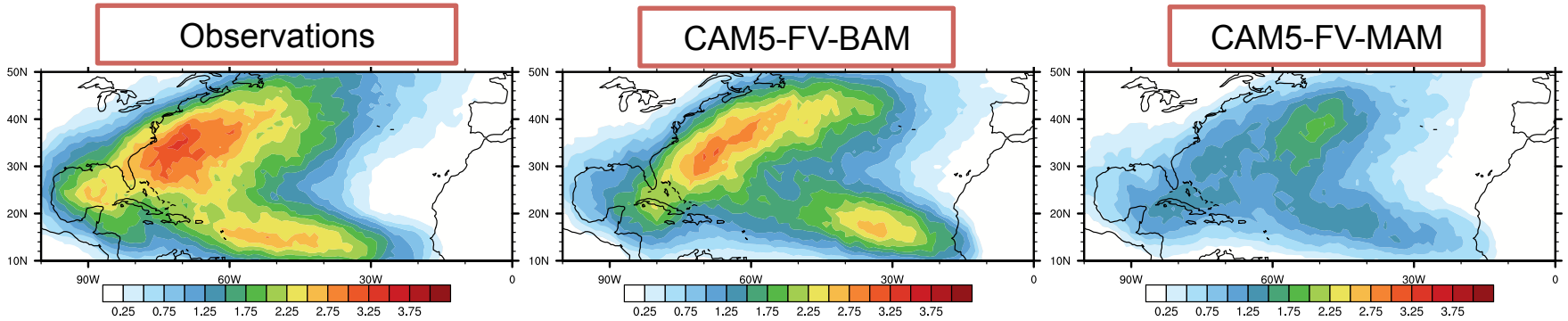


Summary of Runs To Date: Impact on Variability

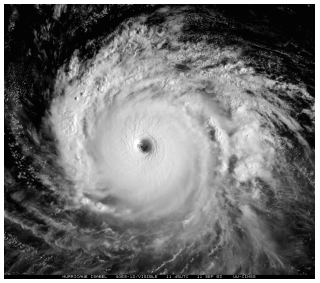




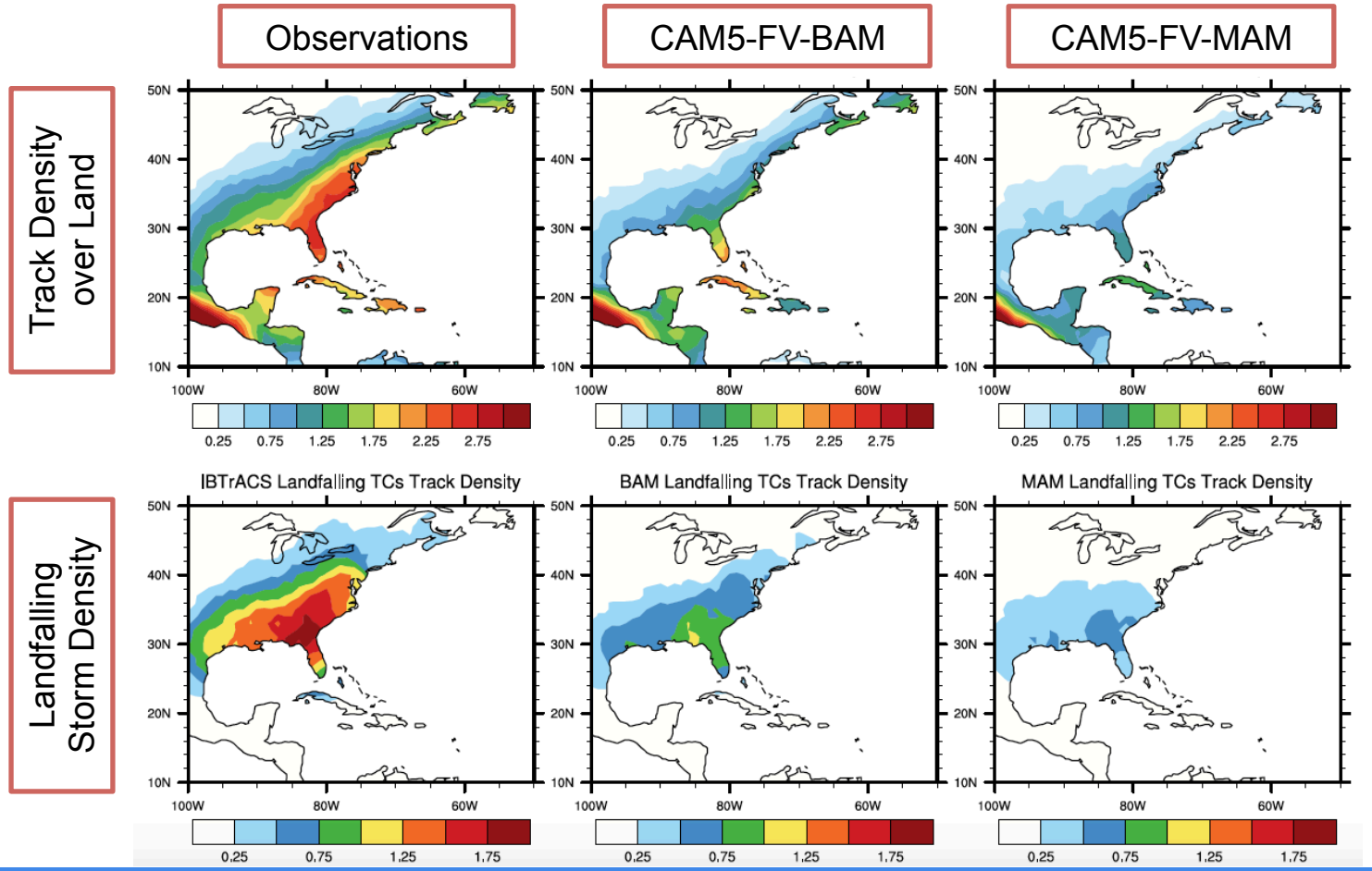
North Atlantic Tracks: Comparison of Aerosol Config.

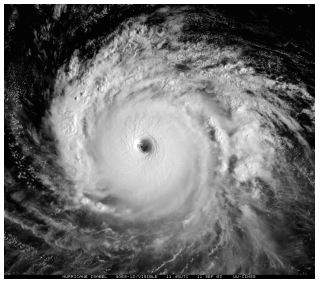


- Large differences between CAM5 and observations, and amongst the models.
- But general distribution of TC is reasonable.

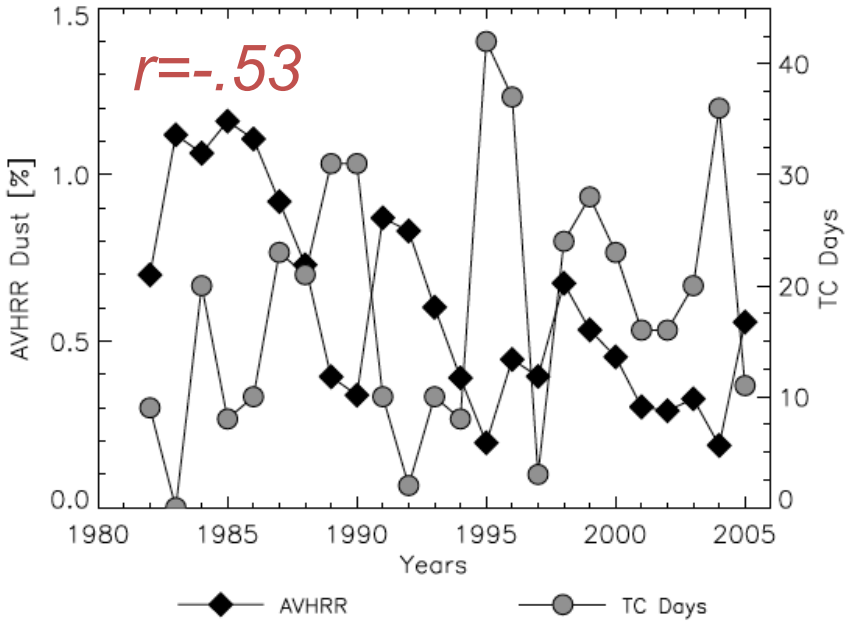


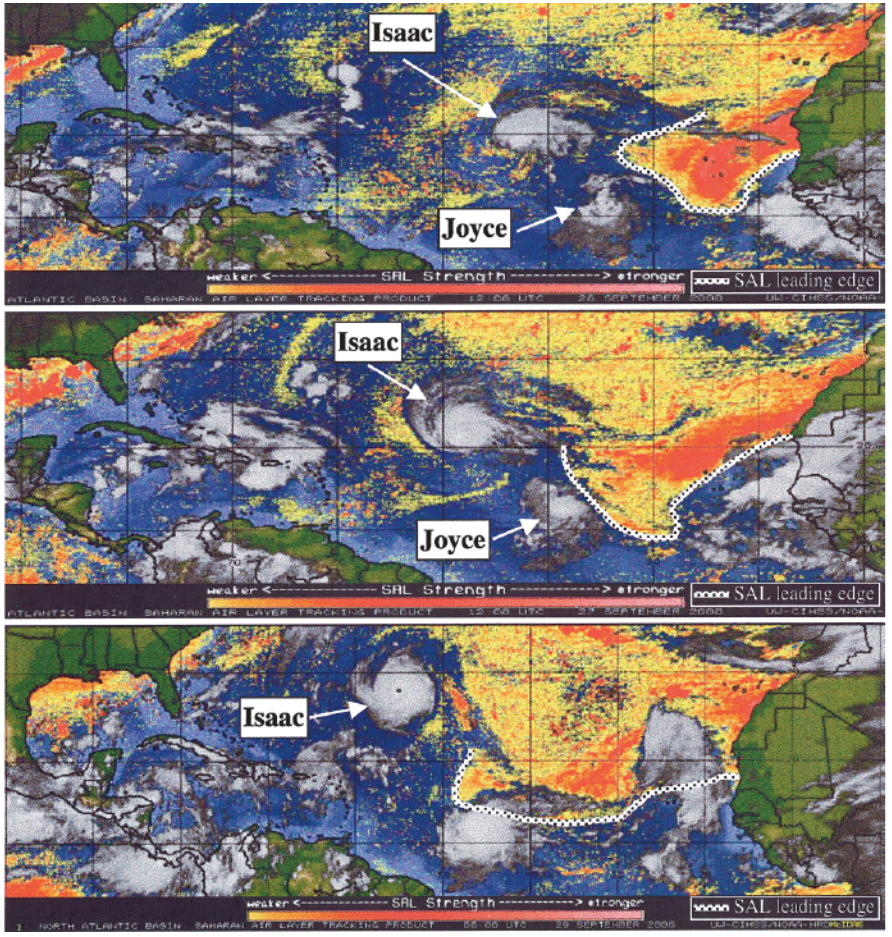
Landfalling TCs in Eastern US



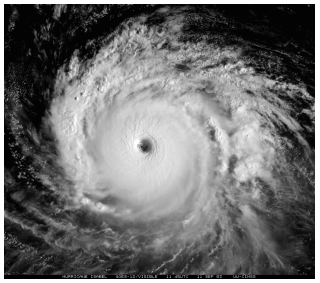


Connection Shown in Observations

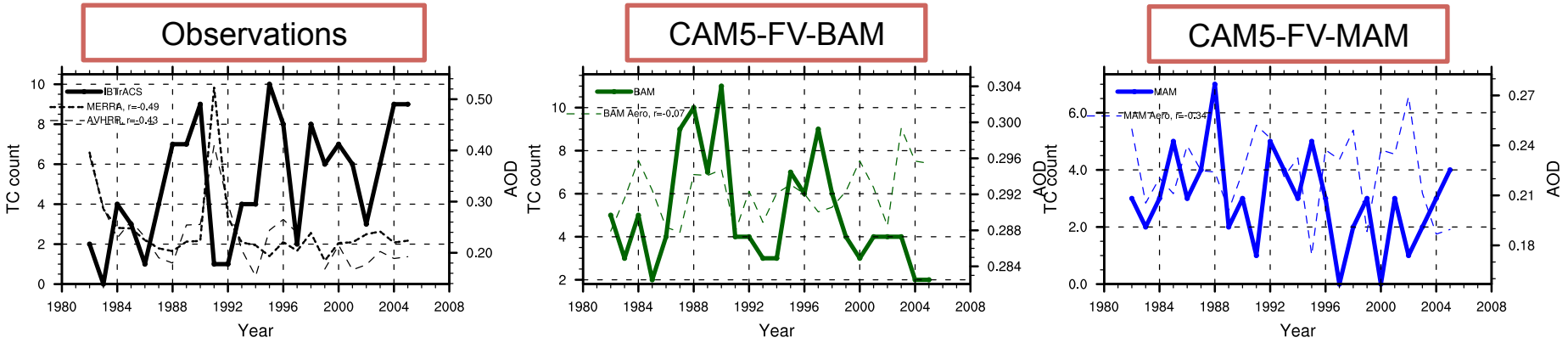




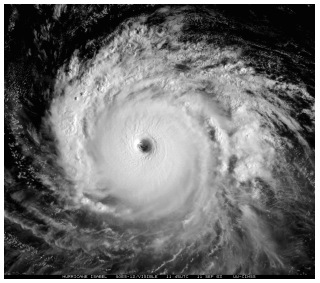
- There is a correlation between dust and hurricanes in the observational record.



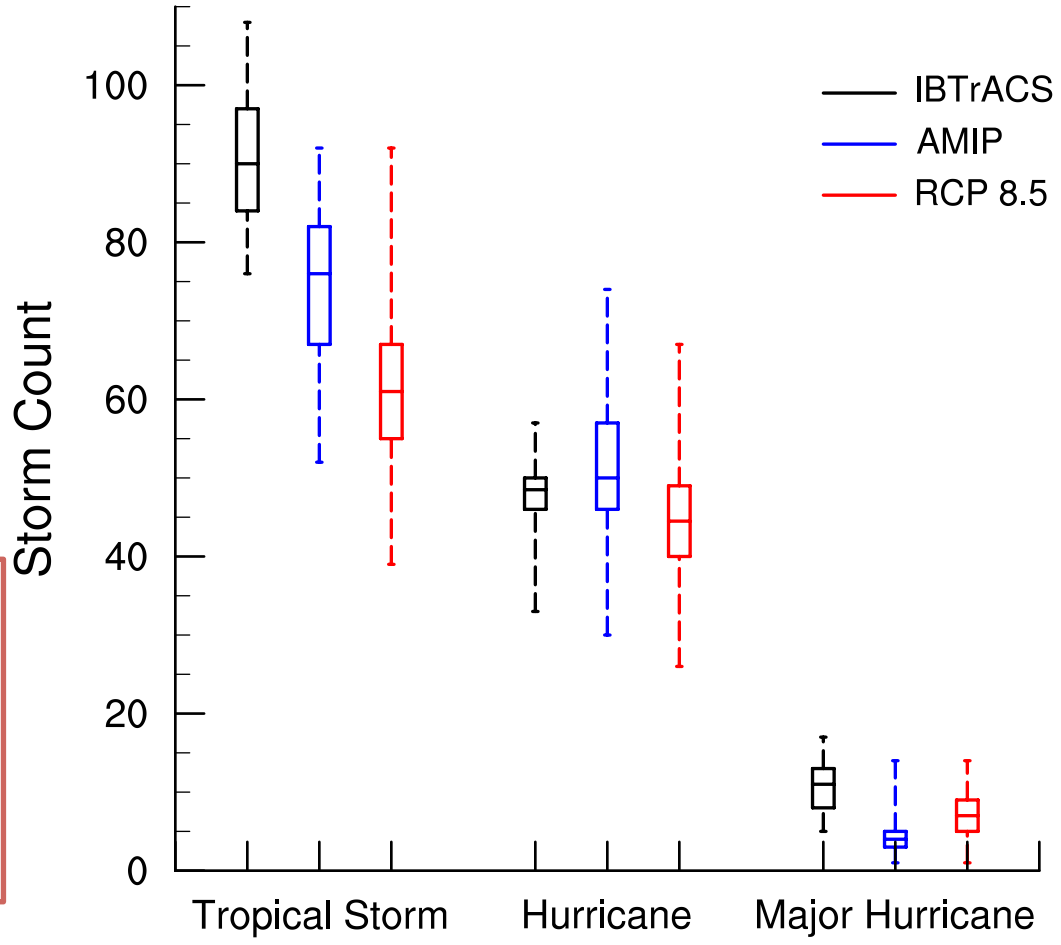
North Atlantic Basin – Do Aerosols Influence TCs?



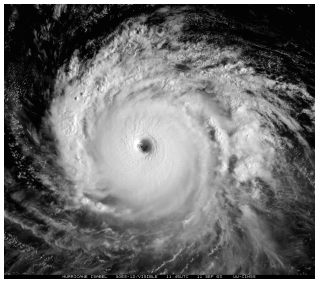
- Correlation between TC count and average AOD over *Main Development Region* is negative (-0.43 to -.49) in observations.
- Only prognostic aerosol (MAM) configuration captures this negative correlation (-0.34) well.
- What if *dust* is removed from MAM?



Future Climate Scenarios: Global Statistics

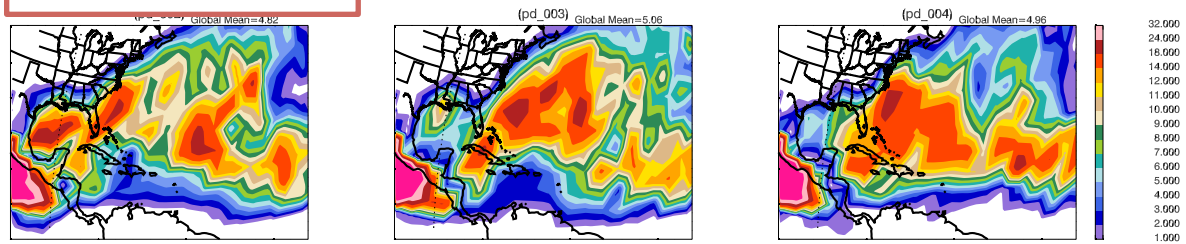


Note:
These are now with the CAM5-SE configuration.



North Atlantic Distributions

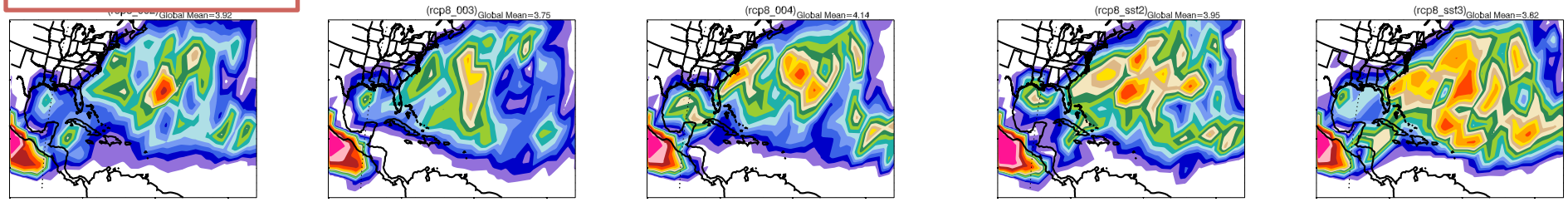
AMIP Ensemble



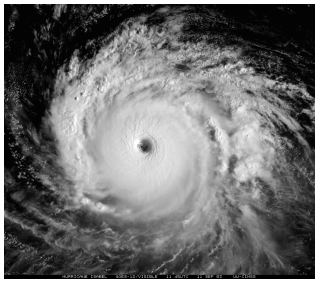
Note:
These are now with the CAM5-SE configuration.

RCP8.5 Ensemble

---Alternate SSTs---



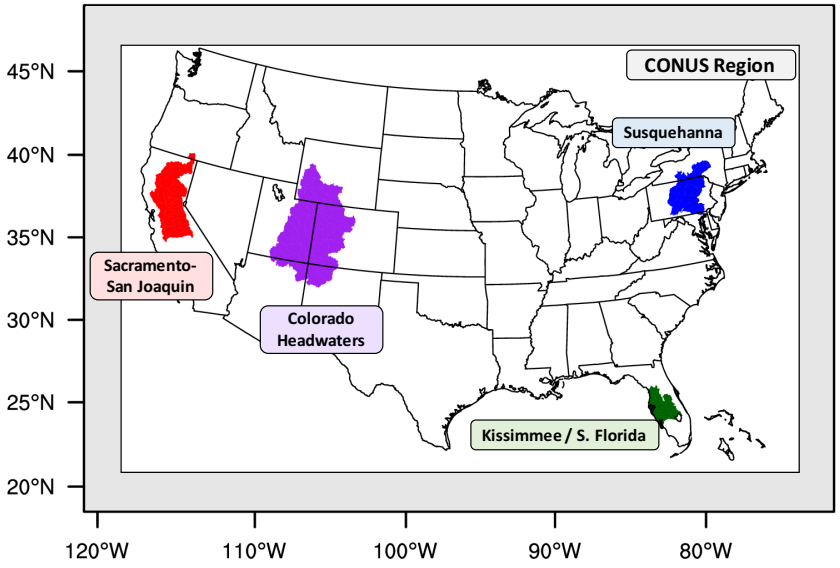
- Appears to be a robust decrease in storms in the North Atlantic.
- Though, the magnitude of the decrease is dependent on the sea surface temperatures.



HYPERION

UNDERSTANDING HYDROCLIMATE DATA WITH USE-INSPIRED METRICS

- ***Project Focus:*** Understand which metrics are most important to stakeholders and assess regional climate datasets in this context.
- ***Stakeholder outreach:*** Representation in the project from water managers in each region plus USGS, Army Corps of Engineers, Bureau of Reclamation.



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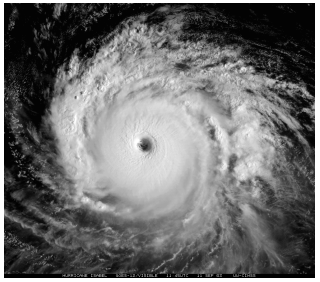
DOE Biological and Environmental Research Program



HYPERION

UNDERSTANDING HYDROCLIMATE DATA WITH USE-INSPIRED METRICS

Meteorological Metrics:

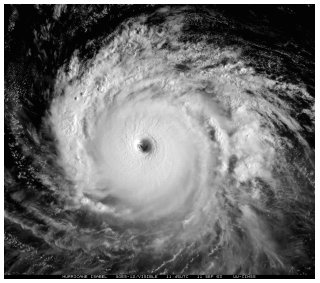
- **Precipitation Character and Extremes:** Origins of rainfall (large-scale vs. convective, coastal storms, NAMS, MCS). 90, 95 and 99 percentile rain events.
- **Mesoscale Convective Systems:** Representation of mid-level vortices and propagation relative to observations.
- **North American Monsoon System:** Timing and character of the monsoon system.
- **Atmospheric Rivers:** Landfall location, total overland precipitation, frequency.
- **Coastal Storms:** Storm frequency, spatial structure, size, overland precipitation, rain/snow partitioning.
- **Sea Breeze:** Occurrence and strength.

Hydrological Metrics

- **Mountain Snowpack:** Total snow water equivalent, snow cover, windward/leeward partitioning of snowpack, total snow per watershed.
- **Streamflow:** Annual maximum simulated flow, Nash Sutcliffe model efficiency
- **Flooding:** Flood occurrence frequency and intensity
- **Aridity:** Standardized Precipitation Index, Palmer Drought Severity Index

Integrated Metrics

- **Water Demand:** Combining temperature and precipitation with simplified models of water demand based on observations.



HYPERION

UNDERSTANDING HYDROCLIMATE DATA WITH USE-INSPIRED METRICS

Atmospheric Models

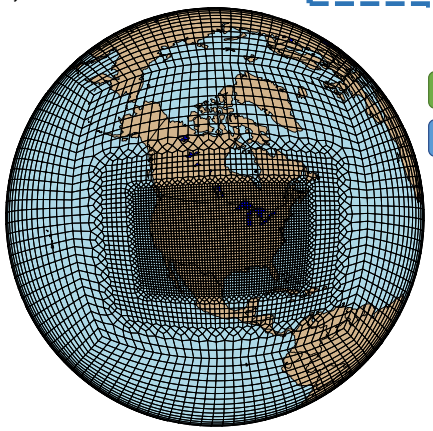
- Dynamical Downscaling (WRF and RegCM), Hybrid Downscaling, Variable-Resolution Modeling (CESM and ACME), Statistical Downscaling

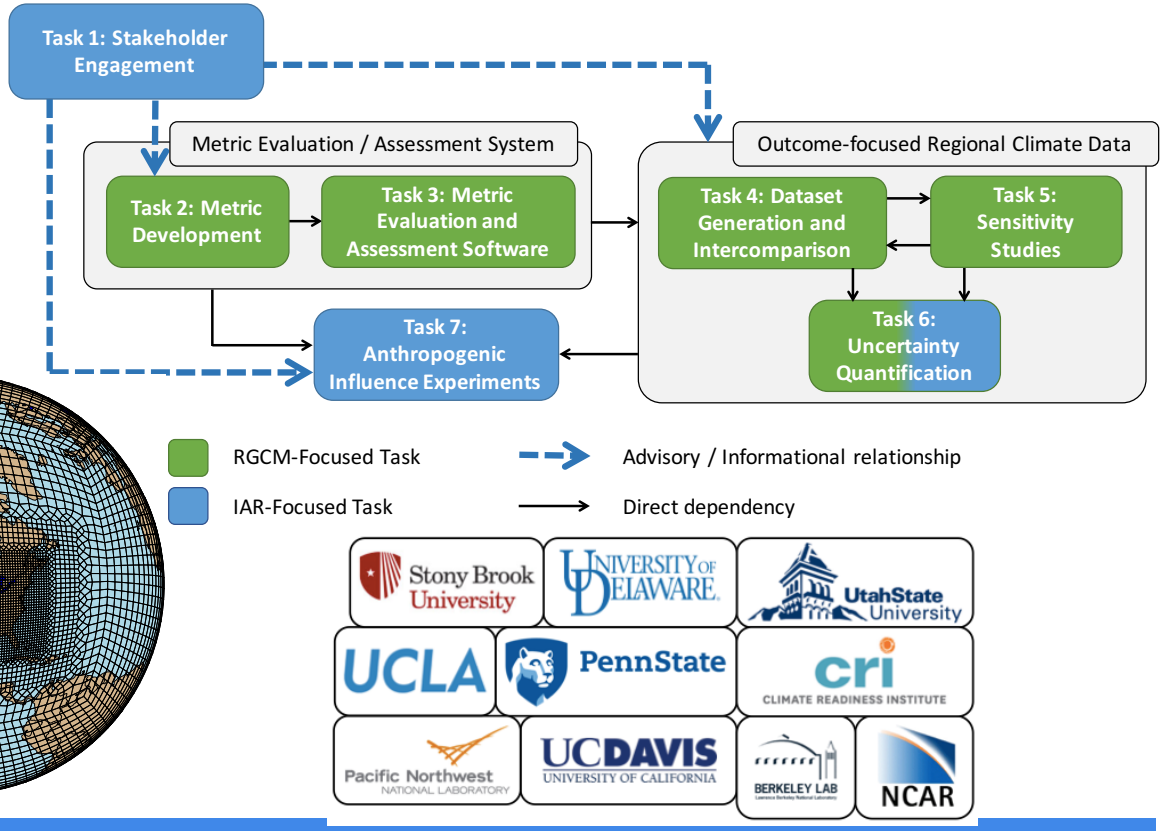
Links with Hydrologic Models

- WEAP, ALM-MOSART, CLM-PAWS

Time Periods

- **Baseline Historical:** 1986 - 2015
- **Near-Term Future:** 2016 - 2055





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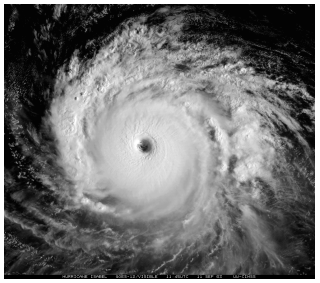

Final Thoughts

- The decadal CAM5 simulations compare reasonably well to global hurricane counts (and other extreme weather events). BUT, there are still biases regionally.
- We can start to use these models to explore climate controls of TCs (*and other extremes*) at decadal timescales.
- Significant work has been done by other modeling groups (i.e., *US CLIVAR Hurricane Working Group*, *HiResMIP*) and for other extremes (as we have seen this week).
- The number of TCs decreases globally in a warming climate in CAM5, while the intensity of the strongest storms increases. This is also true in individual regions.

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