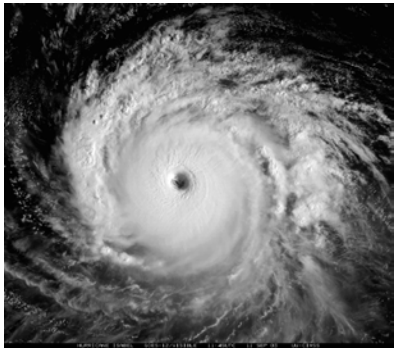
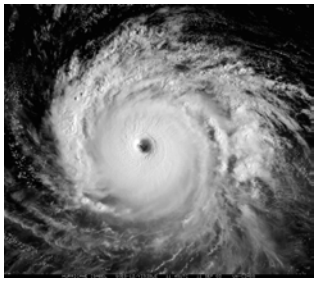


Rotating and non-rotating global radiative-convective equilibrium in CAM

Kevin A. Reed

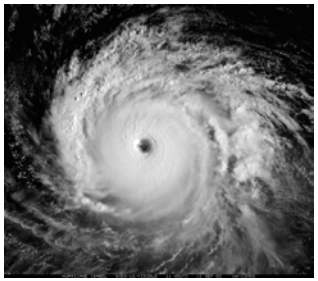
National Center for Atmospheric Research

Brian Medeiros, Julio Bacmeister, Peter Lauritzen, John Truesdale, Andrew Gettelman, Brian Eaton & others



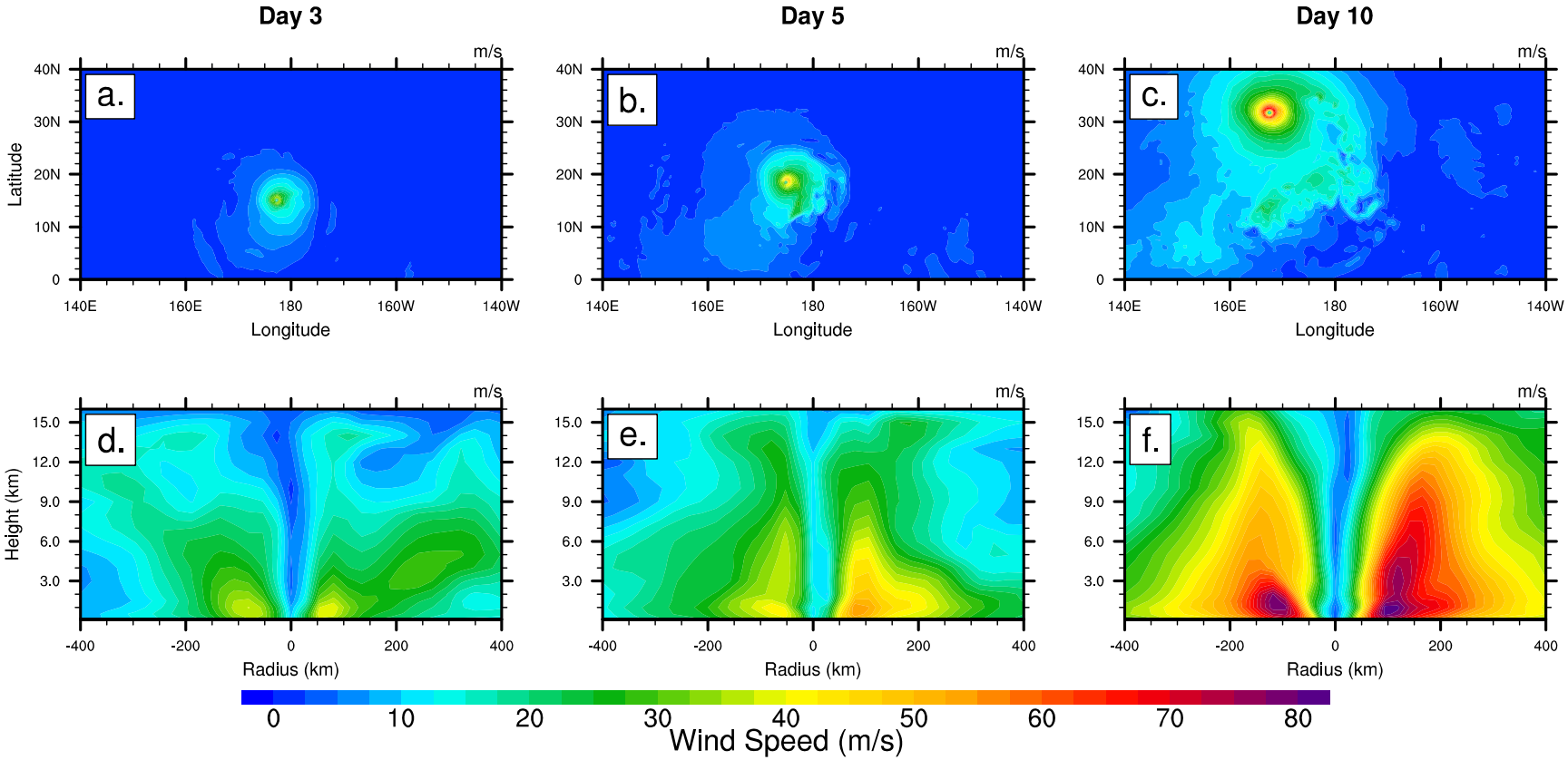
Motivation

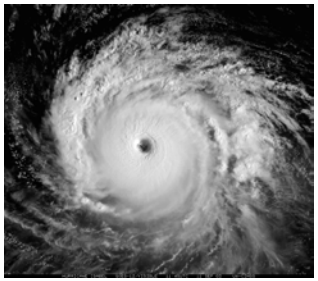
- CAM 5 has shown some *"skill"* in simulating extreme weather events, especially at higher horizontal resolutions (~ 25 km).
- This is particularly true for the simulation of Tropical Cyclones (TCs).



Idealized TCs in CAM 5

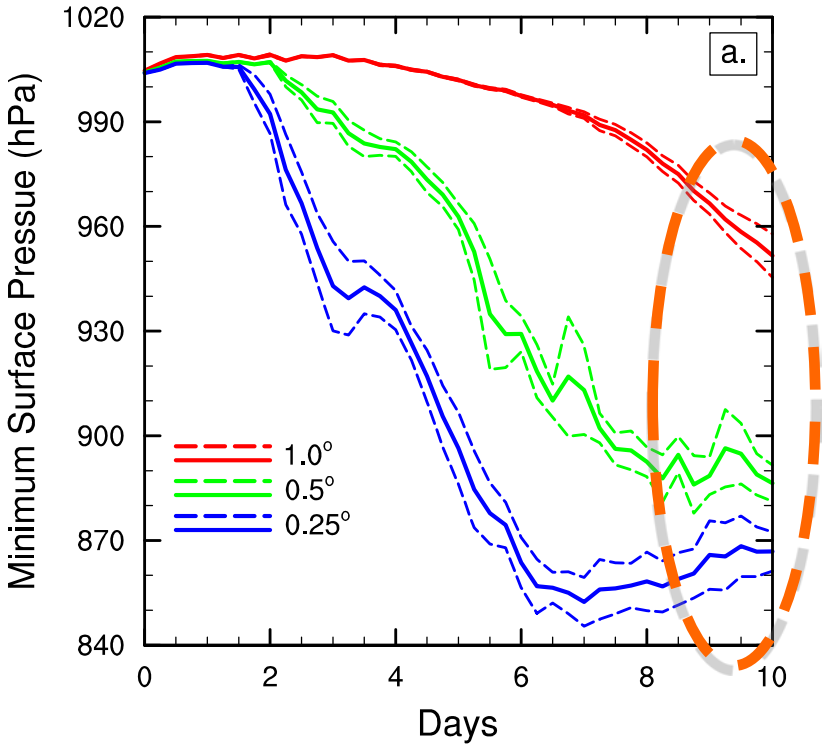
Wind Speed for 0.25^o by 0.25^o Simulation



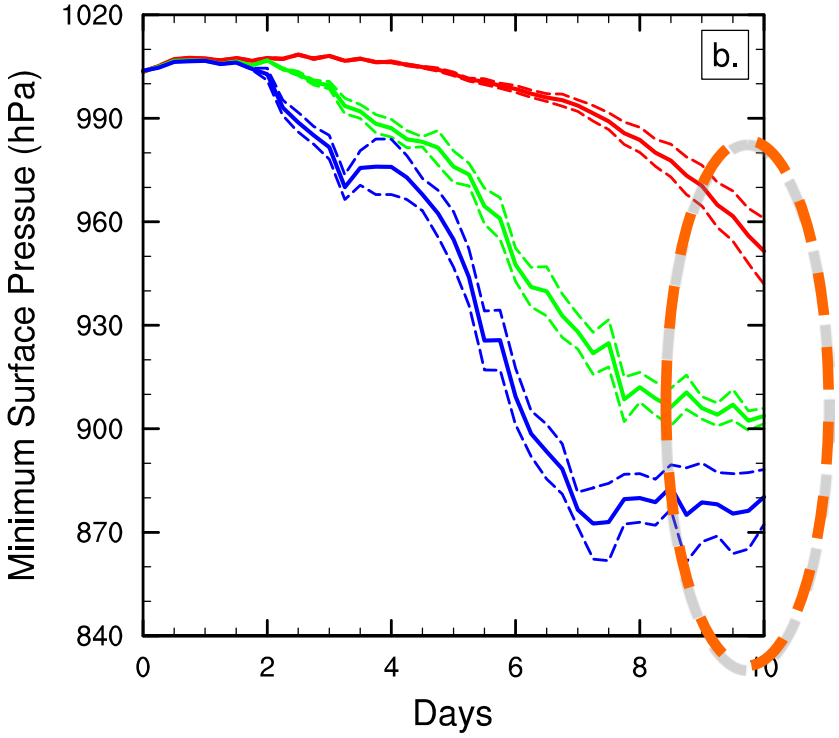


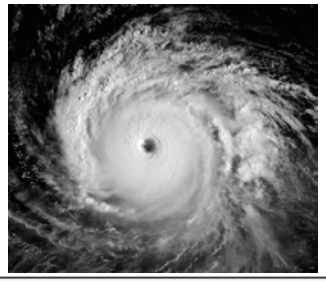
Minimum surface pressure, resolution dependence

SE

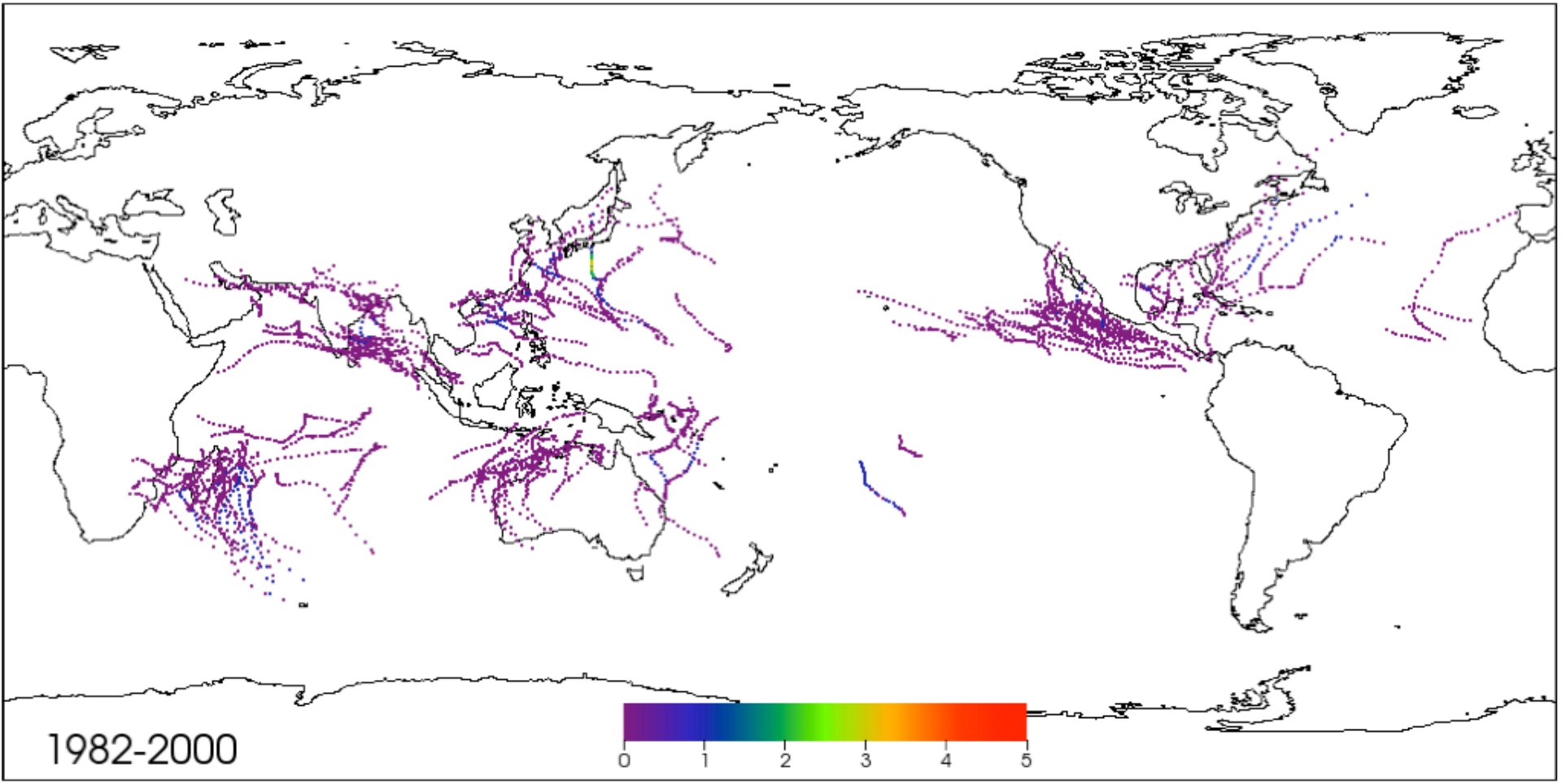


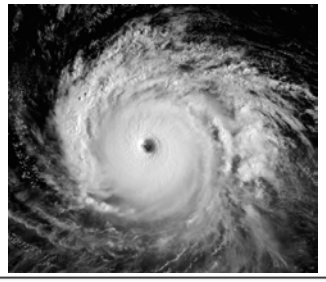
FV



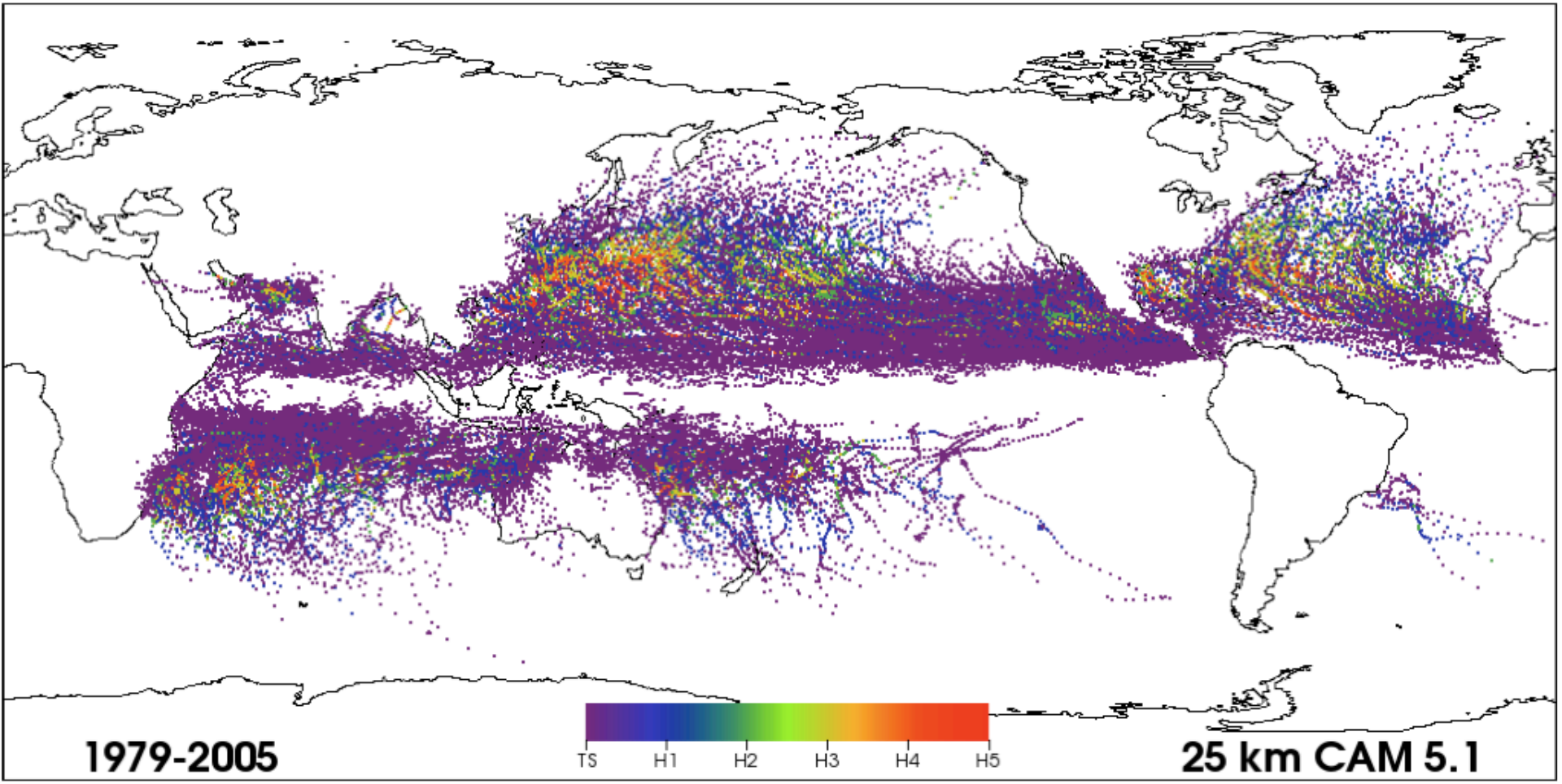


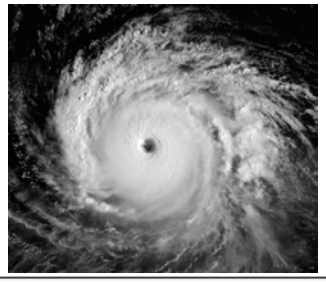
CAM5-FV 0.9º by 1.25º Storm Tracks



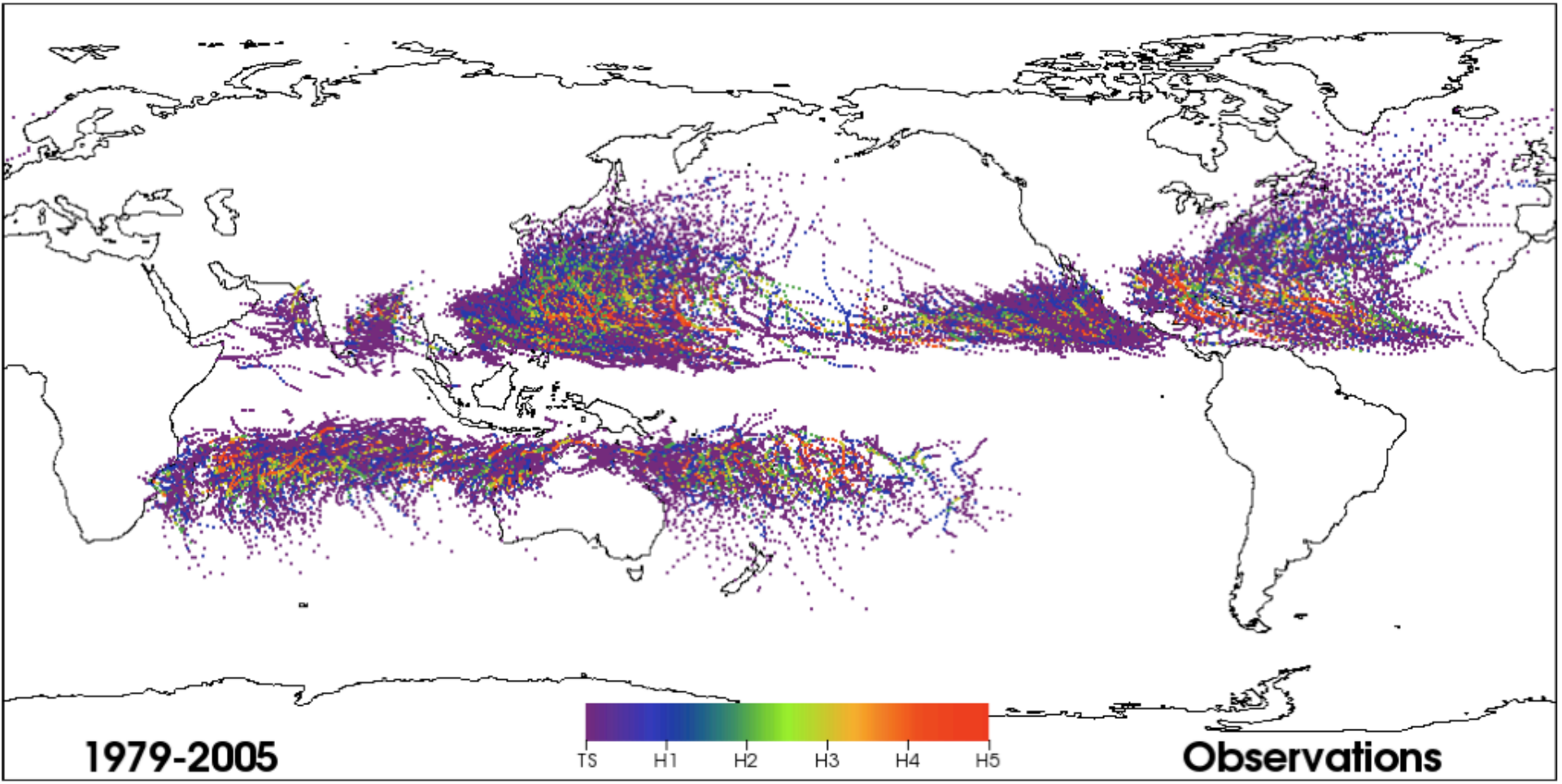


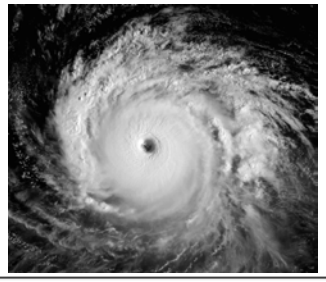
CAM5-FV 0.23º by 0.31º Storm Tracks



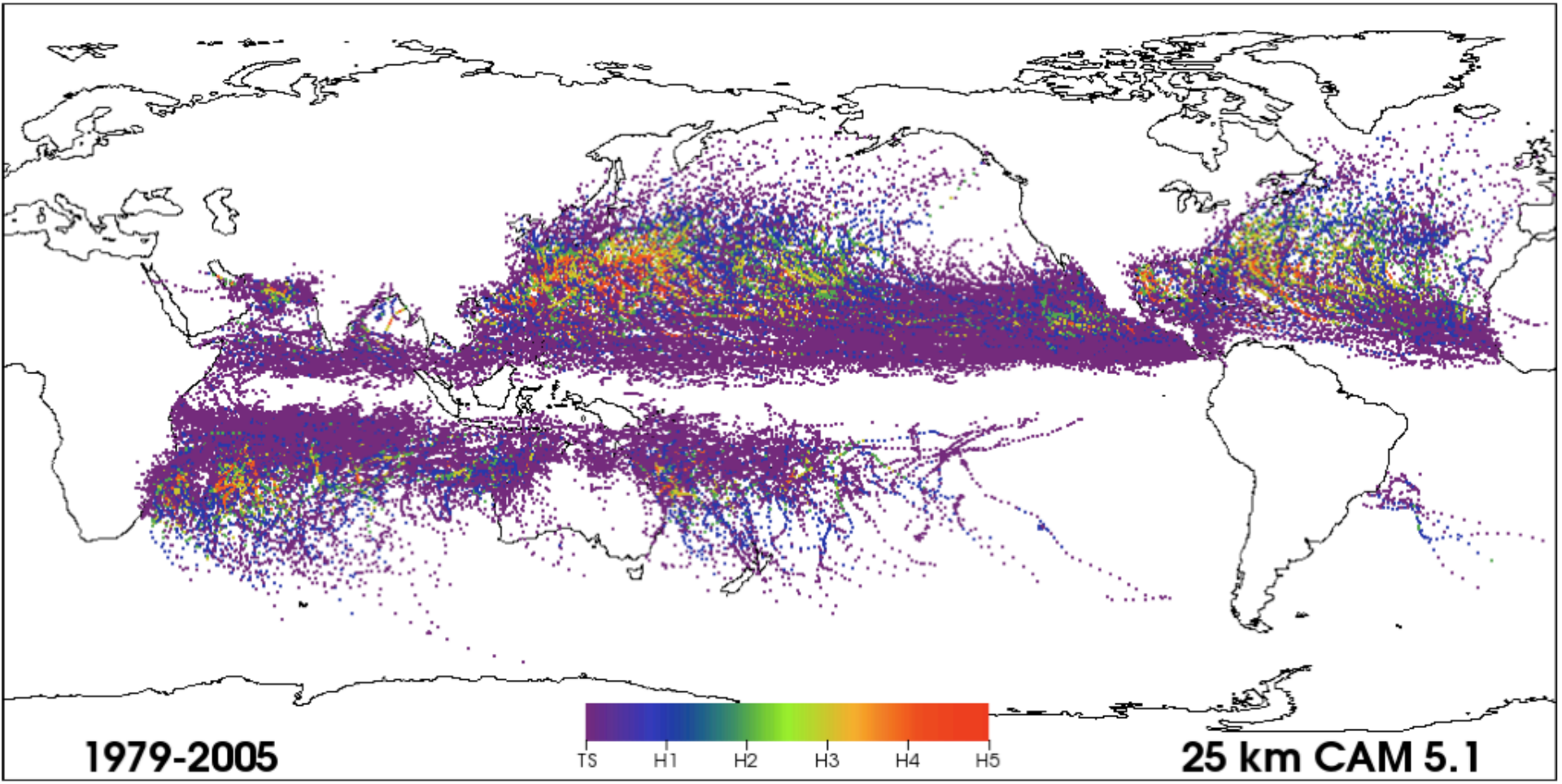


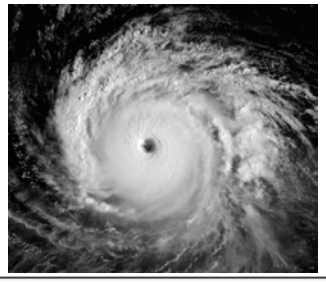
Observations



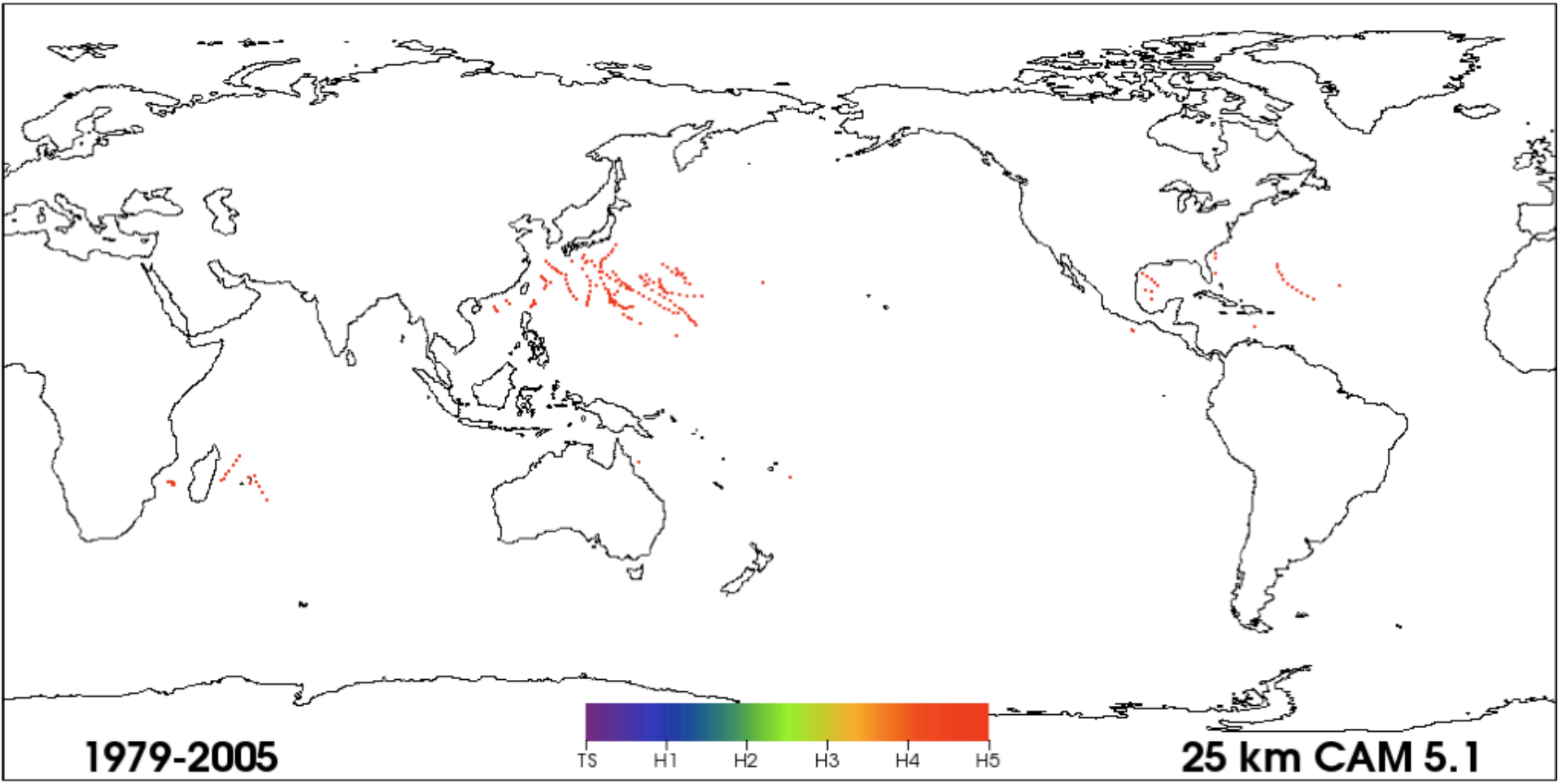


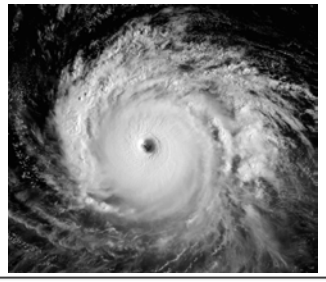
CAM5-FV 0.23º by 0.31º Storm Tracks



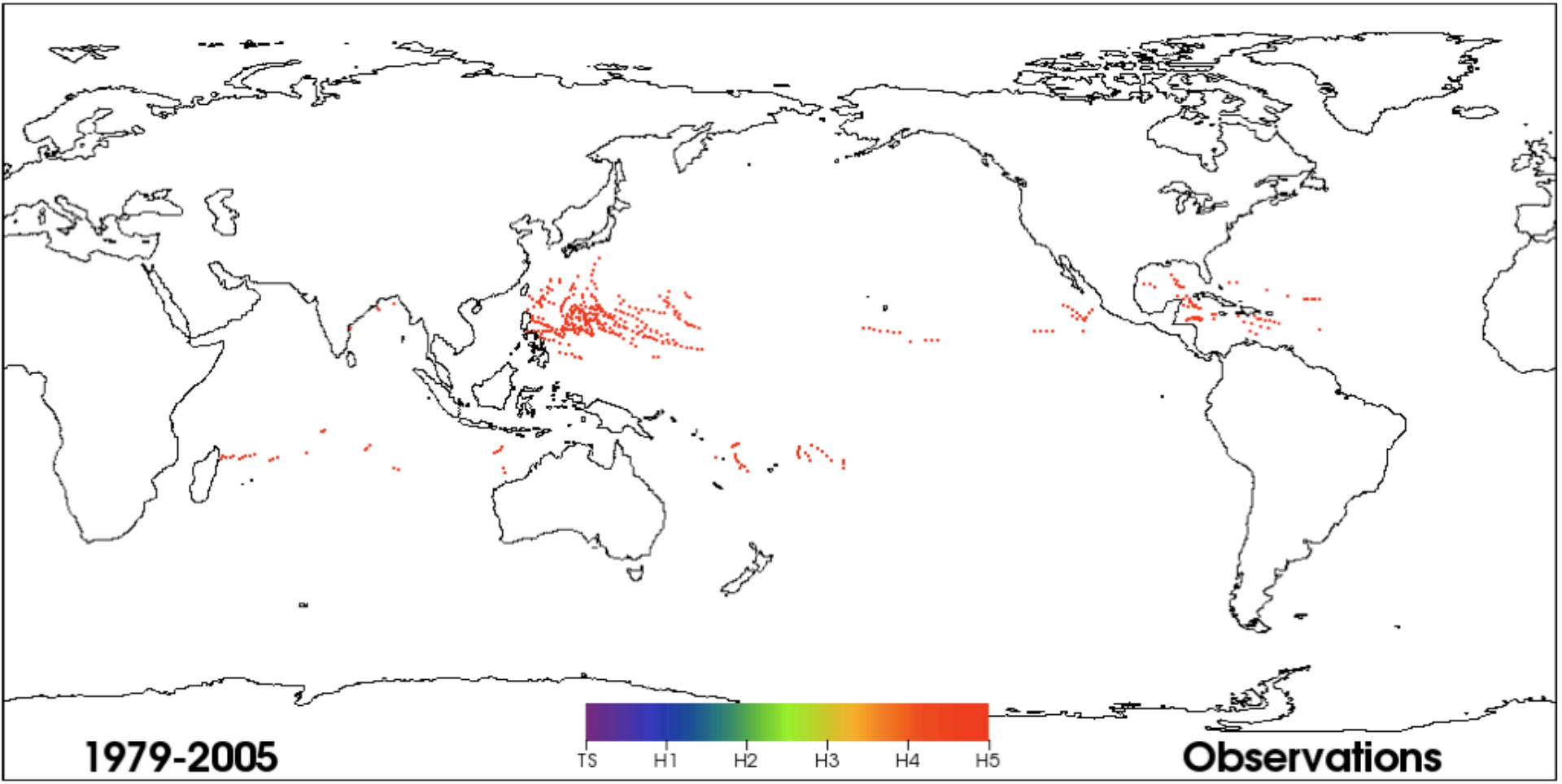


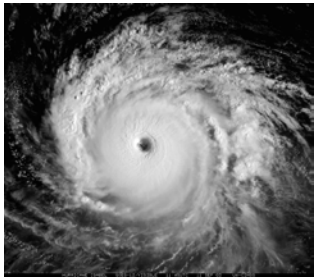
CAM5-FV 0.23º by 0.31º Category 5





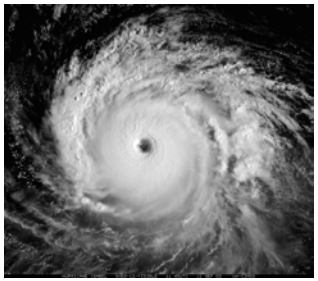
Observations Category 5





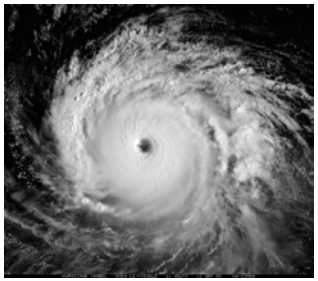
Motivation

- There is still much room for improvement as there exist biases in intensity, track duration, regions of formation, etc.
- In addition, there is uncertainty in the tuning of the model at these high horizontal resolutions and its impact on extremes.
- Here, we propose using an intermediate test bed to provide insight into the simulation of tropical climate at high-resolutions, as well as the model's ability to simulate extreme events such as tropical cyclones.



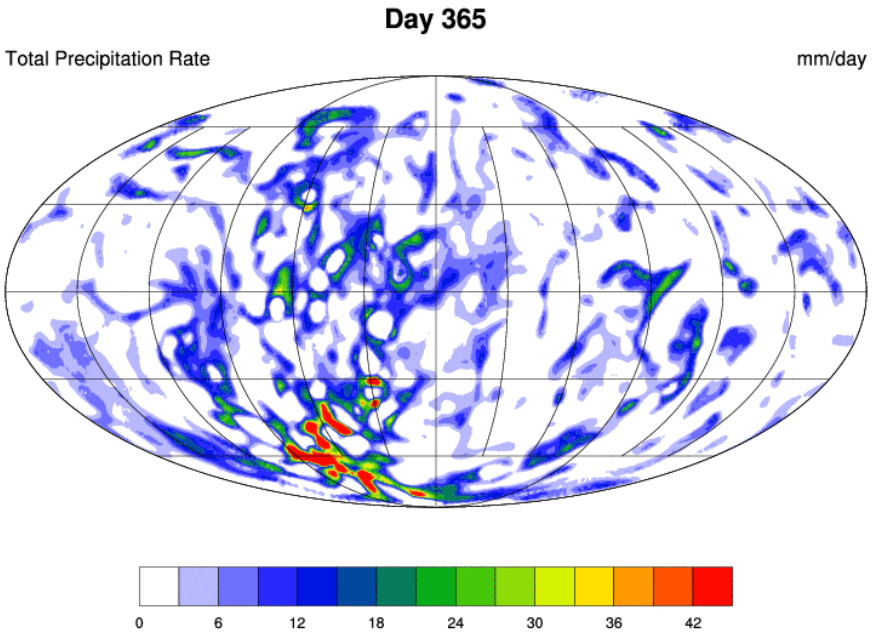
Design of Experiments

- NCAR's Community Atmosphere Model version 5.3 (CAM 5.3).
- The SE dynamical core with 30 vertical levels is used at the horizontal resolutions of:
  - ne=30 (~100 km)
  - ne=120 (~25 km)
- Full physics in Aquaplanet mode is used, with a simplified ocean covered Earth and constant SST of 29^{o} C.
- No rotation effects or spatially uniform rotation effects.
- Diurnally varying, spatially uniform insolation (~340 W/m^2).
- No direct and indirect effects of aerosols.
  - Tuning parameters are set to ne=30 configuration for all simulations.

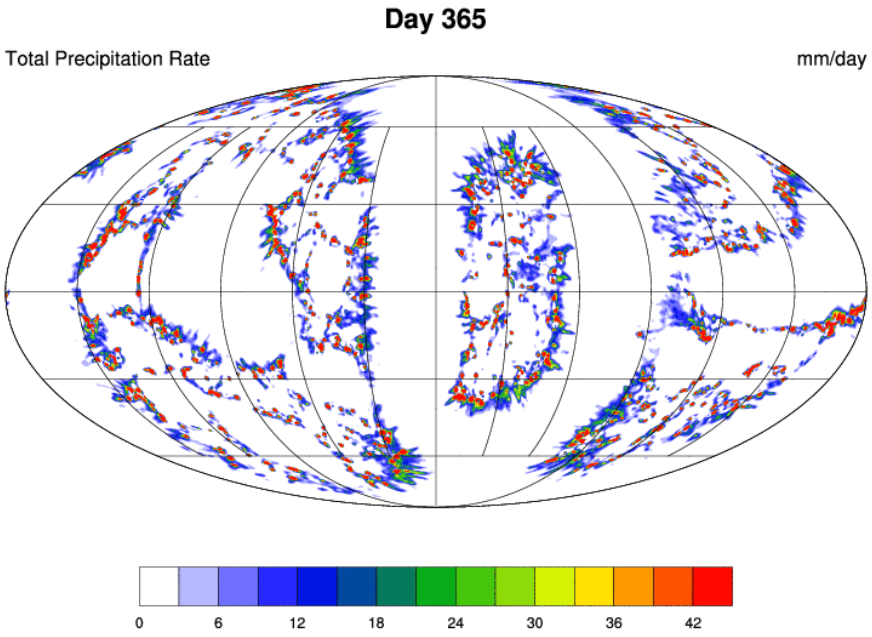


No Rotation: Resolution Comparison

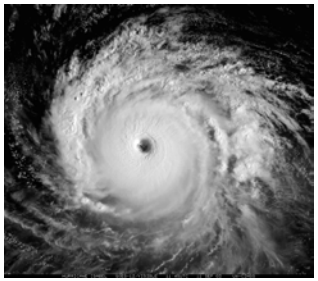
6-hr Avg. Precipitation (mm/day)



ne30 (~100 km)

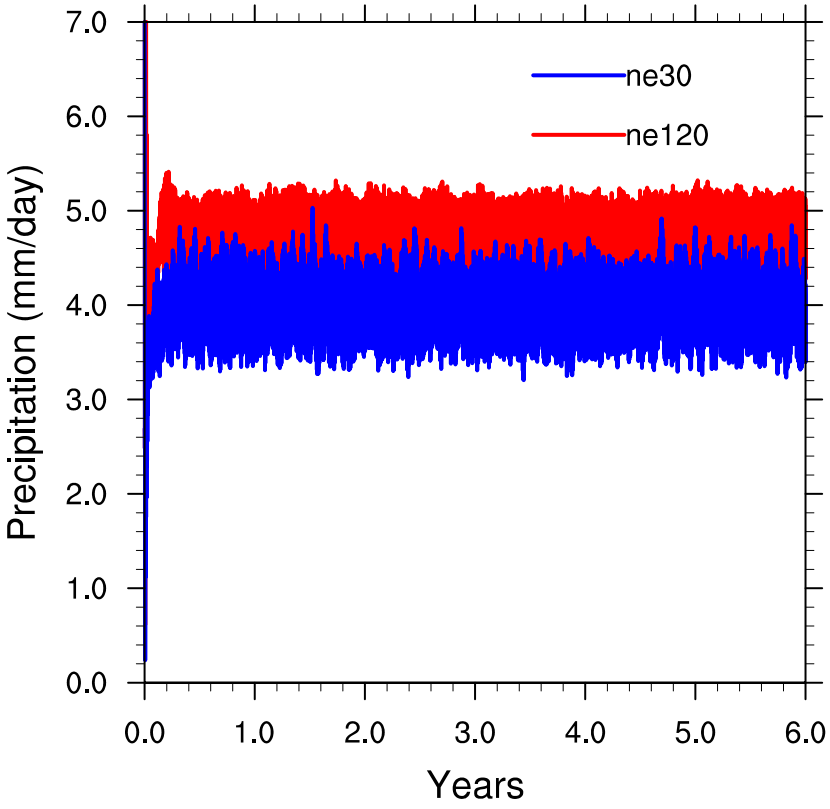


ne120 (~25 km)

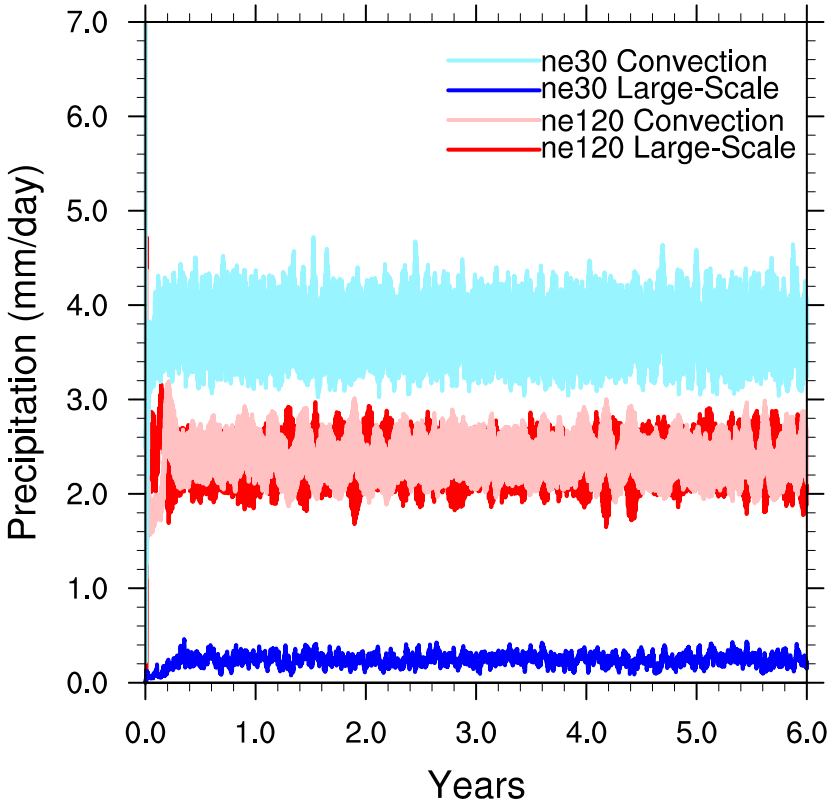


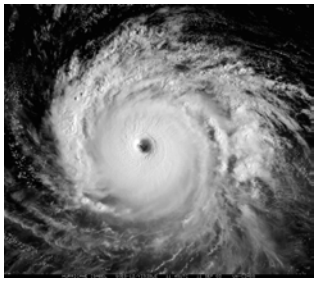
No Rotation: Precipitation Evolution

Total Precip

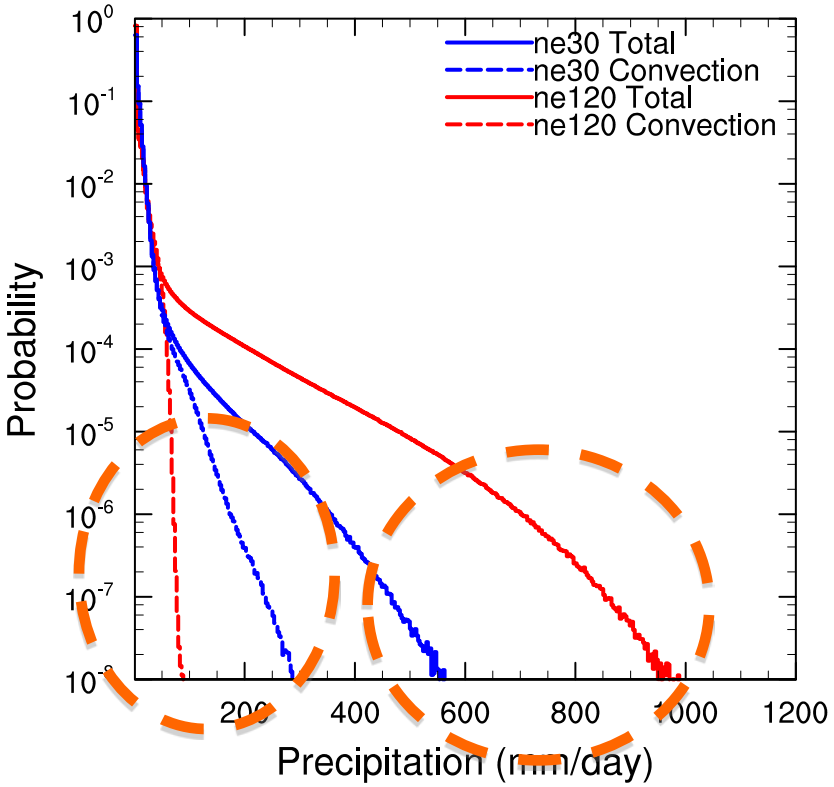


Convection & Large-Scale Precip

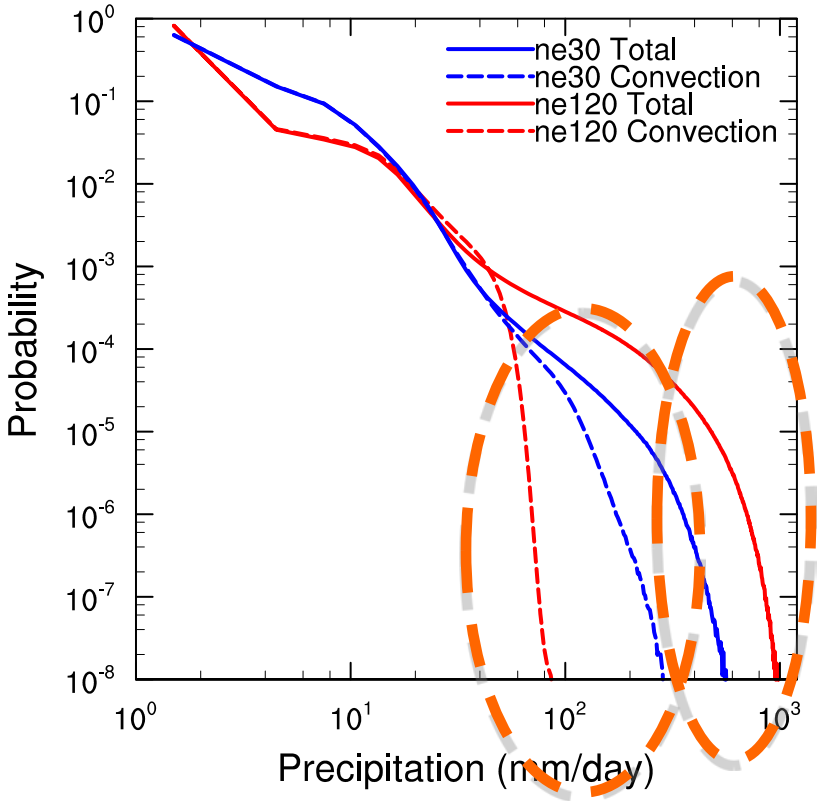




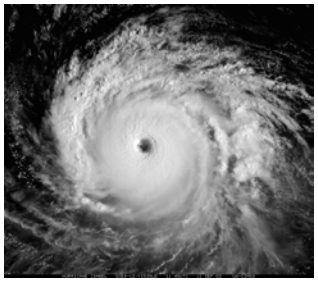
No Rotation: Precipitation PDF



Linear

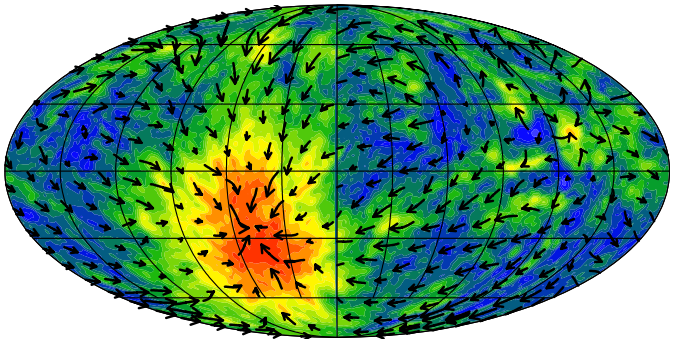


Log

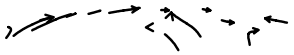


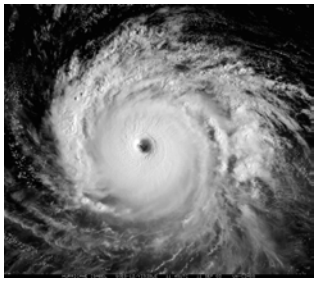
No Rotation: Structure

ne30 (~100 km)

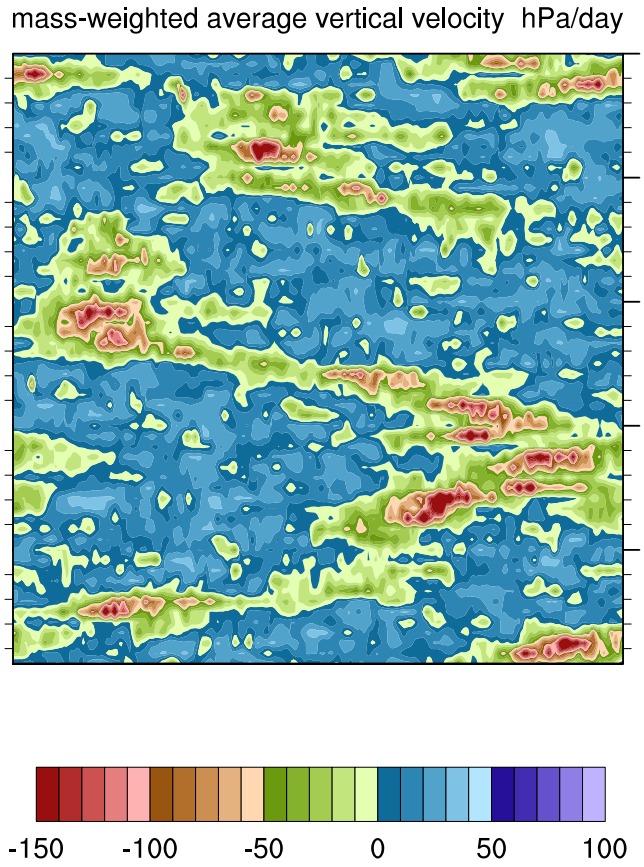


ne120 (~25 km)

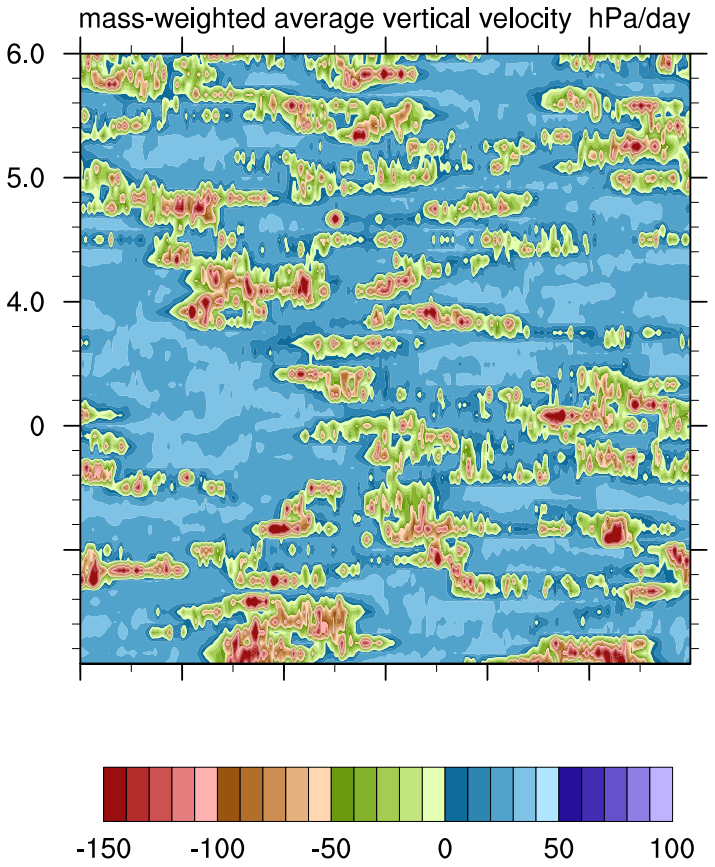




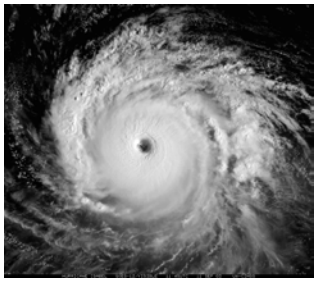
No Rotation: Structure Hovmoller, Vertical Vel.



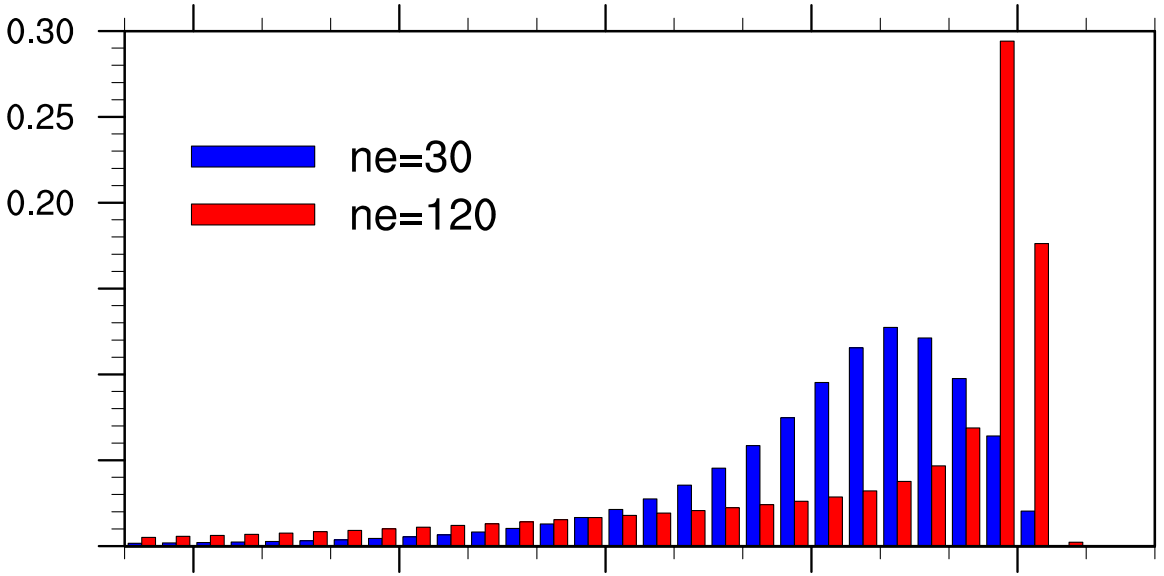
ne30 (~100 km)

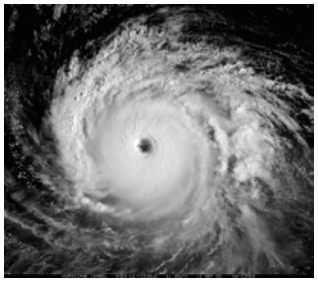


ne120 (~25 km)



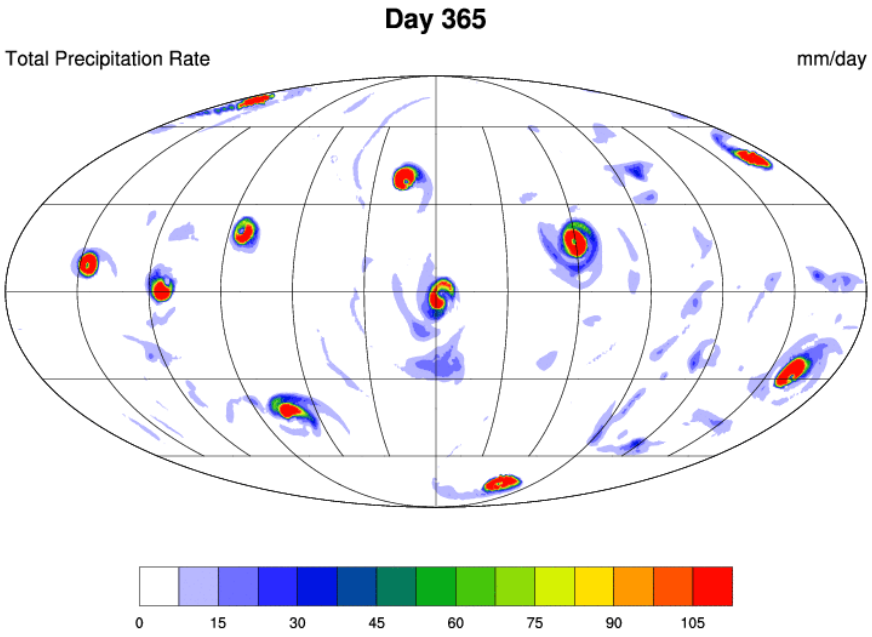
No Rotation: Vertical Velocity PDF



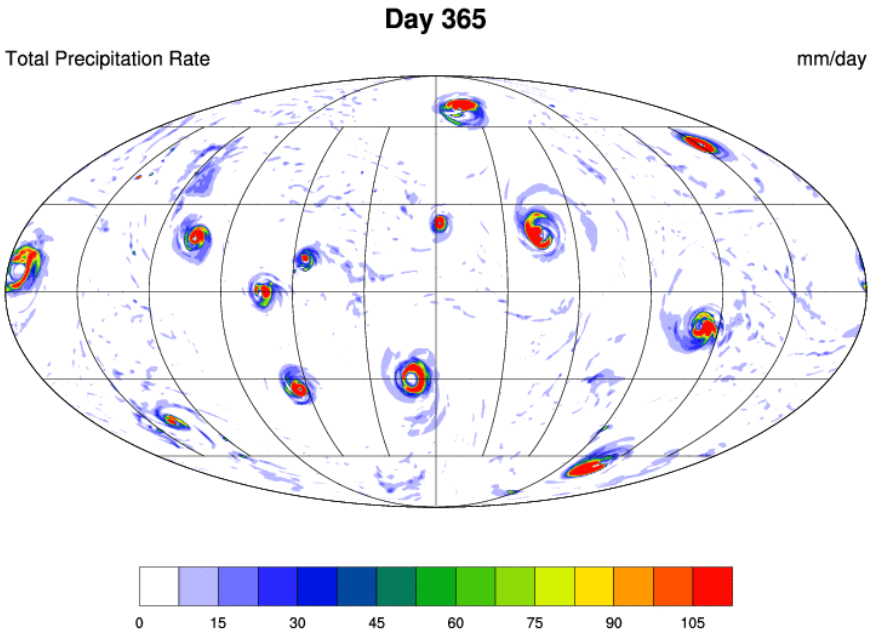


With Rotation: Resolution Comparison

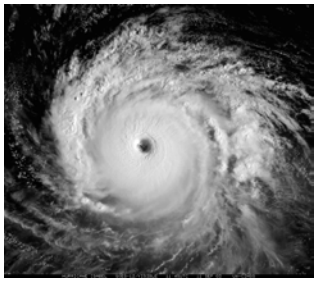
6-hr Avg. Precipitation (mm/day)



ne30 (~100 km)



ne120 (~25 km)



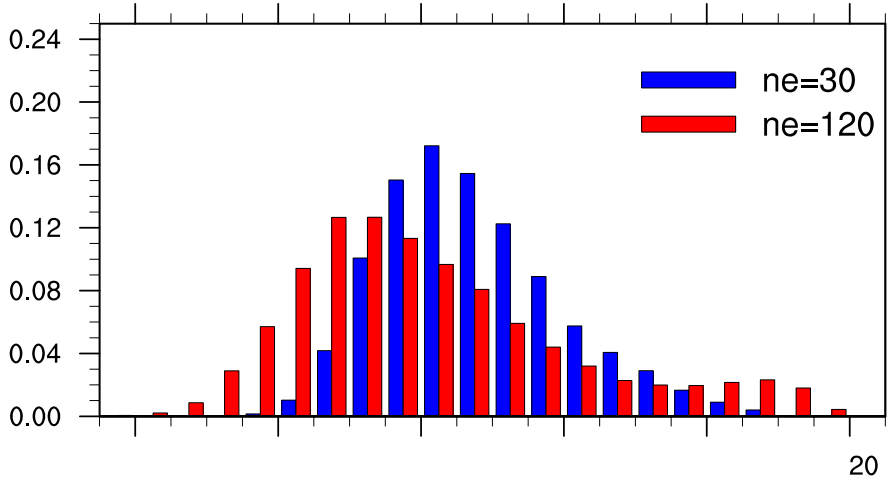
With Rotation: TC Intensity Distribution

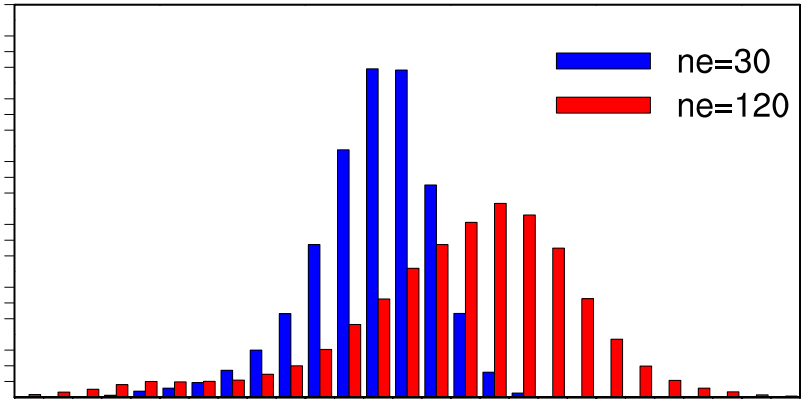
ne30:

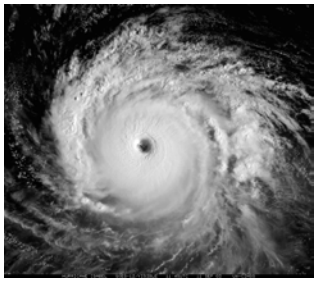
- Avg. Count = 10.916
- Avg. Max. Wind = 34.7237 m/s
- Avg. Min. PS = 967.37 hPa

ne120:

- Avg. Count = 12.9348
- Avg. Max. Wind = 40.4816 m/s
- Avg. Min. PS = 961.36 hPa

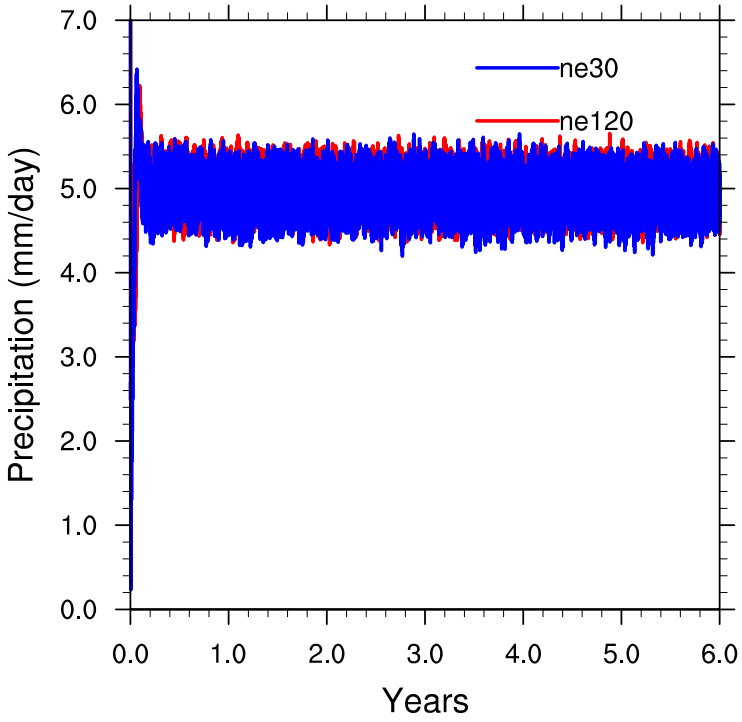




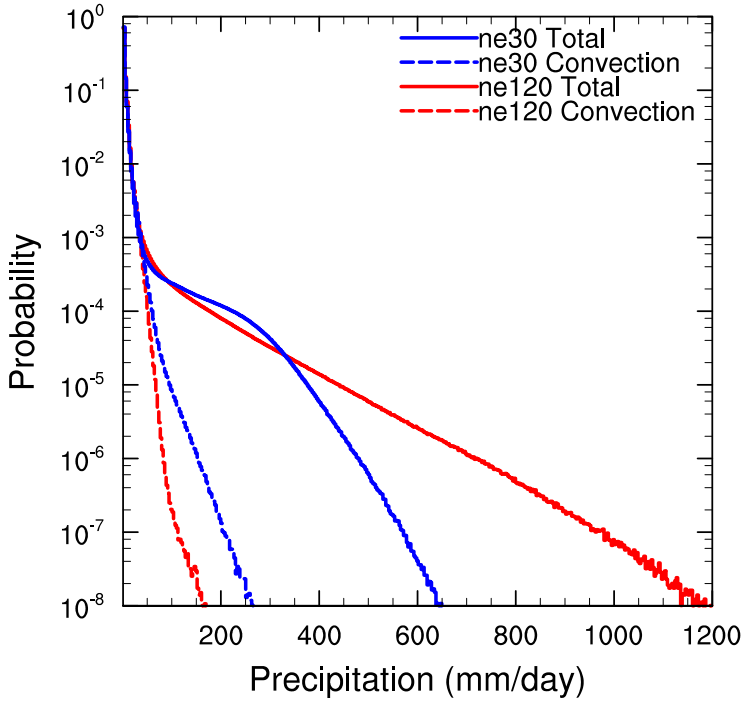


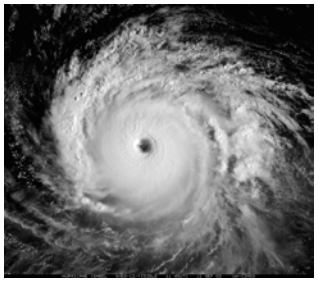
With Rotation: Precipitation Evolution

Total Precip

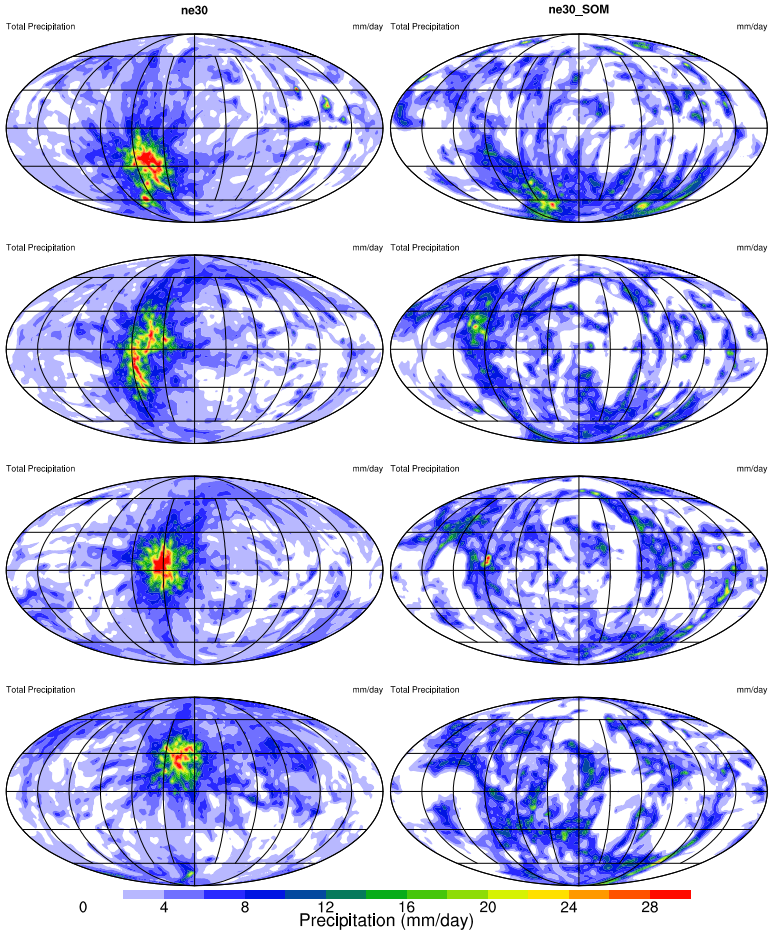


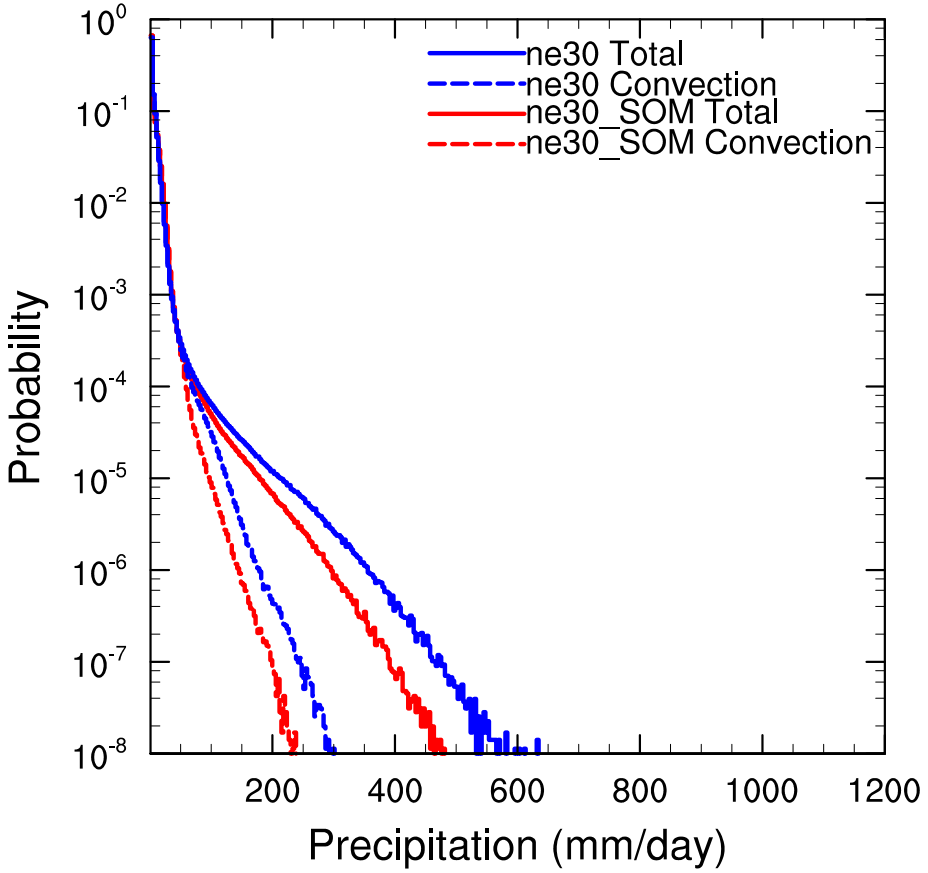
Precip PDF

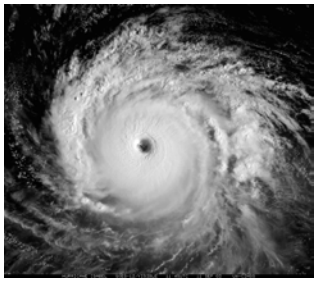




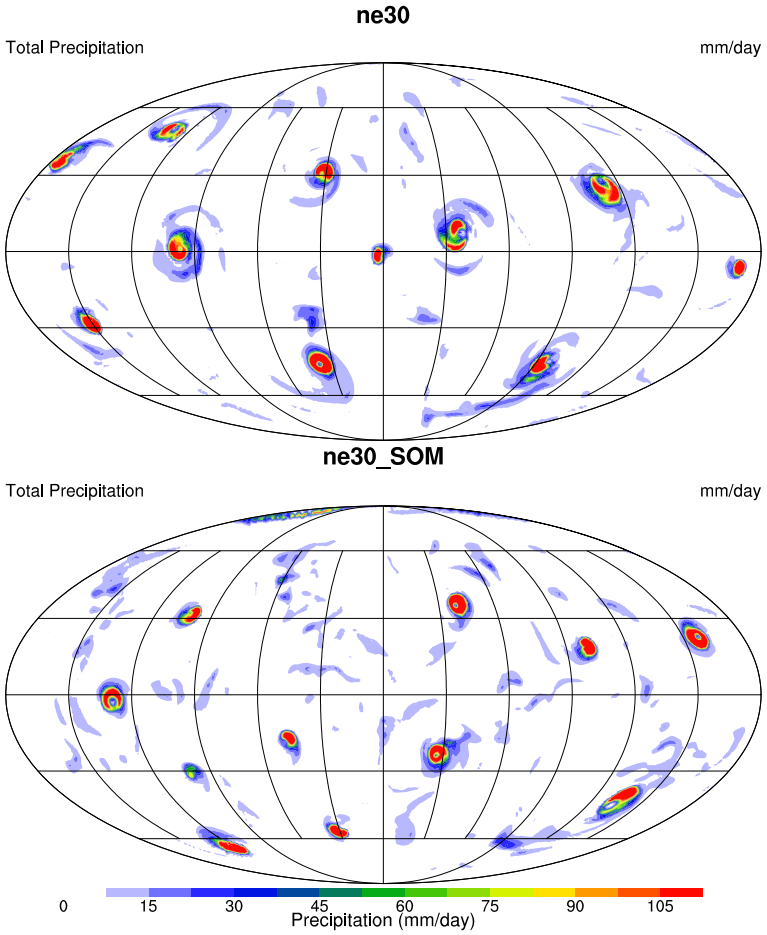
Preliminary SOM Results

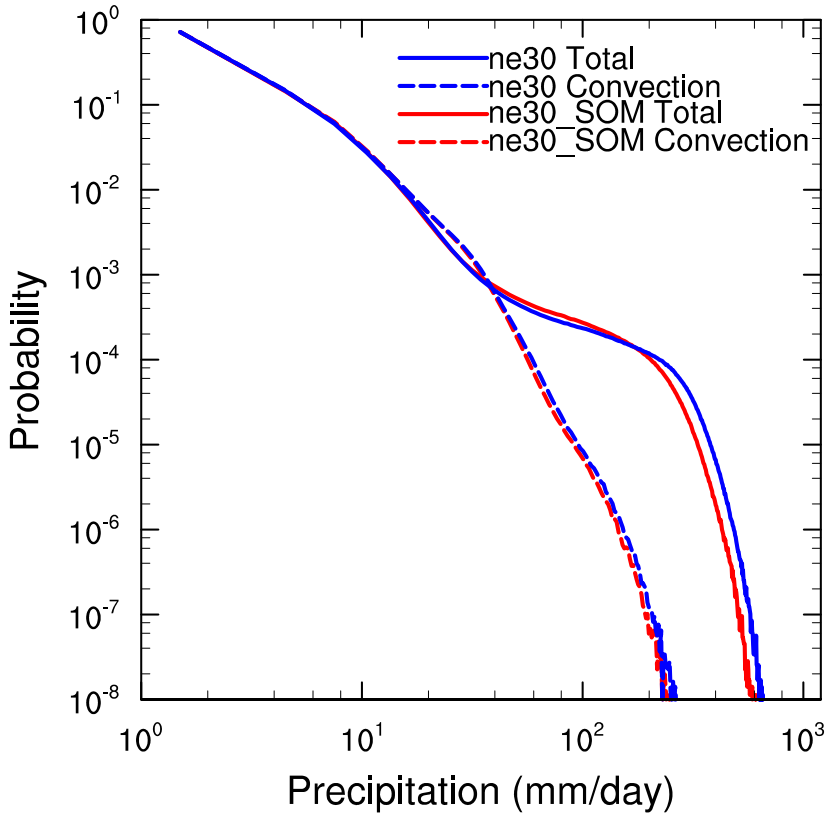


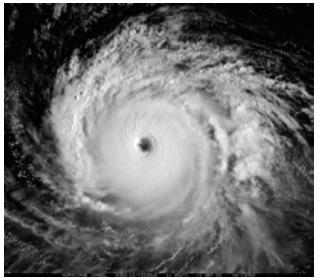




Preliminary SOM Rotation

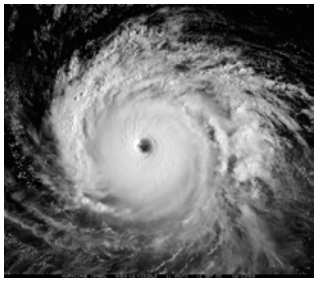






Final Thoughts

- We have introduced an intermediate test bed to provide insight into the simulation of tropical climate at high-resolutions, as well as the model's ability to simulate extreme events such as tropical cyclones.
- In the cases with no rotation the impact of resolution is quite striking, as the general structure of the RCE world differs greatly.
- These resolution differences are much less apparent when uniform rotation is used, as the resulting TC world appears to have a preferred regime with 11-13 tropical cyclones on the globe at any given time. There are differences in the storm intensities, but not nearly as substantial as seen with the full AMIP simulations.
- Further experiments with the Slab Ocean Model are needed.



Thanks!