

The impacts of high-resolution refinement in variable-resolution CAM-SE on regional climate in CESM

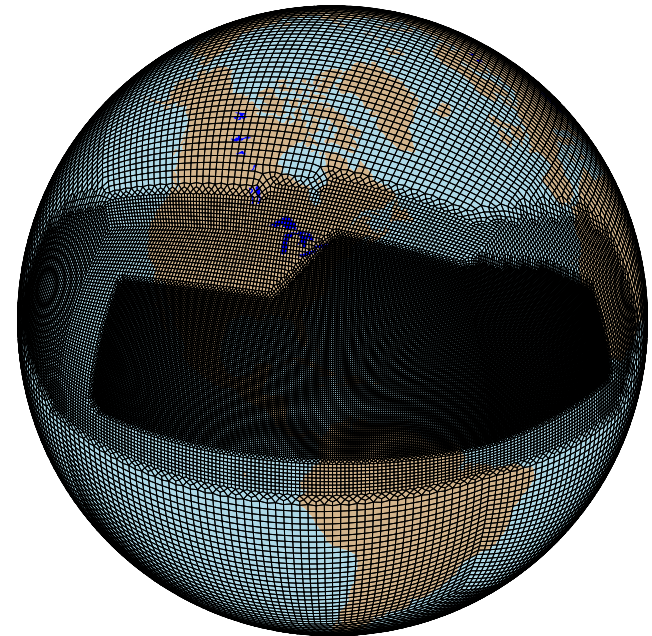
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Mark Taylor
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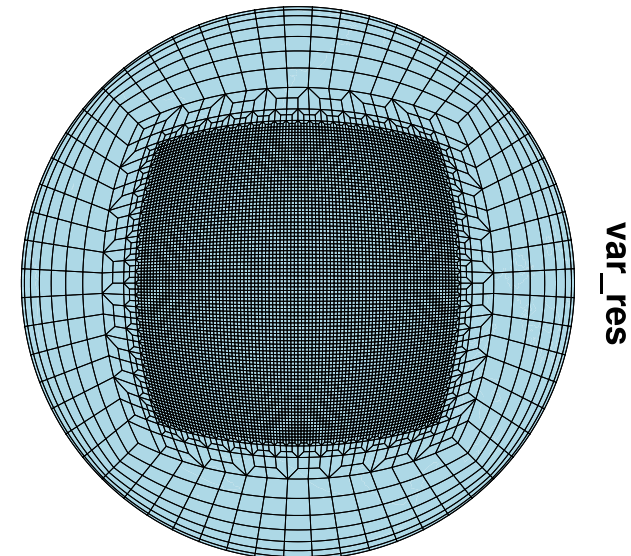
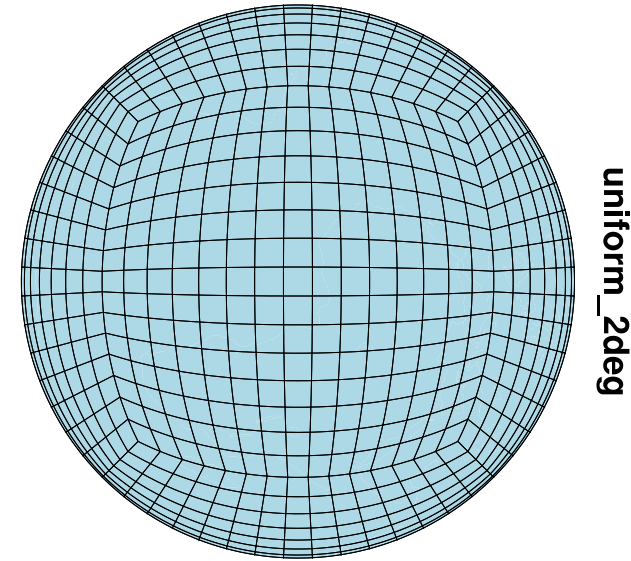
Overview

- Variable-resolution CAM-SE
 - Conforming
 - Quadrilateral
- Explicit diffusion (hyperviscosity) varies with element size
- Timestep globally restricted to finest scale
- Two frameworks for investigating climatology
 - Aquaplanet
 - Coupled CESM



Aquaplanet simulations

- CAM4/CAM5 aquaplanet simulations
 - Uniform coarse grid ($\sim 2^\circ$)
 - Uniform fine grid ($\sim 0.25^\circ$)
 - Var-res ($\sim 2^\circ \rightarrow \sim 0.25^\circ$)
- Standard APE protocols
 - CAM5 uses prescribed bulk aerosols with sulfate correction

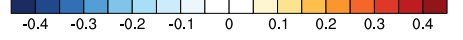
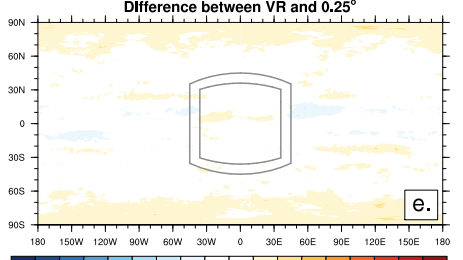
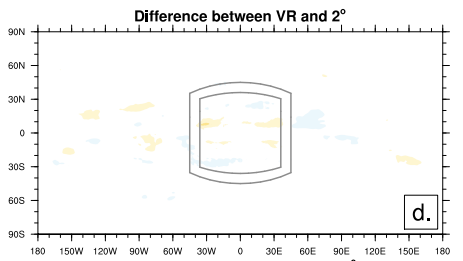
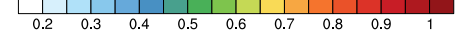
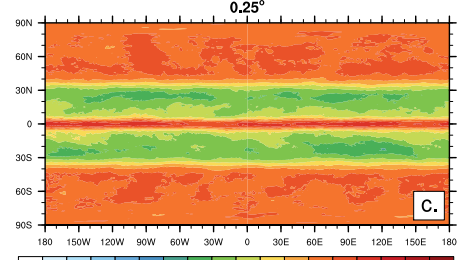
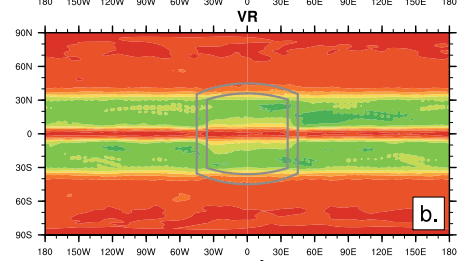
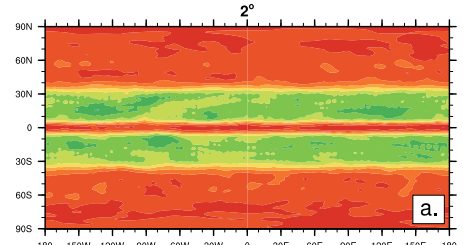
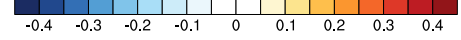
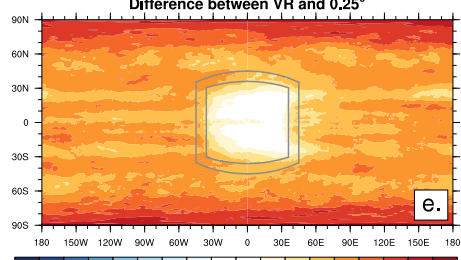
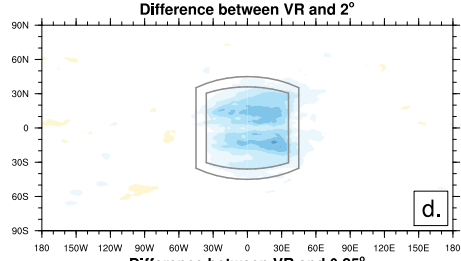
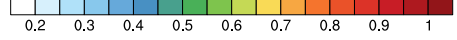
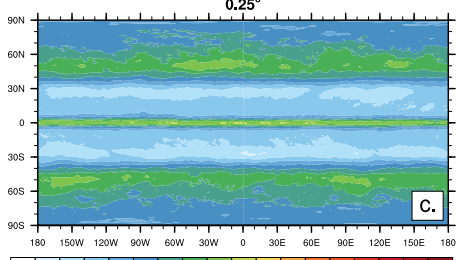
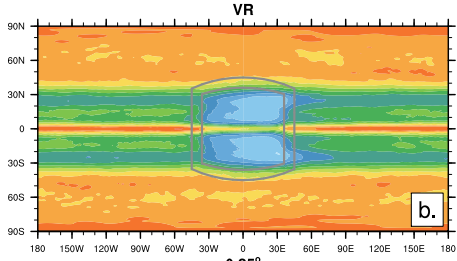
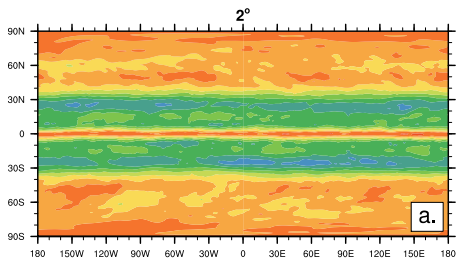


Zarzycki, C.M., M. Levy, C. Jablonowski, J.R. Overfelt, M.A. Taylor and P.A. Ullrich "***Aquaplanet Experiments Using CAM's Variable Resolution Dynamical Core***" Submitted to J. Clim.

Cloud (total) climatology

CAM4

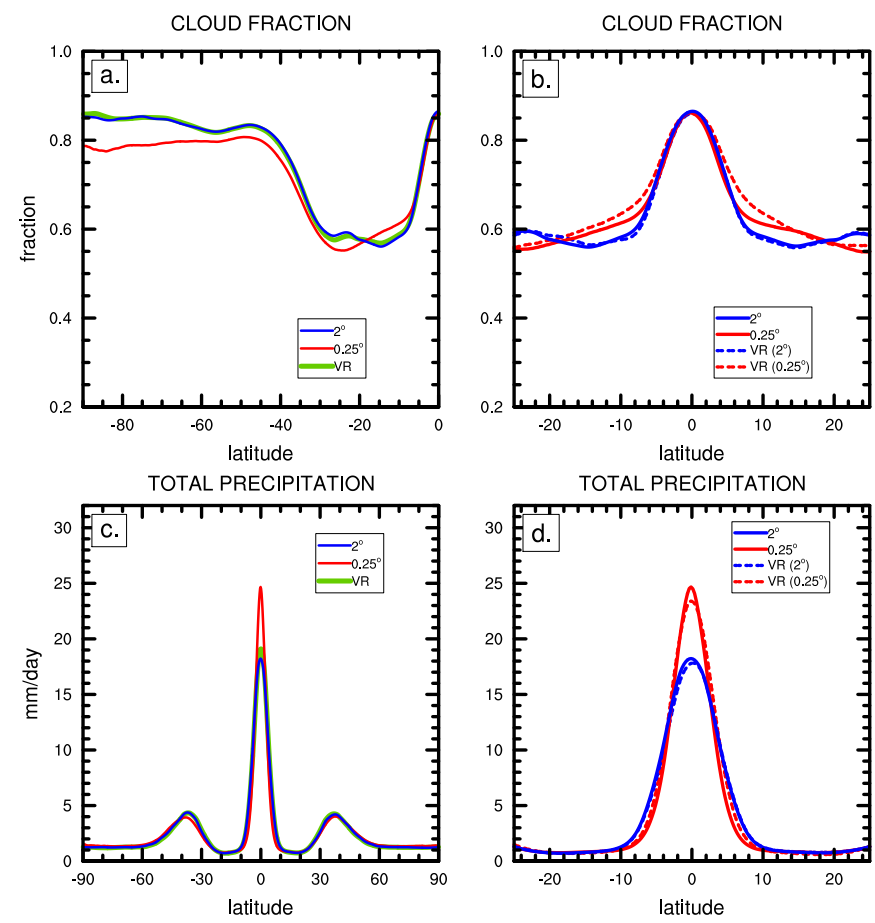
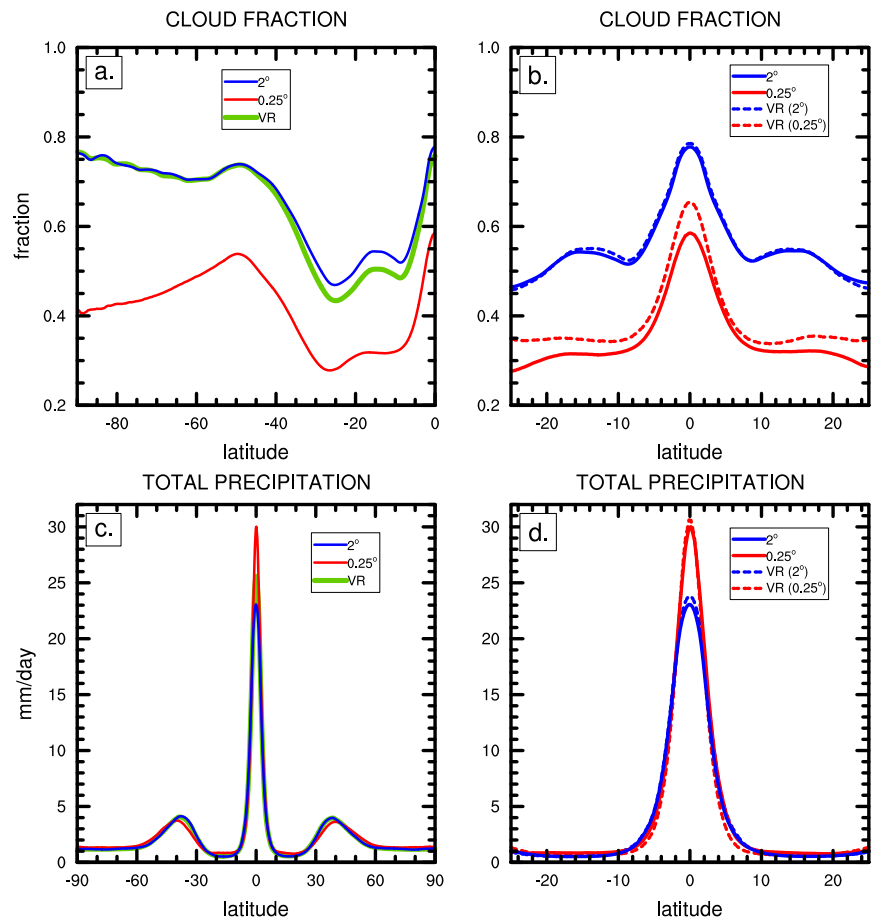
CAM5



Cloud and precip profiles

CAM4

CAM5



Hemispheric average

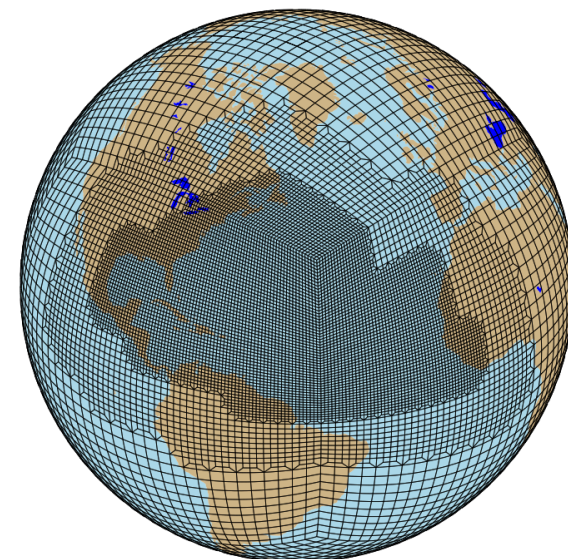
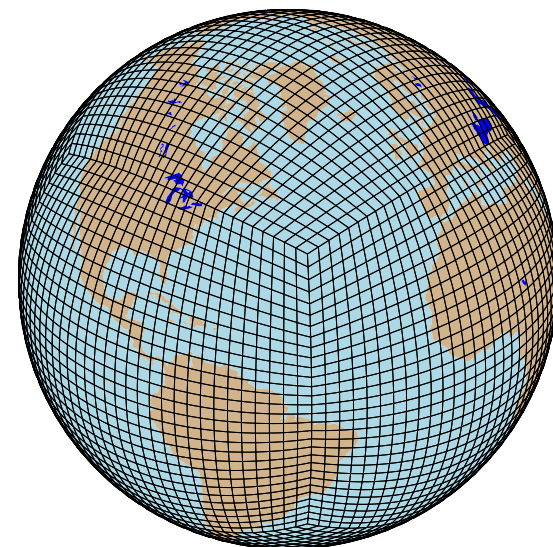
Zoom on tropics

Hemispheric average

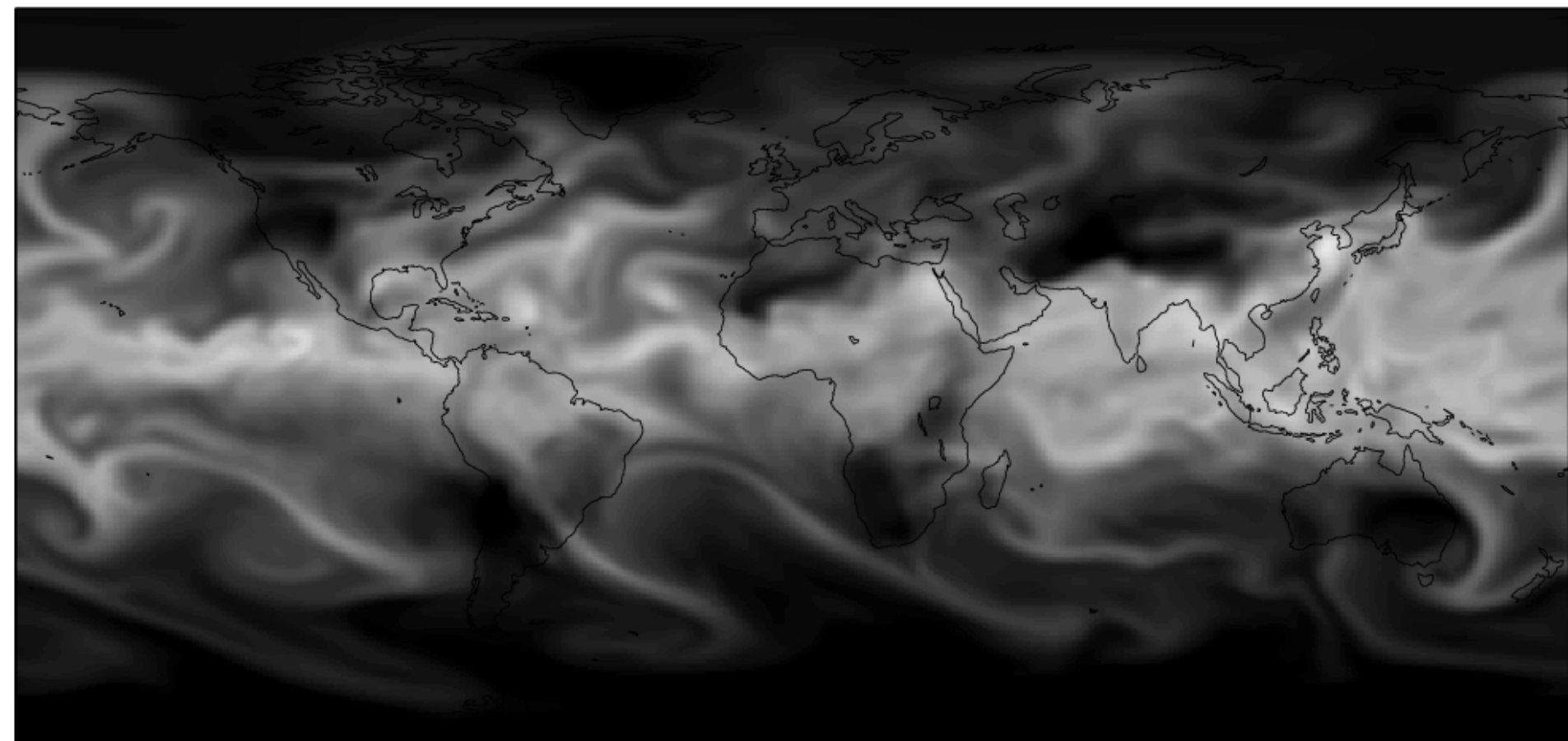
Zoom on tropics

CESM AMIP simulations

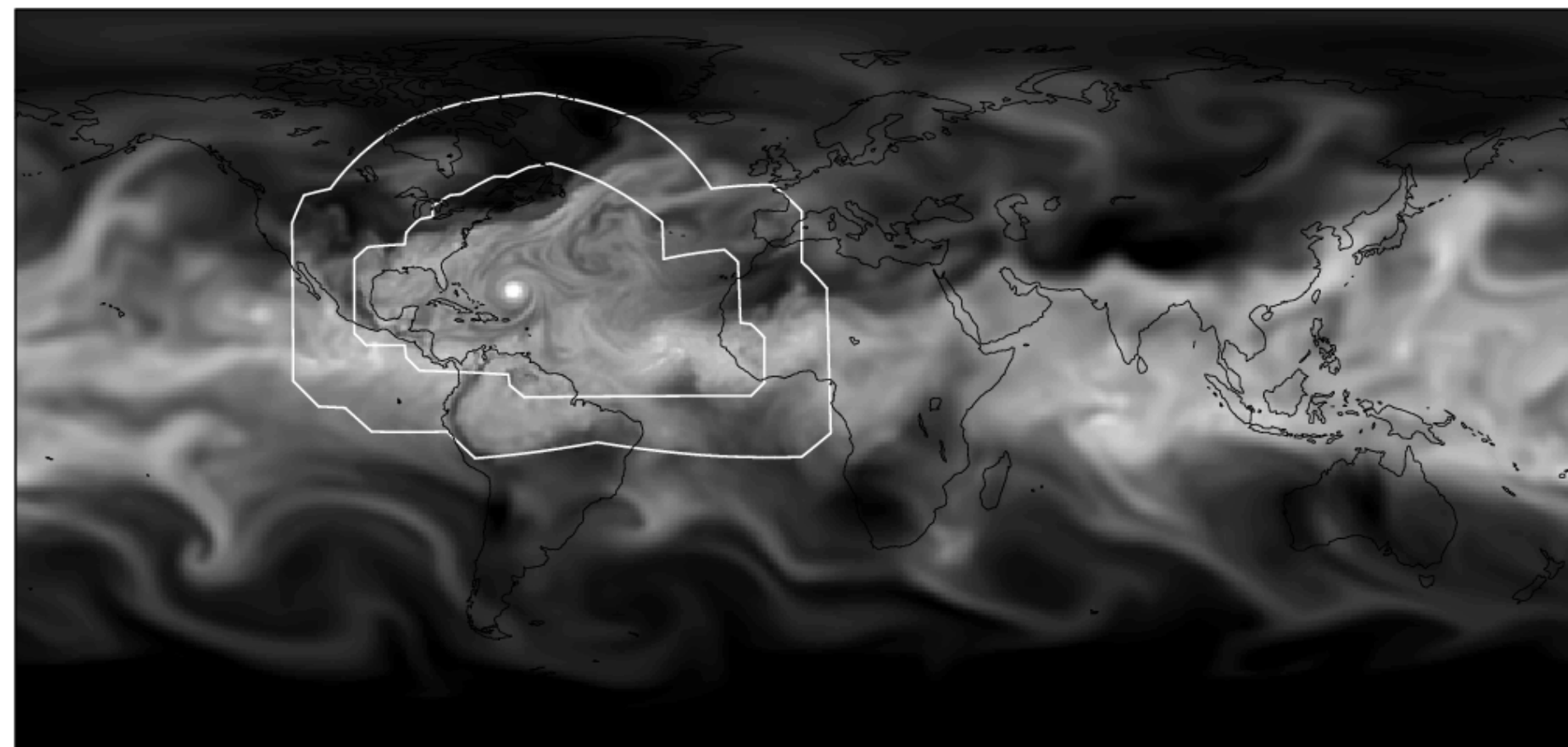
- CESM framework
 - Land: $FV0.9^\circ \times 1.25^\circ$ - active
 - Ocean/Ice: $gx1v6$ ($\sim 1^\circ$) - prescribed
- AMIP protocols
 - 1980-2002 (23 years)
- Two different atmosphere grids
 - Globally uniform 1° (UNI) (~ 110 km)
 - Variable-resolution (VR) (~ 110 km base grid, ~ 26 km refinement over Atlantic)



Uniform global simulation



Multi-resolution global circulation

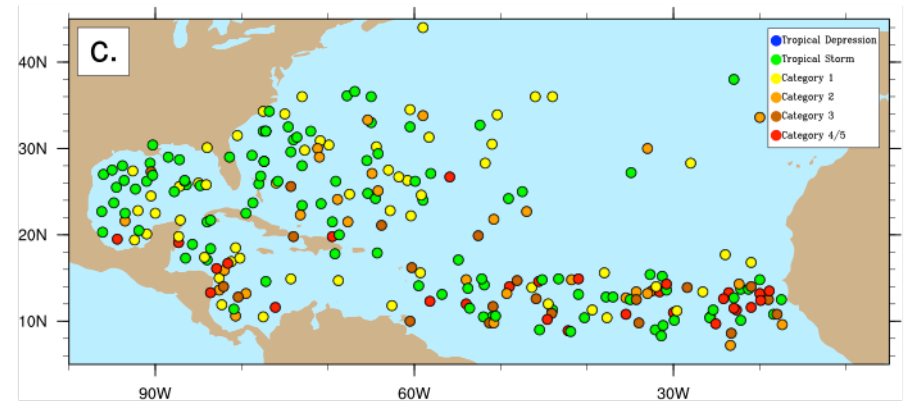
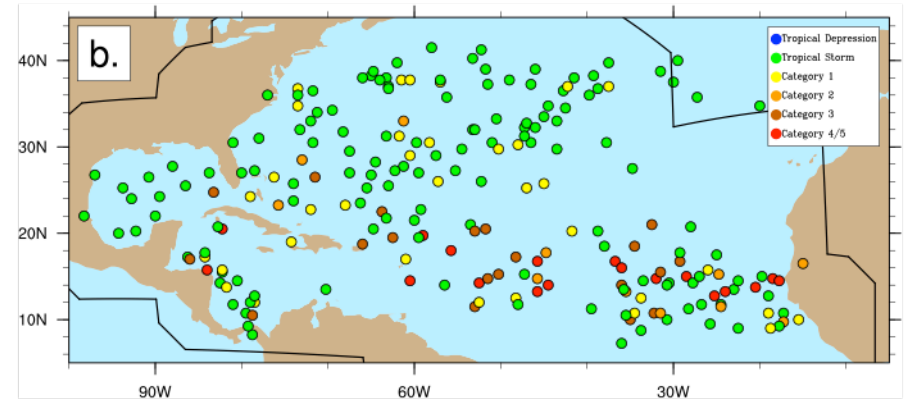
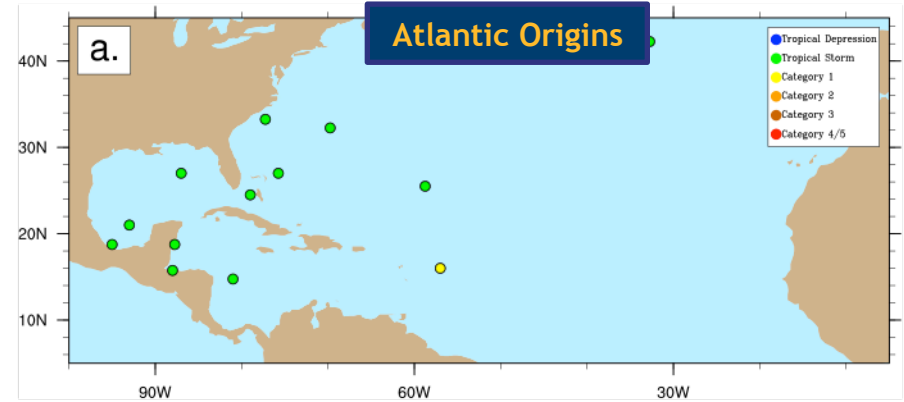
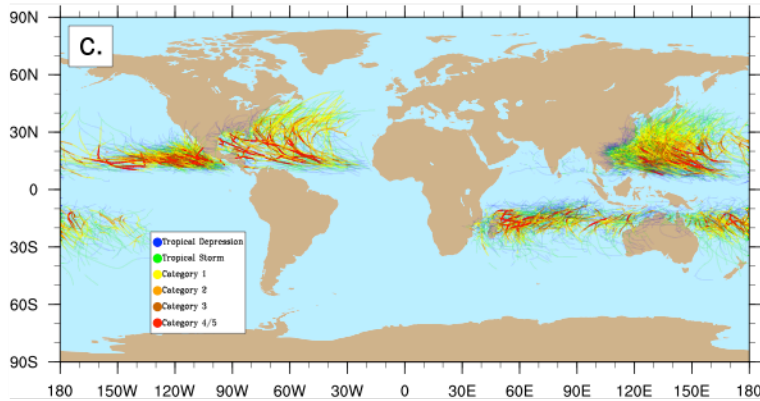
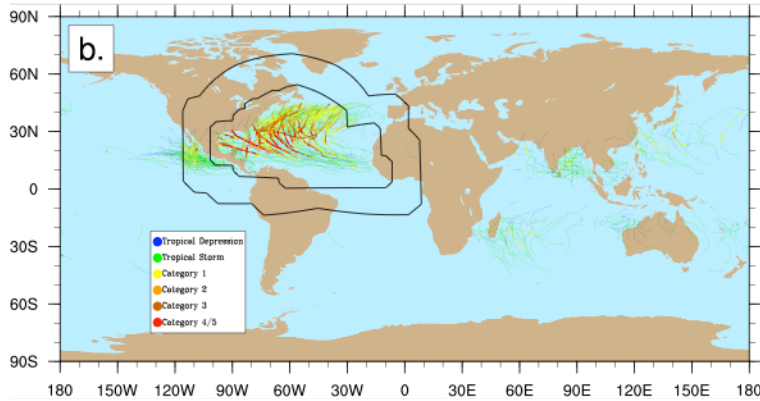
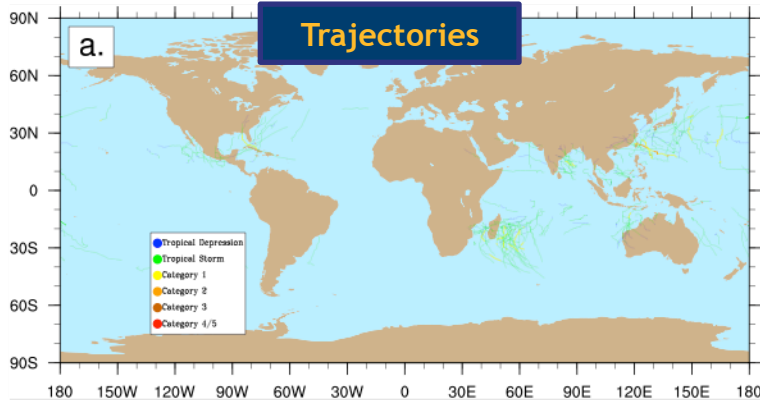


Tropical cyclones

Uniform 1°

Var-res

Obs

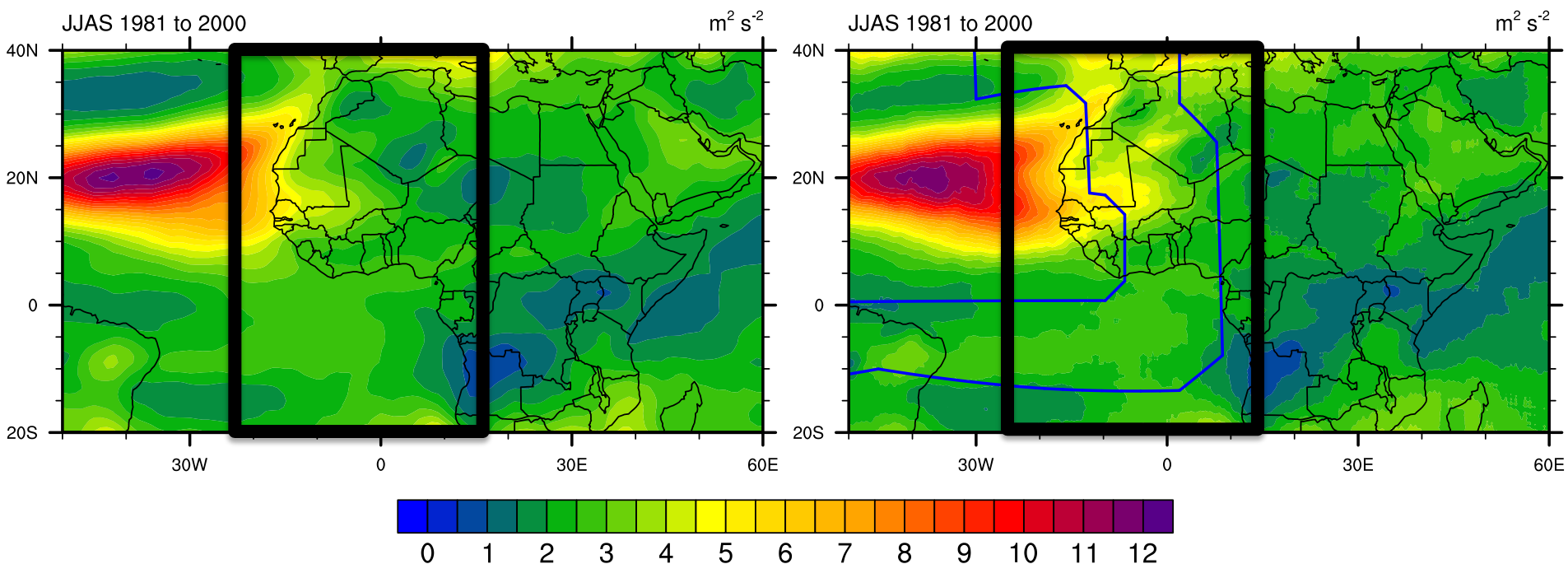


African Easterly Wave activity

CAM-SE Meridional Wind Variance at 700 hPa

Low Resolution

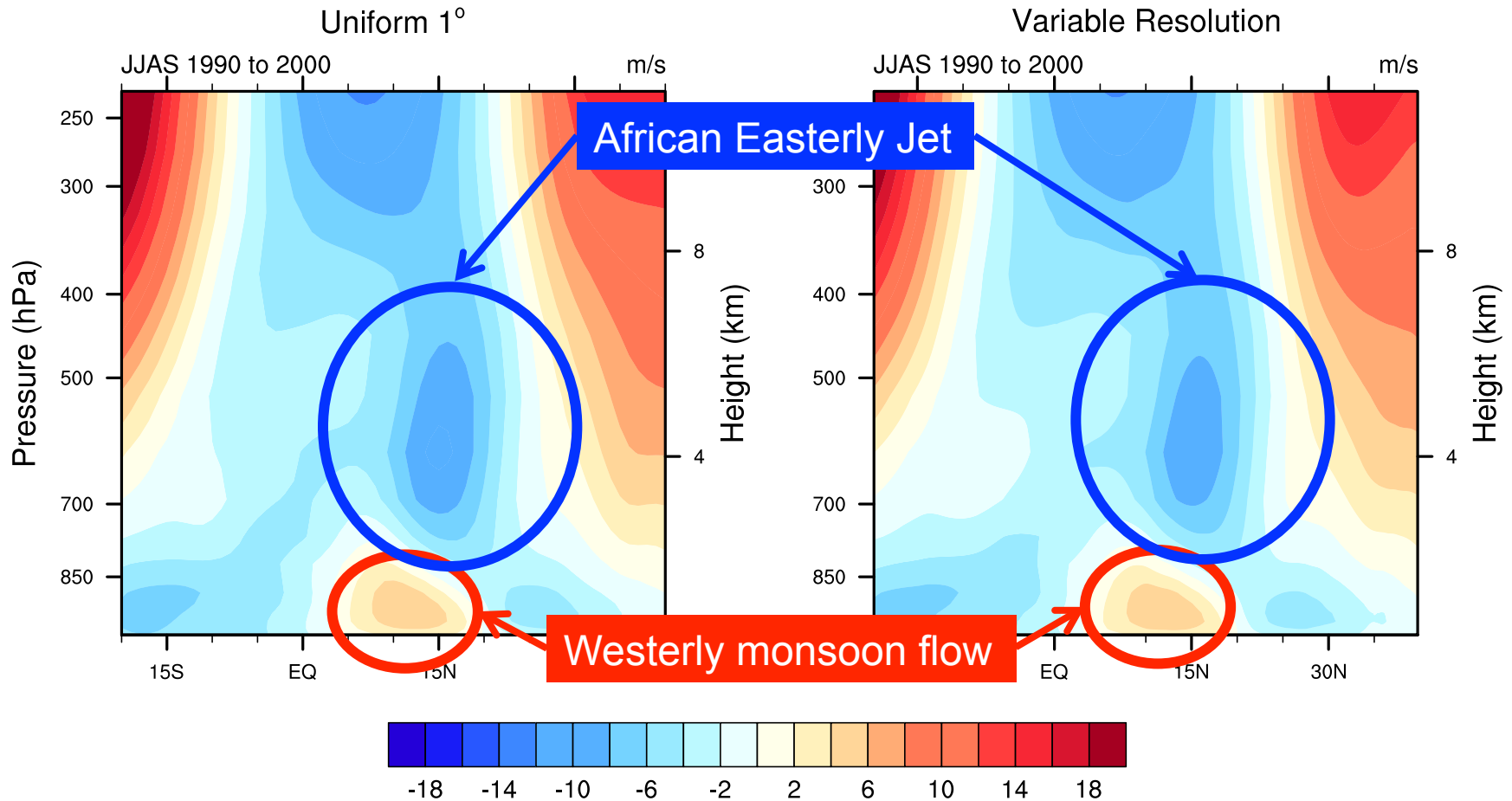
Variable Resolution



Figures from *Diana Thatcher* (UMich), technique
from *Skinner and Diffenbaugh, 2013*

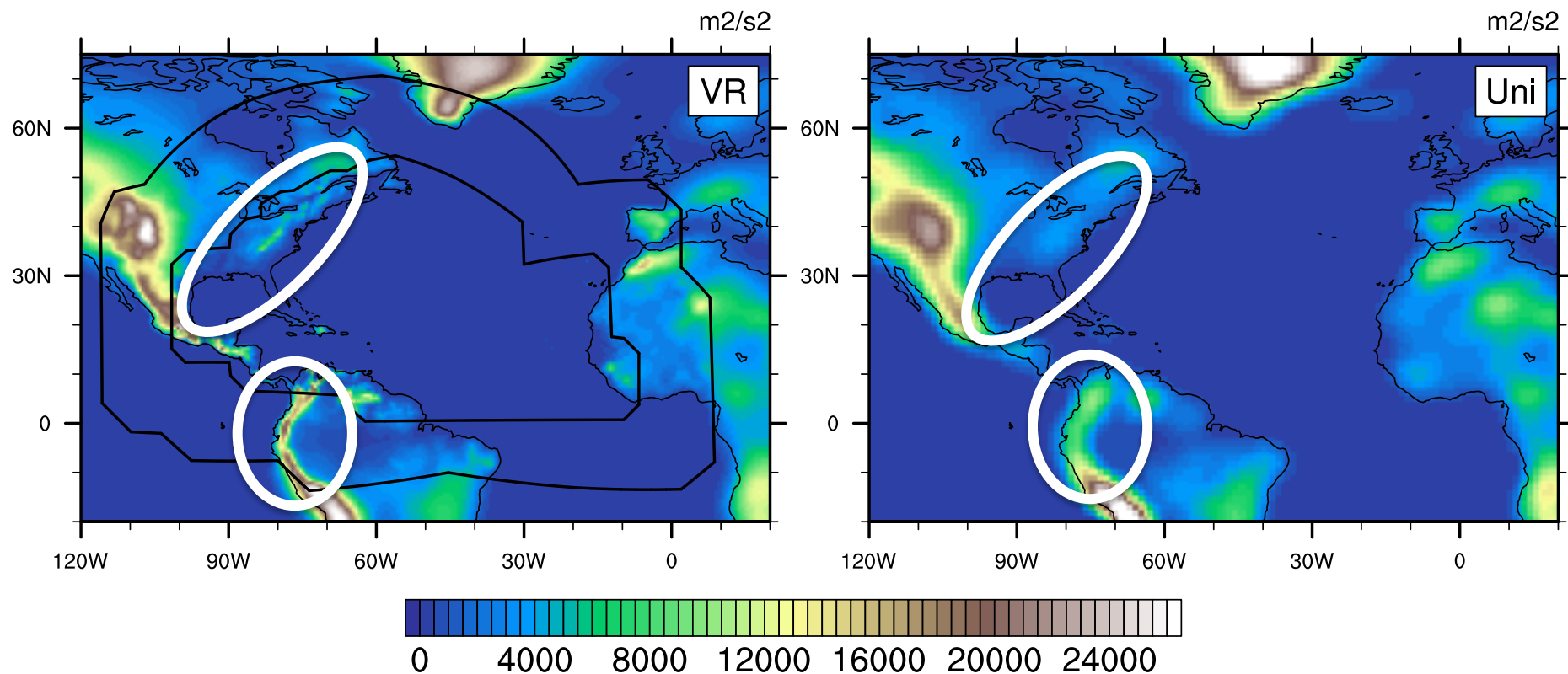
African Easterly Jet

CAM-SE Zonal Wind: Average between 25° W and 15° E



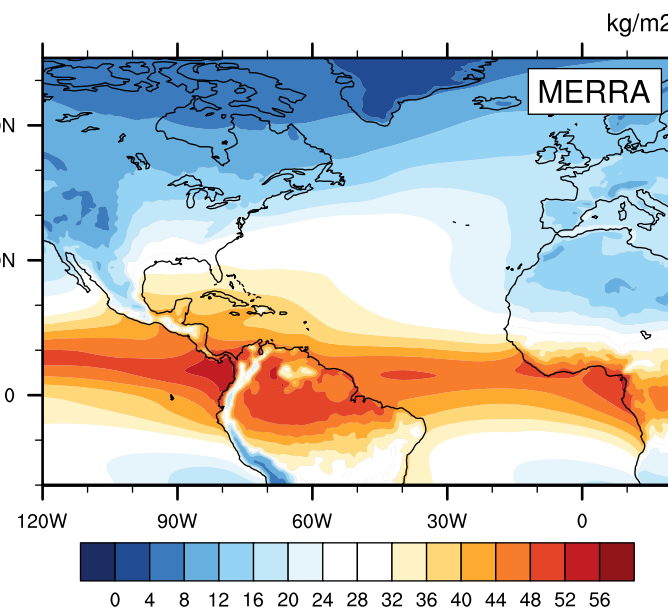
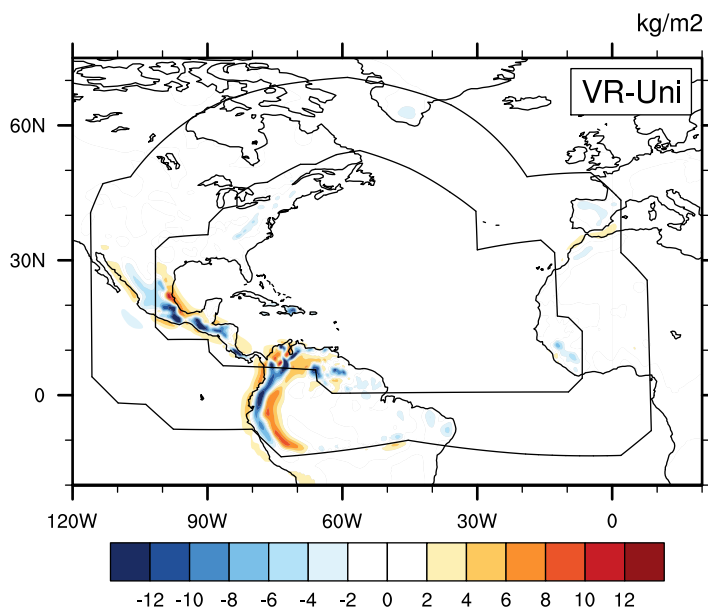
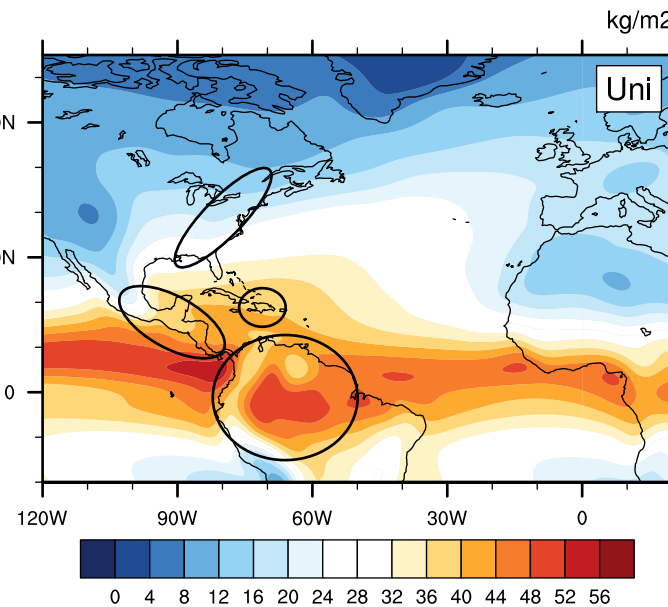
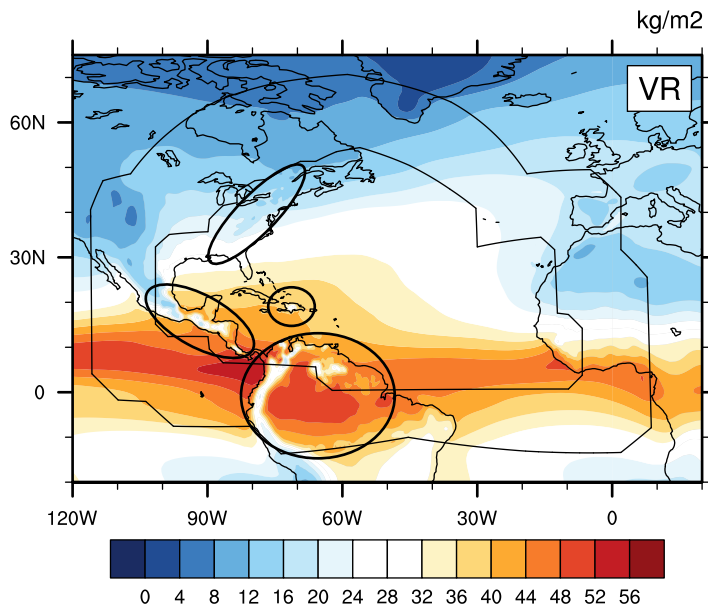
Figures from *Diana Thatcher* (UMich)

Differential topography smoothing



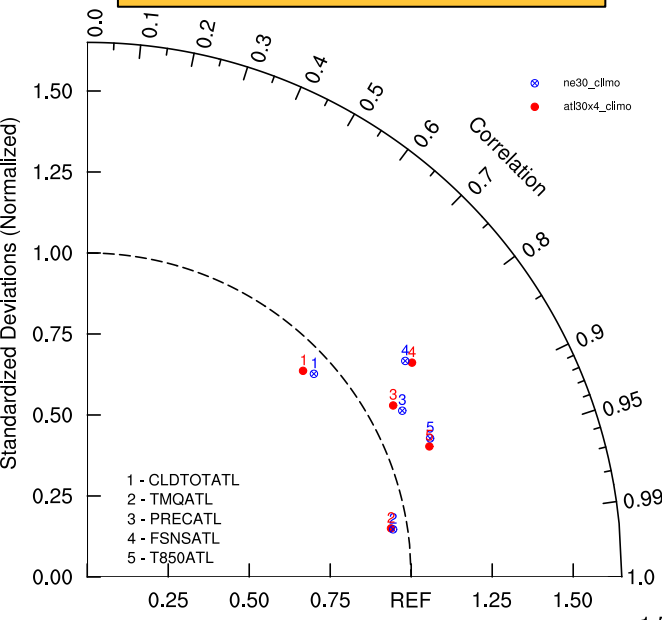
Topographical effects

Total Precipitable Water

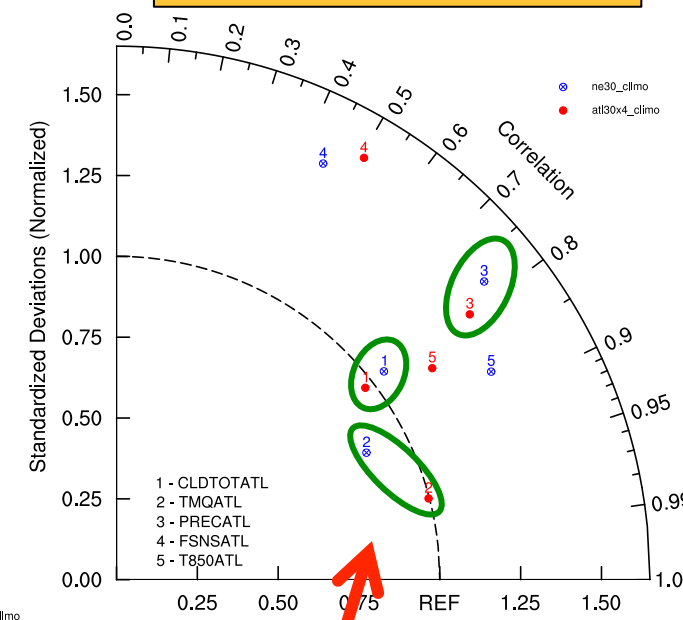


Taylor diagrams

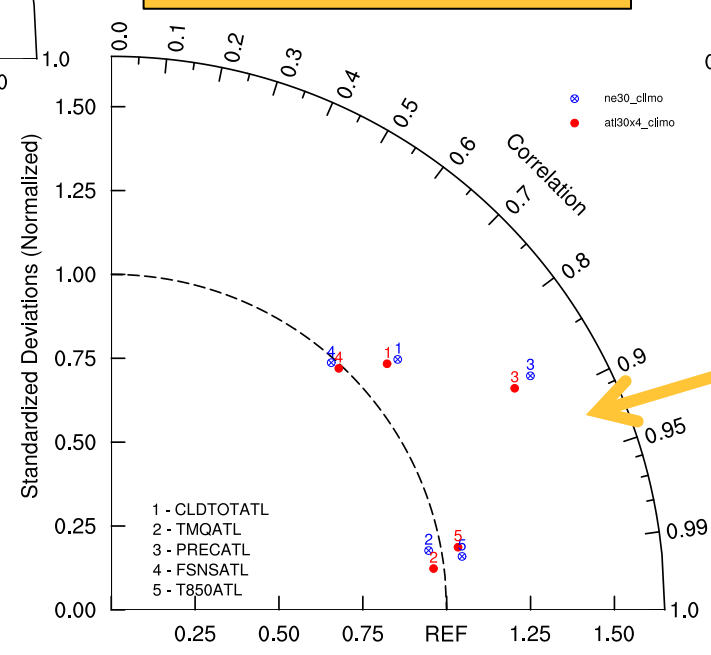
Global “unrefined” grid



C./North S. America

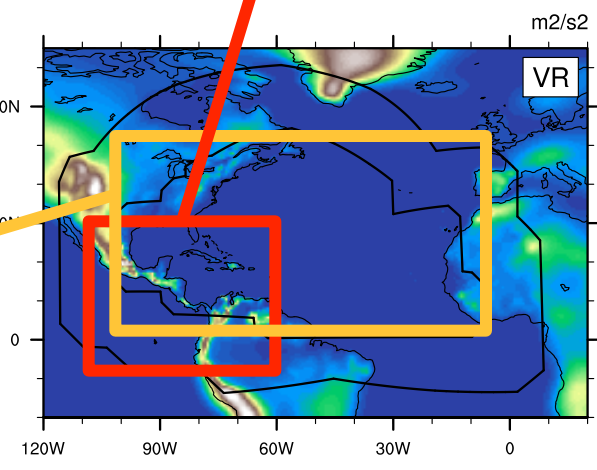


Atlantic Basin



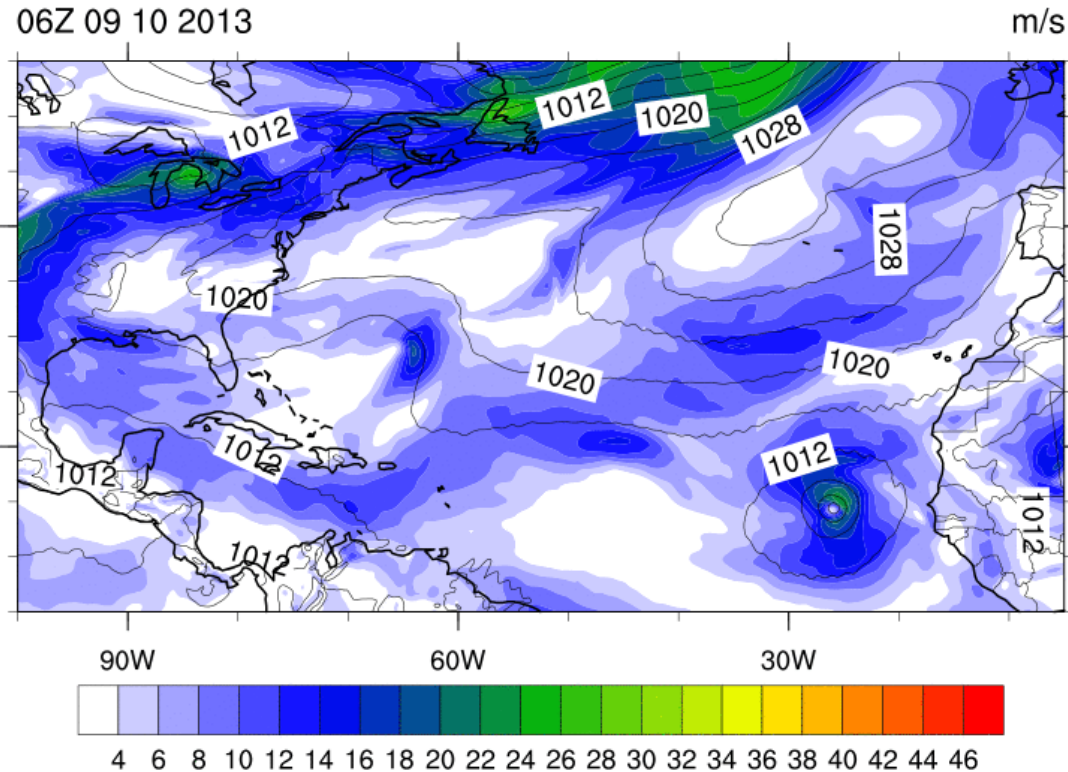
Global 1°
Var-res

- 1 – CLDTOT
- 2 – TMQ (TPW)
- 3 – PRECT
- 4 – Net surface flux
- 5 – T850



Two other ongoing projects...

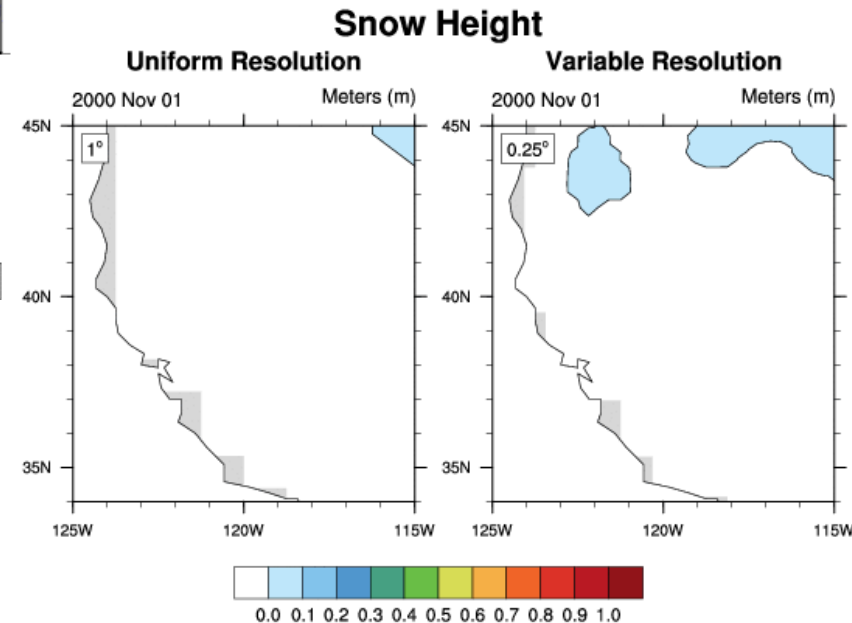
+006



CONTOUR FROM 900 TO 1060 BY 4

- California snowpack studies (Alan Rhoades + Paul Ullrich, UC Davis)
- Better idea if var-res effective mechanism to target topographically-induced effects

- 14 km TC Atlantic “forecast” simulations
- *Early* results show similar skill to other global NWP
- Storm intensity biased high
 - Implications for 1/8deg CAM5 climate simulations?



Summary

- **Testing variable-resolution CAM-SE in both aquaplanet and AMIP frameworks**
- **Aquaplanet**
 - CAM5 appears to be superior choice in terms of multi-resolution cloud/precip scaling
 - CAM-SE var-res climatology at each grid spacing resembles that of globally-uniform counterparts
- **AMIP**
 - Topographical representation in time-averaged climatology improved
 - Large scales do not appear to be significantly harmed by addition of resolution
 - No overt issues found in dynamical fields (yet) in/near grid transition regions