CESM2 Regional Climate Community Simulations

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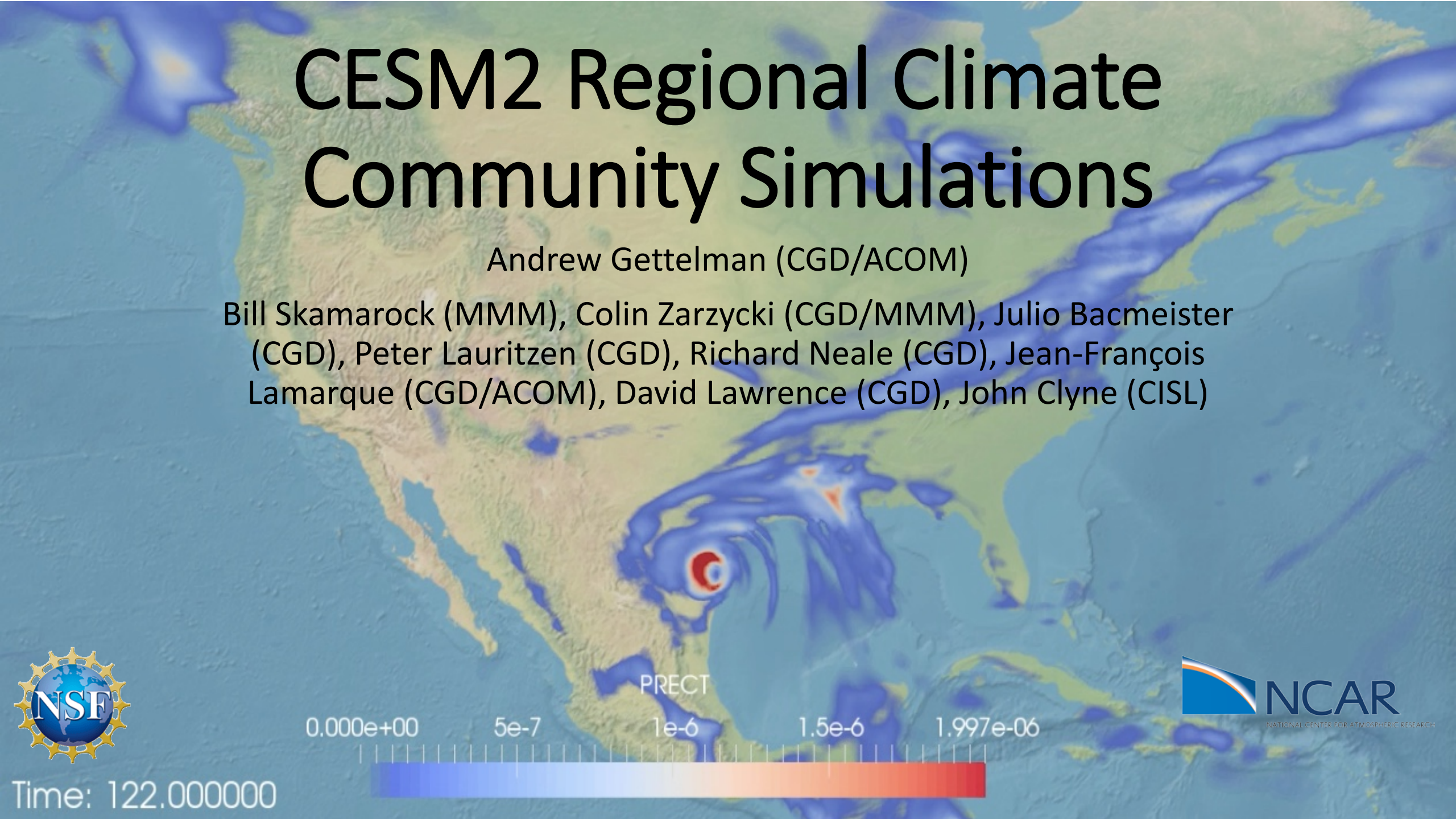


ASD Project: High Resolution CESM2

Because no one is killed by the global annual mean temperature

- CESM2-CAM6 Physics
- Refined Mesh Simulations down to ~15km
- Variable resolution Spectral Element (SE) and MPAS dynamical cores
- 30-year simulations (1980-2010 SST forcing)
- Follows from a Preliminary project (Larson, CHAP 2016):
  - Dynamical Core Evaluation for CAM-SE
  - CAM5.5, CESM1, Refine mesh to 0.25˚, evaluate against uniform high resolution and uniform low resolution
  - CAM5.5 with and without a deep convective scheme

Science Questions

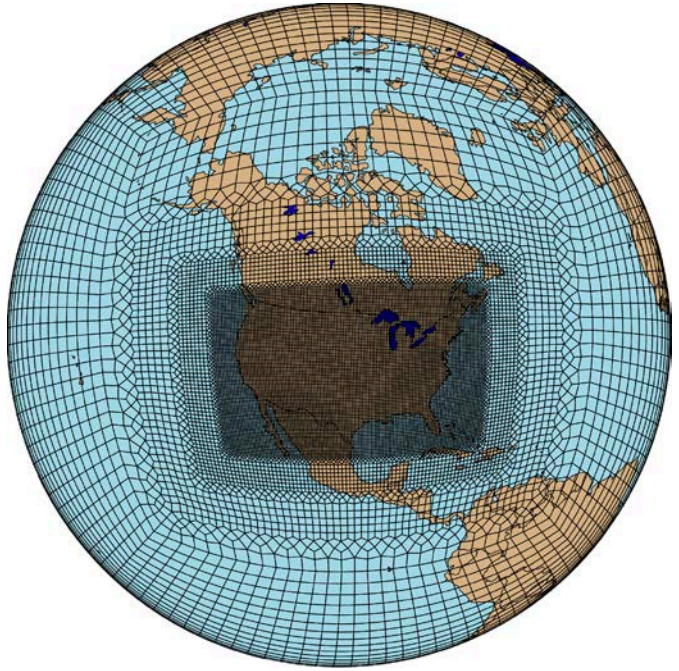
- **Convection:** How does it evolve at high resolution?
- **Dynamics:** does in matter at high (horizontal and vertical) resolution?
- **Extremes:** reproduce statistics for temperature & precipitation?
- **Hydrology:** Can high res simulations drive hydrology models?
- **Snow-climate feedback**: what is it in complex terrain (Western US)?
- **Land Use - Climate Coupling**: How does scale modulate it?
- **Recent Trends:** In extremes of precipitation, temp and hydrology?

Dynamical Core Configurations

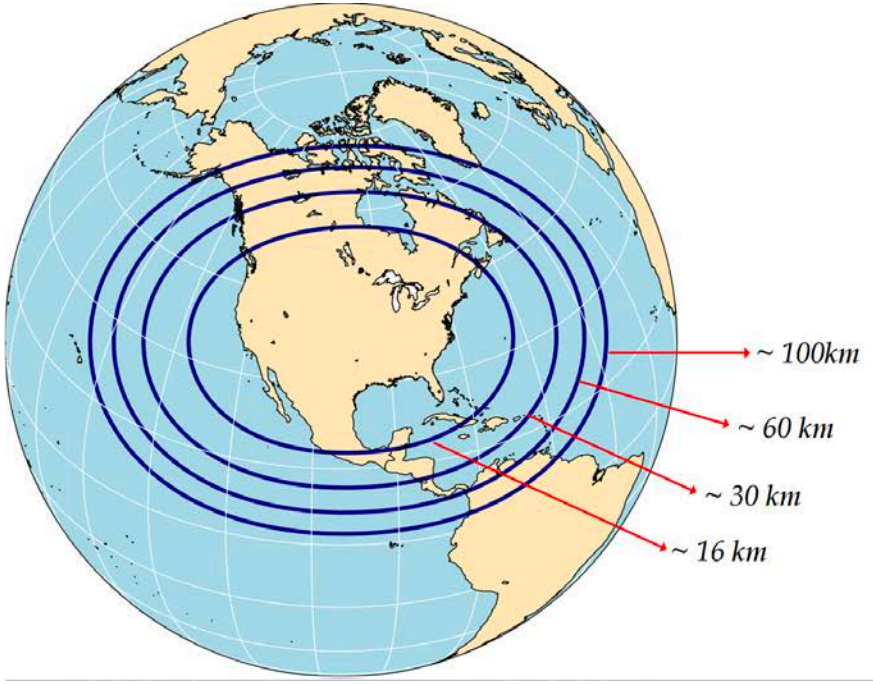
15km refined grid spacing over CONUS

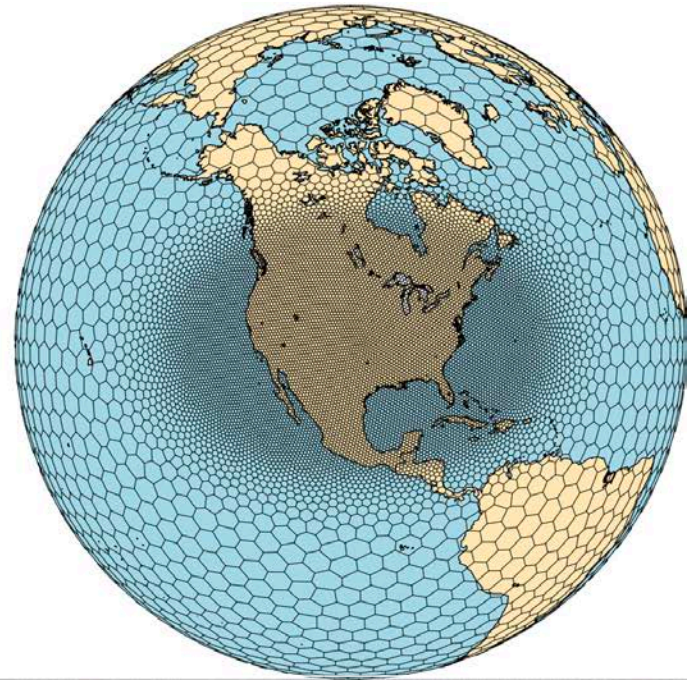
MPAS: Non-Hydrostatic
CAM-SE: Hydrostatic, latest CESM2 version
Physics: CAM6

CAM-SE



MPAS



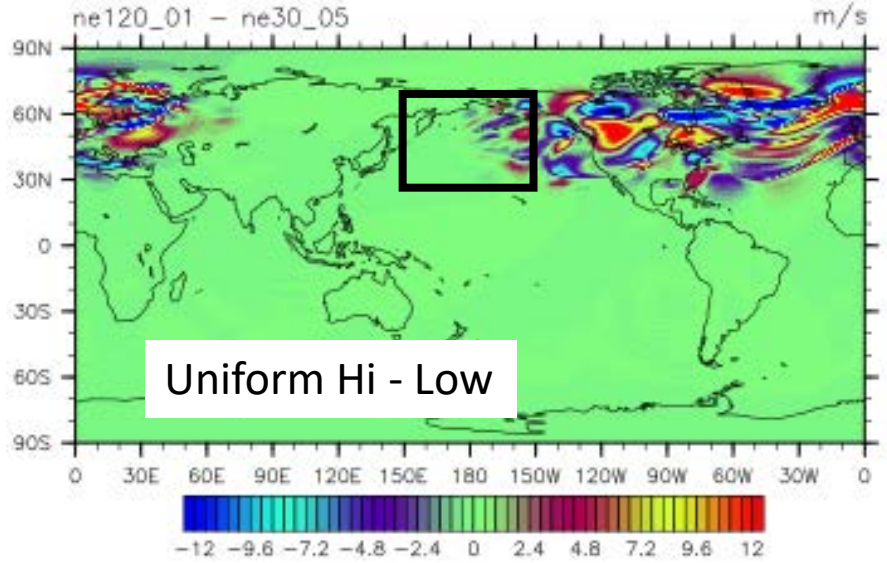


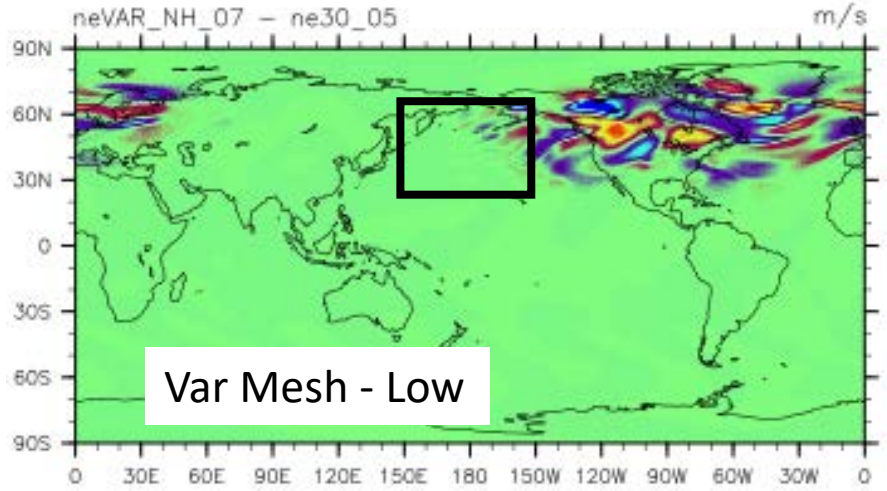
Preparation Work: 25km Simulations

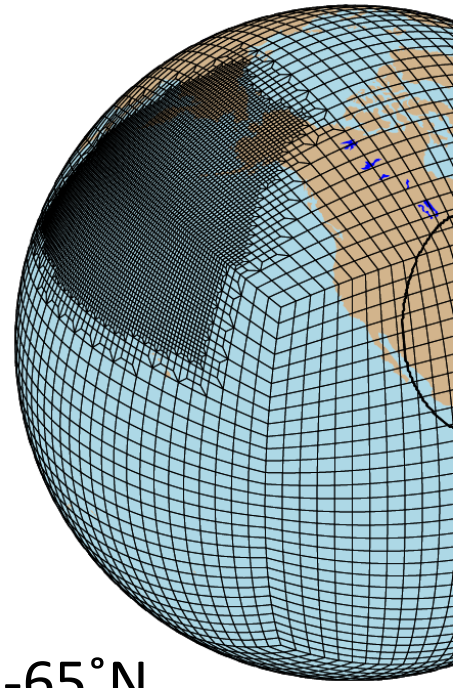
- CAM5, CAM5.5
- Extensive work on variable resolution meshes with the SE core.
- Variable resolution can reproduce global statistics, and high frequency statistics in the high resolution region.
- I.e.: can get the same regional answer as uniform global high resolution, but at a fraction of the cost
- Makes high resolution and climate impacts accessible to more users

Aquaplanet Idealized Baroclinic Wave Test

850 hPa U Difference: Day 15





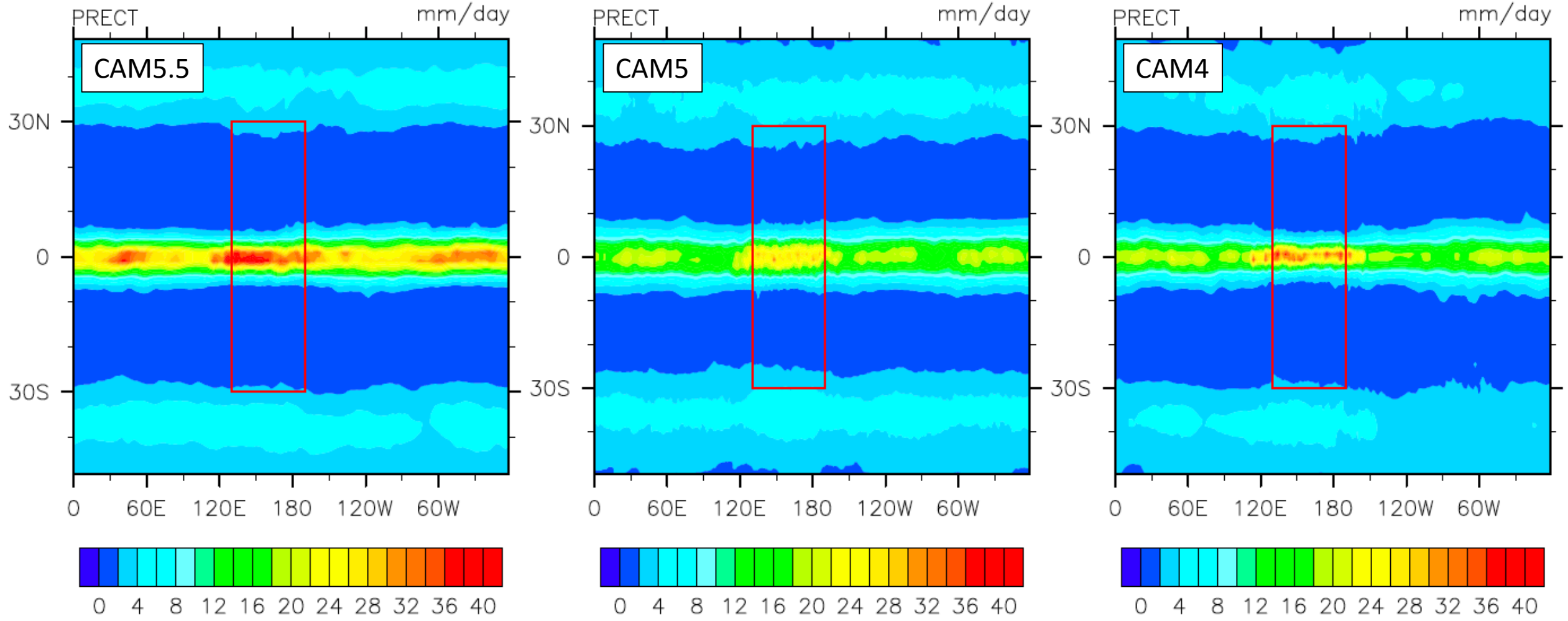


- Refined mesh 60˚ Lon, 25˚N-65˚N
- Variable mesh looks like high resolution (25km) uniform outside of refined region

Variable Mesh and CAM Physics: Aquaplanet

CAM5.5 more consistent across resolutions

Remaining sensitivity is related to balance between deep convection (timescale) and large scale

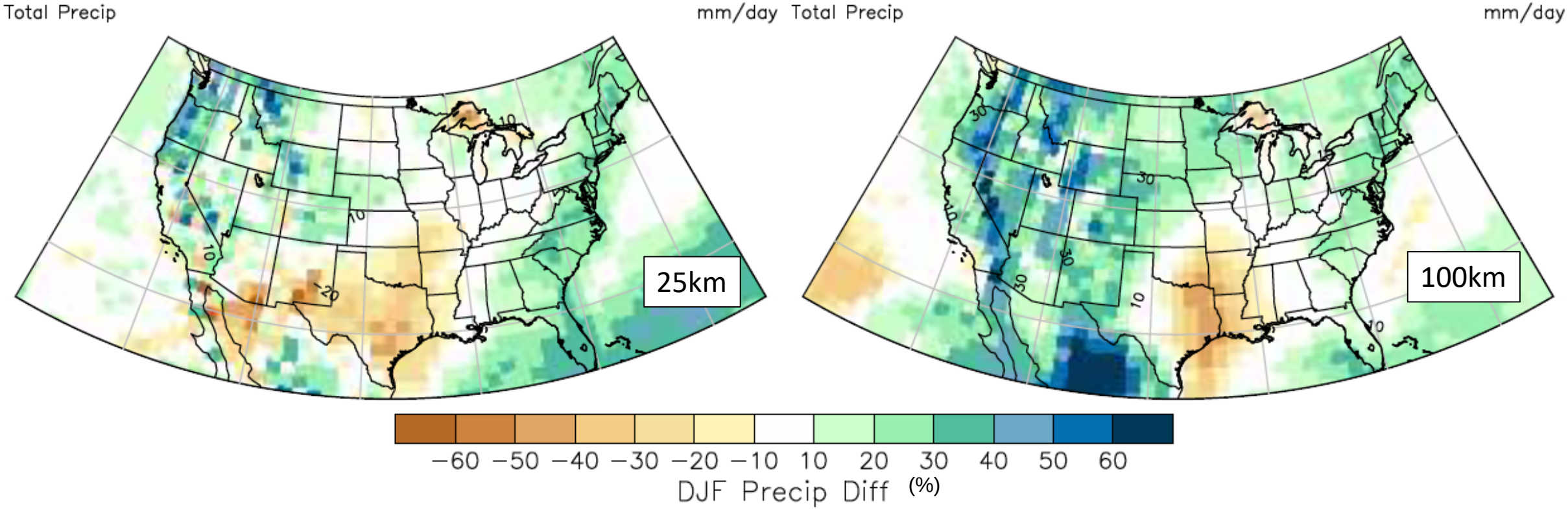


High Resolution Precipitation (0.25˚)

Benefits of Resolution

Biases v. ERA-I DJF Precipitation Climatology

Reduced biases at high resolution, especially in regions with topography

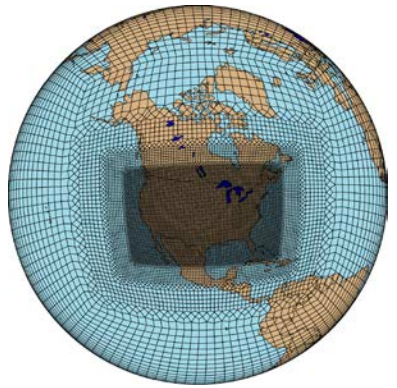


Regridded to 100km

Preliminary Results for 15km

- Started AMIP Style simulation with 1˚→ 0.125˚ resolution over US
- High resolution features resolved, starting to see interesting events
- Here: 6hrly Precipitation rate for MAM for first year of simulation
- What to watch for:
  - Late Winter/Spring Storms hitting Western United States (Day 60-75)
  - Gulf moisture and squall line type storms (Day ~77, 93)
  - Tropical Cyclone (Day ~120)
  - Diurnal convection in late spring (Day 125-130), some propagates

Summary



- Variable Mesh Simulations with CAM6 show promise
  - Dynamics works well, 25km simulations show benefits of high resolution
- CAM6 not very sensitive to resolution (less than CAM4, CAM5)
  - Sensitivity due to deep convection and timescale
- First ASD simulations (15km) started with CAM-SE
- Next Steps: CAM-MPAS simulations, higher vertical resolution
- Analysis of climate statistics for atmosphere and hydrology
- Simulations will be made available on the ESG

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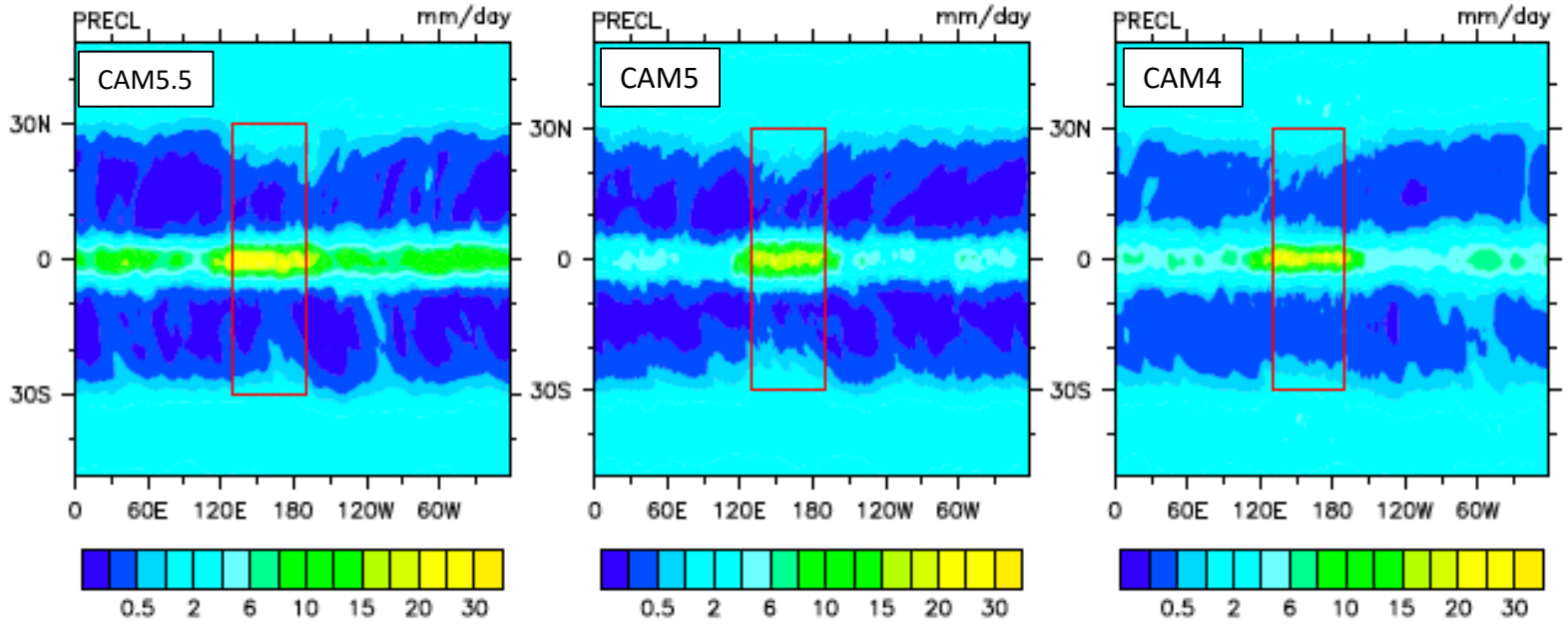
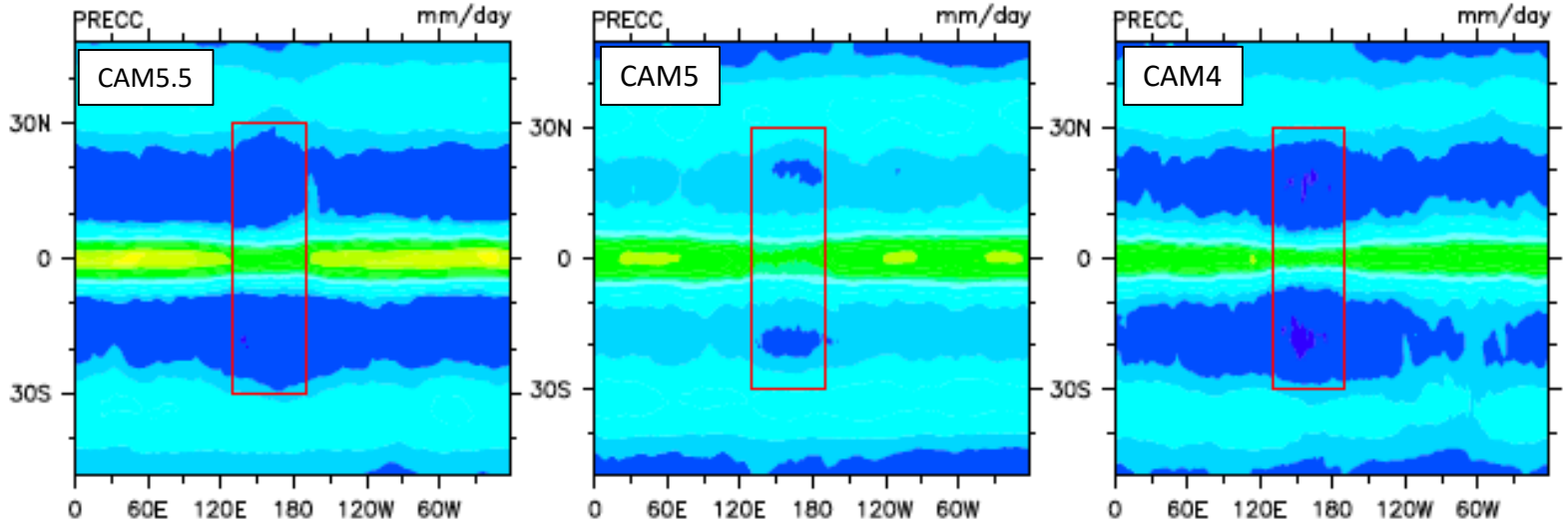
Precip Components

Large Scale Precipitation



Convective Precipitation



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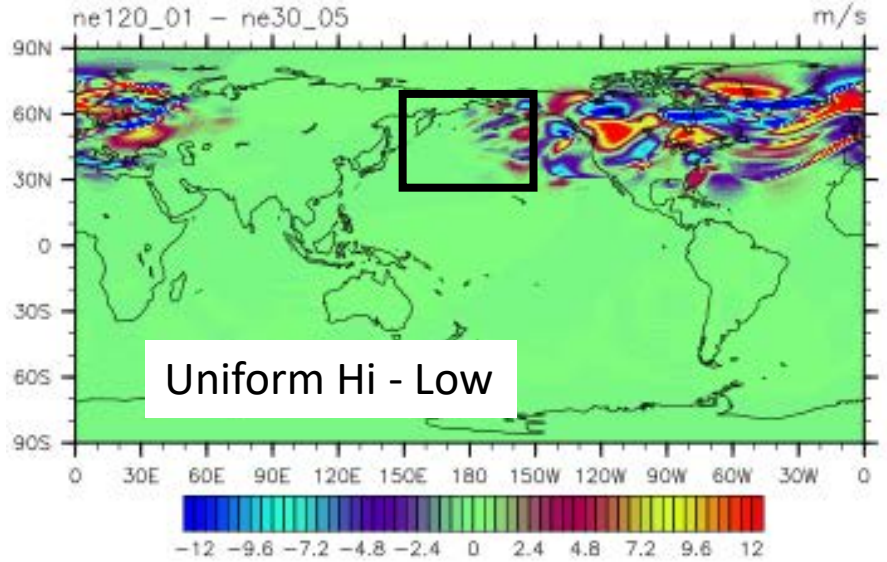

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- Variable mesh looks like high resolution (25km) uniform outside of refined region
- Does depend a bit on SE dycore damping