CAM5 Status and Developments

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Climate and Global Dynamics

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Thanks: Julio Bacmeister, Cecile Hannay, Peter Lauritzen. Andrew Mai,
+ many others in AMWG

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

NESL's Climate & Global Dynamics CGD

U.S. DEPARTMENT OF ENERGY

NSF

Community Earth System Model CESM

Status of CAM5

Releases and simulations

- CAM5.1 released in CESM1.0.3 (June 2011)
- CMIP5 version of the model -> AR5
- Multiple 1^{o} simulations (pre-industrial, 20^{th} C (3), RCPs(3) , AMIP, SOM)
- Initial RCPs recently completed
- PNNL: Multiple 2^{o} simulations
- Reproduces 20^{th} century surface temperature evolution
- CAM4 high resolution (25km) time slice experiments (1980-2005; 2075-2100)

High resolution simulations (25 km and finer)

- Time slices (CAM4-FV, CAM5-FV, CAM5-SE; global spectral)
- Global $1/8^{o}$ (12.5 km) simulations using CAM5-SE (2004-2005)
- Regionally refined simulations over US (1^{o} -> $1/8^{o}$)
- CAM5 realistic hurricane statistics (number/strength/variability)
- Summer time US orogenic propagating systems, atmospheric rivers

Next CAM5 release (May 2012)

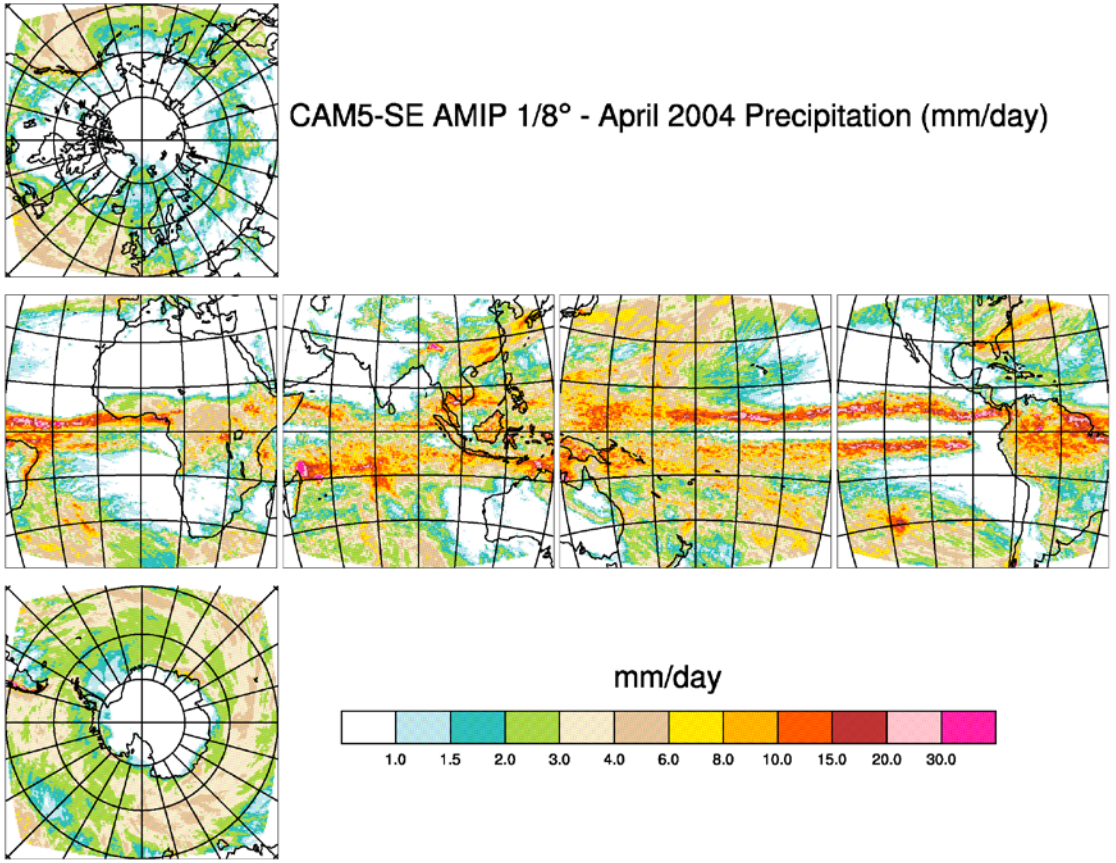
- CAM5-SE 1° coupled climate (retaining CAM5.1 physics)
  - Initial simulation similar to CAM5-FV 1°
  - Differences related to orographic smoothing (too smooth)
  - Complete revamp of orographic specification
- CAM5-FV, MAM prescribed aerosols
  - Sampling methodology of monthly mean aerosol is in place
  - Sub-sample in-cloud and mean aerosol, proportional to liquid cloud frac.
  - Reproduces cloud liquid/radiative forcing fields well (AMIP 2°)
  - Outstanding problems: Low arctic aerosol issues/some code cleanup

New Dynamical Cores

CAM5-Spectral Element on Cubed Sphere Grid

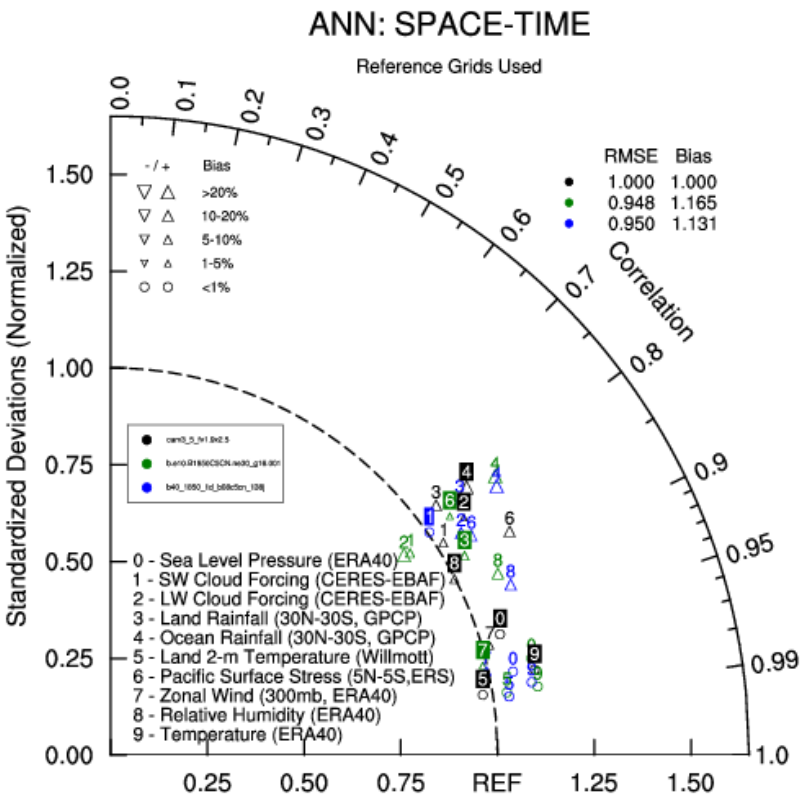
Cubed Sphere

Regular lat-lon

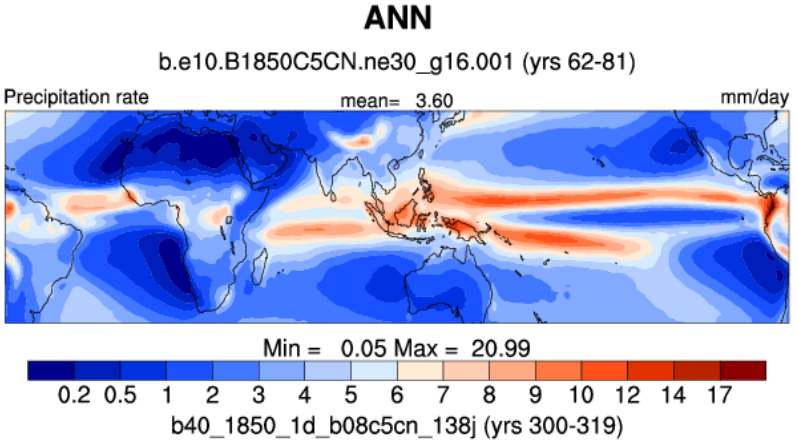


CESM(CAM5-SE) coupled simulations

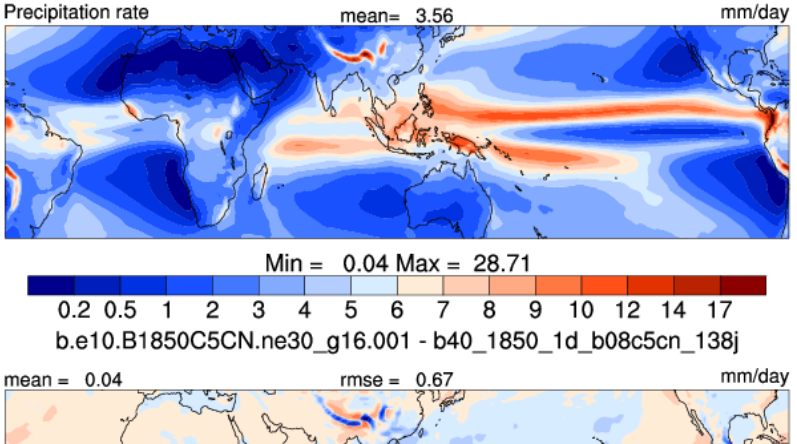
1° Pre-industrial control



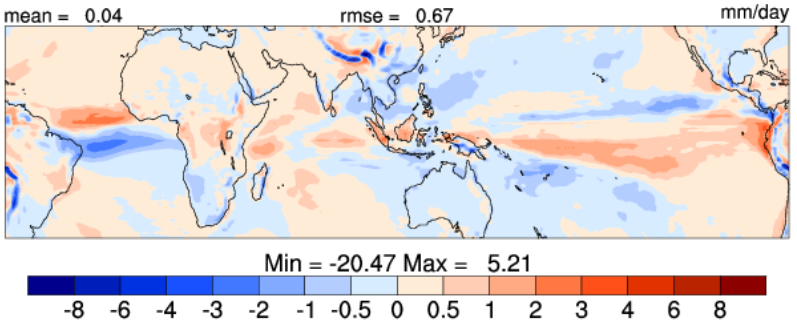
CAM5-SE



CAM5-FV



Diff.

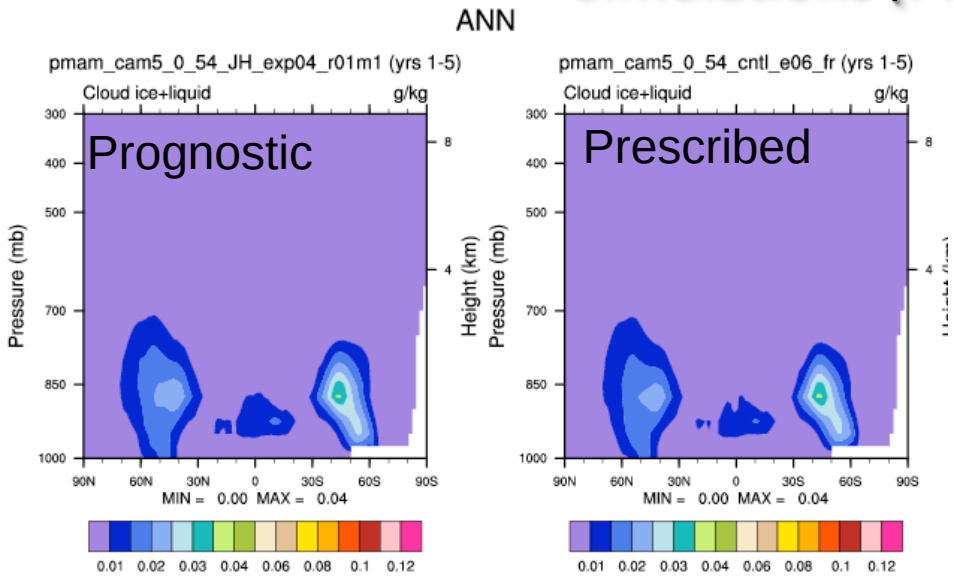


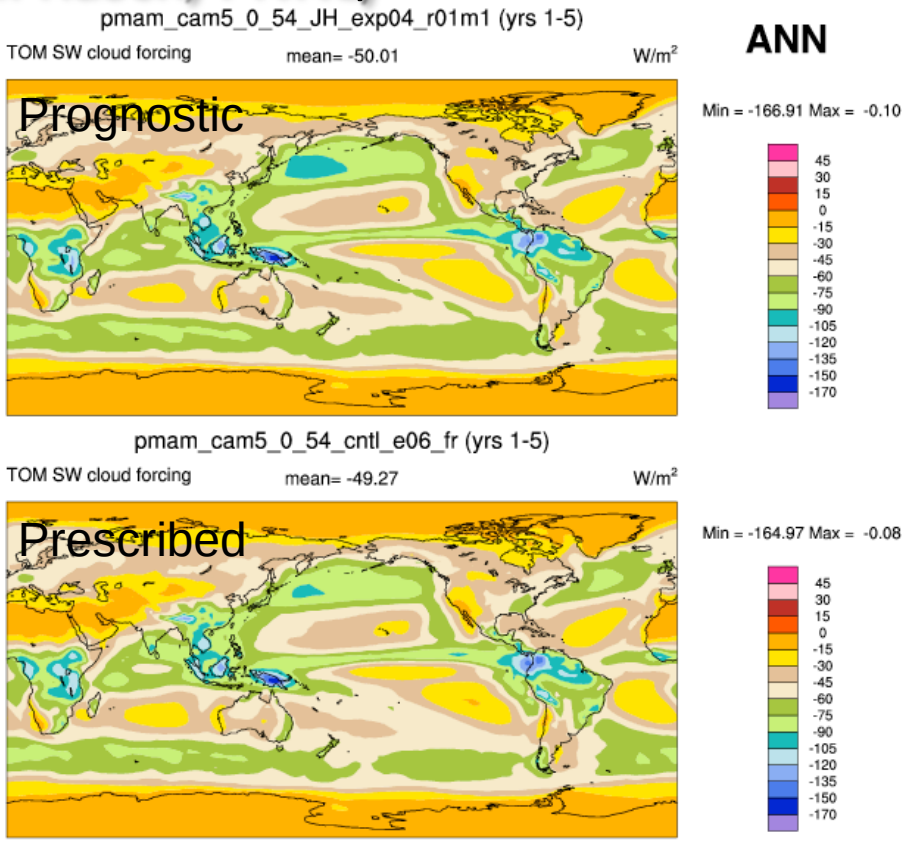
✓Major differences related to orography

Thanks: Andy Mai, NCAR

Prescribed Aerosols

Simulations (Phil Rasch, PNNL)



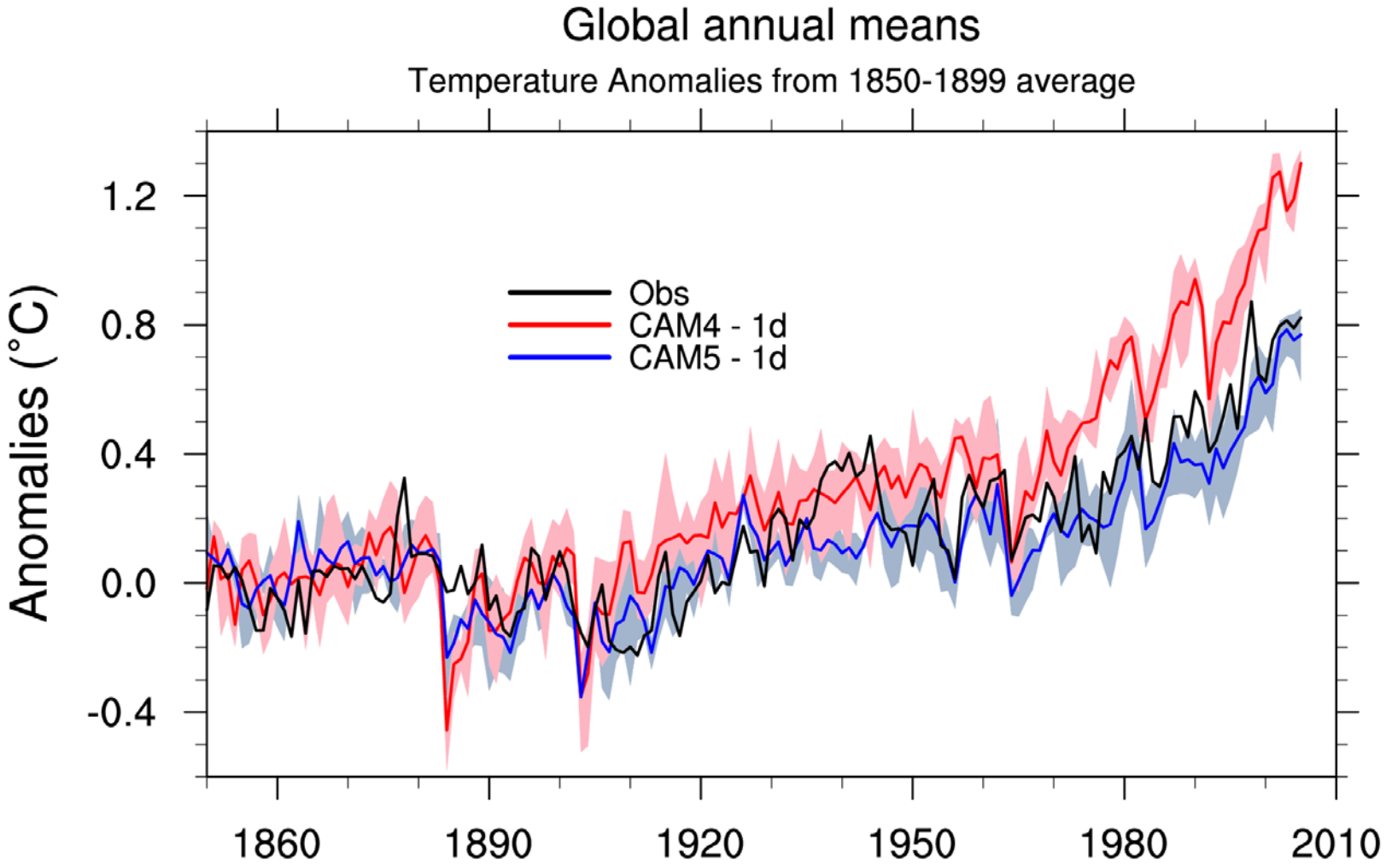


- **Cloud Water**
- Remaining tasks:
  - Remaining Differences are found in Arctic region
  - Aerosol deposition fluxes to surface need to be prescribed, too.(right now they are wrong)

- **Short-wave cloud forcing**
- $X_{prescribed} = X_{cloudy} * F_{liq} + X_{ALL} * (1 - F_{liq})$

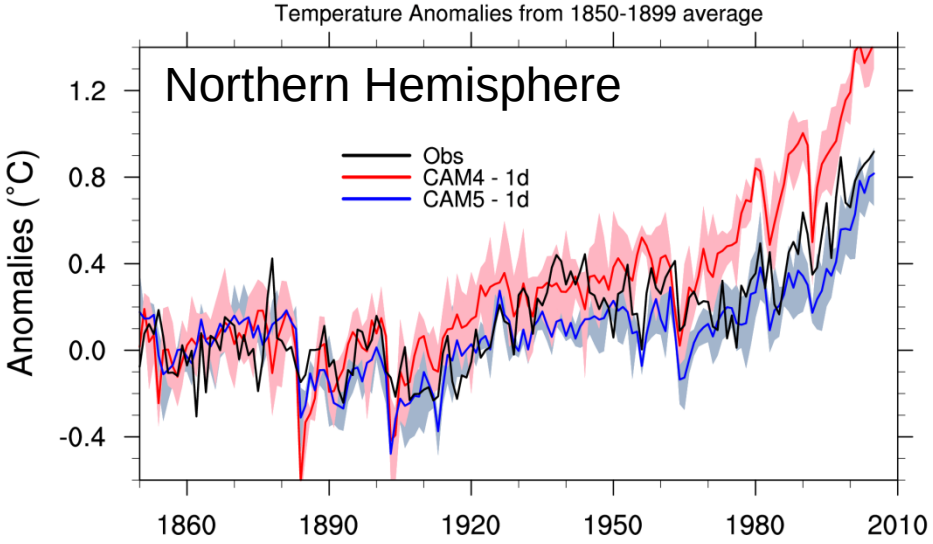
20th Century Climate Change

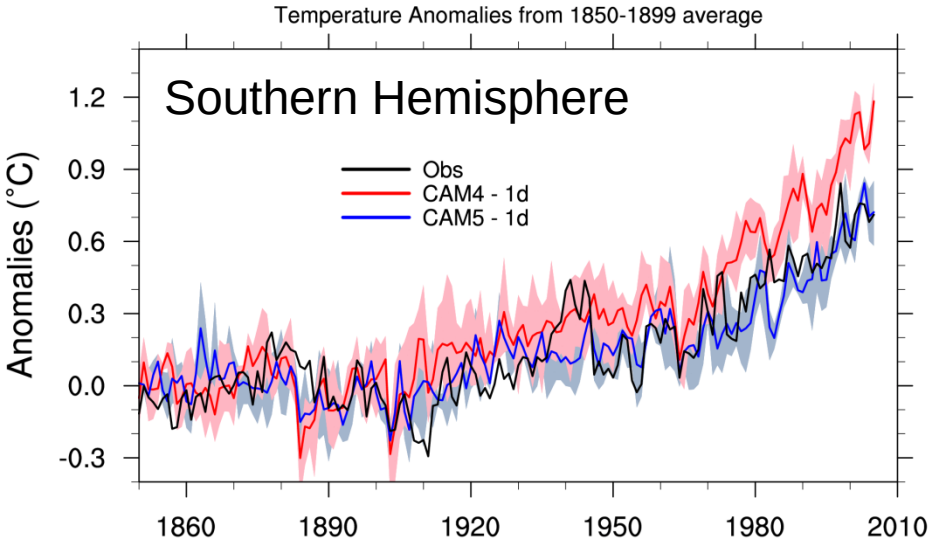
CESM1(CAM5) CMIP version vs. CCSM4(CAM4)

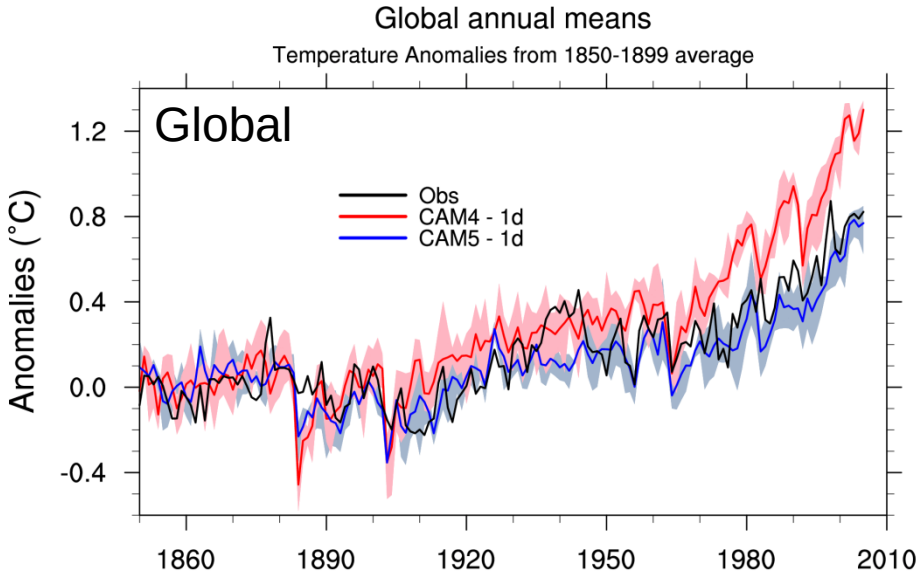


20th Century Climate Change

CESM1(CAM5) CMIP5 version vs. CCSM4(CAM4)

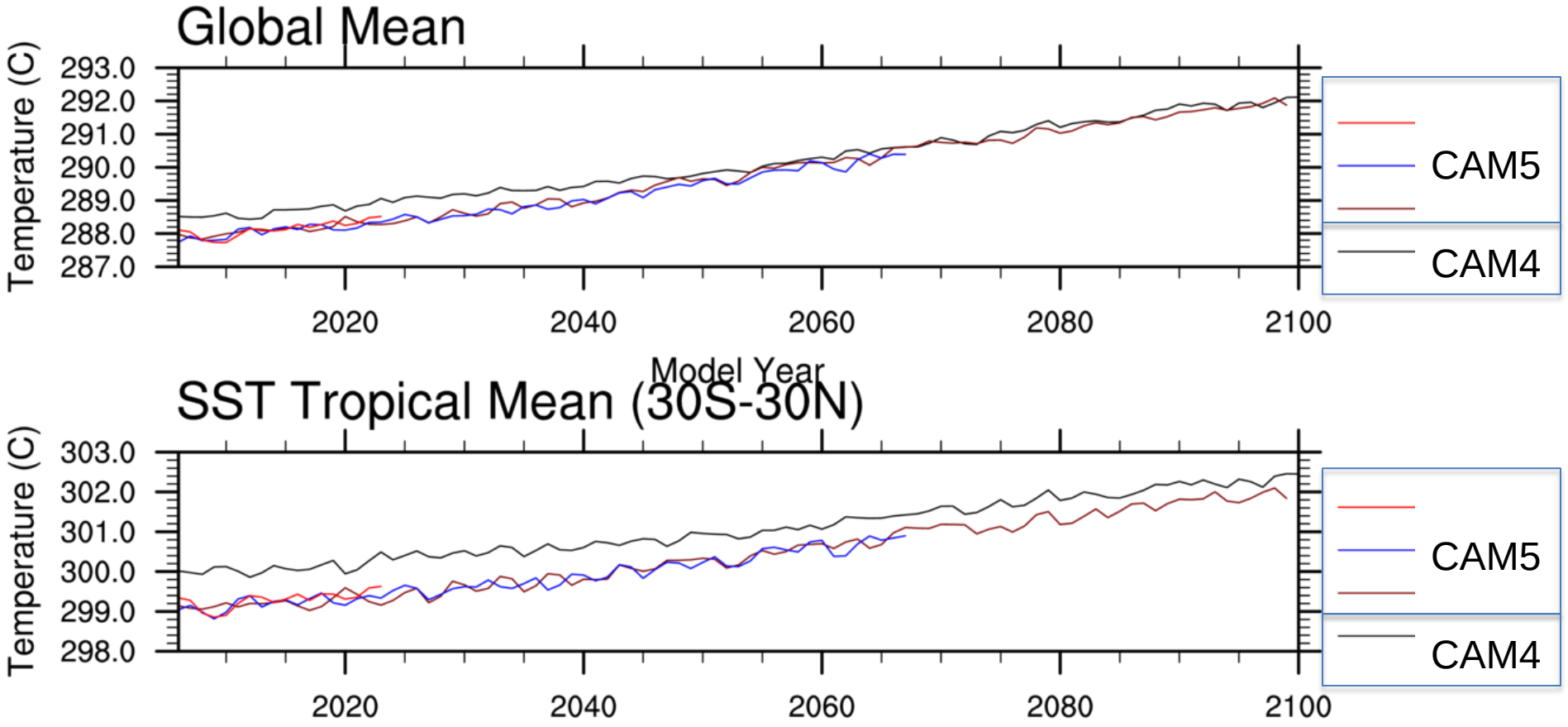






Future Climate Change (RCP8.5)

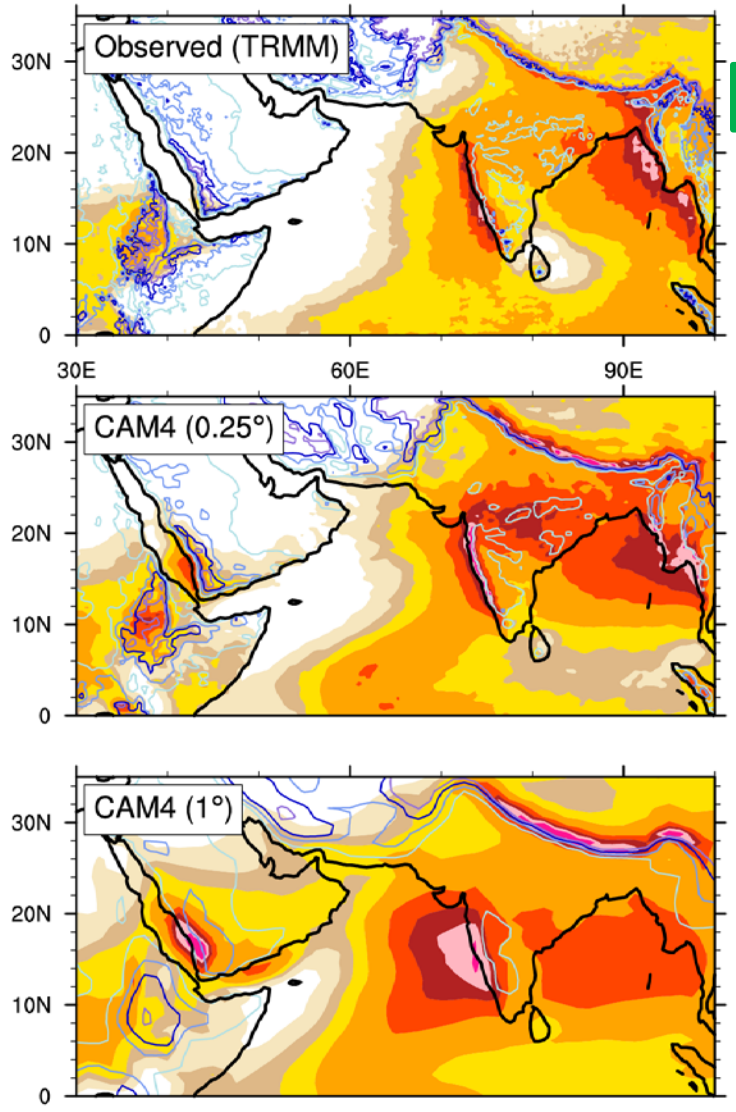
CESM1(CAM5) CMIP5 version vs. CCSM4(CAM4)



Thanks: Trey White, Adrianne Middleton, Cheryl Craig, Andrew Gettleman, and Cecile Hannay, NCAR

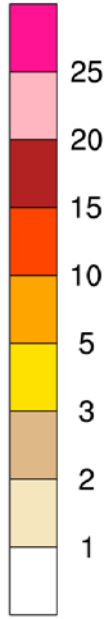
High Resolution: The role of Orography

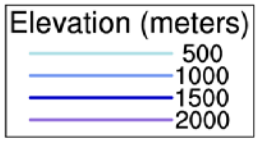
CAM4-FV 25-km AMIP runs/20-year averages



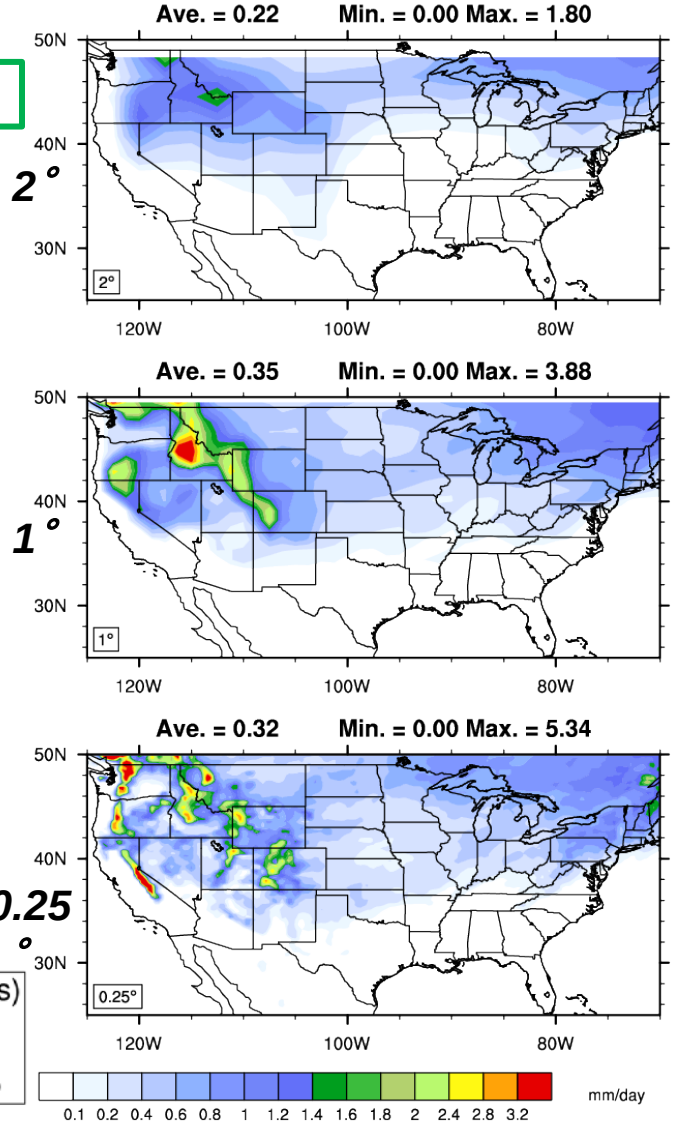
JJAS Precip.

mm/day





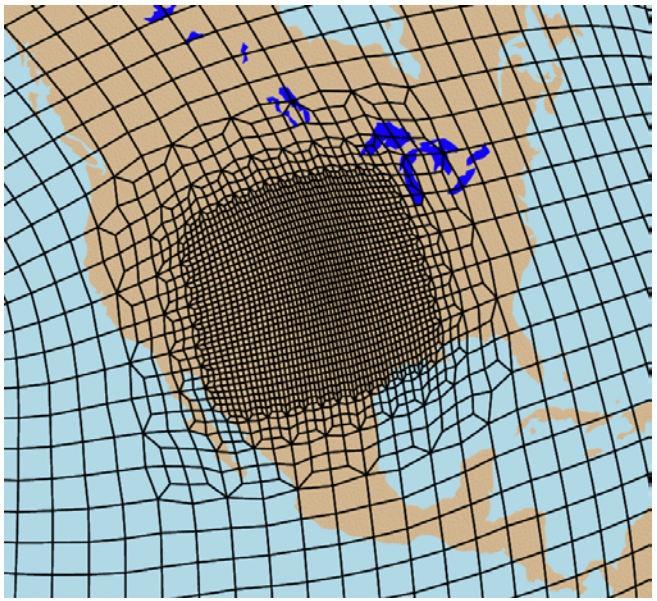
March Snowfall



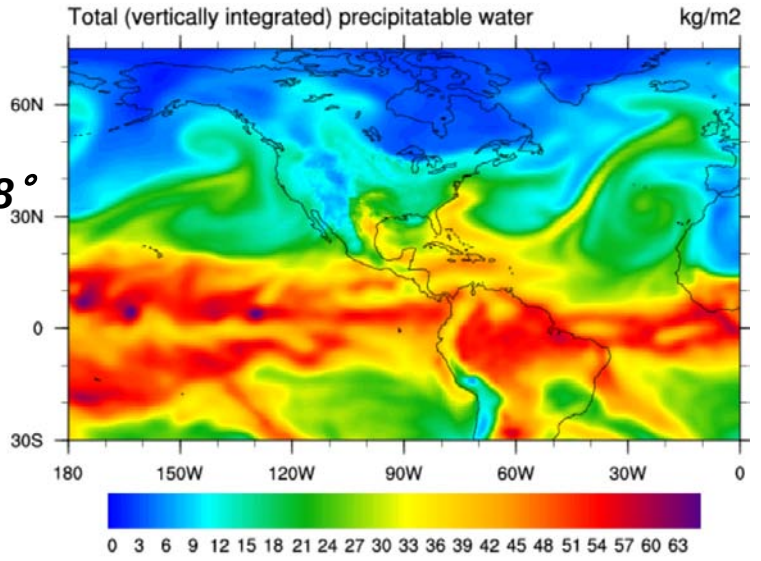
Community Earth System Model

CESM1(CAM5-SE): Regional Refinement

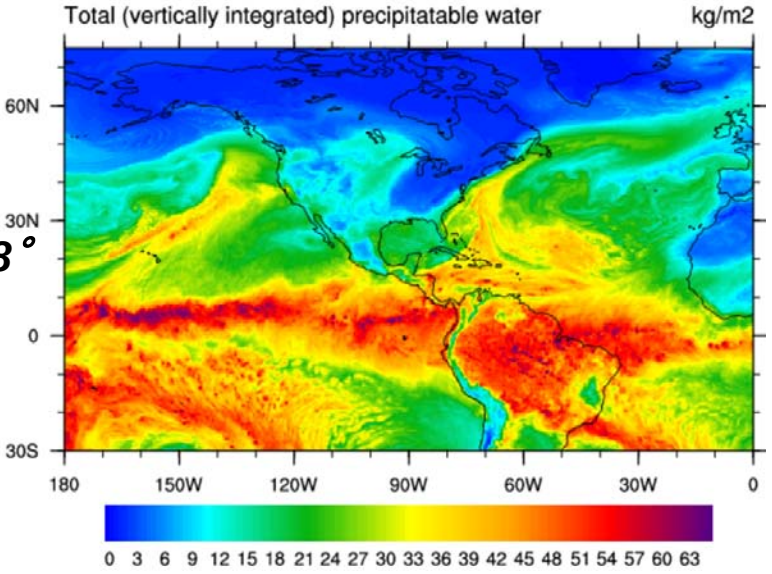
Avoiding Downscaling BUT Implications for resolution dependence



1˚ to 1/8˚



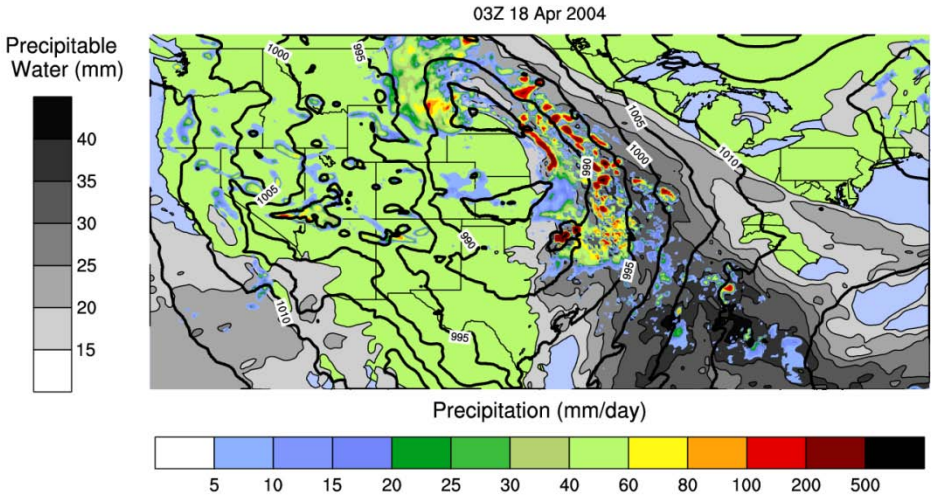
Global 1/8˚



- ✓ 3 levels (steps) of refinement
- ✓ CAM5-SE AMIP simulations
- ✓ Regional refinement should reproduce statistics of global high-res equivalent
- ✓ Land can run on same grid
- ✓ Calibration testbed

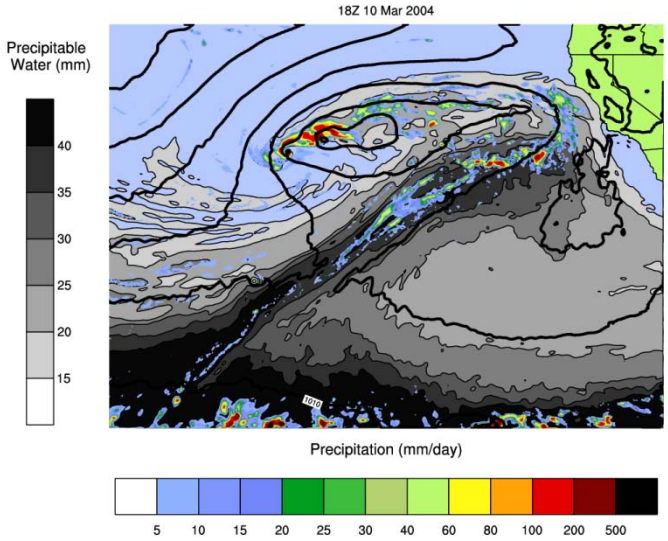
High Resolution: High Impact Phenomena

12-km CAM5-SE AMIP Simulation Snapshots

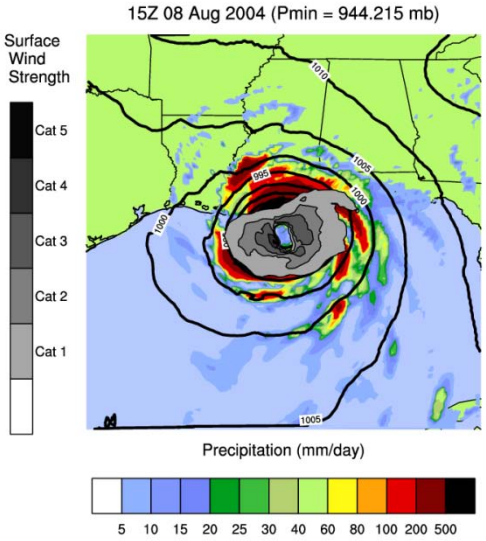


Mid-west Spring time systems

Atmospheric Rive



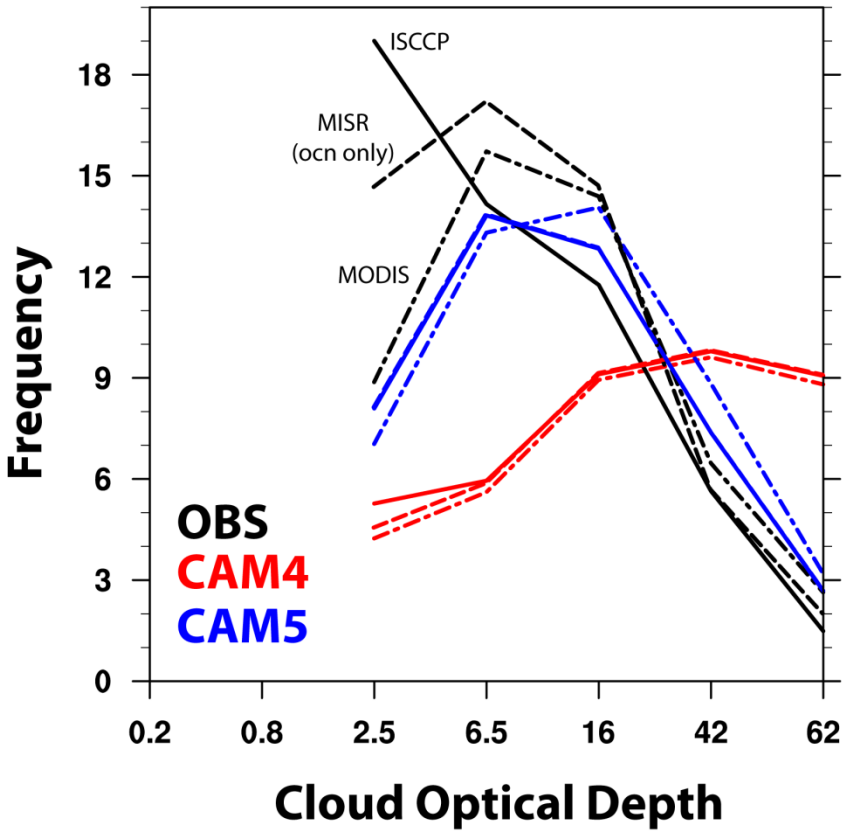
Tropical Cyclones



Diagnosing CAM5 climate

CFMIP Observation Simulator Package (COSP): in CAM5.1 release

Global cloud optical depth distributions from ISCCP, MODIS and MISR using COSP



✓COSP:

•Allows a more direct comparison between the satellite retrievals

✓CAM4:

•Too many optically thick clouds

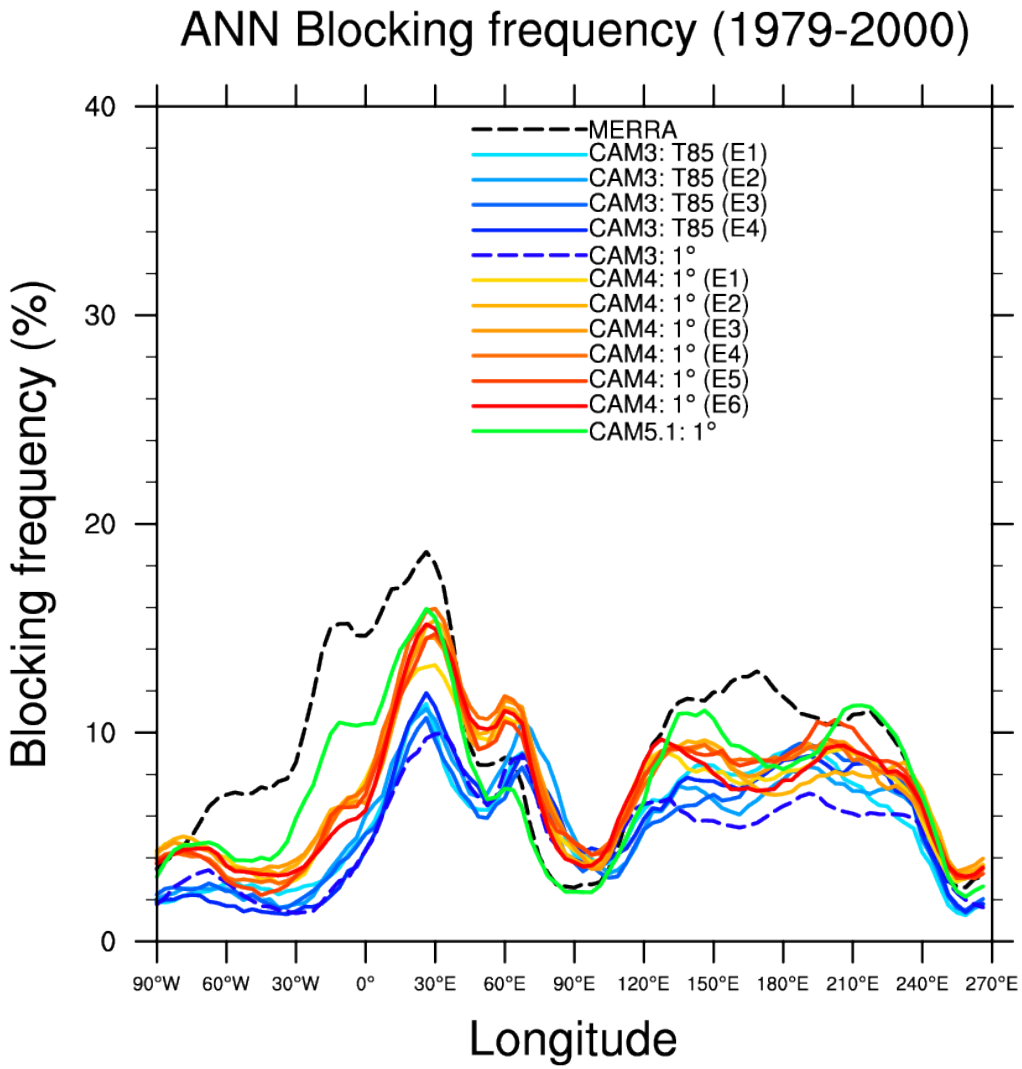
✓CAM5:

• Improved frequency of clouds at all optical depths

Thanks: Jen Kay, NCAR

Blocking in CESM

CAM (AMIP) and Reanalysis



Physics framework in CAM5+

Single grid-column state

q_v, q_l, q_i

Convection
Macrophysics
Microphysics

Sub-Column Generator

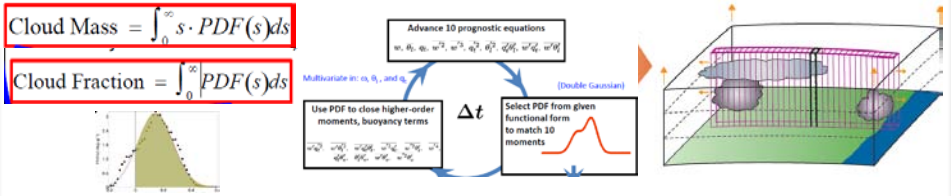
Radiation

$d(q_v, q_l, q_i)/dt$

Single grid-column state

q_v, q_l, q_i

Sub-Column Generator



a) PDF
Gaussian

b) CLUBB

c) CAM-SP

Convection (a,b)
Macrophysics
Microphysics (a,b)

Radiation

$d(q_v, q_l, q_i)/dt$