

High Resolution CAM in CCSM

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Outline (lots of questions!)

- What do we expect (would like!) higher horizontal resolution to give us?
- What resolutions have we run to date?
- What has higher resolution actually given us?
- What have been the (scientific) problems?
- What about vertical resolution?
- What other CAM changes are in store?

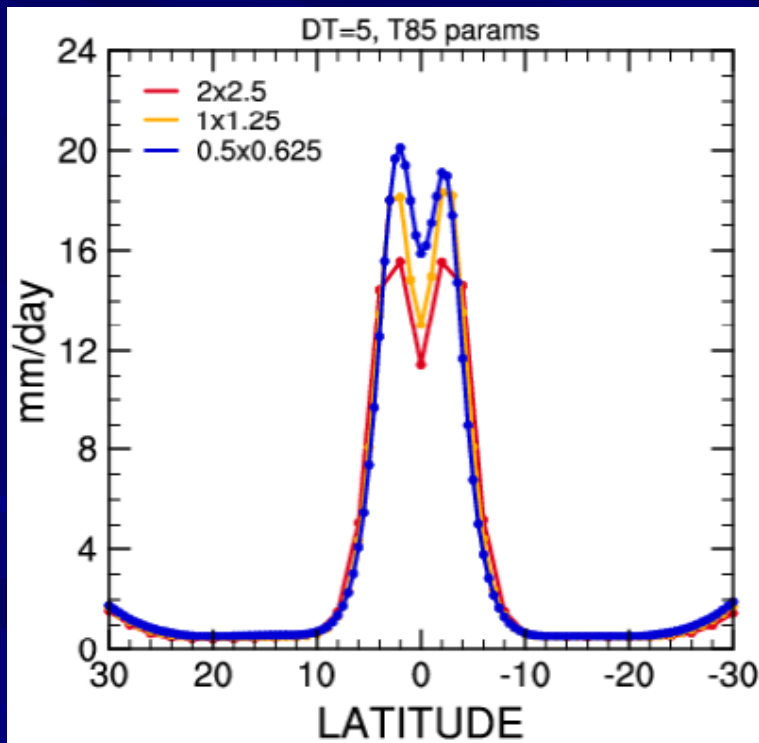
What can we expect?

Double ITCZ

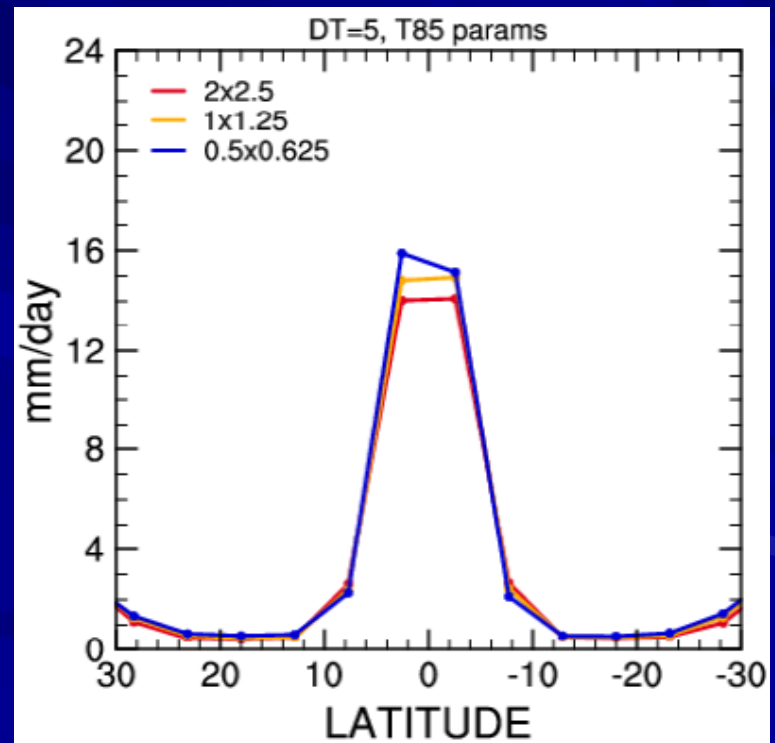
Aqua-planet experiments

Idealized fixed SSTs

Native Grid



5 deg grid



What can we expect?

Increased variability at all scales

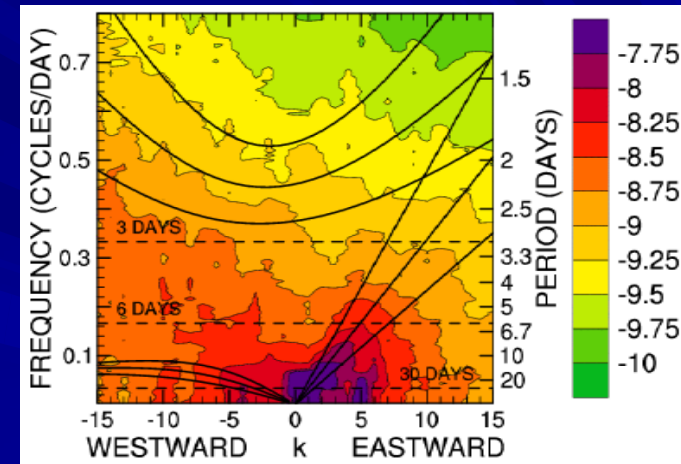
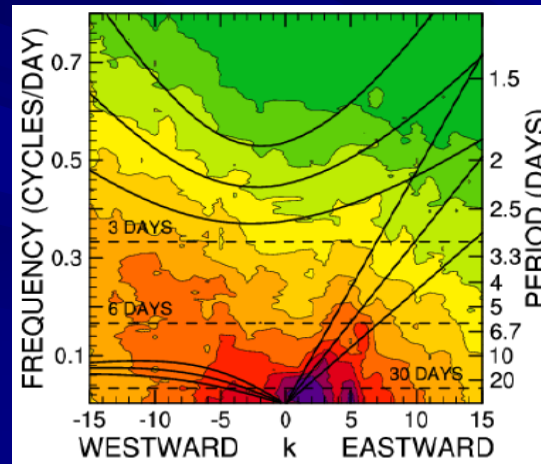
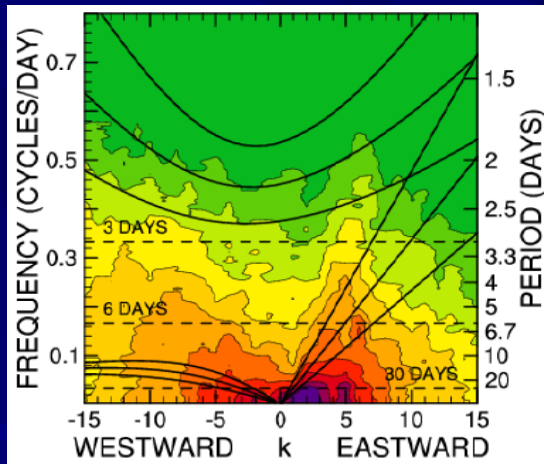
Wavenumber-Frequency Diagrams

Outgoing Long-wave Radiation (OLR)

2 deg

1 deg

0.5 deg



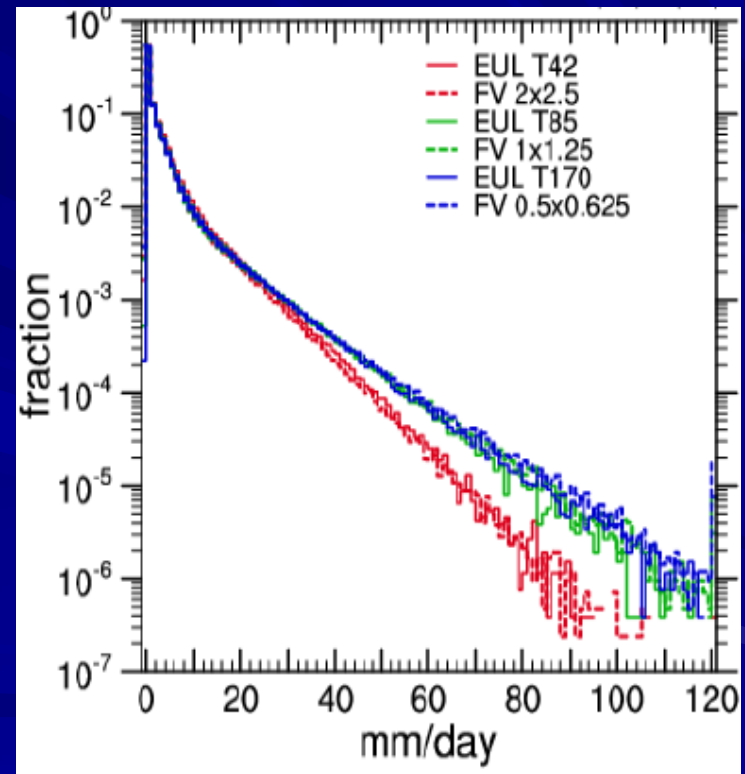
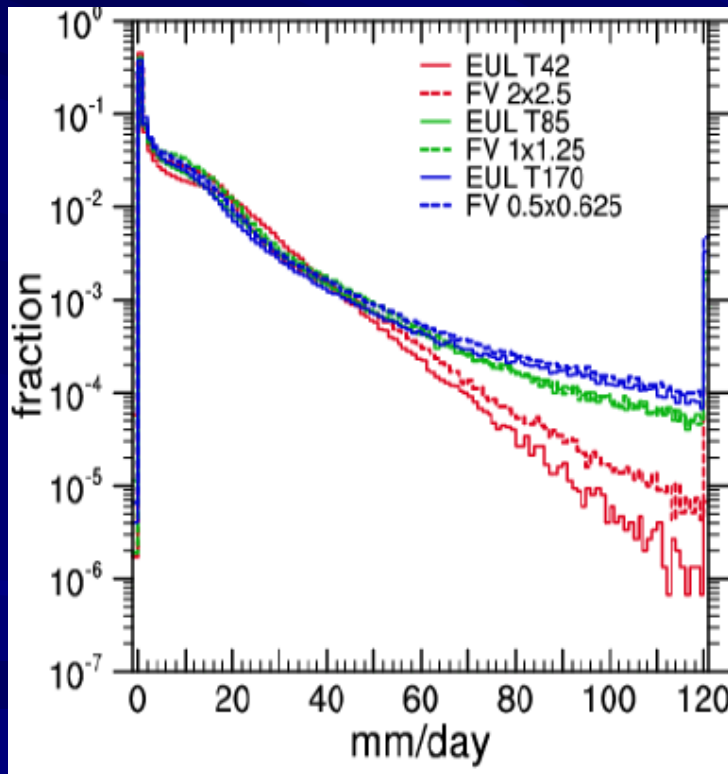
What can we expect?

Increased intense events

Rainfall frequency (on T42 grid)

Tropics

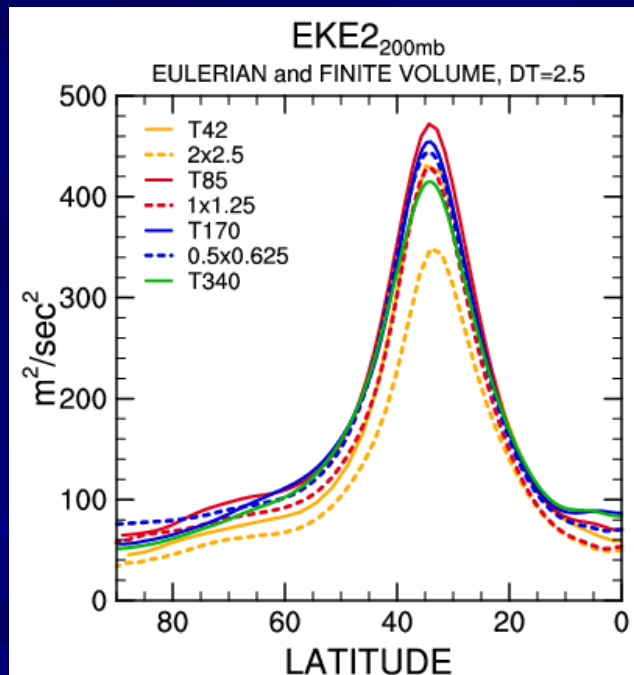
Mid-latitudes



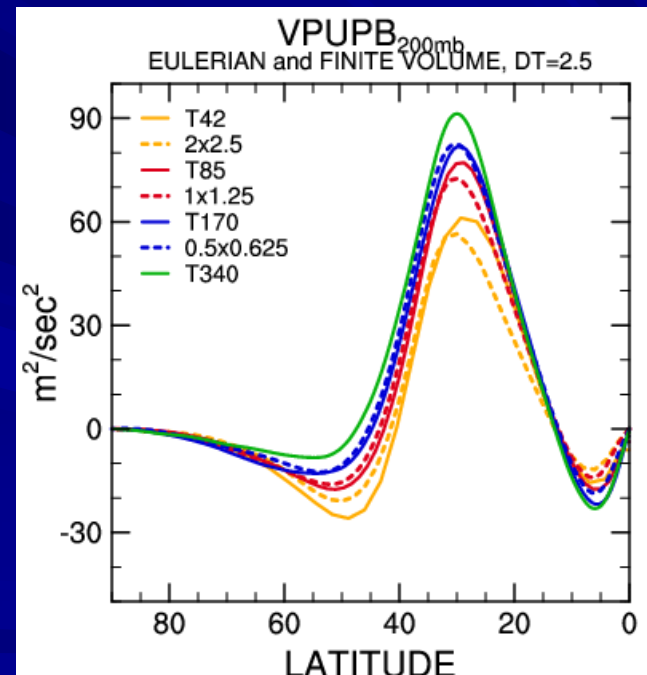
What can we expect?

Convergence of baroclinic instability solution

Eddy Kinetic Energy
(200mb)



Mean V'U'
(200mb)



Resolutions

Finite Volume

■ CAM

- 4x5 (baroclinic problem)
- 3x4 (new paleo for T31)
- 2x2.5
- 1x1.25
- 0.5x0.625
- 0.25x0.3125

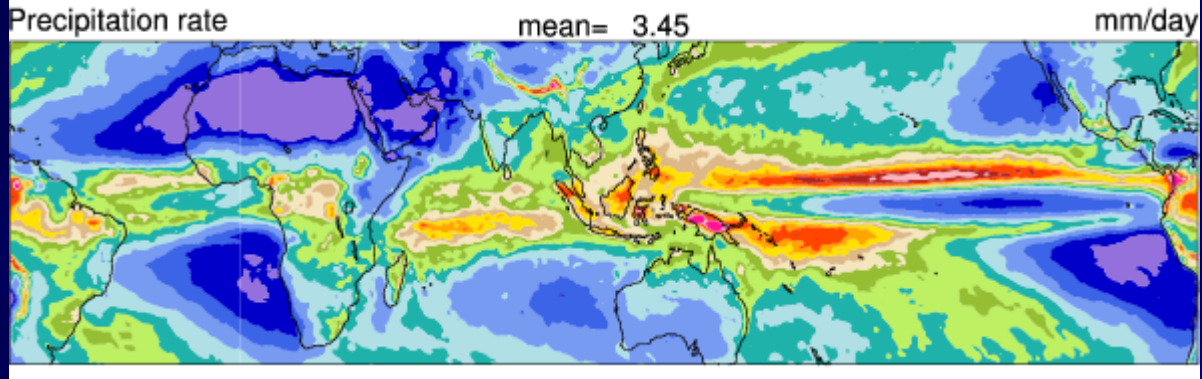
■ Physics time-step (currently 30 minutes)

■ Diffusion

■ Tuning parameters

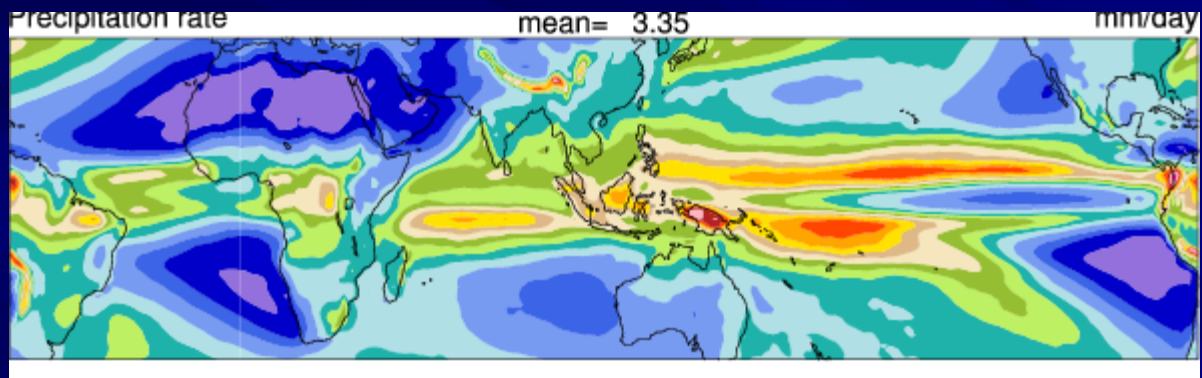
■ CCSM (x1 POP)

- (3x4 - x3 POP)
- 2x2.5 (default)
- 1x1.25 (IPCC)
- 0.5x0.625 (forecast)



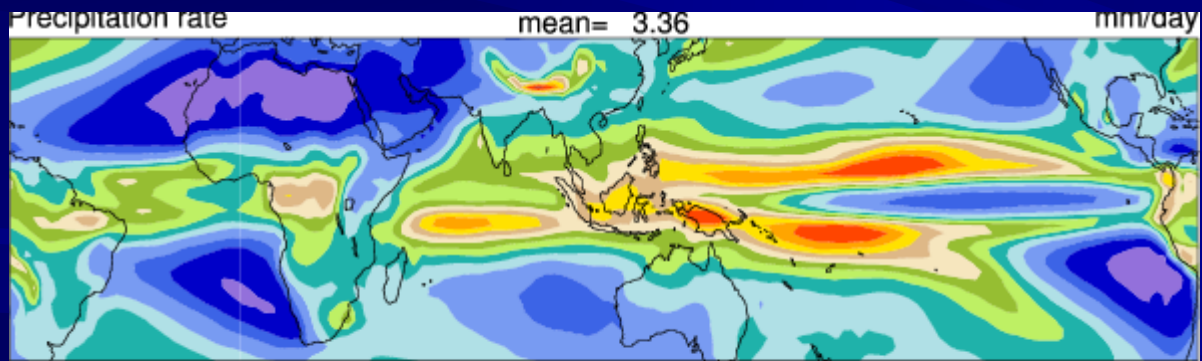
What do we get?
Intense Pacific ITCZ

0.5 deg (2 years!)



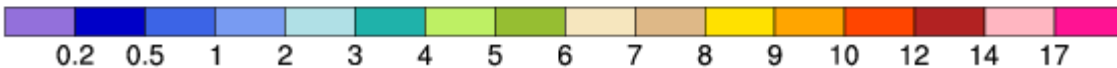
**Annual
Rainfall**

1 deg



2 deg

Min = 0.06 Max = 12.93



What do we get?

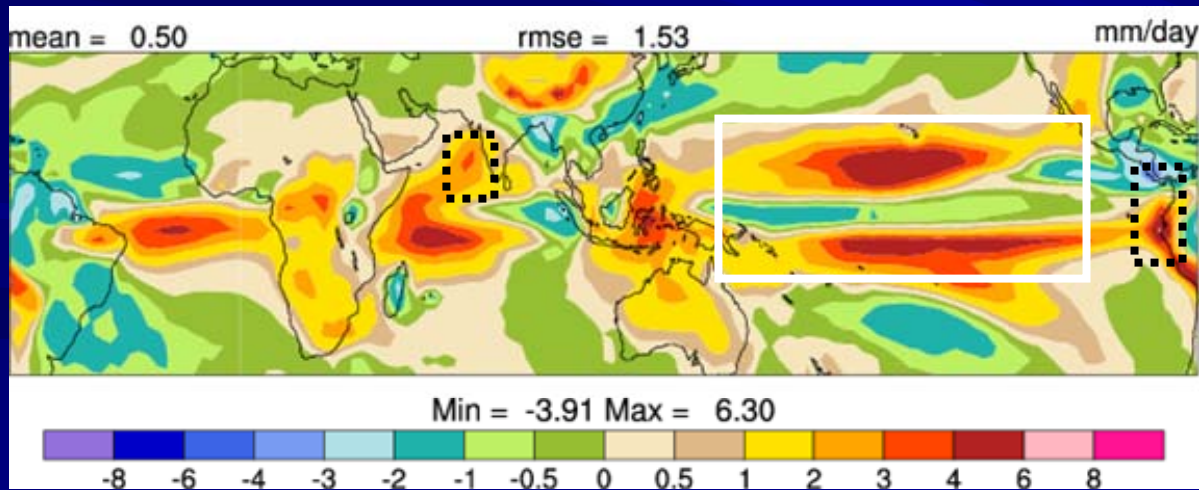
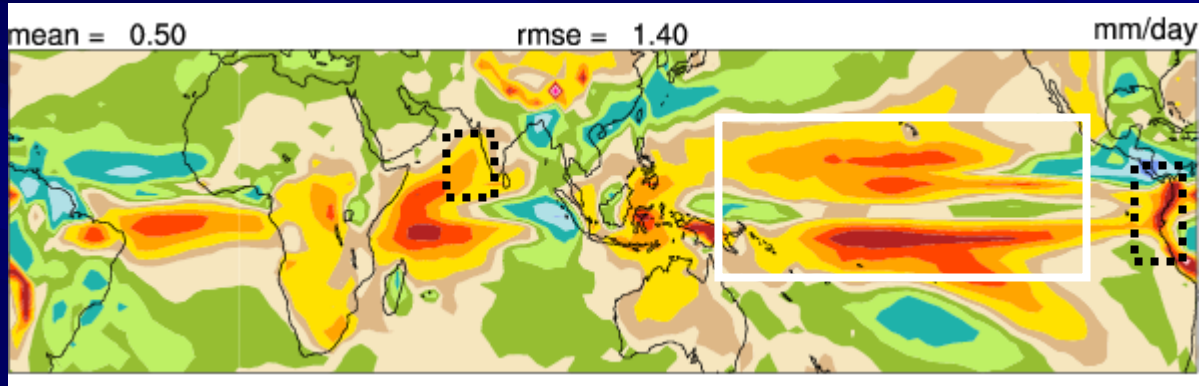
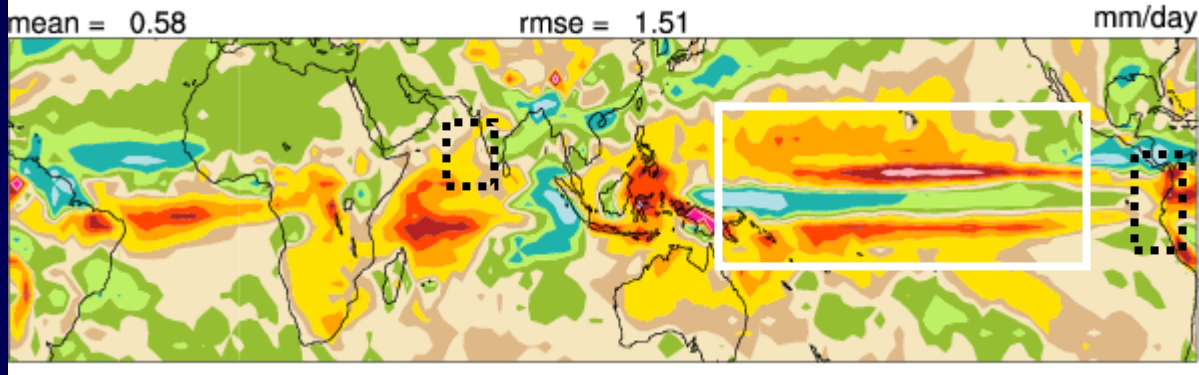
Equatorially confined errors
Defined orographic features

0.5 deg

Annual
Rainfall
Errors

1 deg

2 deg



What do we get?

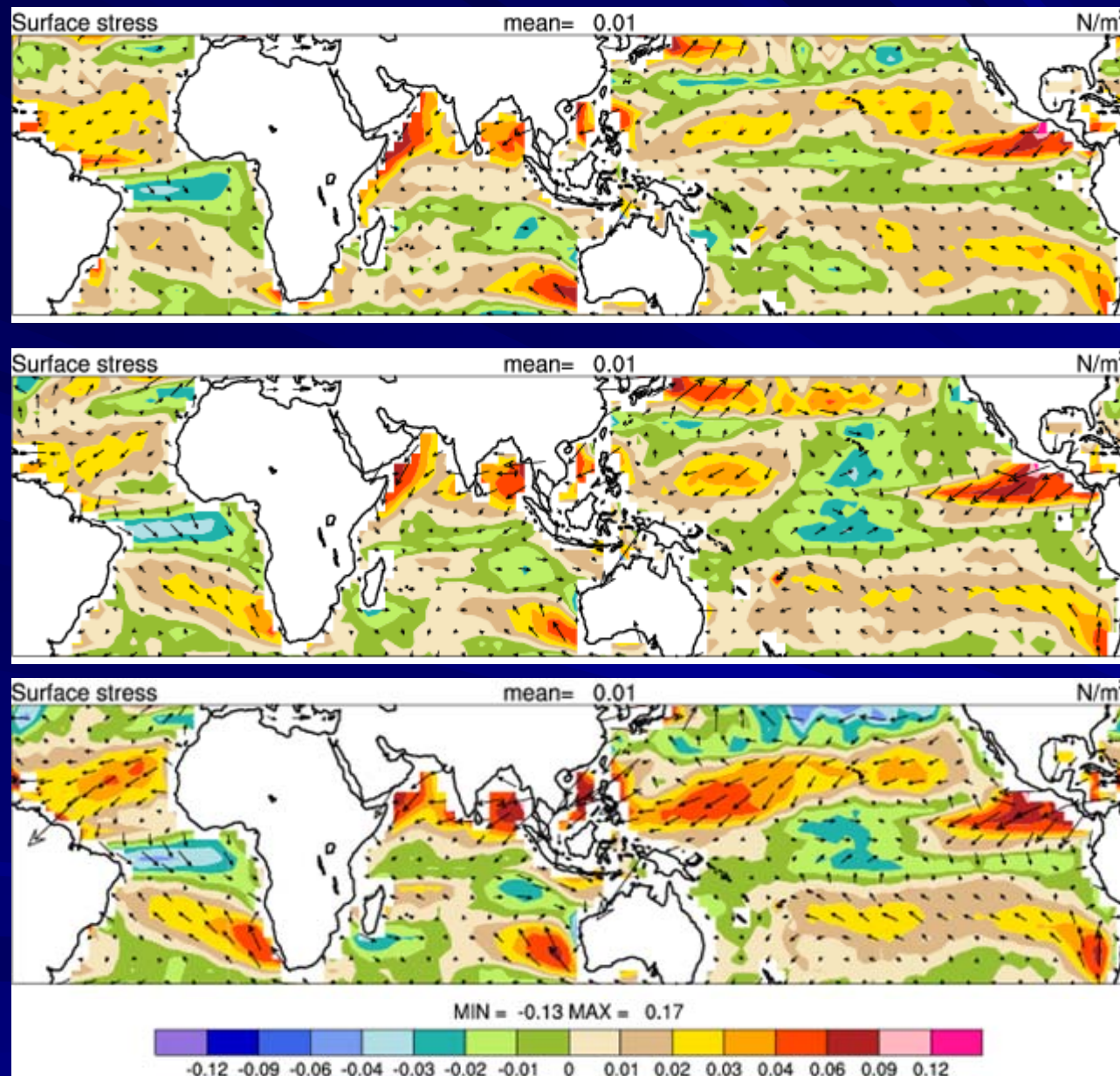
Reduced trade-wind errors

0.5 deg

1 deg

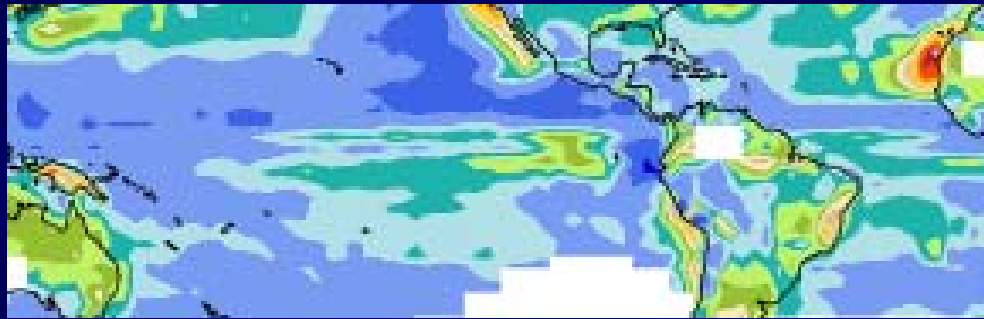
Annual
Stress
Errors

2 deg

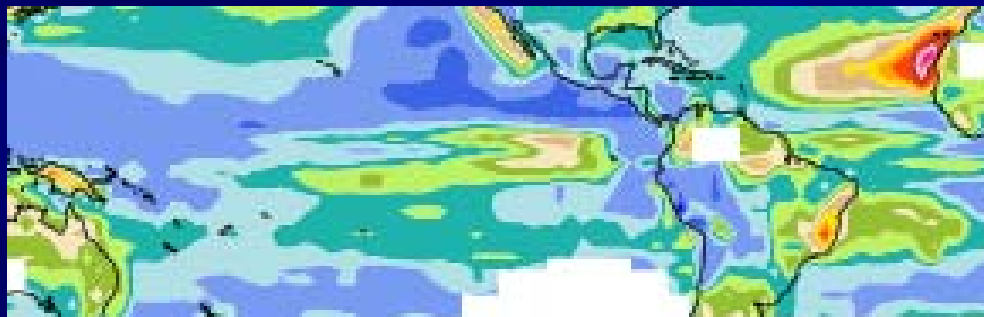


What do we get?

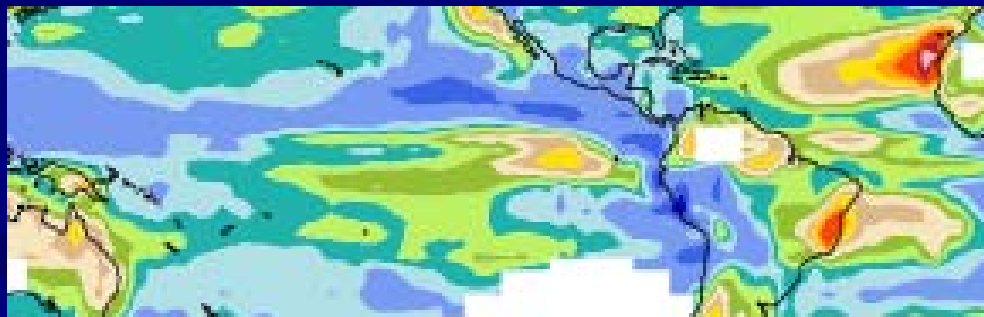
Reduced upwelling
region coastal cloud



0.5 deg



1 deg



2 deg

JJA
Annual Low
Cloud
Errors

Potential Problems

Stratospheric Polar night jet

Winter hemisphere excessive zonal wind

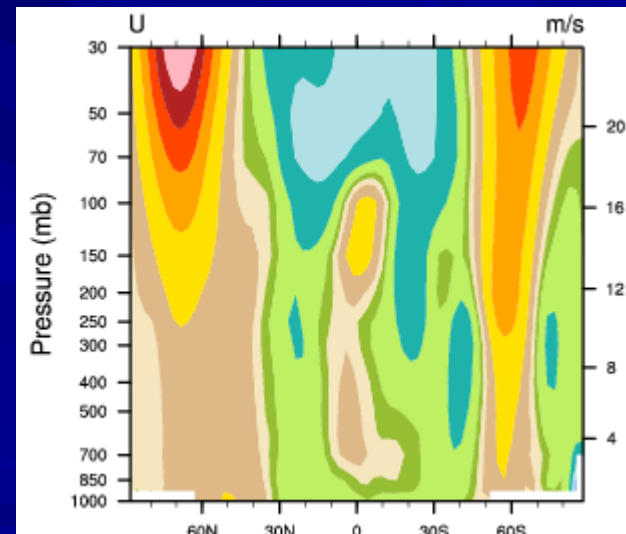
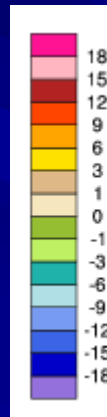
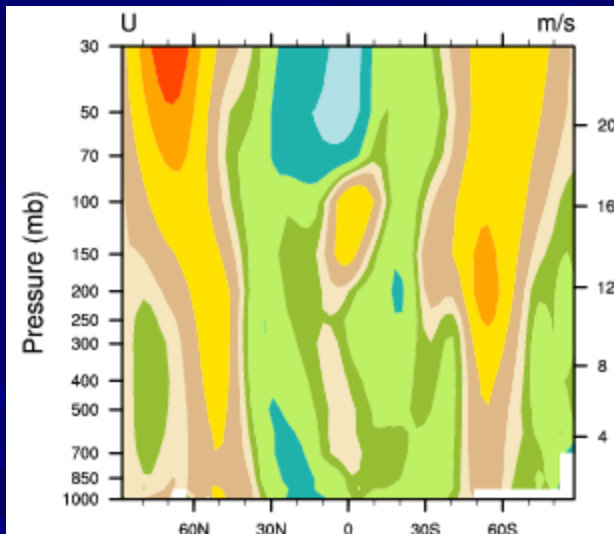
Causes CAM to crash at 0.25 deg resolution

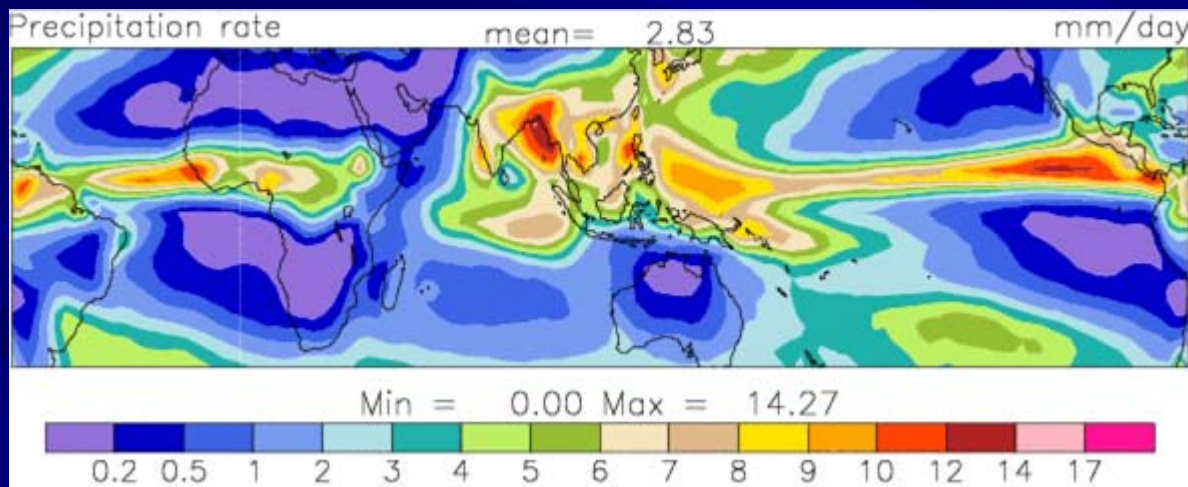
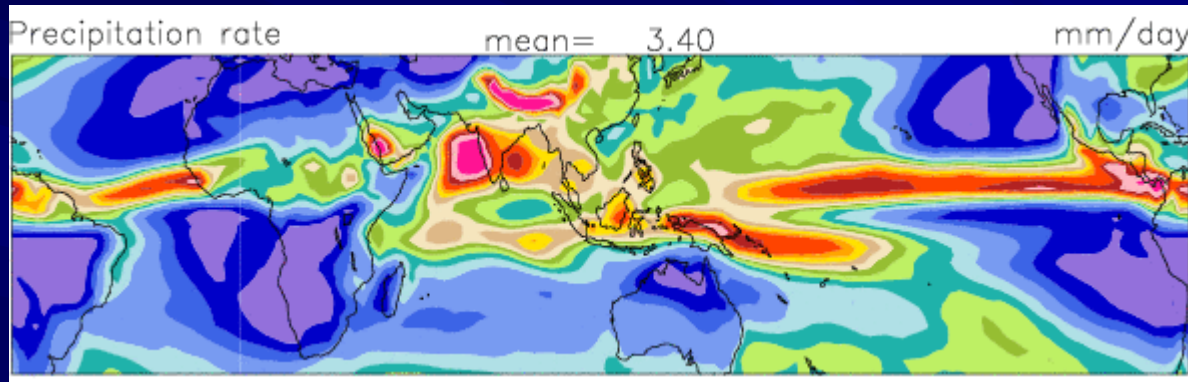
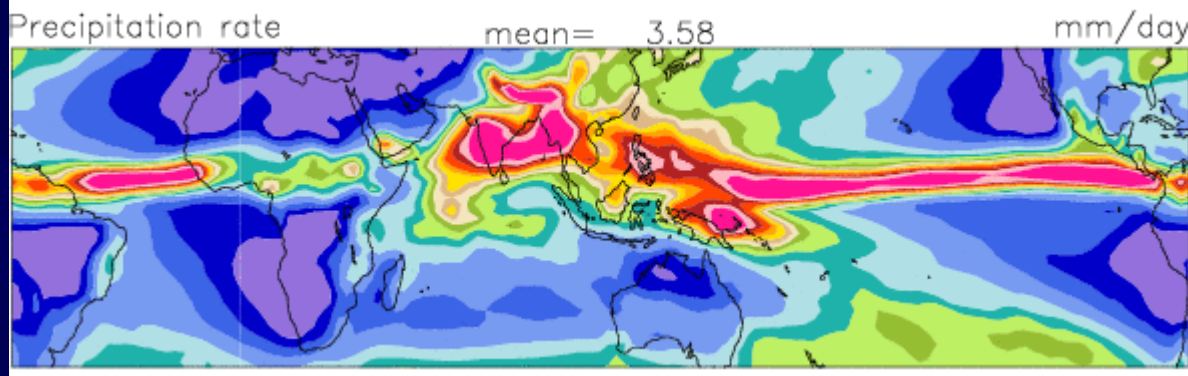
Alternative drag formulations to be implemented

2 deg

0.5 deg

DJF (CCSM)





Increasing vertical resolution

Improved equatorial rainfall

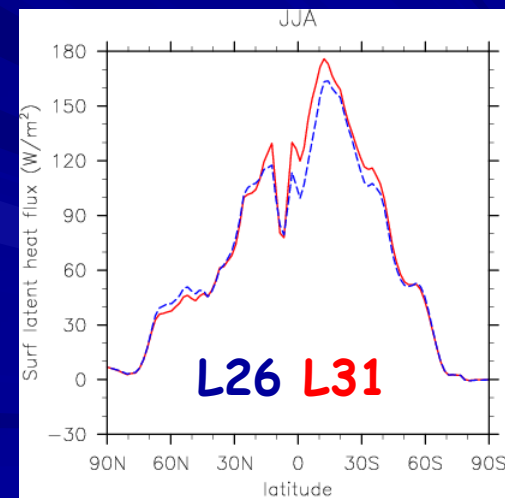
L31 with level @10m

CAM3.5
JJA
Rainfall
(1.9x2.5)

L26

Sfce. LH Flux

Obs.



CAM changes for the future: CCSM4 (and beyond)

■ Next 6 months

- New diagnostic aerosols and prognostic GHGs
- HBR/UW Boundary layer+ UW shallow convection
- Vertical Levels (26 now) - increase to 30, then 31 (20-m layer)
- Significant retuning of gravity-wave drag formulation
- Morrison-Gettleman microphysics (2-moment scheme)
- (Hooking aerosols to microphysics)

■ Post CCSM4?

- Improved radiation scheme
- PDF based clouds scheme
- Sub-column treatment for (most) physics
- Convective organization parameterization

Summary

- Aqua-planet experiments
 - Twin ITCZ problem will remain
 - Increased tropical variability
 - Converging mid-latitude solution
- Running CAM at higher resolution
 - Unresolved issues
 - Physics time stepping/coupling frequency
 - Polar night jet
- Higher resolution CAM in CCSM3.5
 - Tropically confined ITCZ errors in Pacific (upwelling?)
 - Improved orographic features
 - Reduced trade-wind and tropical surface stress errors
 - East Pacific upwelling/coastal cloud
- Potential large changes in next 6-months
 - Boundary layer
 - Addition of 20-m layer