

The Panel Assessment Process for CAM5.5: Simulations, assessment and the recommendations

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Boulder, Colorado



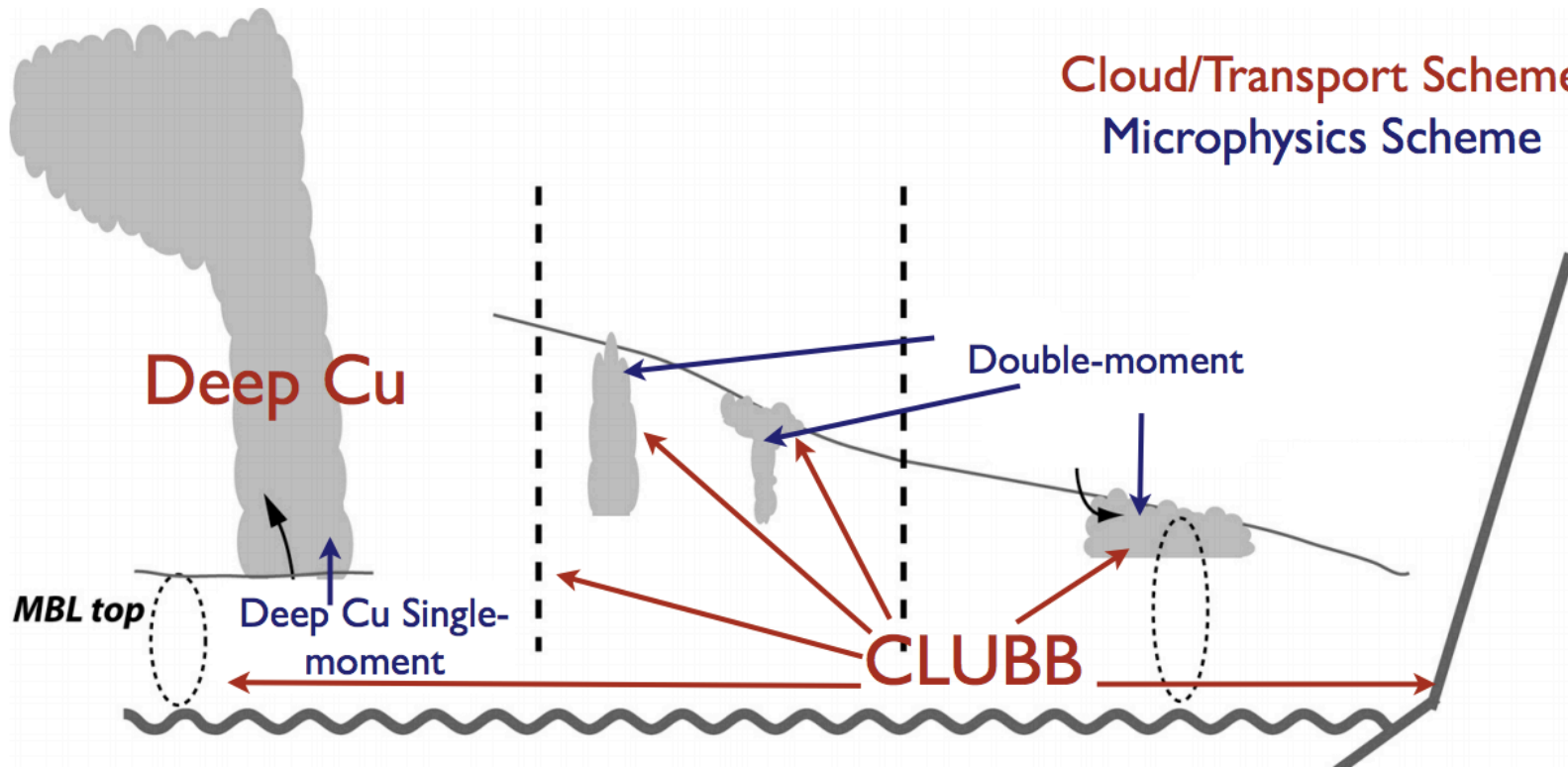
U.S. DEPARTMENT OF
ENERGY



CLUBB: Cloud Layers Unified By Binormals

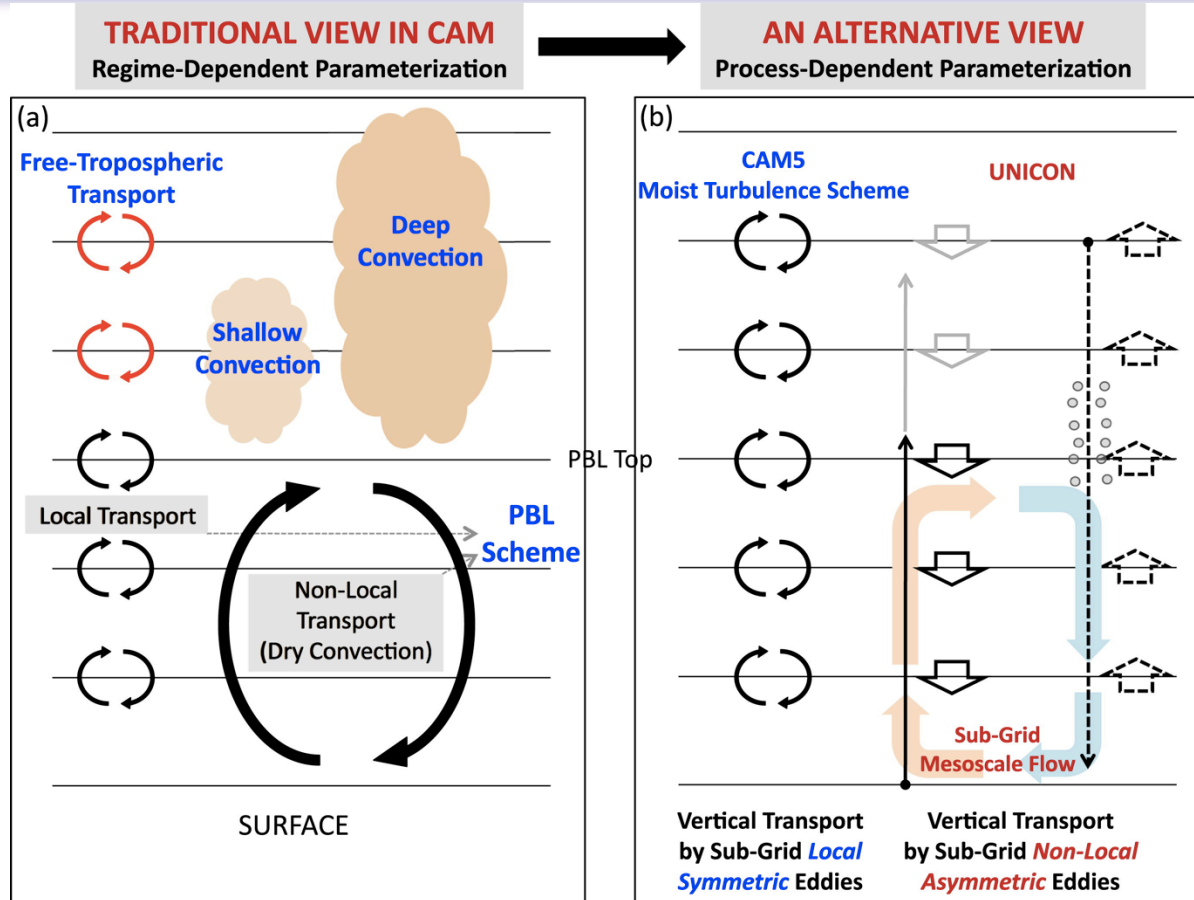
CAM-CLUBB standard

Cloud/Transport Scheme
Microphysics Scheme



- High order closures (1 third order, 8 second order)
- Unifies moist and dry turbulence (except deep convection)
- Use two Gaussians to describe the sub-grid PDF of each quantity

UNICON: Unified Convection Scheme



- Unifies deep and shallow convection schemes
- Generates forced/free/dry shallow convection + deep convection
- Accounts for sub-grid mesoscale flows

CAM5.3 (FV not SE)

CAM development

Bug fixes	Dust (erod.+bin)
MG2	Conv. Scav.+Tr.
MAM4	New orog.
Ice+mix. phase	L32
Energy changes	CLM4.5
Volcanic aero.	GWD

CAM6 dev. Web page

CAM5.4

CLUBB+MG2

Bogenschutz
Gettelman

Simulations

CAM5.3+C/M

UNICON

Park

Simulations

CAM5.3+U

Dec 1

**Analysis Panel
(5 members)**

- Code, Pubs., Data, Simulations (AMIP, coupled, AIE, 20th other)?
- Provide document proposing candidate to analysis team.

AMWG Feb 15

CAM5.5

WACCM5

Criteria?
Combinations?
Recommendations?

Simulations

Breck

RELEASE

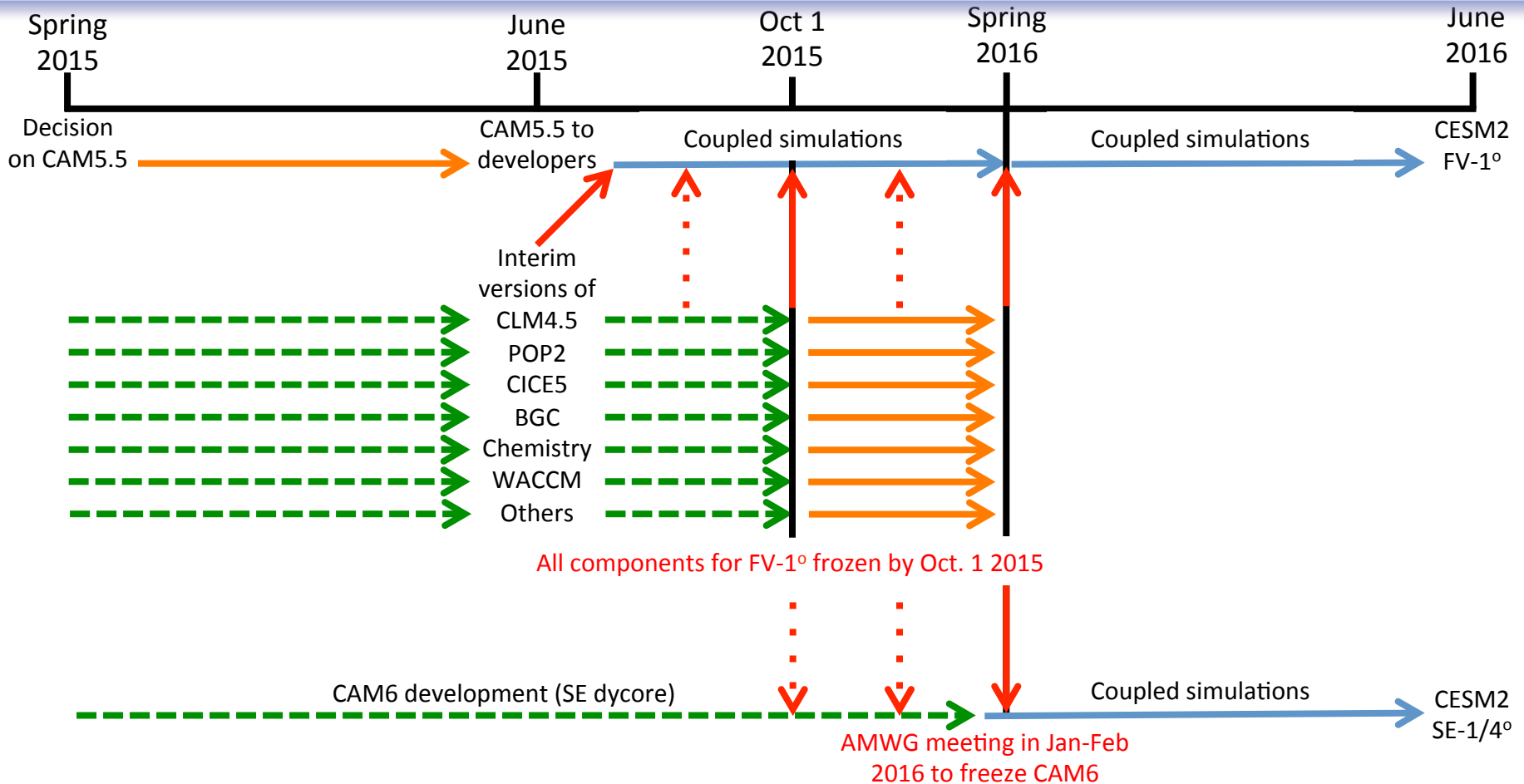
High-res (SE)

2016

CAM6



Timeline for CESM2



→ Code delivery

...→ Potential code delivery

- - - → Potential code development

→ Assembling and tinkering

What do we need to do?

- Decide the new physics to be used for CAM5.5
 - None/UNICON/CLUBB/Both/Punt
 - ‘Rejected’ options would still have a future
- How do we decide?
 - I don’t know
 - Value judgments of simulation/science/viability
- Now and for the AMWG meeting
 - Justify our assessment and recommendations
 - Hope to have unity, but will accept split decision->SSC
- We have formed a **panel** for the process

The Panel Process

- Aim
 - To assess and select model changes for the next version of CAM (CAM5.5)
 - Just the co-chairs: Too top-down; potential for bias
 - The whole of AMWG: Cumbersome/ bureaucratic (still encouraged)
 - Panel of experts: Useful number for consensus
- **Appoint Panel (ok'd by chief scientist)**
 - Antonietta Capotondi (CU/NOAA)
 - Steve Klein (DOE/LLNL)
 - Paul Kushner (U. Toronto)
 - Brian Mapes (U. Miami)
 - Martin Miller (formally of NCAR)
- **Assessment guidelines**
 - Set in place as best as possible guidelines for assessment
 - Did not want to prejudice opinion; so requirements were loose

AMWG Web page

The screenshot shows a Chrome browser window with the URL www.cesm.ucar.edu/working_groups/Atmosphere/development/cam6/cam5.5-process/. The page header features the NCAR UCAR logo, the CESM logo (COMMUNITY EARTH SYSTEM MODEL), and the tagline "earth • modeling • climate". A search bar is visible on the right. The main content area is titled "CAM5.5 assessment" and contains the following sections:

CAM5.5 assessment

CAM5.5 PANEL ASSESSMENT GUIDELINES

OVERVIEW

This webpage is intended to document the procedures and targets for ultimately delivering the version of the Community Atmosphere Model (CAM) for use by other CESM working groups in CMIP6 experiments. The version of CAM (to be tagged as CAM5.5) will be finalized with the inclusion of recent major physics parameterization developments. These candidate parameterizations are the Unified Convection scheme (UNICON) and the Cloud-Layers Unified By Binormals (CLUBB). Webpages providing information on the developments, including scientific background, diagnostics, output data and timings are available here:

- [Control runs](#)
- [CLUBB](#)
- [UNICON](#)

Members of the panel are:

- Antonietta Capotondi, NOAA
- Brian Mapes, Univ. Miami
- Martin Miller, previously of ECMWF
- Steve Klein, Lawrence Livermore National Laboratory
- Paul Kushner, Univ. Toronto

After consideration of all the available material provided by the candidates the panel has provided a [summary document outlining their assessment and recommendations](#) for CAM5.5 and beyond. This document serves as the recommendation to the AMWG, AMWG co-chairs and the CESM Scientific Steering Committee. We encourage AMWG members to review the document and all the supporting material, particularly if they will be attending the AMWG 2015 meeting where the process of selecting CAM5.5 will be discussed in depth. To provide feedback to the panel or the AMWG co-chairs please email [Rich Neale](#).

TIMELINES

http://www.cesm.ucar.edu/working_groups/Atmosphere/development/cam6/cam5.5-process/

The Recommendations

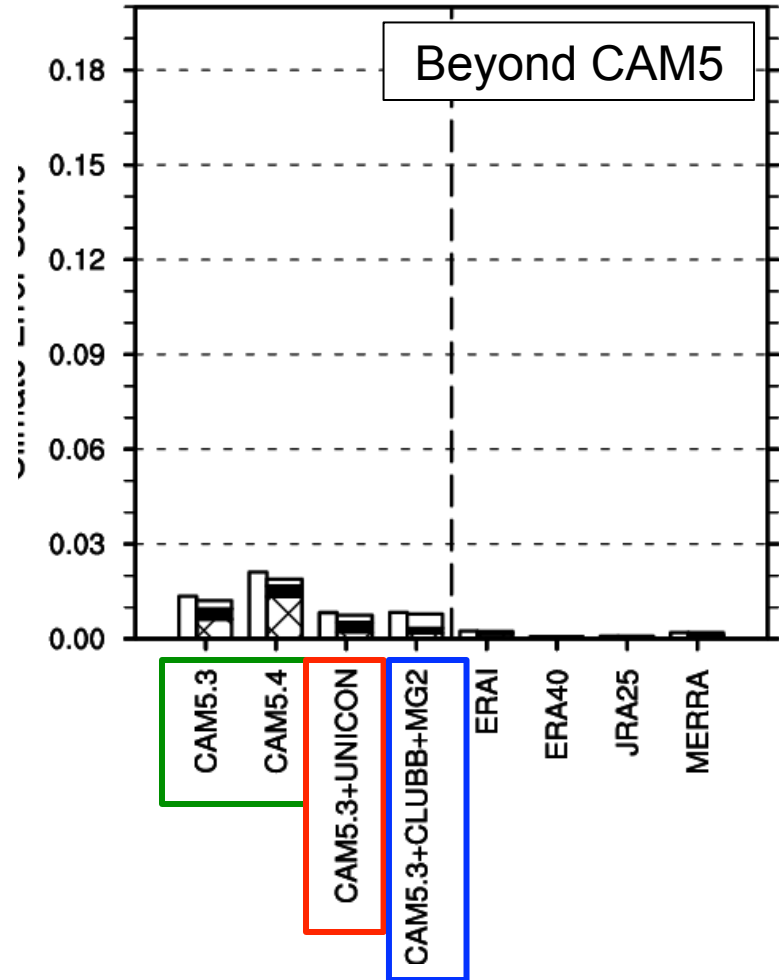
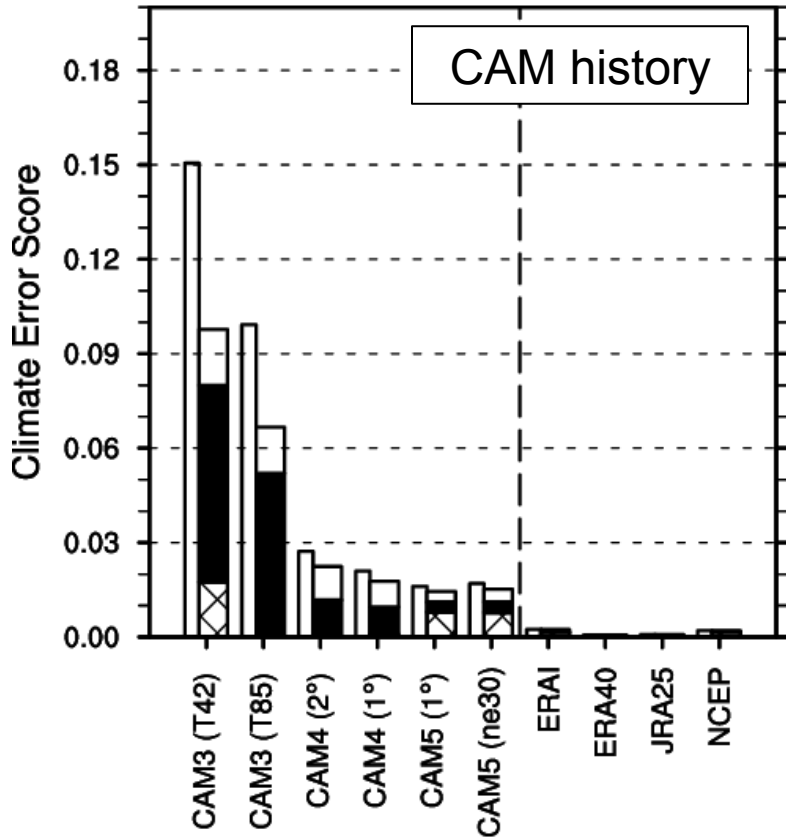
1 Model Choice and ENSO

- At this point CAM5.4 will form contingency version for CAM5.5
- This is because ENSO will be unacceptable with either UNICON or CLUBB
- However, UNICON and CLUBB developers should work towards improving ENSO by May 15 deadline
- At that time the panel will make a recommendation whether to continue with the contingency or to proceed with UNICON or CLUBB if they have an acceptable ENSO

2 Model understanding and development

- All code should be made available to developers after AMWG
- Due to scheme complexity greater effort should be applied to understand parameter sensitivities of schemes
- Each candidate scheme has desirable aspects the should be actively combined beyond CAM5.5 toward CAM6
- Therefore developers should plan for scheme intergration

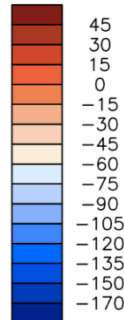
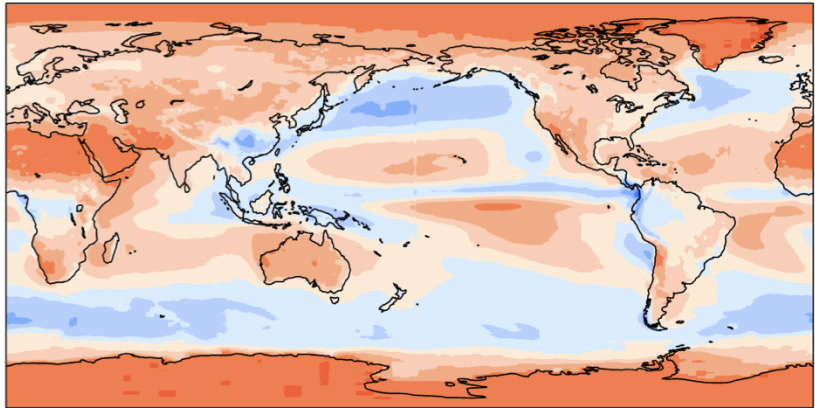
Climate error score: First measure of skill (NH Z500, ANN)



Clouds: Short-wave cloud forcing (AMIP)

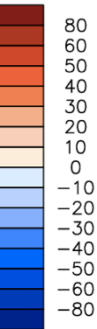
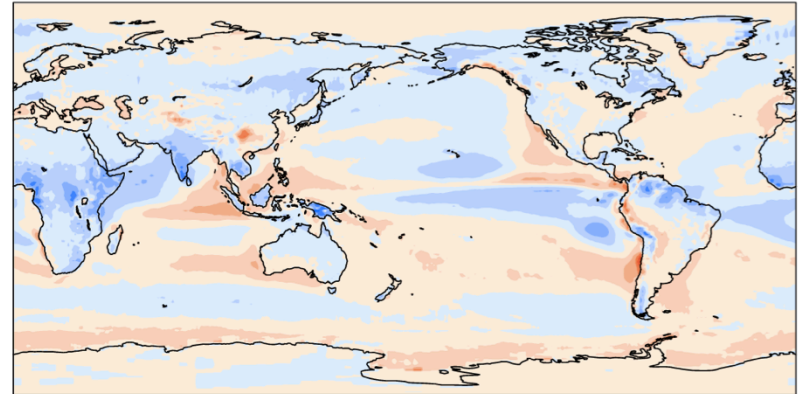
CERES-EBAF

TOA SW cloud forcing mean = -47.07 W/m²



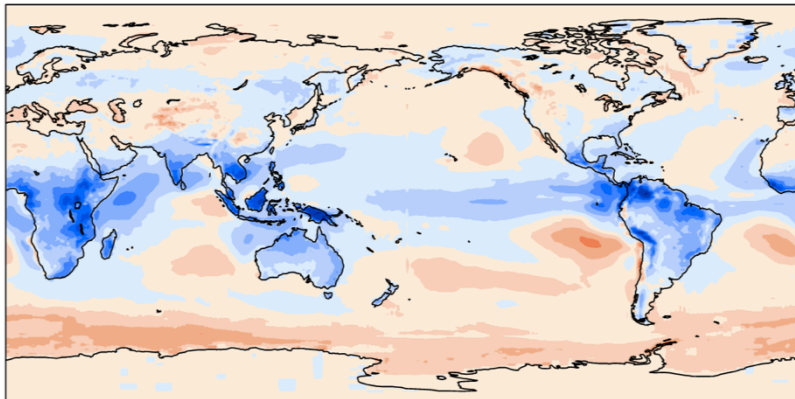
CLUBB

mean = 0.11 rmse = 8.74 W/m²



CAM5.3

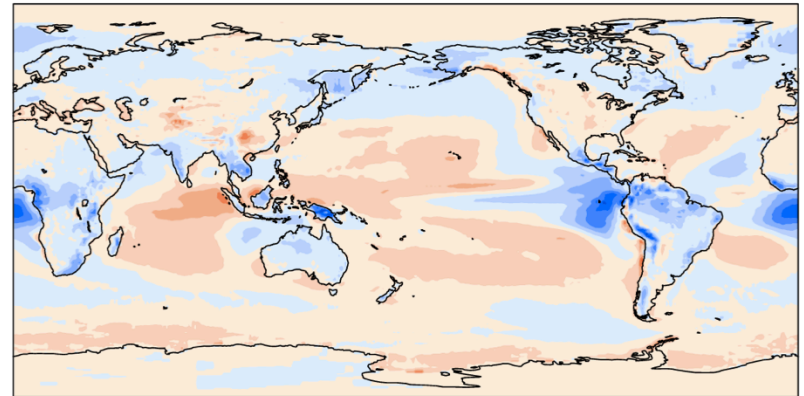
mean = -1.98 rmse = 13.47 W/m²



ANN

UNICON

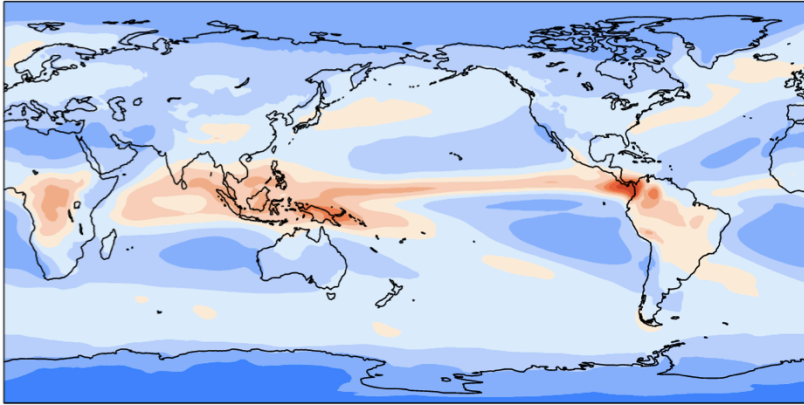
mean = 1.89 rmse = 10.25 W/m²



Clouds: Long-wave cloud forcing

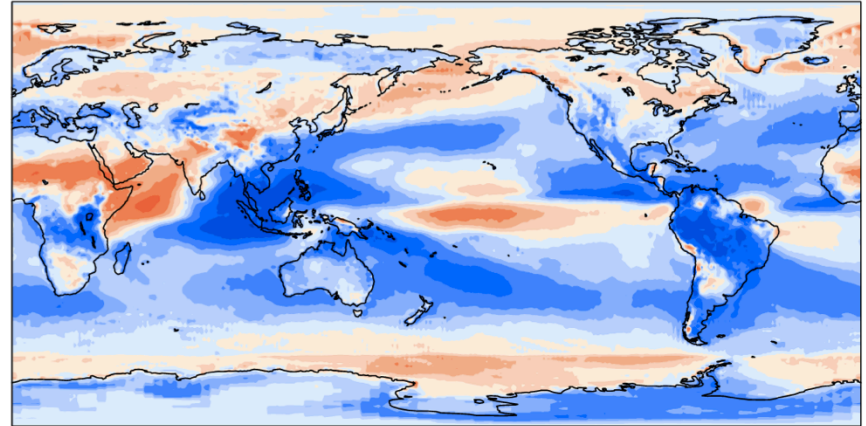
CERES-EBAF

TOA LW cloud forcing mean = 22.39 W/m²



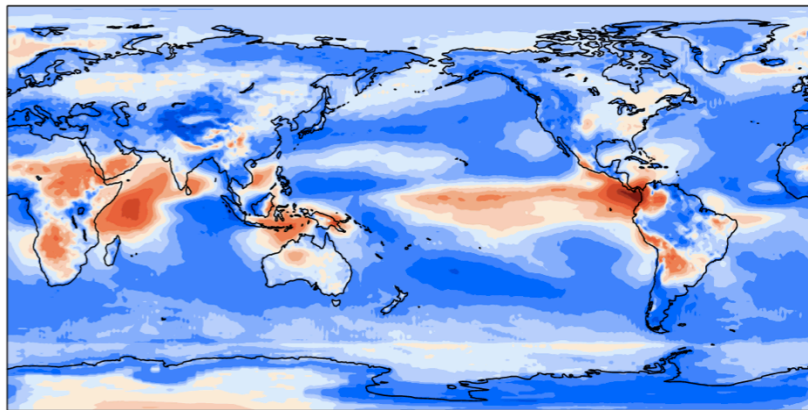
CLUBB

mean = -3.28 rmse = 6.08 W/m²



CAM5.3

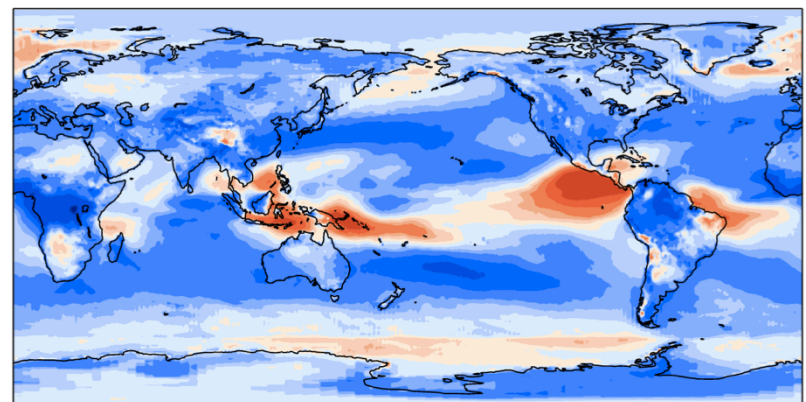
mean = -4.09 rmse = 6.59 W/m²



ANN

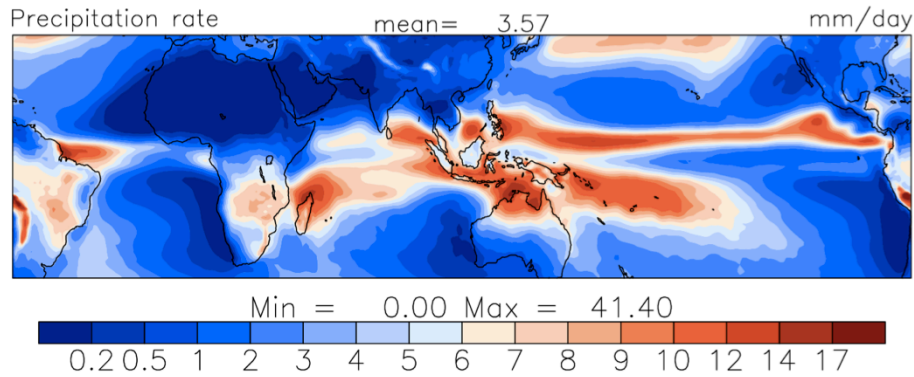
UNICON

mean = -4.50 rmse = 7.13 W/m²

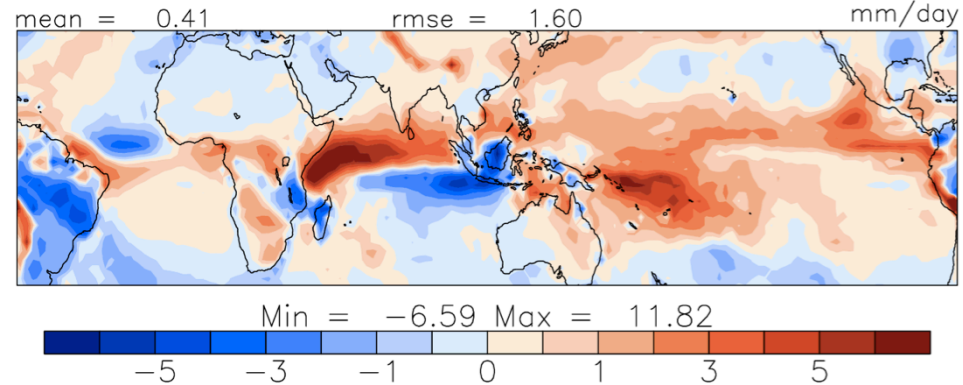


Precipitation: Improved E. Pacific ITCZ in CLUBB

GPCP

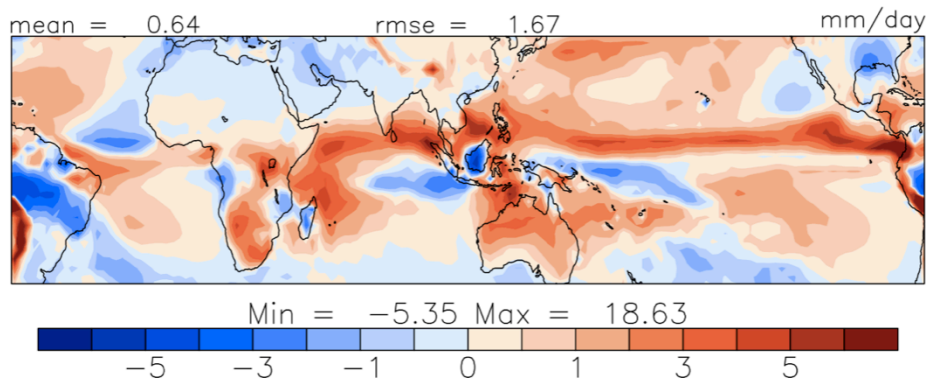


CLUBB

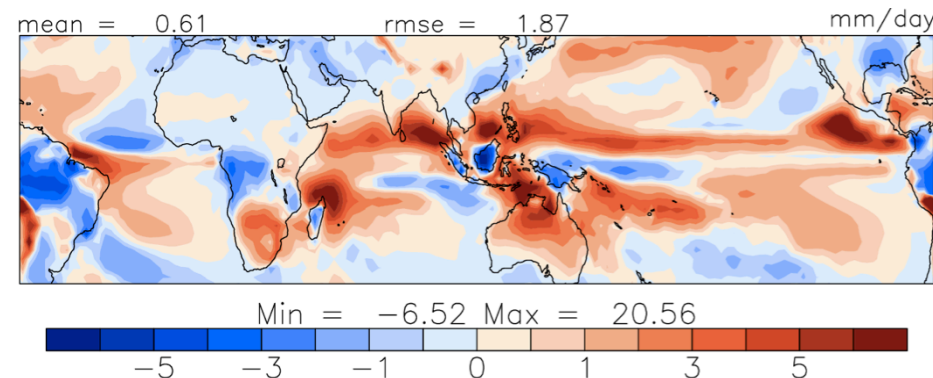


DJF

CAM5.3

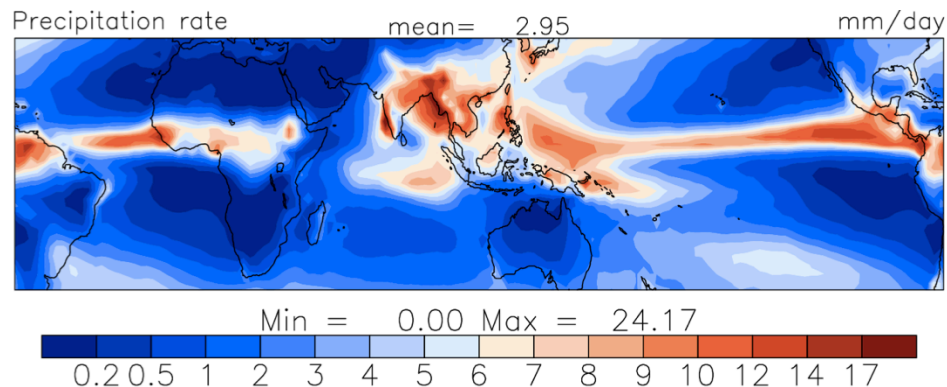


UNICON

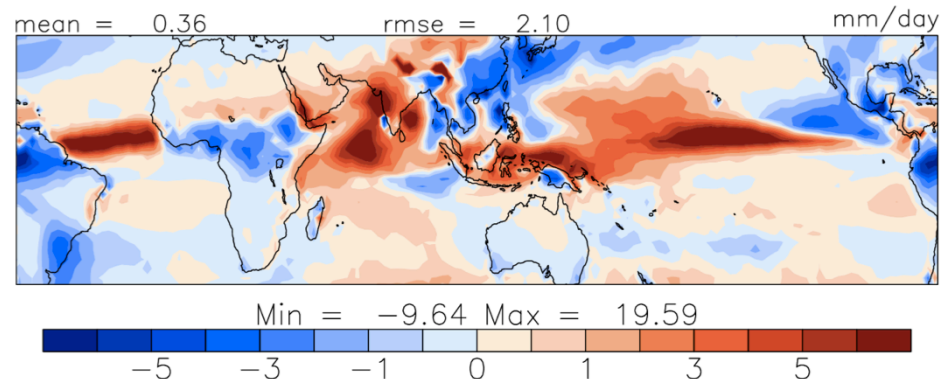


Precipitation: Monsoon

GPCP

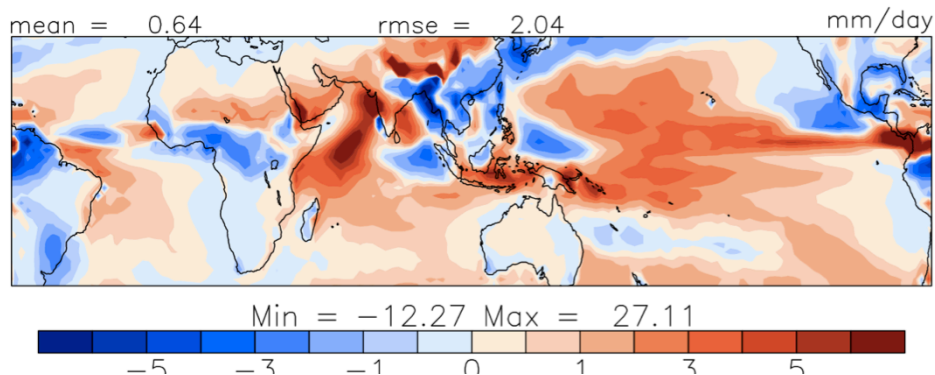


CLUBB

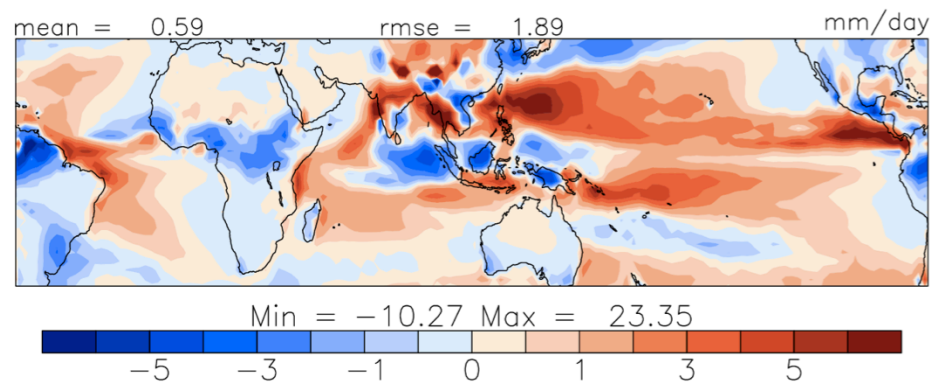


JJA

CAM5.3

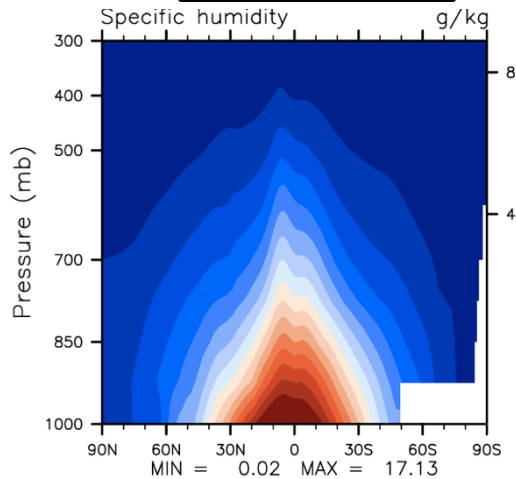


UNICON

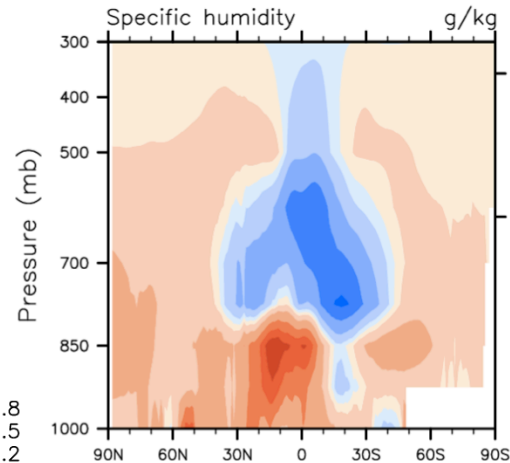


Atmospheric humidity: Reduced moist bias

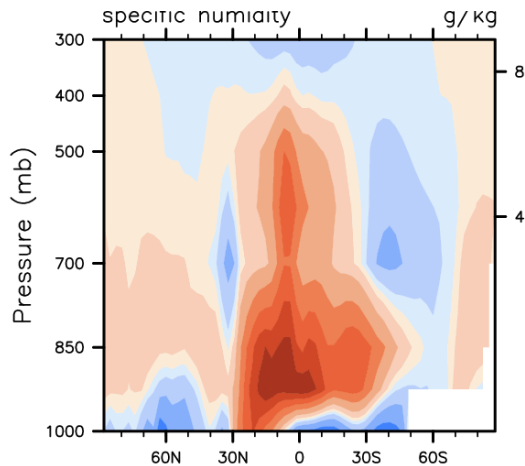
MERRA



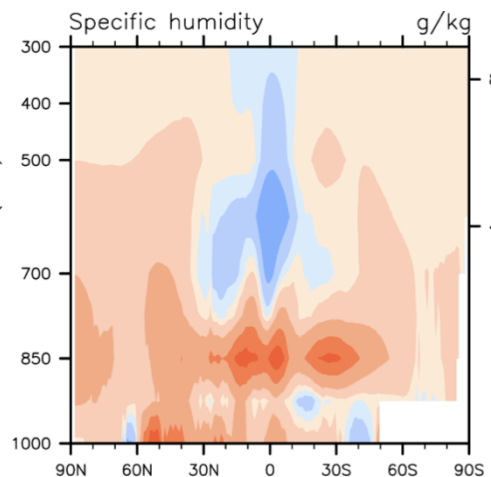
CLUBB



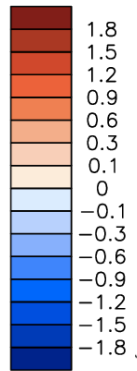
CAM5.3



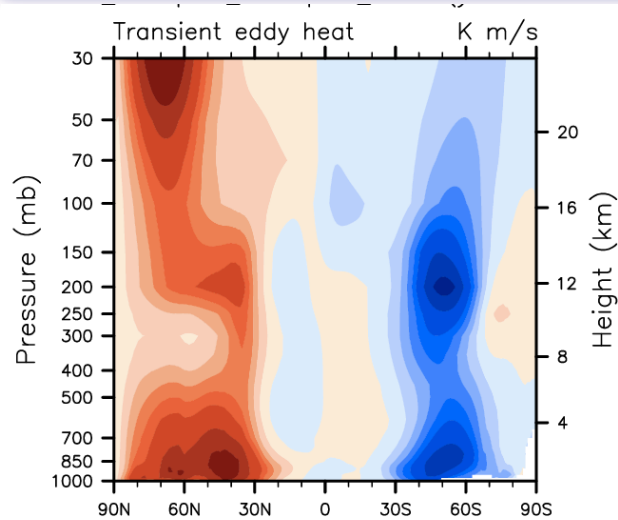
UNICON



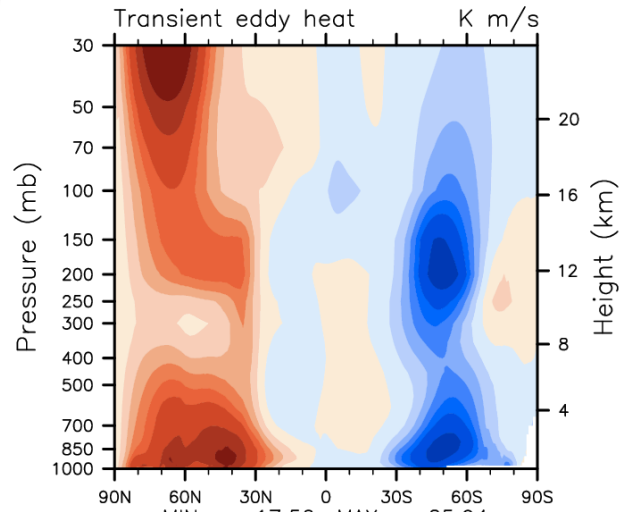
- CAM5.3 persistent wet bias
- CLUBB/UNICON dryer
- PBL water too high
- Mid-latitude moisture increased



Storm Tracks: Transient heat transport increase in CLUBB

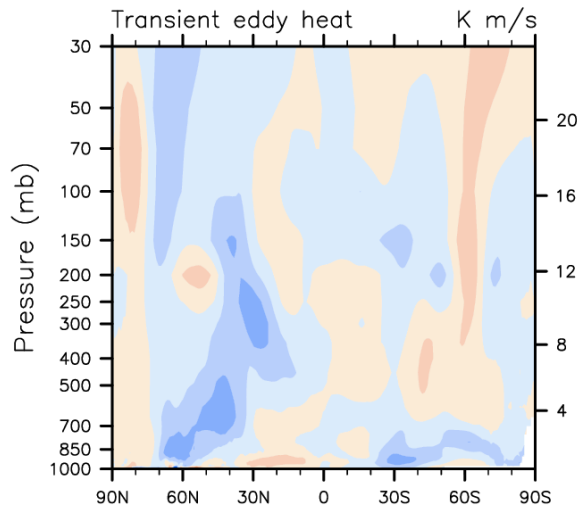
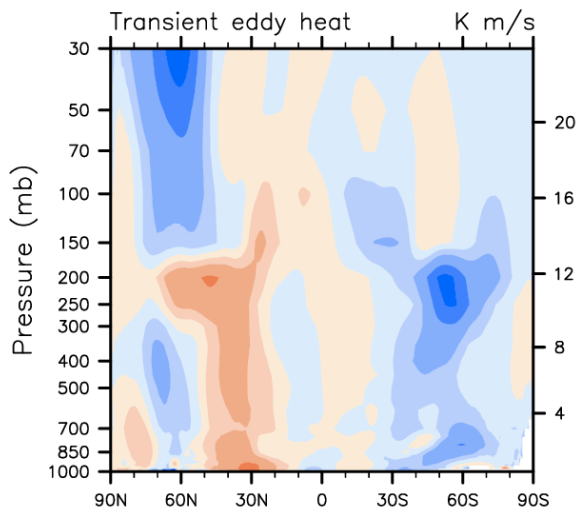


CLUBB



UNICON

- Poleward shift of storm track activity in CLUBB
- Mid-latitude rainfall maximum also shifts poleward



Precipitation Diurnal Cycle: Better Phase

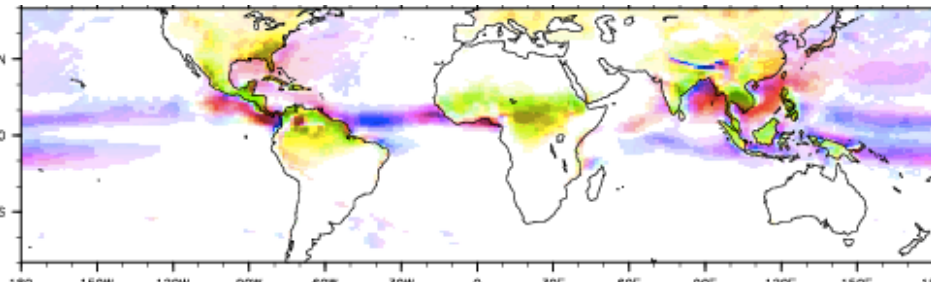
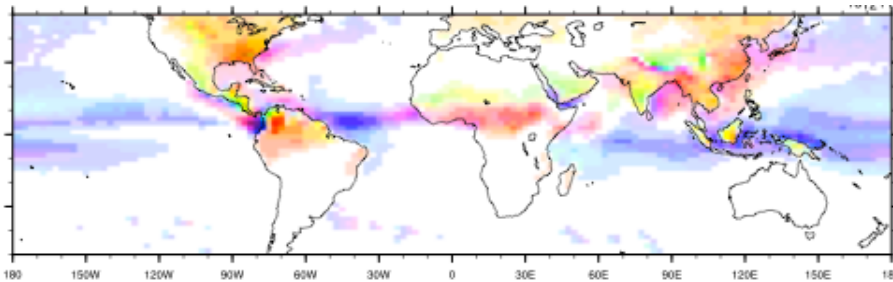
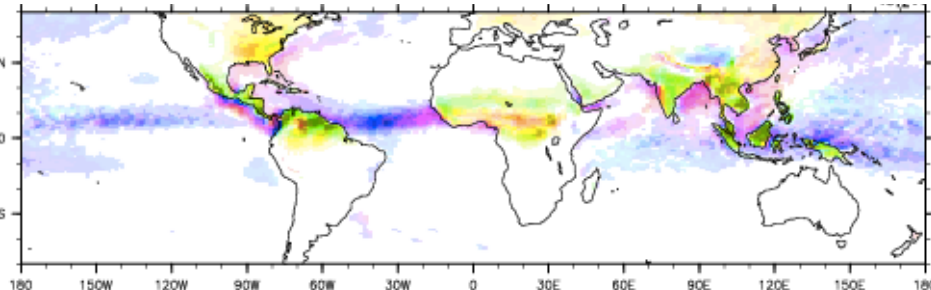
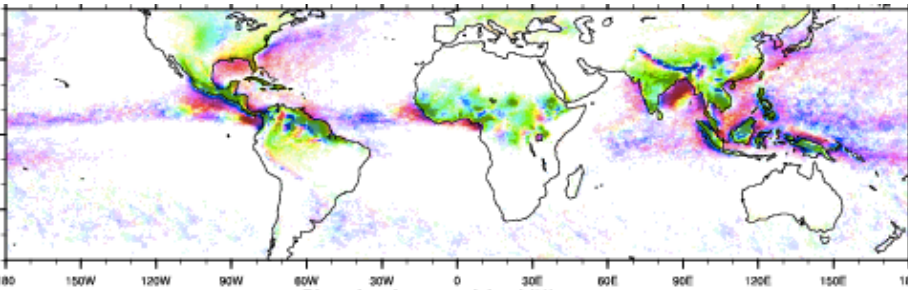
TRMM

CLUBB

CAM5.3

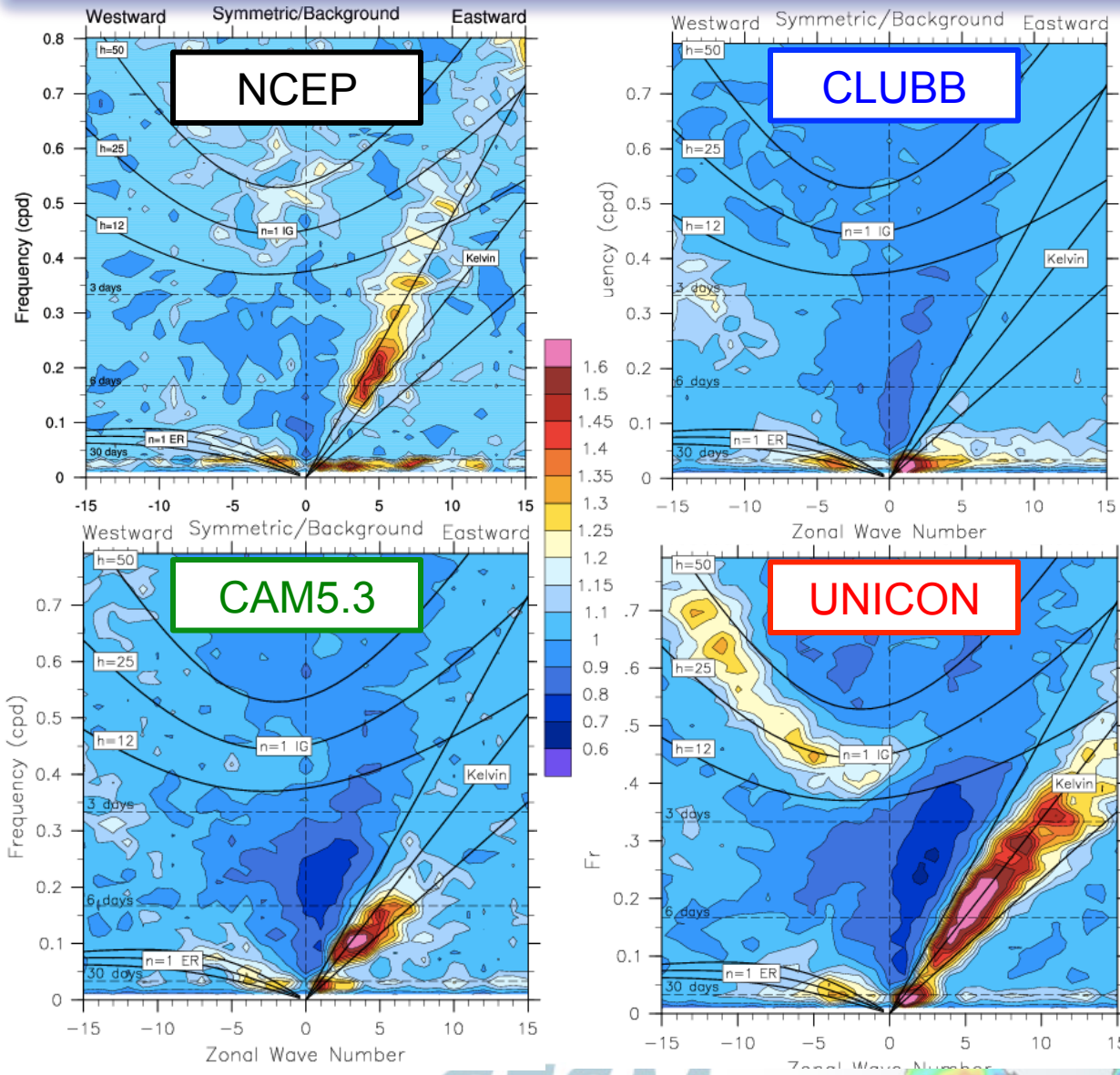
JJA

UNICON



- Diurnal cycle peak remains too early
- Shifts from 12pm to 4pm over land (both)
- Shifts from 2am to 8am over ocean (UNICON better)
- US mid-western rainfall still deficient (at 1°)

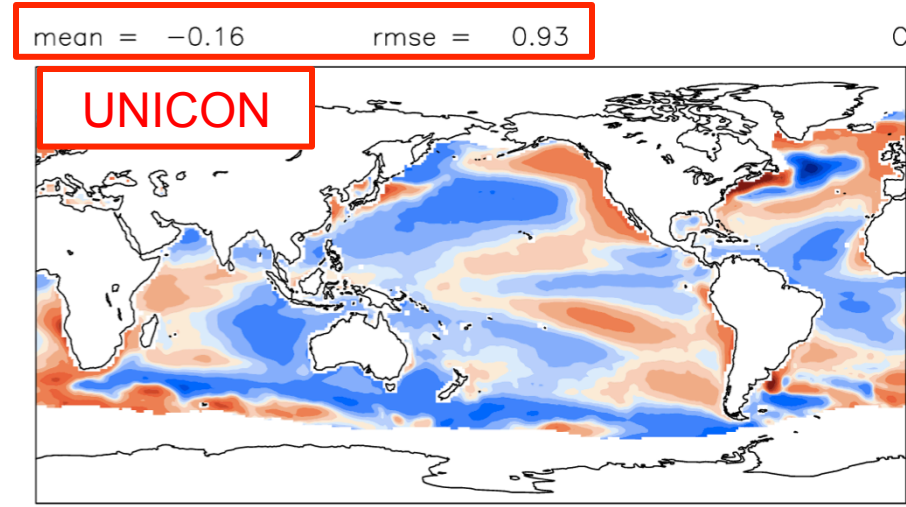
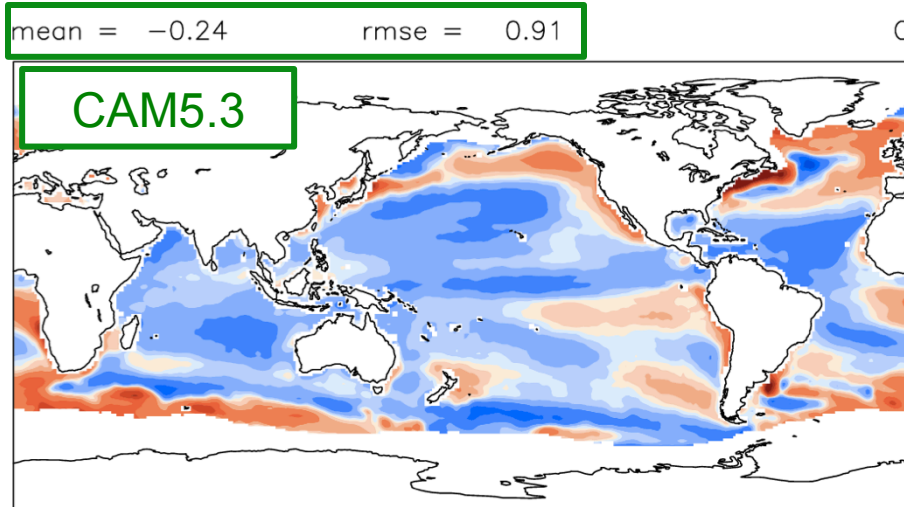
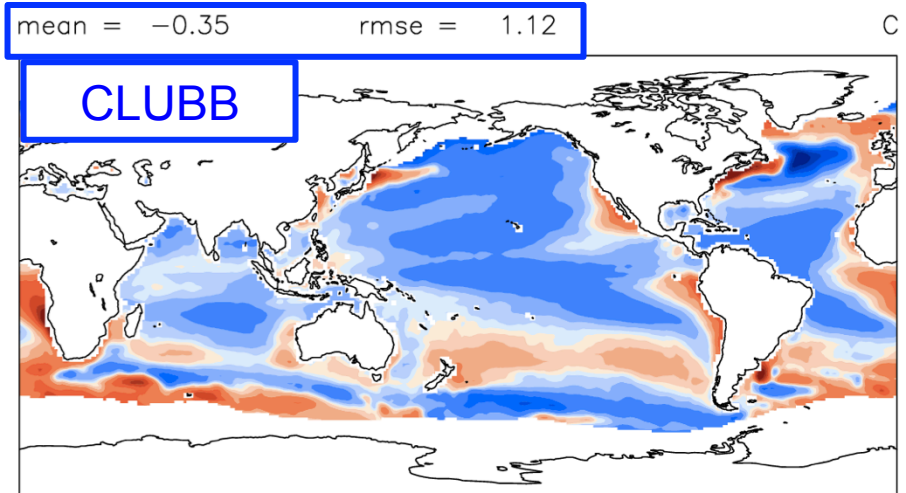
Precipitation: Equatorial waves



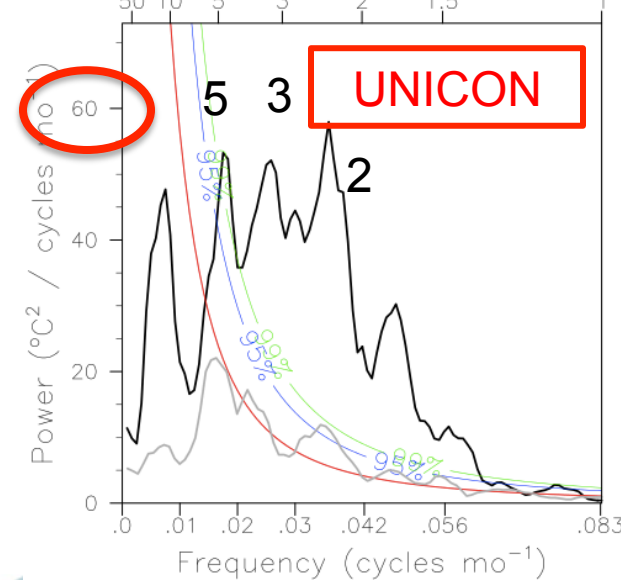
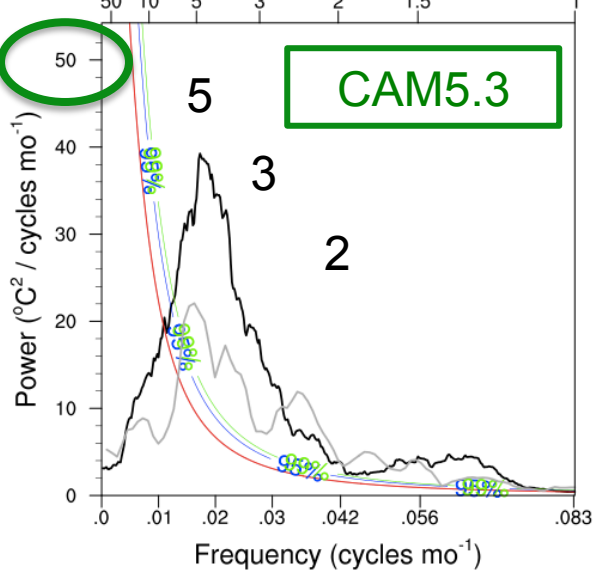
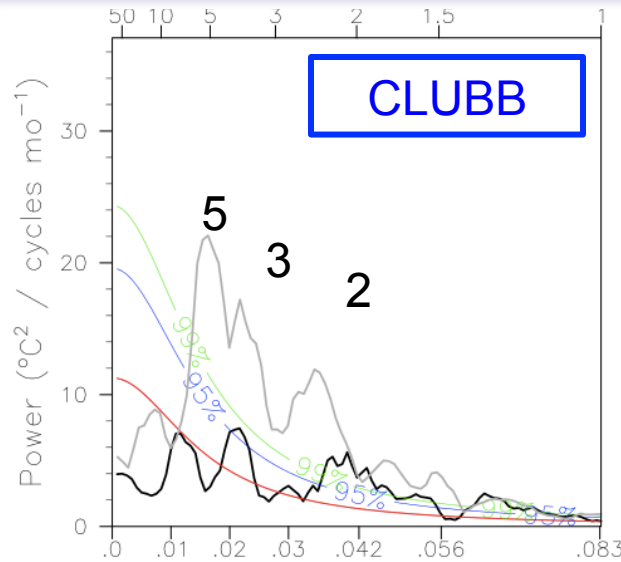
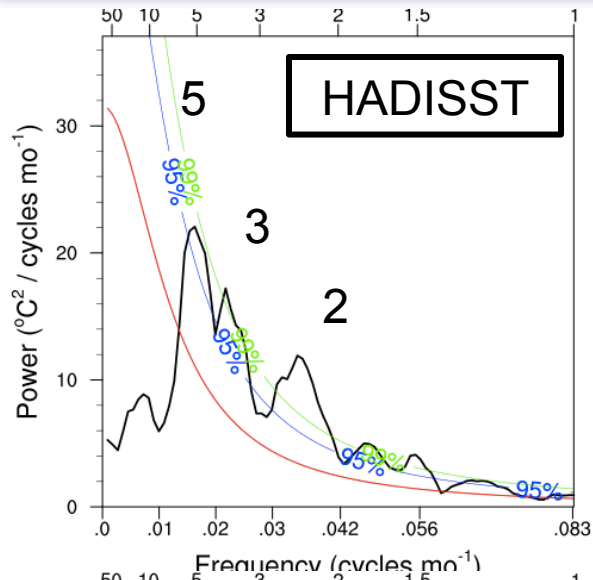
- Madden Julian Oscillation peak improved (still too weak)
- Kelvin wave too strong in UNICON
- Kelvin waves completely absent in CLUBB rainfall
- UNICON captures westward gravity waves

Coupled Simulation: SSTs

- CESM well tuned (hard to beat at this point)
- Ocean: CLUBB taking up too much heat, MOC weakening
- Arctic sea ice: UNICON loses coverage, mass in Summer

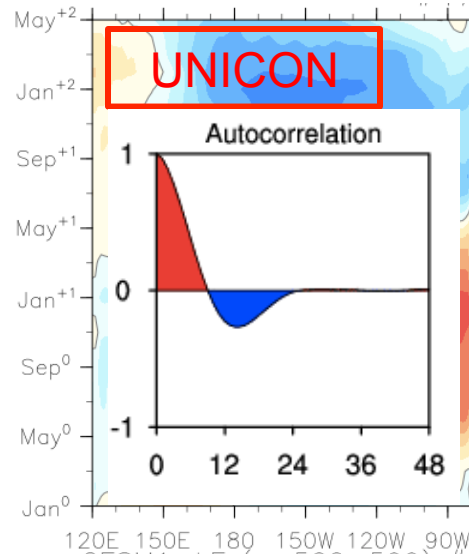
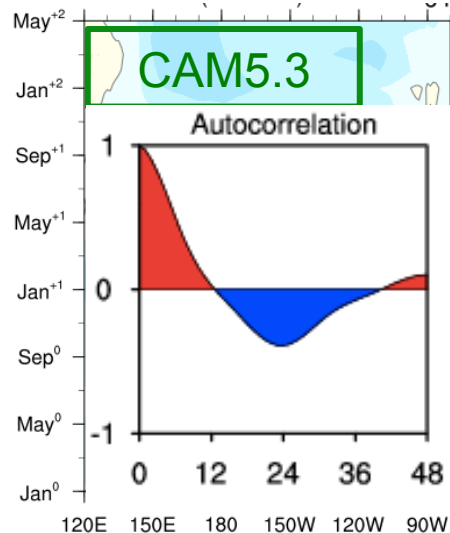
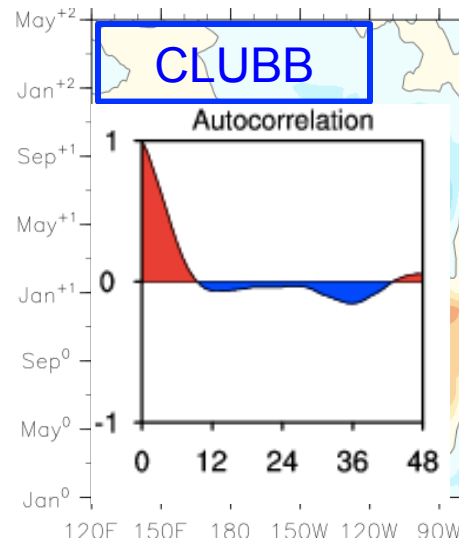
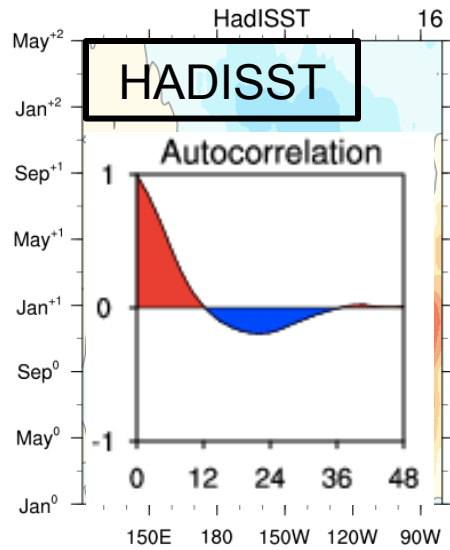


ENSO: Cause for concern



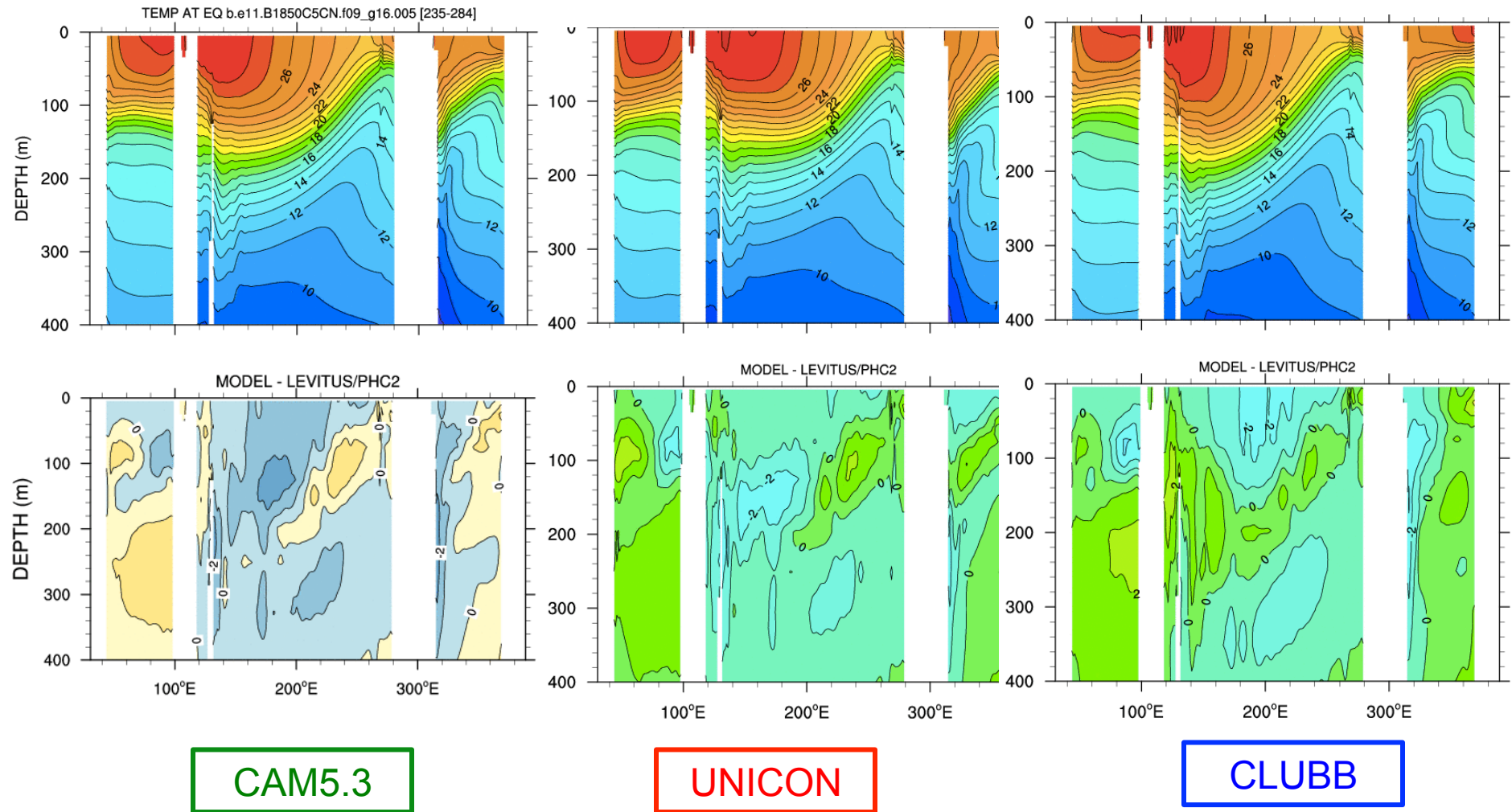
- ENSO not well simulated
- UNICON too strong amplitude at two wide a frequency
- CLUBB has very weak amplitude and no preferred frequency

ENSO: Cause for concern

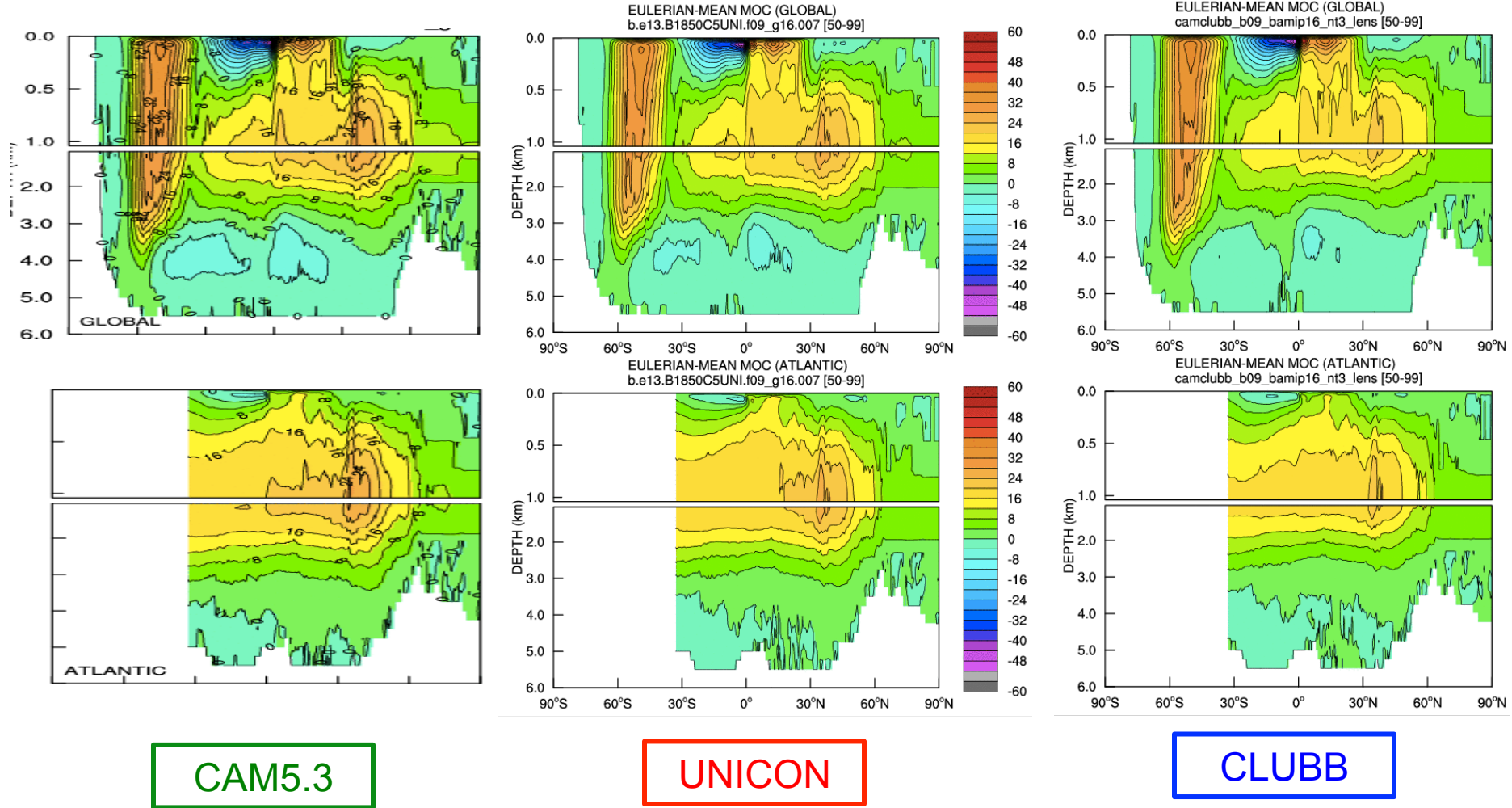


- 1-year autocorrelation too strong in UNICON; followed by weak autocorrelation
- No significant reverse-sign autocorrelation in CLUBB
- CLUBB anomalies too close to E. Pacific coast
- CAM5.3 produces a very good simulation of successive ENSO events.

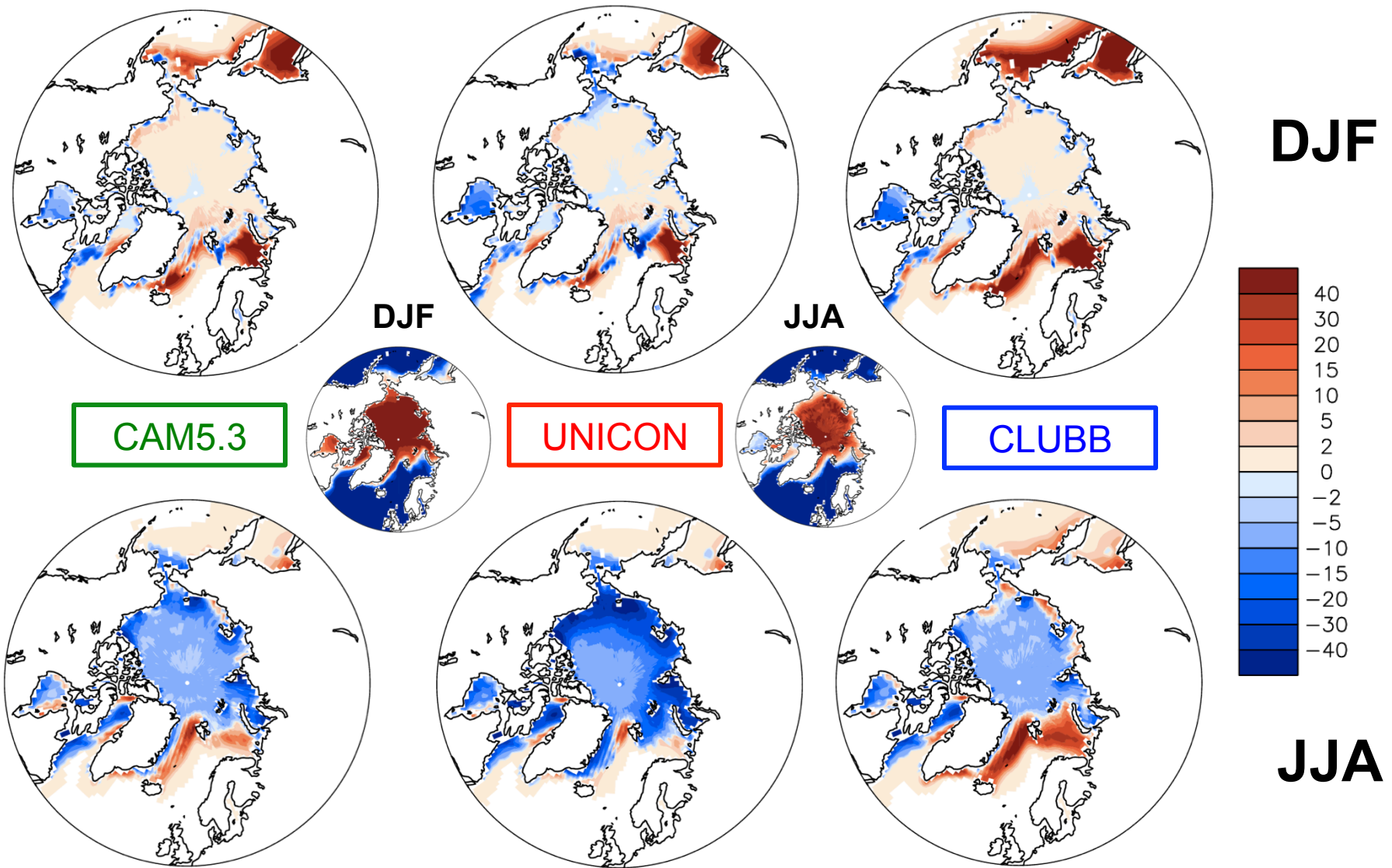
Equatorial temperature: CLUBB cold mid-Pacific



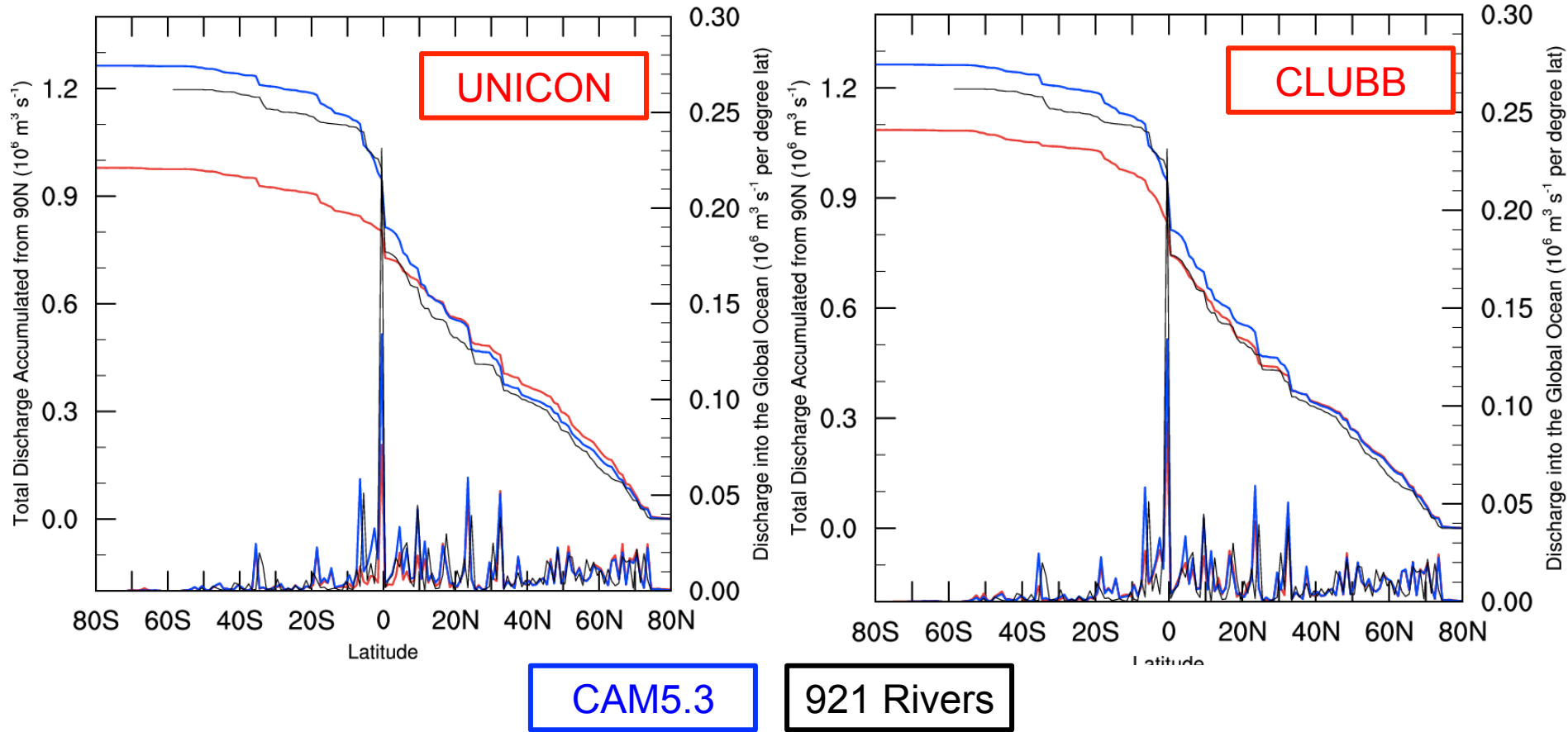
Ocean: MOC; UNICON weak, CLUBB weaker



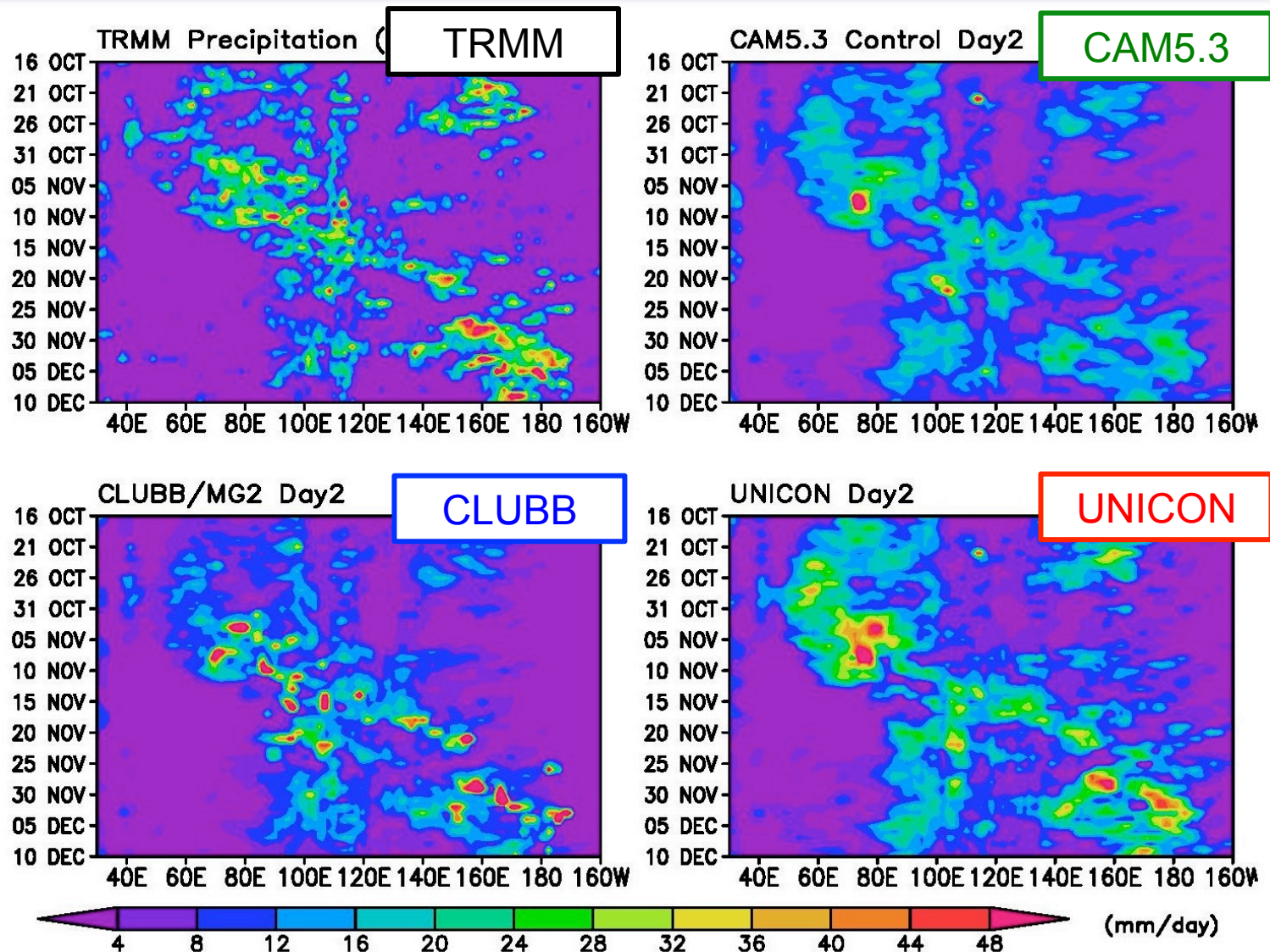
Arctic Sea Ice: Winter excess, summer deficit



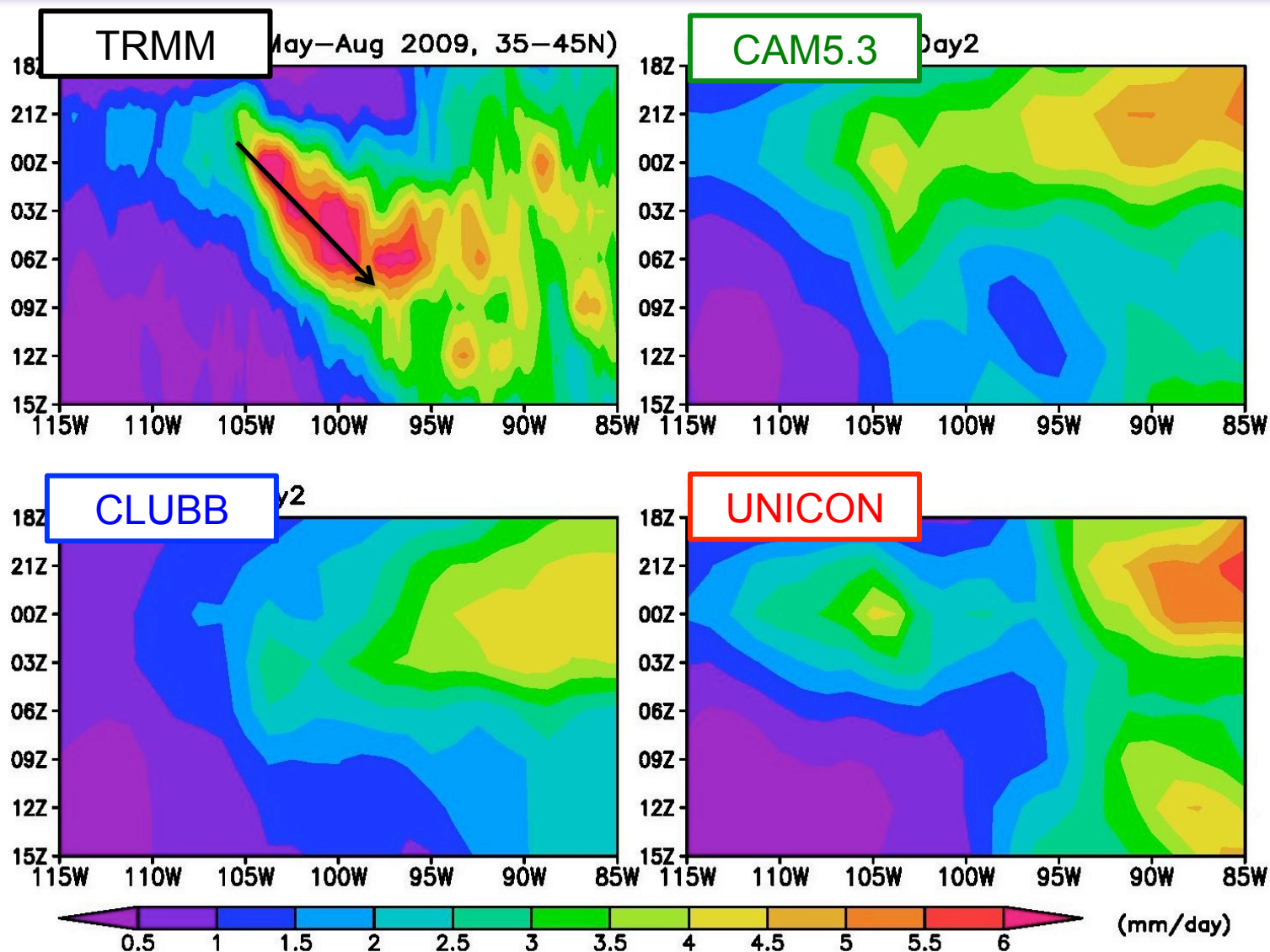
River runoff: CLUBB dry; Amazon dryer in SH



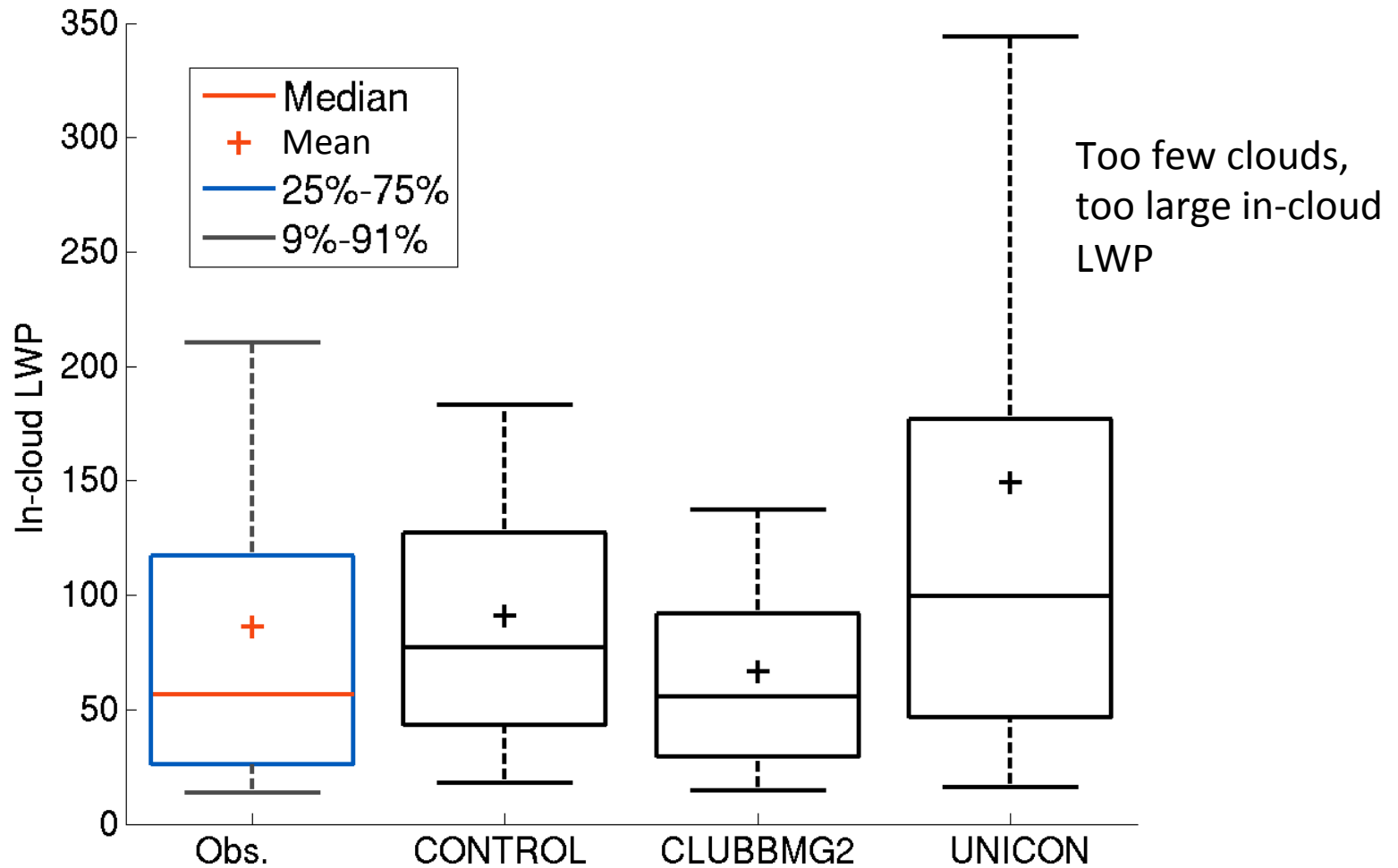
CAPT: YOTC case: MJO "E" event (day 2 composite) - Precipitation



CAPT: YOTC case: Great planes prop. (day 2 composite) - Precipitation

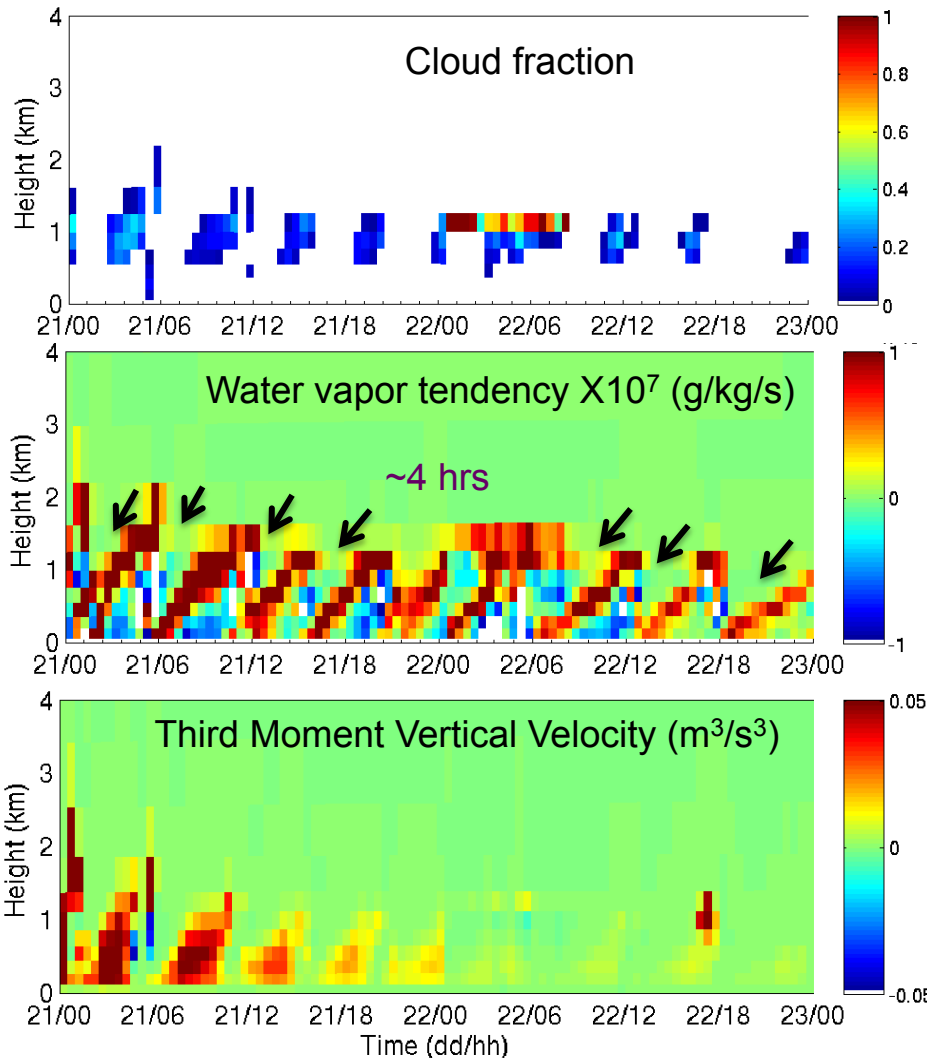


CAPT low-cloud statistics: In-cloud liquid water path (ShCu)

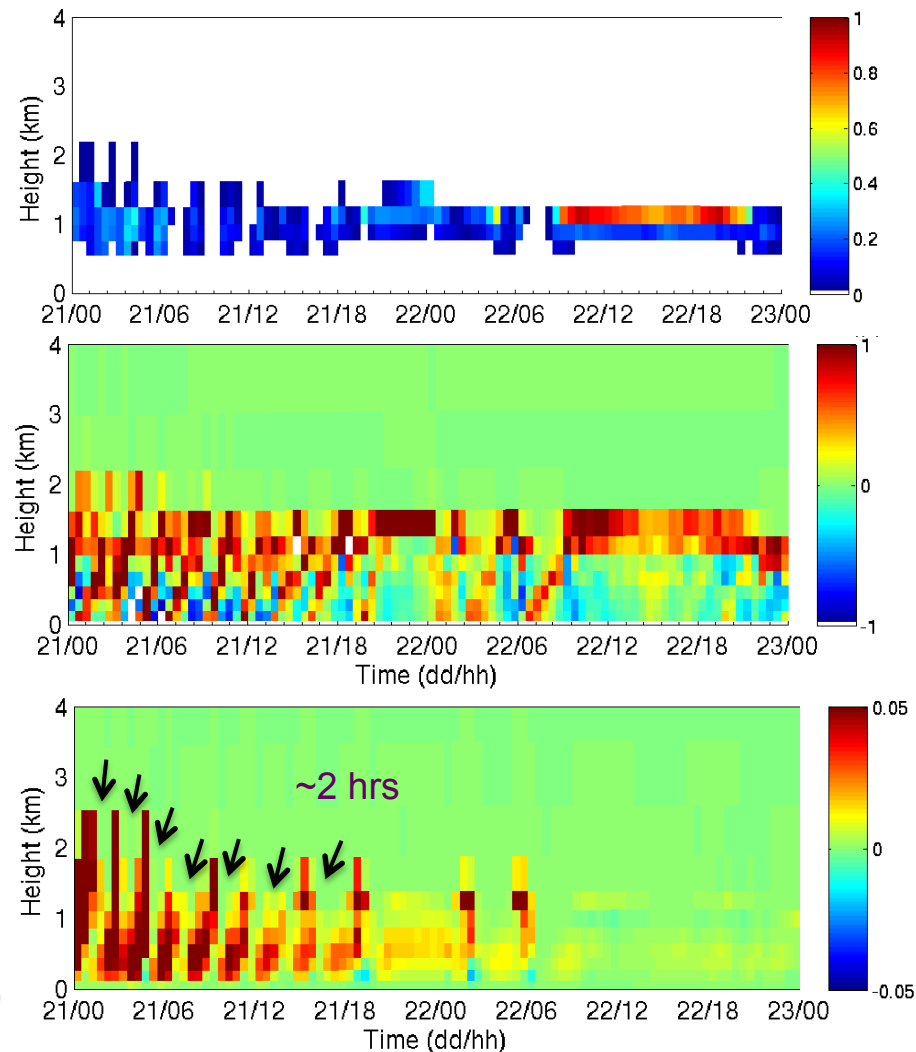


CAPT Cloud/PBL oscillation (ocean open celled convection)

subtime step = 5 min



subtime step = 30 sec



Slide summary (CLUBB)

- Lowest biases
- Tropical oceanic rainfall degraded (but reduced twin ITCZ)
- Improves stratiform cloud characteristics (extent/LWP/radiative humidity; SWCF significant)
- Very weak El Nino (white power/inc. weak teleconnections)
- Later diurnal cycle maximum, weak amplitude
- No Kelvin waves (thermodynamic fields)
- Moderately improved MJO (inconclusive)
- MOC weaker
- Arctic sea-ice less extensive
- Climate sensitivity: 3.7 W/m^2
- Complexity/novelty issues?

Slide summary (UNICON)

- Lowest RMSE
- Improved Asian monsoon precipitation
- Strong El Nino (3yr phase/inc. strong teleconnections)
- Later diurnal cycle maximum
- Kelvin waves distinct from MJO
- More than moderately improved MJO (inconclusive)
- MOC stronger
- Much improved implied ocean heat transport (Pacific/Indian)
- Arctic sea-ice more extensive
- Climate sensitivity: 4.2 W/m^2
- Development/collaboration issues

The Recommendations

1 Model Choice and ENSO

- At this point CAM5.4 will form contingency version for CAM5.5
- This is because ENSO would be unacceptable with either UNICON or CLUBB
- However, UNICON and CLUBB developers should work towards improving ENSO by May 15 deadline
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- All code should be made available to developers after AMWG meeting
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- Each candidate scheme has desirable aspects that should be actively combined beyond CAM5.5 toward CAM6
- Therefore developers should develop explicit plans for scheme integration