Learning from the MMP

Learning from the ~~MMP~~ MMF

MMP is a three letter acronym that may refer to:

- Mixed member proportional representation, a voting system
- Mass market paperback, bookbinding format
- Matrix metalloproteinase enzymes
- Massively Multi-Player, a type of online game
- Massively multiprocessing, large symmetric multiprocessing (SMP) computer systems
- Metal Mind Productions, Polish music label
- Methuselah Mouse Prize, for research into slowing cellular aging
- Minuteman Project, 2005 action to deter illegal immigration
- Manitoba Marijuana Party, now Freedom Party of Manitoba, a Canadian political party
- Moldova Metallurgical Plant, see Moldova Steel Works
- Multi-Man Publishing, a wargame company
- Minute Maid Park, a ballpark in Houston, Texas, United States
- Millennium Mathematics Project, of the University of Cambridge
- Miss Moneypenny, James Bond's secretary
- International Organization of Masters, Mates & Pilots (MM&P), maritime labor union
- *Tokyo Mew Mew*, also known as Mew Mew Power, a Japanese cartoon

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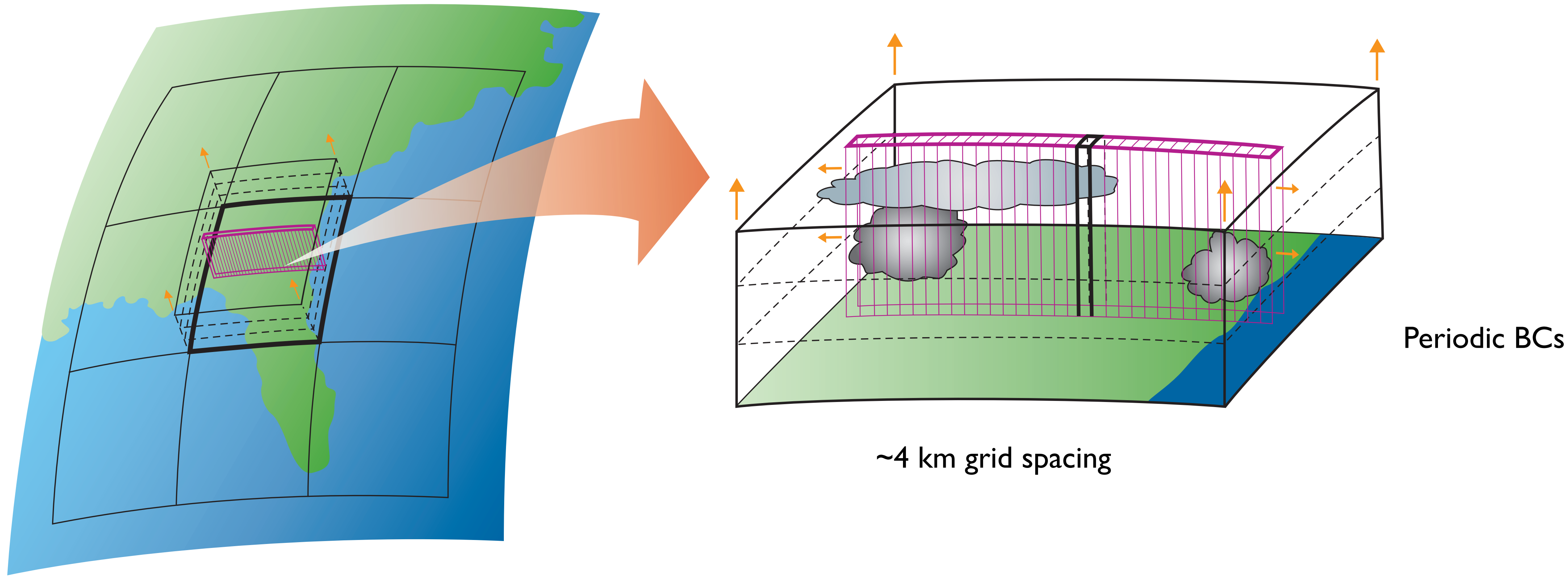
Super-Parameterization

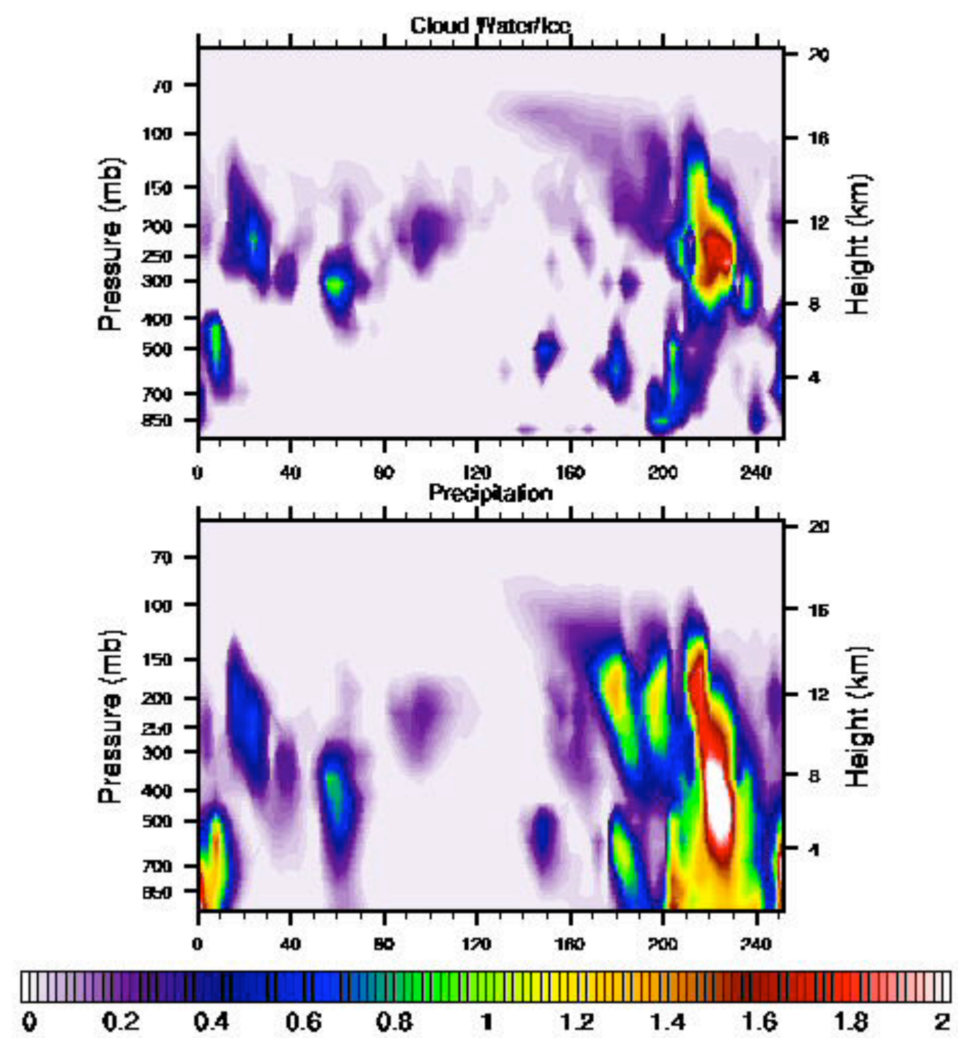
(a.k.a. the Multiscale Modeling Framework, or MMF)



Idea proposed by W. Grabowski

Compared to what?

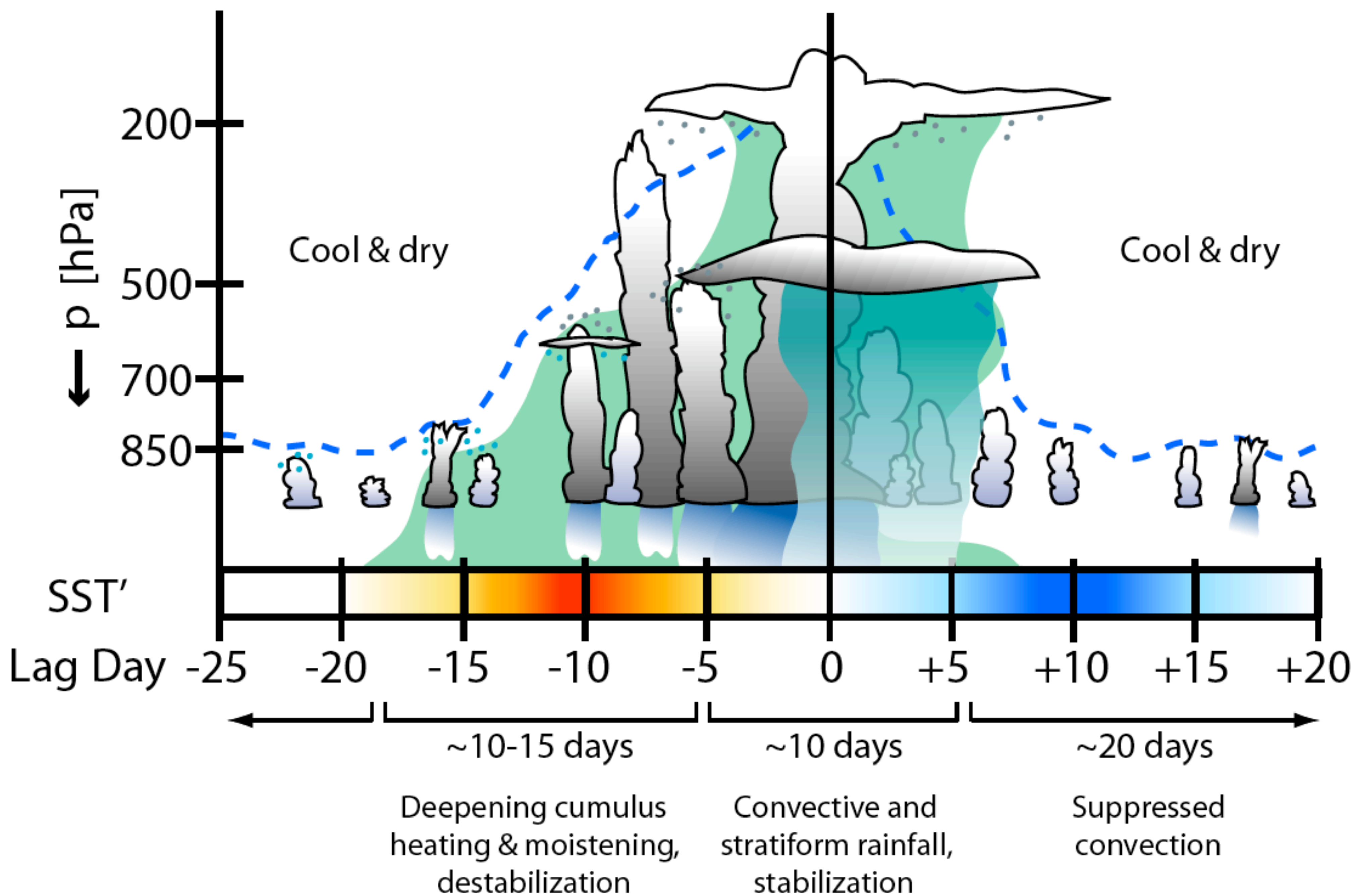
Super-Parameterizations	Conventional Parameterizations
2D or Quasi-3D	1D
Periodic boundary conditions	Boundary whats?
Shallow convection and turbulence must be parameterized.	Same
Microphysics is simplified but the required input is in pretty good shape.	Microphysics even simpler, and the required input (e.g., local vertical velocity) is not
Individual realizations	"Expected values"
200	1

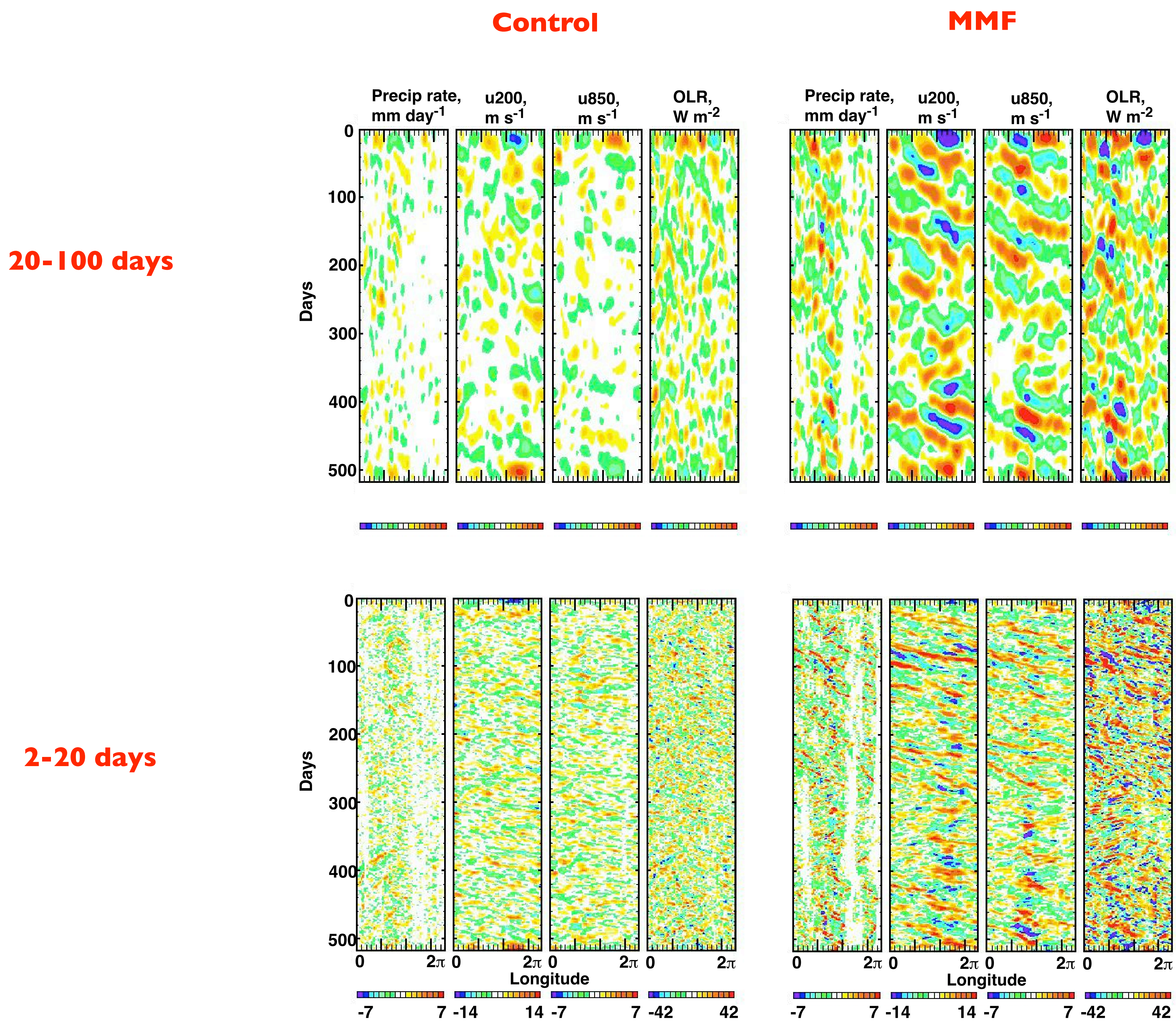


"It's low-resolution, but at least it uses the right equations."

-- Bjorn Stevens

The Madden-Julian Oscillation





Control
MMF
20-100 days
2-20 days
Precip rate, mm day-1
u200, m s-1
u850, m s-1
OLR, W m-2
Days
0
100
200
300
400
500
Longitude
0
2π
-7
7
-14
14
-42
42

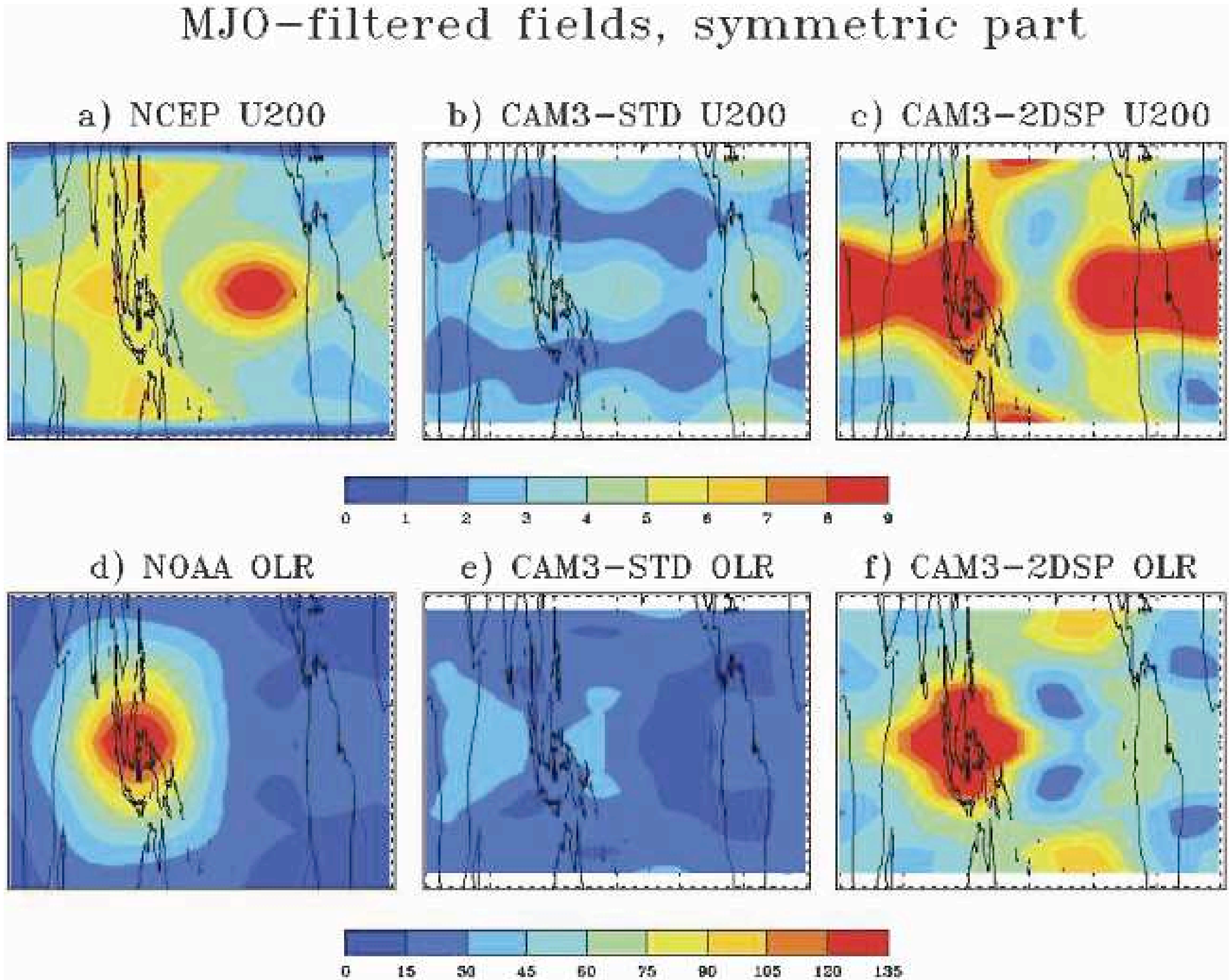
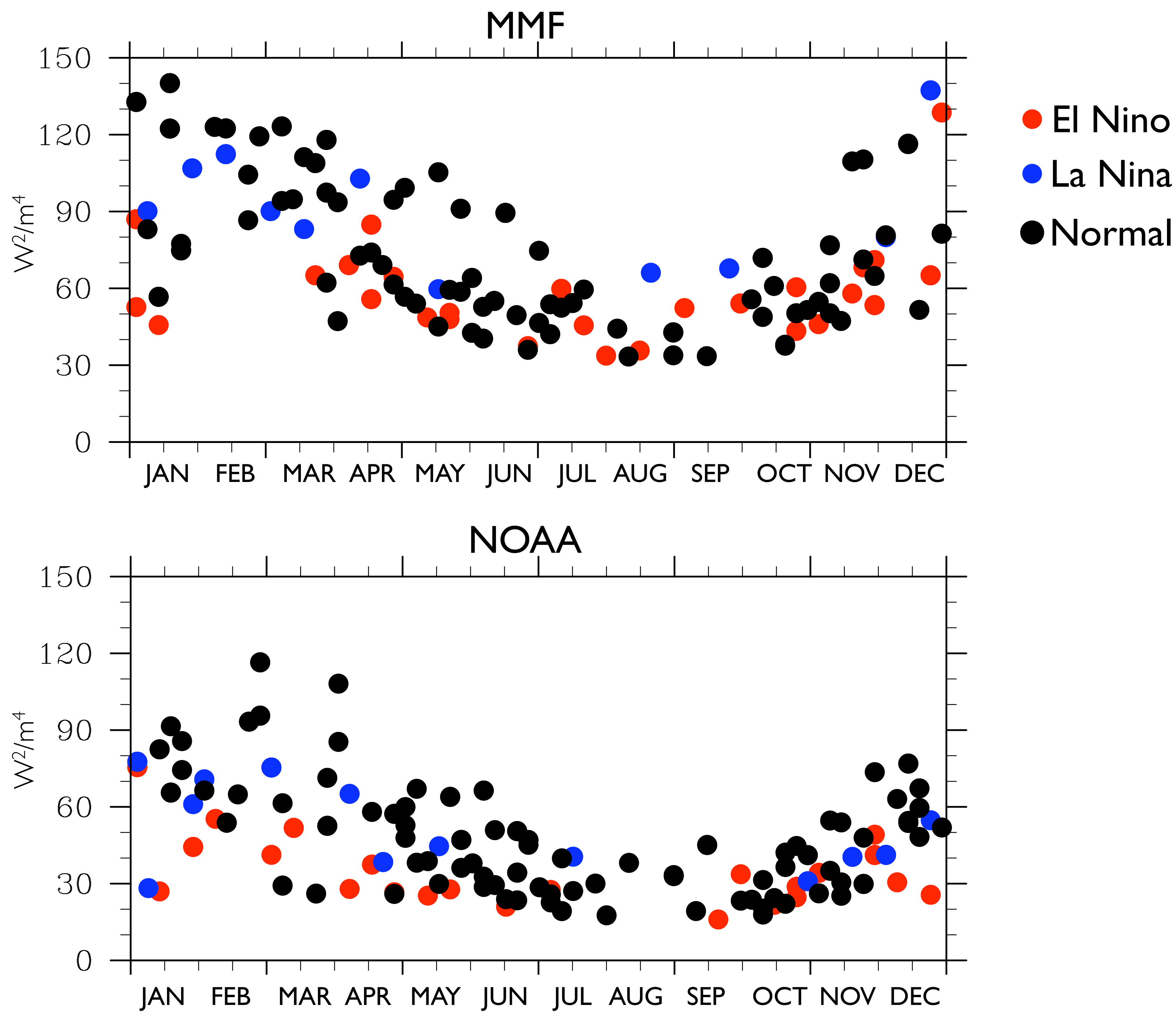


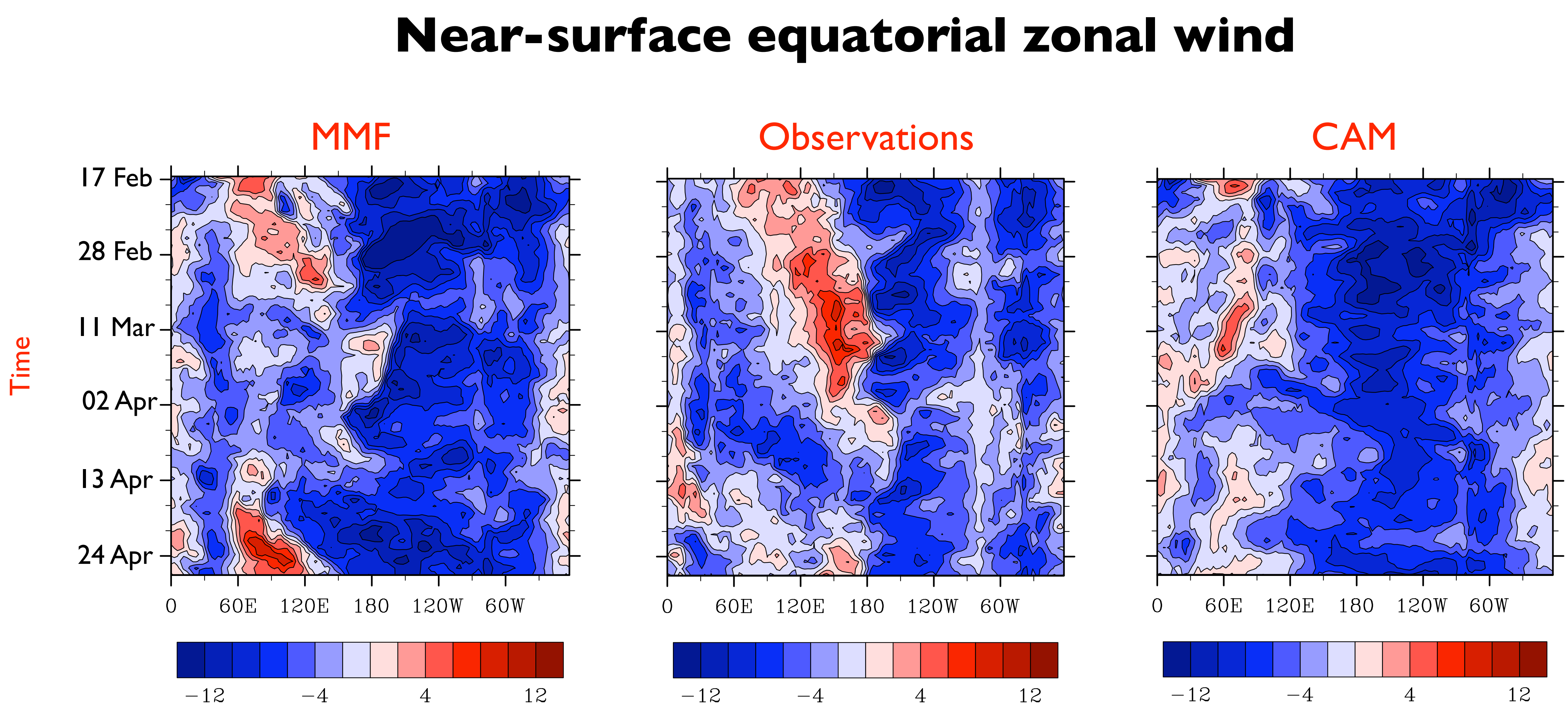
FIG. 15. Geographic distribution of symmetric MJO variance of (a)–(c) 200-hPa zonal winds and (d)–(f) OLR. The MJO signal is computed via an inverse Fourier transform of the coefficients corresponding to eastward-moving waves with zonal wavenumbers 1–4 and periodicities in the 20–70-day range. To simplify the display, the transform is applied to the equatorially symmetric time series, which accounts for nearly 80% of the total variance near the equator.

KRD JAS 05

Seasonal Change, 1986-2003



MJO Forecasts

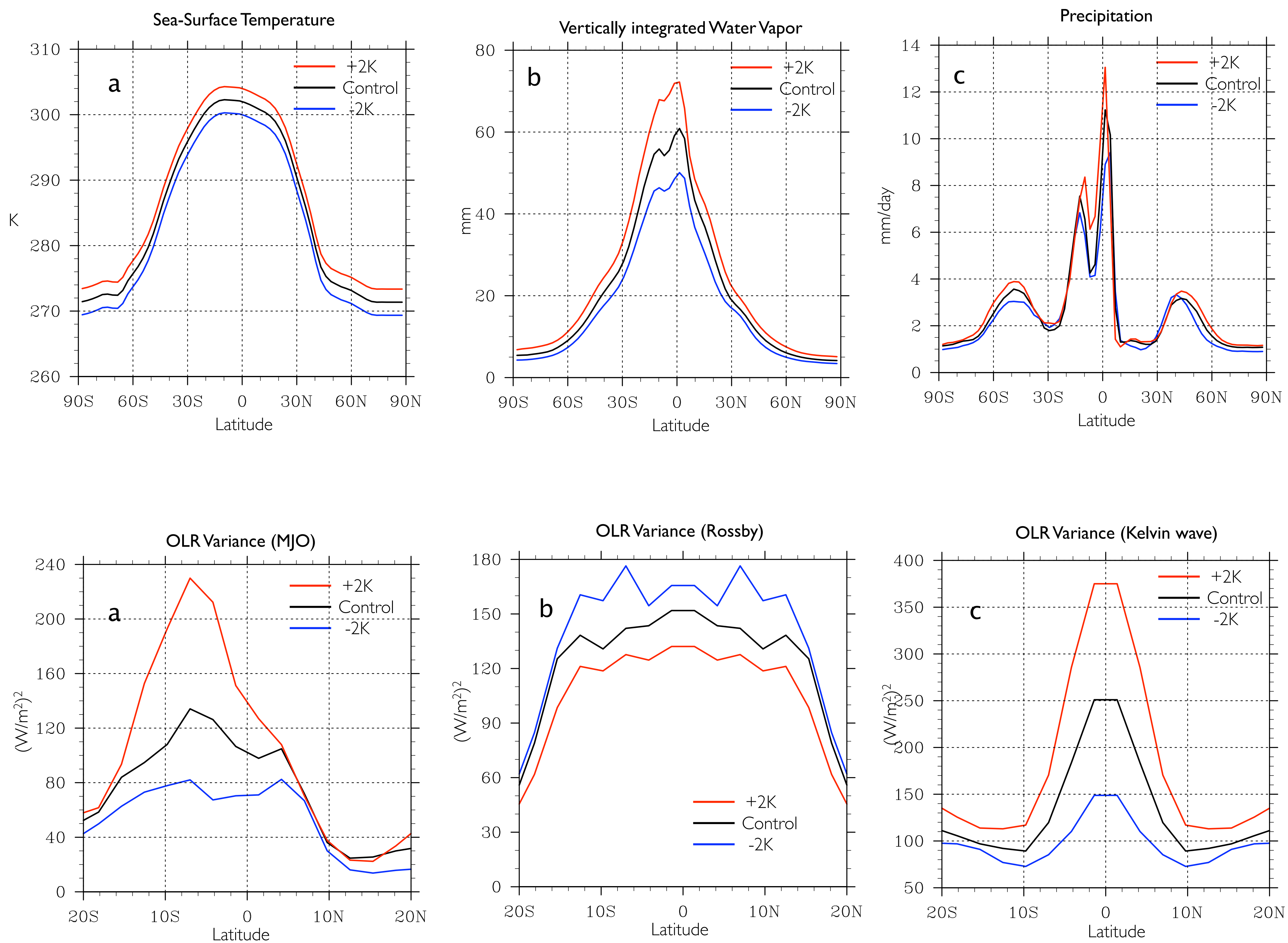


The MMF is able to maintain the observed structure of the MJO for a week or more.

The CAM loses the signal immediately.

Seaworld

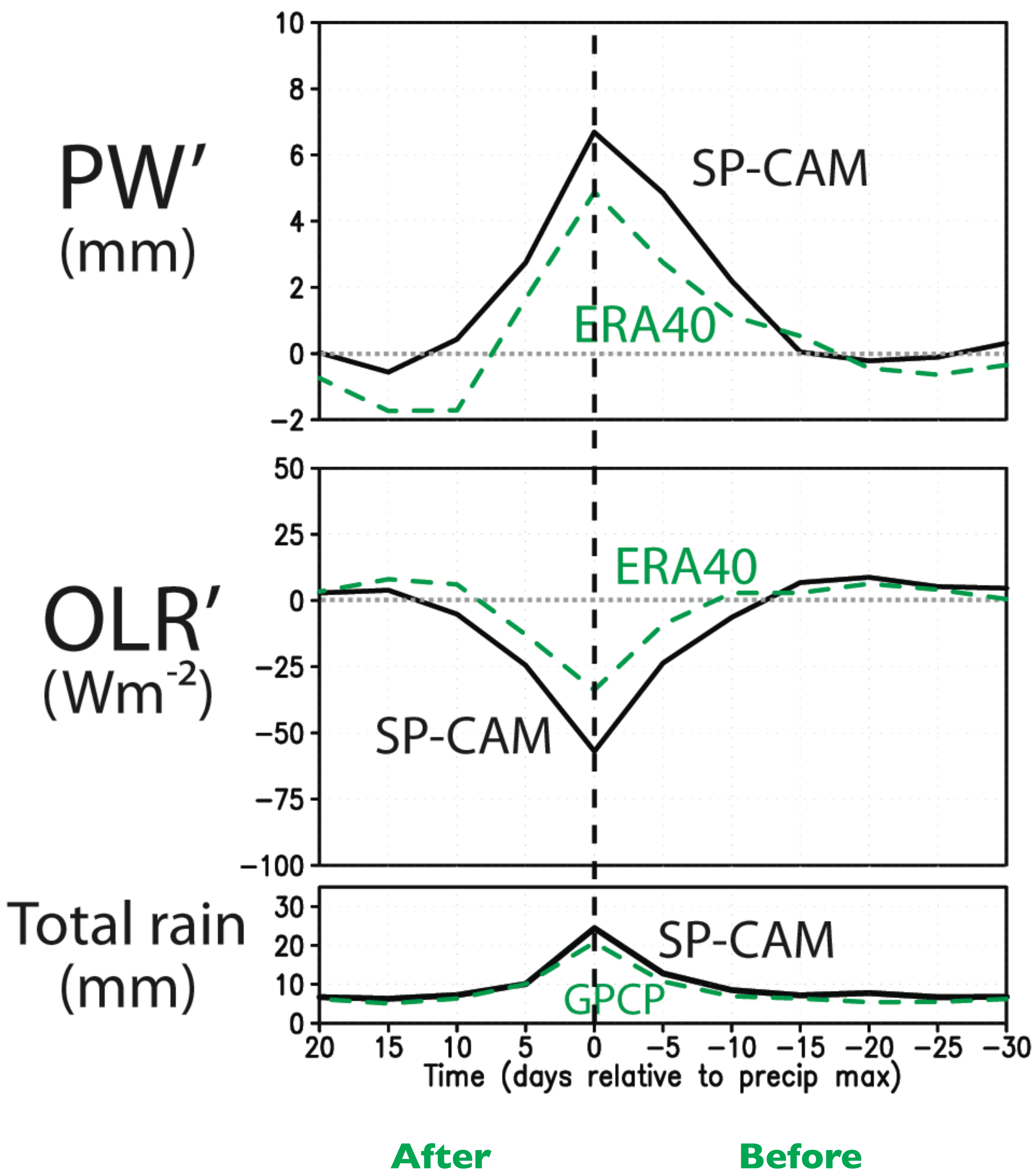
Perpetual January



Is the SP-CAM's MJO realistic?

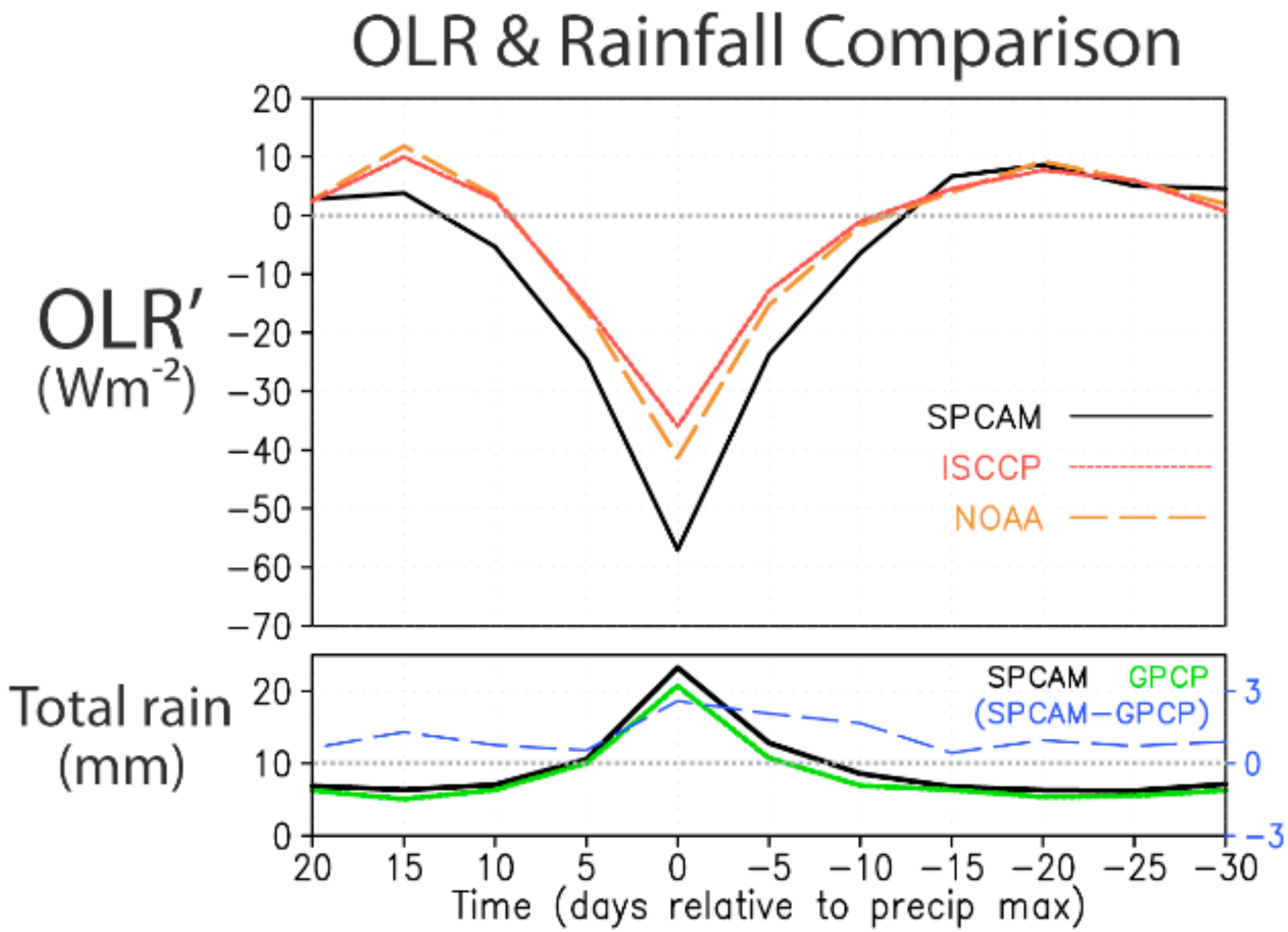
Precipitable water & OLR

Composite of 46 events in GPCP/ERA40 and 46 in SP-CAM

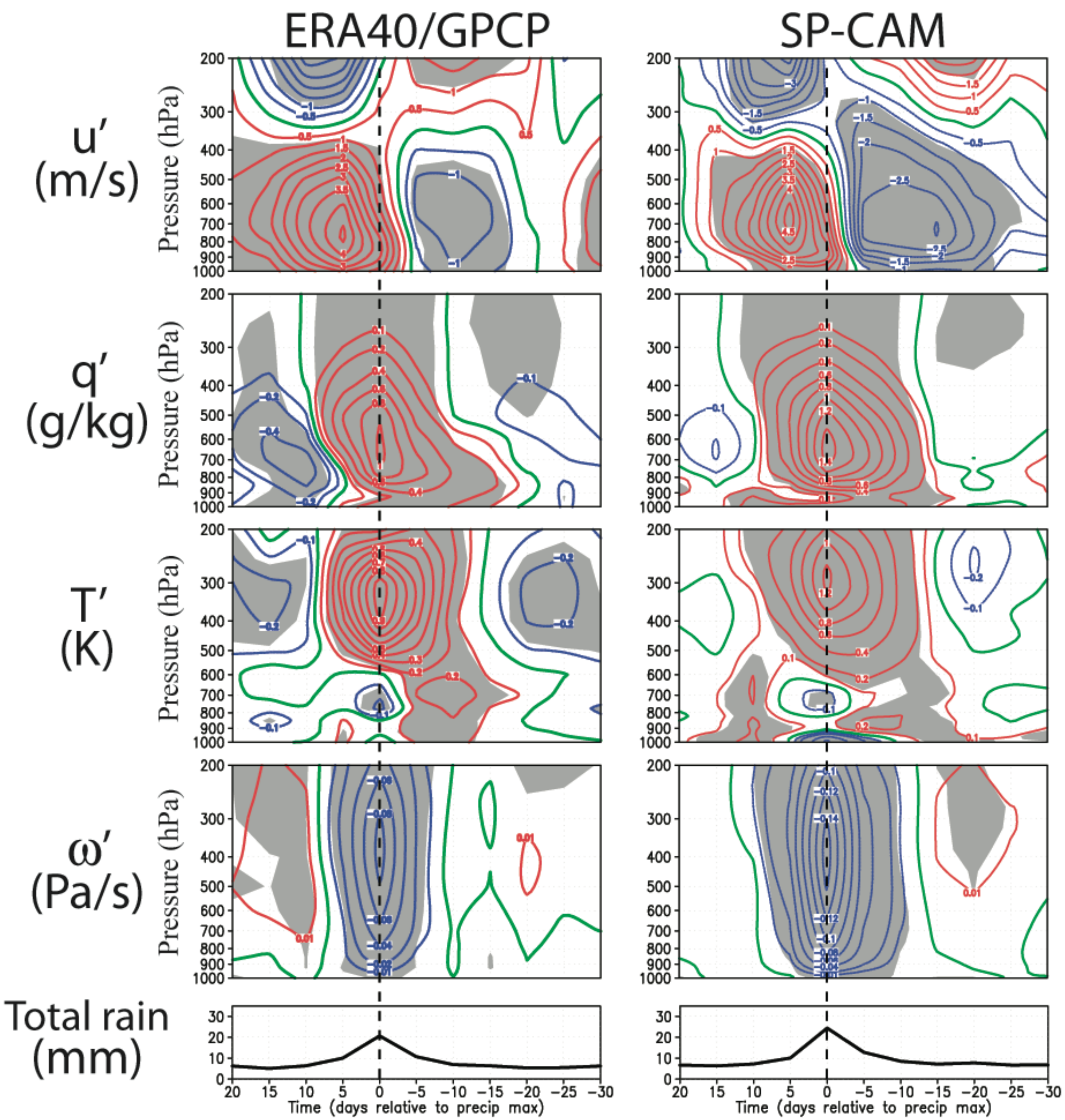


- **Overestimated PW′**
- **Excessively negative OLR′**
- **Exaggerated peak rainfall**

OLR again

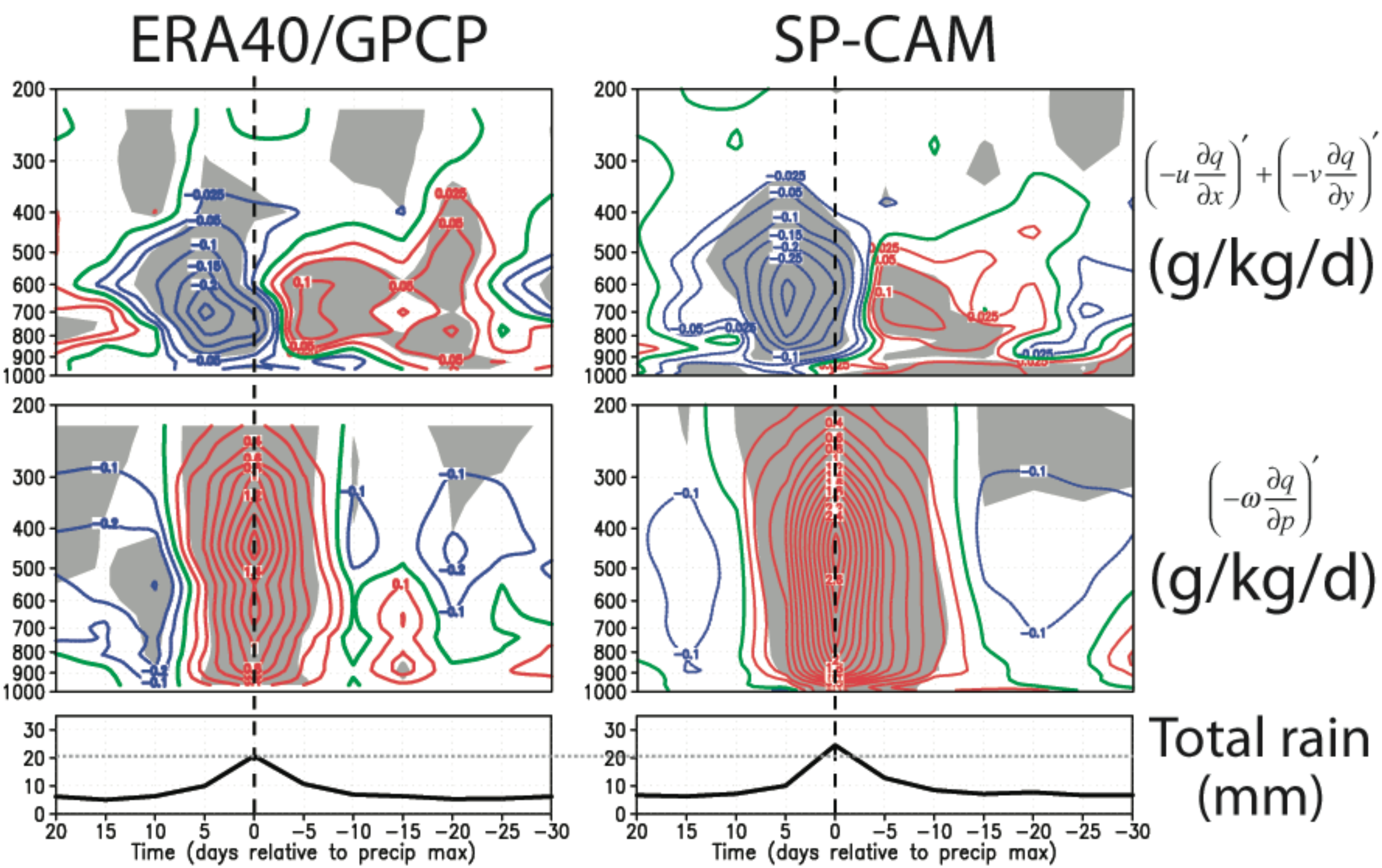

OLR & Rainfall Comparison
OLR'
(Wm^{-2})
20
10
0
−10
−20
−30
−40
−50
−60
−70
SPCAM
ISCCP
NOAA
Total rain
(mm)
20
10
0
SPCAM GPCP
(SPCAM−GPCP)
3
0
−3
20 15 10 5 0 −5 −10 −15 −20 −25 −30
Time (days relative to precip max)

State variables



- **Not bad, but easterlies excessive**
- **Moisture anomaly too strong, less tilt than observed**
- **Leading and trailing cool upper trop. too weak in SP-CAM, warm anoms similar**
- **Upward motion too strong, less tilt than in reanalysis**

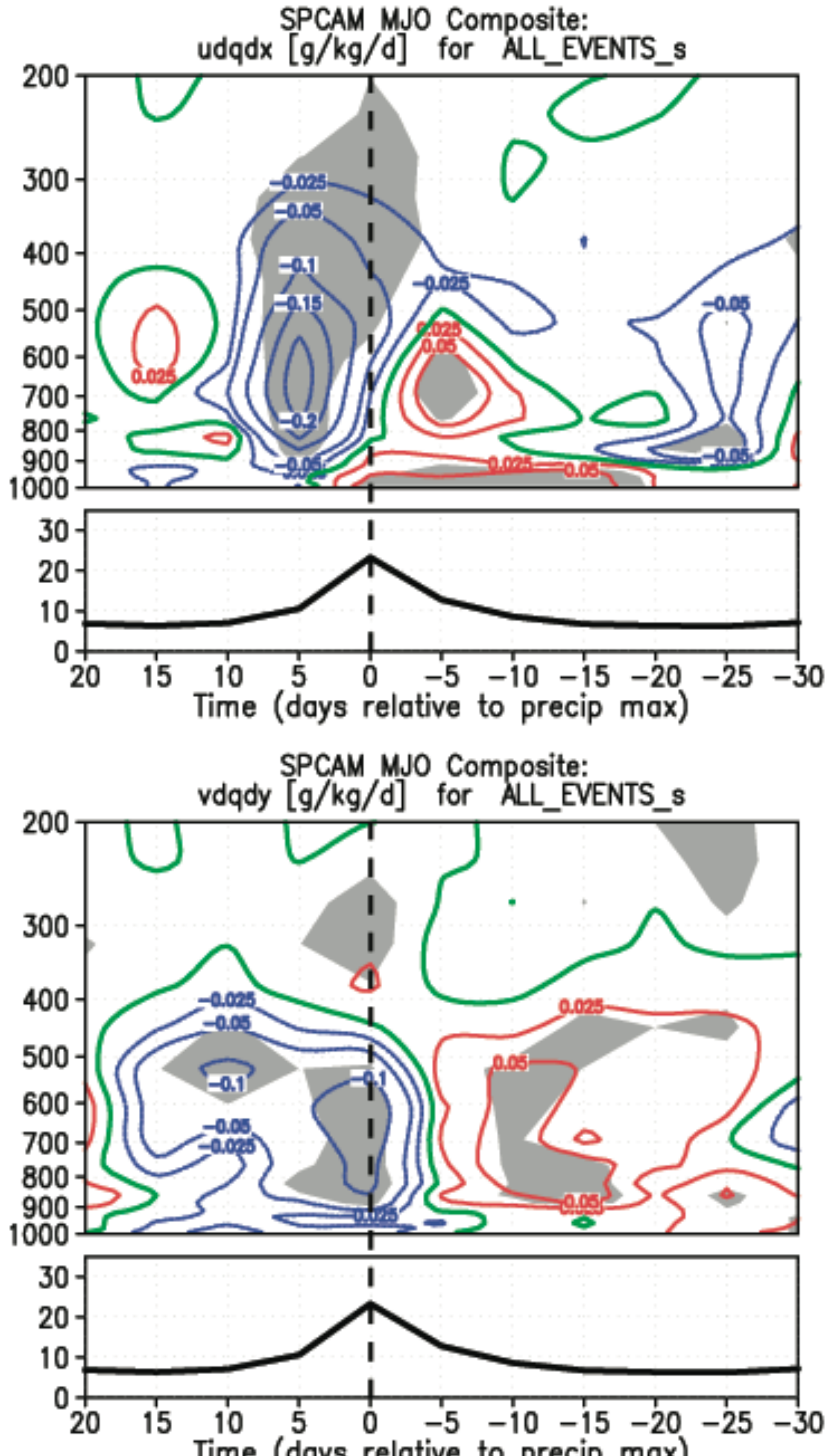
Moisture Advection



Zonal vs meridional moisture advection

Post-event drying:

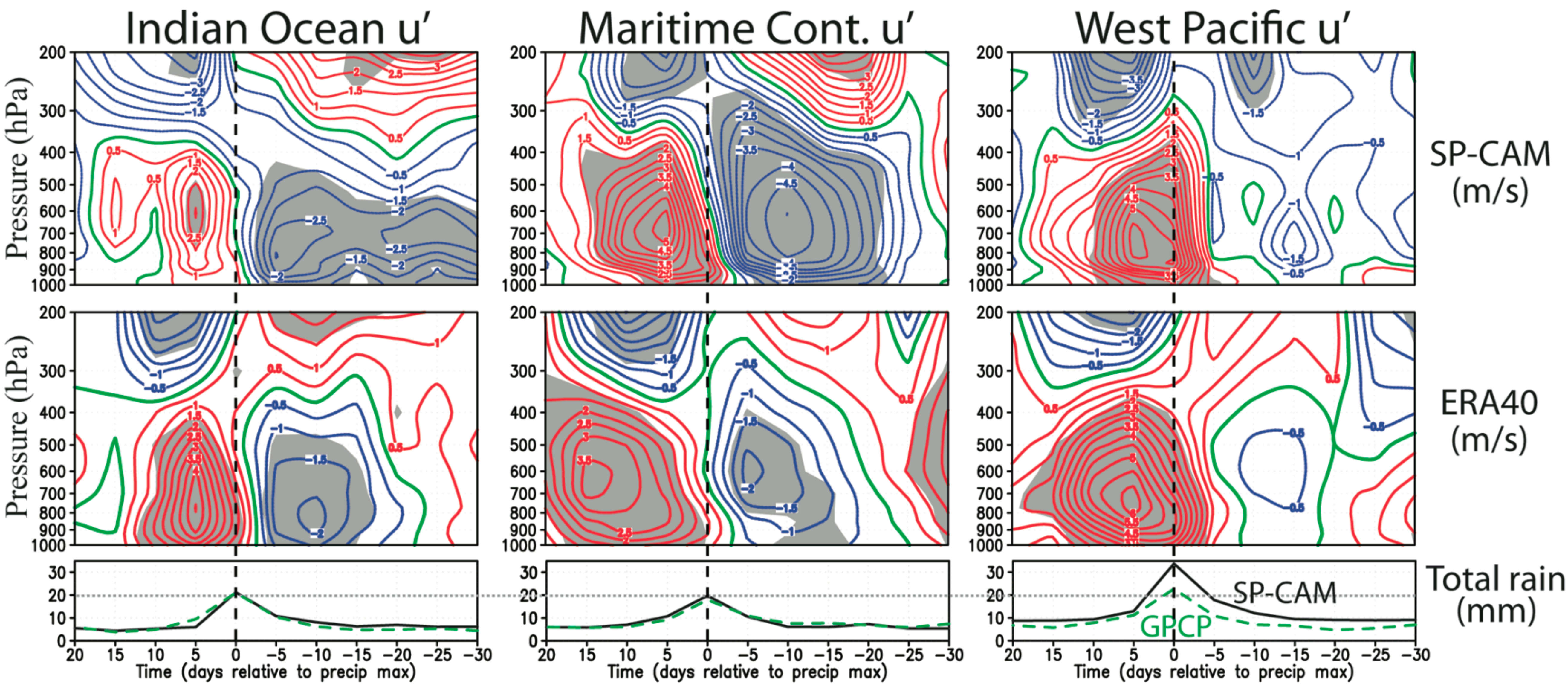
- **0 to +15 days: both zonal and meridional**



Pre-event moistening:

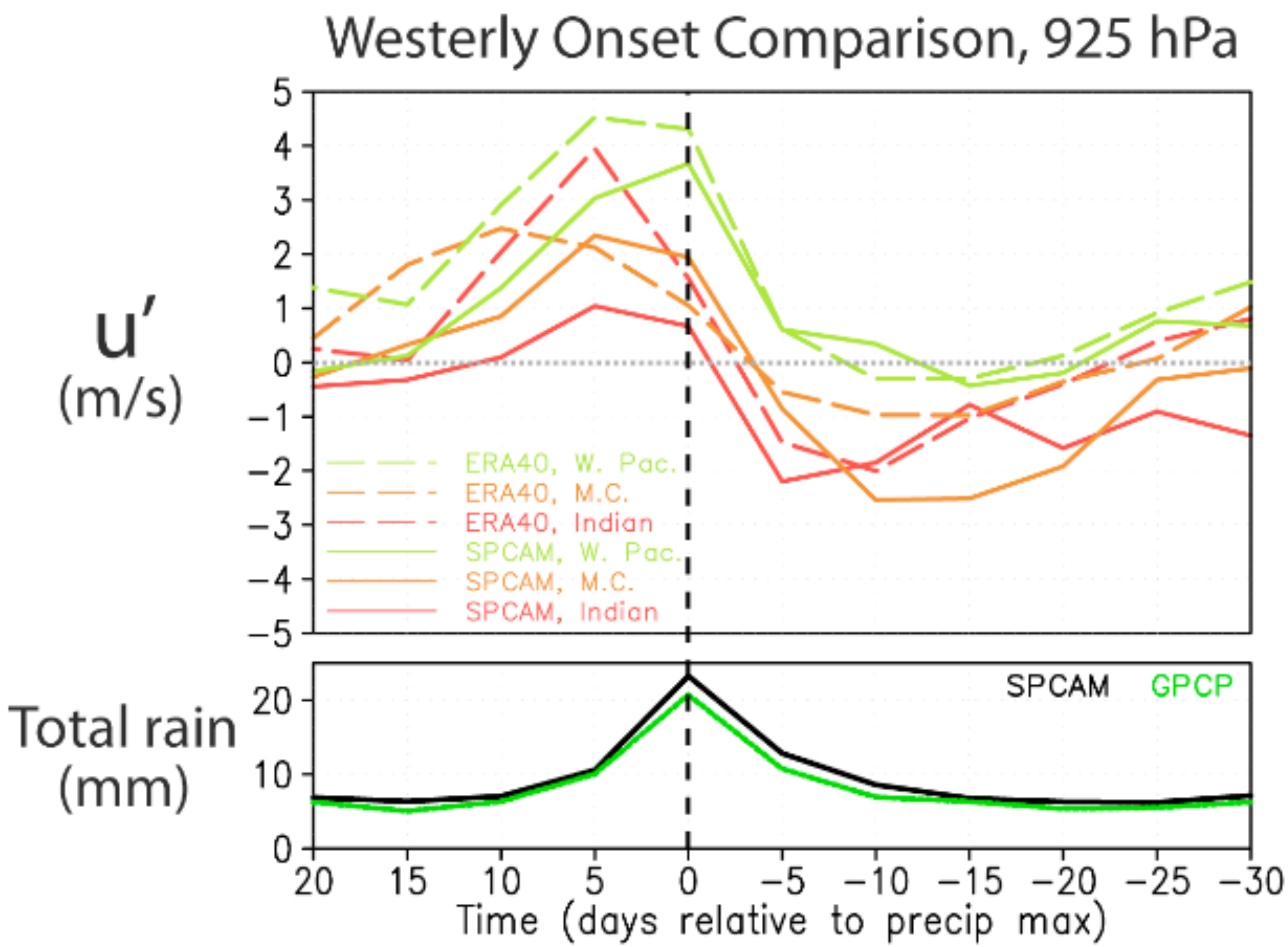
- **-30 to -15 days: weakly meridional, zonal in boundary layer**
- **-10 to 0 days: primarily zonal**

Geographical differences



Westerlies shift eastward relative to precip max
Easterlies weaken

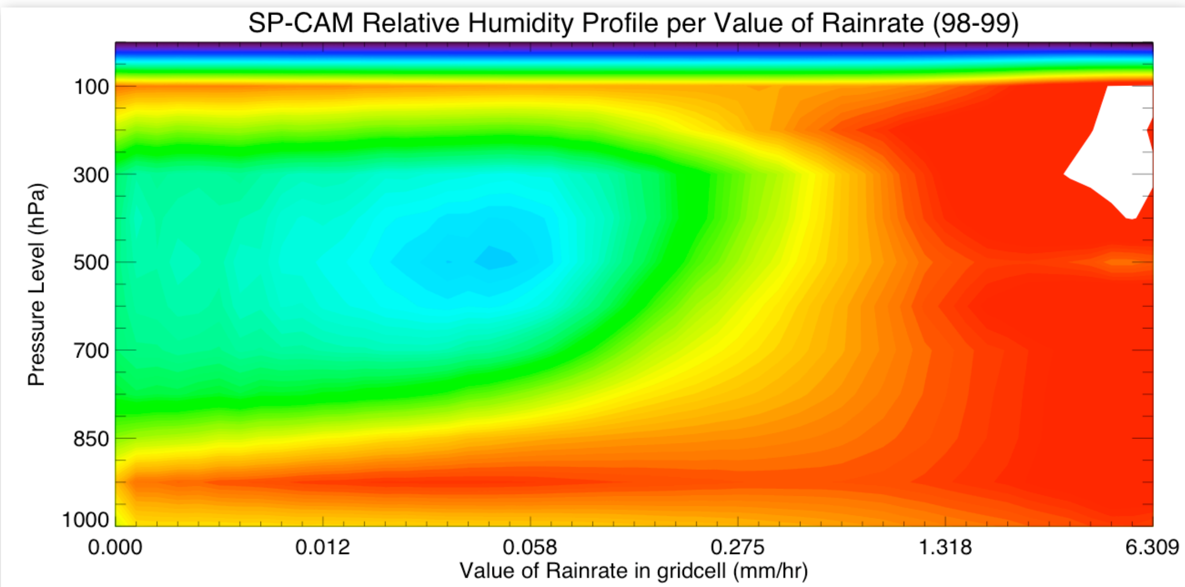
Low-level zonal wind anomalies

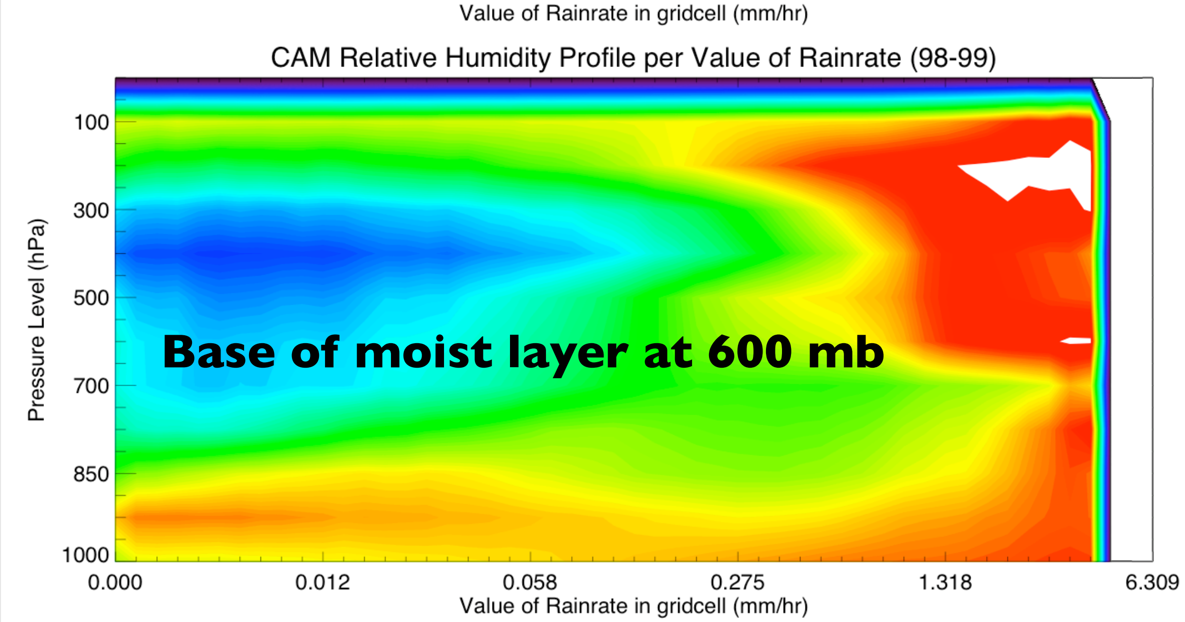


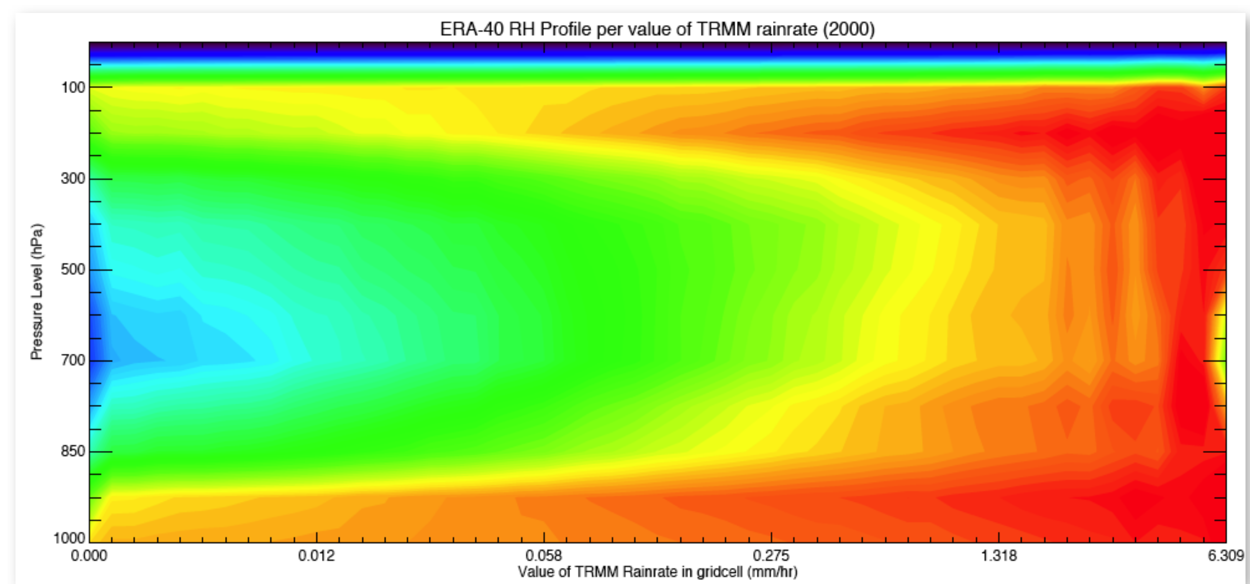
Why is the SP-CAM's MJO realistic?

Rainfall-humidity composites

SP-CAM



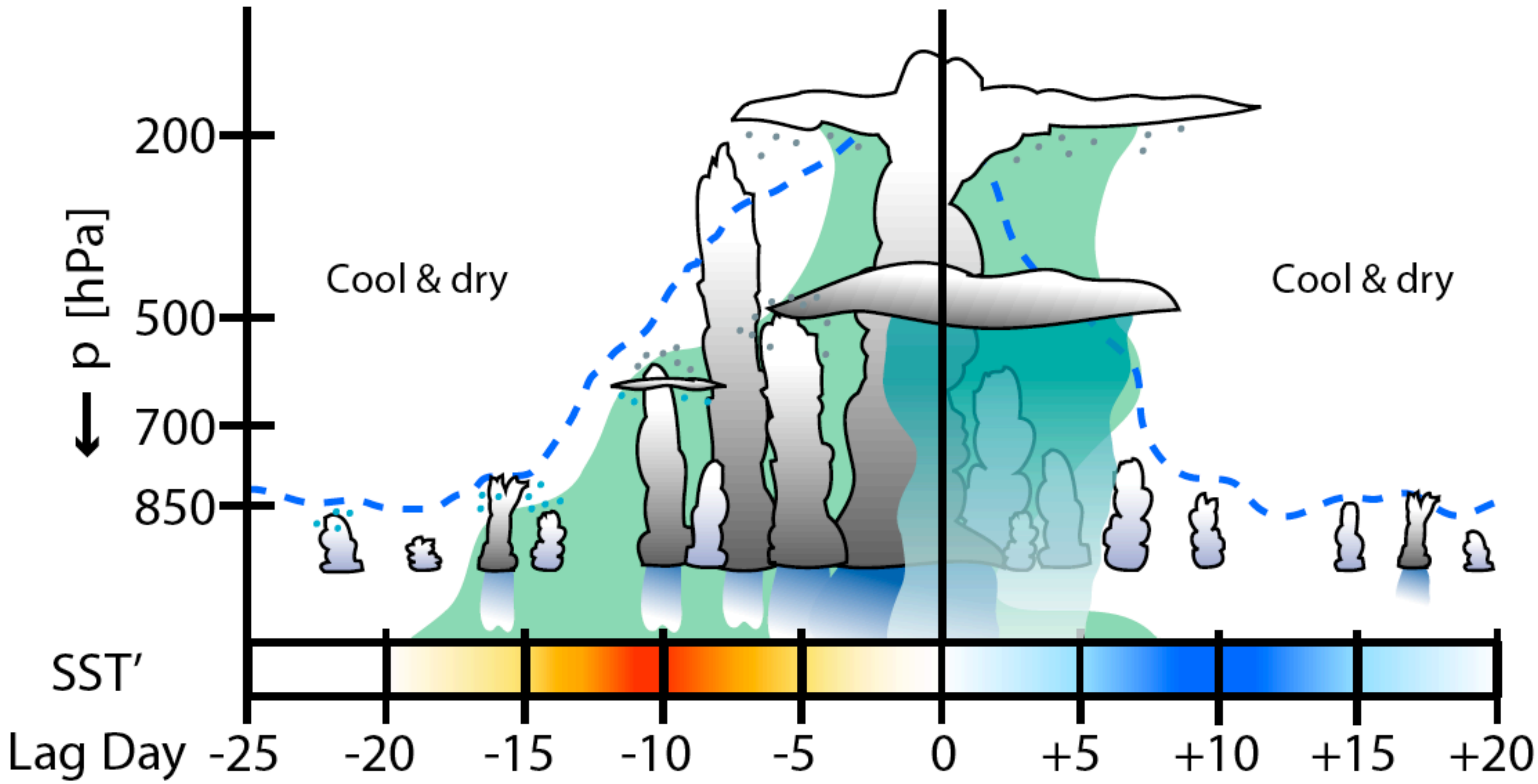




CAM

ERA-40 and TRMM

Why very wet matters

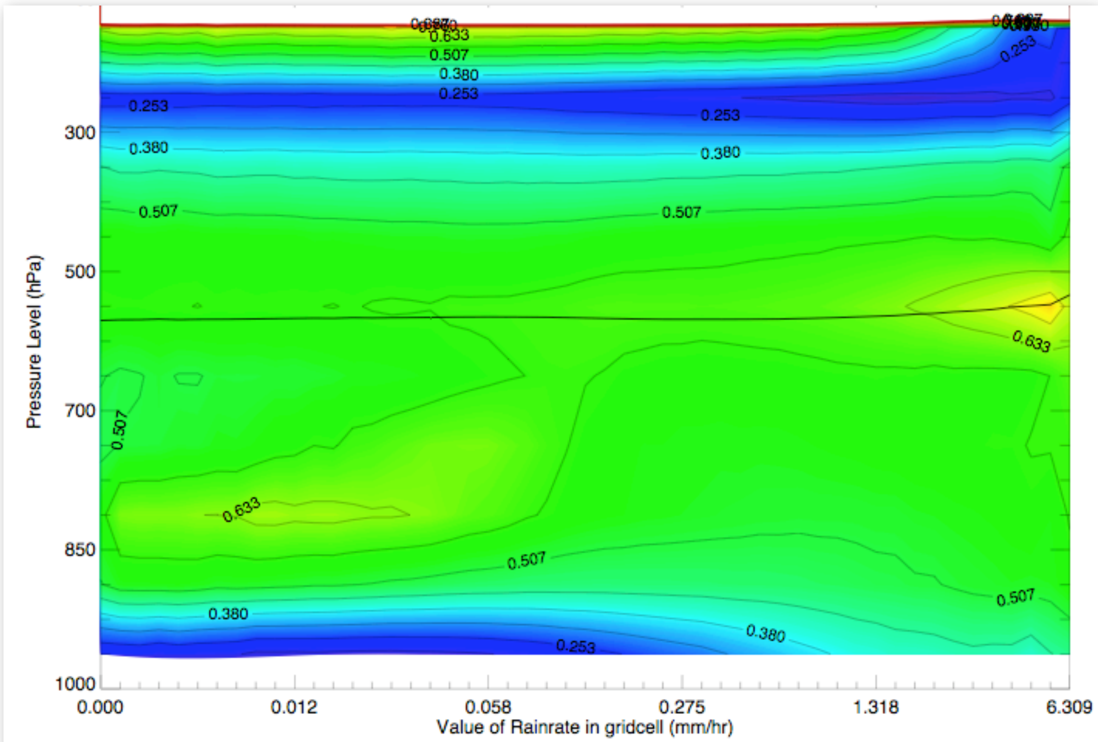


Downdrafts stabilize BL

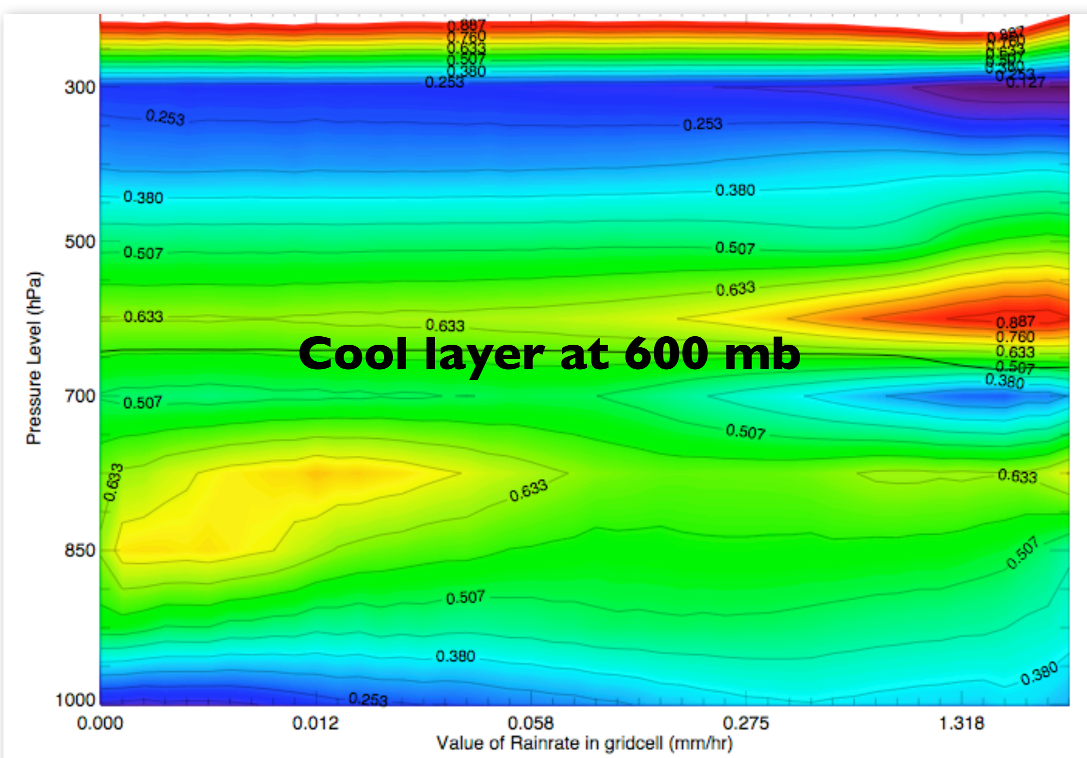
Downdrafts ineffective

Static stability vs. rain rate

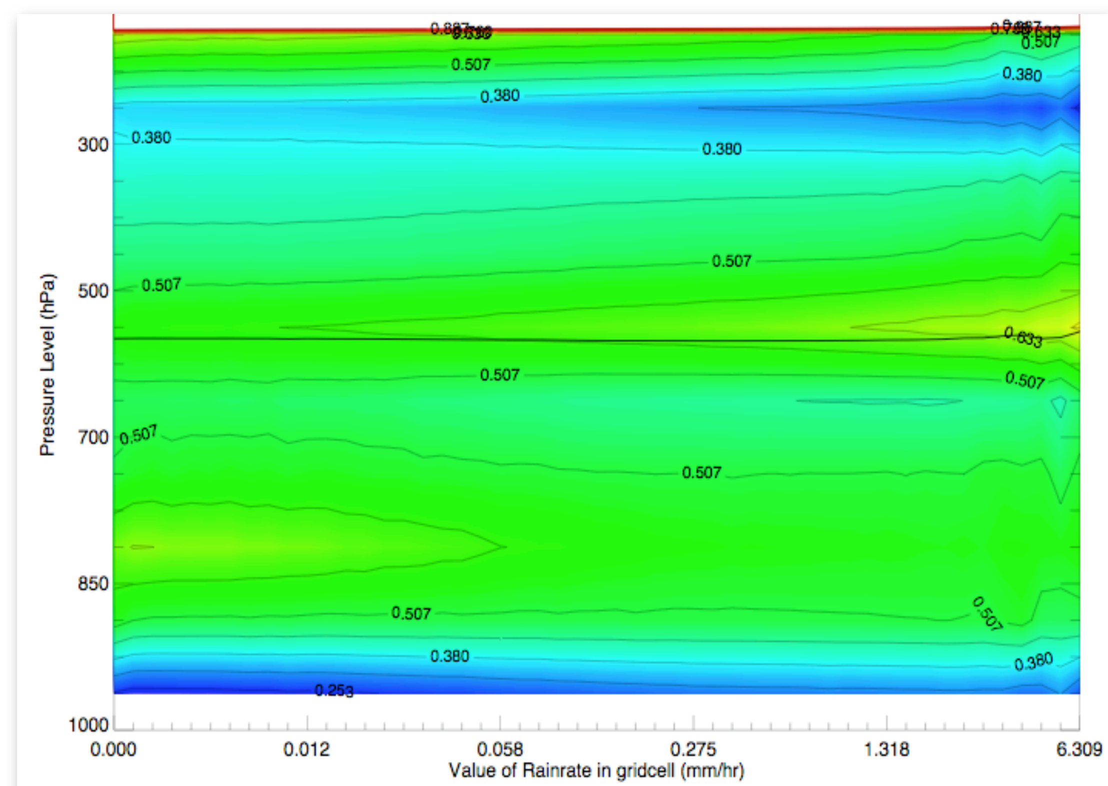
SP-CAM



CAM

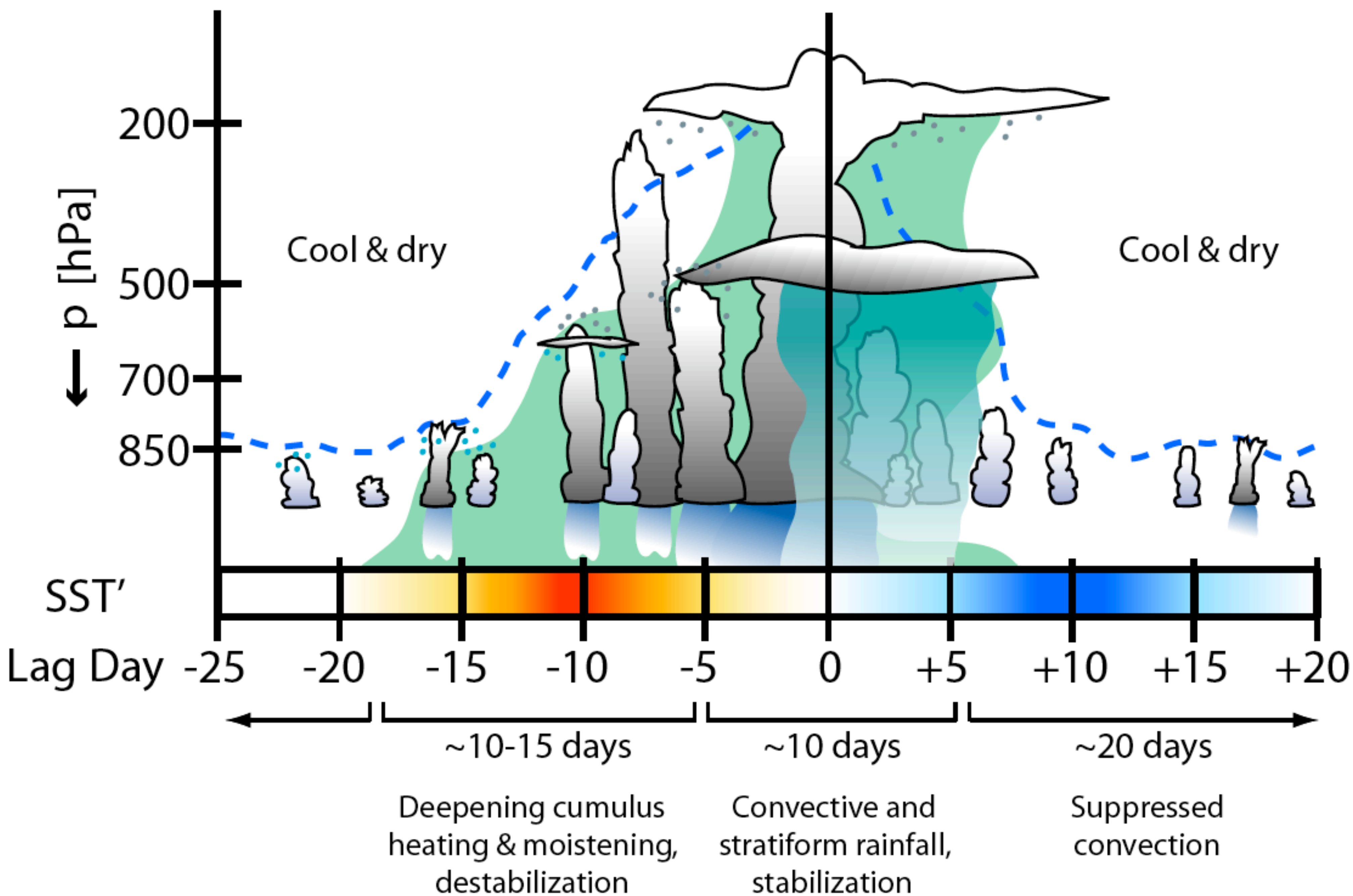


ERA-40

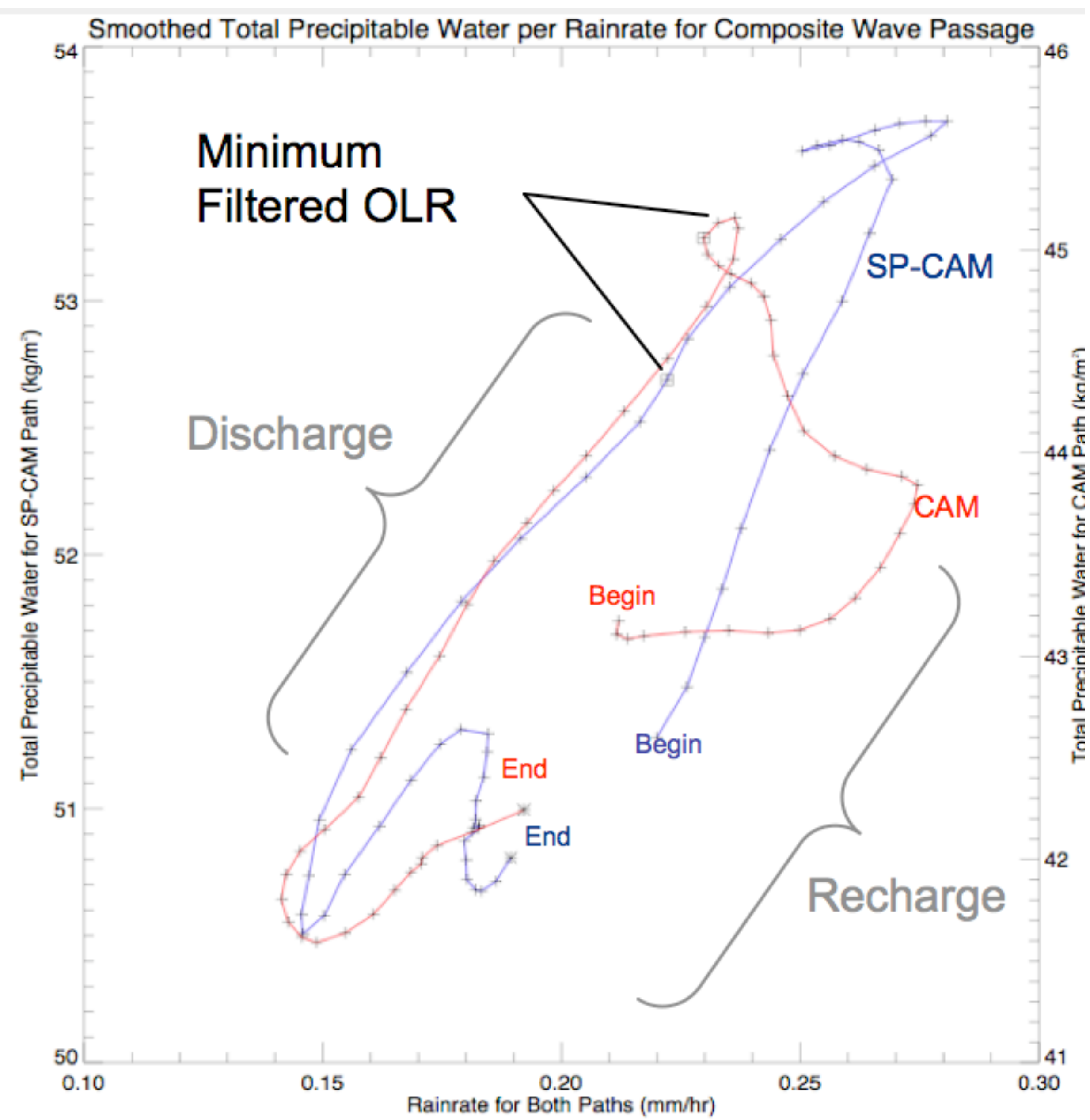


Discharge-Recharge Oscillator

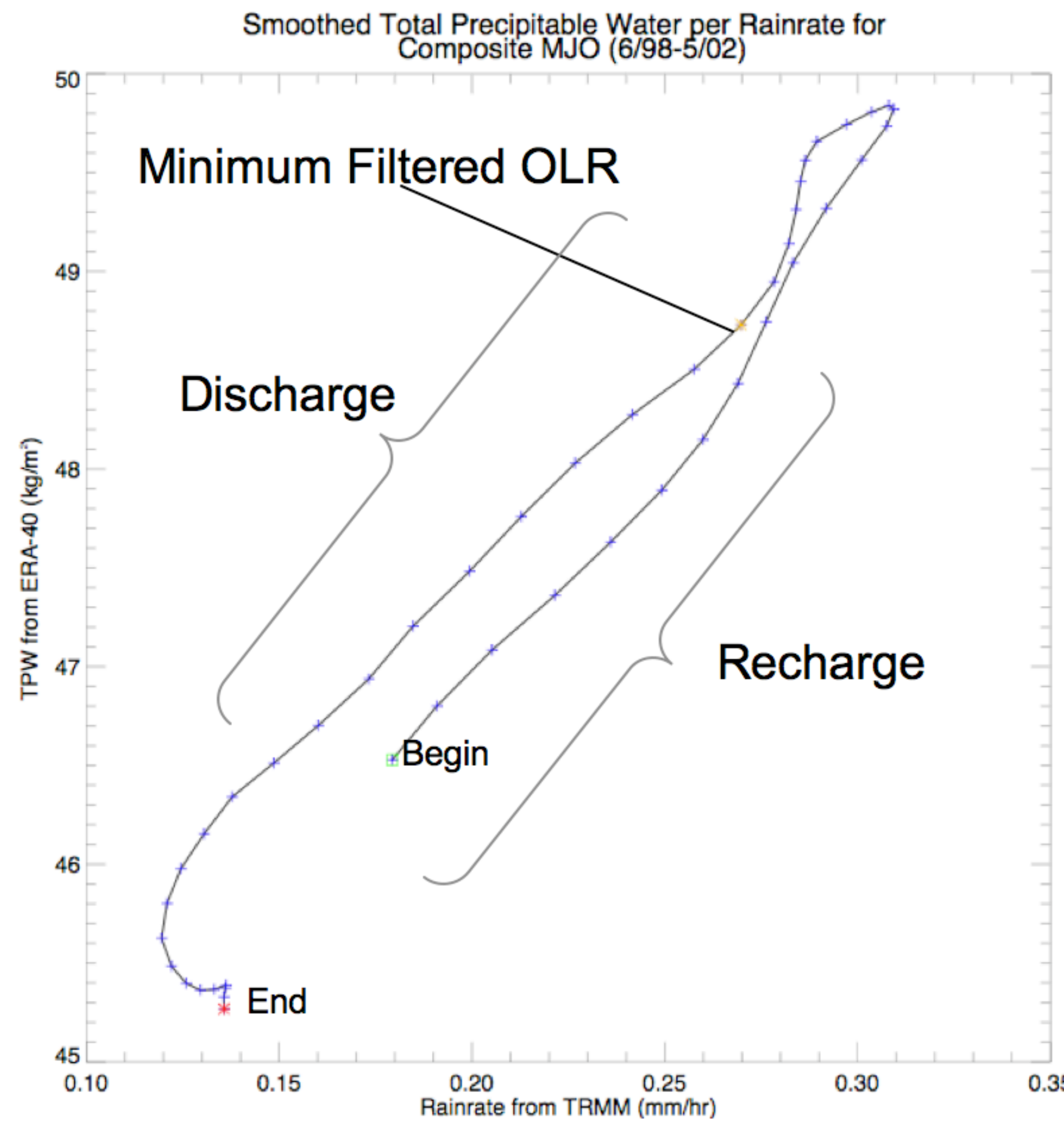
Bladé and Hartmann



Discharge and Recharge



Models



ERA-40 & TRMM

What I think is going on

- During the “recharge” phase, convective stabilization occurs mainly through the effects of downdrafts on the PBL moist static energy (Raymond’s BL QE).
- When the troposphere becomes very moist, this mechanism does not work well. The brakes fail.
- Convection then intensifies, exciting a large-scale disturbance.
- The disturbance produces warming aloft and strong dry advection west of the heating, which shut off the deep convection.
- Recharge resumes.
- This is generally consistent with the model of Bony and Emanuel (JAS, 2005), who discussed a “moisture-convection feedback.”
- For this mechanism to work, a model needs:
  - A tendency to moisten a deep layer as the rainfall rate increases
  - Downdrafts that modify the PBL

Summary

- Despite their identical dynamical cores, the SP-CAM makes a robust MJO while the CAM does not.
- The seasonal variations of the MJO simulated by the SP-CAM are realistic.
- Preliminary MJO forecasting experiments look promising.
- The structure of the simulated MJO is realistic, but its amplitude is excessive.
- The standard CAM dries out the middle troposphere when the rain rate is high.
- The ability to moisten the entire troposphere appears to be a key to the successes of the MMF.