Role of CRM on MJO simulation of SPCAM SOM




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Questions that we will be addressing are as follows:

- MMF shows relatively good MJO features (Kim et al, 2009, JOC). Why is it so?

- The MJO is known to have Multi-Scale Organization- Are the MMF's subgrid scale modes related to its resolved multi-scale organization?

- What sort of subgrid scale mode of variability are present in MMF?

Aims and Objective

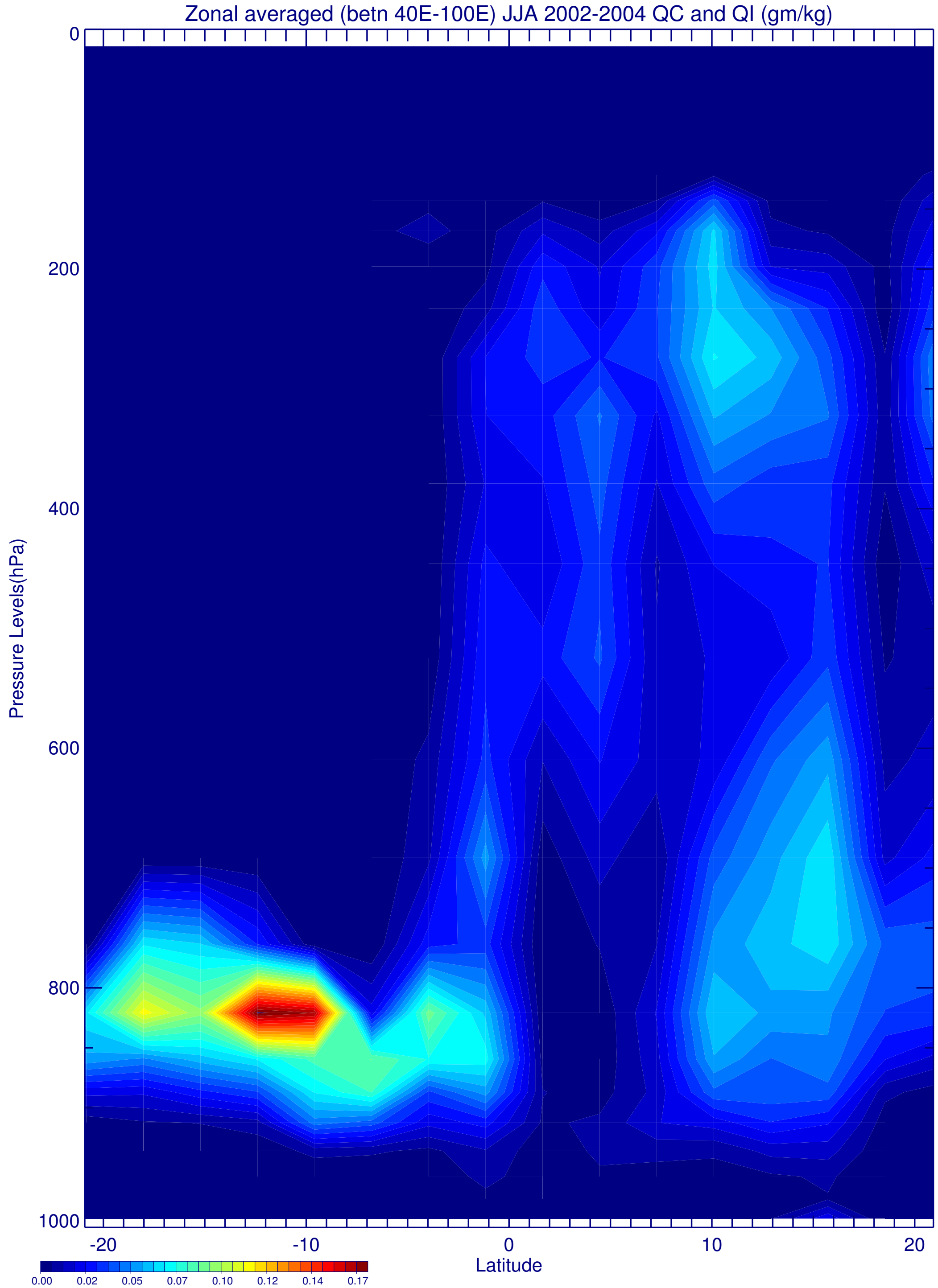
✓The idea is to take the CRM cloud field , constructed from combining liquid + ice clouds and doing an EOF on the CRM vertical profiles to see if the dominant vertical structures are evident.

✓Then to look, where in time and space the projections on these modes are greatest to see how the MMF is producing organized convection and how these relate to mean patterns as well as variability such as the ITCZ, monsoon or MJO phases, Kelvin wave etc.

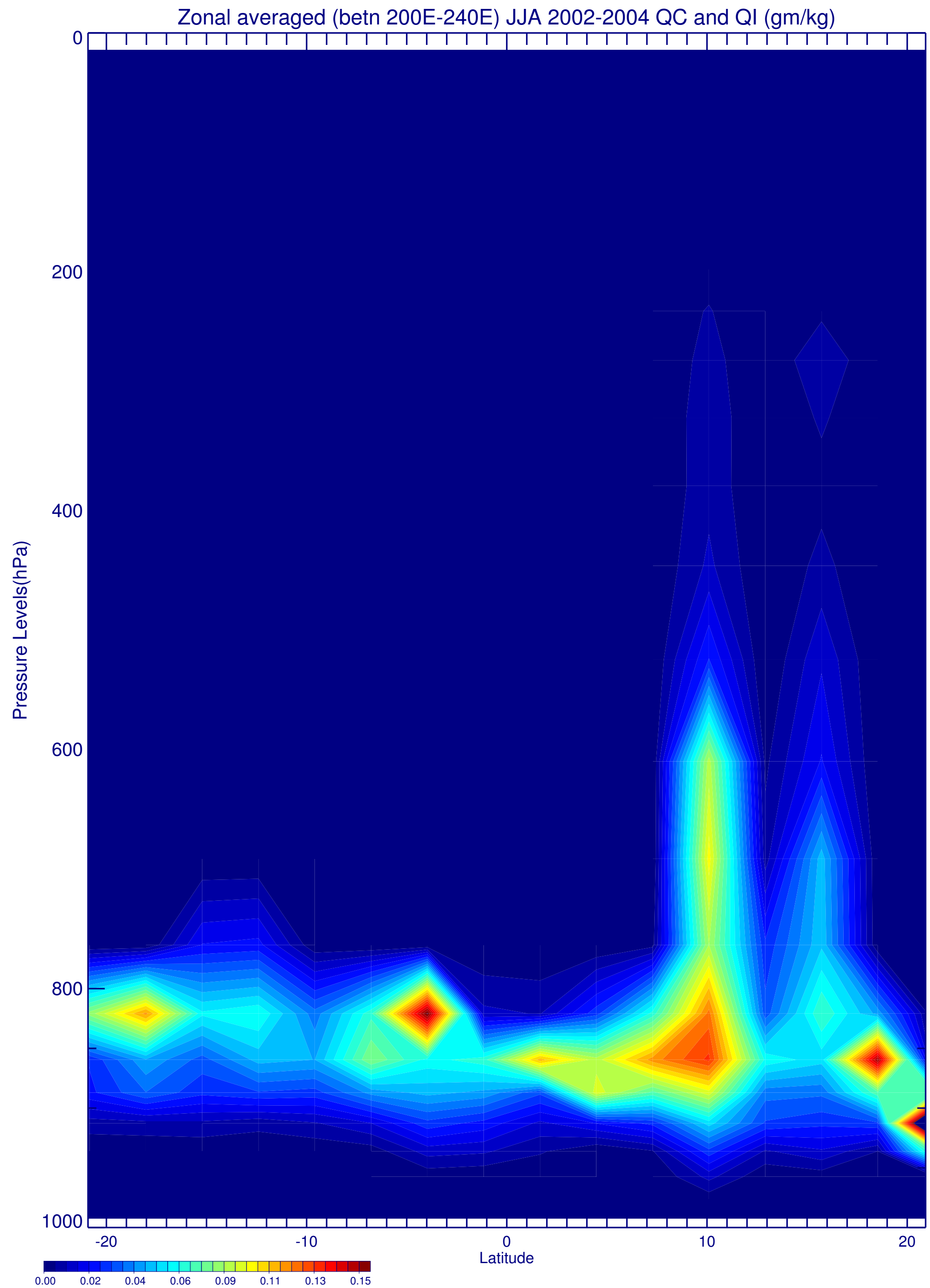
✓Does the model develop shallow heating, ahead of congestus followed by deep as studies based on ovservations (Maloney and Hartman, 1998; Myers and Waliser, 2003; Kiladis et al. 2005; Tian et al. 2006; Benedict and Randall, 2007) suggest that atmospheric preconditioning for MJO development and propagation happens with lower level moisture anomaly east of the convection anomaly which eventually helps in reducing the moist stability and preceded by warm dry (suppressed) moisture anomaly that increases the stability and the propagation takes place towards the east (Tian et al. 2009)

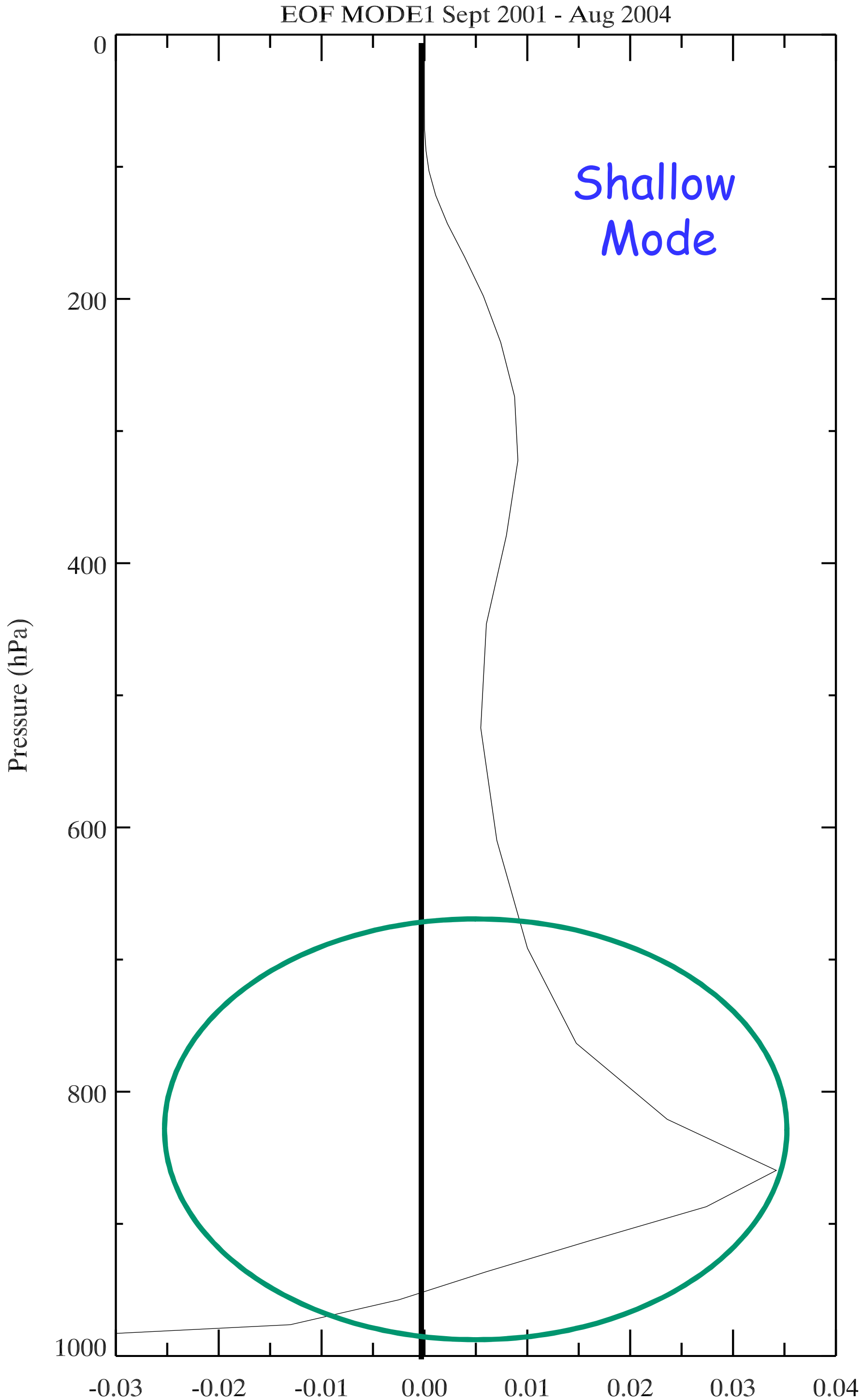
Latitude-height cross section of Zonal averaged (over 40-100E) QC&QI for JJA 2002-2004

Deep cloud associated with strong low level maxima typically represent the monsoon flow across the equator

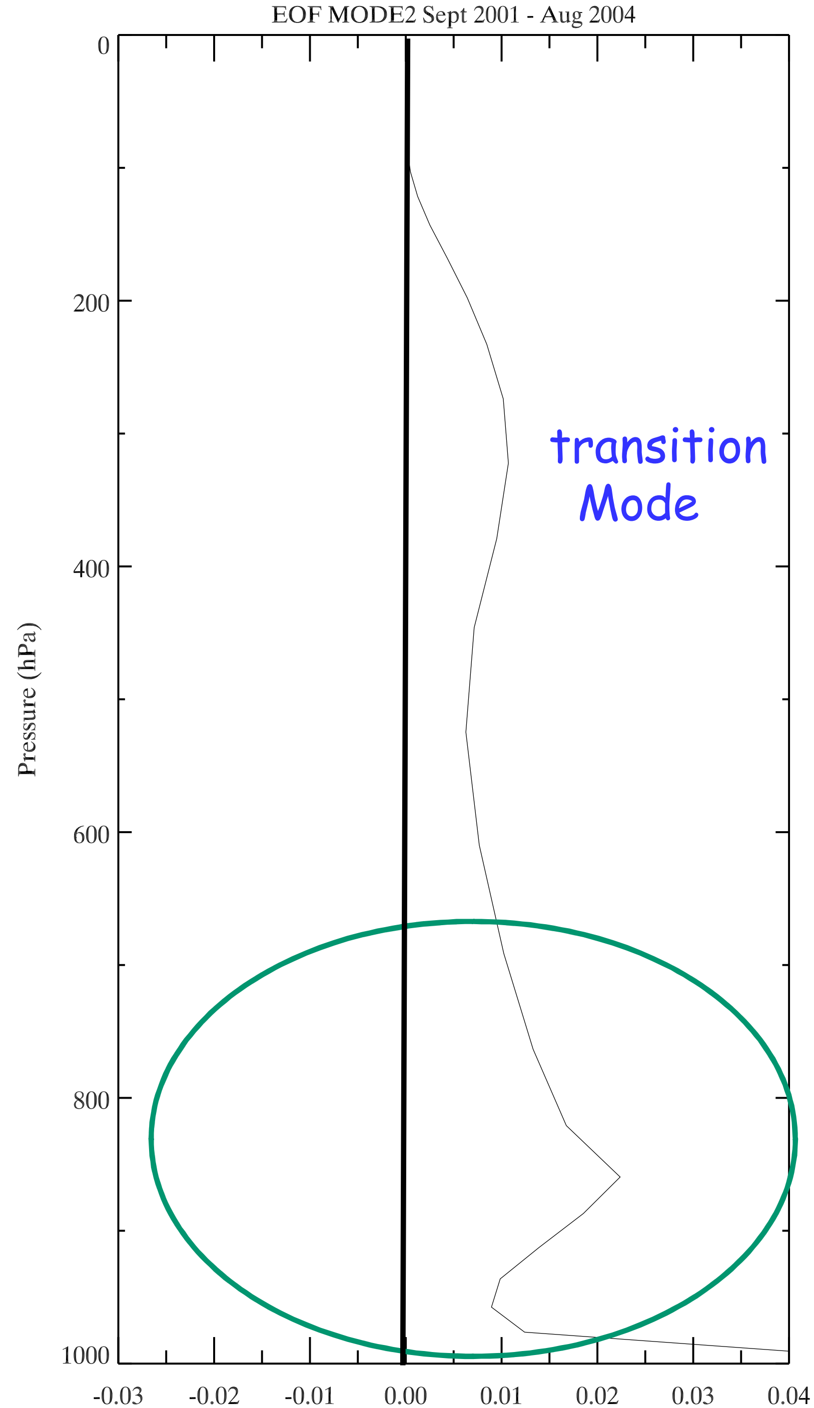


Latitude-height cross section of Zonal averaged (over 200-240E) QC&QI for JJA 2002-2004 (east of dateline; distinctly different than the other two region; dominant shallow regime)

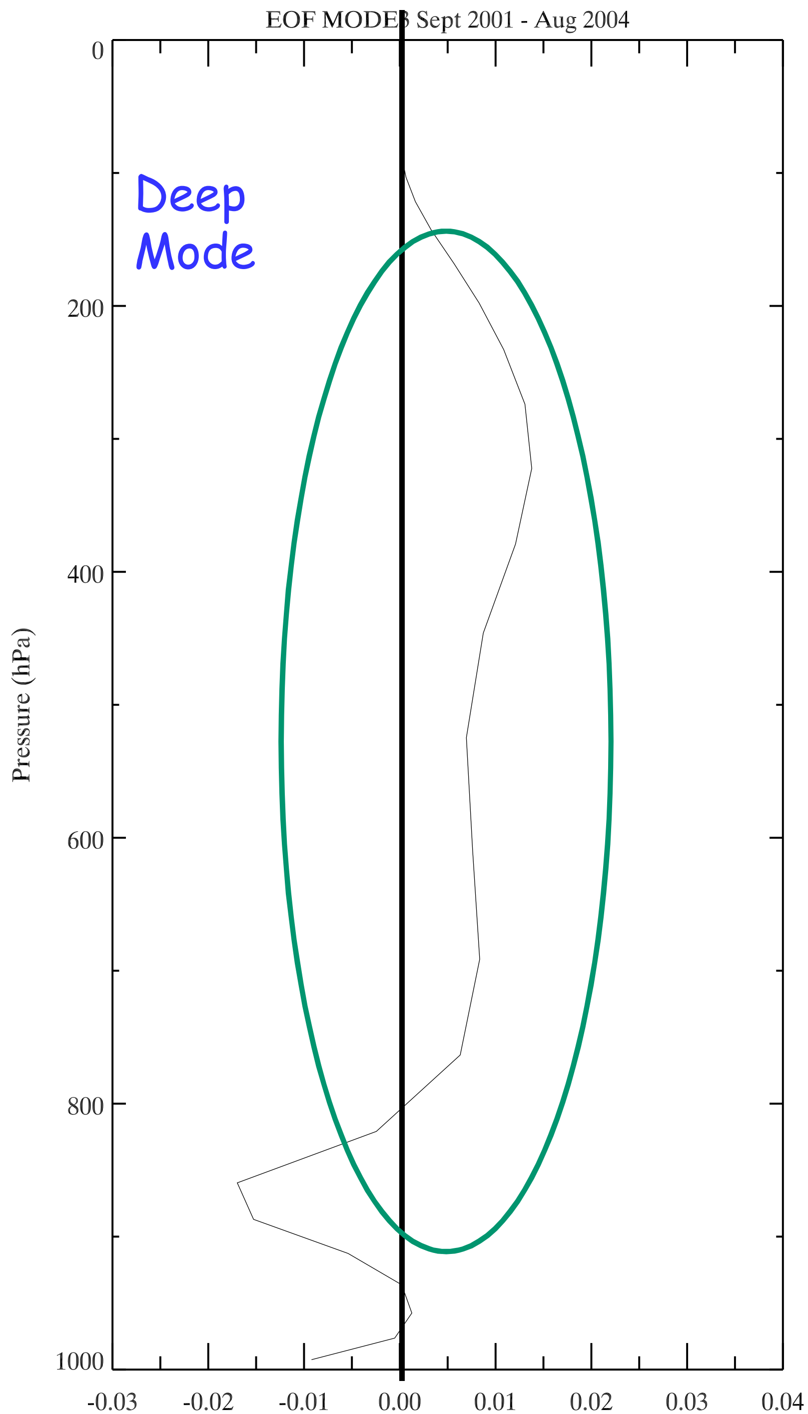




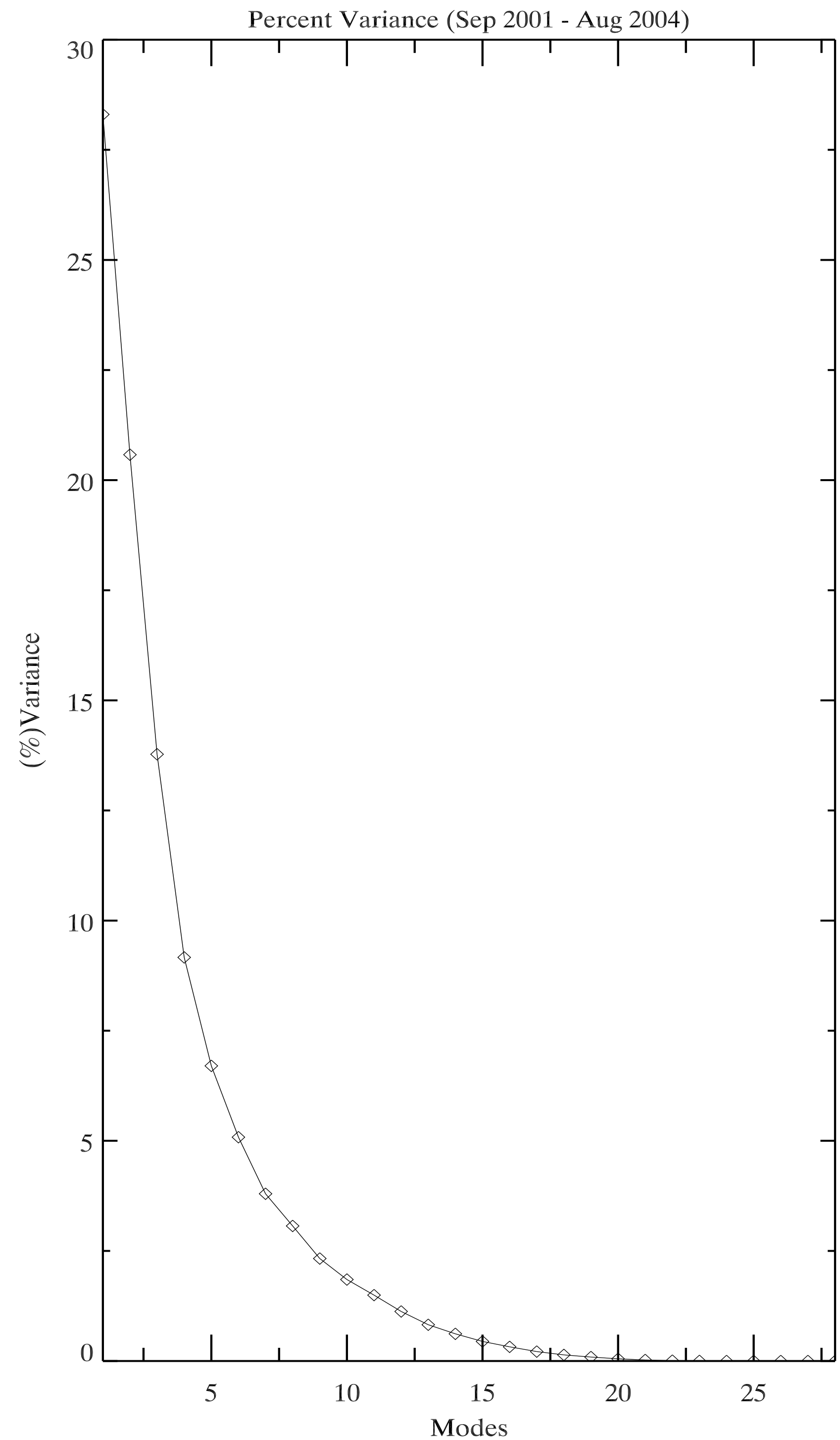
EOF MODE1 Sept 2001 - Aug 2004
Pressure (hPa)
0
200
400
600
800
1000
-0.03
-0.02
-0.01
0.00
0.01
0.02
0.03
0.04
Shallow Mode



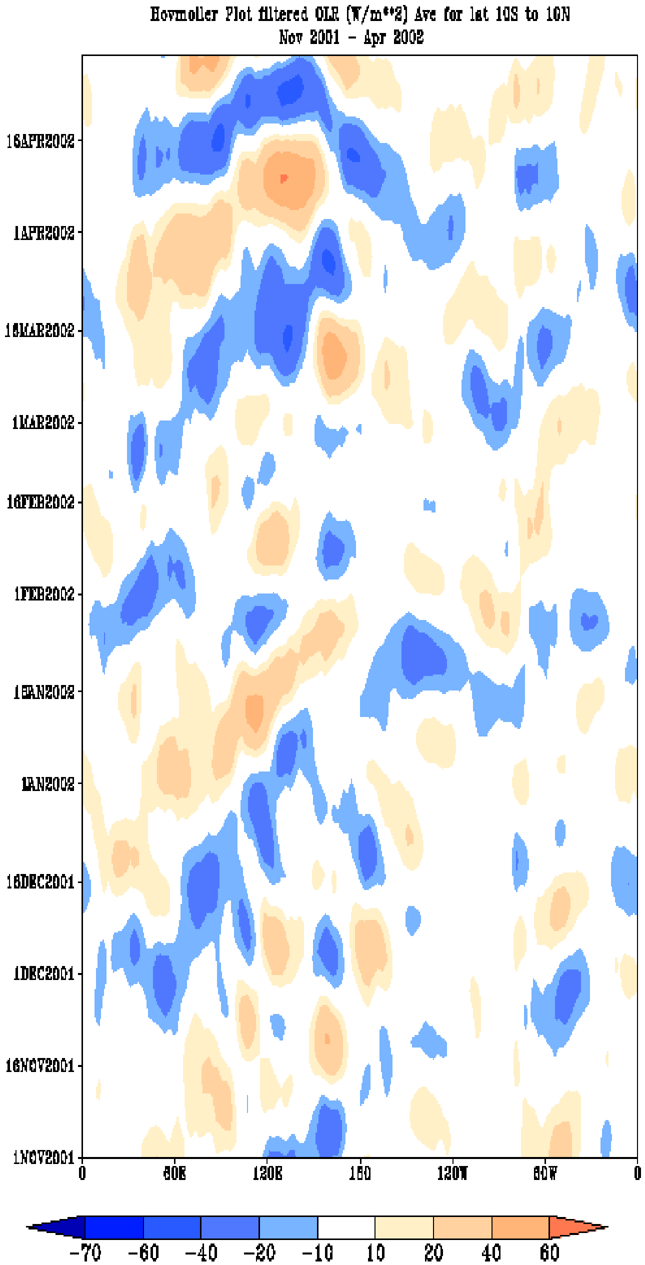
EOF MODE2 Sept 2001 - Aug 2004
Pressure (hPa)
0
200
400
600
800
1000
-0.03
-0.02
-0.01
0.00
0.01
0.02
0.03
0.04
transition Mode

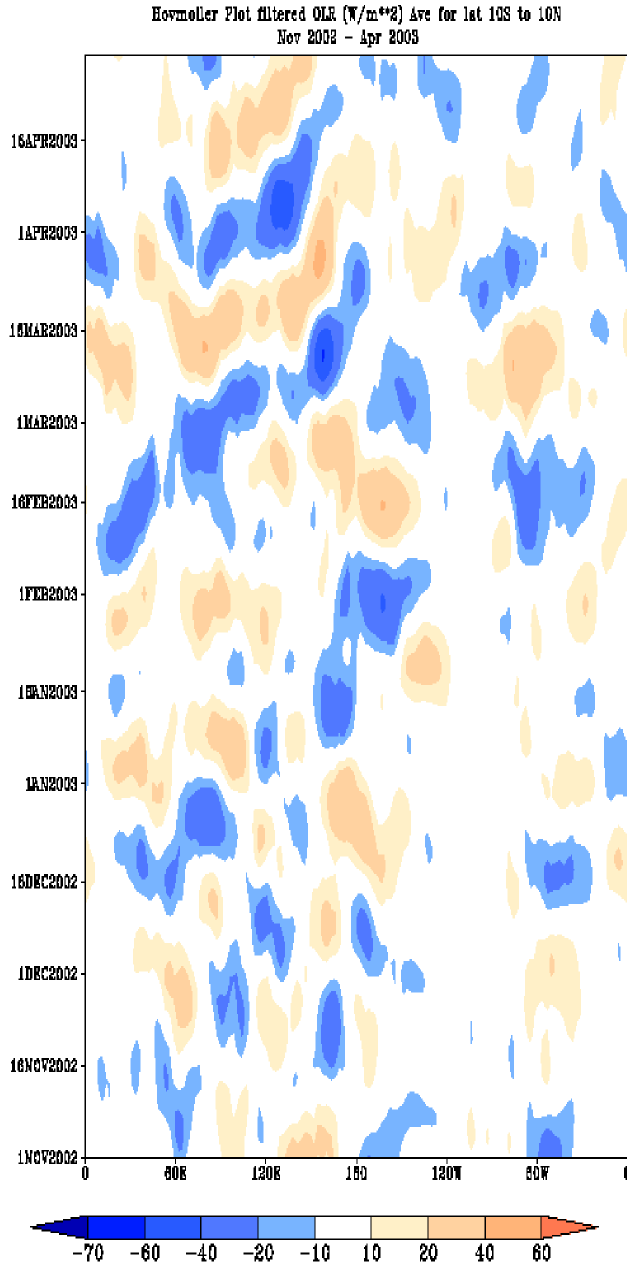


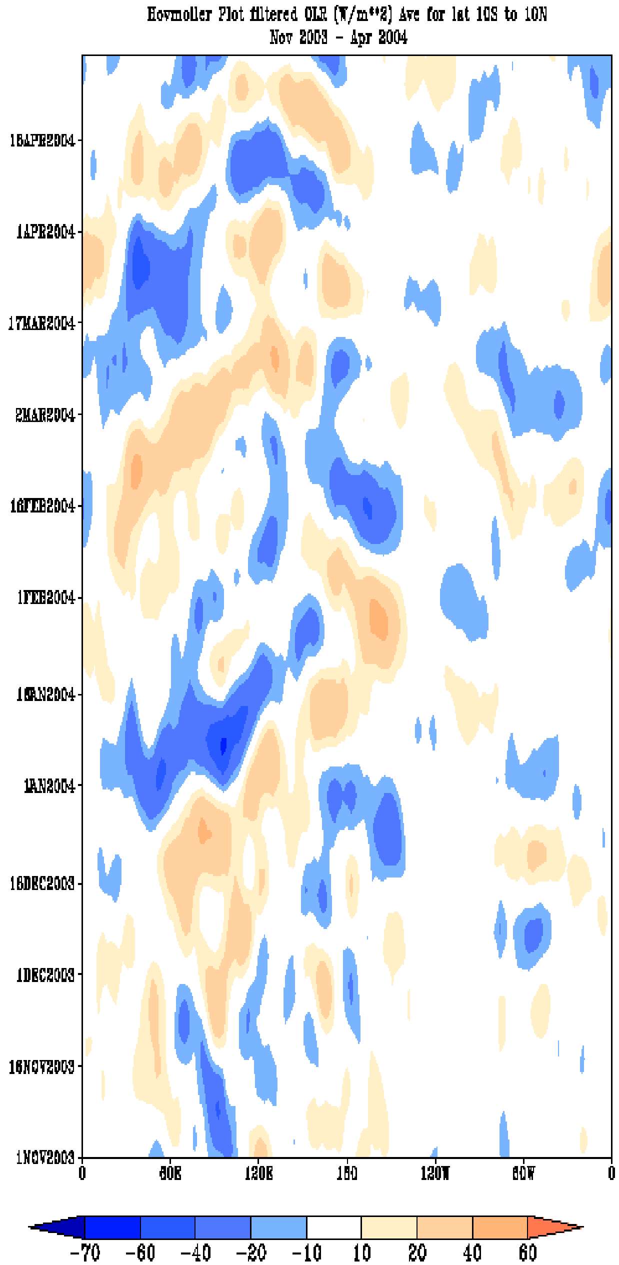
EOF MODE3 Sept 2001 - Aug 2004
Deep
Mode
Pressure (hPa)
0
200
400
600
800
1000
-0.03
-0.02
-0.01
0.00
0.01
0.02
0.03
0.04

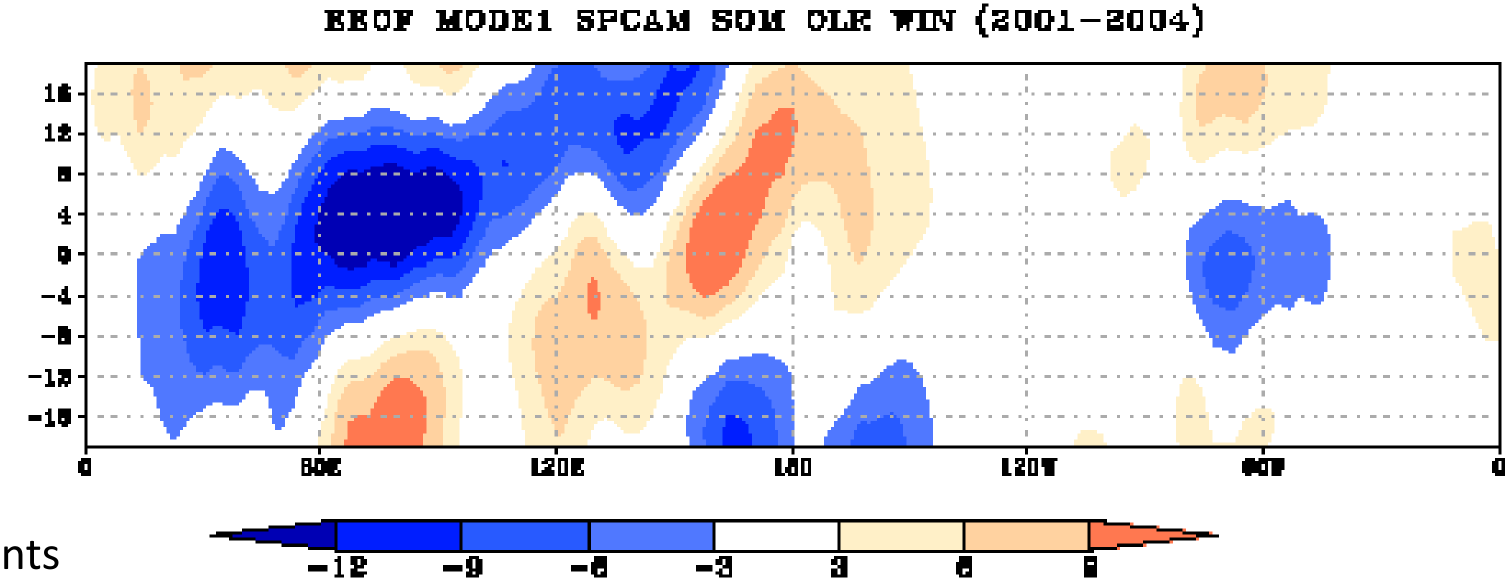


Percent Variance (Sep 2001 - Aug 2004)
(%)Variance
30
25
20
15
10
5
0
5
10
15
20
25
Modes

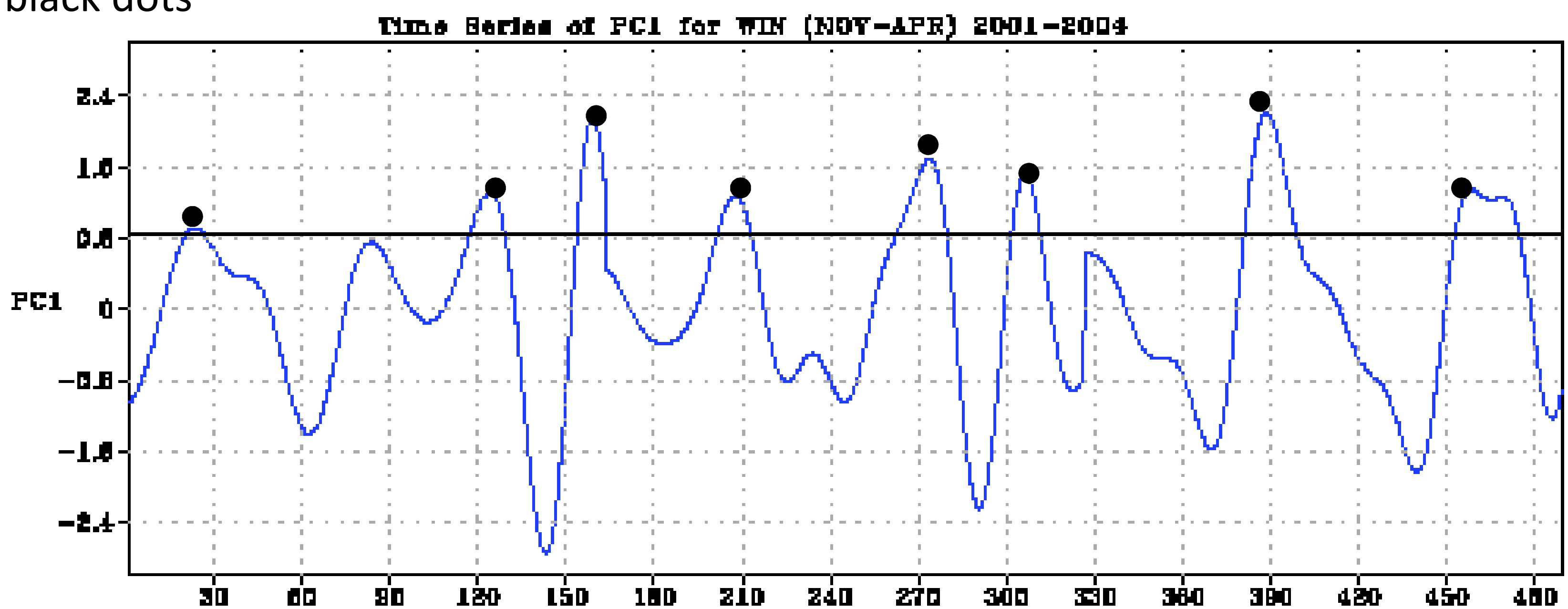

Hovmoller Plot filtered OLR (W/m**2) Ave for lat 10S to 10N
Nov 2001 - Apr 2002
16APR2002
1APR2002
16MAR2002
1MAR2002
16FEB2002
1FEB2002
16JAN2002
1JAN2002
16DEC2001
1DEC2001
16NOV2001
1NOV2001
0 60E 120E 180 120W 60W 0
-70 -60 -40 -20 -10 10 20 40 60

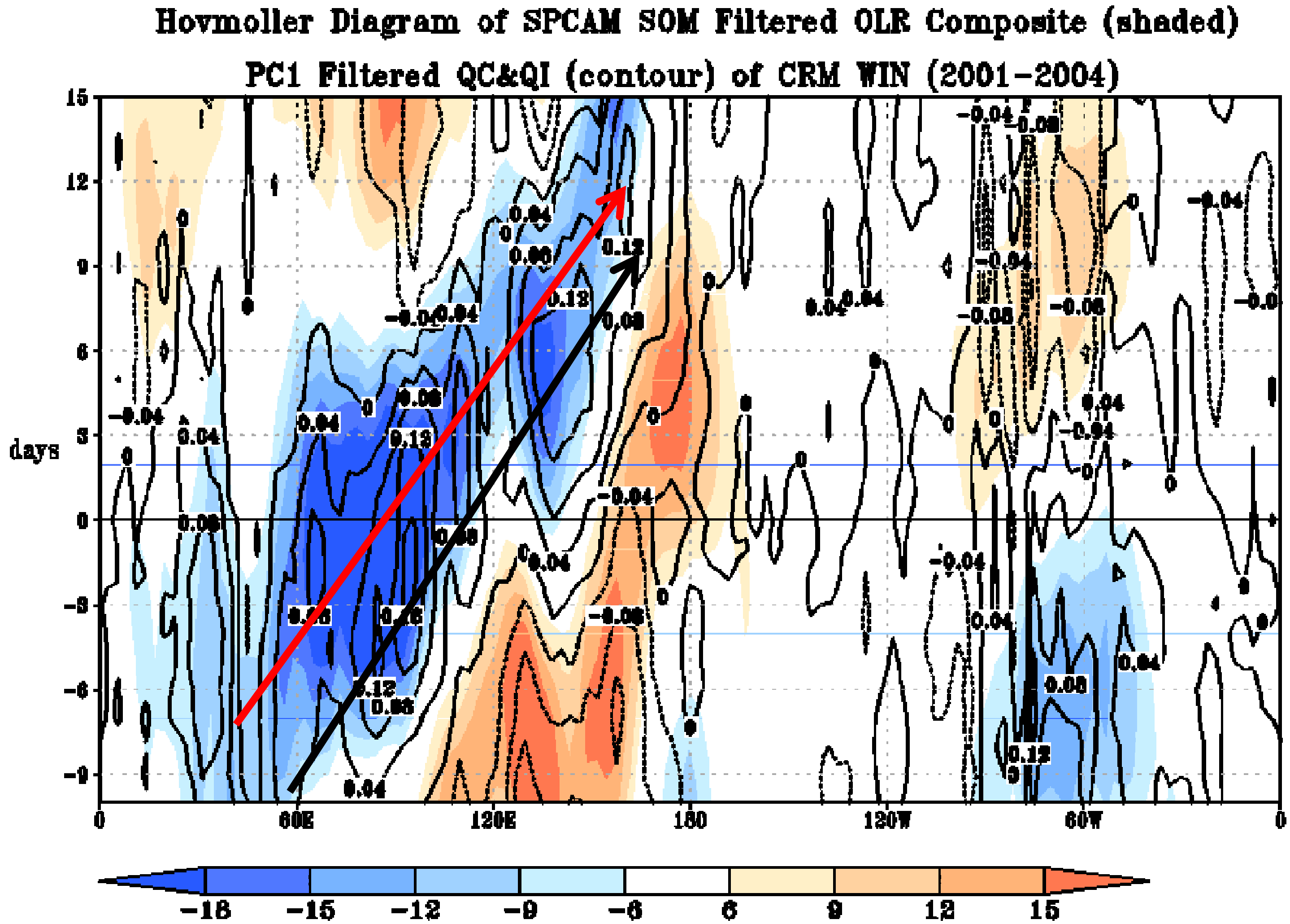

Hovmoller Plot filtered OLR (W/m**2) Ave for lat 10S to 10N
Nov 2002 - Apr 2003
16APR2003
1APR2003
16MAR2003
1MAR2003
16FEB2003
1FEB2003
16JAN2003
1JAN2003
16DEC2002
1DEC2002
16NOV2002
1NOV2002
0 60E 120E 180 120W 60W
-70 -60 -40 -20 -10 10 20 40 60


Hovmoller Plot filtered OLR (W/m**2) Ave for lat 10S to 10N
Nov 2003 - Apr 2004
16APR2004
1APR2004
17MAR2004
2MAR2004
16FEB2004
1FEB2004
16JAN2004
1JAN2004
16DEC2003
1DEC2003
16NOV2003
1NOV2003
0 60E 120E 180 120W 60W 0
-70 -60 -40 -20 -10 10 20 40 60

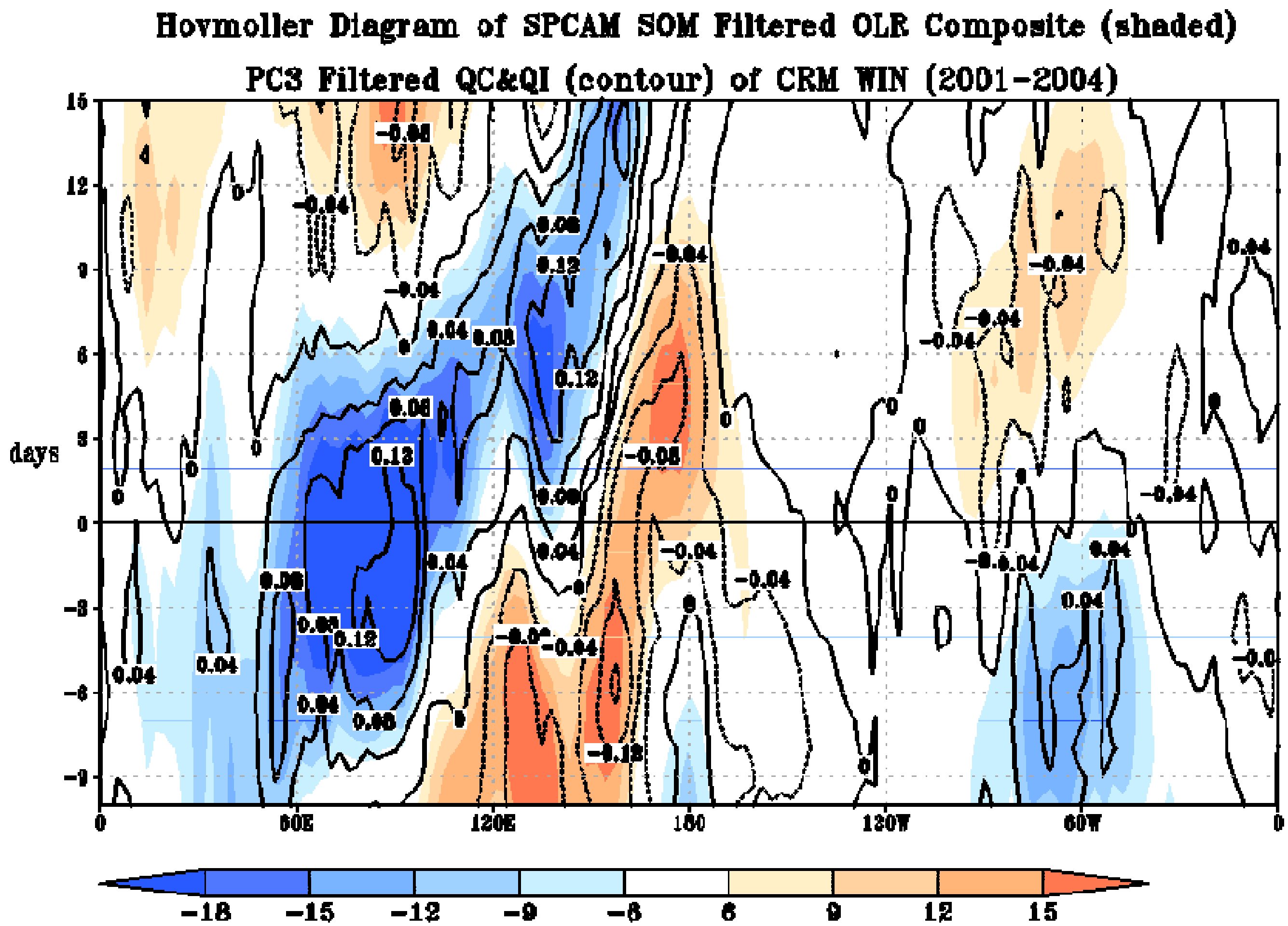


strong events >0.8 denoted as black dots

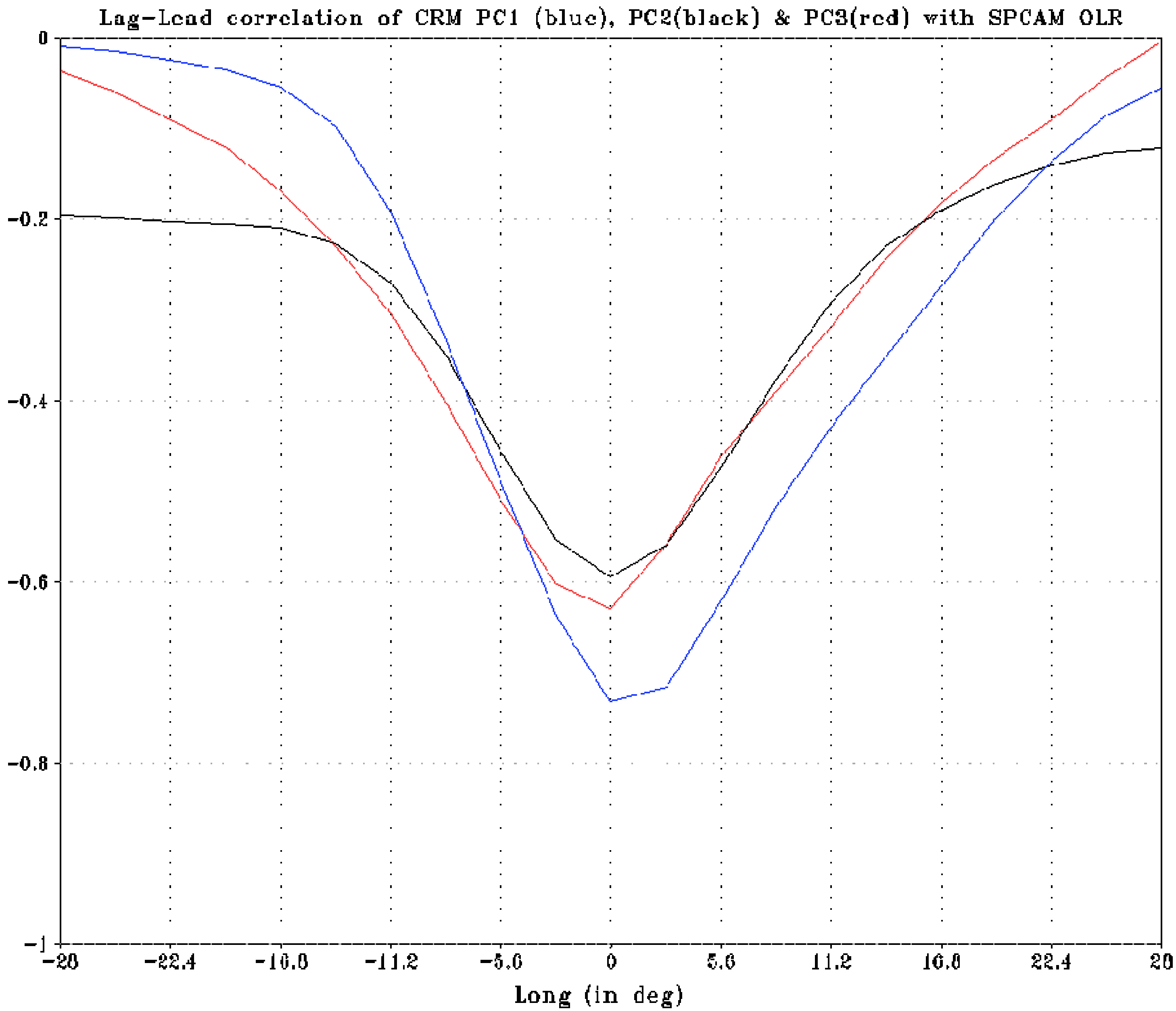




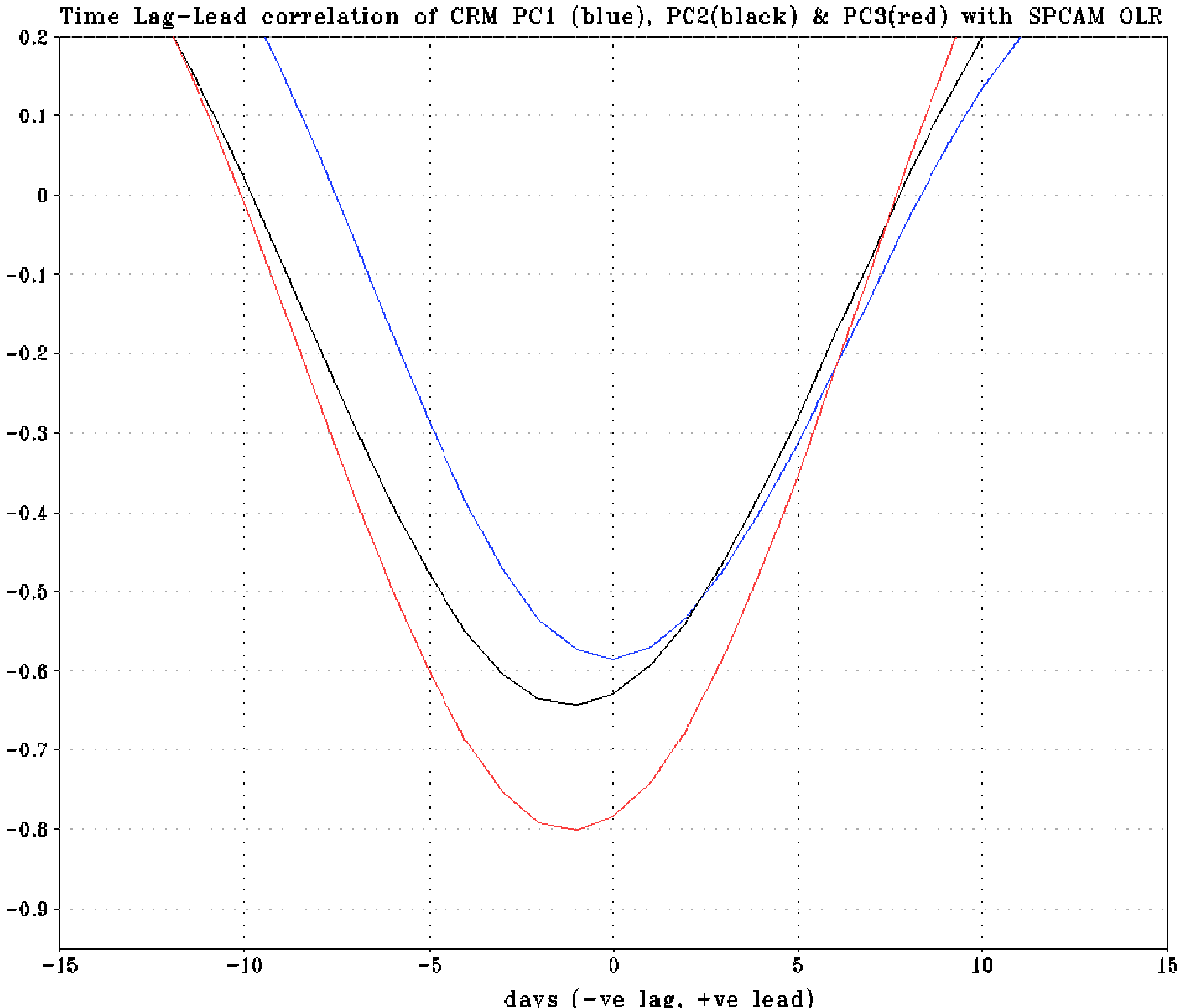
PC Mode1 of cloud is leading the MJO. It suggests that atmospheric preconditioning with warm and moist lower level is created by the CRM that eventually helps the GCM to reproduce the MJO realistically



PC3 being the deeper mode coincides exactly with the strongest SPCAM OLR anomaly



PC1 (blue) leads (in spatial correlation) followed by PC2 (black) and PC3 (red)



PC1 leads in time

Summary of analyses of QC&QI of CRM of SPCAM SOM

- The study brings out the role of CRM in simulating MJO in super parameterized approach.
- The analyses reveal that the CRMs are able to produce the statistics of transition from shallow to deeper modes of clouds realistically in space and time and this feed back essentially enables the GCM (SPCAM) in super parameterized frame work to show the MJO evolution and propagation in a realistic manner.

Space-time structure of summer monsoon Intraseasonal Oscillations (MISO) in the SP-CAM

Neena Joseph Mani , Bidyut B. Goswami, P. Mukhopadhyay, Duane Waliser, Jim Benedict, Marat Khairoutdinov, Eric Maloney and B. N. Goswami

Motivation & Objectives

• In recent times it is found (Kim et al. 2009, Jim and Randal 2009) that super-parameterized CAM (SPCAM) is able to better simulate the dynamical structure and phases of MJO in space and time

•From IPCC AR4 projection (Randal et al. 2007), it is found that climate models have major problem in simulating the precipitation and its variability over tropical Indian Ocean region. It also brought out the models limitation in producing the mean annual cycle over Indian region for example.

•In view of the above, it will be interesting to study whether the SPCAM frame work is able to capture the important features of monsoon circulation namely the seasonal cycle, onset and withdrawal, the intra seasonal oscillations (ISOs) of different modes (e. g. 10-30, 30-60) and northward propagation.

•This analyses will help to bring out the strength or weaknesses of the simulation for the mentioned aspects which then further can be improved.

DATA

SPCAM (2.8°×2.8°) Precipitation, U850,U200,V850 & V200 for the period 01Jun1986-30Sept 2003 (18 years)

GPCP (1°×1°) precipitation data for the period 01Jun1997-30Sep2007 (11 years)

IMD (1°×1°) daily gridded precipitation data 01 Jun 1986 -30Sep 2003 (18 years) (for making Central India precipitation index)

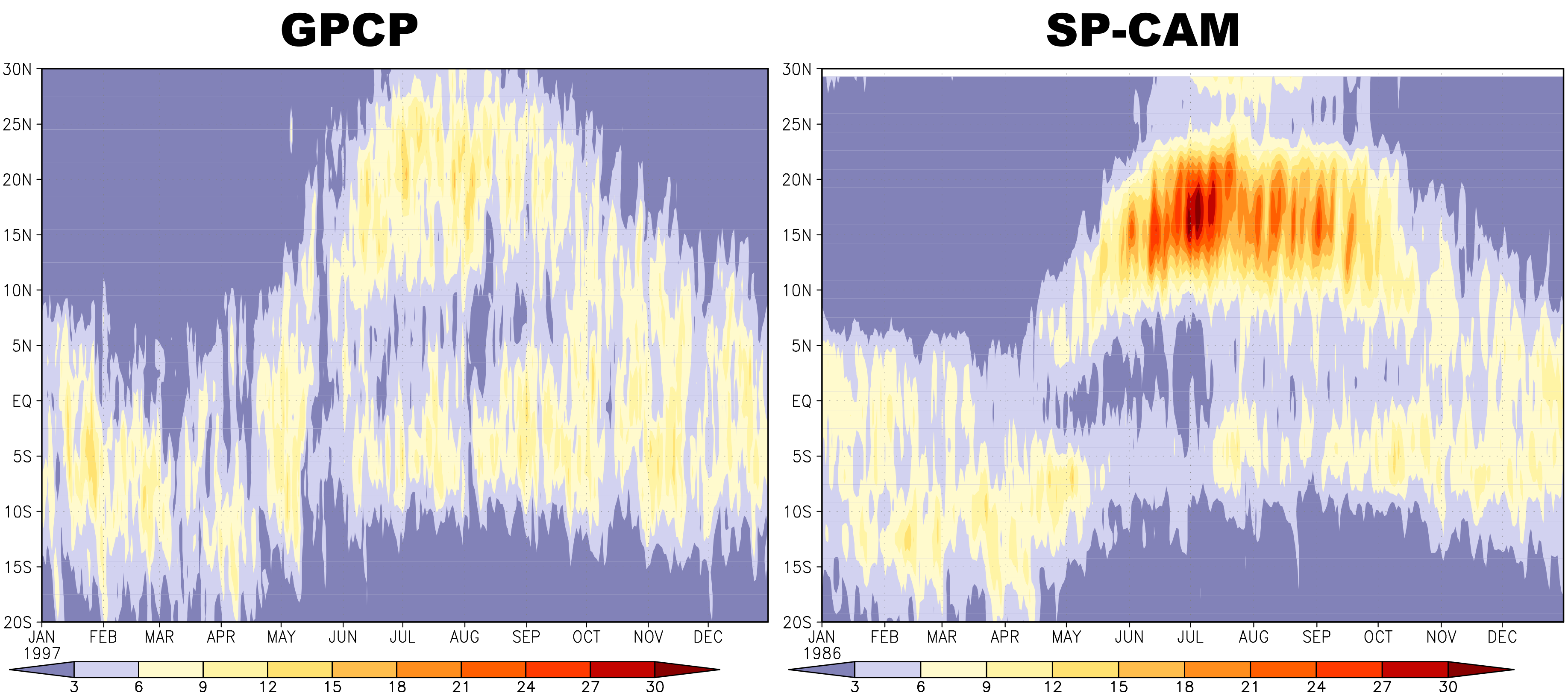
NCEP (2.5°× 2.5°) U850,U200,V850 & V200 data for the period 01Jun1986-30Sept 2003 (18 years)

Computation of Climatological mean JJAS

Daily climatology of precipitation was computed from the SPCAM model output (1986-2003)and from GPCP data (1997-2007)and averaged for the JJAS monsoon season.

Climatology of 850mb and 200mb wind were computed in a similar manner.

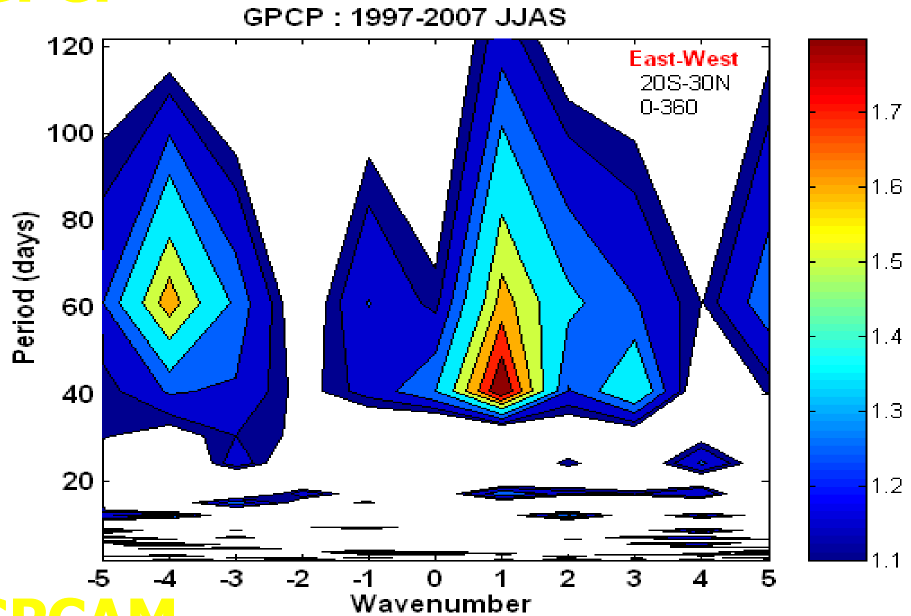
Climatological annual cycle of precipitation over 70E-90E, mm/da



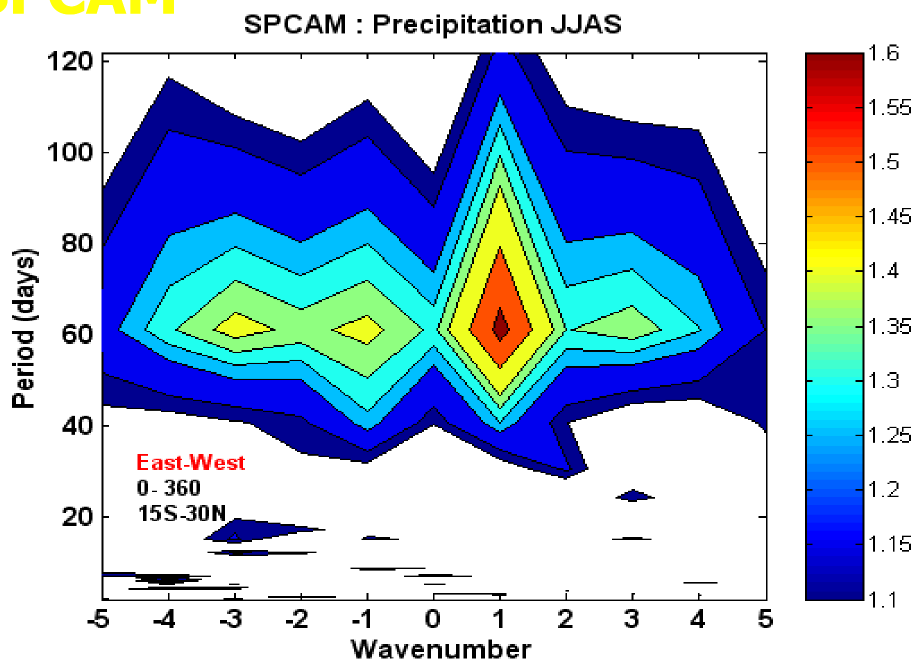
SPCAM produces a good annual cycle of monsoon rainfall, well capturing the onset and withdrawal phases. The two locations of the monsoon trough can be clearly separated out in the rainfall distribution , with the oceanic trough at 5S and continental trough at 18N complying with the observations. The overestimation of rainfall over the continental trough location is the only drawback.

Space-time spectra of Precipitation during JJAS (East-west propagation) (0E-360E,20S-30N)

GPCP

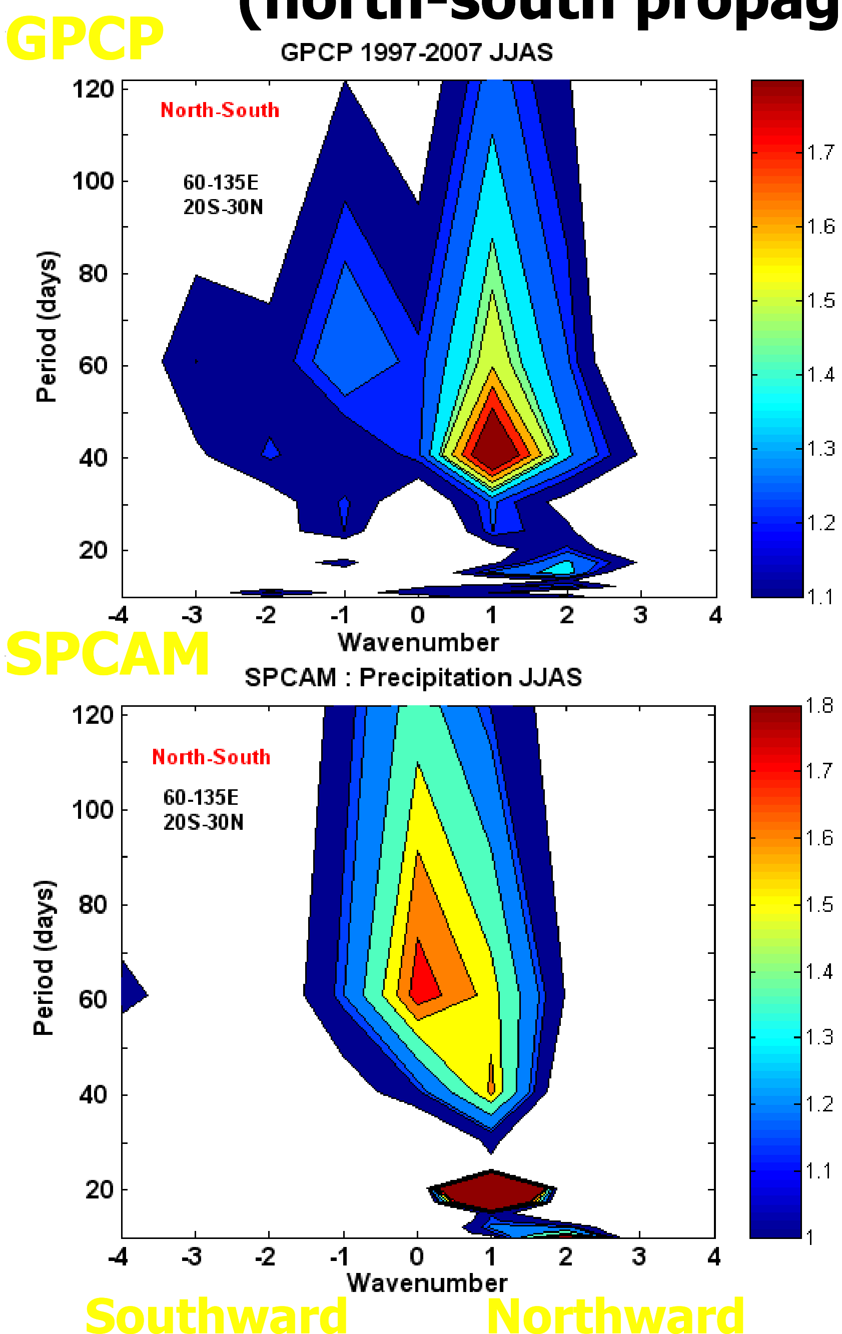


SPCAM



Space–time spectra of precipitation were examined to realize the east-west propagating features. Even though the model generates maximum amplitude at eastward propagating wave number 1, it misrepresents the ***periodicity at 60 day*** instead of the ***observed 40day*** periodicity. Observations show the westward propagating power to be concentrated at wave number 4 with a 60 day periodicity while in SPCAM space-time spectra the westward propagating power is distributed over the -1 to -3 range of wave numbers at 60 day periodicity.

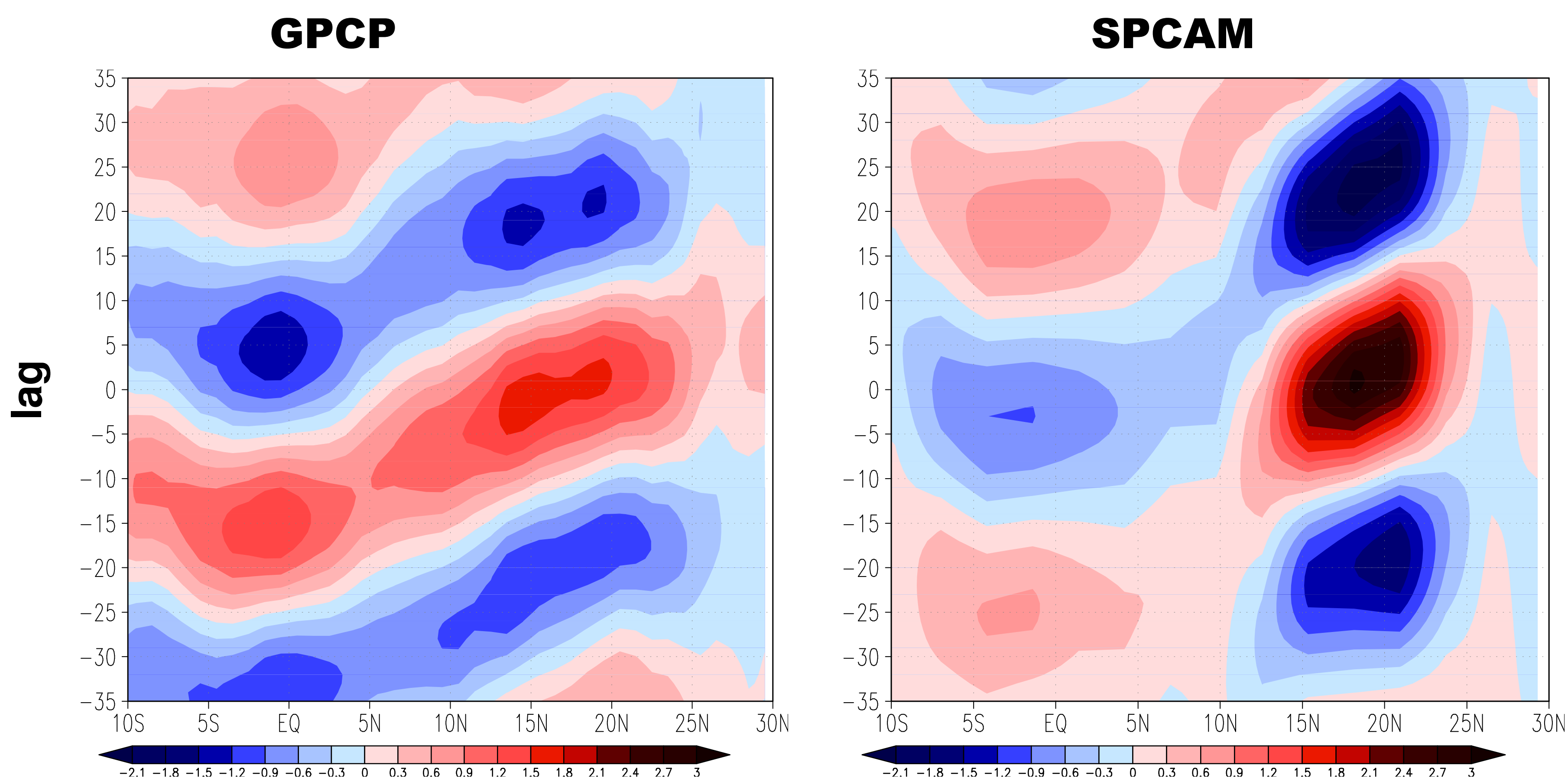
Space-time spectra of Precipitation during JJAS (north-south propagation) (60E-135E,20S-30N)



North-South Space –time spectra of precipitation were examined to look at the northward propagation of ITCZ over the Indian monsoon domain.

Observations *show the maximum northward propagating power to be concentrated at* ***wave number 1 with a 40 day periodicity and some power is also seen at wave number 2 with 10-15day periodicity, corresponding to the quasi biweekly mode (QBM), while*** the ***SPCAM*** space-time spectra shows maximum ***northward propagating power at wave number 1 with 20 day period*** misrepresenting the QBM. The secondary maxima is seen as a ***stationary mode with 60 day periodicity***, implying the failure of the model in capturing the northward propagation.

Latitude-Time propagation of 30-80 day filtered regressed rainfall averaged over 60E to 100E



Coherent northward propagation of ITCZ is not visible in SPCAM regressed anomalies, instead in situ oscillations are seen in the two favored locations of ITCZ with stronger Oscillations over the land mass.

Summary of SPCAM analyses

- Model reasonably simulates the annual cycle with respect to GPCP observation.
- Model does not simulate the Quasi biweekly mode correctly, instead it produces a very strong mode of 20 day periodicity.
- Spatial structure of this 20 day mode is much larger than the observed 10-20 day mode
- The observed 40 day mode is misrepresented as a 60 day mode in the model simulation.
- The 30-80 day filtered anomalies have a smaller spatial scale than in observations.
- Northward propagation is poor. The large precipitation bias over the northern location of monsoon trough may be suppressing the precipitation over the oceanic trough. Hence the 30-80day mode appears stationary.

US CLIVAR MJO Working Group, 2006-09

1) Develop MJO WG Web Site (www.usclivar.org/mjo.php)
2) Diagnostics for GCMS. (J. Climate, 2009)
3) Application of Diagnostics (J. Climate, In Press)
4) Operational MJO Forecast Metric (BAMS, Submitted)
5) MJO Workshop, Irvine, 2007 (BAMS Mtg Sum, 2008)

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Proposal for WCRP/WWRP Task Force

- Develop process-oriented diagnostics/metrics to assess/guide physics and take advantage of more modern data (e.g. A-Train)
- Explore MJO multi-scale interactions and with emphasis on vertical structure and diabatic processes.
- Expand MJO forecast metrics: e.g., boreal summer & ensemble development.

"…. the MJO Task Force should be formed within the framework of the joint WWRP/THORPEX/WCRP YOTC activity, and report to the JSC-WWRP, ICSC THORPEX and the SSG-CLIVAR."

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WCRP- CLIVAR /WWRP - YOTC MJO Task Force

Duane Waliser (co-chair)	Jet Propulsion Laboratory/Caltech
Matthew Wheeler (co-chair)	Centre for Australian Weather &Climate Research
Ken Sperber	Program for Climate Model Diagnostics and Intercomparison
Harry Hendon	Centre for Australian Weather and Climate Research
Eric Maloney	Colorado State University
Xiouhua Fu	University of Hawaii
John Gottschalck	National Centers for Environmental Prediction
Richard Neale	National Center for Atmospheric Research
Chidong Zhang	University of Miami
Daehyun Kim	Seoul National University
Augustin Vintzileos	National Centers for Environmental Prediction
Frederick Vitart	European Centre for Medium-range Weather Forecasting
Dave Raymond	New Mexico Institute of Mining & Technology
Masaki Satoh	Frontier Research Center for Global Change
Hai Lin	Environment Canada

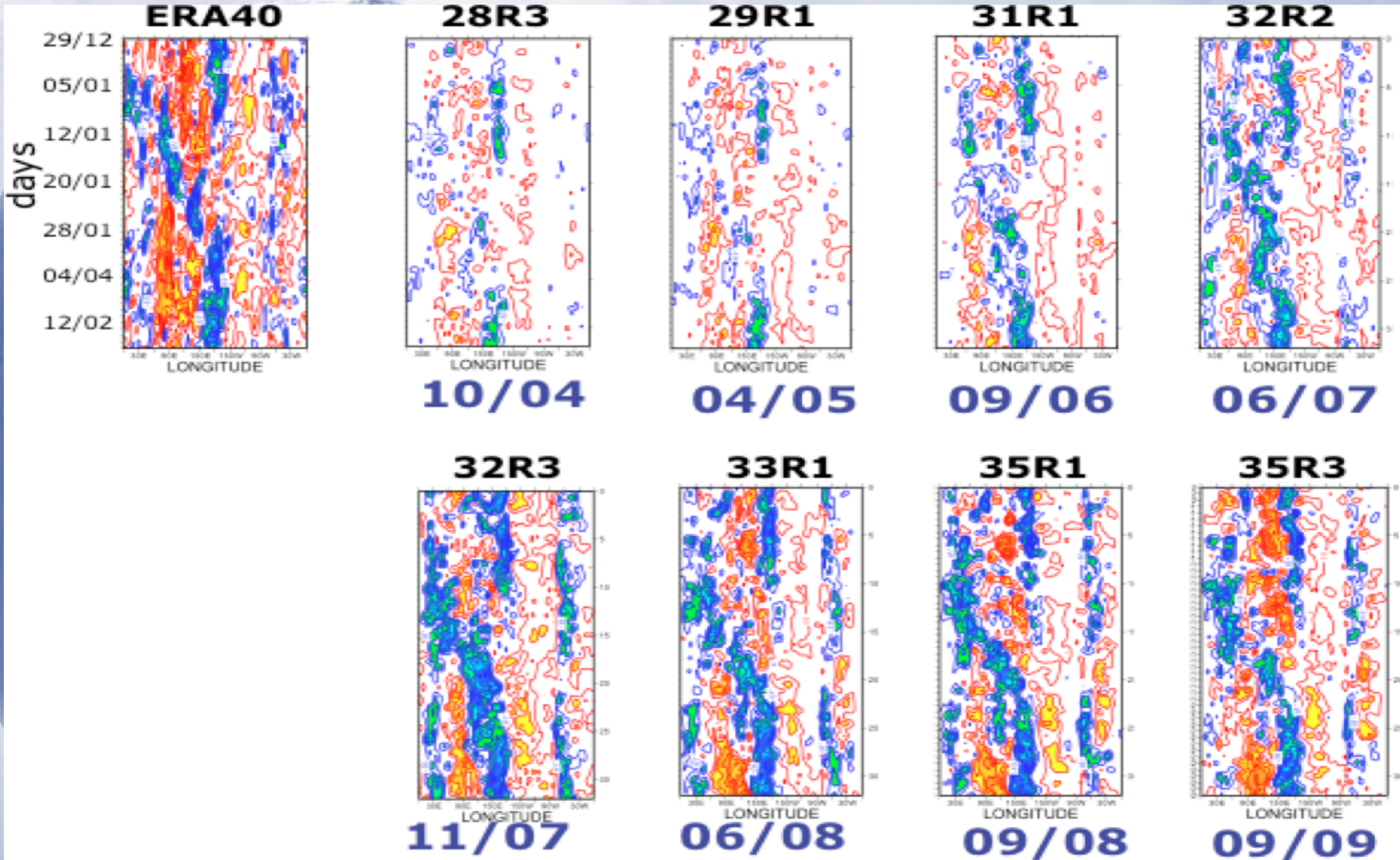
MJO Task Force & Related/Other Activities

- MJO Task Force Meeting – Busan, Korea, June 2010
- AAMP Meeting – “” “”
- Workshop - “” “” [Metrics, Forecasts, Boreal Summer, Hindcasts]

- Prediction/Predictability/Process Hindcast Experiment [PI: B. Wang]
  ~17 models, 20 years, 45-day hindcast every ~5 days
- YOTC Transpose AMIP and other High-Res Experiments
  Multi-model (e.g., CMIP5, CAM, SPCAM), 5-day forecast every YOTC day; also NICAM, GEOS, NCM for selected events
- CPT Proposal Submission [PI: E. Maloney]
- DYNAMO (MJO Initiation/Indian Ocean) Submission [PI: C. Zhang]
- Pending NRC Report on ISI Prediction/Predictability

MJO FORECAST SKILL FROM ECMWF

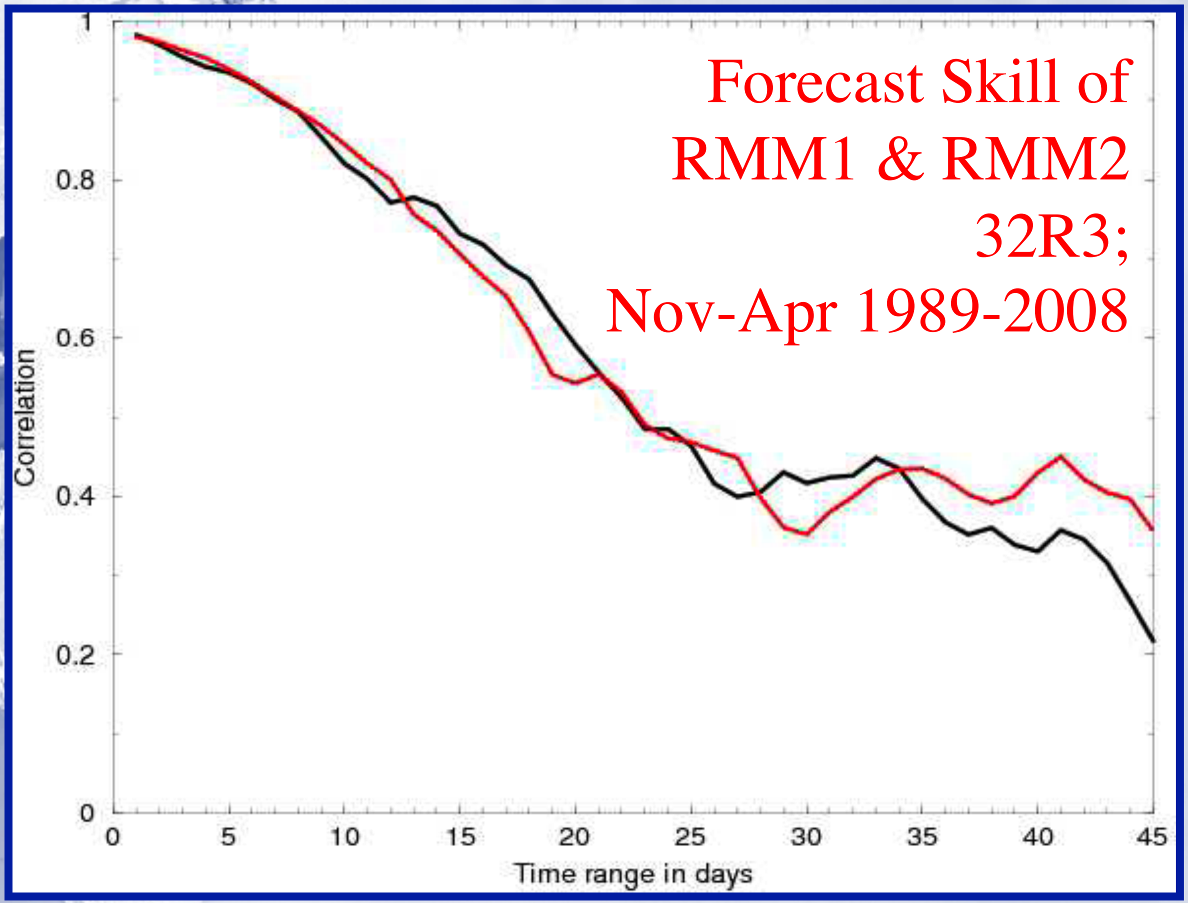
Vp 200 hPa - Forecast range: day 15



Promising gains from continued model improvements.

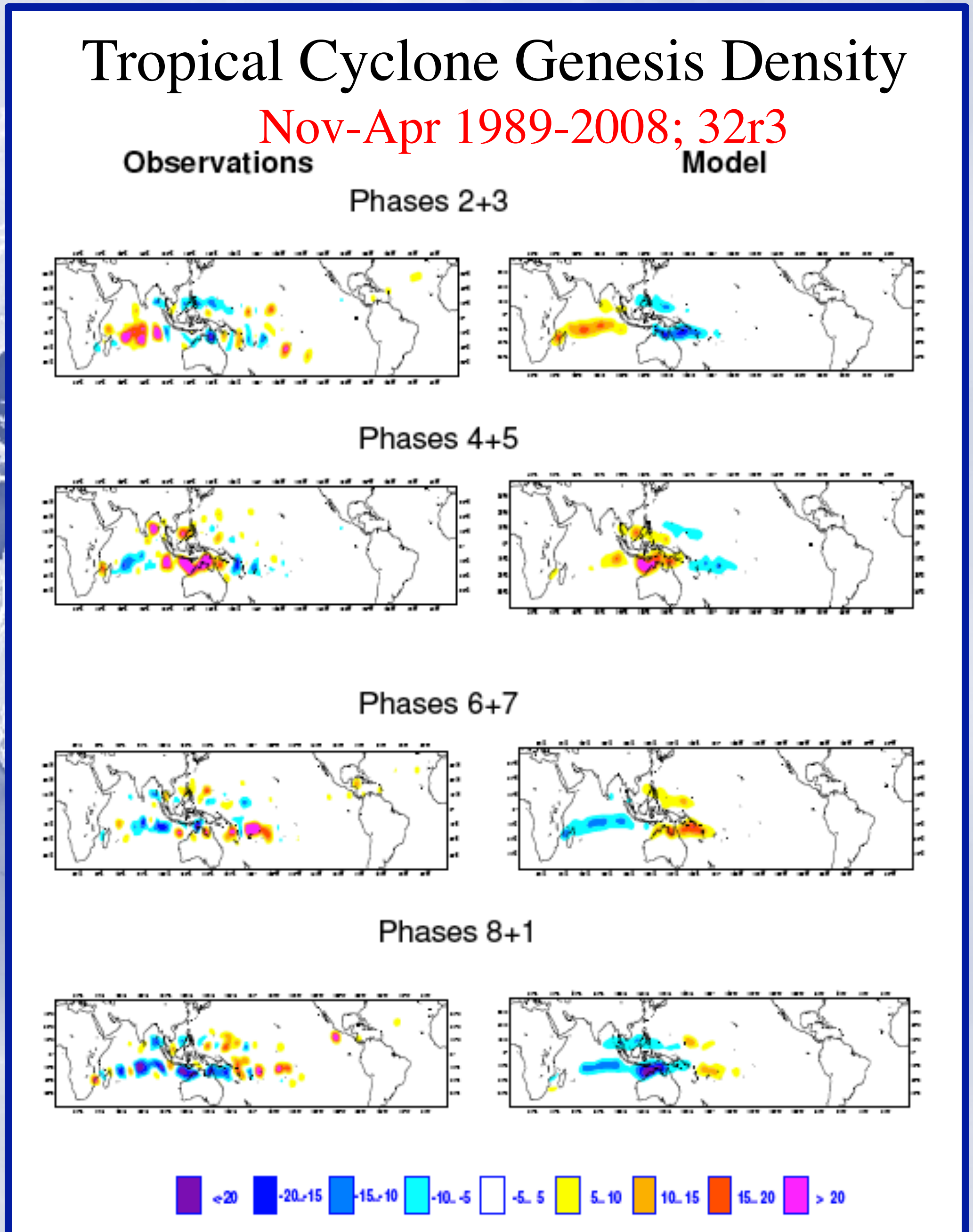
Courtesy F. Vitart

MJO FORECAST SKILL FROM ECMWF



Courtesy F. Vitart

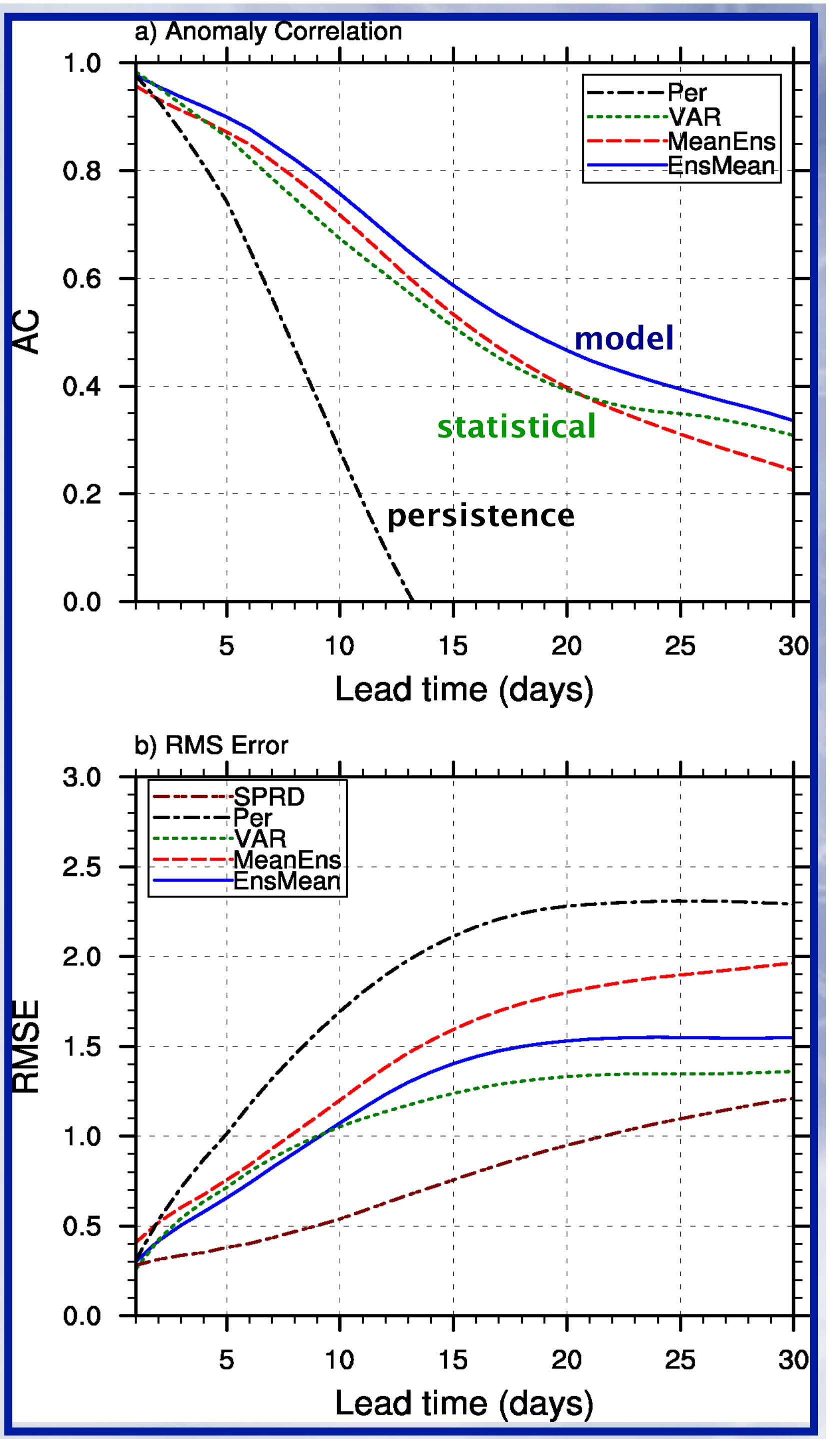
MJO FORECAST SKILL FROM ECMWF



Courtesy F. Vitart

MJO FORECAST SKILL FROM ABOM

- POAMA hindcasts: 10 members from 1st of month for 25 years.
- Correlation &RMS for RMM1 and RMM2 (combined)
- Generally better skill from Dynamical Model!

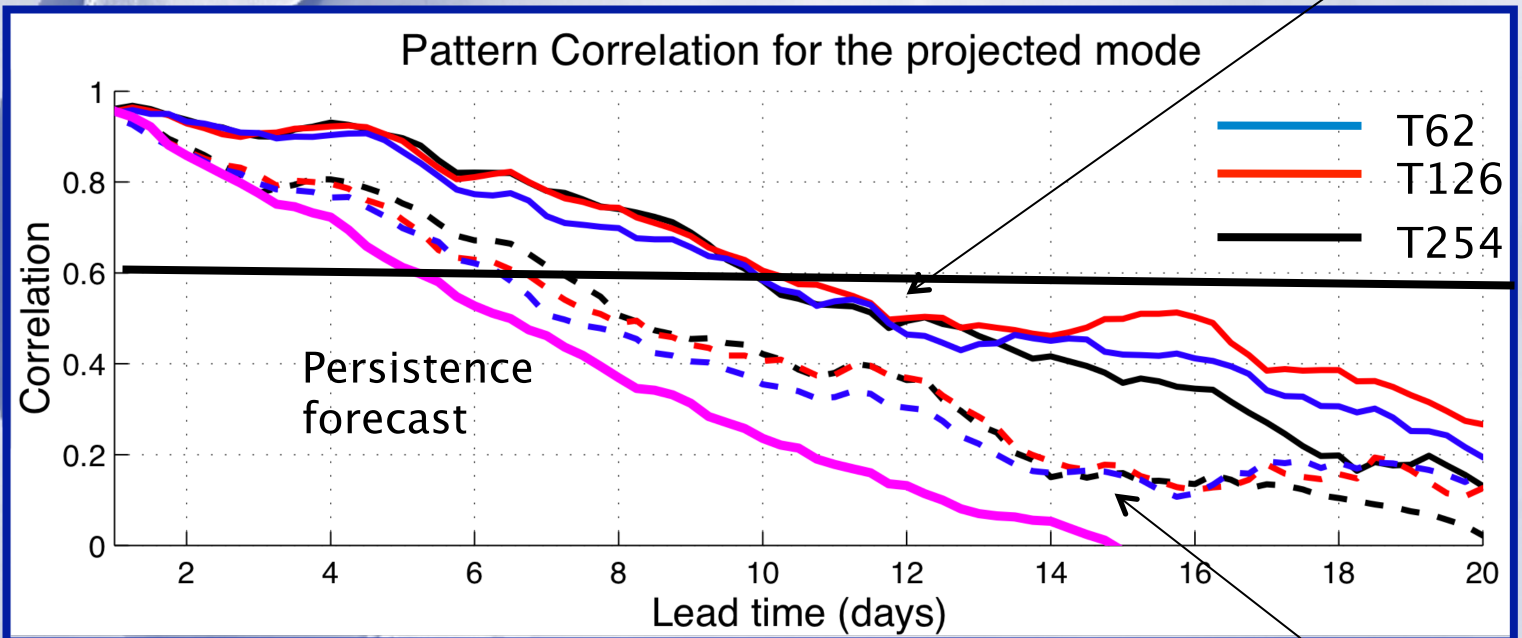


Courtesy M. Wheeler

FORECAST SKILL FROM NCEP CFS

Sensitivity to Horizontal Resolution and Atmospheric Initial Condition

I.C.= GDAS
operational NCEP analysis



(verification R-2)

I.C.= Reanalysis-2

Propagation over Maritime Continent - Still a Challenge

Courtesy A. Vintzileos