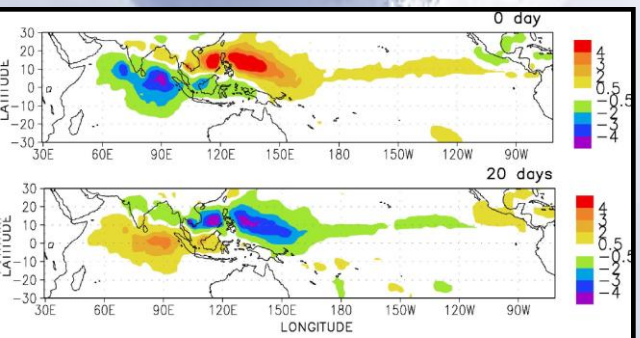
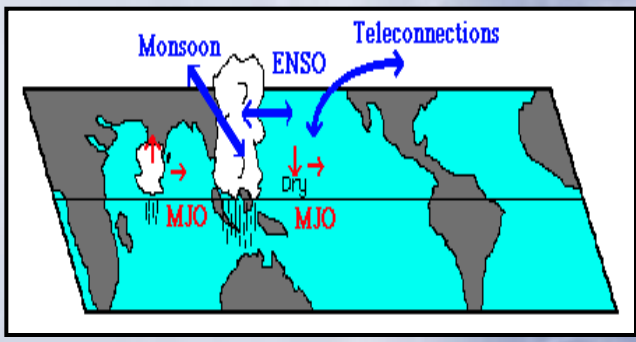
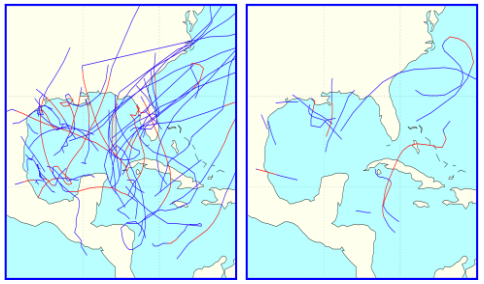
WCRP-WWRP/THORPEX
MJO Task Force

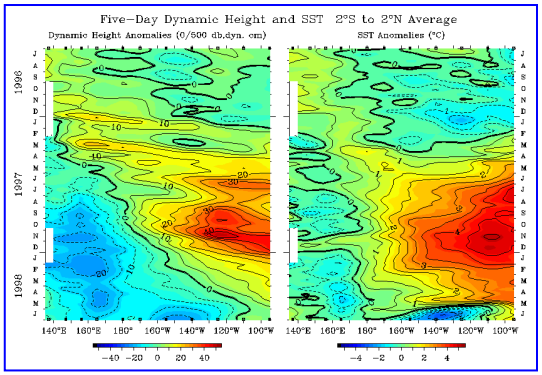
Follow-on from US CLIVAR MJO Working Group

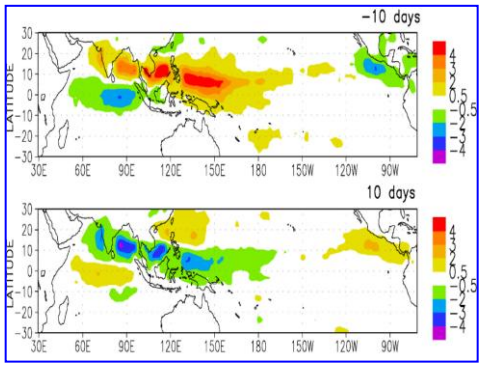


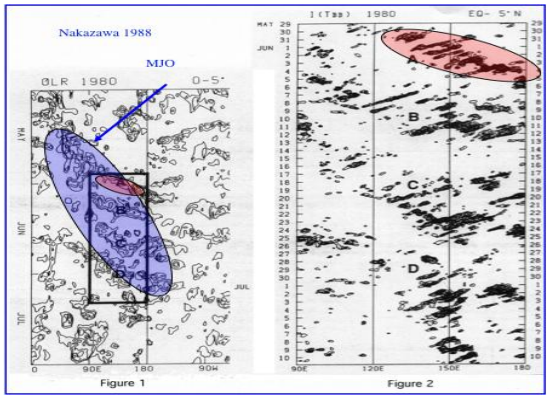


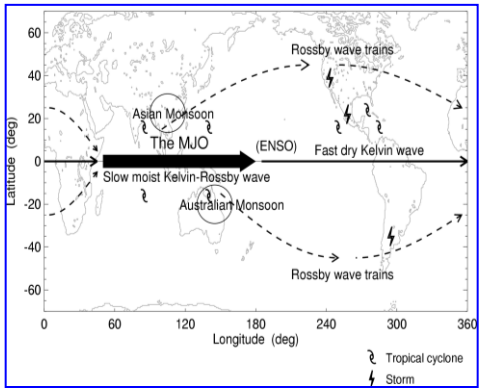
Motivation

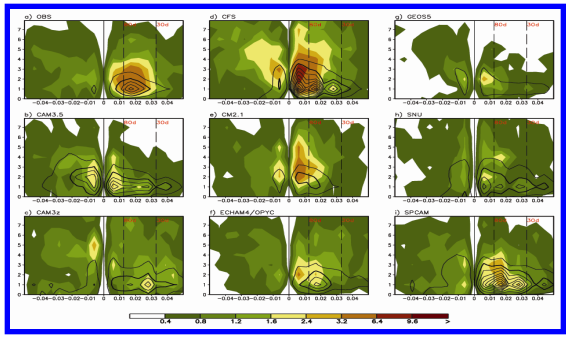












- The MJO is the dominant form of intraseasonal variability in the Tropics.
- The MJO impacts a wide range of weather & climate phenomena.
  - Monsoon Onset & Breaks
  - ENSO+IOD IInteractions
  - Tropical Cyclone Modulation
  - Midlatitude Weather Impacts
  - Organization of Chl, Aerosols, Ozone, etc variability.
- Our weather & climate models have a poor representation of the MJO.
- Great benefit could be derived from better predictions of the MJO - Helps to bridge the gap between weather and seasonal predictions.

Figures: Maloney, PMEL/TAO, Nakazwa, MJO WG, Lin, Waliser

US CLIVAR MJO Working Group

2006-08

Summary of Accomplishments

1) **Develop MJO WG Web Site.** www.usclivar.org/mjo.php

   Diagnostics Link, Meeting & Telecon Updates, Theme Pages

2) **Diagnostics for Asessing Model Simulations.**

On Website. J. Climate Article ~ In Press. Also adopted by NCAR/NCL.

3) **Application of Diagnostics to Models.**

CAM3.5, CAM-3Z, spcam, ECHAM4/OPYC, CFS, SNU, GFDL, GEOS5

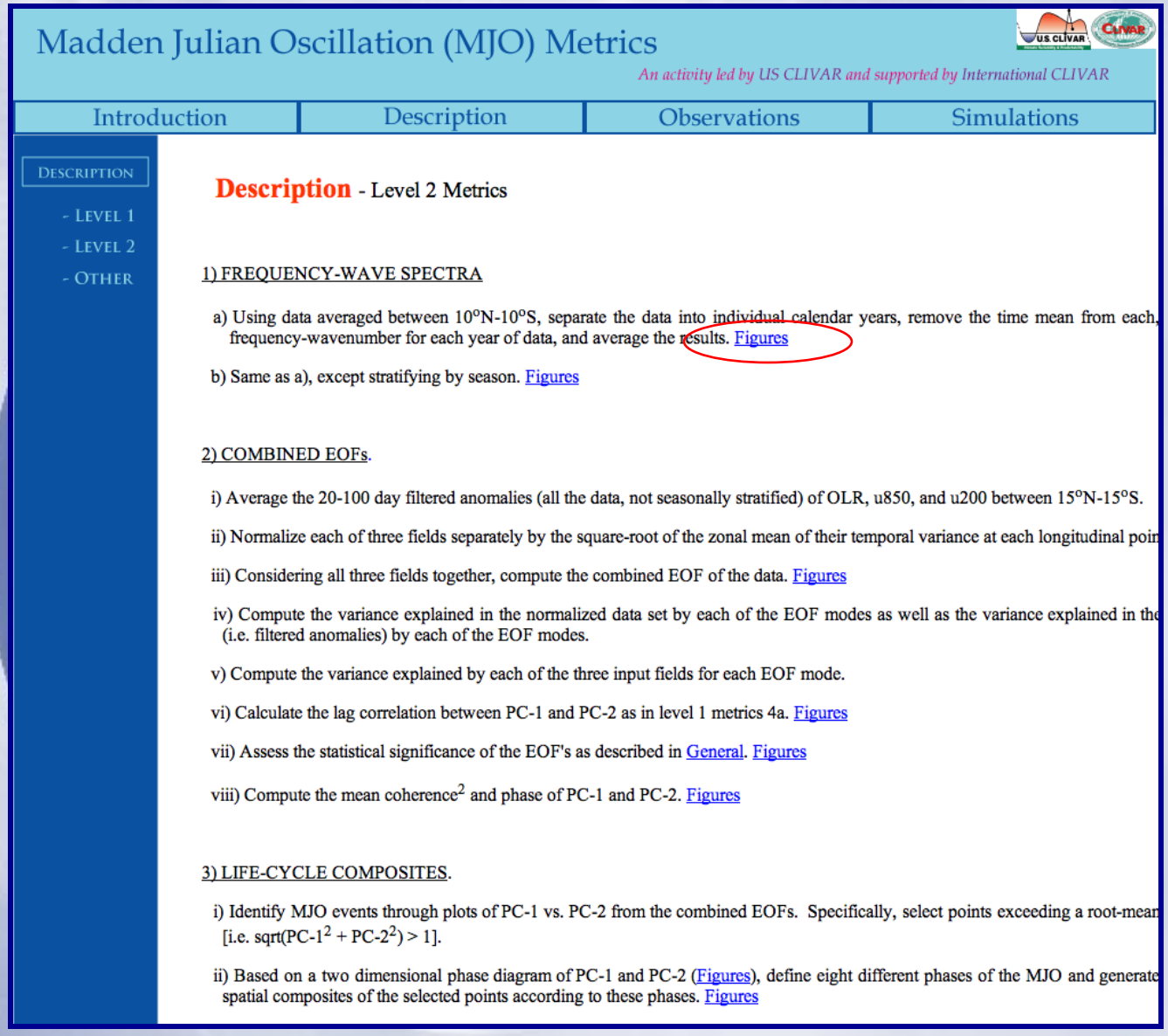
J. Climate Article – In Press.

4) **Operational MJO Forecasts & Metrics.**

   Designed, Implemented at Several Opertional Centers, w/ WGNE Help and NCEP/CPC leading, BAMS Article in Preparation

5) **Workshop/Experimentation Planning**

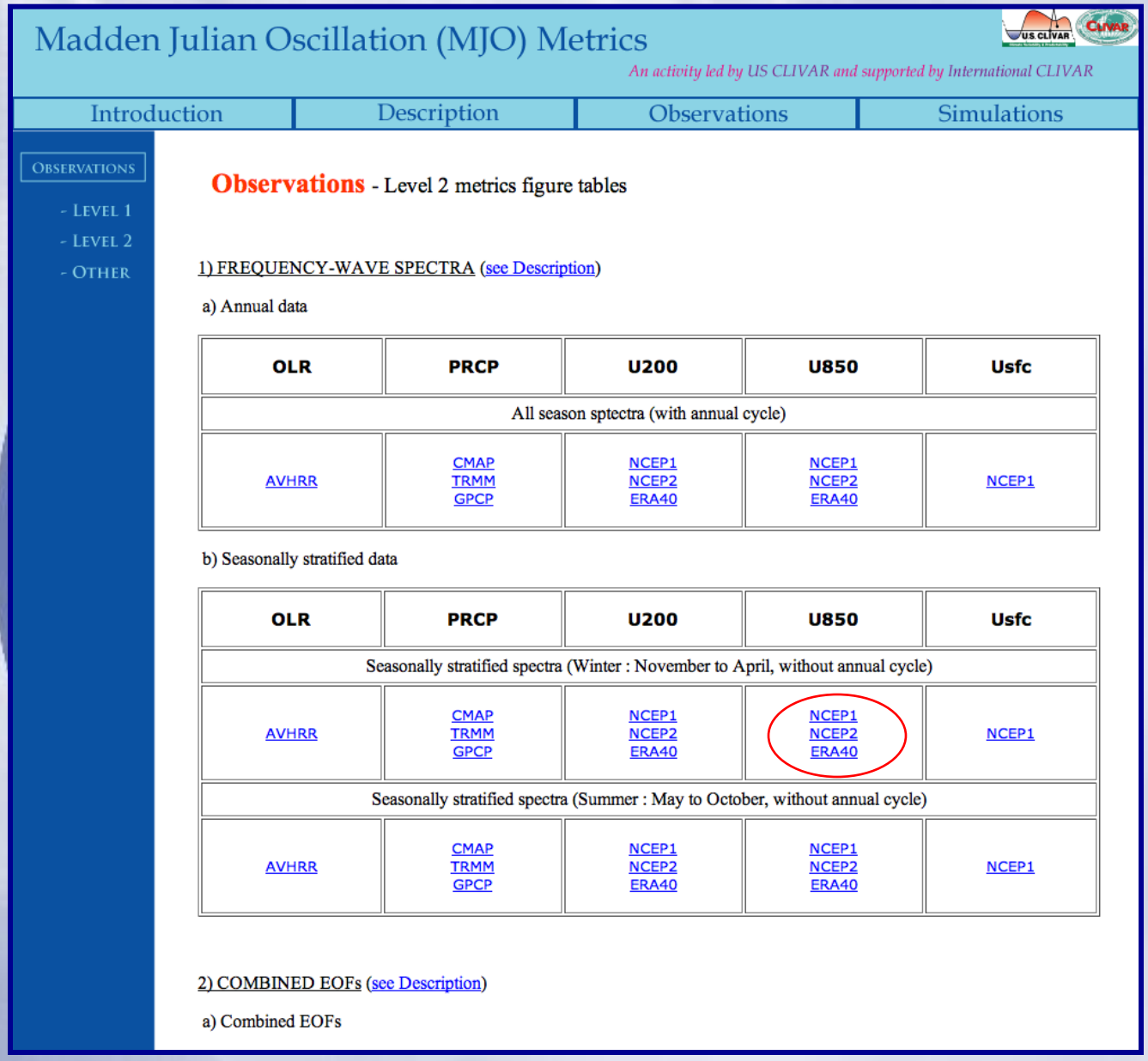
   November 2007, Irvine, CA. BAMS meeting summary published.



MJO Diagnostics

Recipe for Calculating Diagnostics

Calculation Codes Available and now in NCAR NCL latest version



Madden Julian Oscillation (MJO) Metrics

An activity led by US CLIVAR and supported by International CLIVAR

Introduction | Description | Observations | Simulations

OBSERVATIONS
- LEVEL 1
- LEVEL 2
- OTHER

Observations - Level 2 metrics figure tables

1) FREQUENCY-WAVE SPECTRA (see Description)

a) Annual data

OLR	PRCP	U200	U850	Usfc
All season sptectra (with annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1

b) Seasonally stratified data

OLR	PRCP	U200	U850	Usfc
Seasonally stratified spectra (Winter : November to April, without annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1
Seasonally stratified spectra (Summer : May to October, without annual cycle)				
AVHRR	CMAP TRMM GPCP	NCEP1 NCEP2 ERA40	NCEP1 NCEP2 ERA40	NCEP1

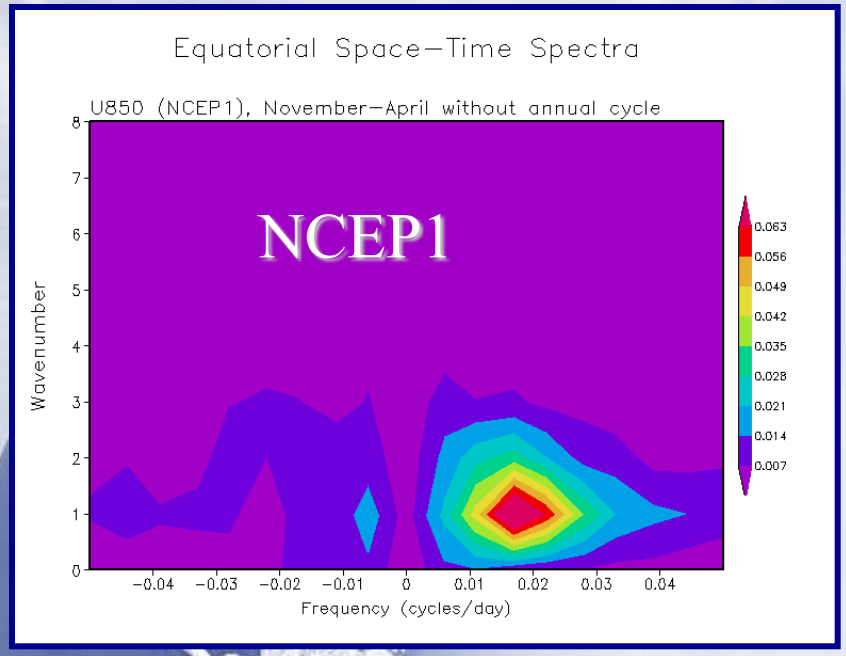
2) COMBINED EOFs (see Description)

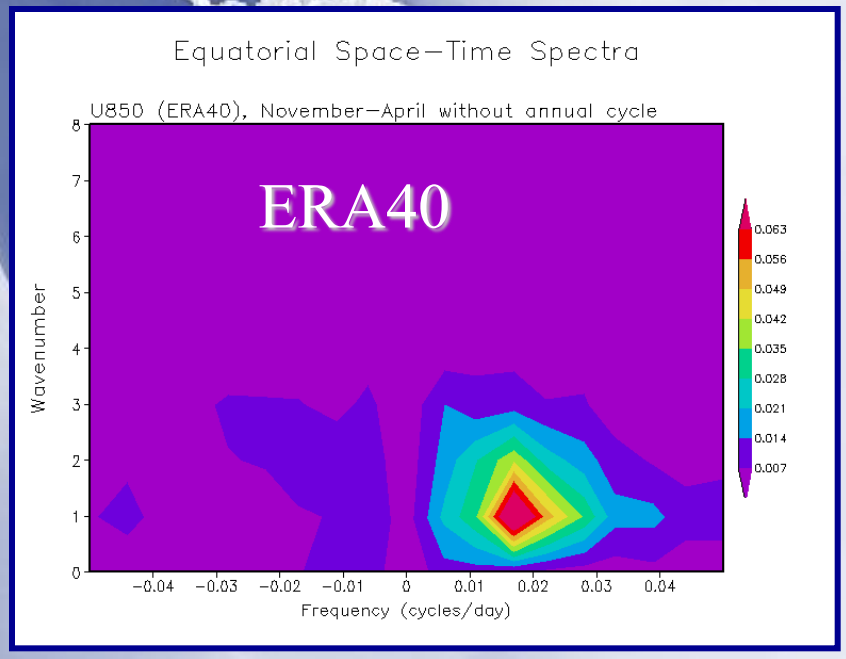
a) Combined EOFs

MJO Diagnostics

Plan To Make The Actual Map/Plot Data Available

Results Are Summarized in a Journal Of Climate Article





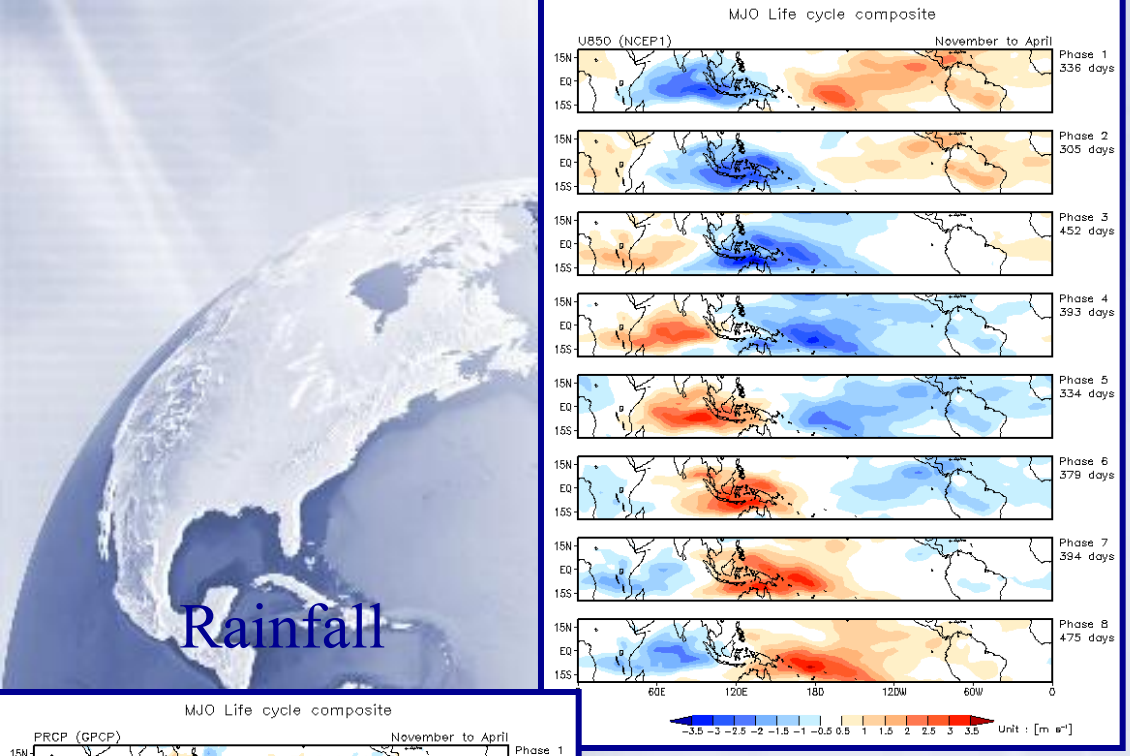
MJO Diagnostics

Equatorial Space-Time Spectra U, Rain, OLR

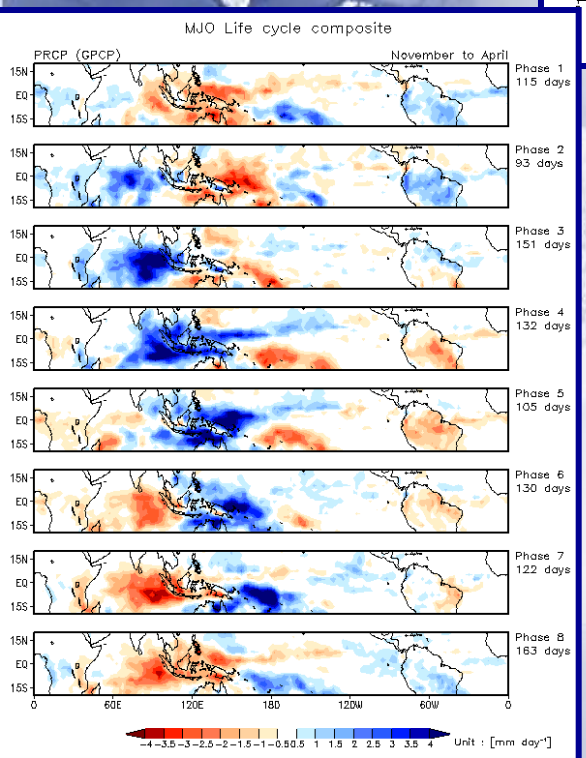
NCEP1, NCEP2, & ERA40

MJO Diagnostics

Life-Cycle Composites U, Rain, OLR, SLP, SF



U850



Rainfall

Satellite Rain/Cloud: AVHRR, GPCP, TRMM
Analysis Data: NCEP1,NCEP2

MJO Simulation Diagnostics: Variance Precip & U850

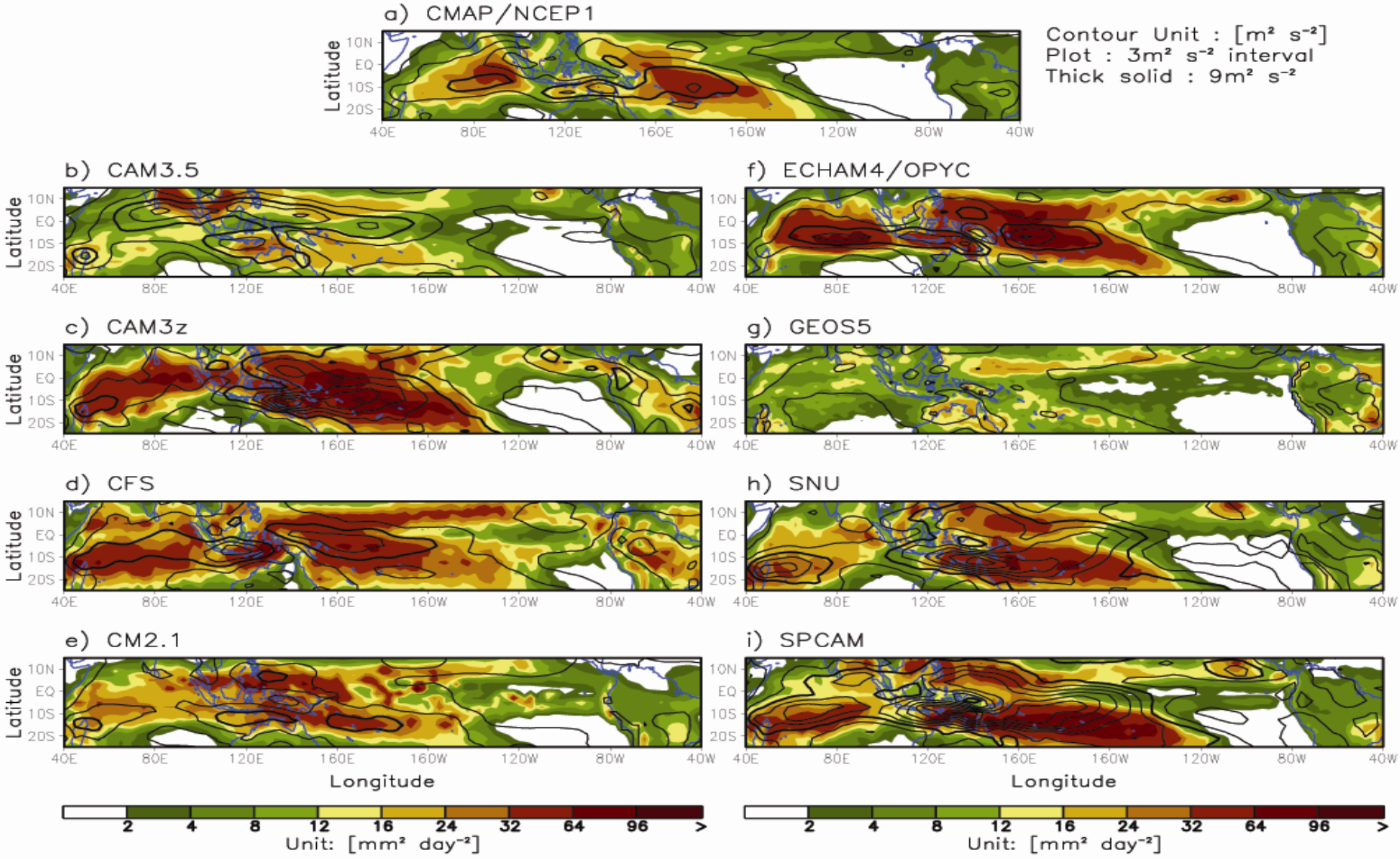


Figure 3 : As in Figure 1, except for variance of 20-100 day band pass filtered precipitation and 850hPa zonal wind. Contours of 850hPa zonal wind variance are plotted every 3 m2 s-2, 9 m2 s-2 line is represented by thick solid line. The unit is mm2 day-2 for precipitation and m2 s-2 for zonal wind.

MJO Simulation Diagnostics: W-F Precip & U850

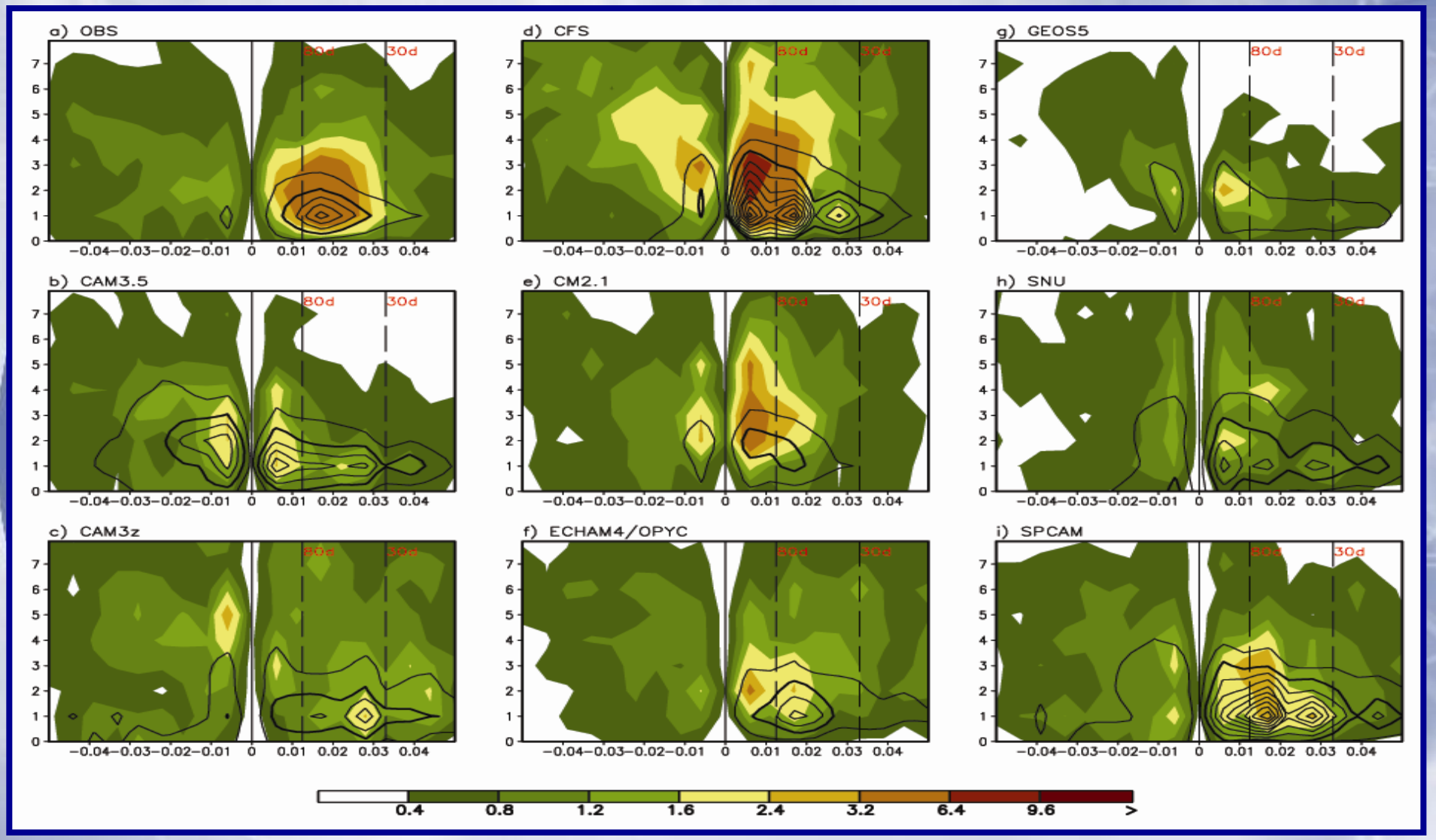


Figure 4 : November-April wavenumber-frequency spectra of 10oN-10oS averaged precipitation (shaded) and 850hPa zonal wind (contoured). a) CMAP/NCEP1, b) CAM3.5, c) CAM3z, d) CFS, e) CM2.1, f) ECHAM4/OPYC, g) GEOS5 h) SNU and i) SPCAM. Individual November-April spectra were calculated for each year, and then averaged over all years of data. Only the climatological seasonal cycle and time mean for each November-April segment were removed before calculation of the spectra. Units for the precipitation (zonal wind) spectrum are mm2 day-2 (m2 s-2) per frequency interval per wavenumber interval. The bandwidth is (180 d)-1.

MJO Simulation Diagnostics: Precip & LH Flux

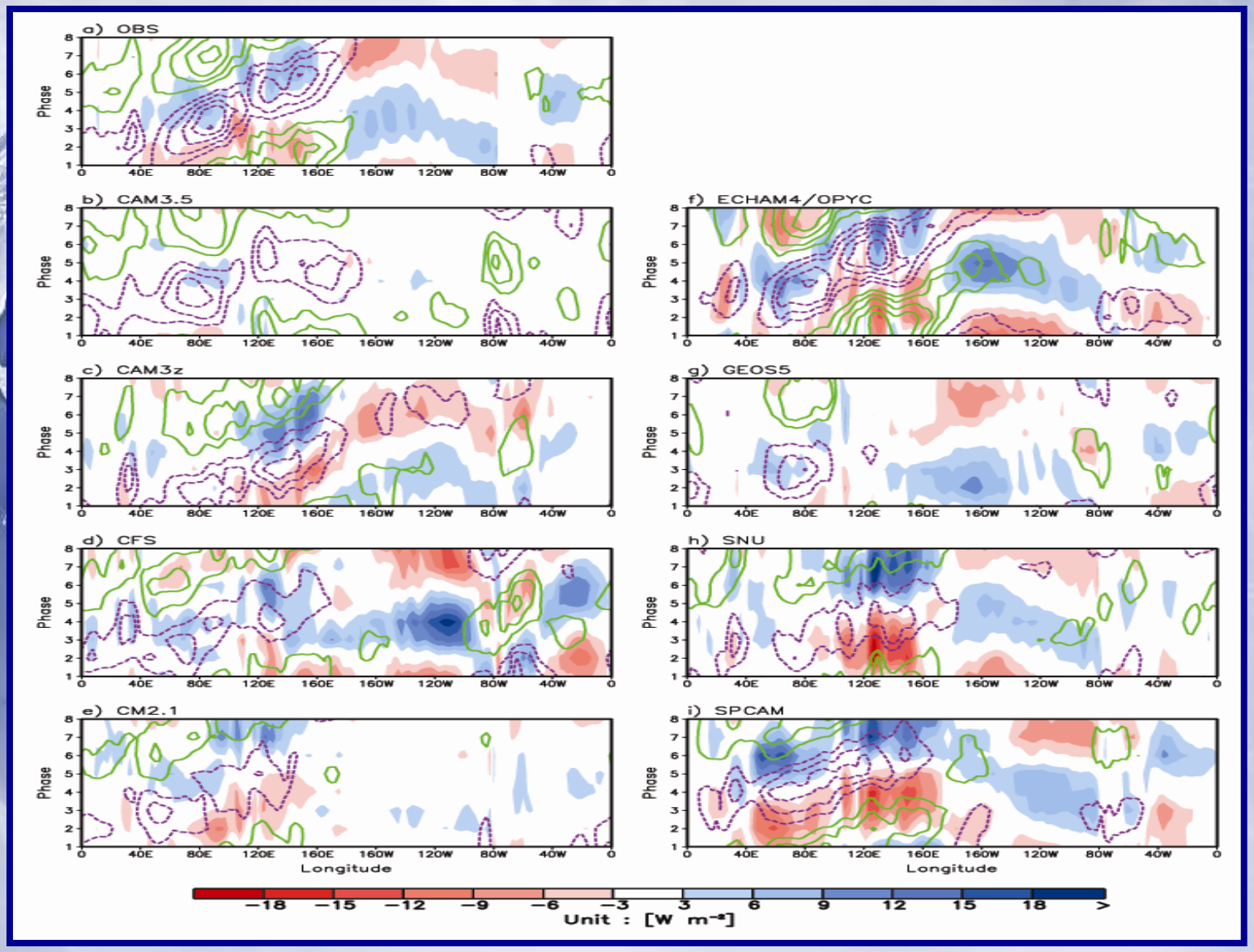


Figure 10: Phase-longitude diagram of OLR (contour, interval-5, green-positive/purple-negative) and evaporation (shaded). Phases are from MJO life-cycle composite and values are 5S-5N averaged. The unit of OLR and evaporation is W m-2.

Metric for Operational MJO Forecasting

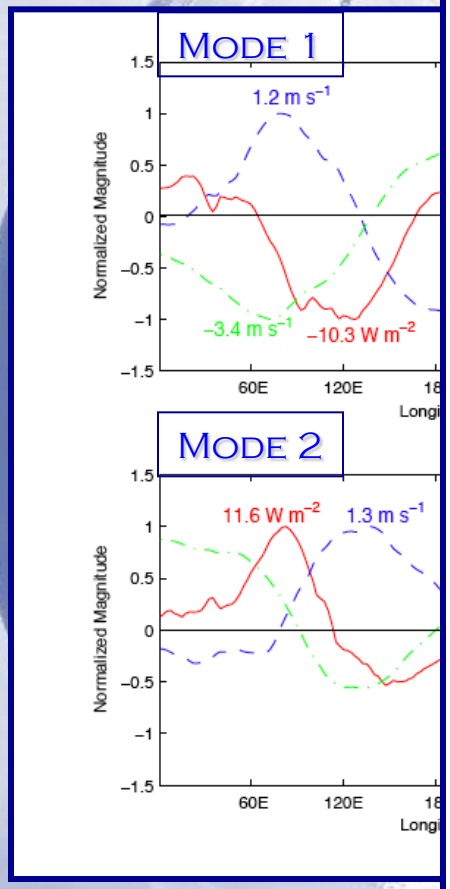
ENSO – "Nino 3.4 Index"
Weather – 500 mb heights
MJO - ?

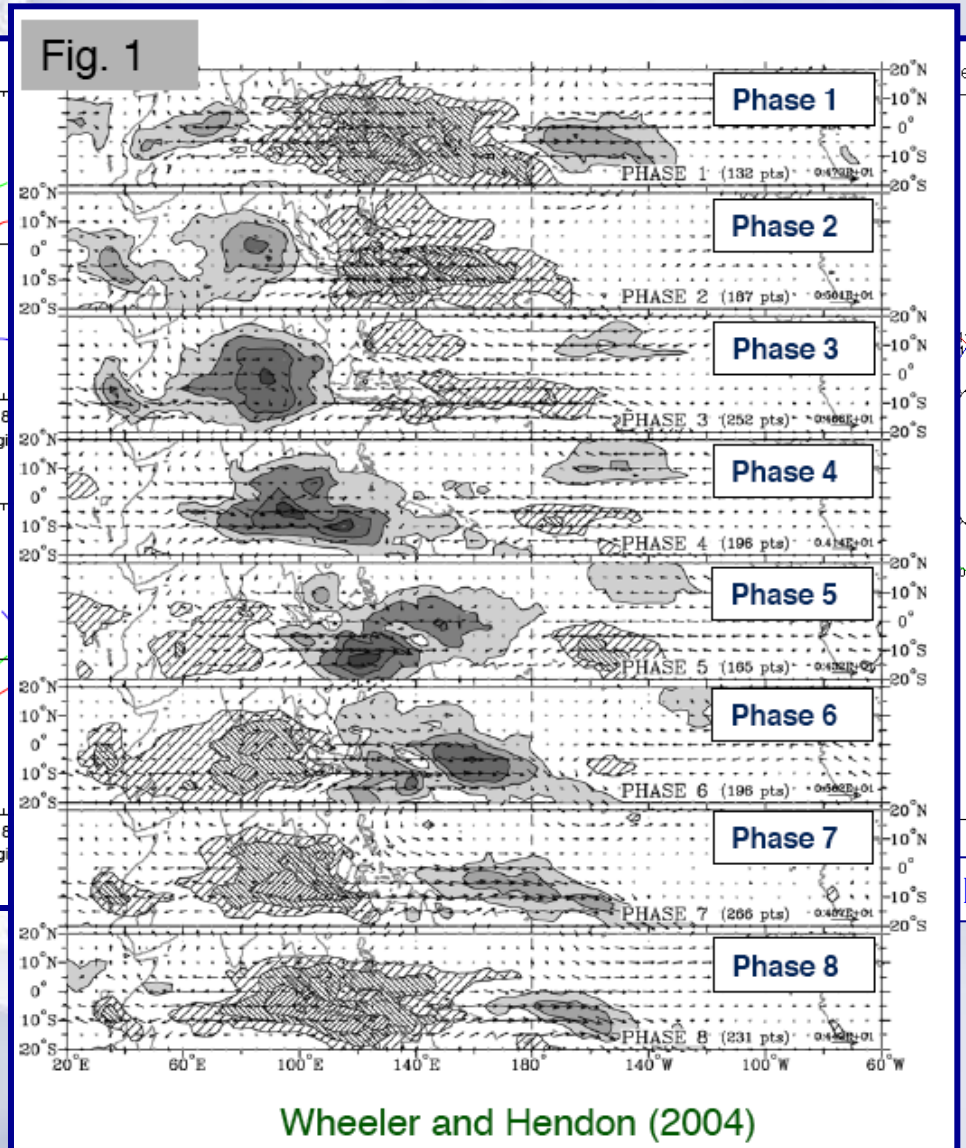
- Use of a common forecast metric allows for:
  - ✓ quantitative forecast skill assessment.
  - ✓ targeted model improvements.
  - ✓ even friendly competition to motivate further improvements.
  - ✓ developing a multi-model ensemble forecast of the MJO.

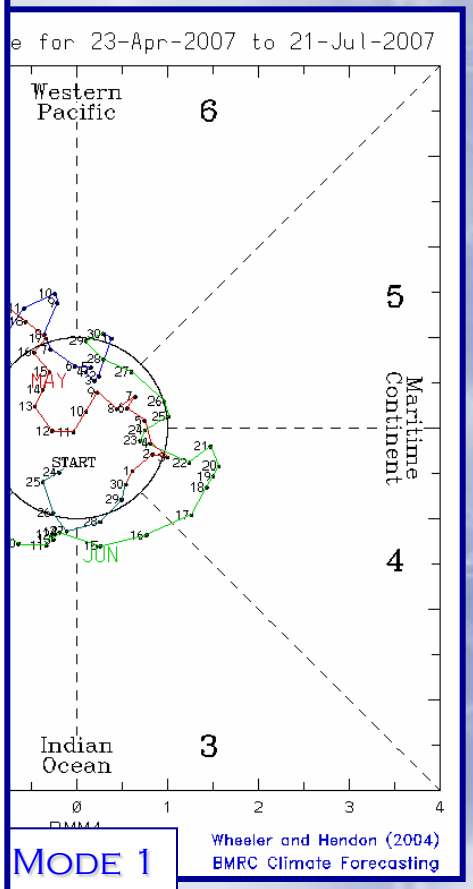
http://www.usclivar.org/mjo.php

Developing an MJO Forecast Metric

US CLIVAR MJO WG – Based on Wheeler & Hendon 2004







Invitation from WGNE & US CLIVAR MJO WG

To: Operational Modelling Centres

From: The CAS/WCRP Working Group on Numerical Experimentation (WGNE)
and
US-CLIVAR Madden-Julian Oscillation Working Group

Date: January 2008

This letter seeks to gain the involvement of Operational Modelling Centres in an activity to monitor and compare numerical model forecasts of the Madden-Julian oscillation (MJO). The activity is a result of discussions and work of the U.S. Climate Variability and Predictability (CLIVAR) programme's MJO Working Group[1]. The group is co-sponsored by international CLIVAR, and the activity has the support of the Working Group on Numerical Experimentation (WGNE). The aim of the activity

Prepare and send – operationally - a select set of forecast fields (U850, U200, OLR) in order to participate and contribute to the possible development in the future of a multi-model ensemble.

CPC/NCEP & J. Gottschalck have agreed to receive the forecast data and compute the metric from each center's data, display it and help develop and carry out validation capabilites.

Contributors, Contents and Status

Courtesy of Jon Gottschalck and CPC/NCEP/NOAA

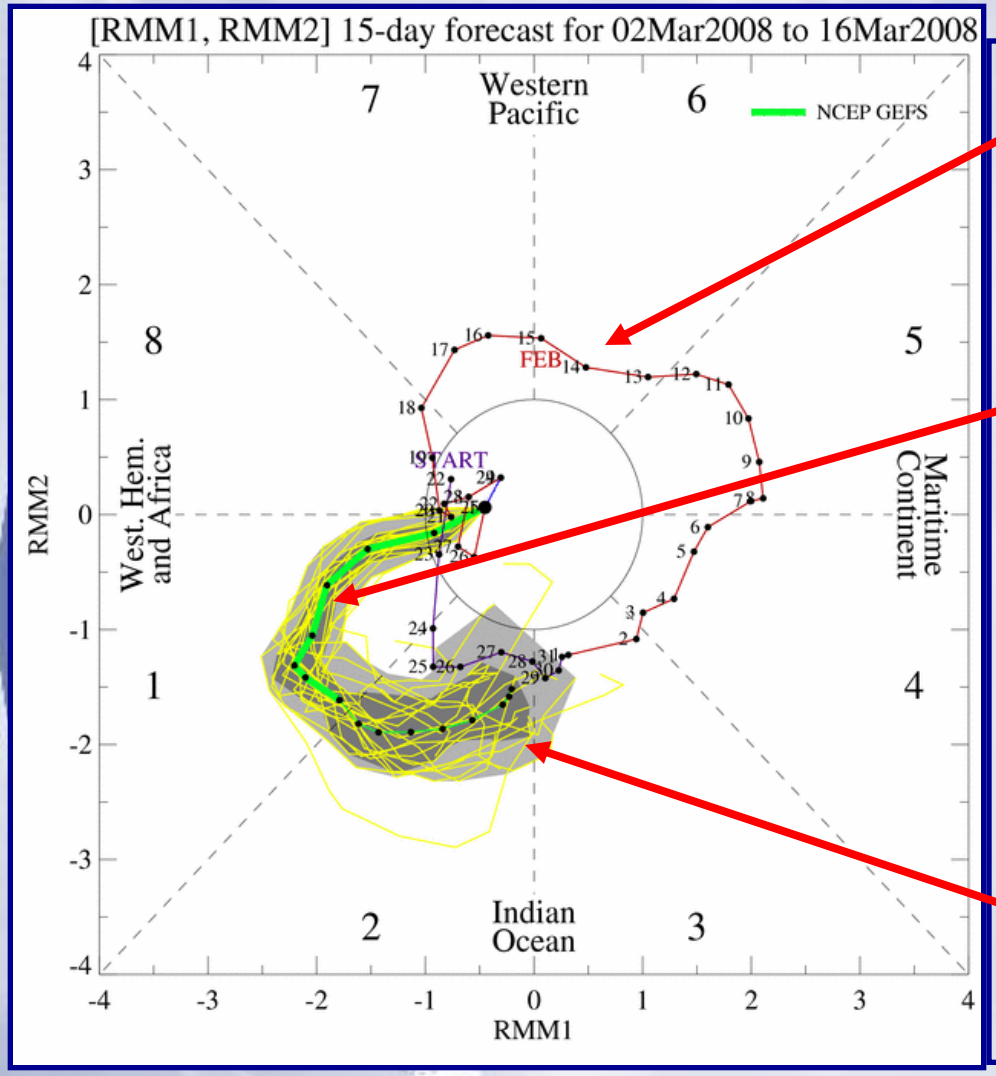
Center	Product ID	Ensemble Members	Forecasts Start	Forecast Length (Days)	Realtime Data FTP	Version 1 Plots	Model Climatology Available
NCEP	NCPE	21	11/1/2007	15	-----	Yes	No
NCEP	NCPA	1	1/1/2008	15	-----	Yes	No
NCEP	NCFS	4	1/1/2005	40	-----	Yes	Yes
CMC	CANM	20	6/8/2008	16	Yes	Yes	No
UKMO	UKMA	1	10/10/2007	15	Yes	Yes	No
UKMO	UKME	23	10/10/2007	15	Yes	Yes	No
ABOM	BOMA	1	1/1/2008	10	Yes	Yes	No
ABOM	BOME	32	------	10	No	No	No
ABOM	BOMC	1	1/1/2008	40	Yes	Yes	No
ECMWF	ECMF	51	6/9/2008	15	Yes	Yes	No
ECMWF	ECMM	51	6/9/2008	15	Yes	Yes	Yes
ECMWF	EMON	51 (W)	6/12/2008	32	Yes	Yes	No
ECMWF	EMOM	51 (W)	6/12/2008	32	Yes	Yes	Yes
JMA	JMAN	51	------	9	No	No	No
CPTEC	CPTC		------		Yes	No	No

See web page for key to Product IDs

W: forecast sent only once per week

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/clivar_wh.shtml

Examples – Display Format



Observational RMM1 / RMM2 values for the past 40 days

15-day model forecasts -
-Green line: Ensemble mean week 1 (thick), week 2 (thin)

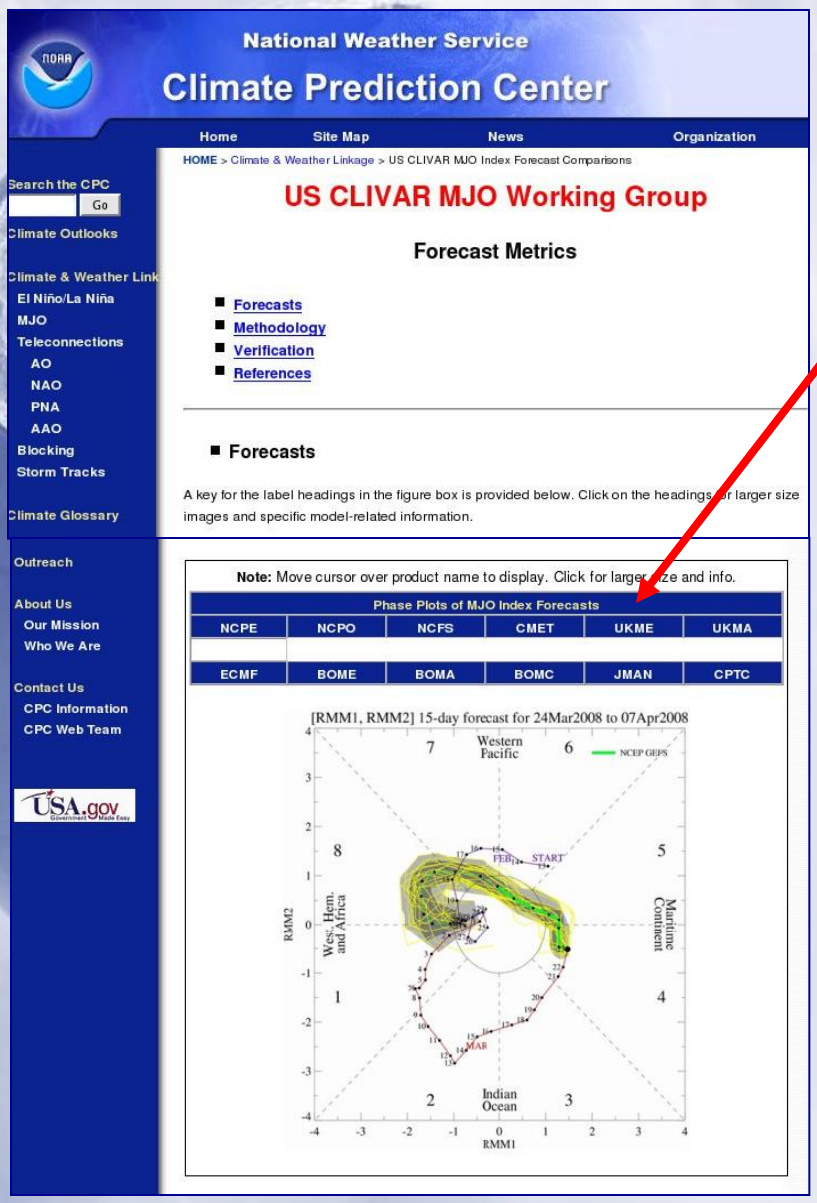
--Ensemble members

light gray shading: 90% of forecasts

dark gray shading: 50% of forecasts

Preliminary Website – Main Page

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/clivar_wh.shtml



- Scroll-over Heading Labels
- Links to Model Specific Information

- A BAMS article, led by J. Gottschalck, is in prepration that will report on this activity to the community.
- B. Wang and others are coordinating an activity/proposals to work towards a multi-model ensemble forecast.

CLIVAR MJO Workshop Recommendations

Objectives of WCRP/WWRP Task Force

- Further development of process-oriented diagnostics/metrics that improve our insight into the physical mechanisms for robust simulation of the MJO and that facilitate improvements in convective and other physical parameterizations relevant to the MJO . (e.g., YOTC, GEWEX/GCSS, WGNE)
- Continue to explore multi-scale interactions within the context of convectively-coupled equatorial waves, both in observations and by exploiting recent advances in high-resolution modeling frameworks, with particular emphasis on vertical structure and diabatic processes. (e.g,. YOTC, CMMAP, CASCADE, AMY)
- Expand efforts to develop and implement MJO forecast metrics under operational conditions, with additional focus on boreal summer and ensemble development. Includes the development of a multi-model hindcast to assess MJO predictability & forecast skill and development of ensemble methods. (e.g., pan-Monsoon, Thorpex, WGNE, WGSIP, TFSIP, APCC, AMY).