

Level 1 Metrics Intercomparison

A key action item from the 31 May 2006 MJOWG teleconference was the establishment of a preliminary intercomparison of a proposed set of level 1 MJO metrics with part of the intent being to address a number of questions that arose regarding variable choices, methodology, etc. Level 1 metrics are meant to provide a basic indication of the spatial and temporal intraseasonal variability that can be easily understood and/or calculated by the non-MJO expert (e.g., graduate student, modeler). Ease of use at this stage dictated that the analytic procedures be identical for summer and winter, with separate calculations performed for each season. Duane agreed to generate the metrics for the two precipitation datasets, Klaus the OLR, and Eric the 850hPa and 200hPa winds.

Entered in red are clarifications/issues that came to light in the 27 June 2006 telecon during which the first round of level 1 metrics were discussed.

Period of Analysis:

January 1979-December 2005 (except TRMM: January 1998-December 2005)

Season Definition:

Boreal summer: May-October

Boreal winter: November-April

Domain of interest:

30°N-30°S, all longitudes

It was necessary to truncate the 850hPa winds between 20°N-20°S due to extratropical influences that precluded the identification of the MJO.

Daily Datasets:

AVHRR OLR from Liebmann and Smith

NCEP/NCAR Reanalysis-1 and Reanalysis-2 for 850hPa and 200hPa winds

TRMM (OLR-calibrated) Rainfall

Pentad Data:

CMAP rainfall

20-100 day filter applied as necessary

The metrics to be calculated are:

1) VARIANCE MAPS

- (a) Unfiltered variance (climatological annual cycle removed)
- (b) Detrended variance (climatological annual cycle removed, and linear trend of each seasonal segment removed)
- (c) 20-100 day filtered variance maps
- (d) 20-100 day filtered variance maps expressed as percent of unfiltered variance
- (e) 20-100 day filtered variance maps expressed as percent of the detrended variance

We will determine if removing the linear trends (i.e. b) is an essential procedure for this metric.

2) SPECTRA

- (a) Use the results from (1) to isolate variance maxima, then calculate time series in a 15° latitude x 25° longitude box (depending on the variable and season the size of the box could vary slightly – in 5° increments) centered around each of the variance maxima. These regions/boxes would be determined from the observations even when applied to models but the regions would be made relatively large to be a little forgiving to the models. For boreal summer rainfall, Ken suggests the addition of a box covering India and the Bay of Bengal (directly north of the near-equatorial box over the Indian Ocean). NOTE: We are defining the locations of these boxes based on this exercise.
- (b) Use one year of data centered about the midpoint of the season of interest calculate spectra using tapering (e.g., cosine or trapezoid), then calculate the mean of the spectra for each season over all years
- (c) Linearly detrend one year of data centered about the midpoint of the season of interest and calculate spectra using tapering, then calculate the mean of the spectra for each season over all years
- (d) Separately for each year, perform spectral analysis (without tapering) on the 6-month time series, and then calculate the mean of the spectra for each season over all years
- (e) Separately for each year, perform spectral analysis on the 6-month time series after linear detrending, and then calculate the mean of the spectra for each season over all years

In all cases include null, 5% and 10% red noise significance level.

Our goal here is simplicity. If calculating the spectra on the 6-month time series provides an adequate representation of the dominant time scale, then we might opt not to use the more involved procedures that use tapering and detrending of the longer record.

3) EOF's

- (a) EOF analysis of 20-100 day filtered OLR
- (b) EOF analysis of 20-100 day filtered CMAP rainfall
- (c) EOF analysis of 20-100 day filtered TRMM rainfall
- (d) EOF analysis of 20-100 day filtered 850hPa zonal wind
- (e) EOF analysis of 20-100 day filtered 200hPa zonal wind

-standard information to be included is percent of variability explained by each mode

The EOF patterns will be scaled by one standard deviation of the respective PC to give units consistent with the input data.

As needed, the EOF's/PC's that we present (on the web and/or in a publication) will be multiplied by -1 if necessary so that the results depict a consistent picture of eastward propagation of enhanced convection and rainfall anomalies. The winds will also be sign adjusted so that the patterns are consistent with the convection/rainfall, including their baroclinic structure. We are not requiring that users who employ these metrics do the same, but we will include a cautionary note regarding the arbitrary signs that can arise in EOF analysis.

4) LAG CORRELATION

a) Calculate the lag correlation between PC-1 and PC2 for each season separately for +/- 30 days; then average the correlations at each time lag and plot correlation vs. time lag.

By adjusting the sign of the EOF's/PC's we should get a consistent S-shape among in the lag correlation plots.

b) Given the shortcomings of EOF analysis that we discussed, namely the possibility that EOF analysis may not extract orthogonal propagating pairs from some models, an afterthought from the telecon that was discussed briefly via email among Ken, Eric, Klaus and Duane in trying to organize the follow-up calculations was the consideration to generate lag regressions between the bandpassed time series from the Indian Ocean and west Pacific boxes that were identified from the variance maps. In observations we expect to recover similar S-shaped curves as from the PC's above, but with reduced amplitude because of the inclusion of standing intraseasonal components. Caveat on this by Ken: We can be fooled by a dipole pair that has convection fading in the Indian Ocean while convection develops in the west Pacific without the propagation actually occurring. I've seen cases of the above in models where there are no intraseasonal convective anomalies that develop over the Maritime Continent, but the standing pair might give the illusion that propagation is present. Duane agreed to compute these to have for illustration and discussion purposes next time and pass them by Eric and Klaus to see if they might also be able to do so.

5) DISCUSSION ITEMS AND CAVEATS FOR THE ABOVE ITEMS

a) In observations the boreal winter extratropical jets precluded the identification of MJO EOF's using the 850hPa winds. It was necessary to truncate the latitude domain between 20°N-20°S.

b) Models have been known to overestimate the intraseasonal variability in the eastern tropical Pacific, which may preclude the extraction of a coherent MJO signal over the eastern hemisphere. Truncation to a regional domain may be necessary (e.g., 0°-120°W).

c) The sign of the individual EOF's/PC's are arbitrary and as such it may be necessary for the user to change the sign of both the EOF and PC of a given mode to determine if there is a pattern match and simulated lag correlations that are consistent with the observed metrics presented.

d) Utilize North criterion to first isolate significant EOF's? Do well separated EOF's need to be established prior to considering lag correlations of PC's? If a propagating EOF pair cannot be isolated then 4b is suggested in lieu of 4a.

e) For models it may be necessary to consider a larger number of EOF's to find matching pairs that correspond to observations. We still need to suggest metrics that quantify the level of agreement between a model and observations. Pattern correlations?

6) FUTURE ITEMS FOR CONSIDERATION

- Chidong brought up the idea of supplying level 1 metrics for a good and a bad model (as Ken had done in a previous telecon). We may consider doing this to illustrate

possible expectations/problems in model analysis (longitude selection may come into play for extracting model MJO [see 5b above]).

- Ken suggested that the PC's from the winds be correlated with the PC's from the convection, and/or pentad averages of the OLR PC's could be correlated with the CMAP PC's (need to get consistent EOF's/PC's signs [see item 3 above]). For the OLR and rainfall this would give an indication of their consistency, which may be less robust in a model.
- Chidong and others suggested including 2-D power spectra as an additional diagnostic which all agreed was good to have with the only question being whether it should be in Level 1 or Level 2.