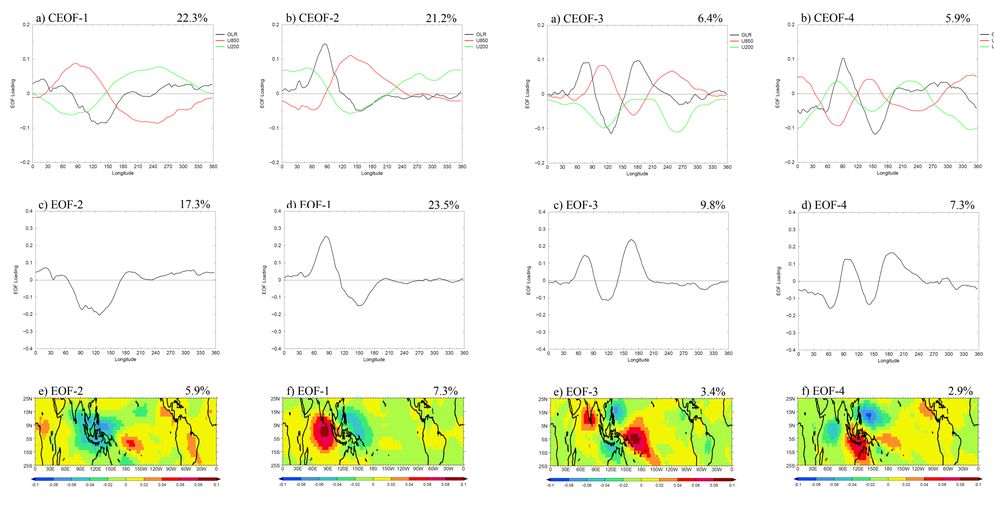
A New Method for Identification of Madden-Julian Events

Kenneth R. Sperber, Lawrence Livermore National Laboratory, USA (E-mail: sperber1@llnl.gov)

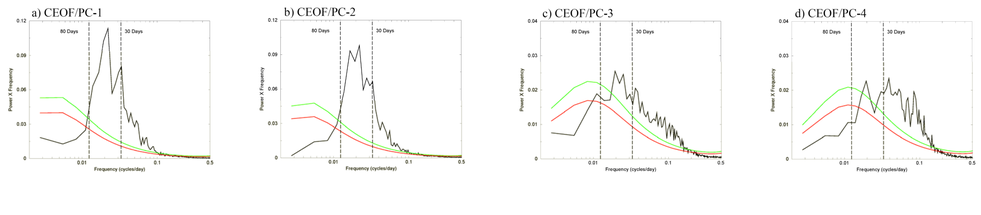
Goal

- Objective identification of individual Madden-Julian events is investigated using four different EOF approaches using 20-100 day bandpass filtered data for 1979-2007
  - Combined EOF analysis of 15°N-15°S averaged AVHRR OLR, u_{850}, and u_{200}
  - AVHRR OLR-only (reconstruct PC's only using the OLR EOF components of the CEOF analysis)
  - EOF2D: 15°N-15°S averaged AVHRR OLR
  - EOF3D: 25°N-25°S maps of AVHRR OLR



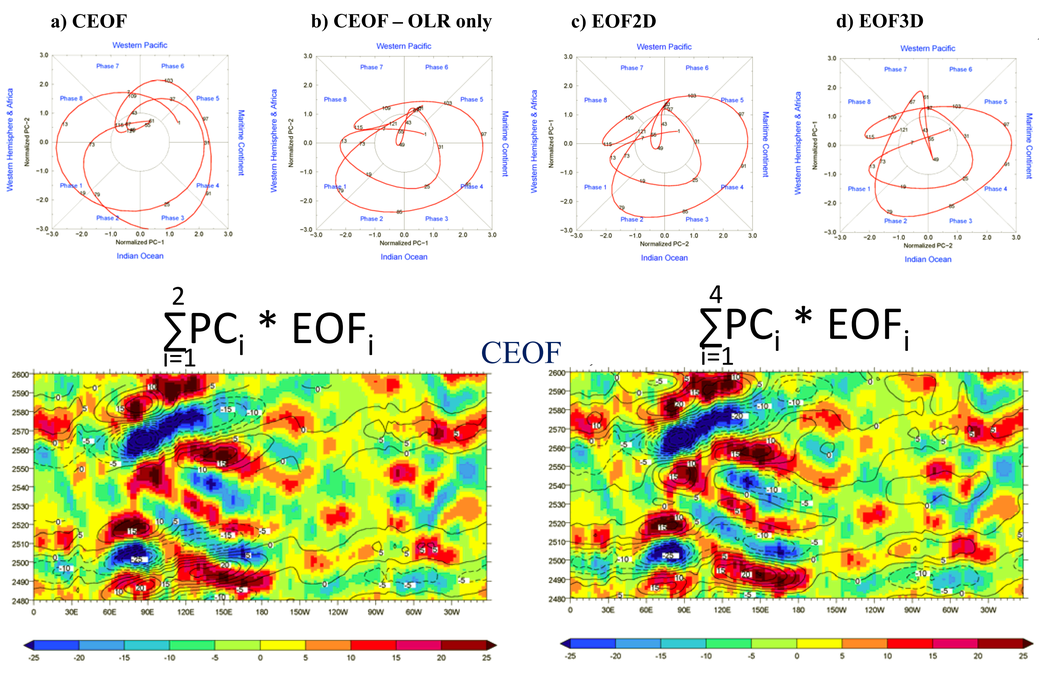
Temporal Characteristics of the PC's

- Respectively, PC's 1 and 2 are strongly correlated among the different EOF approaches
- For PC's 3 and 4 the respective correlations among the different EOF approaches are weaker than for PC's 1 and 2, though they are statistically significant at >1% level
- Like PC's 1 and 2, PC's 3 and 4 also have statistically significant power at intraseasonal time scales (spectral analysis performed in PC time series obtained using daily anomalies of AVHRR OLR; also shown are the null and 5% significant red noise levels)



MJO Propagation (Oct. 5, 1985 – Feb. 12, 1986)

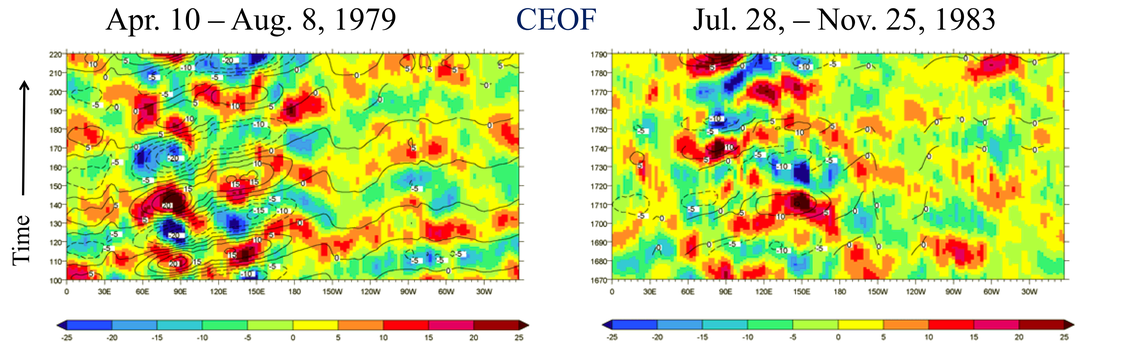
- Phase-space plots of PC-1 vs. PC2 (see a-d below) have been taken to represent the eastward propagation of the MJO when:
  - $(PC\text{-}1^2 + PC2^2)^{0.5} \geq 1.0$ (Wheeler and Hendon, 2004, *MWR*, 132, 1917-1932)
  - $(PC\text{-}1^2 + PC2^2)^{0.5} \geq 0.4$ (Matthews, 2008, *QJRMS*, 134, 439-453)
- In the time-longitude plots, shaded data is 20-100 day bandpass filtered AVHRR OLR
- In the time-longitude plots, isolines are the OLR anomalies from the EOF reconstructions
  - The two-mode reconstruction indicates the presence of the MJO when the observed data indicates that westward propagation dominates (plotted when $[PC\text{-}1^2 + PC2^2]^{0.5} \geq 1.0$ in the lower-left figure)
  - Including modes 3 and 4 in the reconstruction gives a more realistic representation of the observed anomalies (lower-right figure)



This work was performed under the auspices of the U.S. Department of Energy, Office of Science, Regional and Global Climate Modelling Program at Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. (LLNL-POST-426117)

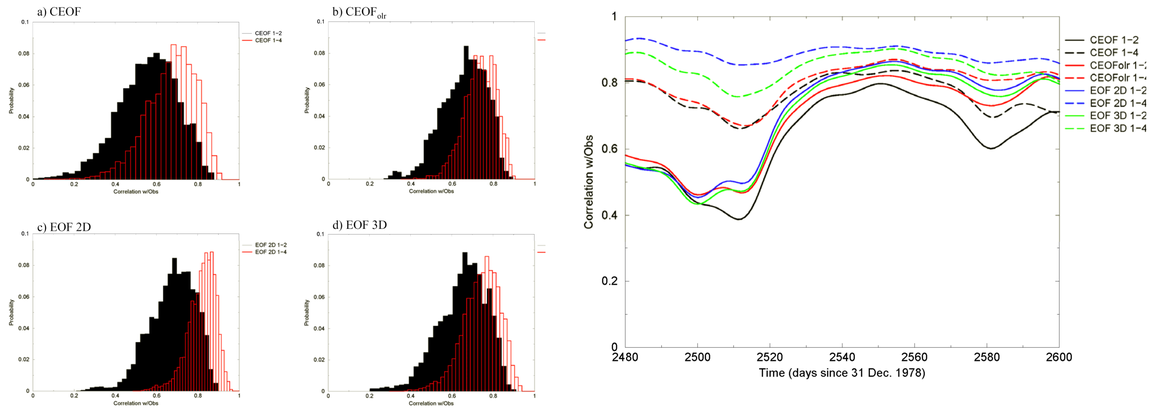
There are many other cases in which reconstruction using only EOF's 1 and 2 gives a false indication that an MJO is present, or the threshold criterion incorrectly yields sporadic indication of MJO

- These cases compromise our ability to composite pure MJO events for improving our understanding of MJO processes
- In forecasting, this would give rise to an increased number of false-positive indications of developing MJO's



The Benefit of Using Modes 1-4

- Premise: Validate time-longitude reconstructions against the 20-100 day filtered observations. If the reconstruction using modes 1-4 has similar skill as the reconstruction using modes 1 and 2, then it is likely that an actual MJO is occurring (i.e., modes 3-4 do not contribute to the variability)
  - The skill metric is the pattern correlation, which is calculated in a 40-day moving window relative to observations for each of the reconstructions
  - For each EOF technique, compared to observations, the mode 1-4 reconstruction has a statistically significant larger pattern correlation than does the mode 1-2 reconstruction (left figures). EOF2D modes 1-4 has significantly better skill than all other approaches.
  - For the Oct. 5, 1985 – Feb. 12, 1986 case, during the early portion of the time period the mode 1-4 reconstruction has much larger skill than the mode 1-2 reconstruction, indicating that the MJO is not the dominant mode of variability during this period (right figure)



New Method for Identifying MJO events

- Recipe: On a given day an MJO is present if
  - $(PC\text{-}1^2 + PC2^2)^{0.5} \geq 1.0$, and
  - The pattern correlation of the 40-day time-longitude mode 1-4 reconstruction vs. observations is ≥ mean mode 1-4 pattern correlation + 0.5σ (0.4σ if an event is already underway), and
  - The pattern correlation of the 40-day time-longitude mode 1-4 reconstruction vs. observations minus the pattern correlation of the 40-day time-longitude mode 1-2 reconstruction is < 1.1σ
  - If these 3 criteria are satisfied an MJO is taken to be present on the given day and 39 days thereafter (due to the width of the time window over which the pattern correlations are calculated), otherwise no MJO is present and the recipe is applied to the next day, …