The MJO-Kelvin wave transition

Adam Sobel[1,2] and Daehyun Kim[2], Columbia University

Introduction

As the Madden-Julian oscillation (MJO) moves eastward from the Indian to the Pacific ocean, it typically accelerates, becomes less strongly coupled to convection, and becomes more similar to a dry Kelvin wave. This transition is analyzed using observations of outgoing longwave radiation and ERA Interim reanalyses of surface pressure and 850 hPa zonal wind.

1 Dept. of Applied Physics and Applied Mathematics and Dept. of Earth and Environmental Sciences, Columbia University, New York, NY USA
2 Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY USA

Data

- Daily-averaged outgoing longwave radiation (OLR) from the Advanced Very High Resolution Radiometer.
- daily 850-hPa zonal wind and surface pressure (ps) from the ECMWF ReAnalysis-Interim [ERA-Interim].
- Data during the period of 1979-2009 are used.
- Climatological seasonal cycle was removed from all fields to obtain daily anomalies.
- Resulting anomalies were then filtered to retain only components that have 20-100 day periods and eastward propagating zonal wavenumbers 1-9.

Transition event definition criteria

1. The minimum value of the filtered OLR anomaly is less than -20 Wm−2 from Day -2 to Day 0.
2. The distance between the longitudes of minimum OLR and ps is less than 12.5 degrees during the period from Day -1 to Day 0.
3. The longitudinal distance between the ps minima on Day 0 and Day +1 is greater than that between the OLR minima during the same period plus 10 degrees.
4. The minimum ps is located more than 40 degrees east of the minimum OLR on Day +5.
5. Reverse all signs above to obtain criteria for MJO suppressed phases (OLR maxima rather than minima, etc.).

There are 56 transition events for OLR minima out of 140 MJO events altogether in the record, or 40%. For OLR maxima, there are 51 events out of 115, or 44%.

Fig. 1 Longitude-time Hovmoeller plot for an MJO event centered on June 3 1982. a) surface pressure, zonal wind at 850 hPa, and OLR. B) lines track the local minima in OLR (red) surface pressure (black) and maxima in zonal wind (blue) in the fields shown in a).

Fig. 2 As in Fig. 1, but for an event centered on November 28, 2009.

Fig. 3 As in Figs. 1a and 2a, but for a) composite events centered on anomalously low OLR (active MJO phases), and b) centered on anomalously high OLR (suppressed MJO phases). Longitude is not absolute as in Figs. 1 and 2, but relative to the ps minimum (a) or maximum (b) on day 0.

Fig. 1

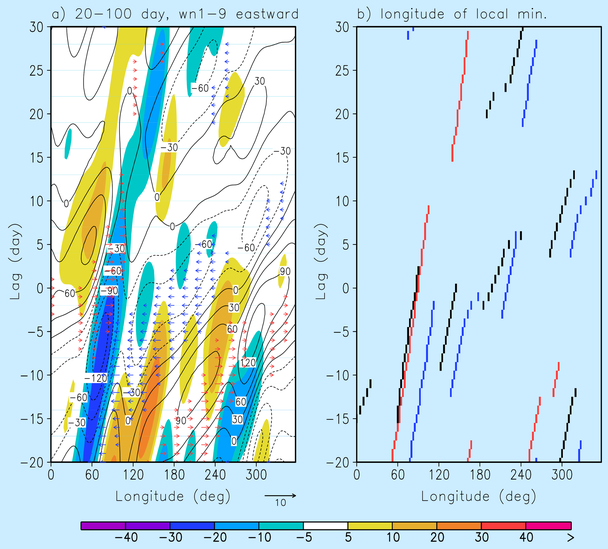


Fig. 2

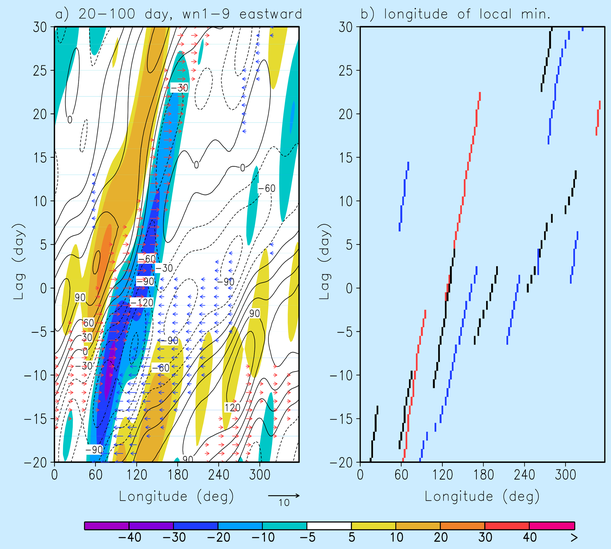


Fig. 3

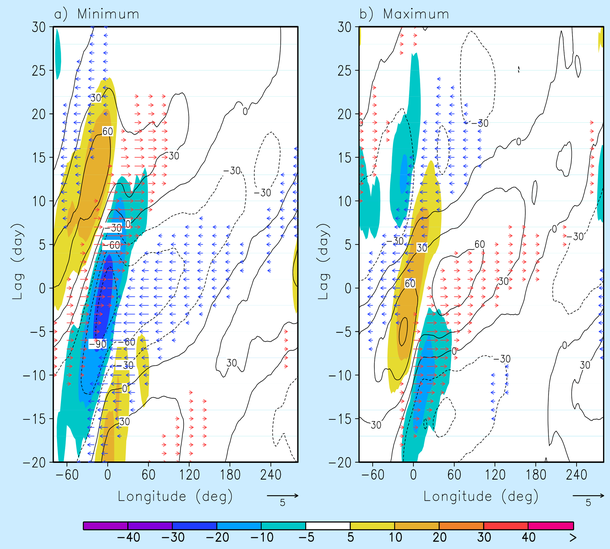


Fig. 4 Histograms showing the longitude (a) and calendar month (b) at which the MJO- Kelvin wave transition occurs, according to criteria given in the text. Blue and red bars show results for OLR minima and maxima respectively.

Fig. 5 Hovmoeller plots for the DYNAMO period in the format of Figs. 1a and 2a. The first MJO event, starting late October, does not pass our OLR amplitude threshold. The pressure-wind Relationships for both events in the Pacific are more MJO-like than Kelvin-like.

Fig. 4

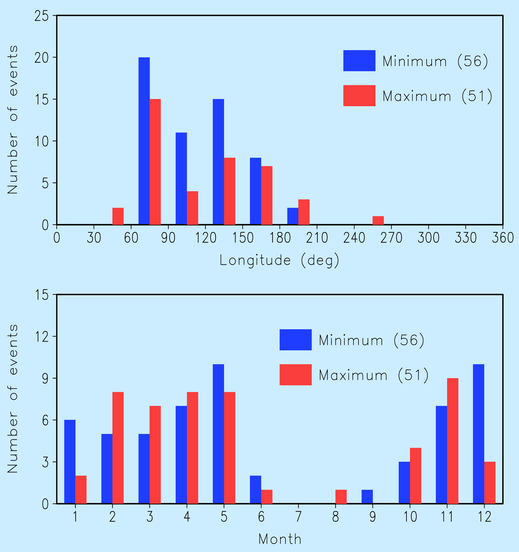
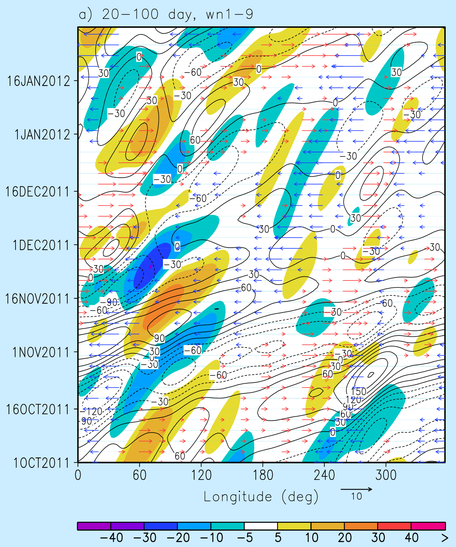


Fig. 5



Conclusions

1. The transitions are fairly sharply defined, with distinct disturbances on either side of the transition whose identities as MJO or Kelvin waves are clear.
2. The transitions occur at different longitudes in different events, over a wide range from the eastern Indian to the central Pacific oceans.
3. Our analysis does not refute the conclusion of Roundy (2012) that a continuous spectrum of hybrid MJO-Kelvin disturbances exists. It does lead us to speculate, however, that some hybrid disturbances could be transitory disturbances undergoing a transition from essentially a pure MJO to a pure Kelvin wave, and taking on intermediate properties only during the transition.

Roundy, P. E., 2012: *J. Atmos. Sci.*, **69**, 2097–2106.
Sobel, A. H., and D. Kim, 2012: *Geophys. Res. Lett.* **39**, L20808, doi:10.1029/2012GL053380