



Tropical-Extratropical interactions: the Madden Julian Oscillation and wave breaking

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The Madden Julian Oscillation (MJO), a large-scale coupled pattern between tropical deep convection and atmospheric circulation, is known to be the dominant source of intraseasonal variability in the tropics. Its impacts, however, are not limited to tropical regions: latent heat release associated with MJO convection can force planetary scale Rossby wave trains that propagate over the globe along the dynamical tropopause.

On the synoptic scale, propagating Rossby wave trains can culminate in Rossby wave breaking, a process that generates so-called potential vorticity (PV) streamers. PV streamers have been linked to positive upper-level PV anomalies that can influence surface weather, extreme precipitation events and the enhanced exchange between the stratosphere and troposphere. The primary goal of the present study is to investigate the possible relationship between the MJO and PV streamers.

Ten MJO indices (representing MJO activity at ten specific tropical longitudes) have been obtained from the Climate Prediction Center for the boreal winter between 1978 and 2001. The data are subsequently separated into terciles (allowing for the designation of convectively active and suppressed periods of the MJO) and compared with a unique PV streamer dataset that has been previously computed from ECMWF Reanalysis data (ERA-40). The streamer dataset allows for the dynamically useful separation of streamers into cyclonically and anticyclonically breaking waves, referred to as LC2 and LC1 streamers, respectively.

Statistically significant differences are found regarding the amount, location and type of PV streamers during different phases of the MJO. When the MJO is convectively

active over the Indian Ocean and Indonesia, the north central Pacific is dominated by a positive 500 hPa height anomaly, a co-located reduction in LC2 streamers and increased LC1 streamers to the south and southeast. As the convection enters the western Pacific warm pool and approaches the international dateline, a distinct regime shift occurs: over an approximately 10-15 day period, a negative 500 hPa height anomaly forms, supplanting the previous positive anomaly. Subsequent to this time, the negative height anomaly strengthens and there is a significant increase (decrease) in LC1 (LC2) streamers.

To illustrate the connection between the MJO, Rossby wave breaking and surface weather in the extratropics, a comparison between PV streamers and surface cyclone frequency (also computed from ERA-40 data; see Wernli et al. 2006) is made. A fairly good agreement between LC2 streamer and surface cyclone frequency anomalies throughout the life cycle of the MJO is found in the north Pacific basin, further highlighting the ability of organized tropical convection to modulate extratropical weather.