Insights from analysis of associations between equatorial Rossby waves, the Madden-Julian Oscillation, and the extratropical atmospheric circulation

Paul E. Roundy
Lawrence Gloeckler
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Signals associated with the Madden-Julian oscillation (MJO) are frequently applied to generate empirical forecasts of the global circulation. Moist deep convection associated with the MJO initiates Rossby wave trains that propagate eastward and poleward across the mid latitudes. The background circulation then guides some of these waves, along with others, back into the tropics of the eastern Pacific Ocean during northern winter. Upper tropospheric westerly winds that extend to the equator facilitate this propagation. These extratropical waves disturb the equatorial waveguide and initiate equatorial Rossby (ER) waves. These ER waves later modulate convection associated with the MJO as they propagate farther west. The MJO modulates the zonal wind, so it can influence the location and even the existence of the westerly wind duct. The MJO thus helps determine the preferred locations of ER wave formation. In turn, later intersection between the active convective phases of the MJO and these ER waves helps to specify the locations of new extratropical Rossby wave dispersion events into the mid latitudes from the tropics. Thus interactions between the extratropical waves, ER waves, and the MJO can form a feedback loop that might yield enhanced empirical prediction of the global atmospheric circulation. We demonstrate through a simple composite analysis that simultaneous assessment of the state of the MJO and ER waves yields more information about the extratropical circulation than can be obtained from either field alone, or from a simple linear combination of the two fields. Thus assessment of the ER wave state during a particular phase of the MJO might yield better empirical prediction of the global atmospheric circulation that follows.