

A Homogeneous Stochastic Model of the Madden-Julian Oscillation

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The Madden–Julian oscillation (MJO) is the most prominent mode of tropical intraseasonal variability with significant influences on monsoons systems and interactions with El Nino/Southern oscillation (ENSO) via westerly wind bursts in the western Pacific. The MJO also modulates rainfall and extreme events in many locations around the world. Since the MJO involves intense tropical convective heating anomalies, tropical–extratropical interactions are significant during its life cycle and some studies have detected noticeable impacts on the skills of weather forecasts on medium-to-extended ranges. Currently, numerical weather prediction and coupled global climate models (CGCM) are unable to realistically simulate the eastward propagation, zonal scale, periodicity, and phase speeds of the MJO.

Regarding the nature of the MJO, some of the outstanding questions are: what are main mechanisms responsible for the MJO initiation and termination? What drives the eastward propagation? Does the MJO have a low-frequency mode of variability? Were there significant changes in MJO regimes in the last 60 years? How will global warming impact the MJO (i.e. frequency of events, period, intensity, seasonality and interannual variability etc)?

To investigate some of these questions and to provide additional tools to improve the representation of the MJO in CGCM, stochastic models of the MJO are being developed. In this presentation, a homogeneous stochastic model will be discussed. The model is developed based on daily averages of zonal winds at 200-hPa (U200) and 850-hPa (U850) from NCEP/NCAR reanalysis (1948-2006) and outgoing radiation (OLR) from polar orbiter satellites (1979-2006). Occurrences of MJO are determined based on combined empirical orthogonal function (EOF) analysis of band-pass anomalies of U200 and U850.

The homogeneous stochastic model is composed of a nine states-first order Markov model to represent the temporal variability of the MJO, while the spatial structure and intensity of the events are stochastically generated based on mean observed composites of OLR, U200 and U850 anomalies. Several statistic measures indicate that, as first approximation, the homogenous stochastic model is able to capture the general features of the MJO. However, some of the limitations include an overestimation of the ratio of primary to successive MJO events and underestimation of the total number of MJO events. The presentation will end with a discussion of current work aiming to extend the present model to include non-homogeneous changes in MJO activity.