



## **Interactions between monsoon intra-seasonal variability and the Madden-Julian Oscillation in long-range simulations with the ECMWF Ensemble Prediction System**

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The influence of the Madden-Julian Oscillation (MJO) on the intraseasonal variability of monsoons in the Asian and African regions has long been recognized. For example, the organization of rainfall anomalies in the equatorial Indian Ocean, South and South-East Asia and the Maritime Continents during the boreal summer often arises from a combination of eastward propagation of organized convection along the Equator and northward propagation of the associated rainfall systems. A proper simulation of these phenomena is a pre-requisite for skilful long-range predictions of the active and break phases of the monsoon.

Until recently, simulations of the MJO in general circulation models (GCMs) have been generally poor, with strong systematic errors affecting both the amplitude and the speed of propagation of the MJO. Usually, the MJO amplitude was underestimated, and convective activity along the Equator tended to remain 'locked' once the active systems reached the Maritime Continent. Such errors were typical of the simulations performed with versions of the ECMWF GCM used for operational forecasts until (approx.) the end of 2007. However, a combination of substantial improvements in physical parametrizations, and the merging of the monthly and medium-range Ensemble Prediction Systems (EPS) in March 2008 led to notable improvements in the quality of MJO simulation.

This paper discusses the interactions between MJO and monsoon intraseasonal variability in a 20-year sample of 46-day ensemble simulations with a recent version of the ECMWF EPS. It shows that this coupled modelling system is able to realistically reproduce the rainfall anomalies associated with different phases of the MJO in both the South Asian and West African regions, despite some residual deficiencies in the MJO propagation speed. The predictability of monsoon rainfall anomalies on monthly and sub-monthly timescales will be discussed, and examples of predictions of rainfall anomalies occurred during recent monsoon seasons will be presented.