MJO empirical modeling and prediction by past "noise"

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The Madden–Julian oscillation (MJO) is the dominant mode of intraseasonal variability in tropics and plays an important role in global climate. Here we presents modeling and prediction study of MJO by using Empirical Model Reduction (EMR). EMR is a methodology for constructing stochastic models based on the observed evolution of selected climate fields; these models represent unresolved processes as multivariate, spatially correlated stochastic forcing. In EMR, multiple polynomial regression is used to estimate the nonlinear, deterministic propagator of the dynamics, as well as multi-level additive stochastic forcing –"noise", directly from the observational dataset. The EMR approach has been successfully applied on the seasonal-to-interannual time scale for ENSO prediction (Kondrashov et al. 2005), as well as atmospheric midlatitude intraseasonal variability (Kondrashov et al. 2006,2010).

In this study nonlinear (quadratic) with annual cycle, three-level EMR model was developed to model and predict leading pair of real-time multivariate Madden–Julian oscillation (RMM1,2) daily indices (June 1974–January 2009, http://cawcr.gov.au/staff/mwheeler/maproom/RMM/). The EMR model captures essential MJO statistical features of observations, such as seasonal dependence, autocorrelations and spectra. By using the "Past Noise Forecasting" approach (PNF, Chekroun et al. 2011), we are able to notably improve the cross-validated prediction skill of RMM indices— especially at lead times of 15-to-30 days. The EMR/PNF method has two steps: (i) select noise samples — or "snippets" — from the past noise, which have forced the EMR model to yield the MJO phase resembling the one at the the currently observed state; and (ii) use these "noise" snippets to create ensemble forecast of EMR model. The MJO phase identification is based on Singular Spectrum Analysis reconstruction of 30-60 day MJO cycle.