

## **Towards a hybrid approach for the extended forecasting of regional precipitation**

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Simulation and extended forecasting of the observed high amplitude tropical intraseasonal activity, a very strong and coherent signal and arguably the most useful time scale from the point of view of the user community, has proven to be a difficult task for the state-of-the-art climate and NWP models. We have approached the problem of intraseasonal prediction from a hypothesis that the strong intraseasonal signal observed in nature is eroded in weather and climate models by errors in high frequency convective parameterization. The following steps were adopted: We develop a Bayesian physically based empirical scheme that uses wavelet banding to separate physically significant bands. This procedure was adopted for the predictor (e.g., regional precipitation in a sector of India, Brahmaputra river discharge.) and a set of predictors. Linear regression and recombination of the bands provides pentad forecasts at 20 days (4 lags) with correlation coefficients of  $> 0.8$ . We also analyzed serial integrations of the ECMWF coupled ocean-atmosphere model in ensemble mode for 30 day periods initialized daily for 15 days before to 15 days after major intraseasonal oscillations thus allowing the examination of the success and failure of a climate model relative to the phase of the oscillation. The results compare well with observations for about 10 days after which the fields rapidly diverge. We also develop an integration scheme that applies the philosophy of the banded wavelet empirical scheme to the coupled ocean-atmosphere general

circulation model and use for 30-day forecasts for the two cases mentioned above. Adherence with observations is greatly improved and a full evolution of the monsoon ISO predicted throughout June 2004. Given the skill of the rainfall forecasting using the empirical scheme, and the fact that numerical forecast for dynamical variables are skillful up to 10 days, we designed a hybrid system that combines the idea of spectral separation of different time scales used in the empirical forecasting scheme with the output from the operational ECMWF 51-ensemble forecasts in order to provide improved probabilistic forecasts of rainfall and river discharge up to 20 days for the South-East Asian region during the summer monsoon. The scheme takes the forecasted circulation structure (each ensemble) and separates it into different temporal scales by projecting them into multivariate EOF modes and then uses the banded numerical forecasts as predictors in the spectral empirical system.

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