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Prediction of Indian Summer Monsoon Rainfall: A comparison of SST indices in the Indo-Pacific region

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The focus of this study is to document and discuss the variability and predictability of the Indian Summer Monsoon (ISM) rainfall at interannual time scales. Various SST indices have already been proposed in literature in order to understand the variability of ISM rainfall (Ashok et al. 2004; Goswami et al. 2005, Terray et al. 2007; Yang et al. 2007). However, the forecast skills and dynamics of these different indices have never been compared in detail.

The present analysis is based on monthly mean rainfall fields from the CPC Merged Analysis of precipitation (CMAP), SST fields from the Hadley Centre Global Sea Surface Temperature data set (HadISST), and atmospheric data from NCEP-DOE Reanalysis 2, for the period 1979-2007. Four SST indices are computed in different regions of the Indian and Pacific oceans – Nino3.4 SST index in December-January, South East Indian Ocean SST (SEIO) in February-March, the Indian Ocean Basin Mode (IOB) in April-May, the Indian Ocean Dipole (IOD) averaged from September to November – and compared through composite analyses of SST and atmospheric fields, and correlation with ISM rainfall, onset and withdrawal.

The results show that SEIO SSTs during late boreal winter or IOB SSTs during boreal spring are significant precursors for both the late ISM (August-September) and withdrawal of the monsoon, while the early part of the monsoon (June-July) and the monsoon onset are mostly influenced by a late ENSO withdrawal and equatorial Pacific variability during spring. Furthermore, correlation and regression analyses show that the IOB index is associated with the decay of ENSO events in one hand, while the SEIO index is linked to developing El Nino/La Nina episodes on the other. Despite different spatio-temporal definitions and relationships with ENSO, IOB and SEIO SSTs can thus both impact ISM rainfall, mainly through air-sea interactions within the Indian Ocean. With comparable predicting skills, the choice of the better index then hinges on SST conditions in the equatorial Pacific Ocean several months before the onset of the monsoon.

Hence, this study not only stresses the importance of a proper definition of the summer rainy season, but sheds light on the respective merits of different SST indices for a better long-range prediction of ISM rainfall.