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Sub-seasonal to seasonal (S2S) prediction of droughts over India using different data-driven models

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Drought, an extreme meteorological phenomenon, has significant impacts on a country's social, economic, and environmental stability. Early prediction of drought is crucial to provide warning and preparedness measures. Sub-seasonal prediction, which encompasses a few weeks to a few months ahead, is a critical timescale with limited memory of initial conditions, and not significantly controlled by boundary conditions. Presently, dynamical models have drawn much attention in the sub-seasonal precipitation forecast, however, the accuracy in drought prediction remains low. Currently, various dynamical models such as North American Multi-Model Ensemble (NMME) provide sub-seasonal prediction of hydro-meteorological variables for the entire globe. The efficacy of NMME model output for sub-seasonal drought prediction has not been explored in India. Also, a comprehensive study regarding the inclusion of climate indices as potential predictors for S2S drought prediction is lacking in the literature. We have investigated the potentiality of NMME precipitation output for sub-seasonal drought prediction over India and found out that the NMME model output doesn't show a reasonable S2S forecast for 3-months standardized precipitation index (SPI3). Further, the study utilized data-driven models such as auto-regression, support vector regression (SVR), XGboost, and recurrent neural network (RNN) with climatic indices and previous month lagged value as predictors to improve the prediction skill. The results show that statistical models are superior to dynamic models. Although the previous monthly data is adequate for lead 1 drought prediction for most of the grids over India, the inclusion of climatic oscillation information was found to be the potential predictor and necessary for higher lead predictions. For example, the western disturbance index helped predict droughts at 2-months lead for the Northwest region of India. Moreover, the wavelet-based post-processing technique has shown the potential to enhance drought predictions significantly. The outcomes of this study will provide an outlook for the sub-seasonal to seasonal drought prediction over India and aid in the improvement of decision-making.