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Ensemble-based empirical predictions of Ethiopian monthly-to-seasonal monsoon rainfall

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Rainfall is the most important climate element that affects the livelihood and well being of the majority of Ethiopians. The main rainy season occurs from June-September (JJAS) and supports 85-95% of the country's food crop. Because all of the agricultural activities and resulting crop production of the nation hinge on the amount and distribution of JJAS rainfall, accurate seasonal prediction of this crucial rainfall is important for agricultural planning and disaster mitigation. This study employs an ensemble-based multiple linear regression technique to assess Ethiopian seasonal and monthly rainfall predictability on both national and regional scales. Up to 471 orthogonalized linear and nonlinear regional atmospheric (at 12 standard pressure levels) and global SST predictors are prescreened and used to individually initialize models in a forward stepwise model-fitting procedure. For retroactive predictions, 165-230 models (each with only 3-5 parameters) are developed for a 1970-89 training data and verified on independent data for 1990-2002. The predictors used in this approach are selected based on predictand-predictor correlations for 1970-99. In an alternative cross validation strategy, predictor selection and model development processes utilize data for all of 1970-2002 except for single years from 1990-2002 that are withheld for verification. Both prediction approaches yielded very high correlations (> +0.82) between observed and predicted Ethiopian JJAS rainfall anomalies for the 13-yrs of independent verification data. For the second above prediction strategy, which ensured no leakage of information from the future state of the predictand, the ensemble-based prediction framework provides exceptionally accurate predictions of Ethiopian JJAS seasonal rainfall one to two months in advance when the sometimes influential ENSO state is known to be unpredictable. Based on the 13-yrs of independent verification data, more than 67% of Ethiopian seasonal standardized rainfall variance is accounted for by the ensemble models developed on the known state of the atmosphere-ocean system observed in March and April. The ensemble forecasts significantly outperform climatology (65%) and persistence (88%). The cross-validation approach also yielded skillful predictions when forecasting equiprobable climatological terciles of below-, near, and above-normal Ethiopian seasonal standardized rainfall anomalies.