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Evaluation of Six Hydro-Meteorological Forecast Products for Seasonal Drought Prediction in Semiarid Northeast Brazil

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Semiarid North-East Brazil has historically and recently experienced severe drought events leading to water scarcity problems in this region. Over time, water infrastructure investments have brought hundreds of strategic water reservoirs and small dams into the region to ensure reliable water supply. To support decisions regarding water distribution, reservoir operation, and agricultural management in this region, reliable seasonal drought forecasts are required, from the level of farmers until that of state administration.

In this contribution, we assess and verify a set of seasonal drought forecast products for the Jaguaribe River catchment in Ceará, North-East Brazil. The forecast products considered are combinations of two multi-model ensembles for seasonal meteorological forecasts, ECHAM4.6 (20 ensemble members) and the ECMWF seasonal forecasts (15 ensemble members), two statistical downscaling techniques, Expanded Downscaling (XDS) and Empirical Quantile Mapping (EQM), and a weather pattern classification approach (WP). XDS, EQM, and WP are tested and combined with the multi-model ensembles in hindcast mode for the period 1981 to 2014. The forecast issue time is January and the forecast lead time is January to June (i.e. the local rainy season). Hydrological drought indices (considering surface water availability) are obtained from the downscaling outputs by fitting a generalized linear model to observations. This way, we are able to obtain forecasts for (a) monthly precipitation, (b) meteorological drought indices, and (c) hydrological drought indices.

The skill of the forecast systems is evaluated with regard to root mean square error (RMSE) and the relative operating characteristic (ROC) skill score. Results show that forecasts of monthly precipitation have only small skill considering the RMSE. Still, the forecast of extreme events of low monthly precipitation show skill for the rainy season (ROC skill score of 0.24 to 0.33). Similar results are obtained when forecasting meteorological drought indices, i.e. there is significant skill regarding the prediction of meteorological drought events (e.g. ROC skill scores of 0.53 to 0.61 for the Standardized Precipitation-Evapotranspiration Index). Simultaneously, the forecast system shows similar performance regarding the prediction of hydrological drought events (i.e. low regional reservoir storage forecasts). With reference to the forecast lead time, the comparatively largest skill of the forecast products is obtained for April. Regarding the comparison of the different combinations of multi-model ensembles and downscaling techniques it is hardly possible to identify one best-solution since the results vary considerably depending on the target variable.

Overall, this work shows that downscaled multi-model ensemble can forecast drought events at time scales relevant to water managers in northeast Brazil. However, there is still a need for major improvements regarding meteorological forecasts for the rainy season in North-East Brazil and for including hydrological and water management information.