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Toward Seasonal Forecasting of Global Droughts: Evaluation over USA and Africa

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Extreme hydrologic events in the form of droughts are significant sources of social and economic damage. In the United States according to the National Climatic Data Center, the losses from drought exceed US$210 billion during 1980-2011, and account for about 24% of all losses from major weather disasters. Internationally, especially for the developing world, drought has had devastating impacts on local populations through food insecurity and famine. Providing reliable drought forecasts with sufficient early warning will help the governments to move from the management of drought crises to the management of drought risk. After working on drought monitoring and forecasting over the USA for over 10 years, the Princeton land surface hydrology group is now developing a global drought monitoring and forecasting system using a dynamical seasonal climate-hydrologic LSM-model (CHM) approach.

Currently there is an active debate on the merits of the CHM-based seasonal hydrologic forecasts as compared to Ensemble Streamflow Prediction (ESP). We use NCEP's operational forecast system, the Climate Forecast System version 2 (CFSv2) and its previous version CFSv1, to investigate the value of seasonal climate model forecasts by conducting a set of 27-year seasonal hydrologic hindcasts over the USA. Through Bayesian downscaling, climate models have higher squared correlation (R2) and smaller error than ESP for monthly precipitation averaged over major river basins across the USA, and the forecasts conditional on ENSO show further improvements (out to four months) over river basins in the southern USA. All three approaches have plausible predictions of soil moisture drought frequency over central USA out to six months because of strong soil moisture memory, and seasonal climate models provide better results over central and eastern USA. The R2 of drought extent is higher for arid basins and for the forecasts initiated during dry seasons, but significant improvements from CFSv2 occur in different seasons for different basins. The R2 of drought severity accumulated over USA is higher during winter, and climate models present added value especially at long leads.

For countries with sparse networks and weak reporting systems, remote sensing observations can provide the real-time data for the monitoring of drought. More importantly, these datasets are now available for at least a decade, which allows for estimating a climatology against which current conditions can be compared. Based on our established experimental African Drought Monitor (ADM) (see http://hydrology.princeton.edu/~nchaney/ADM_ML), we use the downscaled CFSv2 climate forcings to drive the re-calibrated VIC model and produce 6-month, 20-member ensemble hydrologic forecasts over Africa starting on the 1st of each calendar month during 1982-2007. Our CHM-based seasonal hydrologic forecasts are now being analyzed for its skill in predicting short-term soil moisture droughts over Africa.

Besides relying on a single seasonal climate model or a single drought index, preliminary forecast results will be presented using multiple seasonal climate models based on the NOAA-supported National Multi-Model Ensemble (NMME) project, and with multiple drought indices. Results will be presented for the USA NIDIS test beds such as Southeast US and Colorado NIDIS (National Integrated Drought Information System) test beds, and potentially for other regions of the globe.