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The relative value of MRED winter seasonal forecasts vs. statistically downscaled CFS forecasts for seasonal hydrological forecasting

S. Shukla, B. Livneh, and D. Lettenmaier
University of Washington, Seattle, Civil and Environmental Engineering, United States (shrad@hydro.washington.edu)

The relative value of dynamical vs. statistical downscaling of Climate Forecast System (CFS) forecasts for seasonal hydrologic forecasting is assessed. The dynamically downscaled retrospective climate forecasts were produced by the MRED ("Multi-RCM Ensemble Downscaling of NCEP CFS Seasonal Forecasts") project. In MRED, multiple Regional Climate Models (RCMs) were used to downscale CFS wintertime seasonal forecast from original spatial resolution of 2.5 degree to 0.375 degree (dynamical downscaling). We used 10 common ensemble members among all RCMs (initialization dates at 0000 UTC Nov. 21-25, Nov 29-Dec. 3) for the forecast period of Dec. 1-Apr. over 22-year period (1982-2003). The spatial domain is the Conterminous United States (CONUS). We assessed the value of the MRED forecasts in comparison with a much simpler bias correction and spatial downscaling (BCSD) (statistical downscaling); specifically in terms of the resultant seasonal forecast skill of hydrologic variables such as Runoff (RO), Snow Water Equivalent (SWE) and Soil Moisture (SM). At first, a probability mapping approach was applied both to dynamically downscaled and the CFS (at its native resolution), precipitation, Tmax and Tmin forecasts to correct the forecasts bias relative to the statistics of a gridded observation data set. Both sets of forecasts were then spatially downscaled from their original spatial resolutions to the spatial resolution of the Variable Infiltration Capacity (VIC) hydrologic model (0.125 degree) using a resampling approach. We conducted three separate experiments with both dynamically and statistically downscaled forecasts, and ESP forecasts (where precipitation and temperature data were randomly sampled from the observed climatology) to generate reforecasts of RO, SWE and SM. The initial hydrologic state (IHS) and a "synthetic truth" data set of RO, SWE and SM were derived by a control simulation over a long term, where the VIC model was forced using the gridded observation data set. We estimated Root Mean Square Error (RMSE) and correlation-based skill scores for each experiment for lead times (1-5 months) by comparing forecasts of monthly values of RO, SWE, and SM at each lead times with their respective values obtained from the "synthetic truth" data set. Based on the RMSE score and correlation values we estimated the value of dynamically vs. statistically downscaled CFS forecasts and identified the regions across CONUS and lead times when dynamical downscaling of CFS forecasts results in to some or no improvement of hydrological forecast skill relative to statistically downscaled forecasts.