Ensemble Streamflow Forecasting with the Coupled GFS-Noah Modeling System

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Abstract

A major application of numerical weather prediction (NWP) is to provide forcing to hydrological models to generate streamflow forecasts in a one-way or two-way coupled mode. Since precipitation/runoff forecasts exhibit large uncertainties, hydrologic forecasts should be framed in a probabilistic form and follow an ensemble approach. Using NCEP's Global Ensemble Forecast System (GEFS) coupled with the Noah Land Surface Model (Noah LSM), this study evaluates the quality of the output of the coupled air-land ensemble system as external forcing for river routing ensemble forecasting.

A streamflow "analysis" is generated following the methodology of the North America Land Surface Data Assimilation (NLDAS) project over the CONUS domain, by forcing the Land-River system with observed precipitation. This analysis is used as the initial condition for the river routing model in the coupled air-land-river forecast system, and as a proxy for truth in the verification of the experimental ensemble river flow forecasts.

Quantitative evaluation of the streamflow forecasts revealed that (1) The coupled GFS-Noah forecasting system, with a river routing model attached, reasonably captures analyzed streamflows; (2) The GEFS ensemble mean forecasts, and especially the GEFS ensemble based probabilistic forecasts, have more skill than the ensemble control or even a higher resolution single control forecast (GFS); (3) Bias (systematic error) is a significant part of the total forecast error which can possibly be reduced through a suitable bias-correction algorithm; (4) For larger river basins, the ensemble forecasts exhibit skill even without a bias correction; (5) For medium and small river basins, the shorter-range forecasts suffer from considerable under-dispersion, i.e., insufficient spread. These preliminary results suggest that the GEFS-Noah system provides reasonable forcing to hydrological models although a procedure to downscale precipitation is needed for shorter range (up to 5-7 days) predictions especially for smaller and medium-sized basins.