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Hydrologic ensemble hindcasting and verification in the U.S. National Weather Service

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Quantifying the predictive uncertainty in hydrologic forecasts is one of the most pressing needs in operational hydrologic forecasting, to support risk-based decision making for a wide range of applications (e.g. flood risk management, water supply management, streamflow regulation, and recreation planning). Towards this goal, the Office of Hydrologic Development of the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS), in collaboration with the NWS River Forecast Centers, Deltares and other partners, has been developing the Experimental Ensemble Forecast System (XEFS). The XEFS includes the Ensemble Pre-Processor, the Ensemble Streamflow Prediction subsystem, the Ensemble Post-Processor, the Hydrologic Model Output Statistics streamflow ensemble processor, as well as the Ensemble Verification System for assessing the quality of the probabilistic forecasts generated therein. It is currently being integrated into the NWS's Community Hydrologic Prediction System (CHPS), which builds on the service-oriented architecture of the Delft FEWS Flood Early Warning System.

The CHPS-XEFS also provides ensemble hindcasting capabilities to retroactively apply the newly developed ensemble forecasting approaches, and produce large samples of ensemble hindcasts that are necessary for verification. The verification results based on these hindcasts may be used to evaluate the benefits of new or improved ensemble forecasting approaches. Additionally these can be used to analyze the various sources of uncertainty and error in the forecasting system, as well as guide targeted improvements. Hindcasts may also be required by sophisticated forecast users to calibrate their decision support system, and could help operational forecasters identify historical analogue forecasts to make informed decisions in real-time. In this paper, we describe our hindcasting procedures using CHPS-XEFS, present verification results of ensemble hindcasts generated therein, and discuss the scientific challenges in developing meaningful forecasting, hindcasting and verification capabilities and products.