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Evaluating the performance in the Swedish operational hydrological forecasting systems

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The production of hydrological forecasts generally involves the selection of model(s) and setup, calibration and initialization, verification and updating, generation and evaluation of forecasts. Although, field data are commonly used to calibrate and initiate hydrological models, technological advancements have allowed the use of additional information, i.e. remote sensing data and meteorological ensemble forecasts, to improve hydrological forecasts. However, the precision of hydrological forecasts is often subject to uncertainty related to various components of the production chain and data used.

The Swedish Meteorological and Hydrological Institute (SMHI) operationally produces hydrological medium-range forecasts in Sweden using two modeling systems based on the HBV and S-HYPE hydrological models. The hydrological forecasts use both deterministic and ensemble (in total 51 ensemble members which are further reduced to 5 statistical members; 2, 25, 50, 75, 98% percentiles) meteorological forecasts from ECMWF to add information on the uncertainty of the predicted values. In this study, we evaluate the performance of the two operational hydrological forecasting systems and identify typical uncertainties in the forecasting production chain and ways to reduce them. In particular, we investigate the effect of autoregressive updating of the forecasted discharge, and of using the median of the ensemble instead of deterministic forecasts. Medium-range (10 days) hydrological forecasts across 71 selected indicator stations are used. The Kling-Gupta Efficiency and its decomposed terms are used to analyse the performance in different characteristics of the flow signal.

Results show that the HBV and S-HYPE models with AR updating are both capable of producing adequate forecasts for a short lead time (1 to 2 days), and the performance steadily decreases in lead time. The autoregressive updating method can improve the performance of the two systems by 30 to 40% in terms of the KGE. This is mainly because the method has a significant impact on the improvement of discharge volume. S-HYPE seems to perform slightly better than HBV in the longer lead time, probably because the S-HYPE system is capable of updating the lake water level, which has an impact on the longer lead times. Moreover, the deterministic and ensemble HBV systems with AR updating perform fairly similar for all lead times.

***Keywords*:** Hydrological forecasting, S-HYPE, HBV, Operational production, Kling-Gupta Efficiency, Uncertainty.