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Bayesian merging of large scale and local scale hydrological forecasts

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Global or large-scale hydrological forecasting systems covering entire countries, continents and even the entire planet are growing in popularity. As more large-scale hydrological forecasting systems emerge, it is likely that they will co-exist with pre-existing local forecasting systems. It is the case for instance in Canada, where most provinces have their own streamflow forecasting system, while the new NSRPS will eventually cover the whole country using a 1km by 1km grid. Those province, for instance Quebec, built their own forecasting systems on hydrological models configured for river catchments rather than a regular grid. Using this situation as a starting point and a case study, we propose a Bayesian framework for merging the forecasts from two systems. Within this Bayesian framework, the large-scale prior information comes from the NSRPS. This prior information is then updated using forecasts from the government of Quebec and the associated likelihood. In order to account for forecast uncertainty, this work is carried out using a probabilistic approach for both the NSRPS and Quebec's Système de Prévision Hydrologique (SPH). While SPH produces probabilistic forecasts by default, the preliminary version of the NSRPS that we had access to is deterministic. Consequently, forecasts from the NSRPS had to be dressed into an ensemble in order to use them as prior distribution within the Bayesian merging framework. Alternative prior distributions (climatology, Markov chain) are also considered instead of those obtained from the NSRPS. Since both forecasting systems include ungauged sites, a version of this Bayesian merging framework based on regional statistics was also developed and tested using cross-validation. Our results show that the merged forecasts perform at least as well as the best individual system, for both gauged and ungauged basins. For longer lead times, merged forecasts can even outperform individual systems. Considering that the NSRPS relies on a non-calibrated model with no data assimilation, those results show that there could be important practical gains in merging large scale hydrological forecasts with local scale forecasts.