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A framework for improving a seasonal hydrological forecasting system using sensitivity analysis

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Seasonal streamflow forecasts are of great value for the socio-economic sector, for applications such as navigation, flood and drought mitigation and reservoir management for hydropower generation and water allocation to agriculture and drinking water. However, as we speak, the performance of dynamical seasonal hydrological forecasting systems (systems based on running seasonal meteorological forecasts through a hydrological model to produce seasonal hydrological forecasts) is still limited in space and time. In this context, the ESP (Ensemble Streamflow Prediction) remains an attractive forecasting method for seasonal streamflow forecasting as it relies on forcing a hydrological model (starting from the latest observed or simulated initial hydrological conditions) with historical meteorological observations. This makes it cheaper to run than a standard dynamical seasonal hydrological forecasting system, for which the seasonal meteorological forecasts will first have to be produced, while still producing skilful forecasts.
There is thus the need to focus resources and time towards improvements in dynamical seasonal hydrological forecasting systems which will eventually lead to significant improvements in the skill of the streamflow forecasts generated. Sensitivity analyses are a powerful tool that can be used to disentangle the relative contributions of the two main sources of errors in seasonal streamflow forecasts, namely the initial hydrological conditions (IHC; e.g., soil moisture, snow cover, initial streamflow, among others) and the meteorological forcing (MF; i.e. seasonal meteorological forecasts of precipitation and temperature, input to the hydrological model).
Sensitivity analyses are however most useful if they inform and change current operational practices. To this end, we propose a method to improve the design of a seasonal hydrological forecasting system. This method is based on sensitivity analyses, informing the forecasters as to which element of the forecasting chain (i.e. IHC or MF) could potentially lead to the highest increase in seasonal hydrological forecasting performance, after each forecast update.