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Ensemble seasonal hydrological forecasting at the pan-European scale

Ilias Pechlivanidis, Henrik Spångmyr, Thomas Bosshard, David Gustafsson, and Jonas Olsson
SMHI, FoUh, Norrköping, Sweden (ilias.pechlivanidis@smhi.se)

Abstract
Recent advances in understanding and forecasting of climate and climate change have resulted into skillful and useful meteorological predictions, which can consequently increase the confidence of hydrological prognosis and awareness from an end-user perspective. However, the majority of seasonal impact modelling has commonly been conducted at only one or a limited number of basins limiting the need to understand large systems which are heavily influenced by human activities. In here, we complement the "deep" knowledge from basin based modelling using large scale multi-basin modelling, which is capable of representing human influences (i.e. irrigation, reservoirs and groundwater use). We analyse the seasonal predictive skill along Europe's hydro-climatic gradient using the pan-European E-HYPE v3.0 multi-basin hydrological model. Forcing data (mean daily precipitation and temperature) are derived from the WFDEI product for the period 1979-2010 and used to initialise the hydrological model (level in surface water, i.e. reservoirs, lakes and wetlands, soil moisture, snow depth). Re-forecast forcing data (daily mean precipitation and temperature for the period 1981-2010) from ECMWF's System 4 (15 members initialised every month) are firstly bias corrected using a modified version of the Distribution Based Scaling (DBS) method to account for drifting conditioning the bias correction on the lead month, and further used to drive E-HYPE. The predictive skill of river runoff for a number of European basins is assessed on seasonal timescales. Seasonal re-forecasts are evaluated with respect to their accuracy against observed impact variables, i.e. streamflow, at different space and time-scales; the value of the predictions are assessed using various performance metrics. Verification points (around 2600 stations) are used to represent various climatologies, soil-types, land uses, altitudes and basin scales within Europe. We finally identify regions of similar hydrological forecasting skill and link this to physiographic-climatic characteristics and meteorological skill, in order to suggest possible model improvements. This can assist on developing optimal geographical forecasting units, as a function of model physics and stakeholder needs.

Keywords
Hydrological modelling, E-HYPE, ensemble seasonal forecasts, pan-European scale, skill scores