Geophysical Research Abstracts
Vol. 20, EGU2018-7953, 2018
EGU General Assembly 2018

What should I do, if possible, to top ESP sub-seasonal streamflow predictions in Swiss alpine catchments?

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Hydrological predictions at sub-seasonal timescales (i.e. forecasts with lead times of up to one month) is of crucial importance for applications and planning purposes in the private and public sector, e.g. for the electricity market or flood and drought awareness.

Traditionally Ensemble Streamflow Prediction (ESP) systems have been setup and used as first-order sub-seasonal and seasonal predictions. Ensemble numerical weather predictions (NWP) represent an alternative forcing for such tasks. The main difficulty regarding extended-range hydrometeorological predictions is the coarse resolution of the driving meteorological predictions. Different pre- and post-processing methods can be applied to bias correct and downscale the meteorological forecasts and to bias correct the resulting streamflow forecasts respectively. However, it is still an open question if the focus should be drawn to the pre- or the post-processing step or both. Furthermore the superiority of such techniques with respect to ESP need to be demonstrated.

To assess this question in alpine catchments, we bias correct and downscale the extended-range forecasts provided by the European Center for Medium-Range Forecasts (ECMWF) using a quantile mapping technique to downscale and bias correct the driving temperature and precipitation forecasts. These forecasts are used to run the hydrological model PREVAH in two catchments: the snow-dominated Verzasca catchment and rainfall-dominated Thur catchment. Different post-processing methods based on quantile mapping techniques combined with neuronal networks and wavelet transformations are applied to corrected the resulting hydrological forecasts.

To determine the influence of the initial condition on the forecast performance, we compare the pre- and post-processed forecasts with a traditional ESP approach. For the ESP system, measured meteorological inputs of 34 years are used to drive the hydrological model in a cross-calibration setup. This allows to identify whether the increased performance of the streamflow forecasts can be achieved by accurate sampling of the initial condition or by the added value of combining meteorological ensemble forecasts with the hydrological model. First result show that forecasts based on sophisticated NWP and bias correcting techniques can be substantially superior to ESP, but this added value might vanish after less than two weeks depending on season and key topographic features of the target area.

Furthermore results indicate a positive effect of the pre-processing step depending on the season and the catchments on the performance of the resulting streamflow forecasts over the whole forecast horizon in terms of the continuous ranked probability skill score (CRPSS) in comparison to climatological reference forecast. The post-processing methods generally show a larger positive effect at early lead times. In general, the combination of both, pre- and post-processing, results in best performance of the hydrometeorological prediction system.