Joint Virtual Workshop on “Connecting global to local hydrological modelling and forecasting: scientific advances and challenges”
ECMWF- CEMS - C3S – HEPEX – GFP

How can we extend the horizon of skillful hydrological predictions?

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Motivation

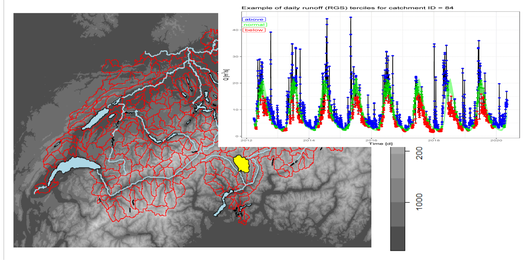
Medium to sub-seasonal hydrological forecasts contain gainful information for water and environmental management tasks (e.g. hydropower, agricultural production) in comparison to climatological or persistence based forecasts. The question remains how to extract this information and at what level of accuracy (e.g. temporal and spatial resolution). Most of the case studies show that the skill of extended range forecasts goes towards zero after 10 to 14 days looking at accurate daily predictions and small mountainous catchments. Therefore, daily hydrological forecasts are aggregated to weeks and classified into three categories: below, above and normal conditions. The resulting forecasts of terciles are compared with pre- and post-processing methods.

Methods

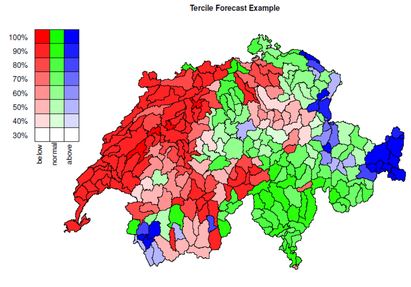
- Possibilities of improvements are investigated by implementing Gaussian Process(GP) models for correcting the hydrological model output.
- The results of these post-processed outputs are compared with pre-processing methods also, where the meteorological forecasts are statistically corrected before their usage in the hydrological model.
- For the verification of the forecast skill and possible improvements the Ranked Probability Score (RPS) and the Area under the Curve (AUC) of the Receiver Characteristic Operator (ROC) are used.

Data

- 300 catchments for Switzerland (basis for the Swiss drought information platform www.drought.ch)
- Long term simulations based on observed meteorological input for deriving weekly climatological terciles
- ECMWF (MeteoSwiss) monthly weather forecasts aggregated to Terciles
- Pre-processed meteorological forecasts (with Quantile Mapping)

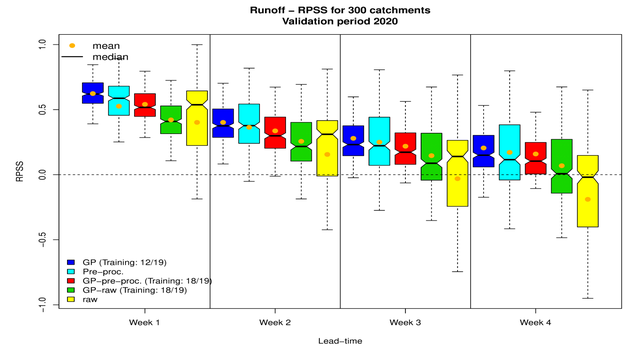


Switzerland subdivided into 300 catchments. In yellow one example of a catchment with its simulation and classification into terciles

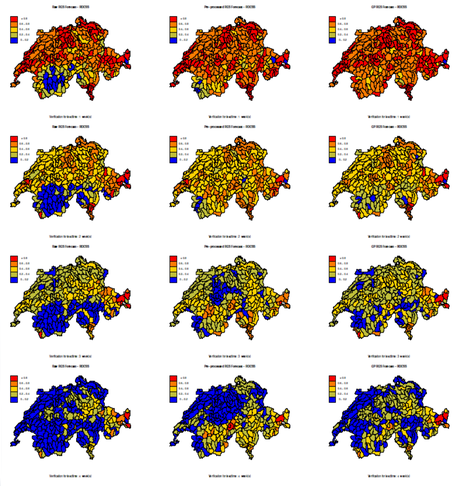


Example of a tercile forecast showing the probabilities (based on ensembles) for each catchment belonging to the class below (red),above (blue) or to the medium tercile (green).

Results



RPSS for the 300 catchments of the raw, pre-processed and post-processed (using the GP method) weekly tercile forecasts for the validation period 2020 of the runoff. The GP has been trained using 1. the raw forecasts from 2012/03-2019/05 (blue), 2. the pre-processed forecasts from 2018/03 - 2019/05 (red) and 3. the raw forecasts from 2018/03 - 2019/05 (green). The results of the pre-processed forecasts without post-processing and the raw forecasts for the same verification period are summarized in the boxes shown in light blue, resp. yellow.



Spatial variability of the RPSS for all catchments comparing the raw (left), the pre-processed (middle) and the GP post-processed (right) soil moisture forecasts for week 1(top) to 4 (bottom).

The results show that looking at weekly aggregates and terciles skill can be achieved up to three weeks lead-time using the pre-processed input and even four weeks using the post-processing method based on the Gaussian Process (GP) model for classification.

Outlook

- Coupling with forecasts of weather patterns (Y-Y Chang’s Talk)
- Severity forecasts – extending the forecast probabilities of a catchment belonging to a certain terciles to probabilities of exceeding thresholds (from extreme to moderate) given that the majority of the ensembles belong to the lower tercile (class 0 - 33%).