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Operational applications of a process-based runoff generation module on the Swiss Plateau and Prealps

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Flash floods evolve rapidly during and after heavy precipitation events and represent a risk for society, especially in mountainous areas. Knowledge on meteorological variables and their temporal development is often not sufficient to predict their occurrence. Therefore, information about the state of the hydrological system derived from hydrological models is used. These models rely however on strong simplifying assumptions and need therefore to be calibrated. This prevents their application on catchments, where no runoff data is available.
Here we present a flash-flood forecasting chain including: (i) a nowcasting product which combines radar and rain gauge rainfall data (CombiPrecip), (ii) meteorological data from numerical weather prediction models at currently finest available resolution (COSMO-1, COSMO-E), (iii) operationally available soil moisture estimations from the PREVAH hydrological model, and (iv) a process-based runoff generation module with no need for calibration (RGM-PRO). This last component uses information on the spatial distribution of dominant runoff processes (DRPs) which can be derived with different mapping approaches, and is parameterised a priori based on expert knowledge.
First, we compared the performance of RGM-PRO with the one of a traditional conceptual runoff generation module for several events on Swiss Emme catchment, as well as on their nested catchments. Different DRP-maps are furthermore tested to evaluate the sensitivity of the forecasting chain to the mapping approaches. Then, we benchmarked the new forecasting chain with the traditional chain used on the Swiss Verzasca catchment.
The results show that RGM-PRO performs similarly or even better than the traditional calibrated conceptual module on the investigated catchments. The use of strongly simplified DRP mapping approaches still leads to satisfying results, due mainly to the fact that the largest uncertainty source is represented by the meteorological input data. On the Verzasca catchment, RGM-PRO outperformed the traditional forecast chain in terms of mean absolute error, independently from the lead time and threshold quantile, whereas the Brier Skill Score did not show any clear preference. Probabilistic input data led generally to better results compared with those obtained with deterministic forecasts.