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A flash flood forecasting system based on high-resolution ensemble precipitation nowcasting

Massimiliano Zappa (1), Daniele Nerini (2), Severin Koller (1), Loris Foresti (2), Ioannis V. Sideris (2), and Urs Germann (2)

(1) Swiss Federal Research Institute WSL, Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland (massimiliano.zappa@wsl.ch), (2) Federal Office of Meteorology and Climatology MeteoSwiss, Locarno-Monti, Switzerland

This study looks at the benefits of using precipitation nowcasting techniques to trigger and force a fully-distributed, event-based flash flood forecasting system.

Hourly rainfall accumulations over the target basins are monitored in real-time by an existing operational alert system developed at MeteoSwiss. The exceedance of a predetermined threshold triggers the hydrological forecast. A useful forecast is derived from combining different individual parts of the forecasts early warning system. Therefore, speaking of a forecasting chain is more accurate. The forecasting chain include (i) the nowcasting product CombiPrecip which combines radar and rain gauge rainfall data. (ii) the meteorological predictions, which are generated by two different numerical weather prediction models (COSMO-1 and COSMO-E). (iii) Soil moisture estimations from the PREVAH model. And finally, (iv) the process-based runoff generation module RGM-PRO, which simulates the amount of runoff forced by the precipitation predictions. Furthermore two systems called Short-Term Ensemble Prediction System (STEPS) and Integrated Nowcasting through Comprehensive Analysis (INCA) system described in Haiden et al. (2011) will be implemented in the model chains. These systems provide a gradually adaption from the extrapolation forecast to the NWP forecast.

The hydrological simulation is forced with ensemble precipitation nowcasts from a seamless forecasting system that is tailored to optimally combines the information and respective uncertainty from multiple sources such as radar observations and short-range NWP forecasts. The system was recently developed to address the challenges of forecasting extreme precipitation in an Alpine context. In particular, these requirements include the need for localization and the formulation of a representative model of the forecast error.

We will illustrate the full forecasting chain, explain the individual components and present results form application in two target areas with nested basins for a set of 41 events between 2016 and 2018.

Results indicate that nowcasting-based flash-flood predictions are in 70% of the cases better than predictions relying on numerical weather predictions only. The presented system takes full advantage of recent developments in both nowcasting and hydrological modelling, thus representing a truly interdisciplinary effort to improve warnings for high impact weather in Alpine regions and, in particular for small ungauged basins.