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Flash flood forecasting using simplified hydrological models, radar rainfall forecasts and data assimilation

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The issuing of timely flood alerts may be dependant upon the ability to predict future values of water level or discharge at locations where observations are available. Catchments at risk of flash flooding often have a rapid natural response time, typically less then the forecast lead time desired for issuing alerts. This work focuses on the provision of short-range (up to 6 hours lead time) predictions of discharge in small catchments based on utilising radar forecasts to drive a hydrological model. An example analysis based upon the Verzasca catchment (Ticino, Switzerland) is presented.

Parsimonious time series models with a mechanistic interpretation (so called Data-Based Mechanistic model) have been shown to provide reliable accurate forecasts in many hydrological situations. In this study such a model is developed to predict the discharge at an observed location from observed precipitation data. The model is shown to capture the snow melt response at this site. Observed discharge data is assimilated to improve the forecasts, of up to two hours lead time, that can be generated from observed precipitation.

To generate forecasts with greater lead time ensemble precipitation forecasts are utilised. In this study the Nowcasting ORographic precipitation in the Alps (NORA) product outlined in more detail elsewhere (Panziera et al. Q. J. R. Meteorol. Soc. 2011; DOI:10.1002/qj.878) is utilised. NORA precipitation forecasts are derived from historical analogues based on the radar field and upper atmospheric conditions. As such, they avoid the need to explicitly model the evolution of the rainfall field through for example Lagrangian diffusion.

The uncertainty in the forecasts is represented by characterisation of the joint distribution of the observed discharge, the discharge forecast using the (in operational conditions unknown) future observed precipitation and that forecast utilising the NORA ensembles. Constructing the joint distribution in this way allows the full historic record of data at the site to inform the predictive distribution. It is shown that, in part due to the limited availability of forecasts, the uncertainty in the relationship between the NORA based forecasts and other variates dominated the resulting predictive uncertainty.