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Temporal moment analysis as a means to improve model parameterisation and peakflow predictions

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Hydrological predictions of extreme flows are often associated with a high degree of uncertainty. Reasons for this are partly that the predictions often are conceived by extrapolating hydrological models outside the prediction range for which the model has been calibrated and validated.

As a means of improving peak flow predictions, we are here focusing on the processes within the stream network as they have proven to be essential factors for determining the timing and magnitude of flow peaks. The average travelling time within a stream network has previously been shown to vary non-linearly with stage, and been shown to depend on the combined effects of geomorphologic, hydrodynamic and kinematic dispersions.

A semi-2D formulation of the kinematic-diffusive wave equation including a lateral exchange with the floodplains is applied to a distribution of flow paths in a stream network, aiming to increase the understanding of the discharge response following a precipitation event. Focus is put on investigating the non-linear relationship between discharge and flow travel time, as well as to formulate generalised methods of incorporating the effects of flooded cross sections into the response functions of hydrological models.

The effects of this novel parameterisation are evaluated in the context of a response function, focusing on the potential improvements when making peakflow predictions. By basing the parameterisation procedure of a compartment model in physical catchment properties and process understanding rather statistical parameterisation based in how a catchment has responded in the past, hydrological models are believed to be more reliable during extreme conditions as well as during changing conditions such as climate change and landscape modifications.

The results show that temporal moment analyses and distributed routing can be used as a means to parameterise the surface water component of compartmental runoff models and that the mean error of runoff models can decrease substantially by the non-linear parameterisation, especially when regarding peakflow predictions.