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Evaluating quantitative precipitation estimates and hydrological models for simulating the 2021 extreme events in Germany

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Implementing an effective nationwide, extreme-flood forecasting system requires improving both the estimation of quantitative precipitation and the hydrological modelling tools. We investigated the ability of state-of-the-art radar-based precipitation products and two contrasting hydrological models in providing reliable flood hindcasts and nowcasts for the July 2021 catastrophic floods. Among others, rainfall retrievals based on specific attenuation, a polarimetric radar variable, were used to improve the accuracy of the rain rates, and different radar-based nowcasting methods (deterministic and stochastic) were tested to quantify their added value in improving the forecast lead time. Hydrological models consisted of a lumped, conceptual model (GR4H) and a distributed physically-based model (ParFlow-CLM) that couples 3D surface and sub-surface flows. The parameters of the lumped model were calibrated on historical data, whereas the parameters of the distributed model were estimated based on landscape and soil properties. Preliminary results indicate that differences in simulated peakflows were predominantly due to differences in the rainfall retrievals rather than hydrological models. Warm rain processes near the surface led to underestimated precipitation sums compared to ground-based estimations. The precipitation estimates largely impacted the ability of models in detecting the exceedance of the 100-year flood, which highlights the need for reliable precipitation estimates to forecast such extreme events.