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Improving flood forecasts through the assimilation of in situ floodplain water stage observations

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The ongoing increase of flood events and the severity thereof has aroused worldwide attention. It poses a great challenge for flood modellers to continuously improve predictions. Flood model predictions can be updated by integrating observational information, using a technique known as Data Assimilation (DA). Although SAR satellite imagery has in this respect proven useful for DA purposes, its high observational uncertainty and low acquisition frequency may hamper real-time flood monitoring. This study presents as an alternative the use of high-accuracy ground data to adequately adjust flood predictions in a DA framework. Whereas multiple studies have focused on updating river flow observations, this study investigates the potential of floodplain water stage observations.

A synthetic experiment evaluates the updating of floodplain water levels by means of an in situ observational network. To this end, a coupled 1D /2D flood inundation model (LISFLOOD-FP) simulates the river Dee flood event of December 2006 (Wales, UK). Since no sensors are yet located in the floodplain of interest, observations are synthetically derived from a projected truth. The synthetic nature of this study allows to investigate not only the impact of different sensor configurations, but also network sizes and assimilation setups. As such, we provide insight into the predictive skill of such network and propose optimal allocation practices.

With a spatiotemporal RMSE of 1.4 cm, as compared to 8.7 cm for the open-loop simulation, the importance of in situ measurements cannot be underestimated. However, suboptimal conditions such as the network configuration, may substantially increase the RMSE. More specifically, a high forecasts skill is associated with a sensor network whose observation locations are prone to early flooding and provide complementary information in both space and time. Further analysis also showed that a network size of 5 observations seemed sufficient for our study area, provided that the sensor locations are chosen carefully.