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Towards assimilation of qualitative flow observations in hydrological models

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The severity and frequency of extreme flood events are increasing worldwide. Advanced mathematical models are commonly used to predict flood events and reduce the impacts on urbanized areas. Technological improvements
have recently led to the spread of heterogeneous networks of low-cost sensors used to measure hydrological variables, such as water level or precipitation, in a more distributed way. Moreover, the growing availability of qualitative flow information, retrieved for example from social media, is opening more opportunities to complement
standard sources of information from in-situ or remote sensors that can be used to improve hydrological and flood predictions. However, only a few studies assessed the usefulness of assimilating qualitative flow observations within hydrological and/or hydraulic model for improving flood predictions.
This study aims at proposing novel approaches for assimilating qualitative flow observations in hydrologic routing model and assessing their usefulness for improving flood estimation. The case study is based on five different rivers in the USA where a three-parameter Muskingum model is used to propagate streamflow. Qualitative flow observations,
generated synthetically from observed flow measurements, are converted into fuzzy observations using main flow characteristic for defining fuzzy classes. An innovative fuzzy error corrector method, adapted from a control system application of robot navigation, is used in this study to assimilate the qualitative flow observations. This study demonstrates the usefulness of assimilating qualitative flow observations for improving flood predictions. In particular, the proposed output updating method is found not sensitive to biased qualitative observations and the definition of fuzzy sets used to represent qualitative observations.