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Comparative analysis of various real-time data assimilation approaches for assimilating streamflow into a hydrologic routing model

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Reliable water depth estimation is an extremely important issue in operational early flood warning systems. Different water system models have been implemented in the last decades, and, in parallel, data assimilation approaches have been introduced in order to reduce the uncertainty of such models.
The goal of this study is to compare the performances of a distributed hydrologic routing model with streamflow assimilation using six different data assimilation methods, including direct insertion, nudging, Kalman filter, Ensemble Kalman filter, Asynchronous Ensemble Kalman filter and variational method. The model used in this study is a 3-parameter Muskingum (O'Donnell 1985) which was implemented in the Trinity River, within the Dallas-Fort-Worth Metroplex area in Texas, USA.
The first methodological step is to discretize the river reach into multiple 1-km sub-reaches in order to estimate water depth in a distributed fashion. Then, different data assimilation approaches were implemented using the state-space approach formulation of the Muskingum model proposed by Georgakakos (1990). Finally, streamflow observations were assimilated at two points where flow sensors are located.
The results of this work pointed out that assimilation of streamflow observations can noticeably improve the hydrologic routing model prediction and that ensemble definition is particularly important for both Ensemble Kalman filter and Asynchronous Ensemble Kalman filter. This study is part of the FP7 European Project WeSenseIt Citizen Water Observatory (www.http://wesenseit.eu/) and NSF Project Integrated Sensing and Prediction of urban Water for Sustainable Cities (http://ispuw.uta.edu/nsf)