Geophysical Research Abstracts
Vol. 21, EGU2019-6496, 2019
EGU General Assembly 2019

Assimilation of flood maps derived from satellite EO data into a flood forecasting model.

Concetta Di Mauro (1,2), Renaud Hostache (1), Patrick Matgen (1), Marco Chini (1), Ramona Pelich (1), and Günter Blöschl (2)

(1) Luxembourg Institute of Science and Technology, Belvaux, Luxembourg, (2) Centre for Water Resource Systems, Vienna University of Technology, Vienna, Austria

Due to the potentially devastating consequences of flood events, it is essential to develop tools enabling reliable, accurate and rapid simulations of floods in near-real time. In this context, hydrologic and hydraulic models represent powerful tools for predicting streamflow and water surface elevation within the riverbed and in the floodplain. However, model inputs, parameters, initial conditions and model structure represent sources of uncertainty that strongly affect the reliability and accuracy of forecasts. Data Assimilation (DA) optimally combines model simulations and observations considering each data sets' inherent uncertainties. In this context, model forecasts can benefit from ground observations; however, these kinds of measurements are not always available. To compensate this lack of data, the use of satellite Synthetic Aperture Radar (SAR) observations is relevant for detecting flooded areas at large scale regardless of weather conditions. The spatially distributed information derived from remote sensing data can complement or substitute ground measurements, especially in data sparse regions, in order to improve model forecast accuracy. A recent study by Hostache et al. (2018) introduces a new DA framework based on probabilistic flood maps derived from SAR images for regularly updating a flood forecasting system. The procedure yielded promising results on a real test case assuming precipitation as the main source of uncertainty.

With the objective to evaluate, validate and further develop the previously introduced DA framework, this study carries out a controlled experiment using synthetically generated satellite observations with known uncertainty. Synthetic probabilistic flood maps are assimilated using a particle filter with sequential importance sampling. For the sake of realism, the experiment is grounded on a real test case: the July 2007 flood along the river Severn in the UK. The synthetic 'truth' is generated based on the following forecasting chain: (i) ERA-interim data are used as meteorological forcings of the SUPERFLEX hydrologic model for each of the 7 contributing upstream catchments; (ii) next, the streamflow hydrographs predicted by this model are used as boundary conditions of the LISFLOOD-FP hydraulic model and 'truth' flood extent maps are derived therefrom. Eventually, synthetic probabilistic flood maps are generated from the 'truth' flood extent maps by first generating synthetic satellite images and next deriving probabilistic flood extent maps from the synthetic satellite images. For the DA experiment, an ensemble of particles is generated by perturbing the rainfall data using a log-normal error distribution. These particles propagate through the flood forecasting system. The DA framework allows updating the particle posterior distribution whenever a new synthetic satellite image is generated.

Our results confirm that discharge and water elevation predictions are substantially improved after the assimilation, meaning that the DA framework works indeed efficiently when its main underlying assumptions are satisfied. For example, at the assimilation time steps, the errors of forecast water elevations is reduced by factors higher than 5. We also notice that the higher the number of assimilated SAR images the more accurate the flood prediction. As a perspective, an evaluation of the DA framework efficiency will be carried out considering additional sources of uncertainties.