Data assimilation method for real-time flash flood forecasting using a physically based distributed model

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The MARINE model (Roux et al, 2011) is a physically based distributed model dedicated to real time flash flood forecasting on small to medium catchments. The infiltration capacity is evaluated by the Green and Ampt equation and the surface runoff calculation is divided into two parts: the land surface flow and the flow in the drainage network both based on kinematic wave hypothesis. In order to take into account rainfall spatial-temporal variability as well as the various behaviours of soil types among the catchment, the model is spatially distributed, which can also help to understand the flood driving processes.

The model integrates remote sensing data such as the land coverage map with spatial resolution adapted to hydrological scales. Minimal data requirements for the model are: the Digital Elevation Model describing catchment topography and the location and description of the drainage network. Moreover some parameters are not directly measurable and need to be calibrated. Most of the sources of uncertainties can be propagated thanks to variational method (Castaings et al, 2009) and finally help to determine time dependent uncertainty intervals.

This study also investigates the methodology developed for real-time flash flood forecasting using the MARINE model and data assimilation techniques. According to prior sensitivity analyses and calibrations, parameters values were determined as constants or initial guess. Then a data assimilation method called the adjoint state method is used to update some of the most sensitive parameters to improve accuracy of discharges predictions. The forecast errors are evaluated as a function of lead time and discussed from an operational point of view. Multiple strategies in term of updatable parameters set, length of time window, parameters bounds and observation threshold used to trigger the assimilation method are discussed regarding accuracy, robustness and real-time feasibility.