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A variational data assimilation technique for flash flood forecasting

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The MARINE (Modélisation de l'Anticipation du Ruissellement et des Inondations pour les évéNements Extrêmes) model is a physically based distributed model developed for flash flood forecasting of small catchments. Physically based models suffer from extreme data request, scale related problems and over-parameterization. Therefore, calibration of parameters is a necessary step in the model development. Variational data assimilation methods for parameters estimation can be exploited to improve parameters identification as well as the prediction of the outlet flow.

In this study, an estimation of the most sensitive parameters was realized. The estimation procedure is based on the adjoint state method that determines the optimal control variables by minimizing a cost function. The objectives are: first to improve the understanding of surface hydrology and second, to reduce uncertainties linked to hydrological system characterization during flash flood generation.

The methodology is applied to the Gardon d'Anduze catchment, southern France. The cost function is a weighted mean-squared error similar to the Nash criterion.

Results show that the methodology may be used to parameterize physically based distributed models. The estimated parameters allow simulating a hydrograph very close to the observations (Nash=0.97). Furthermore, the methodology contributes to validate the physical hypothesis used in the model. From an operational point of view, the methodology is employed to assimilate observations at the upper part of the basin and it results in reliable forecasts at the outlet of the basin. Finally, the methodology allows anticipation, early identification and quantification of an imminent flood and

should contribute to the improvement of a hydro-meteorological prediction chain.