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Data assimilation with the 1D hydraulic code Mascaret and multi-dimensional coupling between Telemac and Mascaret

Data assimilation with the 1D hydraulic code Mascaret and multi-dimensional coupling between Telemac and Mascaret

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Abstract:

In the context of data assimilation (DA) the covariance functions prescribed in the background error covariance matrix are of fundamental importance as they translate information on the observed variables at the measurement locations into correction of the cross-correlated variables over the entire domain. In order to diagnostic the covariance and correlation functions in the context of hydraulic an ensemble Kalman filter algorithm (EnKF) was implemented on top of the 1D hydraulic code Mascaret using the OpenPalm coupling software and the study is carried out on the tidally influenced "Adour maritime" catchment located in south west of France. This algorithm assimilates in-situ water-level observations to correct both water-level and discharges. The members within the ensemble were generated by perturbating the upstream forcings that are supposed to be the main source of uncertainty. In order to enlarge the spread of uncertainty within the ensemble that tends to be under-dispersive an additional covariance inflation algorithm based on the correlation functions diagnosed by the EnKF and *a posteriori* diagnostics is implemented. This leads to an improvement of the results of the assimilation over the entire domain compared to the model only and an improvement of short-term forecasts (1h-3h). The reliability of the analyzed state (water-level and discharge) is closely related to the number of members of the ensemble. In the present study, about 80 members were used. As these members can be run in parallel using the OpenPalm functionality Parasol the cost of the ensemble-based assimilation remains compatible with real-time flood forecasting constraints.

The corrected 1D simulation provides the boundary conditions for a limited-area 2D model over the city of Bayonne. The TELEMAC software, developed by EDF, is used to represent the flow for the confluence between Nive and Adour rivers (in the centre of the city of Bayonne) as well as in the "Plaine d'Ansot" (a flood plain located upstream of Bayonne along the Nive river) where the flow is no longer mono-dimensional. The 1D model with data assimilation (that has no flood plains and infinitely high banks) and the 2D model overlap with the use of a source-term (that represents lateral inflows when the 2D model is in flood) to 1D model to maintain this one close to the 2D. Hence when the 2D is not in flood it is only forced by the 1D model where as when the 2D model is in flood the two models are coupled in order to build a data-driven high-fidelity model for the Adour catchment for operational use in the context of flood-forecasting.

This study demonstrates on an hydraulic network used in an operational context the benefits that flood-forecasting can draw back from the use of data assimilation methods for both correction of the hydraulic state over the 1D domain and the correction of the forcings of the 2D model.