

## **Uncertainty quantification in hydrodynamics bidimensional models : the case of Gironde estuary forecast model**

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*In the context of the development and the implementation of data assimilation techniques in Gironde estuary for flood forecasting, a Telemac 2D model is used to calculate water depths and velocity fields at each node of an unstructured mesh. Upstream, the model boundaries are respectively La Réole and Pessac on the Garonne and Dordogne river. The maritime boundary is 32 km off the mouth of Gironde estuary, located in Verdon. This model, which contains 7351 nodes and 12838 finite elements, does not take into account overflows. It has been calibrated on 4 non-overflowing events and then validated on 6 overflowing events.*

*In a first step, a mesh convergence study was carried out in order to evaluate the error related to the spatial discretization and to determine the mesh allowing to obtain results "independent" of it. Three additional meshes obtained by dividing the number of finite elements at each refinement by 4 were realized and used to simulate the event of 2003. It appears that a mesh of intermediate size (approximately 27000 nodes) seems required.*

*In a second step, propagation and quantification of uncertainties by an unidirectional analysis method (creation of a set of 2000 members perturbed for each parameter and input forcings and analysis of output water depths) was carried out on the numerical parameters (wind influence coefficient, Strickler friction coefficients for 4 zones) and forcings of the model (rivers discharges and maritime boundary conditions, meteorological forcings).*

*The objective is to determine the variation coefficient (if possible standardized by the input variation coefficient) of water depths for 13 major events between 1981 and 2016. The exploitation of 1981 event results shows a predominance of the influence of the maritime boundary conditions and the Strickler coefficient corresponding to the zone studied for the estuarine part and the confluence, to which must be added the Garonne discharge as a predominant parameter for the latter. Unsurprisingly, river zones are influenced primarily by the coefficient of friction and the respective river flows of Garonne and Dordogne rivers. The non-normalized variation coefficients were also calculated by taking into account the time shift of the maritime input signal and, independently, the Arpege Ensemble Predictions provided by METEO-FRANCE. The relative influence of the phase shift and the PEARP has also been determined.*

*On the second hand, a variance sensitivity study (ANOVA) was carried out, by calculating the total and partial Sobol indices, integrating the forcing variables time- and/or space dependent. It has led to the identification of parameters and forcings to which the model is most sensitive, as well as their inter-dependencies, in order to choose the variables to assimilate.*

*Finally, it should be noted that this work has already made it possible to create a database of multi-temporal simulations (over 13 time periods) on Gironde estuary that can, after formatting, feed the SWOT simulator for Gironde Estuary, which is used to prepare the Franco-American mission for the study of ocean and continental water depths.*