A Variational Data Assimilation Algorithm to Estimate Salinity in the Berre Lagoon with Telemac3D

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The Berre lagoon is a receptacle of 1000Mm3 where salty water from the Mediterranean Sea meets fresh water discharged by the hydroelectric plant at Saint-Chamas and by natural tributaries (Arc and Touloubre rivers). The Laboratoire National d'Hydraulique et d'Environnement (LNHE) aims at optimizing the operation of the hydroelectric production while preserving the lagoon ecosystem. To achieve this objective, improving the quality of the simulation and more specifically the description of the salinity state are essential. The hydrodynamics of the lagoon is modelled with a 3D resolution of the shallow water equations using the TELEMAC software (http://www.telemac.org) developed at Electricité De France (EDF R&D). In collaboration with CERFACS, a data assimilation (DA) algorithm is being implemented, using the Open-Palm coupler, to exploit continuous (every 15 min) in-situ salinity measurements at four locations in the lagoon. Preliminary studies were carried out to quantify the difference between a reference simulation and the observations on a test period. It was shown that the model is able to represent reasonably well the evolution of the salinity field at the observing stations, given some adjustments on the observed forcing near Caronte. Nevertheless, discrepancies up to several g/l remain and could be corrected with the DA algorithm.

Similarly to the meteorological and oceanographic approaches, the observations are used sequentially to update the hydrodynamic state. More specifically, a 3D-FGAT algorithm is used to correct the salinity state. This variational assimilation algorithm relies on the hypothesis that corrections to the model state are approximately constant over a chosen time window. Sensitivity experiments show that in order to cope with this constraint, the analysis time window should be at most 3h. As the number of observations over an assimilation window is significantly smaller than the size of the model state vector (70,000 cells approximately), the minimization is performed in a space spanned by vectors of the size of the observation vector. This allows us to reduce both memory usage and computational cost [1]. An inhomogeneous and anisotropic formulation of the background error covariance matrix for salinity is modelled using a diffusion operator [2] using a stochastic estimate of the horizontal and vertical correlation length scales. Preliminary results from the 3D-FGAT system will be presented and the impact of the sequential salinity correction on the model forecast will be quantified.

References

[1] S. Gurol, A. T. Weaver, A. M. Moore, A. Piacentini, H. G. Arango and S. Gratton. " B-Preconditioned Minimization Algorithms for Variational Data Assimilation with the Dual Formulation", ***QJRMS*****,** ***in print*****.**

[2] A. T. Weaver, P. Courtier. "Correlation modeling on the sphere using a generalized diffusion equation", ***QJRMS*****, 127, 1815--1846.**