Coupled multi-grid stochastic modelling and data assimilation and their impact on regional/coastal forecasting in the Bay of Biscay

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Abstract

The main objective of this work is to address, in a data-assimilative parent-child nested dynamical model configuration of the Bay of Biscay, the relative benefit of various grid coupling scenarios on the forecasting skill. A secondary objective is the formulation of the multi-grid control vector for data assimilation, a relatively unexplored topic. The NEMO 4.2 model is first implemented in dual-grid resolutions: 1/36° for the Bay of Biscay parent domain, and 1/108° for the child domain off the coasts of Galicia and Asturias. The grids are coupled by the AGRIF software in 1-way and 2-way modes. As we wish to assess the forecasting skill using probabilistic metrics (namely Continuous Ranked Probability Score – CRPS), we install the whole dual-grid model configuration in a stochastic modelling framework, using appropriate assumptions for the sources of error in the wind forcing of both grids, and in the open boundary conditions of the child grid. In order to focus specifically on the Resolution component of the CRPS, we adopt the solution of a Quasi-Reliable Test-Bench (QRTB), in which Reliability is automatically quasi-satisfied via the use of pseudo-observations from the same generating Ensemble. QRTB also offers the possibility of estimating the CRPS sampling error, enabling objective discrimination between cases of grid coupling. Data assimilation is performed using a stochastic Ensemble Kalman Filter, with fully multi-grid Ensemble covariances and multi-grid control vector.

First results are shown in a winter, mixed-layer situation, focusing on the assimilation of SST, and in a summer, thermocline buildup situation, focusing on SLA assimilation. They seem to highlight the objective advantage of fully-coupled model grids and multi-grid data assimilation for O(1wk) forecasting.