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Quantification of ocean model error covariances in an ensemble of high-resolution Bay of Biscay simulations using stochastic modeling of the wind forcing

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An important factor of any Data Assimilation (DA) scheme is the estimation of the background error covariances. This study is linked to the design of a DA system, based on the ensemble Kalman Filter and the ocean model NEMO. The work is part of the Research and Development activities of LEGOS/CNRS and Mercator-Ocean French teams within the European MyOcean2 project. As a key step towards DA, we perform sensitivity experiments devoted to the evaluation of the model errors and their dynamic, primarily due to wind forcing uncertainties in a free-surface coastal configuration of the Bay of Biscay.
More in details, a stochastic approach of a twin experiment is carried out, by applying spatiotemporal Gaussian perturbations in the wind forcing, as an inertial incertitude of the system. A rank histogram is performed to select a member inside the ensemble spread serving as an SSH/SST observational array. The forecast trajectories of 100 members are used to assess the background error statistics of the ocean model. An ensemble normal probability analysis depicts the linear dependence of ocean surface variables and wind perturbations in the abyssal plain. In the coastal areas and in the shelf non Gaussian behavior is revealed. Initially, the ensemble variance is characterized by a moderate increase in the periphery of eddies and in the river mouths. A rapid increase follows observed mainly in the SSH, due to a chaotic evolution across members of the eddies trajectories. The convergence of covariances presents that a few members are sufficient to depict the spatial pattern of variance, whereas a large ensemble is needed to represent errors and correlations in the domain. Artificial experiments are used to increase the ensemble spread, mainly in the coastal areas and in the shelf, by applying temporal filters. Towards that direction, stochastic processes are investigated to increase the ensemble spread, by perturbing other variables than the wind.
Ensemble forecasts, driven by stochastic methods, are used for the purpose of an EnOI assimilation platform. Mercator-Ocean operational systems are based on a SEEK kernel, using seasonal varying anomalies or modes to approximate the background error covariances. This work explores the performance of the EnOI Data Assimilation to update the error statistics of the kernel.