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Ensemble quantification of short-term predictability of the ocean fine-scale dynamics: a western mediterranean test case at kilometric-scale resolution.

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“Predictability” in operational forecasting systems can be viewed as the ability to meet the forecast accuracy that is required for a given application. In the literature, the most usual approach is to assume that predictability is mainly limited by model instability (i.e. the chaotic behaviour of the system), which means assuming that initial and model errors are small. But, in operational systems, initial and model errors cannot usually be assumed small, because of the complexity of the system and because observations and model resources are limited. In this study, we propose a practical approach to take into account such model and initial condition errors, in the aim to evaluate the predictability of the fine-scale dynamics in a CMEMS-like operational system, based on ensemble experiments with the ocean numerical model NEMO.

To do so, we set up a regional model configuration MEDWEST60 with NEMO v3.6, 212 vertical levels and a kilometric-scale horizontal resolution (1/60°). Such a resolution allows to simulate the fine-scale dynamics up to an effective resolution of ~10 km. The domain covers the Western Mediterranean sea from Gibraltar to Corsica-Sardinia. The configuration includes tides and is forced at the western and eastern boundaries with hourly outputs from a reference simulation on a larger domain, also including tides, and based on the exact same horizontal and vertical grid.

The practical approach we follow consists first in performing a set of several short (~1month) ensemble forecast experiments to study the growth of forecast errors for different levels of model error and initial condition error. In practice, we need to implement a tunable source of model error in MEDWEST60, that might represent e.g. numerical errors, forcing errors, missing or uncertain physics via stochastic parameterization (in this presentation, we will focus on a first set of ensemble experiments where stochastic perturbations are added on the model vertical grid). It is then used to generate different levels of error on the initial conditions.

In a second step, by inverting the dependence between forecast error on the one hand and initial and model error on the other hand, we aim to diagnose the level of initial and model accuracy needed for a given targeted accuracy of the forecasting system.

Practical questions addressed by such experiments relate to the relative importance of model

accuracy vs initial condition accuracy for the forecast of the finest scales in a CMEMS system. From this we can infer information about (a) predictability - for instance, the time along which a forecast remains meaningful for the fine scales. And information about (b) controllability by the observations, for instance, the minimal time to consider between two passes of a future satellite to be able to follow a given observed fine-scale structure - front, eddy, etc