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Sampling strategies based on singular vectors for assimilated models in ocean forecasting systems

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Meteorological and oceanographic models do need observations, not only as a ground truth element to verify the quality of the models, but also to keep model forecast error acceptable: through data assimilation techniques which merge measured and modelled data, natural divergence of numerical solutions from reality can be reduced / controlled and a more reliable solution – called analysis – is computed. Although this concept is valid in general, its application, especially in oceanography, raises many problems due to three main reasons: the difficulties that have ocean models in reaching an acceptable state of equilibrium, the high measurements cost and the difficulties in realizing them.

The performances of the data assimilation procedures depend on the particular observation networks in use, well beyond the background quality and the used assimilation method. In this study we will present some results concerning the great impact of the dataset configuration, in particular measurements position, on the evaluation of the overall forecasting reliability of an ocean model. The aim consists in identifying operational criteria to support the design of marine observation networks at regional scale.

In order to identify the observation network able to minimize the forecast error, a methodology based on Singular Vectors Decomposition of the tangent linear model is proposed. Such a method can give strong indications on the local error dynamics. In addition, for the purpose of avoiding redundancy of information contained in the data, a minimal distance among data positions has been chosen on the base of a spatial correlation analysis of the hydrodynamic fields under investigation.

This methodology has been applied for the choice of data positions starting from simplified models, like an ideal double-gyre model and a quasi-geostrophic one. Model configurations and data assimilation are based on available ROMS routines, where a variational assimilation algorithm (4D-var) is included as part of the code These first applications have provided encouraging results in terms of increased predictability time and reduced forecast error, also improving the quality of the analysis used to recover the real circulation patterns from a first guess quite far from the real state.