Geophysical Research Abstracts
Vol. 17, EGU2015-13867-2, 2015
EGU General Assembly 2015

Design and adaptation of ocean observing systems at coastal scales, the role of data assimilation in the optimization of measures.

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The design and the implementation of observation systems, in the current view, are not limited to the capability to observe some phenomena of particular interest in a given sea area, but must ensure maximum benefits to the analysis/prediction systems that are based on numerical models.
The design of these experimental systems takes great advantage from the use of synthetic data, whose characteristics are as close as possible to the observed data (e.g. in-situ), in terms of spatial and temporal variability, particularly when the power spectrum of the observed signal is close to that reproduced by a numerical model. This method, usually referred to as OSSE (Observing System Simulation Experiment), is a preferred way to test numerical data for assimilation into models as if they were real data, with the advantage of defining different datasets for data assimilation at almost no cost. This applies both to the design of fixed networks (such as buoys or coastal radars), and to the improvement of the performance of mobile platforms, such as autonomous marine vehicles, floats or mobile radars, through the optimization of parameters for vehicle guidance, coverage, trajectories or localization of sampling points, according to the adaptive observation concept.

In this work we present the results of some experimental activities recently undertaken in the coastal area between the Ligurian and Northern Tyrrhenian seas, that have shown a great vulnerability in recent years, due to a number of marine accidents and environmental issues. In this cross-border area an observation and forecasting system is being installed as part of the SICOMAR project (PO maritime Italy-France), in order to provide real time data at high spatial and time resolution, and to design interoperable, expandable and flexible observing platforms, that can be quickly adapted to the needs of local problems (e.g. accidents at sea). The starting SICOMAR network includes HF coastal radars, FerryBoxes onboard ships, and unmanned marine vehicles (e.g. a Wave Glider). This observation system is designed to maximize benefits for the modelling/forecasting component. We will show, through some numerical experiments, how data assimilation is essential both to reduce uncertainty in initial conditions estimates, and to support the observational network design and its future expansion.
In the present work, the improvement in model forecast is assessed using the ROMS-4DVAR algorithm in different model configurations.
The concept of observation networks optimization also applies to the case of existing networks that still have some degrees of freedom. This is the case of Lagrangian float networks, the driving parameters of which can be appropriately modified in order to improve the benefits for the numerical models. In this case we will show the results of the Drive-Floats experiment, realized within the Argo-Italy project, aimed at defining some optimal values for floats driving parameters (parking depth, or frequency of T/S profiles), by first using the model results as a guide, and then verifying the results experimentally.