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Optimal design of a lagrangian observing system for hydrodynamic surveys in coastal areas

Andrea Cucco (1), Giovanni Quattrocchi (1), Fabio Antognarelli (1), Andrea Satta (1), Francesco Maicu (2), Christian Ferrarin (2), and Georg Umgiesser (2)

(1) CNR - National Reasearch Council, IAMC - Institute for Marine Coastal Environment, Oristano, Italy (andrea.cucco@cnr.it), (2) CNR - National Research Council, ISMAR - Institute for Marine Science, Venezia, Italy

The optimization of ocean observing systems is a pressing need for scientific research. In particular, the improvement of ocean short-term observing networks is achievable by reducing the cost-benefit ratio of the field campaigns and by increasing the quality of measurements. Numerical modeling is a powerful tool for determining the appropriateness of a specific observing system and for optimizing the sampling design. This is particularly true when observations are carried out in coastal areas and lagoons where, the use satellites is prohibitive due to the water shallowness. For such areas, numerical models are the most efficient tool both to provide a preliminary assess of the local physical environment and to make short –term predictions above its change.
In this context, a test case experiment was carried out within an enclosed shallow water areas, the Cabras Lagoon (Sardinia, Italy). The aim of the experiment was to explore the optimal design for a field survey based on the use of coastal lagrangian buoys. A three-dimensional hydrodynamic model based on the finite element method (SHYFEM3D, Umgiesser et al., 2004) was implemented to simulate the lagoon water circulation. The model domain extent to the whole Cabras lagoon and to the whole Oristano Gulf, including the surrounding coastal area. Lateral open boundary conditions were provided by the operational ocean model system WMED and only wind forcing, provided by SKIRON atmospheric model (Kallos et al., 1997), was considered as surface boundary conditions. The model was applied to provide a number of ad hoc scenarios and to explore the efficiency of the short-term hydrodynamic survey.
A first field campaign was carried out to investigate the lagrangian circulation inside the lagoon under the main wind forcing condition (Mistral wind from North-West). The trajectories followed by the lagrangian buoys and the estimated lagrangian velocities were used to calibrate the model parameters and to validate the simulation results. A set of calibration runs were performed and the model accuracy in reproducing the surface circulation were defined.
Therefore, a numerical simulation was conducted to predict the wind induced lagoon water circulation and the paths followed by numerical particles inside the lagoon domain. The simulated particles paths was analyzed and the optimal configuration for the buoys deployment was designed in real-time. The selected deployment geometry was then tested during a further field campaign. The obtained dataset revealed that the chosen measurement strategy provided a near-synoptic survey with the longest records for the considered specific observing experiment. This work is aimed to emphasize the mutual usefulness of observations and numerical simulations in coastal ocean applications and it proposes an efficient approach to harmonize different expertise toward the investigation of a given specific research issue.
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