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Coupled wave-ocean modeling system experiments in the Mediterranean Sea

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Wind waves and oceanic circulation processes are of major interest in determining accurate sea state predictions and their interactions are very important for individual dynamic processes.
This work presents a coupled wave-current numerical modelling system composed by the ocean circulation model NEMO (Nucleus for European Modelling of the Ocean) and the third generation wave model WaveWatchIII (WW3) implemented in the Mediterranean Sea with 1/16° horizontal resolution and forced by ECMWF atmospheric fields.
In order to evaluate the performance of the coupled model, two sets of numerical experiments have been performed and described in this work.
A first set of experiments has been built by coupling the wave and circulation models that hourly exchange the following fields: the sea surface currents and air-sea temperature difference are transferred from NEMO model to WW3 model modifying respectively the mean momentum transfer of waves and the wind speed stability parameter; while the neutral drag coefficient computed by WW3 model is passed to NEMO that computes the turbulent component. Five years (2009-2013) numerical experiments have been carried out in both uncoupled and coupled modes. In order to validate the modelling system, numerical results have been compared with coastal and drifting buoys and remote sensing data. Comparison results demonstrate that the WW3 model can fairly reproduce the observed wave characteristics and show that the wave-current interactions improve the representation of the wave spectrum. Minor improvements have been reached by comparing coupled and uncoupled circulation NEMO model results with observations.
A second set of numerical experiments has been performed by considering NEMO model one-way coupled with WW3 model. The hydrodynamic model receives from the wave model the neutral drag coefficient and a set of wave fields used to calculate the wave-induced vertical mixing according to Qiao et al. (2010) formulation. Two experiments have been carried out for one-year period (2010) with and without considering the wave induced mixing. Results show that the wave enhanced vertical mixing produces a general improvement of the model skill when compared to sea surface temperature satellite data and to tracers ARGO vertical profiles.
This work suggests that a coupled model might be capable of a better description of wave-current interactions, in particular feedback from the ocean to the waves might assess an improvement on the prediction capability of wave characteristics, while suggests to proceed toward a fully coupled modelling system in order to achieve stronger enhancements of the hydrodynamic fields.