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Sensitivity of ocean model simulation in the coastal ocean to the resolution of the meteorological forcing

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The quality of the ocean model simulation depends on a number of factors e.g. approximations in the governing equations, errors introduced by the numerical scheme, and uncertainties in input parameters such as atmospheric forcing. Our previous study (Shapiro et al., 2011) has shown that the basin-wide circulation pattern and the temperature structure in the Black Sea produced by the same model is significantly dependent on the source of the meteorological input. The horizontal resolution was approximately the same, however, the wind and cloudiness patterns provided by the reanalysis data obtained from National Centers for Environmental Prediction (NCEP, USA) and Japanese 25 year Re-Analysis Project (JRA) were sometimes quite different, which resulted directly in different responses of the sea. For the purposes of this study we have chosen the Celtic Sea, where high resolution meteorological data are available from the UK Met office from 2006. The Celtic Sea is a tidally dominated water basin, with the tidal stream amplitude varying from 0.25 m/s in the southwest to 2 m/s in the Bristol Channel. It is also filled with mesoscale eddies which contribute to the formation of the residual (tidally averaged) circulation pattern (Young et al., 2004). The sea is strongly stratified from April to November, which adds to the formation of density driven currents.

In this paper we analyse how sensitive the model output is to variations in the spatial resolution of meteorological parameters obtained from the same source, so that any difference in the ocean output is purely linked to variations in resolution. The original resolution of the meteorological parameters was 1/9 of a degree (about 12 km), which was subsampled to create resolutions up to 96 km. The effect of varying the resolution of the meteorological parameters is not obvious a priori. The length scales of most energetic dynamic features in both ocean and atmosphere are defined by the Rossby radius of deformation, which is about 1000 km (the typical size of a cyclone) in the atmosphere while only 10-20 km (the size of a mesoscale eddy) in a shallow sea. However sub-mesoscale atmospheric patterns, such as patchiness in the cloud cover, could result in smaller scale variations of both the wind and solar radiation, hence creating a direct link between these smaller atmospheric features and the ocean mesoscale variability.

The simulation has been performed using a version of the POLCOMS numerical model (Enriquez et al., 2005). Tidal boundary conditions were taken from the Oregon State University European Shelf Tidal Model (Egbert et al., 2010) and the temperature/salinity initial fields and boundary conditions were taken from the World Ocean Database (Boyer et al, 2004). The paper discusses what elements of the circulation and water column structure are most sensitive to the meteorological resolution.

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