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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 ocean simulations depends on a number of factors such as approximations in governing equations, errors introduced by the numerical scheme, uncertainties in input parameters, and atmospheric forcing. The identification of relations between the uncertainties in input and output data is still a challenge for the development of numerical models. The impacts of ocean variables on ocean models are still not well known (e.g., Kara et al., 2009). Given the considerable importance of the atmospheric forcing to the air-sea interaction, it is essential that researchers in ocean modelling work need a good understanding about how sensitive the atmospheric forcing is to variations of model results, which is beneficial to the development of ocean models. Also, it provides a proper way to choose the atmospheric forcing in ocean modelling applications. 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, giving remarkably different responses. For the purpose of this study we have chosen the Celtic Sea where high resolution meteo data are available from the UK Met office since 2006. The Celtic Sea is tidally dominated water basin, with the tidal stream amplitude varying from 0.25m/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, 2003). 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 using low (1.6°) and high (0.11°) resolution meteo forcing, giving the quantitative relation between variations of met forcing and the resulted differences of model results, as well as identifying the causes. 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 (a typical size of a cyclone) in the atmosphere while only 10-20 km (a 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 of these smaller atmospheric features with the ocean mesoscale variability.

The simulation has been performed using a version of 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 mostly sensitive to the meteo-fields resolution.

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