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HIGH RESOLUTION SIMULATION OF COASTAL CIRCULATION: MARMARA SEA STUDY CASE

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Abstract

With the goal of simulate the current patterns in a detail way along the Marmara Sea /Istanbul coast a hydrodynamic model was set up using MOHID modelling system. The high resolution model (20 m) was able to capture the main low and high frequency trends for the level and temperature at the Marmara sea scale, while for the salinity, sucessfuly reproduced the bibliography halocline. Further studies will be realized to undestand artificial maritime structures effect on the currents dynamic and intensity and coast line evolution.

Keywords: Marmara Sea, MOHID, Downscalling, Coastal circulation.

1. Introduction

This study is centred in the Marmara Sea, a small continental sea located between the Black Sea and the Mediterranean. This system is characterized by a two-layer stratification and two-layer current systems, driven by the density and sea level differences between the adjoining seas (Gerin et al., 2013). The persistence of these two layer structures is due to salinity differences. The low salinity Black Sea waters (~18 PSU) flows into the Marmara Sea through the Bosphorus strait while denser salty Aegean waters (~38.5 PSU) flows into the Sea of Marmara through the Dardanelles strait (Chigiato *et al.*, 2012).

2. Methodology and Data

The open source model MOHID, a three-dimensional water modelling system was implemented. The model validation was based in data from three tidal gauges and satellite data for a period of approximately of 1 month (8th of October to 13th of November of 2016). Additionally, the halocline depth validation was based in data presented in the literature. In the case of salinity, only a qualitative validation was done due to the lack of public available data.

2.1 Data

Publicly available data was used as boundary conditions for the model MOHID implementation and validation. Model bathymetry was based in two data sources: local nautical charts for the project area and EMODnet data. The surface boundary condition was defined based in the GFS (Global Forecast System) with quarter degree spatial resolution every three hours. The open boundary condition was defined adding the CMEMS global solution (low frequency circulation) to the FES2012 global tidal solution (astronomic tide). Model validation were performed using GLOSS tidal gauge and SST MODIS-Aqua remote sensing imagery and average values of the halocline depth in the Marmara Sea publish in the literature.

2.2 Model Implementation

A multi-nesting one-way approach was followed, from a starting grid of 2 Km to a final grid of 20 m. The model surface boundary condition was defined using the GFS atmospheric solution. The bathymetries were built using a composite solution from the EMODnet database and nautical charts. Tide was forced in the oceanic open boundary in the first level.

3. Results and Discussion

The two different water masses are separated by a sharp pycnocline at a depth of roughly 25 m (Beşiktepe *et al.*, 1994). Chigiato *et al.*, 2012 presents field data and model results where the halocline depth in the Marmara Sea is located approximately 25 m depth. The model implemented in the framework of this report reproduced similar halocline depth results. The adopted downscaling methodology allows MOHID to simulate the joint effect of the astronomic tide, atmospheric pressure, density gradient and wind over the sea level, with the model reproducing very accurately tide over three distinct hydrodynamic systems (Figure 1).

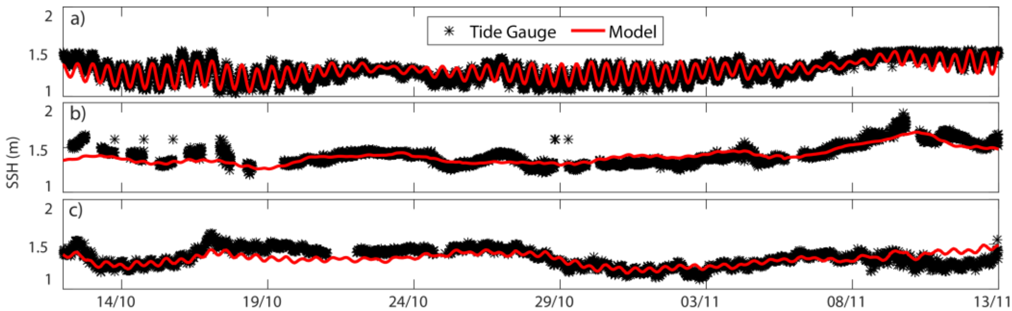

Figure 1. Tide comparisons for the a) Aegean Sea (Gokceada, Turkey), b) Marmara Sea (Ereglisi, Turkey) and Black Sea (Mangalia, Romania) tidal gauge and the model.

Overall deviation of the predicted SST comparatively to the remote sensing show values under 1°C. In spite of the differences, the objective is the accurate spatial variation reproduction.

4. Conclusion

The model implementation for this region was a success, with good validation results allowing developing further studies. As future work, the objective is to study the hydrodynamic effect on coastal line evolution for intense currents near shore.

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