Geophysical Research Abstracts
Vol. 16, EGU2014-8208-1, 2014
EGU General Assembly 2014

Testing the ability of barotropic models to simulate sea level extremes of meteorological origin in the Mediterranean Sea

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Storm surges are responsible for considerable damage to coastal property and loss of life every year. Furthermore, the damage from its combined effect with gradual sea level rise constitutes one of the most visible and costly effects of climate change. Understanding the mechanisms of storm surges as well as improving the predictive skill of storm surge models are hence of primary importance. This study investigates the ability of a 2D hydrodynamic model to simulate sea level extremes of meteorological origin in the Mediterranean Sea. For this purpose, the output of the model is compared to hourly sea level observations from a series of coastal tide gauge records covering most regions of the Mediterranean. It is found that the model underestimates the size of the sea level extremes at most stations. In terms of percentage, the underestimation is independent of the value of the extreme and, at some stations like Marseille, can be as large as 65%. Interestingly, in the Adriatic Sea, and more in particular at Trieste, the model can in some cases overestimate the magnitude of the extremes or even generate significant extreme events when they are in fact not present in the tide gauge record. The extent to which higher resolution sea level pressure (SLP) and wind forcing improve the sea level predictions is explored by comparing various simulations with atmospheric forcing of different resolution. Finally, the effect of the rapid deepening during explosive cyclone events on the performance of the ocean model as well as possible departures from the local inverse barometer effect during such events is also investigated. For the study of the events associated with explosive cyclones we use SLP and wind data with a horizontal resolution of about 7 km as simulated by the COSMO.GR model for 23 cases of explosive cyclogenesis spanning the period 2002-2010.