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# Evaluation of the ECMWF ERA-interim wind data for numerical wave hind-casting in the Caspian Sea

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## INTRODUCTION

Accurate estimate of the design-wave parameters plays crucial role in design of coastal and maritime structures. Nowadays, coastal engineers are capable of knowing the wave climate in a region or predict design-waves characteristics in a certain location, using a suitable set of wind data together with an appropriate numerical model. Though, high speed processors has enhanced application of numerical models in prediction of waves' characteristics and behavior in coastal areas, accessing to rich set of wind data as well as other adequate input data for a numerical model is not always reachable. Previous hind-cast studies for the Caspian Sea revealed that the region had no appropriate set of wind data. In this study, a new set of wind data employed together with SWAN (version 40.91), a third generation spectral model, with unstructured mesh for the simulation of wind waves in the sea, particularly for the southern part of it, i.e. Iranian coastal waters.

## STUDY AREA

The Caspian Sea is the largest enclosed sea in the world, located between the longitude of 46.5°-54° E and the latitude of 36.5°-47° N (Fig. 1). The Caspian Sea with an area of about 364,000 km$^2$ , is 1300 km long. Its width varies from 160 to 450 km. The deepest point of the Caspian Sea is more than 1000 m deep. Iranian coastline is about 750 kilometer long and due to the Mediterranean climate, the coastal area is covered by forests and green farms, and hundreds of towns and cities. Also there are several commercial, industrial, fishery and recreational ports along the Iranian coastline with fast growing coastal activities. The need for design and construction of port facilities as well as coastal and maritime structures support investigations on the wave climate and precise prediction of design wave characteristics.

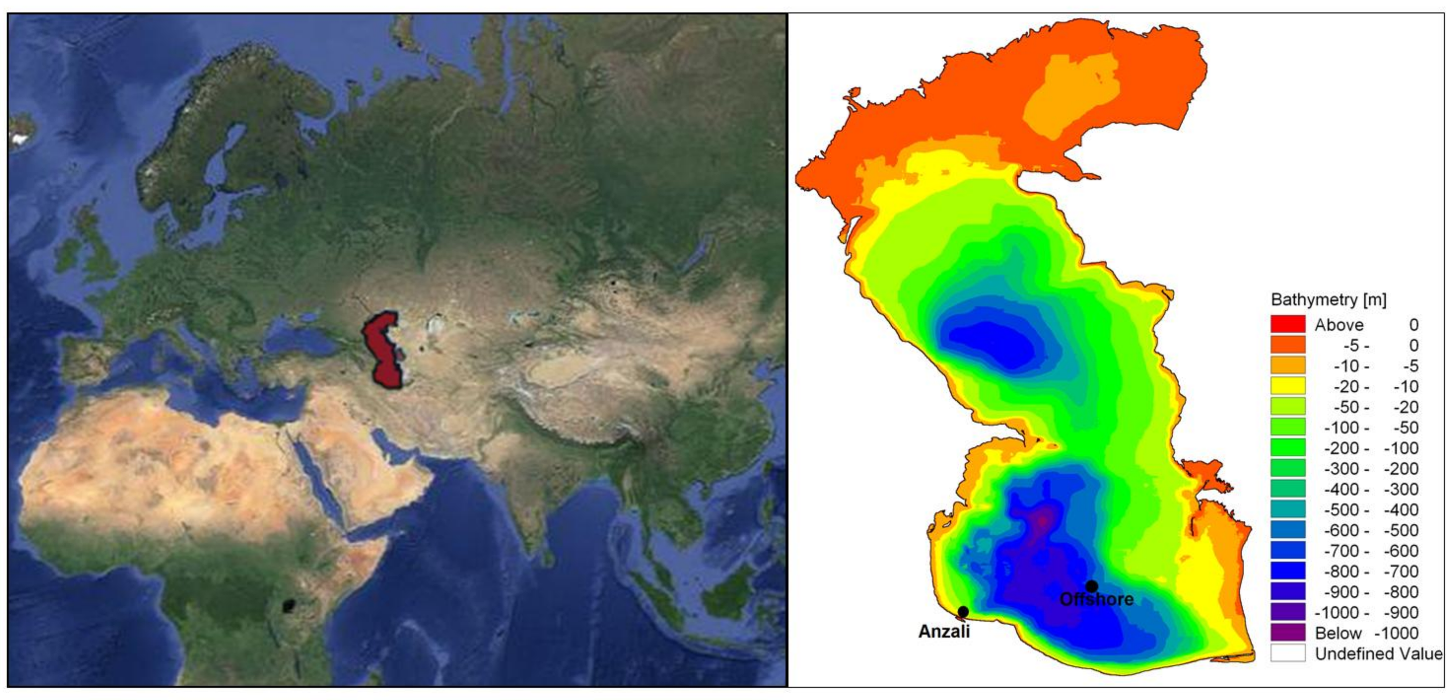


Fig 1. The location of the Caspian Sea

## OBSERVATION DATA

The numerical model is forced by the new re-analysis wind dataset provided by ECMWF which is known as ERA-Interim. This dataset consists of the 6-hourly wind data from 1979/1/1 to 2013/12/31 (35 years) with a resolution of 0.125°×0.125°. To the authors knowledge, the new 35 years of ERA-Interim is applied for the prediction of wave in the Caspian Sea for the first time, in this study.

The numerical modelling results are compared with field measurements, consist of two buoys measurements, located in the southern part of the Caspian Sea (Iranian coasts, Fig. 1), shown in the table 1. In addition, the predicted significant wave height is compared with the corresponding altimeter satellite observations (TOPEX and GFO-1) along various paths over the sea. The computed error indicators revealed that the model predictions are in very good agreement with the offshore observations and good agreement in Anzali Buoy field data.

Table 1. The characteristics of the buoy measurements

| Buoy location | Location | | Water depth (m) | Timeline of the measurements |
|---|---|---|---|---|
| | Long | Lat | | |
| Offshore | 51.51 | 37.87 | 700 | 2006/10/11 — 2007/5/2 |
| Anzali | 49.45 | 37.52 | 22.5 | 2011/3/7 — 2011/11/6 |

## RESULT AND DISCUSSION

Before the main numerical runs, a sensitivity analysis is performed to examine the effects of different parameters on the simulation results. The results show that the simulations follow the wave behaviour well. For example, Fig.2 and Fig. 3 display the comparisons of the numerical modelling results for significant wave height $H_S$, and peak spectral period, $T_P$, against the observations at Offshore and Anzali buoys, respectively. It can be seen that the simulations are in a good agreement with the field measurements.

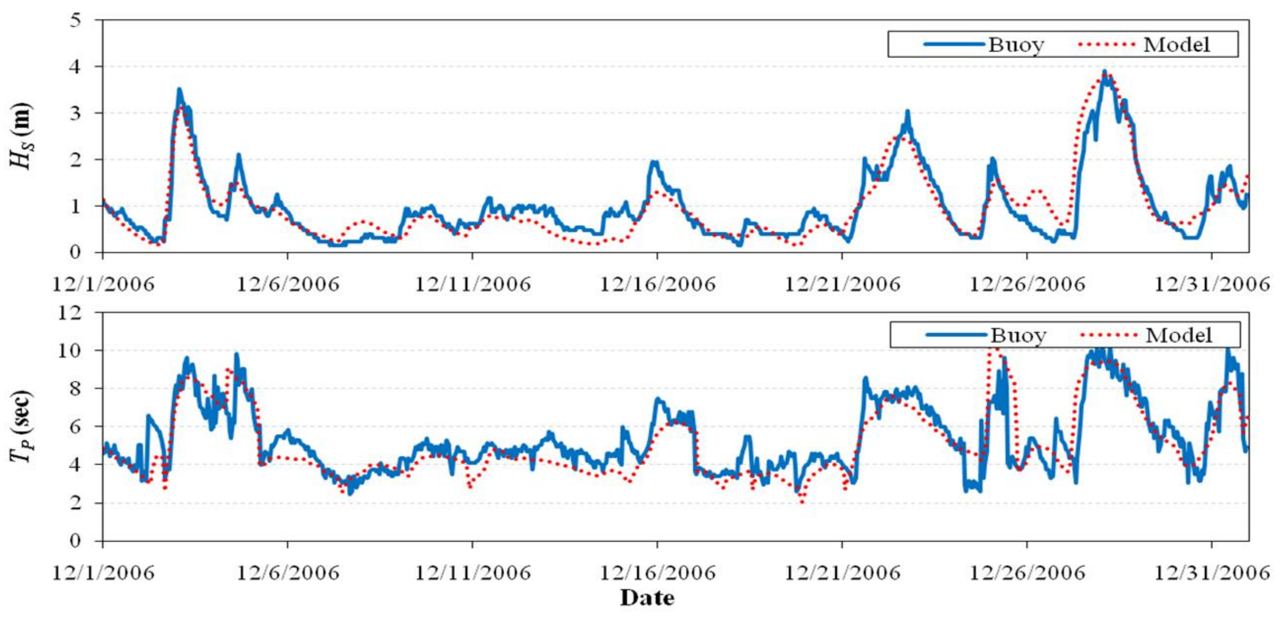


Fig 2. Comparison between modelling results and observations for offshore buoy, December of 2006.

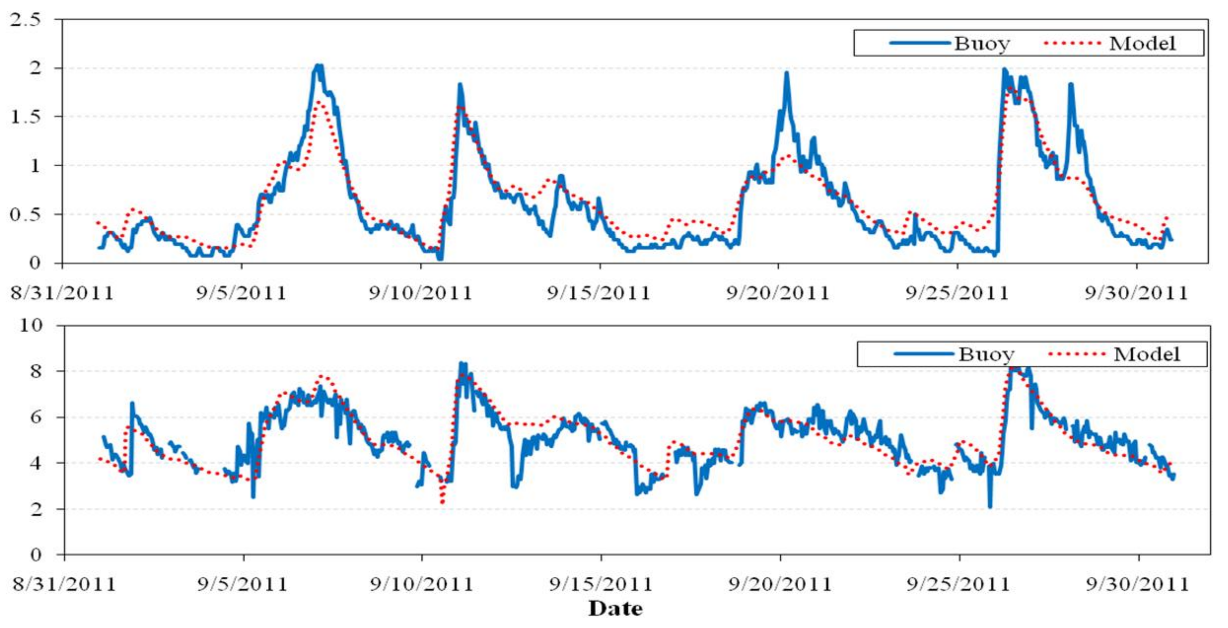


Fig 3. Comparison between modelling results and observations for Anzali buoy, September of 2011.

The calculated error indicators reveal that all of the error measures for $H_S$ at the buoy locations are in a reasonable range. Moreover, the results also indicate that the average error for $H_S$ is less than that of $T_P$. In agreement with the previous studies, the results of the present work also indicate that the SWAN model slightly under-predict $T_P$. The correlation coefficients of the model results at Offshore buoy location are about 0.91 and 0.81 for the predictions of $H_S$ and $T_P$, respectively. In addition to the buoy measurements, comparison of the results with satellite data (Fig. 4) also shows that the model can appropriately simulate wave height trend in the whole area of the Caspian Sea.

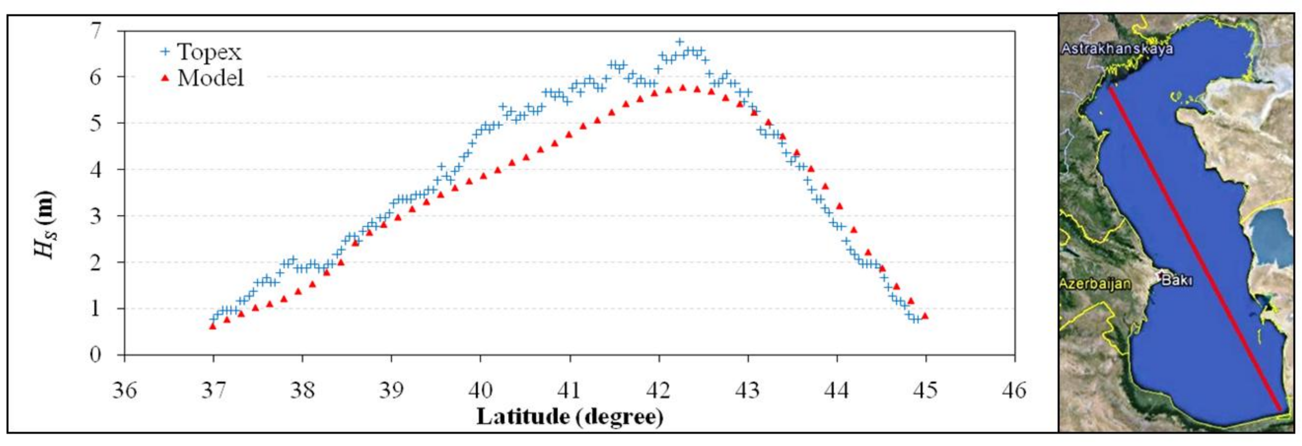


Fig. 4. Comparison of measured and predicted wave height in a path of TOPEX satellite

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