APPLICATION OF CREEPING SEA-FILL METHODOLOGY TO THE WIND SPEED OVER THE CASPIAN SEA

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Abstract
Numerical weather prediction (NWP) products include possible errors near the coastal regions. Effects of such errors on near surface wind speed, which is one of the critical variables for coastal applications are investigated over the Caspian Sea. For this purpose, a creeping sea-fill methodology developed by [1] was applied to the coarse resolution (1.125° x 1.125°) wind speed data obtained from European Centre for Medium-Range Weather Forecasts (ECMWF), and the results compared with the relatively fine resolution (0.25° x 0.25°) satellite based wind speed data. It is shown that the applied methodology improved the accuracy of the wind speed near the coastal regions.
Keywords : Coastal Processes, Air-sea Interactions, Brackish Water.

Coastal applications (e.g regional ocean models, wave models etc.) need accurate wind speed over the sea surface and proper representation of this variable is important. However, atmospheric models do not have enough resolution for inland waters like the Caspian Sea. Since many NWP models are generally designed for global or regional applications, small water bodies are not considered in great detail. Also, because of the irregularities in coastline the few grid points over inland waters can be contaminated by land. For this reason, the wind speed field requires special treatment before using it in coastal applications.

The Caspian Sea is an enclosed water body and very sensitive to the atmospheric forcing, thus improper representations of air-sea fluxes in a regional ocean model could lead to unrealistic trends of total heat, mass, and momentum. For this reason, special attention should be taken to properly represent the atmospheric forcing in this sea. The main goals of this study are (1) to show the effects of land on the surface wind speed near the coastal regions, and (2) to evaluate the success of the applied methodology for reducing the effects of land contamination.

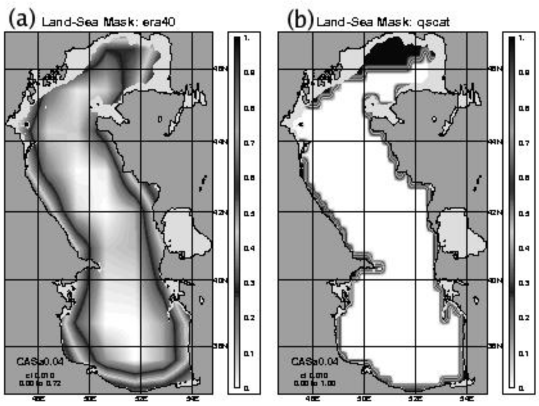

Fig. 1. The land sea mask from a satellite-based product (QSCAT, right), and ECMWF interpolated to the 1/25^o grid (left)

Land-sea mask values from ECMWF [2] (European Centre for Medium-Range Weather Forecasts) (Fig. 1a) and SeaWinds scatterometer on the QuikSCAT satellite (Fig. 1b) are shown. It is clearly seen that the relatively coarse resolution ECMWF land-sea mask is more contaminated by land values effecting the interior of the sea compared to QSCAT land-sea mask, which has relatively fine resolution. In this figure, a contour value of 0.8 in the land-sea masks implies that the interpolated wind speed values are $\mathrm{approx}\ 80\%$ contaminated by land values on the OGCM grid.

In this study, a creeping sea-fill methodology was applied to the wind speed at 10 m obtained from ECMWF 40-year Re-Analysis (ERA40) data for June 2000. The creeping sea-fill simply means that winds are post-processed, so that only values over the ocean (or sea) are used. It replaces the value associated with each land-masked point by using only nearby sea values. For demonstration purposes, the original values were interpolated to a 1/25° x 1/25°, cos (lat) resolution Caspian Sea HYbrid Coordinate Ocean Model (HYCOM) domain. HYCOM, described in [2], is a community ocean model (http://oceanmodeling.rsmas.miami.edu/hycom/). It behaves like a conventional σ (terrain-following) model in very shallow oceanic regions, like a z-level coordinate model in the mixed layer or other unstratified regions, and like an isopycnic-coordinate model in stratified regions.

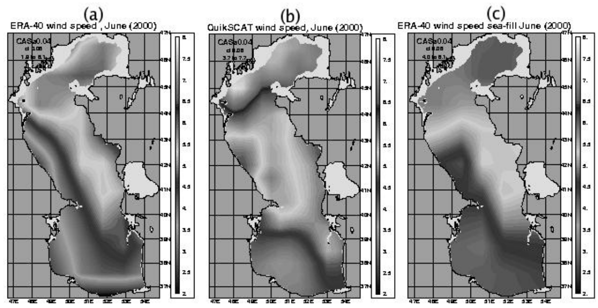

Fig. 2. Spatial variations of wind speed from ECMWF, QSCAT and sea-fill field.

Performance of the creeping sea-fill methodology is evaluated using measurements of wind speed magnitudes at 10 m above the surface from QuikSCAT satellite. ERA40 (Figure 2a), QSCAT (Figure 2b) wind speed data and the sea-filled field (Figure 2c) are plotted to examine wind speed during June 2000. While ERA40 wind spped data shows abrupt features along the southern and western coast of the Caspian Sea, QuikSCAT data is more smooth over these regions. An improvement in the accuracy in ERA40 wind speed data is seen after applying creeping sea - ïňĄll methodology, as these fields display more or less smiliar features compared to QuikSCAT data.

This study shows that applying a creeping sea-fill methodology successfully reduces the error due to the land contamination associated with the coarse NWP grid, and improves the accuracy of wind speed near the coastal regions. To investigate possible effects of improved atmospheric forcing on the dynamical features of the sea, a regional ocean model should be used as a tool for a further study.

References

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