WIND SPEED ACCURACY NEAR THE COASTAL BOUNDARIES OF THE MEDITERRANEAN SEA

Birol Kara *, Alan Wallcraft , Harley Hurlburt and Joseph Metzger
US Naval Research Laboratory, Code 7320, NASA Stennis Space Center - Birol.Kara@nrlssc.navy.mil

Abstract

The atmospheric model grid from NWP (Numerical Weather Prediction) products tend to include land values over the ocean in near coastal regions. This is due to improper land-masks of the NWP products, causing serious errors in wind speed for coastal applications. Possible corrections are introduced to overcome such problems.

Keywords : Air-sea Interactions, Coastal Waters, Eastern Mediterranean.

Introduction

Wind speed differs greatly between ocean and land surfaces due mainly to land-sea heterogeneity. For example, the land roughness can be significantly larger than ocean roughness. NWP centers are commonly used as sources for obtaining global coverage of winds. These NWP products include (1) $1.0° \times 1.0°$ Navy Operational Global Atmospheric Prediction System (NOGAPS), (2) $1.125° \times 1.125°$ European Centre for Medium-Range Weather Forecasts (ECMWF), and (3) $1.875° \times 1.875°$ National Centers for Environmental Prediction (NCEP). A serious problem arises when using these products, for example, for determining coastal upwelling and in forcing fine-resolution ocean models. This is because winds over water during interpolation to the finer ocean grid are contaminated by values over land near coastal regions, mainly because of the much coarser atmospheric computational grid [1].
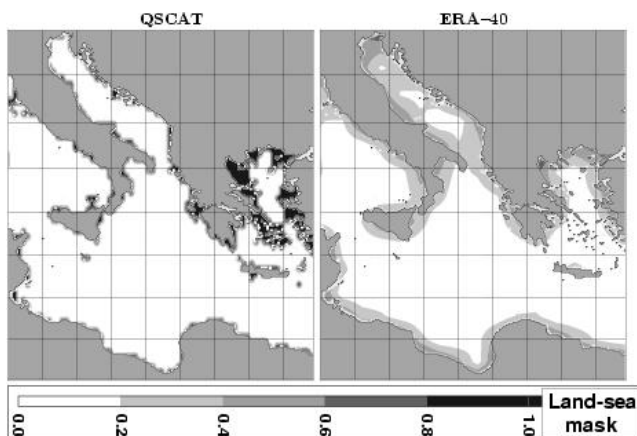

QSCAT   ERA-40

Land-sea mask

0.0   0.2   0.4   0.6   0.8   1.0

Fig. 1. The land-sea masks interpolated to the 1/12°HYCOM grid.

Land-Sea Mask

The model near-surface grid in NWP products is divided into sea and land points using a land-sea mask. The original land-sea masks can be represented as values 0 (for sea) and 1 (for land). Land-sea mask values from the 40-year ECMWF Re-Analyses (ERA-40) and Quick Scatterometer (QSCAT) products are formed to illustrate possible land contamination issues in the Mediterranean Sea (Fig. 1). For demonstration purposes, the original ERA-40 winds were interpolated to a $1/12° \times 1/12° \cos(\text{lat})$ resolution global HYbrid Coordinate Ocean Model (HYCOM) domain (http://oceanmodeling.rsmas.miami.edu/hycom/) zoomed for the eastern Mediterranean region. Unlike ERA-40, the daily mask is 1.0 for 100% data void and 0.0 for valid QSCAT data.

The interpolated representation of the original land-sea mask on the HY-COM grid clearly reveals that some of the ocean points are contaminated by land values, as typically seen from ERA-40 (Fig. 1). For example, a contour value of 0.4 in the land-sea masks implies that the interpolated wind speed values are $\approx$ 40% contaminated by land values. ERA-40 winds are therefore consistently weaker (e.g., 2 m s^{-1}) than QSCAT near the land-sea boundaries (Fig. 2).

Special action must be taken to ensure that wind speed over land value is not contaminated by that over the sea surface. One possibility is to correct winds from NWP products using satellite-based QSCAT winds. The left panel in Fig. 2b shows the accuracy of such a correction, based on a linear regression analysis. That means, assuming QSCAT winds are perfect, monthly ERA-40 wind speeds were regressed against those from QSCAT as there was high correlation (mostly > 0.8) between the two over the

seasonal cycle. Slope and constant values were calculated at each grid point. The resulting corrected wind speeds (cERA-40) are almost identical to those from QSCAT. Another possibility for correcting NWP winds is to apply a creeping sea-fill [1]. The creeping sea-fill simply means that nearby sea values for winds are used at the coastal boundaries.

(a) Wind speed at 10 m above the sea surface during Aug 2001
QSCAT   ERA-40

3.0   4.0   5.0   6.0   (m s^{-1})
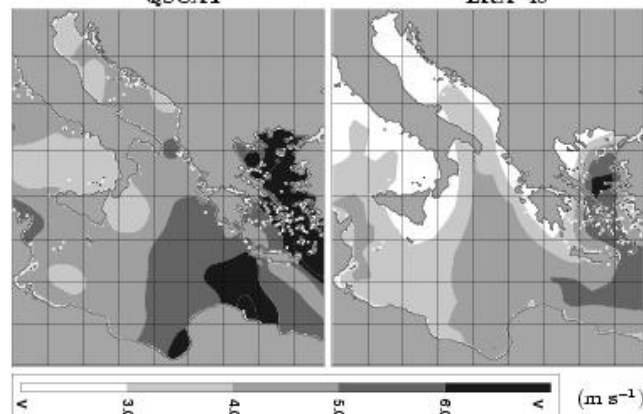
(b) Difference from QSCAT winds during Aug 2001
cERA-40   ERA-40
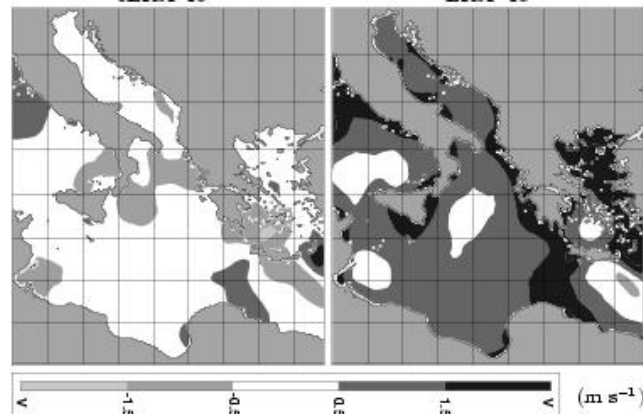
-1.5   -0.5   0.5   1.5   (m s^{-1})

Fig. 2. Spatial variation of QSCAT and ERA winds, and differences for the corrected (cERA-40) and original (ERA-40) with respect to QSCAT.

Conclusions

A near optimal solution to obtain reliable winds near the land-sea boundaries would be to launch new satellites. That will provide a higher time and space resolution than existing ones now.

Reference

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