Long-term Variability of Ocean Surface Winds

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Introduction

Just a few decades ago, almost all ocean wind measurements came from merchant ships. However, the quality and geographical distribution of these wind reports were uneven. The quality of historical wind-stress have been well investigated [e.g., Cardone et al., 1990; Trenberth, et al, 1990; Kent et al., 1999]. Today, operational numerical weather prediction (NWP) also gives us wind information, but NWP depends on models, which are limited by our knowledge of the physical processes and the availability of data. Spacebased sensors have been shown to provide superior high wavenumber wind forcing of global oceans [Liu et al.,1998]. The European Remote Sensing (ERS) satellites have provided over ten years of ocean surface wind vectors [e.g. Quilfen et al., 200]. Considerable amount of science application have made use of the almost five years of data from QuikSCAT at much higher spatial and temporal resolutions [see Liu 2002 for a review]. The Special Sensor Microwave/ Imager (SSMI) have been in operation since 1978, but only wind speeds are retrieved from the radiance. The SSMI wind speeds have been combined with other directional information to provide fourteen years of ocean surface wind vectors, whose application in forcing the ocean have been demonstrated [e.g., Busalacchi et al., 1990; Liu et al.,1996]. This paper intends to examine the long-term and low-frequency variability of the ocean surface wind-field derived from these spacebased sensors .

Long-term Trend

Sato et al. [2002] found long term trends in ocean Ekman heat transport driven by ERS wind vectors over major oceanic regions. The results imply a weakening the zonal component of wind stress. There were no collaborative evidence from other wind data on this trend were shown. We were able to find two clusters of buoy data to validate such trends. The first one is composed of C-MAN buoys of the National Data Buoy Center in thecentral andwestern pacific between 6-12°N. The other are the Tropical Atmosphere and Ocean (TAO) buoys in the eastern Pacific between 5°N and 5°S. Fig. 1 shows that observations from ERS scatterometers agree with both SSMI and buoy data in showing a decreasing easterly component and speed in the monthly data and the interannual anomalies. The trend is particularly clearl between 1992 and 1997. Such trends have not been clearly duplicated from other satellite data sets. A more comprehensive examination of the long-term variability of spacebased vector wind measurements is needed.

Low-frequency Variability

In this study, the annual mean, the seasonal cycle, the interannual anomalies, and the long-term trends of the three sets of pacebased data (from ERS, QuikSCAT, and SSMI) are examined and compared with those derived from data measured at moored buoys and from the reanalyses of numerical weather prediction centers. Their geographical relations and relation with other pertinent environmental parameters will also be discussed.

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References:

Busalacchi, A.J., R.M. Atlas, and E.C. Hackert, 1993: Comparison of Special Sensor Microwave Imager vector wind stress with model-derived and subjectiv products for the tropical Pacific. J. Geophys. Res. 98, 6961-6977.

Cardone, V.J., J.G. Greenwood, and M.A. Cane, 1990: On trends in historical marine wind data. J. Climate, 3, 113-127.

Kent, E.C., P:G. Challenor, and P.K. Taylor, 1999: A statistical determination of the random observational errors present in voluntary observing ships meteorological reports. J. Atmos. Oceanic Technol., 14, 228-242.

Liu, W.T., 2002: Progress in scatterometer application, *J. Oceanogr*., **58**, 121-136.

Liu, W.T., W. Tang, and R. Atlas, 1996: Responses of the tropical Pacific to wind forcing as observed by spaceborne sensors and simulated by model. *J. Geophys. Res.,* ***101***, 16,345-16,359.

Liu, W.T., W. Tang, and P.S. Polito, 1998: NASA Scatterometer provides global ocean-surface wind fields with more structures than numerical weather prediciton. *Geophys. Res. Lett*.,**25**, 761-764

Sato, O., P.S. Polito, and W.T. Liu, 2002: Interannual and intra-decadal variability in the Ekman heat flux from scatterometer winds. *Geophys. Res. Lett*.,29(17). 1831, doi:10.1029/2002GL014775.

Trenberth, K.E., W.G. Large, and J.G. Olson, 1990: The mean annual cycle in global ocean wind stress. J. Phys. Oceanogr., 20, 1742-1760.

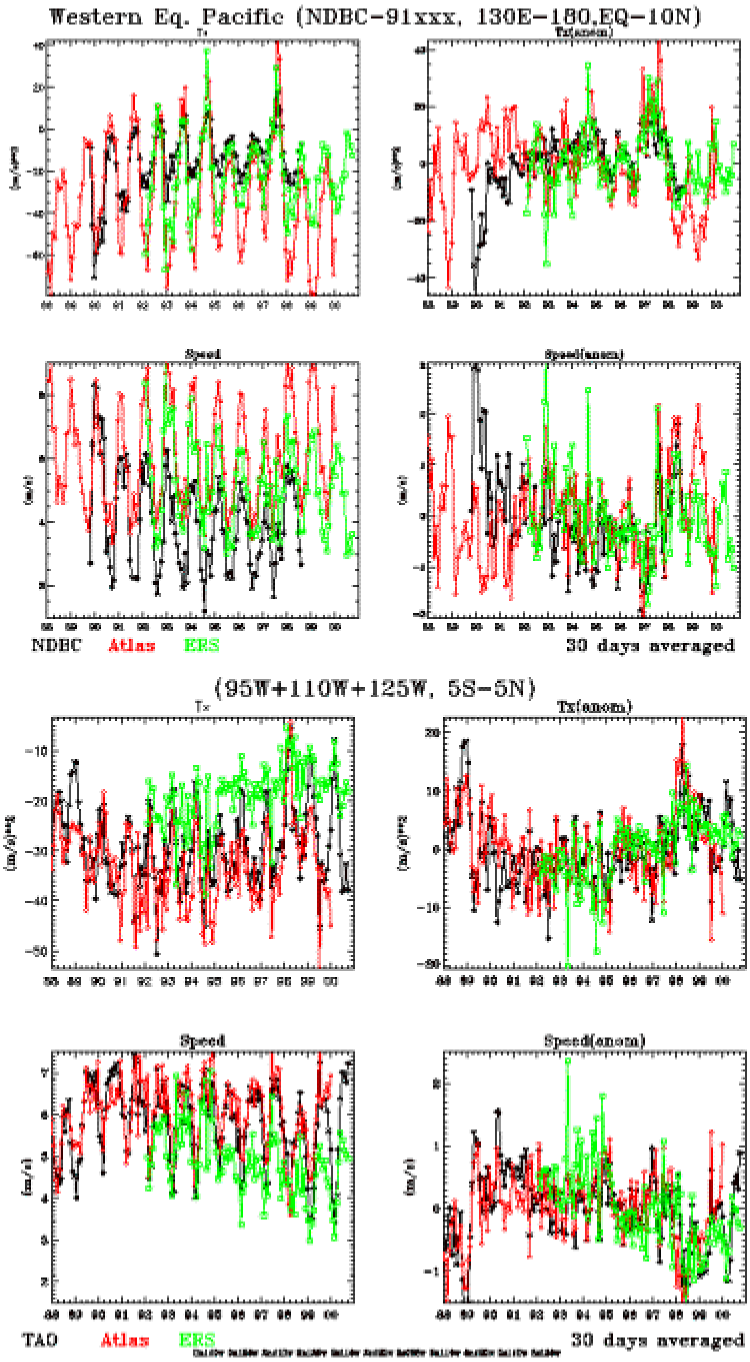

Fig. 1 Time-series comparison of the 30-days mean zonal wind stress and wind speed and their interannual anomalies in two regions measured by moored buoys, the ERS scatterometers, and derved from SSMI.