

AN EXPERIMENT FOR HIGH SPEED RETRIEVAL BY ENVISAT-ASAR CROSS-POLARIZED OBSERVATIONS

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ABSTRACT

We present a new empirical C-band cross-polarization ocean backscatter model for high wind retrievals, from ENVISAT-ASAR. The model relates normalized radar cross section (NRCS) in cross-polarization (VV/VH) to the wind speed at 10-m height. This wind retrieval model has the remarkable characteristic that it is independent of SAR radar incidence angles or wind directions but is extremely linear with respect to wind speeds, especially high winds. To evaluate the accuracy of the proposed model, winds were retrieved from a dual-polarization ASAR image of storm surge and to retrieve wind direction by CMOD5, using the new model and compared with ASAR data. A root mean square error of retrieval wind speed is about 1.13m/s in new empirical C-band model and wind direction is about 16.16°.

Index Terms: ENVISAT-ASAR, cross-polarization, high winds, Advanced Scatterometer, CMOD5

1. INTRODUCTION

Wind vector of sea surface is an important physical parameter of naval meteorology. It is the most basis and important element during much process, such as the field of ocean and weather. There are two sensors usual to use measure wind vectors; they are Passive Radiometer and Active Radar (Altimeter, Scatterometer and Synthetic Aperture Radar). Among these, Synthetic Aperture Radar (SAR) is playing a greater role as it has high spatial resolution, large spatial coverage and can deliver data independent of cloud cover. There are three approaches usual to retrieve wind vectors by Co-polarization SAR data. The first one is based on the analysis of spectral features of SAR imagery [1]; it uses an empirical linear relation to evaluate wind speed from imagery azimuth cut off frequency. The Second approach retrieves wind vector from the radar cross section,

which can be expressed as function of wind vector, direction and radar incidence angle [2,3] Another method is data assimilation. In recent years, several empirical geophysical model functions (GMF), such as CMOD4 [3], CMOD_IFR2 [4], CMOD5 [5] and CMOD5.N [6,7] have been employed, which relate the normalized radar cross section (NRCS) of the ocean surface to the local near-surface wind speed, wind direction relative to antenna look direction, and radar incidence angle.[8].

But the Single Polarization SAR images data have their narrow limitation. The first is that only one the radar cross section of azimuth direction is difficult to ascertain wind direction. Another is that Saturation signals of Radar happen when retrieve high wind speed. Zhang biao et al. provides a new method to retrieve high wind speed by cross polarization. HWANG et al analyzed the feasibility of this method in terms of theory [9]. They analysis of RADARSAT-2 quad-polarization and dual-polarization data collocated with in-situ ocean wind measurements shows that depolarized radar backscatters do not saturate. The nearly cubic wind speed dependence of the depolarized radar backscatters at high wind speeds reflects significant breaking wave contributions. The increased sensitivity in high winds is especially valuable for hurricane wind retrieval [9].

2. METHODS AND RESULTS

In this paper, we provide a new method to retrieve wind vector by (ENVISAT_ASAR) double polarization data of Radar (vertical polarization VV and cross polarization VH). As they have differences in the equipment itself, different calibration and noise floor between RADARSAT-2 and ENVISAT. We use 60 images of ENVISAT ASAR (VV-VH polarization) data (Medium resolution); pixel distance is 75m, 100×100 pixels as a unit of account. As we acquire ASAR double polarization data no buoys data compare with them, so we use Advanced Scatterometer data (549 data). The maximum differences in longitude and latitude are 0.15° and 1h in time.

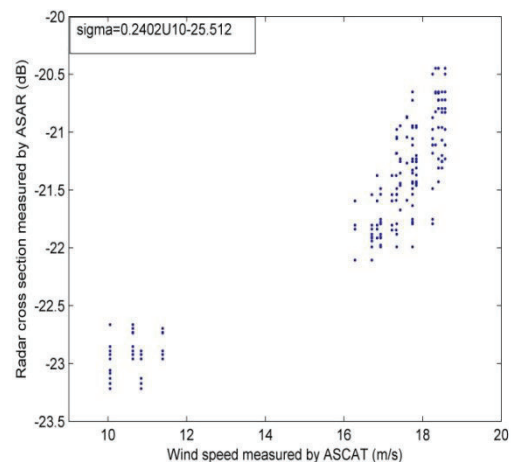


Figure1 Scope of data to fit equation

We use wind speed >8m/s data (342 data) to fit relation between the normalized radar cross section (NRCS) to wind speed (see equation 1).

$$\sigma = 0.24U_{10} - 25.51 \quad (1)$$

Where σ is NRCS, U_{10} is wind speed. We use 207 data to validate equation (1) (see Figure2) and to retrieve wind direction by CMOD5 (we use start wind speed and wind direction of ASCAT to remove blur) that compare with ASCAT data (see Figure 2 and 3). The wind speed yield average absolute bias, average absolute error, and root-mean-square error of -2.0m/s, 2.6m/s, and 3.2m/s, respectively. The wind direction is 1.0°, 30.3°, and 38.8°, respectively.

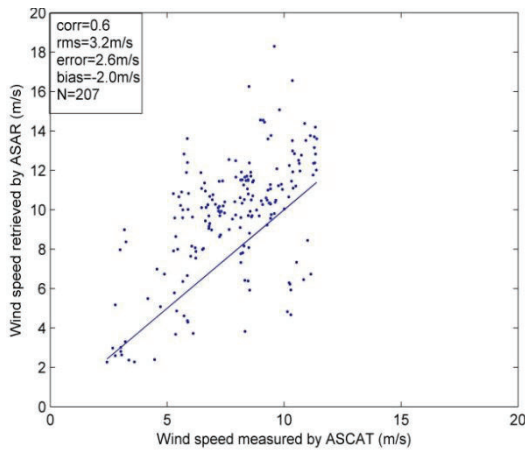


Figure2 Scope of data to compare ASCAT with ASAR data

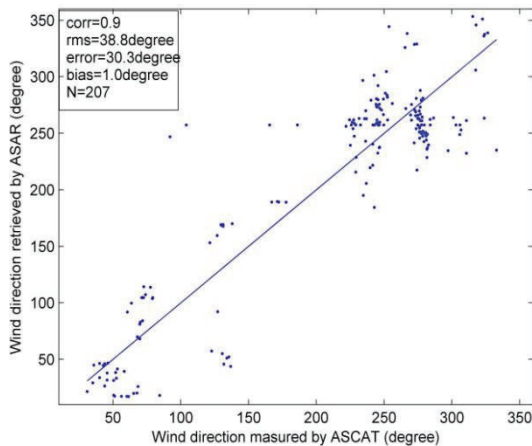


Figure3 Scope of data to compare ASCAT with ASAR data

We use ASAR high wind data (2011-12-14-21: 35) to retrieve wind speed and to retrieve wind direction by CMOD5 (we use start wind speed and wind direction of ASCAT to remove blur) that compare with ASCAT data (see Figure 4 and 5) to verify equation (1) yield average absolute bias, average absolute error, and root-mean-square error of 0.05m/s, 1.13m/s, and 1.41m/s, respectively. The wind direction is -0.16°, 13.04°, and 16.16°, respectively.

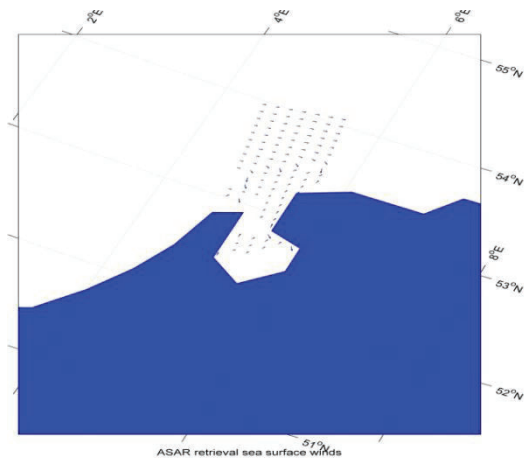


Figure4 Wind vector measured by ASAR

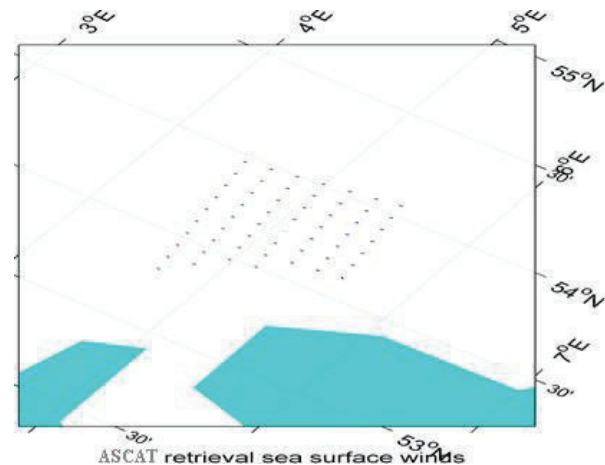


Figure 5 Wind vector measured by ASCSAT

3. CONCLUSIONS

We found that when the wind speed $<15\text{m/s}$ is not good by equation (1) as noise floor. In a word, the high wind speed retrieves by equation (1) is feasible from ENVISAT ASAR (VV-VH polarization) data. Next work is to validate equation (1) by more data.

4. ACKNOWLEDGMENT

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