Abstract

We propose a new analytical C-band polarization ratio (PR) model derived from RADARSAT-2 observations and buoy measurements. A set of 620 RADARSAT-2 Fine Quad-Pol (HH+VV+HV+VH) data from the East and West coasts of North America, Gulf of Mexico and Gulf of Alaska have been collected and collocated with National Data Buoy Center (NDBC) buoy measurements within a spatial interval of 10 km and a time interval of 30 min. The proposed polarization ratio model is found to be not only dependent on radar incidence angle but also to exhibit some correlation with ocean surface conditions (winds and waves), and with a more notable correlation with significant wave steepness. We find that its dependence on incidence angle is significantly different from empirical models previously presented in the literature.

For assessment of the new polarization model, we combine RADARDAT-2 HH-polarized ScanSAR narrow imagery for different sea states with various empirical geophysical model functions (GMF) and our new PR model, as well as empirical PR models previously proposed in the literature, to retrieve wind speeds. The performance of wind speed retrieval from different PR models is analyzed. We found that our new PR model is able to produce more reasonable wind speed estimates from HH-polarized RADARSAT-2 data than the other PR models.

Index terms: Polarization ratio model, Wind speed, RADARSAT-2

1. Introduction

Frequent global measurements of ocean surface vector winds are important to understand atmospheric dynamics and the coupling of the oceanic and atmospheric systems, as well as to aid meteorologists in the preparation of their forecasts. In recent years, a growing interest has been expressed for using synthetic aperture radar (SAR) to estimate ocean surface wind, either because scatterometer data are less available now, or because the horizontal resolution that can be obtained with the SAR is potentially very interesting for coastal applications. RADARSAT-1 only functioned in HH polarization, and this led to some difficulties because the empirical CMOD-type models were established in VV polarization only. Their transposition to HH is still uncertain as indicated by the amount of recent or on-going research on this subject [1]-[5] which include some contradictions between the results of the different studies [9]. However, the successful launch of the new C-band microwave satellite RADARSAT-2 provides a very important chance to study the polarization ratio due to this new satellite because it is able to image of ocean surface with a beam model of Fine Quad-Pol (HH+VV+HV+VH). The purpose of this paper is to derive a new polarization ratio model by using RADARSAT-2 Fine Quad-Pol imagery for different sea states, which can be used to transfer the HH-polarized normalized radar cross section (NRCS) into VV-polarized NRCS and moreover, to retrieve wind speeds with various empirical geophysical model functions (GMF).

2. Dataset

The dataset for derivation of the new polarization ratio model comes from the matchups of RADARSAT-2 Fine Quad-Pol observations and buoy measurements. The buoy data were obtained from the National Data Buoy Center (NDBC). A set of 620 RADARSAT-2 Fine Quad-Pol (HH+VV+HV+VH) data from the East and West coasts of North America, Gulf of Mexico and Gulf of Alaska were collected and collocated with National Data Buoy Center (NDBC) buoy measurements within a spatial interval of 10 km and a time interval of 30 min. The range of incidence angle for Quad-Pol imagery is between 20° and 41°. The scene size of each Quad-Pol image is $25*25\,\mathrm{km}$. Each radar resolution cell has dimension of 4.73 m (range direction) and 4.79 m (azimuth direction).

3. Method and Results

Based on nonlinear least-squares method, we derive a new polarization model as a function as radar incidence angle, which is given as following

$$P(\theta) = A\exp(B\theta) + C, \quad [\text{linear units}] \tag{1}$$

with A , B , and constant coefficients. Table 2 gives the corresponding coefficients. Figure 1 show the new polarization ratio model and a comparison with other empirical models previously presented in the literature.

For assessment of the new polarization model, we combine RADARDAT-2 HH-polarized ScanSAR narrow imagery for different sea states with various empirical geophysical model functions (GMF) and our new PR model, as well as empirical PR models previously proposed in the literature, to retrieve wind speeds. The performance of wind speed retrieval from different PR models is analyzed. We found that our new PR model is able to produce more reasonable wind speed estimates from HH-polarized RADARSAT-2 data than the other PR models.

Table2. Coefficients of proposed new polarization ratio model

Coefficient	Fitted values
A	0.1637
B	0.0558
C	0.5410

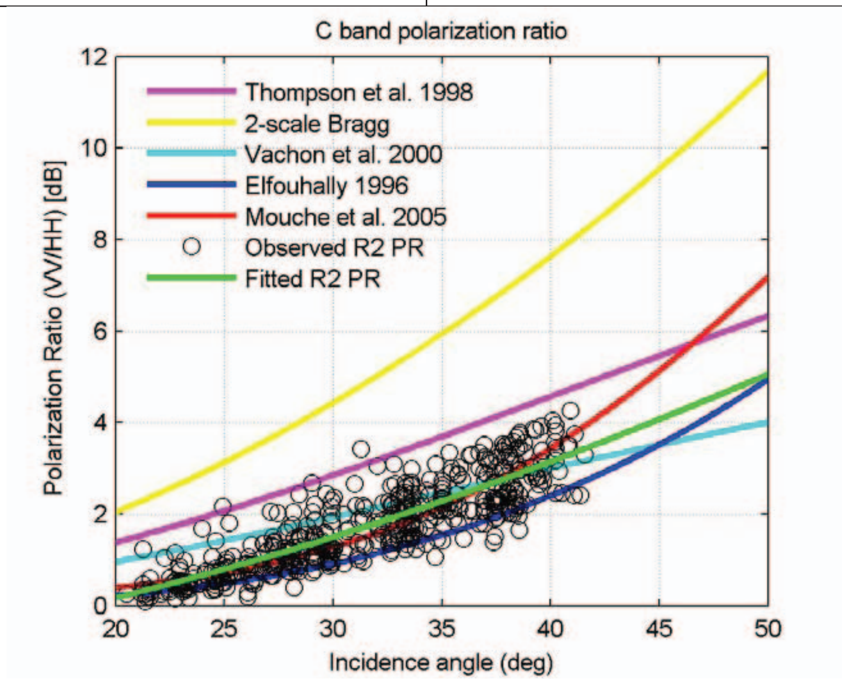

Figure1. Polarization ratio as a function of incidence angle, from the RADARSAT-2 Fine Quad-Pol dataset.

Reference

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