A STUDY ON GEOPHYSICAL MODEL FUNCTION MODELING WITH WATER SURFACE TEMPERATURE AS ONE OF THE INPUT PARAMETERS

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1. INTRODUCTION

Currently, scatterometer is the main instrument that can accurately measure the wind speed and direction over the ocean surface due to its ability of acquiring multiple observations with different look angles. Geophysical Model Function (GMF) is the basis for wind retrieval using the scatterometer data. Since the launching of the SeaSAT-A satellite in 1978, many empirical GMFs have been developed for operational wind retrieval[1-5]. But all the operational models such as CMOD series and Qscat-1 did not take the water surface temperature into account in modeling. Both theory and experiments indicate that not only is the backscattering coefficient related to the several key factors including wind vector (speed and direction), and radar observing parameters (wavelength, polarization, incidence angle, and azimuth angle, etc.), but also it is influenced by some environmental factors such as ocean surface temperature, density, salinity, currents, and so on[6,7]. Therefore, some error must be resulted from using these models in wind retrieval.

According to the problem of these existing models mentioned above, this paper attempts to develop a new geophysical model function, in which the effect of water surface temperature on the radar backscattering coefficient is considered. We refer to such a GMF as WST-GMF in this paper.

2. DATA AND METHOD

Taking SeaWinds scatterometer as an example, we choose its some L2A data and corresponding buoy data from NODC (National Oceanographic Data Center) to conduct WST-GMF modeling experiment. To establish a WST-GMF, the data of backscattering coefficient, radar incidence angle, azimuth angle, polarization, wind speed and direction, and water surface temperature are needed. The backscattering coefficient, incidence angle, azimuth angle, and polarization measurements are collected from the SeaWinds L2A data, while the wind speed and direction, water surface temperature are extracted from the buoy data. The temporal coverage of L2A and buoy data used in modeling experiment is about from January 2001 to January 2002, nearly one year. 51 buoys are selected to set up the modeling data. Before modeling, these two types of data are filtered and spatially and temporally matched well with each other using a specifically designed preprocessing algorithm.

Because the modeling data do not uniformly distribute in the parameter space, the traditional statistical method is not effective for modeling. So we utilize the artificial neural network to establish the WST-GMF owing to its high noise immunity and data incompleteness tolerance. The neural network we design has four layers, including one input layer, one output layer, and two hidden layers. The input layer consists of five parameters, which are wind speed, sine function
value of the relative wind direction, cosine function value of the relative wind direction, incidence angle (or polarization), and water surface temperature. The output of the neural network is the backscattering coefficient. In addition, for the sake of comparison, we divide the modeling data into two subsets—ocean water modeling data subset and fresh water modeling data subset—according to the data’s geographical locations. The data for the Great Lakes in north America is extracted from the whole modeling data as the fresh water modeling data subset, while the remain data composes the ocean water modeling data subset. Then, two WST-GMFs are established using these two data subsets.

3. EXPERIMENT RESULTS

With regard to the ocean water WST-GMF, the experiment results indicate that in the wind speed interval ranging from 3 to 15 m/s, ocean water surface temperature has more effect on the backscattering coefficient at the lower wind speeds than at high wind speeds, and the effect degree decreases with increasing wind speed. There are similar effect features under the fresh water condition, but the extent of temperature effect for fresh water is dramatically larger than that for the ocean water, which means that the salinity plays a significant part in the response of backscattering coefficient to water surface temperature.

4. CONCLUSIONS

From the experiment results, it can be concluded that the effect of water surface temperature on the backscattering coefficient can be quantitatively characterized by the established WST-GMF. Therefore, it is expected that the error of wind vector retrieval can be reduced by using the WST-GMF. Meanwhile, it must be noticed that more L2A and buoy data will be needed to establish a more accurate WST-GMF, but the modeling idea and method presented in this paper are still applicable for reaching such a goal.

5. REFERENCES