OCEAN SURFACE WINDS MEASUREMENT USING REFLECTED GNSS SIGNALS

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1. INTRODUCTION

Signals of the Global Navigation Satellite System (GNSS) can be used for purposes rather than navigation and positioning. Reflected GNSS signals can also be used to obtain ocean surface wind speed and direction. Contrasted with traditional means of ocean surface winds measurements, the technique based on reflected GNSS signals has many benefits. For example it can provide accurate, real-time, high-resolution measurements of ocean surface wind velocities, under all weather conditions. So many research organizations in the U.S. and Europe (NASA Langley Research Center(LaRC), University of Colorado(CU), European Space Agency(ESA), etc.) began to investigate the technique since 1990s[1,2,3,4]. But until early 21st Century, scientists in China began to investigate the technique. Designed a special GNSS reflection signals receiver and took a series of campaigns of aircraft flights to demonstrate this technique. Based on the aircraft flight experiments taken in China, this paper presents a modified retrieval algorithm for the estimation of ocean surface winds using reflected GNSS signals. In order to verify the accuracy of the retrieval algorithm, the retrieval results have been compared with the QuickSCAT satellite's ocean surface winds sounding results. The retrieval accuracies of wind vectors are 2m/s wind speed and 2 deg wind direction.

2. EXPERIMENT DESCRIPTION

The Institute of Remote Sensing Applications, Chinese Academy of Sciences (IRSA,CAS), cooperated with Beihang University, first began flight campaigns to collect reflected GNSS signals in the coast of Bohai Sea in China. The collection had been completed by nine aircraft flights between August, 2004 and January, 2005, and the nine aircraft flights' courses had been shown in Figure.1. The airplane platform in these experiments is shown in Figure 2. A modified GNSS signals receiver--Delay Mapping Receiver (DMR), acts as the bistatic receiver to measure forward scattering GNSS signals, which are then used to infer the ocean surface characteristics of interest. Upon reflection, the right-hand circularly polarized (RHCP) GNSS signal becomes predominantly left hand circularly polarized (LHCP) for a conducting dielectric surface like sea water. Thus, the DMR uses RHCP antenna to view direct signals for navigation and positioning, and LHCP antenna to view reflected signals for ocean surface winds measurement.

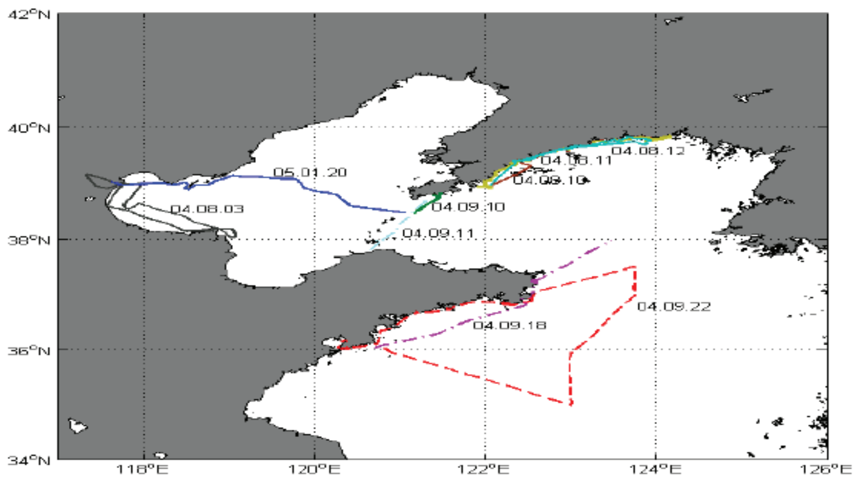

Fig.1 The nine aircraft flights' courses

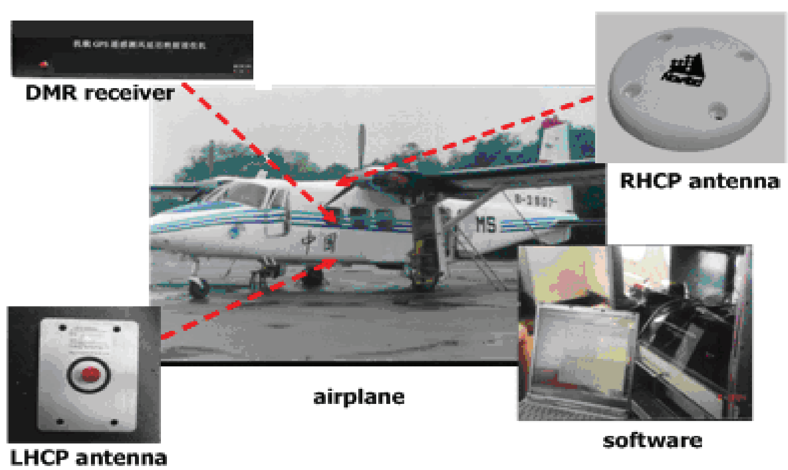

Fig.2 The airplane platform of the experiments

3. METHODOLOGY

It had been recognized that the reflection of electromagnetic radiation from the ocean surface contains information about the ocean environmental parameters. The information is indirectly related to the sea surface meteorology conditions. This relationship forms the basis of ocean surface wind remote sensing using reflected GNSS signals.

The model used to characterize the interaction of the GNSS signals and sea-water in this paper is based on Zavorotny and Voronovich (Z-V) electromagnetic model. The Z-V model is a bistatic, forward-scattering radar equation. The model was derived using the geometrical optics limit of the Kirchhoff approximation and had been extensively documented in [5,6,7,8]. The Z-V model was used to generate the predicted shape of reflected signal power waveform as a function of ocean surface wind speed and wind direction. When the comparison between the predicted reflected signal power waveform with the experimental reflected signal power waveform, we can determine the optimal wind-field estimate results.

In this paper, I modified the Z-V model, introduced the noise power model. Atmosphere loss and signal to noise ratio are considered in the modified model. Doppler waveform and two dimensional delay-Doppler waveform of ocean scattered signal was also described.

4. CONCLUSIONS

China first aircraft flight experiments for ocean surface winds sounding was done with the self designed GNSS reflection signals receiver. Based on the aircraft flight experiments, this paper presents a modified approach to realize the estimation of ocean surface wind vectors using reflected GNSS signals. The accuracies of wind vectors are 2m/s wind speed and 2 deg wind direction compared with QuickSCAT satellite's scatterometer sounding results. I hope this paper will help more and more Chinese researches to pay close attention to this field of research.

5. REFERENCES

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