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論 文 名　：Research on Waveform Data of Radar Satellite Altimeters
（レーダー衛星海面高度計の反射信号波形に関する研究）
Title

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Category

論 文 内 容 の 要 旨
Thesis Summary

Radar altimeters transmit modulated chirp pulses towards the sea at nadir, and then record the returned echoes which were reflected from the sea surface in an altimeter footprint. Time series of the power of received echoes by altimeters is usually known as “waveform”. Geophysical parameters are retrieved by a process called “waveform retracking”, which consists of fitting a theoretical model response to the measured waveforms. Over the open ocean, so-called Brown mathematical model is always treated as the standard model. The fundamental parameters derived from waveform retracking are the satellite height above the sea surface (range), the significant wave height (SWH) and the backscatter coefficient (sigma0) related to sea surface wind. In addition, subsequent studies have also indicated the possibility of retrieving a wave period parameter from SWH and sigma0 measurements of altimeters, and numerous empirical models have been proposed in the last two decades. Moreover, in contrast to open ocean, the radar altimeter data gathered over the coastal zones (particularly, within 10 km from the coastline) are always flagged as “bad” due to the issues of land contamination in the footprint and intrinsic difficulties in the geophysical corrections. In this thesis, two issues on waveform retracking are studied and described in separated parts Ⅰand Ⅱ; namely, wave period retrieval and waveform retracking over coastal zone, respectively.

Part Ⅰ: Recent researches have investigated the possibility of deriving an altimeter wave period parameter from the SWH and sigma0 measurements. Several retrieval models have been proposed, but the results of these studies show that wave periods estimated from satellite altimetry data behave differently from those calculated from buoy data, especially in low-wind conditions. In this thesis, the geometric mean wave period *Ta* is calculated from buoy data, rather than the commonly used zero-crossing wave period *Tz*. The geometric mean wave period uses the fourth moment of the wave frequency spectrum and is related to the mean-square slope of the sea surface measured using altimeters. The values of *Ta* obtained from buoys and altimeters agree well (root mean square difference: 0.2 s) only when the contribution of high-frequency sea waves is estimated by a wavenumber spectral model to complement the buoy data, because a buoy cannot obtain data from waves having wavelengths that are shorter than the characteristic dimension of the buoy.

Part Ⅱ: Altimeter waveforms are corrupted at coastal zones due to due to the heterogeneous reflective surfaces over altimeter footprint. The waveform corruption mainly consists of two types:

1) waveform corruption due to the effect of land contamination. Around the coastal area, the returned echoes reflected from the targets located above the mean sea surface such as land superimpose on the ocean returns. Generally, the power of land reflection is much weaker than that reflected from the sea surface. Even for the case of highly reflective point targets, like artificial construction, ship and iceberg etc., the echoes returned from these targets present as “speckle” noises and only appeared at the waveform thermal noise area. On the other hand, a

power deficit can be seen in waveform trailing edge due to the weak reflection from land in altimeter footprint. The power deficit exceeded the normally decaying which controlled by the antenna beam pattern in the theoretical Brown model.

2) waveform corruption due to the inhomogeneous of the sea surface reflectivity. This is known to happen in particular for semi-closed seas, where the sea surface usually smoother than surrounding waters. The calm semi-closed seas can be seen as bright targets in the radar signal. Reflections from the calm water seriously corrupted waveforms and present as redundant peaks in the waveform trailing edge. Previous research has been pointed out that two of the predominant coastal waveform classes are quasi-specular and multi-peak echoes. Both of them are connected with the presence of bright targets like calm water.

Since coastal waveforms are generally complicated, it is difficult to distinguish whether an echo is corrupted in a single waveform. In previous studies, sub-waveform retrackers which use only the waveform leading edge are recommended for coastal waveform ratracking. Different from the sub-waveform retrackers, the along-track waveforms (echogram) are used in this thesis considering its spatial distribution. In fact, the strong reflections from calm water obviously present as a parabola in the echogram. Utilizing the parabolic signature, these noises which are difficult to distinguish in individual waveform are explicitly selected and removed in this study. In addition, the power deficit due to weak land reflection is also compensated. The method has been performed to Jason-2 altimeter 20Hz data around Tsushima in Japan. Results show that the correlation coefficient of sea surface height anomaly (SSHA) derived from altimeter and tide gauge measurements remains larger than 0.9 even at about 3km depart from coast. The root mean squared difference is about 20cm.