USE OF THE MERGED DUAL-FREQUENCY RADAR ALTIMETER BACKSCATTER DATA OVER CHINA LAND SURFACE

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Abstract

Radar altimeter [1] is an active microwave sensor, which designed to measure the instantaneous sea surface height, wave and backscatter of the open ocean surface at the nadir point of satellite. The capability of radar altimeter [2, 3] for land surface studies at regional or global scale has been demonstrated. Different types of land surfaces can be clearly distinguished using dual-frequency altimetry backscatter measurements. It is a new way to investigate continental surfaces using radar altimeter, besides scatterometers and Synthetic Aperture Radar (SAR) among the active microwave remote sensing sensors. The scatterometer [4] and SAR [5] operate at the large incidence, while the altimeter works at the nadir point of satellite, which means that the scatterometer and SAR measurements provide only information on vegetation canopy and none on underlying surfaces, while altimeter microwave signals penetrate much deeper. Furthermore, the scatterometer and SAR operate at single frequency, while modern altimeter works at dual-frequency (Jason1/2: Ku and C band, Envisat RA2: Ku and S band), which can measure the backscatters from different layers instantaneously. However, the spatial and temporal converges of single radar altimeter are rather low, since the swath width of altimeter is only about 10km at the nadir point of satellite.

The aim of this paper is to merge multi-radar altimeter dual-frequency backscatter measurements over land surface to achieve better spatial and temporal resolution. For this purpose, we use data from three dual-frequency altimeters: Poseidon2 [6] and Poseidon3 on board the CNES/NASA satellite Jason1 and Jason2, respectively, which have a 9.91-day repeat cycle and provide measurements in Ku (13.6 GHz) and C (5.4 GHz) bands; RA2 [7] on board the ESA satellite Envisat, which has a 35-day repeat

cycle and provides measurements in Ku (13.6 GHz) and S (3.5 GHz) bands. Two steps are used to merge the multi-radar altimeter data: cross-calibration and extrapolation. Firstly, data are cross-calibrated using Jason-1 backscatter measurements as reference. Systematic differences between backscatter estimates from two altimeters can be identified based on comparisons of their backscatter histograms assuming that the backscatter distribution measured by an altimeter is relatively stable over a sufficiently large geographical region and a long enough time periods. We compute The Cumulative Probability Distribution Function (CPDF) for the two altimeter backscatter distributions, and fit a smooth spine to the fixed CPDF. Then the cumulative percentage point for each binned value Sigma0_a of the CPDF to be adjusted is determined. From the spline fit to the fixed CPDF, we determine the value Sigma0_f which corresponds to this cumulative percentage value. Each backscatter value is adjusted by an amount of Sigma0_a-Sigma0_f, which brings the two histograms into exact agreement. Secondly, we average of a mono-mission array by 1°x1° boxes, smoothed and extrapolated by a Loess filter of 16° x 8° (gaps due to missing data are filled, signal is strongly smoothed). Extrapolation is limited to 8°x4°, in order to avoid artificially filling areas without data. Therefore, merged altimetry backscatter map over China land surfaces every 3 days are generated in Ku, C, and S band for the period from January 2006 to June 2009.

Finally, temporal profiles of backscatters are extracted for main land types (desert, tropical forest, wet and dry savanna) to validate the dataset and to analyze radar response to land surface variability through 3 years. The merged altimetry backscatter data at Taklimakan Desert, which locates at southwest of china and covers an area of 270,000km2 of the Tarim Basin, are examined. The behavior of Ku, C and S band backscatters over this well-known homogeneous and time-stable target surfaces is excellent. Over vegetated areas with a strong seasonal cycle, the multi-frequency measurements exhibit strong seasonal variations, which are promising to provide information related to the growing stage of vegetation. Since smaller frequency is less sensitive to the presence of leaves and can penetrate the foliage, the signal is also controlled by the underlying lower backscatter level ground echo, which is damped by the presence of vegetation.

Reference

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