Geophysical Research Abstracts
Vol. 14, EGU2012-230-1, 2012
EGU General Assembly 2012

Measurement and simulation of topographic effects on passive microwave remote sensing over mountain areas: a case study from Tibetan Plateau

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Mountain areas, occupying one quarter proportion of terrene area on the earth, characterize topography as the diversity of the mountain ecosystem and the hill-scale climate change, and also provide resource and services for equivalent to the one fourth global populations, among which Tibetan Plateau is known as the world famous mountain plateau. Because of topography land-surface hydraulic energy and thermal energy over mountain areas are redistributed, characterizing the diversity of mountain ecosystem and spatial heterogeneity under coarse-scale microwave pixels.

A ground-based experiment performed to measure relief effects on microwave radiation for C band. Relief effects we observed were dived into two parts, one is the primary terms varied with topographic geometry features (i.e. slope, orientation, elevation) with ± 12K bias against flat terrain, and the other is secondary terms caused by surface scattering from circumambient elevated terrain arisen 4K brightness temperature bias. It is much more important to prove relief effects, especially the primary effects, still have radiative influence in microwave pixels underlying the method of spatial convolution statistic analysis. The statistic analysis of the primary effects for normality indicates the presence of relief effects in the Tibetan Plateau in the tens of kilometers microwave pixel scale. Based on the microwave radiative transfer over the Tibetan Plateau mountain area the brightness temperature (T_B) simulation described the impact of topography including terrain geometrical properties and the complexity of terrain related to topographic roughness, on the microwave radiation of uncovered land surface at passive C-band.

According to the statistic analysis results, relief effects cannot be counteracted by the interaction from different topographic geometrical features in one microwave pixel. The simulated results correlated relevantly with T_B from the Advanced Microwave Scanning Radiometer (AMSR-E), for both the vertical polarization and the horizontal polarization, and their error within ± 1K, which validates the reliability of the relief simulation model. In this way, the maximal biases of T_B ($\Delta T_B = T_{B\_relief} - T_{B\_flat}$) for V-polarization is -16K, and 18K for H-polarization. The soil moisture error (ΔSM=SM_{relief}-SM_{flat}) due to relief effects is more than 4%, and the maximal error soars to 16% volume percentage in the most rugged terrain of mountain areas. Exploring relief effects on microwave radiation and soil moisture retrieval will contribute to a more feasible possibility of the topographic correction for passive microwave remote sensing, whereupon derived more accurate ecosystem information for mountains.