Subtraction of Rough Soil Surface Scattering in SWE Retrieval at X and Ku Band using SnowSAR Data from SnowEx 2017

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ABSTRACT

The physical basis of snow water equivalent (SWE) retrieval using X and Ku band radar observations is that the volume scattering of snow is assumed to increase with SWE. However, for small to moderate SWE, the total radar backscattering signal at X and Ku band contains effects of rough surface scattering. Therefore, rough surface scattering degrades sensitivity to SWE. To enhance the sensitivity and increase the correlation of X and Ku band radar observations with SWE, we propose to subtract out the rough surface effect. The subtraction procedure is as follows. Lower frequency radar backscattering data at L and C band are used to retrieve rms heights h and soil permittivity. The retrievals are based on lookup tables of rough surface scattering at L and C band. Then retrieved rms heights and permittivity are used to calculate surface scattering at X and Ku band. The volume scattering components of snow are obtained by subtracting out surface scattering from radar observations. To apply this procedure, we investigated using rough surface scattering results of physical models from L to Ku band. In this paper, we present results of soil surface scattering from L to Ku band based on the numerical solutions of Maxwell's equations in 3D (NMM3D) full wave simulations. Simulations results are plotted as a function of frequency for fixed rms heights and soil permittivity. In the past, physical model results have been limited within the range of $kh < 3$, where k is the free space wavenumber of the microwave signals. Full wave simulations have been limited in the past to $kh < 1.5$. In plains, rms height is up to 3 cm. In mountainous areas, rms height is up to 5cm. At a Ku frequency of 17.2 GHz, rms height of 5cm means $kh = 18$. Therefore, the past full wave simulations with $kh < 1.5$ are too limited. In this paper, we present results for kh up to 15. We simulate results for a wider range of rms heights from L to Ku band. We also perform and validate the subtraction procedure with L band UAVSAR and X and Ku band SnowSAR data from the SnowEx 2017 campaign.

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