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Modeling and Measurement of Multi-Frequency Microwave Emission of Soil Freezing and Thawing Processes

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Extended Abstract

Soil freezing and thawing processes in seasonally frozen ground influence surface energy and water fluxes and is important for many agricultural and environmental issues. An increase in the number of soil freeze-thaw cycles may alter the mechanical and physical properties, which could affect various hydrologic processes. Microwave radiometry provides good sensitivity to the soil liquid water content, and hence the near-surface soil freeze/thaw state could be detected from space[1]. Due to the differences in penetration of different frequencies, the combination of multi-frequency observations provides complementary information which can be used to better detect the near-surface freeze/thaw state and even physical properties of frozen ground.

In this study, a three-week radiometric measurement was conducted over a pastureland of seasonally frozen ground. Multi-frequency (L, C and X bands) and multi-angular (30° to 60° with 5° interval) microwave brightness temperature (Figure 1) was collected with corresponding ground parameters. It is found that the L, C and X bands have distinguished responses to soil freeze-thaw process. The L band is more sensitive to water phase transition and could sense a much deeper soil when is frozen. Modeling is adopted by using a multi-layer soil model to calculate the effective temperature and dialectic constant, and only roughness at the air-soil boundary is considered by using the AIEM model[2]. The soil medium below the surface is assumed to be plane-parallel. Simulation results are found to be consistent with ground measurements that the L band demonstrates a longer response to soil freezing process compared with C and X bands. These results are beneficial for model and algorithm study for the Chinese Water Cycle Observation Mission (WCOM)[3].

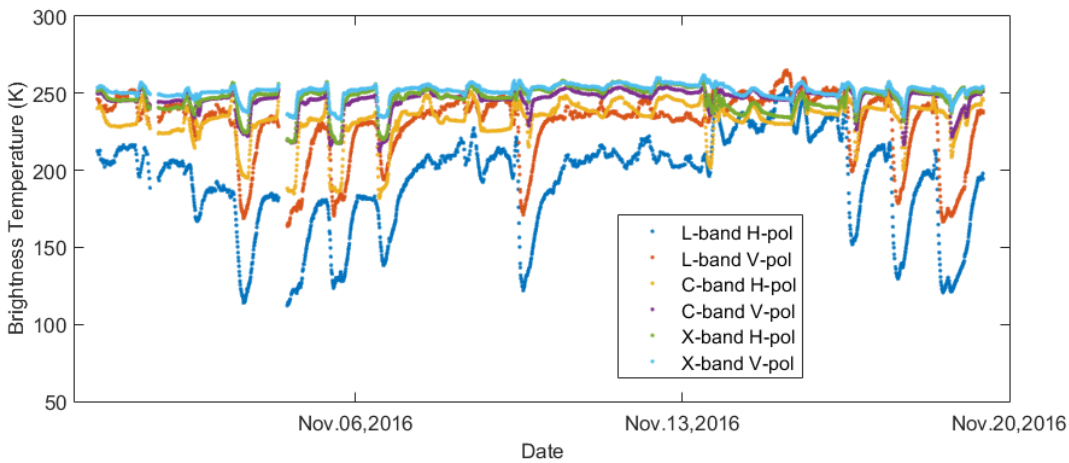

Figure 1. Multi-frequency (L, C and X bands) brightness temperature observed at incidence angle of 40°

References

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