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L-Band Emission of Soil Freeze-Thaw State in a Tibetan Meadow Ecosystem

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Soil freeze-thaw transition monitoring is essential for quantifying climate change and hydrologic dynamics over cold regions, for instance, the Tibetan Plateau. We investigate the L-band (1.4 GHz) microwave emission characteristics of soil freeze-thaw cycle via analysis of tower-based brightness temperature (TB) measurements using the ELBARA III radiometer in combination with simulations performed by a model of soil emission considering vertical variations of permittivity and soil temperature. Vegetation effects are modelled using the Tor Vergata discrete model. As part of Soil Moisture and Ocean Salinity (SMOS) and Soil Moisture Active Passive (SMAP) calibration and validation activities, the ELBARA III radiometer is installed on a 4.8 m high tower located in a seasonally frozen Tibetan meadow ecosystem to measure diurnal cycles of L-band TB. The daily measurements include elevation scanning sequences toward the ground and zenith (sky) measurements. The angular range considered for the elevation scans is performed every 30 min between 40°-70° (relative to nadir) in steps of 5°. The sky measurement is performed at 23:55 every day with an observation angle of 155°. Supporting micro-meteorological (e.g. solar radiation, air temperature and humidity) as well as soil moisture and temperature profile measurements are also conducted near the radiometer. Analyses of the measurements reveal that the impact on TB caused by diurnal changes of ground permittivity is generally stronger than the effect of changing ground temperature. Moreover, the simulations performed with the integrated Tor Vergata model and Noah land surface model indicate that the TB signatures of diurnal soil freeze-thaw cycle is most sensitive to the liquid water content of the soil surface layer, and the measurements taken at 5 cm depth are less representative for the L-band emission.