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Measuring L-Frequency Polarimetric SAR Volume Scattering Penetration on Lowland Tundra on Arctic Periglacial and Permafrost Terrains

Reginald Muskett
University of Alaska Fairbanks, Geophysical Institute, Fairbanks, United States (reginald.muskett@gmail.com)

Geodetic methods to measure centimeter to millimeter-scale changes using aircraft- and spacecraft deployed Synthetic Aperture RADAR (SAR) cannot ignore volume scattering. Backscatter and coherence at L-frequency and others possess both surface and volumetric scattering. On lowland tundra underlain by permafrost, volume scattering is the dominant backscatter mechanism. Measurement of the L-frequency penetration depth for evaluation of mass balance (i.e. gain or loss and transport) through permafrost thaw-degradation with erosion is necessary. UAVSAR L-frequency Full Polarimetry Cross-Pole HHVV (polarization rotation, i.e. HH send and VV receive) confirms the dominance of volume scattering on lowland tundra (RADAR-soft target, low bulk density) whereas surface scattering (HHHH or VVVV, no rotation) dominates on river channel deposits, rock outcrops and metal objects (RADAR-hard targets, high density). HHHH, HHVV and VVVV combined in 3-Channels illustrates that the sigma-naught polarizations are coming from the ground surface and subsurface (snow, above ground vegetation, root zone and soil volumes). With full Polarimetry-SAR information on the depth (i.e. depths) of penetration are within the two-way travel time polarizations. Validating and verifying L-frequency multi-polarization volume scattering penetration depth on lowland tundra calls for a new field validation experiment. Knowing this parameter is of vital importance as a reference, i.e. a benchmark, in near-term and decadal-term monitoring of the mass balance of carbon, soil and water.
Reference: Muskett, R.R. (2018), To Measure the Changing Relief of Arctic Rivers: A Synthetic Aperture RADAR Experiment in Alaska, Journal of Geoscience and Environment Protection, 6 (9), 207-222. doi: 10.4236/gep.2018.69016.