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The Importance of Volume Scattering in the Permafrost and Periglacial Terrains of Earth

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Measuring centimeter-scale and smaller surface changes by aircraft and satellite-based systems on the periglacial terrains and permafrost zones of Earth is an ongoing challenge. A drawback is that many investigations have ignored the fact that RADAR frequencies, for instance, in the P- and L-range interact with Earth materials and have high proportions of volumetric scattering on RADAR-Soft target terrains such as lowland tundra underlain by permafrost. This necessitates the direct measurement of the L-frequency penetration depth. To explore the consequences of this oversight we are conducting InSAR experiments across the northern of Alaska. To do this we are using data from the NASA Ice, Cloud, and land Elevation Satellite Geoscience Laser Altimeter System (ICESat GLAS), the JAXA Advanced Land Observing Satellite Phased Array type L-frequency Synthetic Aperture RADAR (ALOS PALSAR) and the aircraft-deployed NASA L-frequency UAVSAR. Collocation of ICESat GLAS exact-repeat profiles for elevation change (surface scattering) with PALSAR InSAR Line-Of-Sight (LOS) changes (volume scattering) and UAVSAR Polarimetry Cross-Pole HHVV (volume scattering) confirms volume scattering as the dominate RADAR scattering mechanism on tundra (RADAR soft targets) and surface scattering on river channel deposits and rock outcrops (RADAR hard targets). We emphasize the importance of recognizing topographic and tropospheric phase and mitigation of terrestrial radio frequency interference in successful InSAR processing to achieve valid centimeter and millimeter scale change estimates. Methods and techniques utilizing L-frequency SAR and Gravity (e.g. GRACE and GRACE-FO) measures the changes of volume over time. Forgetting this leads to critical errors of interpretations of Earth changes.

Ref.: Muskett, R.R. (2015), ICESat GLAS Elevation Changes and ALOS PALSAR InSAR Line-Of-Sight Changes on the Continuous Permafrost Zone of the North Slope, Alaska. International Journal of Geosciences, 6 (10), 1101-1115. doi:10.4236/ijg.2015.610086 http://www.scirp.org/Journal/PaperDownload.aspx?paperID=60406

Ref. Muskett, R.R. (2017), L-band InSAR Penetration Depth Experiment, North Slope Alaska. Geoscience and Environment Protection, vol. 5, no.3, p. 14-30. DOI: 10.4236/gep.2017.53002.