Passive Microwave Remote Sensing of Snowmelt and Freeze/Thaw in the Kuparuk Basin, Alaska, using Calibrated Enhanced-Resolution Brightness Temperature (CETB) from SSMI/S and SMAP

VICKI JAGDEO[1], JOAN M. RAMAGE[1], MAHBOUBEH BOUESHAGH[1], AND MARY J. BRODZIK[2]

ABSTRACT

The relationship between snow and permafrost on Arctic terrain has significant implications for water storage, flooding hazards, and infrastructure vulnerability. Studies show that earlier snowmelt and high runoff cause increased permafrost thaw and earlier freeze/thaw cycles, which can be especially problematic for communities in Arctic regions facing disproportionate warming from climate change. To analyze permafrost vulnerability due to snow dynamics, we compared snowmelt and soil moisture in the Kuparuk River Basin in Northern Alaska from 2010-2019. We used Calibrated, Enhanced-resolution Brightness Temperatures (CETB) from two passive microwave sensors, Special Sensor Microwave Imager/Sounder (SSMIS: F18) 37 GHz vertically polarized channel and Soil Moisture Active Passive (SMAP) at 1.41 GHz vertically and horizontally polarized channels. Snowmelt onset timing and duration are derived from SSMI/S brightness temperature (Tb) and diurnal amplitude variations (DAV) threshold exceedance which is sensitive to changing levels of liquid water content. Additional pixel level standard deviation statistics were used to understand dynamics and finer spatial differences. Soil thaw and refreeze dynamics are captured using the Normalized Polarization Ratio successfully utilized with SMAP data3, along with SMAP Level-3 L-band radiometer soil products. The end of high DAV corresponds with snow saturation and snow depletion. It appears that soil thaw is closely aligned in time with high DAV and continues to fluctuate above seasonal freeze thresholds until snow accumulation. We investigate the spatial patterns of multiple factors to test whether early snow melt, longer melt refreeze, early snow saturation and disappearance increase permafrost vulnerability at different elevations and environments.

[1] Department of Earth & Environmental Sciences, Lehigh University, Bethlehem, PA, USA
[2] NSIDC/CIRES, University of Colorado Boulder, Boulder, CO, USA
Corresponding author: vsj221@lehigh.edu