Potential of the Global Precipitation Measurement Constellation for Characterizing the Polar Firn

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This study explores the utilization of the Global Precipitation Measurement (GPM) constellation as a single multi-frequency spaceborne receiver with 11 channels from C- to W-band to profile important subsurface properties of the polar firn. No previous study has analyzed all of these channels together, and initial investigations focusing on the Concordia and Vostok stations in Antarctica have demonstrated that GPM brightness temperature measurements can provide information regarding the subsurface temperatures and physical features of the firn such as density and grain size from the surface (in W-band) down to a few tens of meters depth (in C-band). The firn temperature, density, and grain size are important indicators for the polar ice mass balance and climate; thus, their retrieval versus depth through spaceborne microwave radiometry has a potential to advance future polar studies significantly.

Data provided by the radiometers in two polar orbiting members of the GPM constellation, SSMIS and AMSR2, are considered in this research. A microwave radiation model has been developed, and top of the atmosphere brightness temperatures at the GPM frequencies are simulated throughout a year using typical ice sheet and atmospheric parameters based on in-situ measurements. Then, these parameters values are tuned to match the simulated brightness temperatures to the space-borne radiometer measurements for retrievals.

In this presentation, we will demonstrate the sensitivity of radiometer measurements at different GPM frequencies to ice sheet subsurface temperature, density and grain size properties at various depths. Then, a comparative analysis of Concordia and Vostok stations regarding their retrieved polar firn properties will be presented to validate the research. Finally, implications of this study on future radiometer designs will be discussed.