Dielectric Constant and Thickness Measurement of Dry Snowpack and Lake Icepack using Correlation Radiometry

Mohammad Mousavi1, Roger De Roo2, Kamal Sarabandi1, and Anthony W. England3

1Electrical Engineering and Computer Science Department, University of Michigan, Ann Arbor, MI
2Climate and Space Sciences and Engineering Department, University of Michigan, Ann Arbor, MI
3College of Engineering and Computer Science, University of Michigan, Dearborn, MI

Abstract

- Objective: The main goal is to estimate the amount of water in Earth’s terrestrial snow-covered regions. The knowledge of the distribution of snow-water equivalent (SWE) drives the mission objective.
- Importance of Snow and Ice: Important role in providing the water supplies for domestic, agricultural, and industrial purposes. Effects on human activities, such as industrial production, building, transport of goods and waste, sports, etc.
- Necessity of monitoring snow and ice: Significant changes in snow accumulation, timing, and melt.

Instruments and Measurement Approach

- Instruments: The Hamming window was used for the measured delay time by WIBAR at two distinct incidence angles: 
  - The measured time delay by WIBAR at two distinct incidence angles: 
    - Assuming c1 is real (low-loss pack): 
    - Using the measured c1p: 
    - Assuming pencil beam antenna and ideal conditions of the target, the error is mainly due to the error in the measured time delay (δt), and using the error propagation rule: 

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- Measurement Approach: 
  - The received power: 
  - Calibration: 
  - Antenna

Wideband Autocorrelation Radiometry

- Finding the vertical extent of the pack by measuring the time delay between the brightness temperature of the ground beneath the pack and its double-reflected signal from the lower and upper boundaries of the pack: 

Conclusions

- The potential of the WIBAR technique for material characterization was demonstrated.
- This technique can also be used to measure snowpack depth, density, and thus snow-water equivalent (SWE), by itself.
- The effect of the incident angles separation on the retrieved refractive index and thickness of a loss-less slab were demonstrated. For example, for the angle separations of more than 55°: 
- C = 0.35% and Δn = 0.35% (δr = 20 cm, Δn = 20 cm, n = 3.13).
- The measured refractive index and thickness of the fresh-water ice pack by WIBAR was 3.24 and 36.24 cm (Δn = 2% and Δr = 1.86%). The ground truth was about 35.66 cm.

Acknowledgements

- Support provided by NASA Terrestrial Hydrology Program contract NNX15AB36G and NASA Earth Science Technology Office contract NNX17AD26G.

References