Sub-Pixel Variability of the Measured Ice or Snow Pack Thicknesses using Wideband Autocorrelation Radiometer

MOHAMMAD MOUSAVI¹, ROGER DE ROO², KAMAL SARABANDI¹, AND ANTHONY W. ENGLAND³

ABSTRACT

The seasonal terrestrial snowpack is an important source of water for many parts of the globe. Snow’s high albedo, relative to the terrain in the absence of snow, is an important driver of Earth’s energy balance, and long term changes to the statistics of the snowpack’s properties are both a consequence and a cause of climate change. In most remote sensing applications, the gross parameter of the target, such as snow depth and snow water equivalent (SWE), are often the parameters of interest. A novel and new passive microwave remote sensing technique, known as wideband autocorrelation radiometry (WiBAR), offers a direct method to remotely measure the microwave propagation time difference of multipath microwave emission from low-loss layered surfaces such as a dry snowpack and freshwater Lake Icepack. The microwave propagation time difference through the pack yields a measure of its vertical extent.

The presence of variable pack thicknesses in a footprint of the radiometer’s antenna will add more complexity to the retrieved time delay. This issue is more severe for WiBAR on airborne and spaceborne platforms since the footprint will be large and contains more variable thicknesses. We present a simple forward model to include the variable thicknesses in one pixel and derive the system requirements needed to observe sub-pixel variability in the measured pack thickness. An X-band instrument fabricated from components-off-the-shelf (COTS) measured the thickness of freshwater lake ice at the University of Michigan Biological Station. Sub-pixel variability of 3 cm is demonstrated at incident angle of about 70°.

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