Dual-pol Passive Coherent Measurement of Snow-on-Ice near Grazing with WiBAR

SEYEDMOHAMMAD MOUSAVID AND ROGER DE ROO1

ABSTRACT

WideBand Autocorrelation Radiometry (WiBAR) is a passive microwave technique to measure the thickness of low-loss layers such as snow pack and lake ice pack. For wavelengths sufficiently long that the surfaces appear smooth and the scattering is negligible, the microwave brightness emitted from the first lossy material (the ground, or water) has at least two paths of different lengths to the microwave remote sensor. One path is directly upward through the low loss layers to the antenna; another path involves the reflection of the upward traveling brightness by the layer upper surface, then again by the layer lower surface, before traveling to the antenna. The noise in the second path is an attenuated and delayed copy of that in the first, and the delay, revealed as a non-zero local maximum in the temporal autocorrelation function (ACF) of the received waveform, is the observable signal.

When multi-layer structures exist, such as a snow pack on lake ice, multiple paths exist, which may confound the interpretation of the ACF. Dual pol measurements can be used to resolve the ambiguities. Due to its significantly higher reflection coefficients, H-pol often has observable delays regardless of incidence angle (nadir to at least 85deg), while V-pol often has no observable delays. However, near grazing, the V-pol reflection coefficients become sufficiently large for some of the interfaces in a snow over ice scene, while the H-pol reflection coefficients remain sufficiently large for most interfaces. As a result, the two polarizations provide complimentary information about the scene, and the snow depth, which could be too thin to observe directly in the ACF, can be retrieved from dual polarization observations at the same grazing angle. Examples from measurements on South Sturgeon Lake, MN, USA on 2018 Mar 07 illustrate these principles.

1 University of Michigan, Ann Arbor, MI, USA