Non-Destructive Characterization of a Freshwater Lake Icepack using Wideband Autocorrelation Radiometry

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ABSTRACT

The behavior of electromagnetic waves in homogenous media is dependent on the medium's macroscopic parameter, the relative dielectric constant. The relative dielectric constant is an electrical property of the material which changes the magnitude, phase, and direction of an applied electric field. The dielectric constant is a complex quantity. In a low-loss material, where there is no significant absorption or heat dissipation, the imaginary part of the dielectric would be nearly equal to zero, and the dielectric constant would be a real quantity.

There are many techniques in the literature to measure the dielectric constant of a material, such as the resonant technique. These methods require direct sampling of a material, which is destructive and impossible in some scenarios, such as snow on high altitude mountains. To address these issues, we introduced a novel technique for measuring the dielectric constant of a low-loss layer without the need for sample preparation. This technique inspired by a passive microwave remote sensing method, known as wideband autocorrelation radiometry (WiBAR), which measures the microwave propagation time difference of multipath microwave emission from low-loss layered surfaces, such as freshwater lake icepack. This time delay is dependent on the incident angle. By measuring the time delay at two distinct incident angles, the real part of the dielectric constant can be measured. An X-band instrument fabricated from the commercial-off-the-shelf (COTS) components are used to characterize the freshwater lake ice at the University of Michigan Biological Station.

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