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PRECISE MEASUREMENT OF DIELECTRIC LOSS OF ICE AT 5–40 GHz (ABSTRACT)

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The relative complex dielectric permittivity, $\varepsilon^*=\varepsilon'-i\varepsilon''$, of ice has been measured in the frequency range 5 GHz to 40 GHz and temperature range −80 to −10°C. So far, knowledge about the dielectric loss, $\tan\delta = \varepsilon''/\varepsilon'$, of ice which governs the attenuation of the propagating wave has been unsatisfactory at microwave frequencies. It is important to investigate the dielectric properties of ice for radar remote sensing applications in a polar environment. In this study, the cavity resonator method at 5,10 GHz and the open resonator method at 30–40 GHz were used. Both methods are suitable for precise measurement of low loss ($\sim 10^{-4}$) materials.

The result suggests that the dielectric loss of ice at microwave frequencies should increase with increasing frequency and increasing temperature. In general, the values of the dielectric loss at microwave frequencies are characterized by the high-frequency tail of the Debye relaxation spectrum with a relaxation frequency in the kHz range and low-frequency tail of the far-infrared absorption band. In this study, the component of the Debye relaxation spectrum is 20% in terms of the value of $\tan\delta$ at 5 GHz, −10°C. Then the component of far-infrared absorption band increases with increasing frequency and decreasing temperature. The estimated value of penetration depth in ice, extrapolated to 1 GHz, is 200 m at −10°C and reaches the order of 1000 m under −30°C.

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