

PENETRATION DEPTH OF SYNTHETIC APERTURE RADAR SIGNALS IN ICE AND SNOW: AN ANALYTICAL APPROACH

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**Workshop Remote Sensing and Modeling of Surface Properties.
14-16 March 2016**

1. ABSTRACT

Because of the importance of analyzing radar backscatter signals over the cryosphere, we examined the dependence of penetration depth radar signal on ice and snow. A range of microwave frequencies, temperatures and various impurities $NaCl$, HNO_3 and H_2SO_4 is considered. We studied the sensitivity of the temperature and of the impurity concentration, a determinant parameter for the penetration depth, and used a ice dielectric model where permittivity can be described by a sum of multiple resonance Lorentzian functions and a snow dielectric model derived from strong fluctuation theory. The penetration depth ranges, depending of temperature, in pure ice for the synthetic aperture radar signals are the following: 21-30 m at 5.6 GHz (C-band), about 6.6-9.3 m at 10.9 GHz (X-band) and 2.5-3.4 m at 18 GHz (Ku-band). The dielectric loss of ice increased with the increases in temperature and the contained impurity concentration, therefore the penetration depth from radar signal decreases. Then, we discuss the possible mechanisms which govern the dielectric loss of ice containing impurities by the change of volume fraction and impurity concentration of the liquid phase inclusions with the temperature. Below 10 GHz, the snow cover temperature and layering determine this depth, whereas above 20 GHz (Ku-Band), the determinant factor is the snow crystal size; all parameters have an effect at intermediate frequencies.