A Numerical Comparision of Dielectric Based Measurement of Atmospheric Ice Using COMSOL

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Abstract

Atmospheric ice is a very complex material with varying electrical properties due to different polymorphs of ice itself. Also if the medium is considered to be snow, then density becomes an additional parameter because it is a mixture of three dielectrics water, ice and air. The electrical properties of ice and snow are directly related with various applications, glaciological problems and icing hazards particularly in cold regions. The permittivity and loss tangent of naturally occurring ice and snow shows lot of variation at different conditions. This paper is a comparative study between some experimental results found from literature review and some simulations of ice and snow that are done in COMSOL. By limiting ourselves to pure ice, free from cracks, bubbles, impurities and stress, a Cole Cole diagram can be easily simulated using COMSOL. The only constrain to get more detailed picture of the electrical properties of ice and snow is the addition of a new material (can be a mixture of dielectrics as, air, water and ice) which have properties variation linked with its density, temperature and orientation. Lot of experimental results can be found in the literature to compare the dielectric properties of ice and snow to be found from Simulations. The results of Kuroiwa [1] to determine the epsilon_r_real and epsilon_r_imag by sweeping the frequency are very impressive. [1,2] and many other experimentally determined the dielectric properties of ice (Figure 1) and snow (Figure 2) which in good agreement with each other. Likewise the frequency sweep, the temperature can also be swept to compare the variations due to temperature. Due to addition of water in snow there are also some conductivity changes in the snow which can also be simulated.

Reference

[1] Koroiwa D., ‘The dielectric behavior of snow cover’, T.K. 8. 1951.
[2] Cumming W. A., ‘Dielectric properties of ice and snow at 3.2 cm’, J. Apply Phys. 23, 768.

Figures used in the abstract

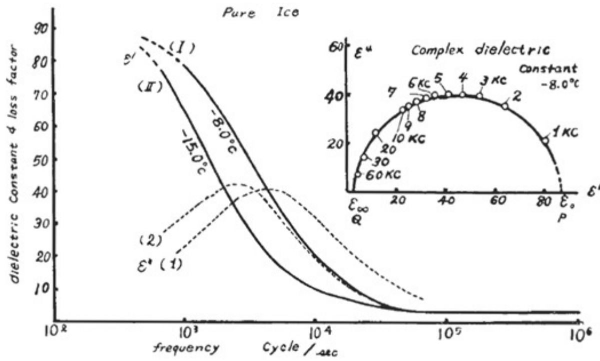

Figure 1: Dispersion of permittivity of pure ice.

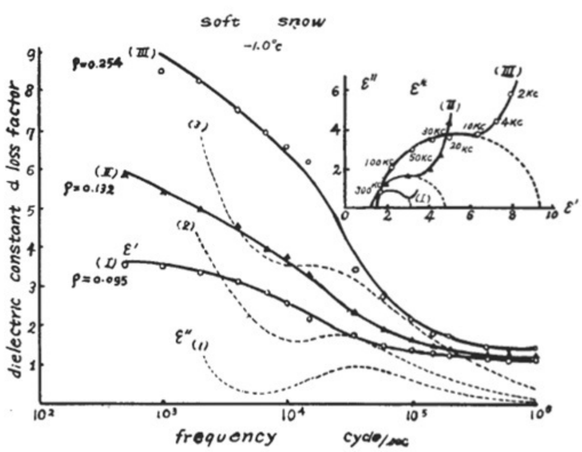

Figure 2: Dispersion of permittivity of snow at different volumetric ratios.