C–10–3 SINGLE FREQUENCY MICROWAVE REMOTE SENSING OF SNOW ON AN ALUMINUM PLATE

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Both experimental and theoretical investigations in the remote sensing of a snow field have established the fact that snow is a highly scattering medium. The scattering properties can be characterized by either a statistically random medium [1-3] or a homogeneous background medium containing discrete scatterers [4-5]. Three theoretical approaches have been developed to study the microwave remote sensing of snow: (1) Radiative transfer theory that assumes incoherence in wave interactions, (2) Modified radiative transfer theory that incorporates partial coherent effects, and (3) Wave theory that accounts for coherent interactions.

The subject of the prediction and interpretation of remote sensing data from a snow field is a very complicated one. The properties of snow change during different hours of the day and depend critically on external meteorological conditions. To isolate many of its electromagnetic emission characteristics, we propose the use of a single-frequency radiometer to carry out the brightness temperature measurements of artificial as well as naturally formed snow packs on an aluminum plate [Fig. 1]. The use of an aluminum plate greatly reduces uncertainties concerning the subsurface electromagnetic properties of the snow pack.

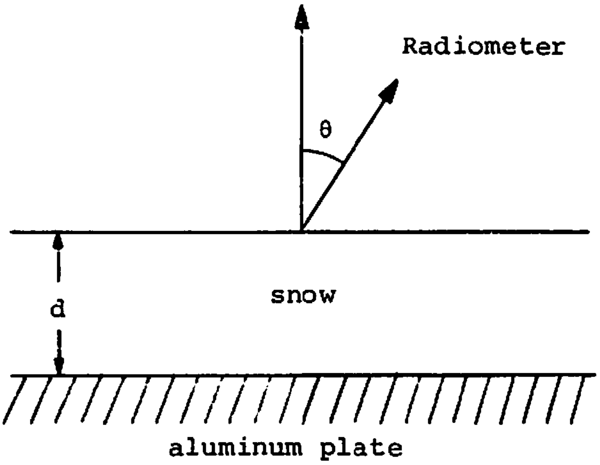

Figure 1

In this report, we investigate the following four topics: (1) angular dependence of the brightness temperature as snow depth increases, (2) changes in measured brightness temperatures as a target made of aluminum foil is placed on top of a layer of snow, (3) possible interference effects exhibited as oscillations in brightness temperature measurements as the snow depth is changed, and (4) diurnal changes.

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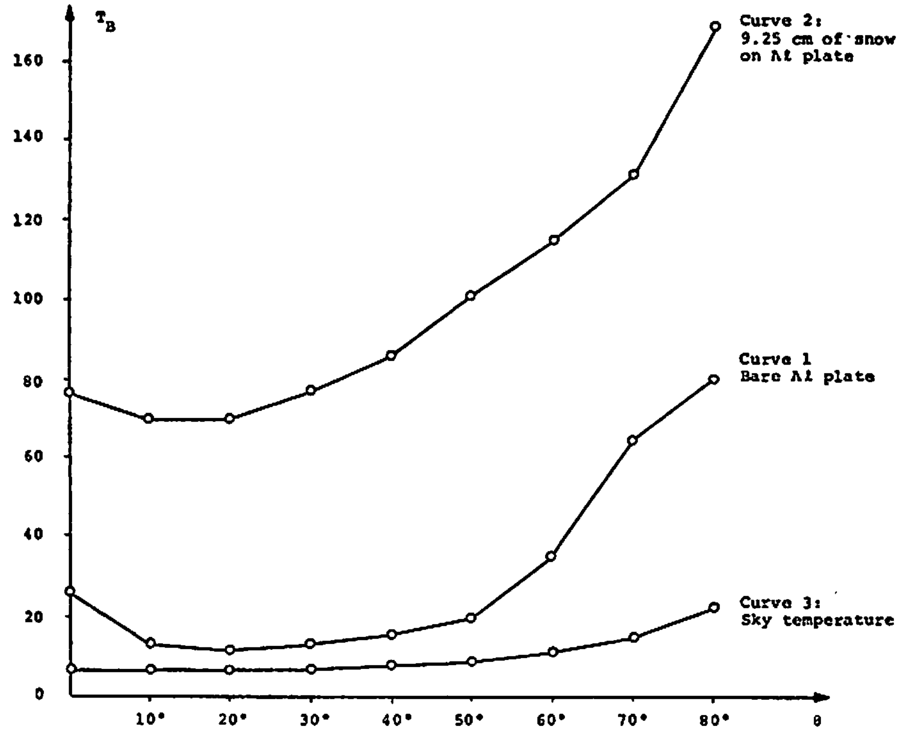

Figure 2

In Fig. 2 we measure with a 35-GHz radiometer the vertical polarization component of the brightness temperature T_B as a function of angle. Curve 1 is for a bare aluminum plate and curve 2 is for a snow layer with depth 9.25 cm and density 0.4 gram/cc. As we see the presence of the snow increases the brightness temperature readings in general. The surprising thing is the minimum at about 20° even for a bare aluminum plate. The same result is also reported in the Manual of Remote Sensing [6]. As an aluminum plate is basically a cold object, the variation in the brightness temperature may have been caused by reflections from the sky. A measurement of the sky temperature is shown in curve 3, which explains the rise in T_B for large angles of observation. The relatively large T_B reading at angles near nadir is in fact due to the image of the radiometer itself. This is ascertained by changing the height of the radiometer from the plate and it was observed that T_B decreases as the radiometer height increases.

In Fig. 3 we show the percent change in the vertical polarization components of T_B as a function of observation angle θ for three different sizes of aluminum foil placed over the snow pack and compared with T_B measurements in the absence of the foil. As expected, the change in T_B decreases as θ increases and the larger target gives rise to greater change in brightness temperatures. Fig. 4 illustrates the interference effects for vertical polarization measured from a snow layer with density 0.17 gram/cc. by a radiometer at 1.42 GHz and an observation angle of θ = 10°. This demonstrates the partial coherent properties of wave interactions in snow. In Fig. 5 we show both the vertical and horizontal components of T_B for the same snow configuration in curve 2 of Fig. 2. The only difference is that Fig. 5 is measured in the afternoon (1 pm) while Fig. 2 is obtained in the morning. The diurnal change is evident. We attribute this to the change in the surface conditions of the snow pack as temperature rises in the afternoon.

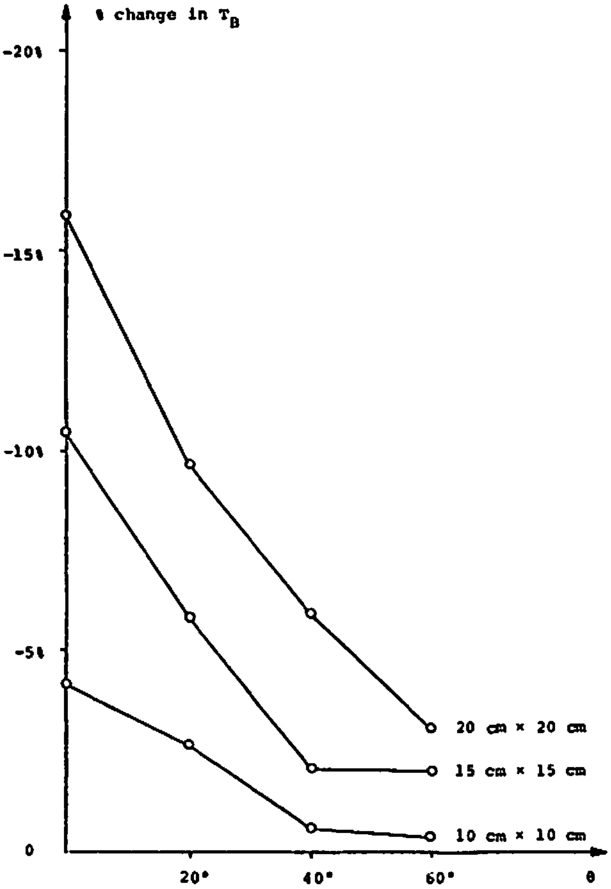

Figure 3

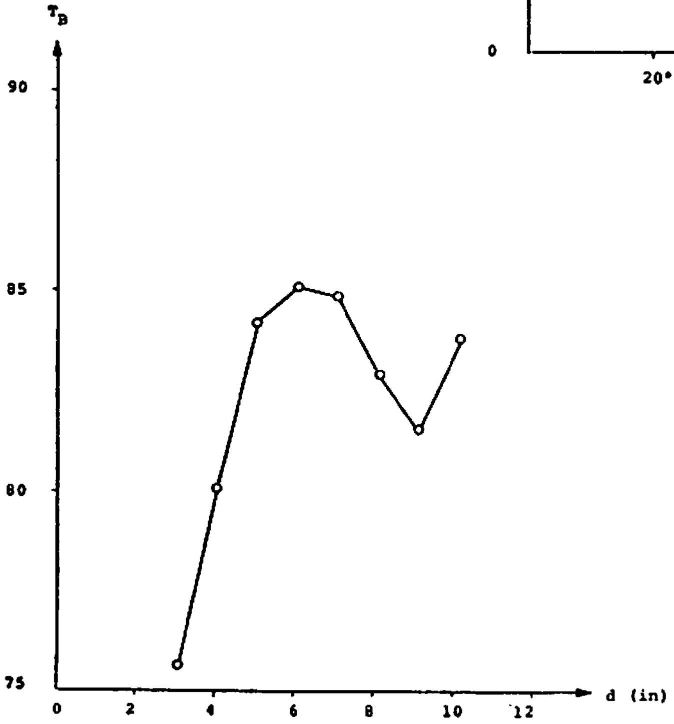

Figure 4

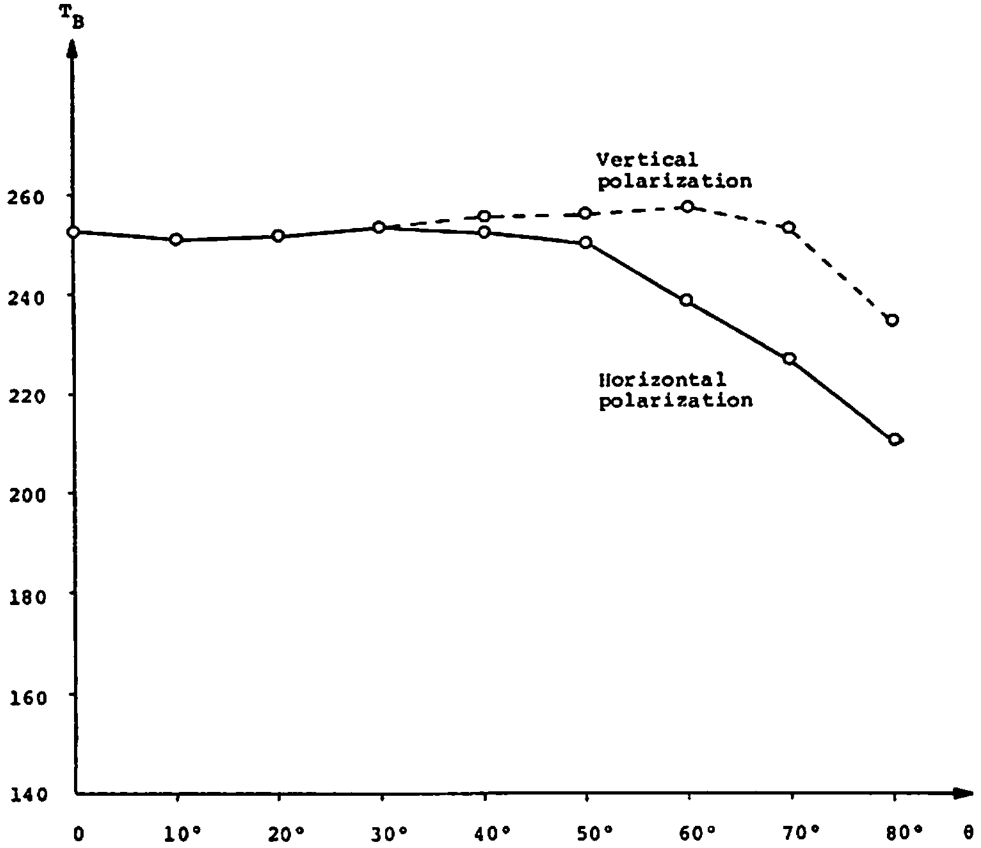

Figure 5

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