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Brightness Temperature Sensitivity to Variations in Solid Precipitation Cloud Profiles

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Abstract— **In the past few years, solid precipitation detection and retrievals have been developed and shown to be applicable for snowing clouds and blizzards. All of the algorithms require the use of millimeter-wave radiometer observations. This investigation probes the sensitivity of computed brightness temperatures resulting from variations in solid precipitation cloud profiles. Variations include: (1) changing the snowfall rates from heavy to medium to low, (2) solid precipitation melting just before landfall, and (3) evaporation (virga) prior to landfall. The results show that the 89 and 150 GHz channel are primarily sensitive to low altitude changes, such as melting or evaporation near the land surface. Some of the the 183 GHz channels are sensitive to the amount of the snow and to the water vapor in the cloud profile, with the 183±1 GHz sensing only the upper portions of the cloud, while the 183±7 GHz channel probes deeper into the snow cloud.**

Keywords-snow, precipitation, millimeter-wave, retrievals.

I. INTRODUCTION

Recently, solid precipitation detection and retrieval algorithms have been reported and shown to be useful in studying surface snowfall. Solid precipitation retrieval algorithms reported in the literature over the past 18 months include those that rely on neural nets, statistics, or physical relationships [1-3]. These algorithms require the use of millimeter-wave radiometer observations. The millimeter-wave frequencies are especially sensitive to the scattering and emission properties of frozen particles due to the ice particle refractive index. Passive radiometric channels respond to both the integrated particle mass throughout the volume and field of view, and to the amount, location, and size distribution of the frozen (and liquid) particles with the sensitivity varying for different frequencies and hydrometeor types.

This investigation probes the sensitivity of computed brightness temperatures resulting from variations in solid precipitation profiles. Variations include: (1) heavy medium and low snowfall rates, (2) solid precipitation that melts just before landfall, and (3) evaporation (virga) prior to landfall. These various cloud profile structures are used as input in a radiative transfer model where brightness temperatures are calculated. In order to investigate the changes in cloud profile structure more exclusively, the polydisperse particle size distribution parameters for the snow remain relatively fixed for the various cloud profiles tested. The focus will be on frequencies from 89 to 183 GHz. Weighting vectors provide a method to examine the sources and locations of contributions to the brightness temperature (T_B) values for the various frequencies. As expected, the 89 and 150 GHz channels respond to low altitude changes, such as melting or evaporation near the land surface. The 183±1 senses only the cloud top and does not respond to changes in the lower part of the cloud. The other two 183 GHz water vapor channels are sensitive to the location and amount of the snow, with the 183+/-7 GHz channel probing deepest into the snow cloud.

Section II describes the procedure of selecting the snow profiles, while section III indicates the radiative transfer procedure and particle size distributions used for the snow and rain hydrometeors. An analysis for the temperature weighting vectors in discussed in section IV and conclusions are presented in section V.

V. CONCLUSIONS

This work has shown that near-surface changes in the snow precipitation affect the 89 and 150 GHz brightness temperatures more so than the 183 GHz channels. Thus these channels, and likely lower frequency channels (e.g., 19, 50+ GHz) are also necessary to determine near surface conditions of precipitation. The 183±3 and 183±7 GHz channels can be used to determine and estimate the presence and relative amounts of solid precipitation.

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