This year's theme was Learning Earth's Shapes and Colors. 149 topics were arranged into 7 sections, including:

- **Applications of Remote Sensing**
- **Mission and Programs**
- **Geoscience, Modeling, & Processing**
- **Data Processing & Algorithms**
- **Electromagnetic Problems**
- **Instrumentation & Techniques**
- **Policy, Societal Issues, & Education Initiatives**

Intercomparison of Millimeter-Wave Radiative Transfer Models

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Abstract

This study analyzes the performance of the Eddington second-order approximation with and without δ-scaling, the Neumann iterative method, and the Monte Carlo method at millimeter-wave frequencies. The reliability and consistency of these radiative transfer models is identified and the differences and source of those differences in brightness temperatures that may originate in the forward computations are examined. In addition, computation speeds of the radiative transfer calculations are also compared for evaluation.

1. Introduction

Accurate and computationally efficient forward radiative transfer calculations are essential for the retrieval of atmospheric properties from remotely sensed microwave observations. Interest has grown in the retrieval of liquid and ice hydrometeors from radiometers operating at millimeter microwave frequencies that were originally selected for temperature and moisture sounding. The Advanced Microwave Sounding Units (AMSU-A and B) on the NOAA 15, 16, and 17 provide such measurements.

In order to develop fast inversion algorithms, using pregenerated cloud radiative databases that can be used to minimize the observed and calculated brightness temperature differences, the radiative transfer calculations are required to be reliable and efficient.

This study analyzes the performance of three radiative transfer models which have been used for liquid and ice hydrometeor profile retrievals in terms of accuracy and computation efficiency. Solutions to the Eddington second-order approximation [1],[2] with and without δ-scaling [3], the Neumann iterative method [4],[5] and the Monte Carlo (MC) method [3] are compared at frequencies of 89, 118, 150, 183.3+/-1, 183.3+/-7, 220, 340 GHz at nadir and at 53° off-nadir. Three atmospheric profiles (light rain, moderate rain + snow, and heavy snow) are desplayed for these comparisons and the weighting functions for these profiles at each frequency are presented.

4 Conclusions and Discussion

Both of the Eddington approximations with and without the δ-scaling yielded satisfactory results at 53° off-nadir. The δ-scaling made brightness temperature differences up to 2 K at 183.3±1 GHz at nadir while it did not make difference at 53° off nadir. The δ-scaling is expected to simulate better brightness temperatures in case of large size ice particles that cause strong forward scattering especially at millimeter wavelengths.

At least 6 quadrature angles are required for the iterative method to adequately represent the inhomogeneous vertical structure of the scattering and absorbing components of clouds. However, it was found that a large number of quadrature angles can generate numerical instability in the iterative method that cause erroneously high brightness temperature values at high frequencies for hydrometeor profiles with strong scattering. The iterative method also can consume computer time that is even greater than the MC method if there are sufficient quadrature angles to describe strong scattering. In view of the ease of introducing scaled parameters into the Eddington approximation, we recommend its use for millimeter-wave radiative transfer calculations.