VALIDATION OF RADAR BASED ICE WATER CONTENT RETRIEVAL ALGORITHMS USING CloudSat AND AIRBORNE RADAR AND IN-SITU MEASUREMENTS

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ABSTRACT

It is well recognized that ice clouds play a significant role in climate and weather by modulating the Earth's radiation budget. Depending on their optical thickness, altitude and microphysical properties, ice clouds can either cause warming or cooling at the surface of the Earth. Because of the complexity of the microphysics and atmospheric dynamics, the ice clouds are not treated adequately in the current Numerical Weather Prediction (NWP) and General Circulation Models (GCMs). One of the important parameters needed for determining the optical properties of ice cloud is the ice water content (IWC). Most of the current NWP models do not predict this quantity directly; it is diagnosed based on parameters such as temperature. As a result, the value of IWC predicted using NWP models can vary significantly. Aircraft in-situ observations provide very valuable information about the microphysical properties of clouds, but these data are not representative on a global scale. The experimental satellite CloudSat, which was launched in 2006 with a 94 GHz radar on board should provide a global picture of cloud microphysical properties including IWC that can be used to constrain these models. However, radar measures the equivalent reflectivity factor (Ze) of cloud particles, but not their mass. The accuracy of the retrieved ice mass based on Ze is highly dependent on the algorithms used. These algorithms are usually developed on the basis of in-situ aircraft measurements, sometimes in combination with coincident radar observations. In most cases, however, these retrieval algorithms are based on Ze alone. Using aircraft measurements conducted in glaciated clouds in several extra-tropical regions, Boudala et al. [2006] have developed an IWC retrieval algorithm in term of temperature and Ze. The parameterization has been tested against observations made using vertically pointing and scanning X-band radars. The main objectives of this study are to further validate and improve IWC retrieval algorithms done so far (e.g., Boudala et al.) using the CloudSat data, ground based Doppler C-band and airborne W-band radars and in-situ aircraft measurements. The aircraft data were colleted during the Canadian CloudSat/CALIPSO Validation Project (C3VP), which was conducted in Ontario, Canada between October 2006 and March 2007. This project employed the National Research Council of Canada (NRC) Convair-580 aircraft, which was equipped with several instruments that measure aerosol and cloud particle size distribution, cloud water content, radar reflectivity and many other basic microphysical and dynamical parameters. This paper will focus mainly on measurements obtained using the two dimensional cloud imaging probes 2D-C and 2D-P, the W-band radar, the counter flow virtual impactor (CVI) probe that measures cloud total water content, and the King probe that measures liquid water content. The CloudSat reflectivity data also be used when they were coincidently available during the field measurements. The 2D particle images, Rosemount icing detector, and other instruments will be used to identify only the glaciated portion of the cloud and the measured IWC (from CVI/Nevzorov) will be compared to the one derived based on the measured ice crystal size distribution, and radar reflectivity factor. In addition, the horizontal and vertical distribution of IWC and associated microphysics will be investigated using both radar and in-situ aircraft data.