Cloud liquid water database derived from a global cloud-system resolving model for precipitation retrievals of GPM/DPR observations

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The Dual-frequency Precipitation Radar (DPR) onboard the Global Precipitation Measurement (GPM) Core Observatory was launched on February 2014. The DPR expands the coverage of observations to include higher latitudes than those that are obtained by the Precipitation Radar (PR) onboard the Tropical Rainfall Measuring Mission (TRMM). The DPR measures precipitation via higher-sensitivity observations than those of the TRMM/PR and provides drop size distribution (DSD) information based on the differential scattering properties at the two frequencies. The DPR consists of Ku-band (13.6 GHz) precipitation radar (KuPR) and Ka-band (35.5 GHz) pre-cipitation radar.

In generating precipitation datasets, it is necessary to develop computationally efficient, fast-processing DPR Level-2 (L2) algorithms that can provide estimated precipitation rates, radar reflectivity factors, and precipitation information, such as the DSD and precipitation type. In the L2 algorithms, an assumption related to Cloud Liquid Water (CLW) is one of uncertain factors; the algorithm assumes the liquid water profiles in precipitating clouds. Attenuation by CLW is larger in the Ka-band than in the Ku-band, as shown in previous works . Therefore, estimating precipitation intensity with high accuracy from KaPR observations requires developing a method to estimate the attenuation due to CLW and incorporate it into the algorithm.

As the CLW assumption in precipitation retrievals for the spaceborne radar, regional atmospheric simulations and observational data were utilized in previous works. Recently, high-resolution global atmospheric simulations have been done using a global cloud-system resolving model (GCRM) (Stevens et al. 2019). The GCRM explicitly calculates moisture convection using a microphysical cloud scheme. The development of the GCRM was pioneered by the Nonhydrostatic ICosahedral Atmospheric Model (NICAM).

The DPR-L2 algorithm uses a correction method for attenuation by CLW that was developed using 3.5km-mesh NICAM simulation data. In the algorithm, the CLW value is assumed using the database with inputs of the surface precipitation rate, precipitation type (convective or stratiform), temperature, latitude, and surface type.

By comparing the one-month experiment of CLW with 0 mg/m^3, the impact of current CLW assumptions for surface precipitation estimates were evaluated using the Normalized Mean Absolute Error by 1.8% for the Ku, 14.0% for the Ka, and 8.0% for the Dual-Frequency algorithms in global averages.

Effects of the precipitation estimates from the CLW assumption were examined further for correction of the radar reflectivity by path-integrated attenuation (PIA) due to CLW and consideration of the PIA due to CLW in estimating the PIA due to precipitation. While the experiments confirmed the offsets between both

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effects and therefore reduced residual errors related to the CLW assumption, this paper emphasizes higher impacts of the consideration in estimating the PIA by the precipitation to precipitation retrievals.

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