Characteristics of Products Associated with Path Attenuation Estimate After the Scan Pattern Change of the DPR Ka-band Radar

*Hyokyung Kim[1,2], Robert Meneghini[2], John Kwiatkowski[3,2]

1. GESTAR/MSU, 2. NASA/GSFC, 3. Geroge Mason University

The Dual Frequency Precipitation Radar (DPR-Ku and DPR-Ka) on board the GPM satellite has been providing reliable products related to estimates of global precipitation since it was launched 5 years ago. On May 21, 2018, the scan pattern of DPR-Ka radar was changed from near-nadir scanning (0 to 9 deg) to a scan pattern matched to that of the DPR-Ku radar (0 to 18 deg). The major advantage of this change is that the dual-frequency precipitation data are now available over the full swath so that, in principle, more accurate estimates of the precipitation amounts can be made over an area twice as large as the original area.

One of methods to estimate path-integrated attenuation (PIA) for GPM-DPR is the Surface Reference Technique (SRT) that compares the difference of the radar normalized backscattering cross section (NRCS) of the surface outside the rain to that measured within the rain. As the performance of the PIA estimate by the SRT is closely related to the behavior of the rain-free NRCS, this study focuses on the statistical features of the NRCS and an assessment of PIA estimates over the outer swath of the DPR-Ka using data measured from June 2018 to May 2019.

The SRT estimate of path attenuation is a weighted average of spatial and temporal reference estimates. The spatial reference is formed by an average of rain-free NRCS measured near the raining area at approximately the same time. For the temporal estimate, the attenuation is taken to be equal to the difference between the time-averaged rain-free NRCS and the NRCS measured in rain. The rain-free temporal statistics are computed and stored in the form of a look-up table that include: number of observations, and mean and standard deviation of the NRCS. The table values are given as a function of latitude, longitude, incidence angle, radar frequency, including differential frequency, and surface type.

One of the challenges with the new Ka-band data is to construct a look-up table that is applicable to the full swath and, in particular, includes statistics for the Ka-band and Ku-Ka-band difference in the outer swath. With regard to the use of statistics of temporal reference NRCS in the outer swath, the statistics at DPR-Ku are computed from datasets over the last five years, while those at DPR-Ka are derived from only a single year. One way to overcome this difference in sampling is to use a variable area sampling strategy so that the averaging area is expanded over statistically similar areas so as to include a larger number of samples. Another issue is the difference in sensitivity of the Ka-band in the outer and inner swaths. As a longer pulse length is used for the outer swath data, the sensitivity at Ka-band increases by about 5 dB relative to the inner swath data. Because of this, it is necessary to examine the statistical continuity of the NRCS between the outer and inner swaths and the statistical similarity of the differential surface cross sections (difference in NRCS between DPR-Ku and DPR-Ka bands), which is considered to be a key factor in determining the accuracy of the PIA estimates by dual frequency method.

Keywords: Path Attenuation Estimates, GPM-DPR, Radar Back Scattering of the Surface, New Antenna Scan Pattern at DPR-Ka