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Correction of Radar Reflectivity and Differential Reflectivity for Rain Attenuation at X-band

Dong-Soon Kim[1*], Masayuki Maki[1], Dong-In Lee[2], Shingo Shimizu[1], Maesaka Takeshi[1], Koyuru Iwanami[1]

[1]NIED, Japan, [2]PKNU, Korea

Rain attenuation correction is very important to obtain accurate radar reflectivity Z_H and differential reflectivity Z_{DR}, particularly with the X-band wavelength radar. In the case of a dual-polarized radar, Z_H and Z_{DR} can easily be corrected by differential propagation phase measurement (K_{DP} or PHI_{DP}), because phase measurements are not affected by attenuation or calibration errors. In the self-consistent method with constraints proposed by Bringi et al. (2001), an optimal value (alpha) for the specific coefficient between K_{DP} and specific attenuation at h-polarization A_H (A_H = alpha$*K_{DP}$) is determined by employing a minimization process for each beam of the radar. However, the specific coefficient alpha can vary widely, mainly as a result of natural variations in DSD, temperature, and drop shape in a precipitation system.

The shifted self-consistent (SSC) algorithm based on the self-consistent method for rain-attenuation correction of reflectivity Z_H and differential reflectivity Z_{DR} are presented for X-band polarimetric radar. This SSC algorithm calculates the optimum coefficients for the relation A_H-K_{DP}, every 1 km along a slant range. The advantage of this method is that the natural distribution of DSD along the range of radar can be represented by the optimum alpha distribution. The attenuation-corrected Z_{DR} is calculated from reflectivity at horizontal polarization and from reflectivity at vertical polarization after attenuation correction. The SSC algorithm is applied to RHI (range-height indicator) scans as well as PPI (plan position indicator) volume scan data observed by X-band wavelength (MP-X) radar, as operated by the National Research Institute for Earth Science and Disaster Prevention (NIED) in Japan. The corrected Z_H and Z_{DR} values are in good agreement with those calculated from the drop size distribution (DSD) measured by disdrometers. The developed attenuation correction algorithm can be applied to various situations observed by the NIED MP-X radar.

Keywords: Rain attenuation correction, X-band Polarimetric radar, Reflectivity, Differential reflectivity, Specific attenuation, Differential propagation phase