Improved QPE with Multi-Angle PPIs Measurement

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Accuracy of radar-based quantitative precipitation estimation (QPE) is affected by various uncertainties such as beam blockage, non-meteorological echoes, height difference between the radar beam height and ground, and beam broadening. Hybrid surface rainfall (HSR) studies have been conducted using the lowest elevation angle avoiding the effects of beam blockage and non-meteorological echoes (Fulton et al. 1998; Kwon et al. 2012). Since HSR technique needs complete radar volume scan, there is a weakness that the time resolution can be large according to the radar schedule. In previous studies, the accuracy of rainfall estimation can be improved with decreasing time resolution of radar scan. In addition, the time lag due to the sedimentation of precipitation particles from radar beam height to the ground can be corrected by the best cross-correlation (BCC) (Kneifel et al. 2015). The random error caused by beam broadening can be minimized by applying different area averages according to the radar beam height (Chiang et al. 2006). In this study, a new QPE technique (named SWEEP) using multi-angle PPIs measurement is proposed and is evaluated by ground disdrometer compared to HSR technique. We also try to correct the time lag by BCC technique and beam broadening effect by applying different area averaging techniques according to the altitude of radar beam.

For the analysis, the Mt. Bisl S-band dual-polarization radar data is used. The rainfall cases of 17 cases (206 hours) of rainfall are used. For the verification, we use the reflectivity (Z) and differential reflectivity ( ) generated by T-matrix scattering simulation using DSD data of 2DVD. The and relationships generated by regression analysis is used to estimate precipitation rate. We compare three different type of rainfall products : SWEEP, HSR1.0, and HSR2.5. The SWEEP used all PPIs with individual time information. The HSR1.0 and HSR2.5 produced HSR map every 1 min and 2.5 min, respectively with fixed a time window of 2.5 time. We applied 2 options to SWEEP, HSR2.5, and HSR1.0 products to analyze rainfall estimation errors. The one option is the BCC method to reduce error from the time lag. The other option is the average of the different area according to beam height determined elevation angle.

The advantage of SWEEP is summarized as follows : 1) Accurate QPE is possible with fine resolution. 2) The accuracy of SWEEP is increased because the variability of precipitation is well represented as the reflectivity increases. 3) The standard deviation of rain rate is reduced by 1.7 and the correlation is increased by 0.16 by applying BCC method and different area averaging. 4) The always shows a good score regardless of correlation method because SWEEP is generated by averaged PPIs within 1-minute.

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