A STUDY OF QUANTITATIVE PRECIPITATION ESTIMATION METHODS BASED ON S-BAND DUAL-POLARIZATION RADAR

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ABSTRACT

A joint Taiwan-United States experiment called Southwest Monsoon Experiment/Terrain influenced Monsoon Rainfall Experiment (SoWMEX/TiMREX) was conducted during the period of May 15 to June 30, 2008 at southern Taiwan. Three rainfall cases occurred on June 2, 5 and 14 collected by S-POL radar were selected in this study. Totally, twenty four Quantitative Precipitation Estimation (QPE) methods, including three R(Z) schemes, seven R(K_{DP}) schemes, seven R(Z, Z_{DR}) schemes and five R(K_{DP}, Z_{DR}) schemes are used to estimate hourly accumulated rainfall. To evaluate the results in this area, two areas are considered based on the beam blockage percentage (BBP). The area without beam blockage is considered as plain area, while the other area is the mountain area. First, the results in the mountain area is studied at the tilt of 0.5° and in plain area at the tilt of 0.5° and 1.1°. The results show that: 1) At the tilt of 0.5° in the plain area, the R(Z) scheme from QPESUMs in Taiwan and the synthetic scheme proposed by Ryzhkov (2005) perform the best. 2) At the tilt of 1.1°, in contrast, in the plain area the R(Z, Z_{DR}) scheme proposed by Illingworth and Blackman (2002) performs the best at the tilt of 1.1°. The Ryzhkov (2005) method ranks second. 3) At the tilt of 0.5° in the mountain area, all schemes that using the variable K_{DP} perform better than those using variable Z_H, while after the Z_H fields have been corrected using the partial beam blockage correction (PBB) method, the mean bias of R(Z_H) decrease to a extent of 30%, but still larger than those R(K_{DP}) schemes. Also, the impact of the rainfall intensity, the range from the radar and the beam blockage percentage on the QPE algorithms were examined in this study. Results show that: 1) R(Z), R(Z, Z_{DR}) schemes, Ryzhkov (2005) method and Illingworth and Blackman (2002) scheme perform better than all R(K_{DP}) and R(K_{DP}, Z_{DR}) schemes if the rainfall rate is less than 20mm·hr^{-1}, otherwise, the latter performs better than former. 2)The R(K_{DP}) and R(K_{DP}, Z_{DR}) algorithms overestimate the rainfall beyond the distances of 100 km due to the increased light rainfall samples and the effect of the beam broadening. However, the precisions of R(Z), R(Z, Z_{DR}) schemes, the algorithm proposed by

Ryzhkov (2005) and the method proposed by Illingworth and Blackman (2002) just changed slightly with the range. 3) As the beam blockage increases, all the algorithms' performances become worse. Simultaneously, the percentage of the underestimated precipitation using Z_H schemes increase with the beam blockage percentage.

The conclusions include that the observations at the lowest elevation were severely contaminated by ground clutter, so the SPOL data at the tilt of 1.1° should be used to estimate the rainfall with the Ryzhkov (2005) scheme or R(Z, Z_{DR}) scheme proposed by Illingworth and Blackman (2002). The PBB correction on the Z_H field is necessary to improve the radar QPE in the mountain area.

Keywords: Quantitative precipitation estimation in the mountain area, Dual-polarization radar, Monsoon rainfall