Radar Rainfall Estimation on Hybrid Surface Based on Reflectivity Statistics

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Hybrid Surface Rainfall (HSR), radar rainfall estimation at the two-dimensional hybrid surface consisting of the lowest radar bins that immune to contaminations from beam blockage and ground echoes, shows a significant improvement in radar-based quantitative rainfall estimation (QPE) over complex terrain. The traditional HSR (THSR) method utilizes the beam blockage (BBK) simulation based on beam geometry under the normal refraction and the ground echo (GRE) mask using accumulation of reflectivity for clear days. THSR does not take account of the change of beam geometry and GRE mask for rainy conditions, manmade structure (i.e., building, communication tower, and etc.), and seasonal variation in vegetation. To improve these limitations in THSR, new HSR, called statistical HSR (SHSR), based on statistical analysis of reflectivity from radar dataset is proposed in this study.

For identifying potential BBK and GRE, SHSR utilizes a fuzzy logic with six feature parameters: frequency of occurrence of reflectivity (FOR), vertical gradient of FOR (VFOR), Relative of FOR (RFOR), mean reflectivity (MREF), vertical gradient of MREF (VREF), and Relative of MREF (RREF). In addition, the GRE mask is created by combination of FOR and MREF. The BBK mask is generated by fuzzy logic with membership functions and their weights that are derived from probability density functions (PDFs) for six feature parameters at BBK and clear sectors. The membership functions and their optimal weights are determined by ratio and overlapping areas between two PDFs, respectively.

The performances of THSR and SHSR are evaluated by using rainfall accumulation map and comparing with rainfall from rain gauge. In the accumulation map of THSR, abnormal overestimated spots occur around radar due to GRE residue, whereas there are no unnatural spots for SHSR. The SHSR shows significant improvement in comparison with THSR. Correlation coefficient and normalized standard deviation for THSR are 0.19 and 0.93, whereas those for SHSR are 0.62 and 0.39.

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