

# Advances in Quantitative Precipitation Estimation Techniques for Operational Weather Radars in China

Lei Wu<sup>1</sup>, Hao Wen<sup>1</sup>, Yunlei Liu<sup>1</sup>, Yang Zhang<sup>2</sup>, Yanjiao Xiao<sup>3</sup>

(1. Meteorological Observation Centre of China Meteorological Administration, Beijing 100081, China;

2. State Key Laboratory of Sever Weather, Chinese Academy of Meteorological Sciences, Beijing 100081, China;

3. Institute of Heavy Rain, China Meteorological Administration, Wuhan 430074, China)

**Abstract:** China currently operates 267 S- and C-band weather radars. By integrating raindrop size distribution observations, surface rain gauge data, and high-resolution terrain data, a national networking system operationally generates high spatiotemporal resolution (6-minute,  $0.01^\circ \times 0.01^\circ$ ) gridded rainfall rate and 1/3/24-hour quantitative precipitation estimation (QPE) products in real-time. The core technologies of this product mainly include: 1) Effective elimination non-precipitation echo using physical thresholds and fuzzy logic methods based on single/dual-polarization radar physical characteristics; 2) utilizing high-resolution digital elevation data and analysis of accumulated long-term radar data to dynamically select elevation angles with low or no beam blockage, constructing hybrid scan reflectivity to minimize beam blockage effects; 3) using raindrop size distribution data to fitting localized polarimetric rainfall relationships ( $R(Z_H)$ ,  $R(K_{DP})$ ,  $R(Z_H, Z_{DR})$ ,  $R(K_{DP}, Z_{DR})$ ) through T-matrix calculations, and dynamically fit and optimize the  $R(Z_H)$  relationship based on rain gauge data to enhance the algorithm's adaptability to different regions, seasons, and weather conditions; 4) achieving seamless mosaic product in overlapping radar coverage areas through multi-parameter weighting considering distance, altitude, and quality indices; 5) calibrating the QPE product using radar-rain gauge data pairs and the inverse distance weighting method to reduce estimation errors. Using hourly precipitation data from 80% of surface rain gauges in Guangdong and the Beijing-Tianjin-Hebei region from June to September 2022-2024 to correct the radar network's hourly precipitation product, with the remaining 20% used for evaluation. Matching data pairs where both radar and rain gauges observed hourly precipitation  $>0.1$  mm were selected. After correction, the product showed a mean absolute relative error of 22.4% and a correlation coefficient of 0.94.

**Key Words:** radar precipitation estimation; mosaic; operation