

Enhancing Global Precipitation Observation: The Contribution of FY-3 Satellites in Filling Critical GPM PMW Observation Gaps

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Global precipitation observation relies on integrating data from multiple satellite sources to generate high spatiotemporal resolution products. This typically combines active and passive microwave observations from low-Earth orbit satellites with visible/infrared data from geostationary satellites. For instance, the IMERG product provides global precipitation estimates at 0.1° spatial and half-hourly temporal resolution by merging precipitation retrievals from various satellite sensors. While precipitation radar data offer the highest accuracy, their limited spatial coverage restricts their primary use to cross-calibrating passive microwave (PMW) observations. When PMW data are unavailable, IMERG supplements with microwave propagation algorithms and infrared-based precipitation estimates, though with reduced accuracy. Consequently, IMERG quality heavily depends on the availability of PMW observations. However, gaps in the global PMW satellite network compromise IMERG reliability, particularly in low-latitude regions with frequent precipitation and sparse PMW coverage. Our study reveals that PMW data account for only about 20% of the total data sources during early morning and evening periods. To address this limitation, we developed a PMW precipitation retrieval algorithm for the FY-3 series satellites (FY-3D, 3E, 3F, and 3H) and integrated the resulting precipitation products with other microwave-based retrievals from the GPM mission. The integration significantly increased the proportion of PMW data in the final merged product, raising the daily PMW contribution to approximately 50%. Evaluation against approximately 4,400 ground-based stations demonstrated marked improvements in IMERG accuracy after incorporating FY-3 data: the root mean square error decreased from 1.64 mm/h to 1.49 mm/h, and bias improved by 13%, from -0.038 mm/h to -0.033 mm/h. These results underscore the effectiveness of FY-3 satellites in enhancing the precision and reliability of global precipitation products.