

Influence of Atmospheric Pollution on Precipitation Microphysics: Insights from Gpm Dpr Analysis of Clean Vs. Polluted Events

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Abstract

This investigation elucidates the ramifications of atmospheric pollution on the microphysical properties of precipitation by conducting a comparative analysis of Global Precipitation Measurement Dual-frequency Precipitation Radar (GPM DPR) parameters between clean and polluted precipitation events. Our findings reveal that polluted rainy days exhibit elevated precipitation rates, a greater prevalence of larger-diameter raindrops, and enhanced radar reflectivity compared to their pristine counterparts, with these disparities being particularly pronounced within convective precipitation systems. Contoured frequency by altitude diagrams (CFADs) of precipitation parameters clearly demonstrate that polluted conditions are associated with more vigorous precipitation, characterized by cloud tops exceeding 8 km in altitude and broader distributions of radar reflectivity and mass-weighted mean diameter. Within the warm rain regime, polluted precipitation events are dominated by size-sorting evaporation and collision-coalescence processes, whereas clean precipitation days exhibit a marked dominance of raindrop breakup mechanisms. These observations suggest that atmospheric pollution amplifies storm intensity and promotes the development of larger raindrops, particularly within convective frameworks, resulting in heavier precipitation. The insights derived from this research enhance our understanding of the precipitation microphysical disparities during pristine and polluted conditions, offering critical implications for improving of meteorological forecasting and hydrological modeling in anthropogenically influenced environments.

Key words : GPM DPR, Taiwan, Polluted rainy day, clean rainy days