PMW-PrecipNet: A U-Net–Based Deep Learning Framework for Passive Microwave Precipitation Retrieval

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Abstract:

Precipitation retrieval from passive microwave (PMW) observations is essential for global hydrological monitoring, yet conventional approaches often rely on physically based or statistical inversion methods with inherent limitations in representing complex precipitation processes. In this study, we introduce PMW-PrecipNet, a novel U-Net–based deep learning model for end-to-end precipitation retrieval from multi-channel microwave observations.

The proposed model integrates microwave brightness temperatures together with geolocation information through a dual-branch architecture, enabling effective learning of both physical and spatial dependencies. Compared to conventional retrieval algorithms, the deep learning–based approach demonstrates significantly improved performance, including enhanced correlation with reference radar measurements and better representation of precipitation structures across both land and ocean surfaces.

In addition, we address inconsistencies arising from evolving satellite retrieval algorithms, which introduce label space shifts in training datasets. To mitigate this issue, we propose a fine-tuning framework that adapts models trained on legacy datasets to updated target distributions.

Experiments using GPM GMI observations and DPR-derived precipitation products show that PMW-PrecipNet achieves robust and consistent performance, while fine-tuning effectively alleviates performance degradation caused by dataset shifts. These results highlight the potential of deep learning–based retrieval frameworks to surpass traditional methods and remain reliable under evolving satellite observation systems.