

國立中央大學大氣物理研究所書報討論

Date : 2025/10/03

Location : S1-713

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StarNet: A Deep Learning Model for Enhancing Polarimetric Radar Quantitative Precipitation Estimation

Abstract

Traditional radar-based quantitative precipitation estimation (RQPE) methods estimate rainfall intensity based on the exponential relationship between radar reflectivity (Z) and surface rainfall rate (R) (i.e., the Z - R relationship). Recently, meteorologists have also attempted to use neural networks to model the relationship between radar observations and rainfall, and to predict short-term rainfall. Unlike traditional precipitation estimation methods, deep learning employs hierarchical feature extraction and combination techniques to identify patterns and correlations within the data. However, previous models only focused on the spatial characteristics of the lowest and second-lowest elevation angles in radar observations, neglecting the temporal correlation between data across different elevation angles.

This study aims to enhance the mapping capability from radar observations to precipitation. It includes three improvements: incorporating physical altitude information into the radar data to convey distance information from the radar station; utilizing a multi-head attention mechanism with 3D convolution to further refine the spatiotemporal characteristics of precipitation at different scales; and designing a reweighted loss function to effectively address the imbalance in the distribution of heavy, moderate, and light rainfall events.

Keyword

QPE (Quantitative Precipitation Estimation)

DL (Deep Learning)

Reference

- W. Li, H. Chen, L. Han and W. -C. Lee, "StarNet: A Deep Learning Model for Enhancing Polarimetric Radar Quantitative Precipitation Estimation," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. **62**, pp. 1-13, 2024, Art no. 4106513, doi: 10.1109/TGRS.2024.3426532.