Rainfall Downscaling for Global Data-Driven Weather Prediction Models

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Abstract

This study focuses on applying rainfall forecasts for the Taiwan region using global data-driven weather prediction (DWP) models through deep learning approaches. Compared to global numerical weather prediction (NWP) models, DWP models demonstrate better performance in synoptic weather predictions while requiring less time and computational resources. However, due to their lower resolution (0.25°), DWP models struggle with predicting mesoscale and convective-scale weather systems, which may lead to systematic bias in regional weather forecasts. This study aims to downscale the rainfall forecasts from DWP models, specifically FourCastNet and Pangu-Weather, using two deep learning models: U-Net with Generative Adversarial Network (GAN) as a baseline and Swin-Unet. The label data is the Quantitative Precipitation Estimation and Segregation Using Multiple Sensor (QPESUMS) radar-retrieved rainfall data from the Central Weather Administration (CWA) covering the period from 2021 to 2023. Results indicate that deep learning models can effectively correct the underestimations of heavy rainfall in DWP models. Case studies show that the baseline model successfully corrects the systematic bias in DWP models, while the Swin-Unet model tends to generate patch-like artifacts and requires further investigation.

Keywords: Deep learning, rainfall downscaling, Swin-Unet, FourCastNet, Pangu-Weather