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A Priori Diagnosis of Uncertainty in Cloud-Resolving Typhoon Rainfall Forecasts over Taiwan Using Machine Learning

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Uncertainty remains a major challenge in typhoon rainfall forecasting over Taiwan, even when cloud-resolving numerical weather prediction models are employed. Individual forecasts often exhibit large variability in rainfall amount and spatial distribution, particularly at long lead times, while their credibility is generally unknown at forecast time.

This study presents a machine learning–based framework for the a priori diagnosis of uncertainty in typhoon rainfall forecasts. Approximately fifteen years of cloud-resolving regional model forecasts and corresponding precipitation observations are used to quantify forecast quality through a similarity skill score (SSS), which measures the spatial agreement between forecasted and observed accumulated rainfall during the typhoon impact period. The machine learning model is designed to predict the future SSS of individual forecasts using only information available at forecast time, including diagnostics from the regional model and large-scale environmental and track-related predictors derived from global forecasts.

To ensure robust evaluation, the dataset is split by independent typhoon cases and time periods to avoid information leakage. Preliminary analyses suggest that the proposed approach can capture variations in forecast credibility, with forecasts predicted to have high SSS exhibiting a substantially higher likelihood of achieving high observed SSS.

Rather than improving rainfall forecasts themselves, this study focuses on statistical post-processing and uncertainty diagnosis, demonstrating the potential of machine learning as an objective tool for assessing the credibility of high-resolution typhoon rainfall forecasts.