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Machine Learning-Based Bias Correction of RWRF Surface Wind Forecasts over Taiwan's Complex Terrain

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Abstract

Despite the advances of numerical weather prediction (NWP), accurate surface wind forecasting remains challenging over Taiwan because of its complex terrain. Systematic biases in surface wind predictions are commonly observed in the Radar Weather Research and Forecasting (RWRF) model when compared with surface station observations. RWRF is an operational modeling system developed by Central Weather Administration (CWA) that assimilated radar and surface station data. To address these biases, we developed machine-learning-based bias correction models using two algorithms: Extreme Gradient Boosting (XGBoost), a widely used tree-based method, and TabNet, an interpretable deep-learning architecture. The results demonstrate that both approaches reduce surface wind bias and root-mean-square error (RMSE) relative to the original RWRF forecasts. Improvements are evident not only at the analysis time but also throughout forecast lead times up to 6 hours. Moreover, the interpretability of TabNet enables to identify the most influential features. The key features include the raw surface wind components, the geographical location and elevation of the model grid, and indicators associated with the weather system. These findings demonstrate the potential of machine-learning-based bias correction to improve surface wind forecasts over complex terrain.

Key words: TabNet, XGBoost, Wind bias correction.