運用數值天氣預報結合人工智慧技術發展陣風預報產品
Wind Gust Forecast Using Numerical Weather Prediction Model and Machine-Learning Methods

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摘　　要

強陣風往往造成顯著的生命及財產損失，尤其在颱風期間，更是深刻影響人民生活與企業運作。本研究運用現行中央氣象局區域系集預報系統(WEPS)之地面風速預報與地面測站之陣風觀測資料，透過分析地面風速預報與陣風觀測兩者之對應關係，套用至地面風速預報來產生陣風預報產品。文中評估採用三種演算法分析地面風速預報與觀測陣風兩者之關係：(1)線性回歸法(LR)；(2)微基因演算法(MGA)；(3)Adaptive Boosting演算法(ADA)。線性回歸法中，將以斜率及截距描述兩者關係；微基因演算法與Adaptive Boosting則僅以一個最佳因子表示兩者關係。此外，三種演算法針對各別觀測站建立關係時，其模型訓練所採用之樣本累積自該預報資料最近5次之地面風速預報及對應之陣風觀測，並利用2021年4月18日至30日間51個預報個案，以臺灣本島8個測站(臺北、淡水、新屋、臺中、臺南、高雄、彭佳嶼及蘭嶼等)進行初步校驗評估。

分析結果顯示，運用系集平均地面風速預報結合三種演算法產製之陣風產品(LR/MGA/ADA)，在預報第60小時前之平均預報偏差(Mean Error)分別為0.23/-0.47/0.19(m/s)，微基因演算法(MGA)所得之陣風預報呈現低估，其餘演算法之陣風產品則略有高估; 預報第60小時前之平均預報誤差(RMSE)則分別為2.83/2.74/2.72(m/s)。此初步評估結果顯示，使用Adaptive Boosting演算法所獲得之陣風產品，具有最佳之預報能力，其預報誤差較線性回歸法降低約4%。未來將針對強風個案，進行三種演算法陣風產品之預報能力評估。

關鍵字：線性回歸、微基因演算法、Adaptive boosting、系集預報、陣風

Abstract

Human activities and operation of the enterprise are suffered from the strong gust, especially in typhoon events. The surface wind speed forecast from the operational WRF ensemble prediction system (WEPS) and the observed wind gusts from surface stations operated by the Central Weather Bureau are used to provide the actually observational wind gust factor. The relations between wind speed forecast from numerical model and observed wind gust was archived in 3 different methods. One is linear regression (LR) and the other two are the machine learning methods: (1) Micro-genetic algorithm (MGA); (2) Adaptive Boosting (ADA). The training data set for deriving the relation between wind speed forecast and observed wind gust are accumulated from the latest 5 forecasting cases and the corresponding observed wind gust. Finally, two factors (intercept and slope) from the linear regression method as well as the other two are only resulted in one optimal ratio.

Hourly wind gust forecast at 8 stations was provided from April 18 to 30 in 2021 with 6-hour cycle. Preliminary results with 51 cases are indicated that the mean error in averaging the first 60 forecast hours of the 3 experiments (LR/MGA/ADA) are 0.23/-0.47/0.19 (m/s) and the root mean square error are 2.83/2.74/2.72 (m/s). To sum up, using the Adaptive Boosting (ADA) method was the best strategy to perform the relation between surface wind speed forecast and the observed wind gust. In the future, more cases study will be investigated to enhance the robustness and capability of the wind gust forecast.

Key words: Linear regression, Micro-genetic Algorithm, Adaptive Boosting, Ensemble forecast, Wind Gust.