2024 臺灣分區降雨校驗

Zone Rainfall Calibration in 2024

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摘要

目前天氣預報對於臺灣地區局部降雨的預測仍有改良空間。由於臺灣地形複雜，在模式預報網格解析度的極限內無法完整模擬所有地形細節，導致模式對局部強降雨的掌握有限。因此局部降雨依然有賴於人工經驗判斷，針對模式預報無法預估的降雨進行事先預警。

本團隊由於業務需求自 2024 年起，針對臺灣地區進行每日分區降雨預報。並針對 5 月至 11 月的汛期降雨預報做分區系統性校驗，採用偏倚得分、準確率、誤報率、預兆得分等定量指標進行分析，並輔以 T 檢定、Wilcoxon 符號排序檢定與機率密度函數等統計分析，進行多面向評估預報穩定性與分布差異評估。結果顯示：在豪雨等級以下的降雨預報偏差較多，颱風影響期間的極值預報大致能有效預估。T 檢定、Wilcoxon 符號排序檢定的結果顯示：團隊在颱風期間的預報與實際雨量呈現顯著吻合，但極端降雨個案雨量預報誤差達數百毫米。顯示現行模式對地形與局部降雨系統掌握仍有限，部分天氣環境下主觀預報也具進步空間：特別是對午後對流與遠距降水等複雜機制的掌握。未來仍須強化多元資料佐證與滾動修正機制，以提升局部災害性天氣發生時的即時反應與掌握力。

關鍵字：降雨預報、降雨分區預報校驗、T 檢定、列聯表、統計檢定

Abstract

Weather forecasting for localized rainfall in Taiwan remains an area with room for improvement. Due to Taiwan’s complex terrain, the limited grid resolution of numerical weather prediction models constrains their ability to fully simulate fine-scale topographic features, resulting in underestimation of localized heavy rainfall. As a result, human forecaster experience continues to play a critical role in identifying rainfall events not captured by models and issuing timely early warnings.

Since 2024, our team has been producing daily regional rainfall forecasts across Taiwan to meet operational needs. We conducted a systematic verification of these forecasts during the May to November wet season, using quantitative indicators such as Bias Score, Probability of Detection (POD), False Alarm Rate (FAR), and Threat Score (TS). In addition, we employed Student’s t-test, Wilcoxon signed-rank test, and probability density function (PDF) analyses to evaluate forecast stability and distributional differences from multiple perspectives. The results show that forecasts for rainfall events below the heavy rain threshold tend to exhibit larger deviations. However, forecasts during typhoon periods generally demonstrated effective performance in estimating extreme rainfall. Both the t-test and Wilcoxon test indicated a statistically significant match between forecasted and observed rainfall during typhoon impacts, although some extreme rainfall events showed deviations exceeding several hundred millimeters. This reflects limitations in current models' capability to capture terrain-driven and localized convective systems, and highlights room for improvement in subjective forecasting—especially for complex phenomena such as afternoon convection and remote precipitation systems.

Moving forward, enhancing the integration of multi-source observational data and implementing real-time rolling correction mechanisms will be essential for improving responsiveness and situational awareness during localized hazardous weather events.

Keywords: rainfall forecast, regional forecast verification, t-test, contingency table, statistical validation