

多源即時警示於劇烈對流防災應用

Multi-Source Real-Time Alerts for Severe Convection Disaster Mitigation

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摘要

因應近年氣候變遷下短延時強降雨與劇烈對流的威脅，臺大天氣團隊整合中央氣象署大雷雨即時訊息、QPEplus雷達定量降雨預報(QPN)等多源資料，自2024年起開發並運行鐵路沿線客製化天氣警示方案。2024年於鐵路沿線發布警示後，針對沿線時雨量大於40毫米的SR為0.42，實際發生災害（如淹水、樹倒、土石流等）的比例約為3%。雖然可用於校驗的地面觀測資料偏少，對於強風事件的POD可達0.90，但FAR亦達0.85。

今(2025)年本方案已擴展應用於地勢陡峻、降雨反應敏感之新生崩塌區，提供監測與通報。針對今年5月起高風險區參考測站達警戒值的事件中，POD為0.34。針對多數事件出現「發布延遲」或「空間落點偏差」等情形，推測原因可能包括：預警閾值低於大雷雨即時訊息發布標準。另以5月20日東部雷雨事件為例，發現QPN資料對複雜地形有偏移及漏報現象，顯示需對區域性演算法進行修正。

綜合驗證顯示，多源資料整合系統對劇烈對流防災有潛力，但仍需持續改進降雨估算與警示可信度，未來將透過多案例校驗、守視人員回饋及演算法修正，提升對短延時強降雨與其他劇烈天氣的應對能力。

關鍵字：大雷雨即時訊息、QPEplus、劇烈對流、即時警示、雷達定量降雨預報

Abstract

In response to the increasing threats of short-duration heavy rainfall and severe convection under climate change, the TAIDA Weather Group has integrated multi-source data, including the Central Weather Administration's Instant Torrential Rain Alerts and QPEplus radar quantitative precipitation nowcasts (QPN), to develop and operate a customized weather alert system along railway lines since 2024. After alerts were issued along railway lines in 2024, the success ratio (SR) for hourly rainfall exceeding 40 mm was 0.42, while the actual proportion of disasters occurring (such as flooding, trees falling, and landslides) was about 3%. Although ground observation data available for validation were limited, the probability of detection (POD) for strong wind events reached 0.90, but the false alarm ratio (FAR) was also as high as 0.85.

In this year (2025), this system has been further extended to newly formed landslide zones characterized by steep terrain and sensitive rainfall response, providing monitoring and notification services. Among events since May this year, where reference stations in high-risk areas exceeded alert thresholds, the POD was 0.34. For many cases with "alert delays" or "spatial displacement," the potential causes are presumed to include the lower alert thresholds compared to the issuance criteria for Instant Torrential Rain Alerts. A case study of the eastern Taiwan thunderstorm on 20 May revealed positional bias and underestimation in QPN data over complex terrain, highlighting the need to adjust regional algorithms.

Comprehensive validation shows that the multi-source data integration system has considerable potential for disaster mitigation related to severe convection. However, continuous improvements in rainfall estimation and alert credibility remain necessary. Future efforts will focus on multi-case validation, user feedback integration, and algorithm refinements to enhance the capability to respond to short-duration heavy rainfall and other severe weather events.

Keywords: Instant Torrential Rain Alerts, QPEplus, severe convection, real-time alerts, radar quantitative precipitation nowcasting