臺北市致災午後強降雨發生的環境與降雨特性分析

Environmental and Rainfall Characteristics of Disaster-Causing Heavy Afternoon Rainfall Events in Taipei City

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摘　要

近年來，臺北市都會區常於夏季午後發生短延時強降雨，對城市防汛與防救災工作造成極大挑戰。本研究統整並回顧過去12年臺北市平地時雨量大於90毫米之極端午後雷陣雨個案，共計13例，旨在剖析其綜觀環境特徵與致災降雨機制，以預報人員之實務需求出發，以期提升即時氣象監測與預報之效能。

初步歸納分析顯示，在此類極端強降雨個案發生時，大氣多呈現低層暖濕、高層較冷的極度不穩定狀態，且700 hPa環境風速普遍偏弱。在動力特徵上，本研究發現當時雨量達90毫米以上時，700 hPa風向主要呈現偏南風（由山頂往山腳吹）或西南風（沿雪山山脈地形吹拂）之特徵。在西南風環境下，對流胞多由桃園偏西風與基隆河海風輻合激發，若移動較慢，易與西南側上游對流胞或兩側新胞合併，常形成西南－東北走向之列車狀回波；在偏南風環境下，對流胞則多由淡水河與基隆河海風會合輻合激發，隨後往西北側傳播，且常與南側新店山區因地形激發並移入平地之對流胞合併，導致降雨增強與延時。

考量目前數值模式對都會區午後短延時強降雨預報仍具高度不確定性且誤報率偏高，本研究從預報作業實務出發，將此初步歸納之風向環境特徵與雷達回波合併路徑轉化為客觀的預報概念模式。預期此成果將能有效改進每日上午發布之午後雷雨預報資訊，並為午後雷雨守視與即時預報提供關鍵的預報指引，進而補足數值預報之局限並提升極端大雷雨之預警效能。

關鍵字：短延時強降雨、臺北市都會區、700百帕風向、對流胞合併

Abstract

In recent years, short-duration, high-intensity afternoon convective storms in the Taipei metropolitan area have posed severe challenges to urban flood control and disaster prevention. This study reviews 13 extreme afternoon thunderstorm cases over the past 12 years where the hourly rainfall in the Taipei plains exceeded 90 mm. Aiming to address the practical needs of weather forecasters, this study dissects the synoptic-scale environmental features and disaster-causing rainfall mechanisms of these events to enhance the efficacy of real-time meteorological monitoring and forecasting.

Preliminary analysis indicates that during these extreme rainfall events, the atmosphere exhibited a highly unstable profile with warm, moist air at low levels and cold air aloft, accompanied by generally weak environmental winds at 700 hPa. Regarding dynamic characteristics, this study reveals that when hourly rainfall reached 90 mm or more, the 700-hPa wind direction predominantly featured southerly winds (blowing from mountain peaks to the foothill plains) or southwesterly winds (blowing along the Hsuehshan Range topography). Under southwesterly wind conditions, convective cells are mostly triggered by the convergence of westerly winds from Taoyuan and sea breezes from the Keelung River. If these cells propagate slowly, they tend to merge with upstream cells on the southwestern side or newborn cells on both flanks, frequently forming a southwest-to-northeast "train-effect" echo pattern. Under southerly wind conditions, convective cells are primarily initiated by the convergence of sea breezes from the Tamsui and Keelung Rivers. These cells subsequently propagate northwestward and frequently merge with convective cells triggered by the terrain over the southern Xindian mountainous area that move into the plains, leading to localized rainfall intensification and prolonged durations.

Given that current numerical weather prediction models still exhibit high uncertainty and high false alarm rates in forecasting metropolitan short-duration heavy rainfall, this study translates the summarized wind-field features and radar echo-merging paths into an objective, conceptual forecasting model based on operational forecasting practices. These findings are expected to effectively improve the daily morning forecasts of afternoon thunderstorms and provide critical operational guidance for convective monitoring and nowcasting, thereby overcoming the limitations of numerical models and enhancing warning capabilities for extreme convective storms.

Key words : Short-Duration Intense Rainfall, Taipei metropolitan area, 700-hPa wind direction, Cell merge