# 智慧化多模式雨量整合預警技術研發與應用

# Intelligent Development of Multi-Model Rainfall Integration and Optimization

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## 摘　要

國家災害防救科技中心為面對極端天氣挑戰，發展了多模式之無接縫降雨統計後處理技術：初期奠基於動態校驗權重修正，落實跨尺度整合基礎；隨後導入人工智慧超解析度演算法(MSRN)，增加成員多樣性並降低系統性誤差，此階段技術已實務應用於水資源管理。為更有效率的處理龐大的多模式特徵，本研究引進「Optuna 自動化最佳化架構」，以貝氏最佳化動態搜尋最佳整合權重，在雨量準確度與空間形態之間取得最佳平衡。此外，針對預報不確定性，應用非監督式機器學習(K-means)群集分析進行降雨特徵分群，延伸出情境分析技術。本研究透過氣象模式與 AI 演算法的跨領域結合，不僅提升了定量降雨預估的準確性，更為防災決策提供了更具彈性的情境決策支援。

關鍵字：無接縫、多模式、最佳化

## Abstract

To address extreme weather, the National Science and Technology Center for Disaster Reduction(NCDR) developed a multi-model seamless statistical post-processing technique for rainfall estimation. Initially, verification weight adjustments established a cross-scale integration foundation. Subsequently, AI-based MSRN downscaled members were introduced to expand ensemble diversity and reduce systematic errors, a stage currently applied in water resources management. To efficiently handle massive model features, the Optuna framework was adopted to optimize weights, balancing rainfall accuracy and spatial patterns. Additionally, K-means clustering groups rainfall features to address forecast uncertainty for scenario analysis. By bridging meteorological models and AI, this approach enhances precipitation estimation precision and delivers flexible decision support for disaster mitigation.

Key words : seamless、multi-model、optimization