利用統計後處理技術進行臺灣地區系集機率型與單一決定性降雨預報

Ensemble Probabilistic and Single Deterministic Precipitation Forecasts over Taiwan Using Statistical Post-Processing

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摘 要

天氣現象是多重尺度交互作用的結果，由於較高頻的小尺度過程對降雨扮演著重要角色，使得降雨的可預報度相對其他氣象場量並不高；5天以上的預報對氣象學家而言是極具挑戰的。但另一方面，近年來農業、林業、畜牧業以及水資源管理單位對於中期(3-10天)與展期(10-30天)降雨預報的需求卻是顯著增加。本研究發展結合類比後處理方法(Analog Post-processing，AP)與機率擬合平均方法(Probability-Matched mean，PM)的統計後處理技術，稱為APPM，以進行臺灣地區1-14天降雨預報的偏差修正和降尺度，目的在於提供使用者更正確的定量降雨預報(Quantitative Precipitation Forecast，QPF)與可信的定量降雨機率預報(Probabilistic Quantitative Precipitation Forecast，PQPF)。

類比後處理方法主要是在歷史預報中搜尋與目前系集降雨預報最相似的20組類比預報(forecast analogs)，並以20組類比預報所對應的高解析降雨觀測作為類比預報系集(AP forecast ensemble)，再採用頻率計數於類比預報系集，以得到良好校正且降尺度後的1-14天定量降雨機率預報。此外，本研究應用機率擬合方法於類比預報的系集平均，以得到更接近真實觀測的定量降雨預報。預報評估顯示：(1)在系集預報部分：原始系集預報呈現明顯離散度不足(under-dispersion)的現象，但類比系集的離散度可以良好地反應預報的不確定性。(2)在定量降雨機率預報部分：相較於原始預報，校正後的降雨機率預報有較佳的可信度與較高的區辨能力，並可提供較高的經濟價值給較廣的使用者。(3)在定量降雨預報部分：相較於原始預報，校正後的降雨預報呈現出較細尺度的降雨特徵、其可解釋的觀測變異量提高到3-5倍以上，同時移除大部分的預報偏差並降低平均絕對誤差。

關鍵字：類比後處理、機率擬合平均、定量降雨預報、定量降雨機率預報、偏差校正、降尺度

Abstract

The predictability of precipitation is limited due to the important role finer scale processes play; therefore, the prediction of precipitation beyond 5 days is a big challenge for meteorologists. On the other hand, demand for medium- (3-to-10 days) and extended-range (10-to-30 days) precipitation forecasts by users in agriculture, forestry, livestock, and water resource management has grown significantly. In this study, a statistical post-processing technique combining Analog Post-processing (AP) and Probability-Matched mean (PM), called APPM, is developed to perform bias correction and downscaling of 1-to-14 day precipitation forecasts in Taiwan. The aim is to provide users with more accurate Quantitative Precipitation Forecast (QPF) and reliable Probabilistic Quantitative Precipitation Forecast (PQPF).

Analog Post-processing (AP) searches for the best analogs to the current forecast in a historical set of predictions. The AP forecast ensembles are derived from the observed high-resolution precipitation patterns corresponding to the

historical forecast analogs that most resemble the current ensemble precipitation forecast. Frequency counting is then applied to the AP ensembles to produce well-calibrated and downscaled 1-to-14 day PQPF. For QPF with a more realistic range of precipitation amount, PM is applied on the AP ensemble mean. Forecast evaluation shows that the raw ensemble is under-dispersive with a wet bias. In contrast, the AP ensemble spread well represents the forecast uncertainty. Compared to the raw PQPF, the AP-based probabilistic forecast has better reliability, higher skill in discrimination, and higher economic value for a wider range of users. The calibrated QPF displays finer scale details of precipitation, explains about 3 to 5 times more variance in observations, as well as removes most bias and reduces Mean Absolute Error (MAE) in most seasons and lead times compared to the raw QPF.

Key words: Analog Post-processing (AP), Probability-Matched mean (PM), Quantitative Precipitation Forecast (QPF), Probabilistic Quantitative Precipitation Forecast (PQPF), bias correction.