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Improvement of Statistical Typhoon Rainfall Forecasting with ANN-Based Southwest Monsoon Enhancement

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ABSTRACT

Typhoon Morakot 2009, with significant southwest monsoon flow, produced a record-breaking rainfall of 2361 mm in 48 hours. This study hopes to improve a statistical typhoon rainfall forecasting method used over the mountain region of Taiwan via an artificial neural network based southwest monsoon enhancement (ANNSME) model. Rainfall data collected at two mountain weather stations, ALiShan and YuShan, are analyzed to establish the relation to the southwest monsoon moisture flux which is calculated at a designated sea area southwest of Taiwan. The results show that the moisture flux, with southwest monsoon flow, transported water vapor during the landfall periods of Typhoons Mindulle, Bilis, Fungwong, Kalmaegi, Haitaing and Morakot. Based on the moisture flux, a linear regression is used to identify an effective value of moisture flux as the threshold flux which can enhance mountain rainfall in southwestern Taiwan. In particular, a feedforward neural network (FNN) is applied to estimate the residuals from the linear model to the differences between simulated rainfalls by a typhoon rainfall climatology model (TRCM) and observations. Consequently, the ANNSME model integrates the effective moisture flux, linear rainfall model and the FNN for residuals. Even with very limited training cases, our results indicate that the ANNSME model is robust and suitable for improvement of TRCM rainfall prediction. The improved prediction of the total rainfall and of the multiple rainfall peaks is important for emergency operation.

Key words: Southwest monsoon, Statistical typhoon rainfall forecasting, Artificial neural networks, Moisture flux

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1. INTRODUCTION

Taiwan is located in the hot zone of the Western Pacific typhoon tracks with an average three to five typhoons making landfall in Taiwan each year. While the typhoon rainfall is the most important water resource in Taiwan, it also causes serious disasters. Obviously, the typhoon rainfall prediction affects disaster mitigation and emergency operations. The importance of the central mountain range in typhoon precipitation has long been realized (e.g., Hong et al. 2010; Lin et al. 2010). The long term rainfall data suggest that the mountain stations of ALiShan and YuShan often experience extreme typhoon rainfall. The interactions of summer or winter monsoons as important factors that contribute to the extreme rainfall in Taiwan are also recognized by the meteorological community (e.g., Wu et al. 2009; Chien and Kuo 2011; among many others).

Typhoon Morakot 2009 produced a record-breaking rainfall, 2361 mm in 48 hours, causing the most serious flood and landslide disaster in southwestern Taiwan in 50 years. Typhoon Morakot's landing on Taiwan occurred concurrently with the cyclonic phase of the intra-seasonal oscillation, which may have enhanced the background southwesterly flow. The extreme rainfall event is caused by the

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