P2.21 STATISTICAL FORECAST ON PRECIPITATION OVER TAIWAN AREA DURING TYPHOON INVASION USING GMS-5 DATA

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1. INTRODUCTION

Of all natural disasters occurring in Taiwan, Typhoons are the most series. Highly populated, blooming economic and technological development in Taiwan has created stress on the island's physical and biological environment. A serious consequence of this is steadily increasing loss and damage caused by natural hazards (Ma *et al.*, 1999). Resent study has suggested that successful prediction, mitigation of natural hazards as well as properly use of natural resources has become an urgent issue and has obtained nationwide attention (Sui *et al.*, 2002).

Statistics over the past 20 years has indicated that Taiwan was struck by an average of 3.7 typhoons annually. No matter where typhoon made her landfall, strong wind and heavy precipitation associated with typhoons significantly affect the living and sometimes threaten human lives. Although satellite imageries are capable of portraying parts of the typhoon's structure, for example the spiral rain band, wall cloud, eye diameter, symmetric and asymmetric cloud cover *etc*., the mesoscale topographic characteristic of the Central Mountain Range (CMR) complicates the wind and precipitation forecast.

It has no doubt that typhoon intensity positively proportional to the boundary layer wind strength and precipitation. Deep convection not only strengthens the secondary circulation but also provides critical ingredients necessary for CISK process. With this simple concept, parameters derived from satellite observation were selected and linked to deep convection Griffith *et al.* (1978). Classical statistics is then employed to estimate inland precipitation as typhoon strikes. The purpose of this study is to find an objective precipitation forecast using multiple regressions with satellite observed predictor variables.

2. DATA AND METHODOLOGY

IR1 Data of GMS 5 was used throughout this study. Operational experience suggests that If typhoon tracks long enough over the northwestern Pacific, it usually has better chance to intensify and broaden its coverage of deep convection. Consequently, typhoons from the Pacific ocean are normally different in size and intensity comparing to those from the South China Sea, Therefore, two sets of typhoon tracks were classified to delineate this difference. Tracks west of 20 degree N and 122 degree E were classified into northward moving typhoons. All the others were categorized as westward moving ones.

Figure 1 illustrates all typhoons from 1998 to 2001 that struck Taiwan and their associate tracks. A total of 46 samples extracted from 16 typhoons were selected. The number of westward and northward moving cases was 9 and 7 respectively (Table 1).

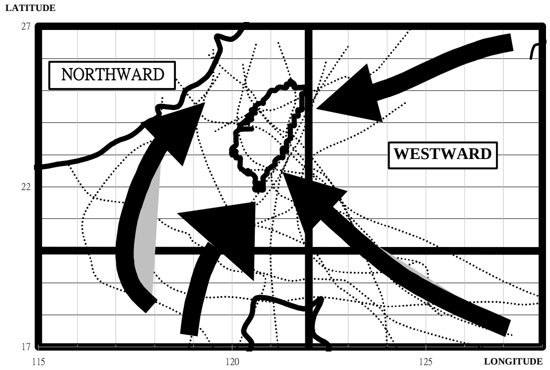

Figure 1: The tracks of all Typhoon samples.

Table 1: Data used in the study.(A: westward; B: northward)

	Typhoon	Sample time	Case no.	Sample no.
A	OTTO	1998.8.4.	2	46
	MAGGIE	1999.6.5.~6.	2	
	BILIS	2000.8.22.~23.	3	
	CHEBI	2001.6.23.~23.	3	
	UTOR	2001.7.4.~5.	3	
	TRAMI	2001.7.11.~12.	2	
	TORAJI	2001.7.29.~30.	5	
	NARI	2001.9.16.~19.	12	
	LEKIMA	2001.9.25.~29.	14	
B	YANNI	1998.9.27.~28.	5	29
	ZEB	1998.10.15.~16.	4	
	BABS	1998.10.27.	3	
	DAN	1999.10.8.~9.	4	
	KAI-TAK	2000.7.8.~9.	5	
	XANGSANG	2000.10.31.~11.1.	4	
	CIMARON	2001.5.12.~13.	4	

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Precipitation within the time when typhoon produced rainfall inland were collected. Six-hour mean precipitation amount were also calculated and then worked with the satellite data. Without taking into account the mesoscale variation of clouds and precipitation within 6 hours, it is hope that our approach would enlighten the connection between the characteristics of clouds embedded within typhoon and its associated inland precipitation.

Mean, minimum, standard deviation of brightness temperature, and cloud coverage at a distance of 25 km, 50 km 100 km and 200 km centered at typhoon center were computed. These parameters were used to bridge the typhoon's rain band structure and the surface rainfall amount. Followed the research results proposed by Barrett *et al*. (1981) and Liu *et al*. (1992), we take into account the contribution of deep convection in enhancing surface precipitation. The number of pixel of brightness temperature less than 235 K and 210 K within 200 km was thus computed. Once these were done, correlation coefficients between precipitation and remote sensing parameters were then calculated. Multivariate regression equations for westward and northward moving were further obtained.

Six sets of samples extracted from typhoon AMBER (1997) and typhoon NAKRI (2002) were utilized to perform cross validation.

3. RESULTS

Correlation coefficients between precipitation and satellite derived parameters for westward moving case have value less than 0.3. Similar result was also noticed for northward case. However, for the northward moving case data also indicate that that increase in radius results in a sharp decrease in correlation. This seems to suggest that northward moving case has a smaller size than its companion part.

Mean and standard deviation of brightness temperature could be used to describe the cloud characteristics within typhoon. Combined use of these two sets of parameters significantly improved the precipitation correlation for the northward moving case. However, meaningless change in precipitation correlation was found for the westward moving case. When the minimum brightness temperature was taken into account, it is noticed that the correlation increases as the radius of the sample decreases. This fact again suggests that the northward moving case possess a compact characteristic in size.

The correlation increases for the westward moving case when the cloud area coverage was taken into account. In obtaining a multivariate regression for the westward moving case, including the cloud area coverage seems critical.

All northward moving cases indicated that precipitation correlated closely to the derived parameters with radius within 100 km. This seems to suggest that significant precipitation occurs mainly within 100 km radius.

The multivariate regression for northward and westward moving case were evaluated with all 14 derived parameters. Our result showed that the correlation between precipitation and derived parameters is 0.71 with root mean square error 4.7 mm for westward moving case. As of the northward moving case the correlation reach to 0.73 with root mean square error 4.7 mm. Using NAKRI and AMBER to cross validate the northward and westward moving case respectively. Higher correlation in precipitation estimation was obtained associated with NAKRI (0.91 with root mean square error 3.1 mm; shown in Figure 2) , while for the AMBER this value sharply dropped to 0.57 (with root mean square error 7.4 mm) (Figure 3). The causes of the sudden drop of the correlation results from the mesoscale precipitation due to CMR.

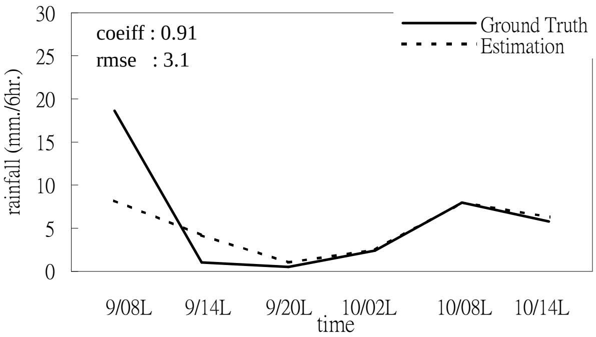

Figure 2. Rainfall estimation for northward moving Typhoon

4. FUTURE WORK

This study further strengthen that the critical role of mesoscale topographic effect on precipitation amount. Obtaining individual multivariate regression for the north, center, south, and east part of the CMR might improve the precipitation estimation.

Classification on size, intensity, and symmetry of westward and northward moving cases should improve the results.

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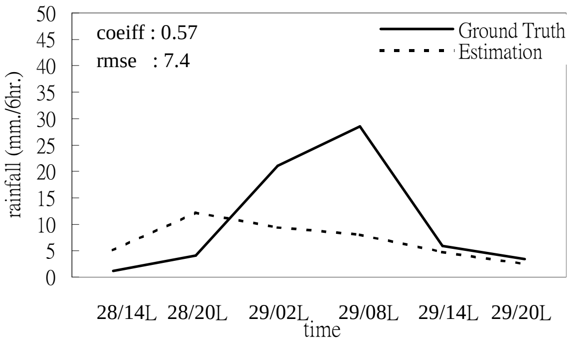

Figure 3. Rainfall estimation for westward moving Typhoon

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