IDENTIFICATION OF PREDICTORS FOR NOWCASTING HEAVY RAINFALL IN TAIWAN. PART II: STORM CHARACTERISTICS AND NOWCASTING APPLICATIONS

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ABSTRACT

1. INTRODUCTION

This is the second of a two-part paper on research to develop sufficient understanding of the meteorological processes that produce heavy rainfall, so that predictors can be developed for a heavy rainfall nowcasting system. Floods cause more human fatalities (>120) per year in the United States than any other thunderstorm-related weather phenomenon; and most of these are due to flash flood events (NRC, 2005). Most flash floods are caused by heavy rainfall associated with semi-stationary thunderstorms, thunderstorms that repeatedly move over the same location, or with large-scale, convective storm complexes such as Mesoscale Convective Systems (MCSs), tropical cyclones or hurricanes.

In order to predict when heavy rainfall may result it is important to identify and automatically detect the environmental characteristics and storm attributes associated with heavy rainfall events. In 2008, the Southwest Monsoon Experiment (SoWMEX) and the Terrain-induced Monsoon Rainfall Experiment (TiMREX) (Jou et al 2011) was conducted during Taiwan's warm season, gathering high resolution dual-polarization radar, surface, sounding, dropsonde, and special vertical profiling measurements during heavy rainfall events triggered by a range of weather phenomena. Because of the frequency of heavy rainfall and flash floods in Taiwan, the SoWMEX/TiMREX data is ideally suited for examining the attributes associated with heavy rainfall events and identifying robust predictors for nowcasting heavy rainfall (Davis and Lee 2012; Roberts et al. 2010).

The environmental characteristics and methodologies for automated detection of heavy rainfall events are discussed in Part I of this study (Wilson et al. 2012). In Part II of this study we examine characteristics of storms that produce heavy rainfall and the predictability of these attributes for nowcasting applications.

2. STORM CHARACTERISTICS

Taiwan presents unique challenges for prediction of heavy rainfall, being an island surrounded by water and with steep mountains running through the central and eastern portions of the island. Heavy rainfall exceeding 100 mm per day occurs frequently and occasionally, days with over 300 mm per day have been observed.

a. Synoptic influences and terrain effects

On 5 June 2008, 226 mm of heavy rainfall fell along the southwestern coastal city of Kaoshiung. An MSC that formed along a cold front over the South China Sea was the primary trigger for the storms. A shallow (<1 km in height) convergence zone persisted offshore all day concentrating moist, conditionally unstable air in this region and was the focusing mechanism for new convection initiation and strongly influenced the intensification of rainfall along the coast (Davis and Lee 2012), as can be seen in Fig. 1. The most intense rainfall occurred during a 4 hour period from 04-08 UTC. Storm evolution during this case has some similar attributes to flash flood event that occurred in Boscastle, United Kingdom, (Golding et al 2005) associated with a slow-

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moving, synoptic low pressure area located to the west of the UK that set up a stationary sea breeze front along the north coast of Cornwall. Storms that developed over the sea breeze during a 4 hr period produced significant rainfall amounts in the coastal region.

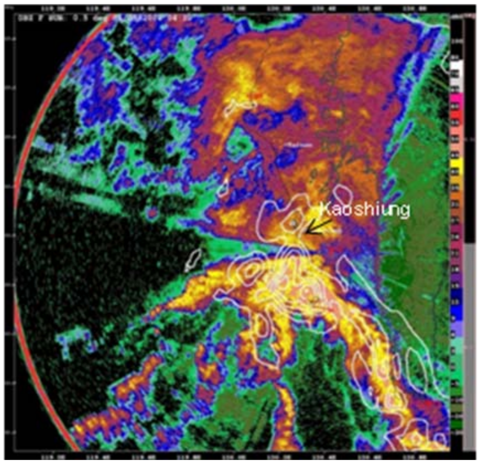

Figure 1. Reflectivity field from the NCAR S-Pol radar on 5 June 2008 at 04:30 UTC. Contours of surface convergence obtained for the 4-D Variational Doppler Radar Analysis System (VDRAS) are overlaid.

b. Local influences and terrain effects

On days when synoptic influences were weaker, storms in Taiwan formed locally through diurnal heating of the land and heavy rainfall events resulted from back-building and merging of storms, or from continuous rainfall at a location as thunderstorms tracked continuously over that area. Figure 2 shows the diurnal tracks from 25 May, where most of the storms tracked to the southeast, except for one storm that initially tracked to the southeast and then began back-building.

c. Applicability to nowcasting

In this study, we utilize the properties from a storm tracking algorithm to automatically identify storms that undergo a reversal in storm motion, that may be indicative of back-building storms or a storm merger process resulting in increased rainfall. We also test a methodology for tracking and tabulating storm cells passing over or continuously initiating over specific locations in Taiwan where heavy rainfall occurred. The above information will be examined in conjunction with radar accumulation and rain gauge data, and environmental and storm predictor fields to determine if it is possible to increase the accuracy in predicting heavy rainfall compared to basic storm extrapolation techniques more commonly used in hydrologic runoff models.

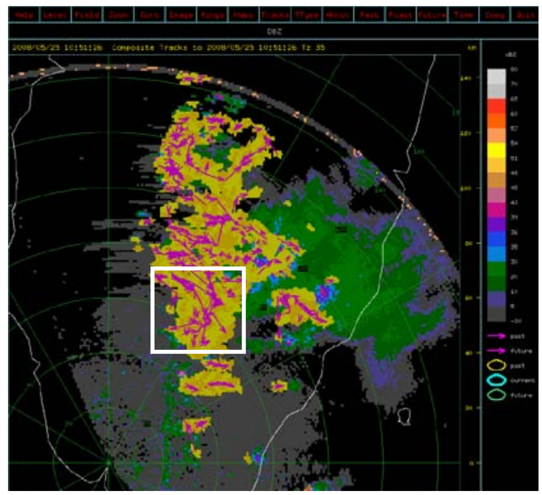

Figure 2. Diurnal storm propagation and tracks (magenta vectors) over southwest Taiwan (thin white polyline) on 25 May 2008. The white box bounds a back-building storm with a reversal in storm direction.

3. REFERENCES

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