Identification of Predictors for nowcasting heavy rainfall in Taiwan:
Part I: Environmental Characteristics and Automated Detection of Heavy Rainfall

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ABSTRACT

1. INTRODUCTION

This is the first Part of a two Part paper to develop sufficient understanding of meteorological process that produce heavy rain so that predictors can be developed for a heavy rain nowcasting system for Taiwan. That system is the NCAR AutoNowCaster (Mueller et al 2002). Taiwan is an excellent location for such a study because of the very high frequency of heavy rain. This initial effort is focused on the use of data collected during the 2008 Terrain-induced Monsoon Rainfall Experiment (TiMREX) that was conducted during Taiwan's warm season (Jou et al. 2011), Special instrumentation used in this study included high resolution dual-polarization radar, surface stations, sounding, and disdrometers, Because of the frequency of heavy rainfall and flash floods in Taiwan, the TiMREX data is ideally suited for examining the attributes associated with heavy rainfall events and identifying robust predictors for nowcasting heavy rainfall (Roberts et al. 2010).

Part I focuses on the real-time detection of heavy rain events and the associated meteorological environment. Part II (Roberts and Wilson 2012) focuses on storm characteristics that along with environment conditions may be used in real-time as nowcasting predictors of where and when heavy rain may occur.

There is abundant scientific literature that details the meteorological conditions that have produced heavy rain flooding situations. The real-time identification of these situations often depends on radar and rain gauge rainfall estimates.

The focus of this paper is southeast Taiwan over an area covered by the NCAR S-Pol polarimetric S-band radar. Figure 1 shows the area of this study, which includes the radar range rings, location of rain gauges, soundings and disdrometers overlaid on the topography.

Detection of heavy rainfall events

For this study heavy rain events are defined as 100 mm of rain occurring in 6 hr or less as estimated by either radar or rain gauge. The radar estimate is based on the horizontal radar reflectivity. Although S-pol is a polarimetric radar for this preliminary study only the rainfall estimates based on the horizontal reflectivity are available. The age old question of what Z-R relationship to use and the accuracy of the radar estimates is of course a question here also.

For the TiMREX period we compare distrometer, rain gauge and radar reflectivities. The radars used were S-pol and the Tawain 10 cm wavelength network radar RCCG. Figure 1 shows the relative locations of these instruments.

The reflectivities from the two radars agreed very closely (correlation coefficient 0.97). Reflectivity comparisons between S-Pol and the two distrometers had a 0.91 coefficient of correlation but S-pol averaged 1.2 to 2.8

db less than the distrometers depending on the storm and distrometer. An average Z-R relationship for the distrometers was $280R^{1.38}$. The use of this relationship for the radars generally lead to an underestimate in the rainfall rate particularly at the higher rates. This can be primarily attributed to the generally lower reflectivities measured by the radar compared to the distrometer

For this study at this time we are not that concerned about the absolute accuracy of the rainfall estimates rather a rough relative estimate of how much rain fell, the duration and spatial extent.

Environmental conditions

Based on those events that are identified as heavy rain using the 100 mm in 6 hr criteria a table is in preparation that provides the environmental conditions at the onset of the heavy rain period. Environmental parameters that are listed are CAPE, CIN, average relative humidity between 850- 500 mb, boundary layer mixing ratio, boundary layer wind, 3 km height wind and synoptic situation. All the above environmental values with one exception where from the soundings shown in Fig 1. The exception is the boundary layer wind which was based on the S-Pol Doppler velocity. In most instances soundings were available within 3 hr of the start of the heavy rain.

For the cases with weak synoptic forcing the average layer humidity is most correlated to the likelihood of heavy rain with CIN the next most correlated.

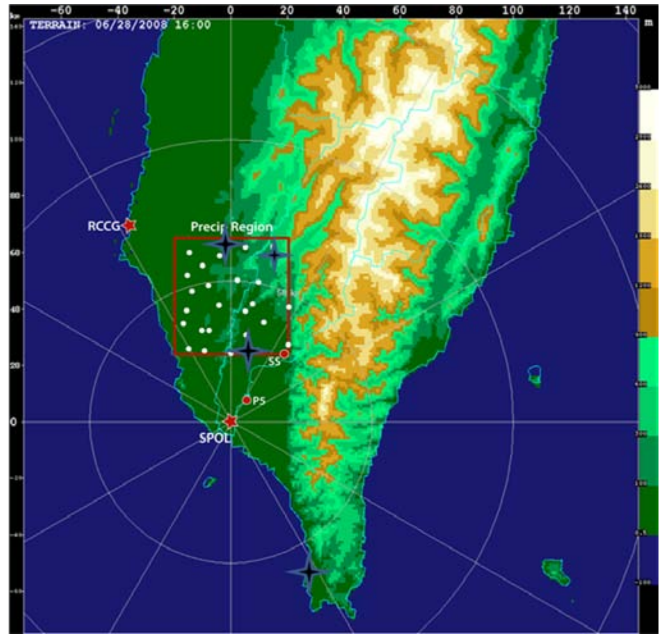

Figure 1 Location of radars (RCCG and SPOL), SPOL range rings (50 km white rings) disdrometers (SS and PS), 900 km^2 box used to compare average rain gauge and radar estimates of rainfall (red square), radiosounde sites (✦) overlaid on Taiwan topography (height scale on left).

References

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