P14R.13 Drop size distribution and radar rainfall estimation for different precipitation systems in Taiwan

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1. Introduction

Taiwan is located in the subtropics off the southeastern coast of China. Its climate is strongly affected by the East Asian monsoons. In addition, the presence of the central mountain range (CMR) causes large spatial variations in the island climate throughout the year. Precipitation in Taiwan is influenced by the topographic effect and the prevailing wind in different season. The major weather systems influence Taiwan are cold surges in winter, cold fronts in spring, Mei-yu fronts, mesoscale convective systems (MCSs) and orographic rainshowers during Mei-yu season (mid-May to mid-June), tropical disturbances (including tropical storms) and orographic rainshowers in summer, late season's tropical storms, cold fronts and MCSs in fall. The measurements of drop-size distributions are important for many meteorological applications, including estimation of rainfall, precipitating cloud microphysics studies, and cloud model initialization and verification (Cifelli et al., 2000; Tokay et al., 2003). In particular, accurate estimates of area rainfall through radar measurements benefit from the knowledge of the drop size distribution (Tokay et al., 2001)

2. Instruments and DSD Observation

Six impact disdrometers, three 2DVD optical disdrometers, more than 100 tipping bucket rain gauges and three Doppler radar(Wu-Fen Sun/CWB S band NexRad Radar, CAA C band Radar and NCU dual polorization Radar) constitute a very good network to study DSD and rainfall estimation and verification in the northern part area of Taiwan(Fig. 1) In order to test how accurately they measure drop size distribution and rainfall rate, a unique set of instruments, including two video and one Joss-Waldvogel disdrometer and three tipping bucket rain gauge was deployed and operated at NCU weather station. .Simultaneous observations made with optical-and impact-type disdrometers have been made and analyzed since 2002. The DSDs were used to derive reflectivity Z, calculate the rainfall rate and compare with the radar and raingauge measurements. The Gamma drop size distributions are derived from disdrometer observation at six minutes interval. The Z-R relations through Gamma distribution are derived.

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3. DSD Characteristics and Radar rainfall estimation

Based on three years observation, we can find clear differences in DSD patterns in different seasons' precipitation systems. In typhoon cases, even in the same time window, there are distinct difference in Gamma distribution pattern in the different site in the northern area of Taiwan (Fig. 2). In particular, the small size of raindrop at Nan-Gang Size are clearly less than the other stations. During the heaviest rainfall rate (greater than 60 mm/hour) period of typhoon, the medium drop size did not very much to exceed 2.5 mm. The N0 increased as the rainfall rate increased. In typhoon Aere, based on the event-basis derived reflectivity from DSD in comparison with radar measurement reflectivity, we can find that radar reflectivities are severe underestimated when dBZ is less than 20(Fig. 3). Due to the complex terrain of northern Taiwan, the locations of the underestimate of the reflectivity by the blockage and partial beam filling have been identified. The correction of radar reflectivities is necessary in order to get accurate radar rainfall map. Fig. 4 and Fig. 5 show the rainfall estimation results derived from different methods. Based on the corrected radar reflectivity and Z-R relation derived from DSD observation, we can get very accurate rainfall estimation (Fig. 4, Fig. 5). The vertical profiles of reflectivity in both stratiform and convective regions will be studied for the purpose of better extrapolation of reflectivity at lowest level in the near future.

Acknowledgments

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Reference:

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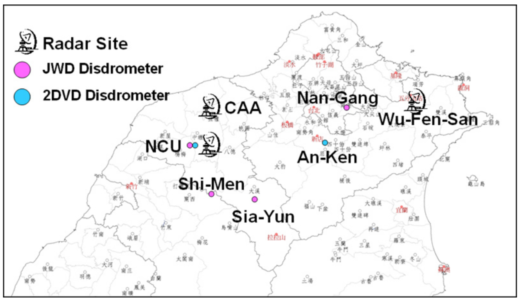

Fig. 1 A network of disdrometer, rain gauge and Doppler radar site in the northern area of Taiwan.

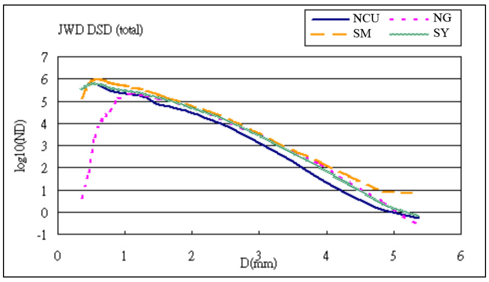

Fig. 2 Drop Size Distribution at different four stations in northern Taiwan during 2004 typhoon season.

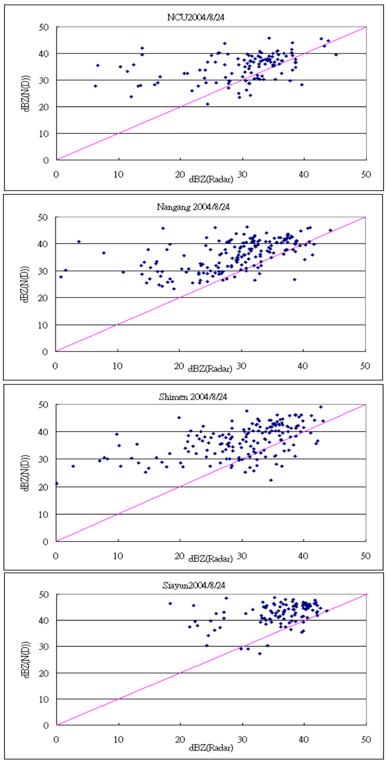

Fig. 3 Event-basis reflectivity retrieved from DSD measurement in comparison with radar measurement.

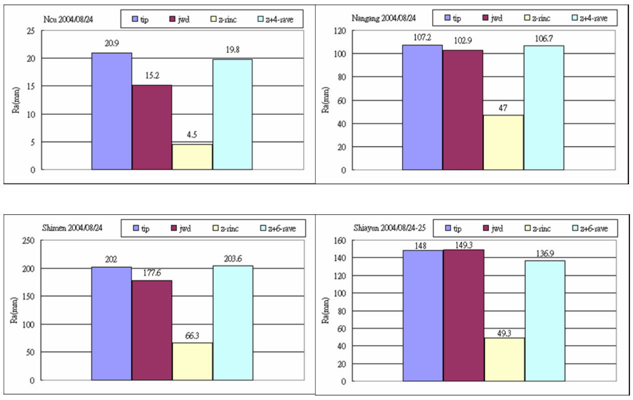

Fig. 4 Selected-event rainfall estimation by different methods tip – tipping bucket measurement, jwd – JWD disdrometer measurement, Z-rinc – radar rainfall estimate base on Z-R relation, Z+No-rave – corrected radar rainfall estimate base on Z-R relation.

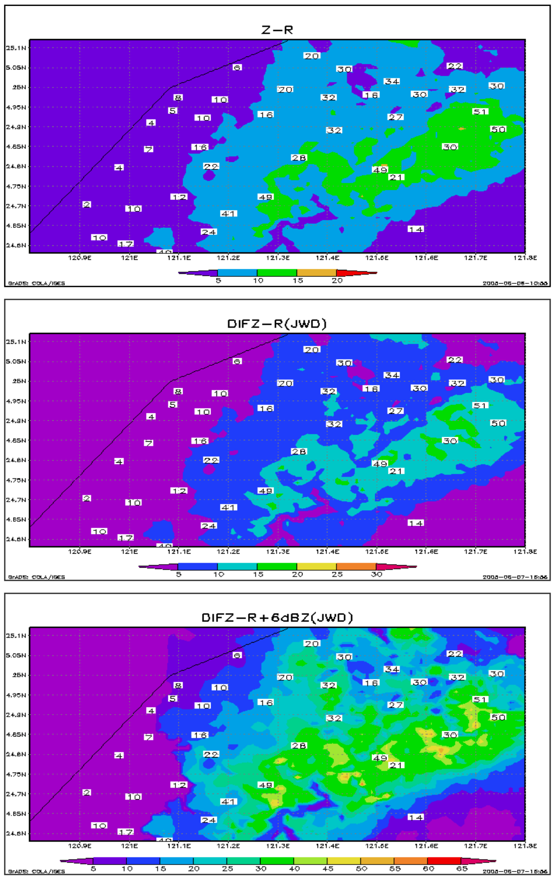

Fig. 5 Selected event (Aug. 24, 2004) surface rain gauge measurement (digital number) in comparison with radar rain map derived from Z-R relation. (a) Z=300R1.4 (b) Z-R relation derive from DSD observation (c) Z-R relation derive from DSD and corrected dBZ.