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Observations and Polarimetric Signatures of Flash Flood Storm in Metropolitan Taipei

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Abstract

In monsoon season, flash floods in megacities caused by organized multicellular complex are common. Due to short period of life cycle and high variability of rainfall intensity, the prediction skills of which are very low. In this paper, observations and polarimetric signatures of urban flash flood thunderstorm complex systems are investigated using dense meteorological surface stations and newly upgraded WSR-88D dual-polarized radar.

In this paper, a flash flood case caused by the afternoon thunderstorm complex (14 June 2015) over Taipei basin is examined. Observations from dense network of automatic rain gauges and meteorological surface stations are analyzed. It is found more than 190 mm rainfall has been recorded by Kong-Quan (C1A730, in NTU campus) station between 2-4pm. There are several stations on the SE district recorded 3 hourly rainfall greater than 100 mm. Surface wind and moisture analyses indicate sea breezes from both river mouths, the Tanshui and Keelung, were the major water vapor providers. Pronounced convergence zone can be identified. The environment was moist and unstable and suitable for thunderstorm to develop.

Initially, the storms were generated in the mountain region south of the basin and propagated northward into the basin. In the basin, cell merge process was observed. It is found cell merge process is the major mechanism in producing multicellular complex storm. Cell after merge has a larger horizontal extend of high reflectivity and enhanced rainfall intensity. Pronounced low-level convergence was identified during the cell merge and the convergence was related to sea breeze and cold outflows from pre-existing storms.

It is also found that the cell movement was from SW to NE parallel to the averaged mean wind and also parallel to the mountain range before merging. However, the

track has been changed toward NW after merging. The change of cell track after merging seems to indicate the importance of interaction of outflows from existing cell and moisture-abundant sea breeze.

Structures of thunderstorm complex before and after merge are analyzed using data observed by the WSR-88D (NEXRAD) polarimetric radar in northern Taiwan. There was significant variation on the structure and distribution of polarimetric variables before and after cell merge. Column of Zdr extended 2~3 km above the melting layer after cell merge is the manifestation of mixed phase cloud process. Pronounced cloud-to-ground lightning was observed at the same time. The appearance of Kdp column suggests potential of heavy rainfall and can be served as a good index for quantitative precipitation estimation.

Keywords: Urban flash flood storm, cell merge, sea breeze, cold pool, enhanced low-level convergence, polarimetric signature, Zdr column, and Kdp column.

Quasi-steady state thunderstorm complex in Taipei: A flash flood storm study

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Abstract

Quasi-steady state (definition: the period the area occupied by reflectivity ≥ 45 dBZ keep constant)

Characteristics: cell merger, large volume of rain water below freezing level, large volume of ice mixed rain particles above freezing level, much longer life period than usual single thunderstorm cell, multicellular structure (several updraft cores co-existed in the system, pronounced lightning (IC+CG), usually accompany with short period extreme heavy rainfall.

1. Introduction
2. Case description and environment condition
3. Kinematic and precipitation structures (dual-Doppler analysis)
4. Polarimetric signature
5. Formation mechanisms and terrain effect
6. Conclusions