Observations of S-Band Polarimetric Radars during SoWMEX/TiMREX and Beyond

西南氣流實驗期間 S 波段雙偏極化雷達的觀測以及後續研究

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Abstract

The Southwest Monsoon Experiment (SoWMEX) and the Terrain-induced Monsoon Rainfall Experiment (TiMREX) are cooperative field programs conducted by scientists from Taiwan and the United States. Interactions of southwesterly monsoonal flows over the South China Sea and the steep terrain of Taiwan during the early summer (May and June) often produce severe weather and heavy rainfall. The mesoscale environment favorable for the severe weather development and the microphysical processes which lead to heavy rainfall are two major scientific objectives of these two programs. In this presentation, four topics are presented and discussed.

A. **A study of microphysical properties of maritime squall line observed on 2 June 2008**. The squall line has been partitioned into four regions based on the radar reflectivity patterns: leading (convective) edge, convective center, trailing (convective) edge, and stratiform at the end of the line. Rain drop size distribution (RDSD) observed by x-band bistatic radar-type disdrometer (POSS, Precipitation Occurrence Sensing System) was used for the analysis. The results from each region of the maritime squall line suggest the existence of different cloud microphysical processes and described by the change of RDSD parameters. The coalescence process induces an increase of median volume diameter (Do) and shape parameter and a decrease of normalized number density (Nw), while the break-up process induces a decrease of Do and an increase of Nw. A follow-up study of 2010-2012 summer time precipitating systems over southwest of Taiwan using collision type disdrometers (JWD) are also presented for comparison. The number density observed are much larger than that observed by POSS during SoWMEX/TiMREX and is attributed to the small volume sampling issue.

B. **Observations of sea breeze circulation and thunderstorm development over Pingtung plain by SPOL radar.** The location and timing of sea breeze front (SBF) in the Pingtung plain is identified by using high-temporal surface station observations. The leading edge of sea breeze circulation has shown pronounced frontal-like structure, including temperature drop, humidity and wind speed increase, and wind direction change. The corresponding SPOL observations are analyzed accordingly. It is demonstrated the clear-air echo signal of SPOL can be very useful to identify location and movement of the sea breeze circulation

with proper clutter filtering. The averaged moving speed of SBF is 2.2m/s, the inflow from ocean can reach 4-5 m/s at height 500m and the return flow can reach 6 m/s at height 1.5km. It becomes difficult to identify SBF after the front moved into the mountain area. The wind field derived from the clear-air echo is consistent with the sounding observations and vertical structure of the sea breeze circulation is described. The flow structures at SBF, pre-SBF and post-SBF show significant differences possibly due to different atmospheric stability conditions. At pre-SBF, the flow was turbulent with pronounced vertical mixing and at post-SBF, the flow revealed two-layer stratified fluid characteristics. The depth of SB circulation increased from 600m to 1000m and the return flow increased from 1-2km to 1.5-3km. Dual-Doppler wind synthesis was also conducted for the developing stage. The role of sea breeze front and the terrain is further investigated in the study.

C. Three Mei-Yu heavy rain events are selected for the **S-band polarimetric radar-retrieved quantitative precipitation estimation (QPE) experiment**, two are from 2008 SoWMEX/TiMREX NCAR SPOL radar data and the other one is from northern Taiwan Wu-Fen-San radar data, respectively. Wu-Fen-San radar is a WSR-88D type radar and was upgraded to have polarimetric function since March 2014. Four different radar rainfall retrieval methods, e.g., the NEXRAD Z-R, QPESUMS Z-R, Kdp-R, and Hybrid method (Ze, Zdr, and Kdp) are applied to these three cases. The performance of these QPE methods on plain and mountain areas is differentiated for comparison. The experiment results show (1) the plain area QPE is in general much better than mountain area; (2) the stratiform rain area QPE is better than the convective rain area; (3) QPESUMS Z-R is overestimated over most plain area and standard NEXRAD Z-R is underestimated over most of the mountain area; and (4) In the mountain area, Kdp-R and Hybrid method performed better than the other two methods. Kdp-R is too noisy for weak rain situation especially in long wavelength radars (WFS radar, for example). Heavy smoothing is necessary when the method is applied.

D. **Observational characteristics of an urban flash flood storm in the Taipei basin is studied**. The major findings are (1) merge of convective cells produces enlarged and stronger precipitation area and strong echoes can extend to a much higher altitude. (2) Enhanced horizontal convergence produced by the sea breeze circulation and cold outflow induced from the pre-existed storm over the sloping terrain was favorable for the cell merge. (3) Significant variations on the distribution of polarimetric variables and rain drops are observed. There is a possibility that the distribution of columns of Zdr and Kdp can be helpful for early warning purpose.

Reference:

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