Analysis of isolated convective systems by using multi-parameter phased array weather radar

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Introduction

A multi-parameter phased array weather radar (hereafter MP-PAWR) was developed under the Cross-ministeral Strategic Innovation Promotion Program (SIP) under Council for Science, Technology and Innovation (Cabinet office, Government of Japan) in November 2017. MP-PAWR is settled at the Saitama University that located just north of Tokyo downtown area. In the summer 2018, several isolated convective storms over Tokyo area are observed by MP-PAWR. The purpose of this study is to characterize the three dimensional structure of the convective systems in short time.

2. MP-PAWR

The MP-PAWR is an X-band, dual-polarimetric radar and utilizes the phased array system for fast RHI scanning; the MP-PAWR transmits fan beam and the receiver retrieves fine elevational structure. By rotating the antenna this radar realizes the three-dimensional (60 km in radius and 15 km in height) observation within 30 seconds. Detailed characteristics of the radar is explained in Takahashi et al. (2019). Since MP-PAWR enables to capture the three dimensional structure with very short time intervals, it has an advantage for observing short lived small systems, rapidly changing severe convective systems, and echoes existing only aloft which are only observed in fragmentary by conventional radars.

3. Analysis

In this study, isolated convective systems are targeted because those are supposed to be generated by simple thermal/plume mechanism and MP-PAWR is suitable for detection of the fine structure of the first echo. In this study, time-lapse camera that takes every 20 seconds are utilized for the comparison. Several isolated systems are observed on 2, 3, and 16 August 2018. Three dimensional structure of Z, ZDR, ρhv, and Doppler velocity field are compared with 30-second intervals.

4. Result

On 2nd August 2018, several isolated convective system were observed by MP-PAWR. An echo generated around 1507 JST (Japan Standard Time) shows a typical characteristics on this day (Fig. 1). The first appeared at 5 km in height where is just below the freezing height (5.4 km). The echo expanded vertically the echo top reached more than 7 km eight minutes later. At the same time the echo reached at the surface. About 12 minutes later the echo started dissipation and disappeared about 25 minutes from the

first echo appearance. As the echo developing, ZDR value increases below 4 km and it decreased at the dissipating stage indicating the development of rain droplet and its evaporation during its life cycle. Doppler velocity field shows horizontal gradient in the developing stage of the echo indicating rotating motion in the cloud. From the mature to dissipating stage, more homogeneous motion reflecting the environmental wind dominated whole the structure. The horizontal extent of this echo was only a few kilometers in diameter.

Time-lapse camera images are utilized to identify the external structure of each convective systems and these images are identified each convective systems.

Note that the environmental condition of this area (Tateno 09JST) indicates that the height of LCL, LFC are about 1200 m and 3800 m, respectively, and CAPE and CIN are 39.13 and -251.95, respectively.

5. Summary

Several isolated convective systems were observed by MP-PAWR during the summer 2018. Detailed life cycle of isolated system is well described by MP-PAWR and characterized by Z, ZDR and Doppler velocity field.

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Reference

Takahashi, N., and co-authors, 2019: Development of Multi-Parameter Phased Array Weather Radar (MP-PAWR) and Early Detection of Torrential Rainfall and Tornado Risk, J. Disaster Res. Vol.14, No.2, 235-247.

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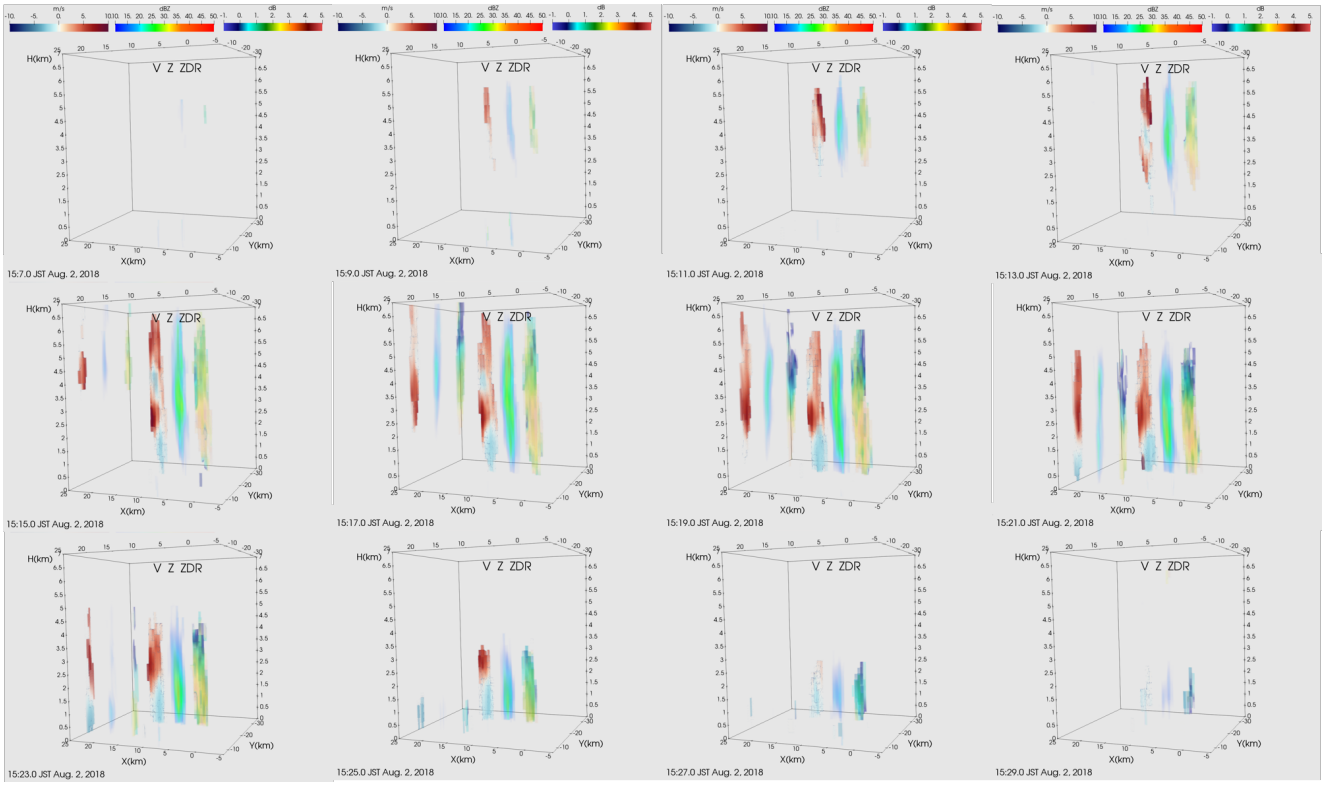
V Z ZDR
H(km)
X(km)
Y(km)
15:7.0 JST Aug. 2, 2018
15:9.0 JST Aug. 2, 2018
15:11.0 JST Aug. 2, 2018
15:13.0 JST Aug. 2, 2018
15:15.0 JST Aug. 2, 2018
15:17.0 JST Aug. 2, 2018
15:19.0 JST Aug. 2, 2018
15:21.0 JST Aug. 2, 2018
15:23.0 JST Aug. 2, 2018
15:25.0 JST Aug. 2, 2018
15:27.0 JST Aug. 2, 2018
15:29.0 JST Aug. 2, 2018