Precipitation microphysics of non-tornadic supercell near the radar site of MRI in Tsukuba, Japan.

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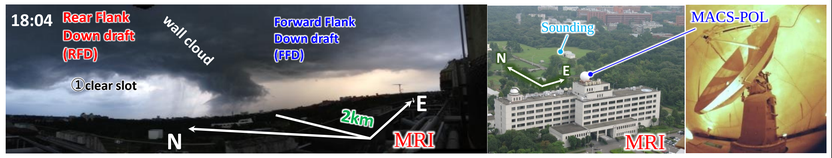
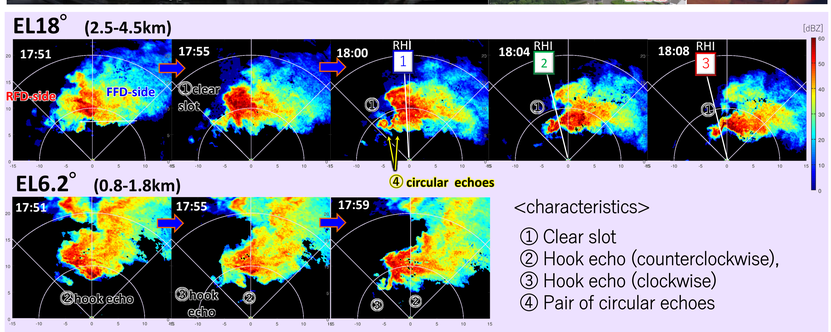
1.Introduction

A supercell passed 2 km north of the MRI (Meteorological Research Institute) and was observed by the MACS-POL (MRI advanced C-band solid state polarimetric radar). This storm had a wall cloud between the FFD (fore-flank downdraft) and RFD (rear-flank downdraft), and hook echoes in spite of non-tornadic supercell.

Tornado detections are already researched (e.g., low level ρ_{hv} signals), then we focused on the microphysics around MC (meso-cyclone), in terms of raindrops size and their movement to help understanding the signals as a stage before tornado development.

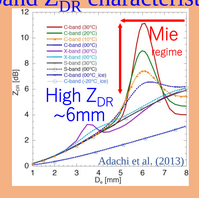




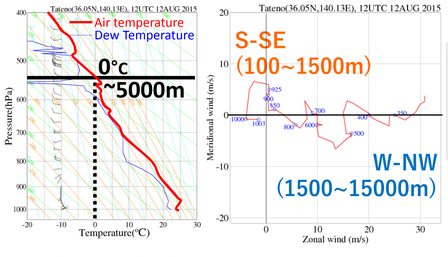
2.Radar specification

Frequency	5370 MHz (C-band)
Transmitters	GaAs Power FET (solid state)
Peak Power	3.5 kW
Antenna diameter	4 m (beam width 0.7°)
Antenna speed	4 rpm (max 10 rpm)
Range gate spacing	150 m
Transmitting mode	simultaneous
PRF	624 / 780 Hz (EL<8°) 936 / 1170 Hz (EL>=8°)
Pulse width	1 μs (R<20km), 129 μs (R>20km) (EL<8°)
Scan sequence	4 min, RHI ×2, PPI ×13
	(0.5°, 1°, 1.5°, 2.1°, 2.8°, 3.6°, 4.8°, 0.5°, 6.8°, 8°, 10.4°, 14°, 18°)

C-band Z_{DR} characteristic



3.Environmental characteristics



SReH$_{max}$: 110 m^2s^{-2} (Araki et al. 2015)
*reanalysis data 18:00 JST

< **Typical non-tornadic Super cell** (Thompson et al. 2003)

Acknowledgements

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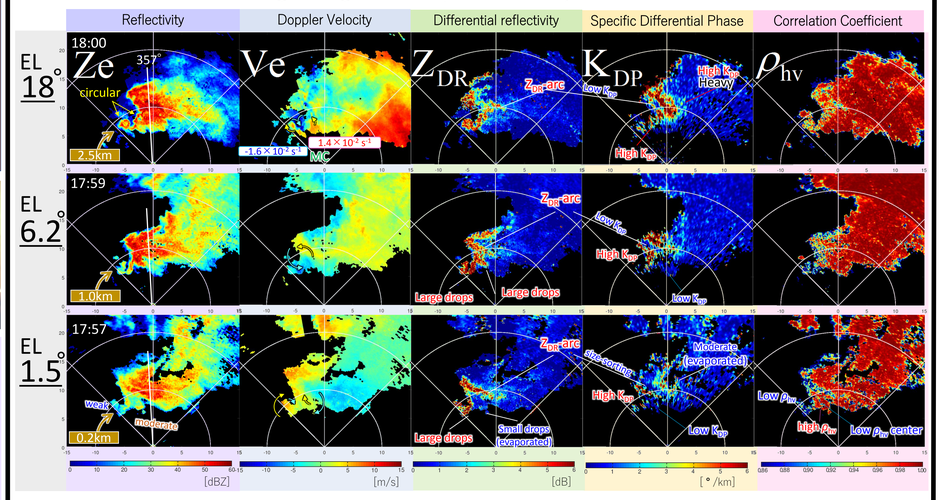
4.Analysis of microphysics

4.1. Horizontal structure from MC to ground

The distribution of dual-polarized signals opposite to typical tornadic echoes around hook echo (e.g., Large raindrops, variability of correlation).



Ze · Hook echoes with high reflectivity even in non-tornadic environment.
- · EL18° :Pair of circular echoes along the clear slot (>50 dBZ)
- · EL1.5° : Ze (cyclonic hook ~40dBZ) > Ze (anti-cyclonic hook ~20dBZ)

Ve · EL18°: Cyclonic (Anti-cyclonic) circulation $\mp 1\sim2\times10^{-2}$ s^{-1}
- · EL 6.2° : Cyclonic
- · EL 1.5°: Anti-cyclonic (ambiguous RFD)

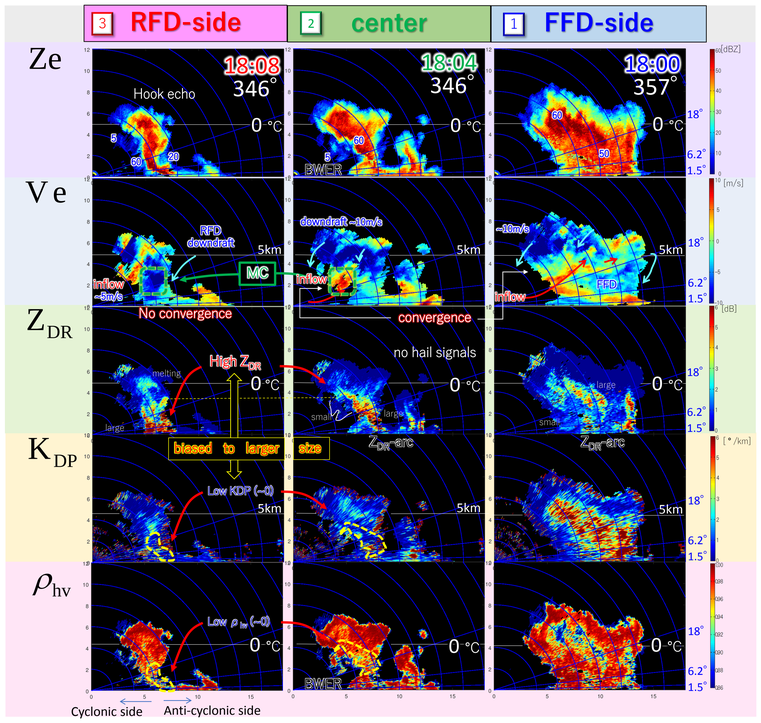
Z_{DR} · High Z_{DR} (>6dB; Mie regime) ⟶ presence of Large raindrops ~6 mm.
1. (1) Z_{DR}-arc
2. (2) Anti-cyclonic hook (but, Low Ze at EL1.5°)
3. (3) Cyclonic hook at EL 6.2° locally
   - ⟶ involving toward cyclonic side
   - ⟶ weak at EL 1.5° (⟶ evaporation)
4. (4) Edge of Clear slot

K_{DP} · High K_{DP}/ High Z_{DR} ⟶ Heavy rain (small to large size ~6mm)
· Low K_{DP}(~0°/km)/ High Z_{DR} ⟶ [Z_{DR}-arc] biased to larger raindrops
(Mie regime; e.g., Ryzhkov et al. 2005, 2013)

ρ_{hv}· Correspond with Z_{DR}
1. (1) Z_{DR}-arc Low
2. (2) Cyclonic hook/ Anti-cyclonic hook High / Low (EL6.2° high locally)
   Opposite to past tornado reports.

4.2 Vertical structure around MC

The vertical distribution near the mesocyclone (MC) center.
RFD-side ([3]18:08), center ([2]18:04), FFD-side([1]18:00)



Ve · [MC] between inflow[2] and downdraft[3] : 1.5~4 km

Z_{DR} · [Precipitation] **No hail** signals around 0°C (~5km).
- · [1]-[2] Large raindrops (High Z_{DR}) in **convergence** zone.
- · [3] Large raindrops (High Z_{DR}) in **no convergence** zone.

K_{DP} · [1] Heavy rain (High K_{DP}/High Z_{DR}) (no bias to larger drops)
[2]-[3] Large raindrops (High K_{DP} /High Z_{DR})
Size-sorted large drops formed in [2] and fell on [3]

ρ_{hv} · Low ρ_{hv} in hook tilts toward anti-cyclonic side as near the ground.
⟵ RFD is weak

5.Summary

We analyzed the three dimensional structure of non-tornadic supercell. This no hail event showed some signals toward anti-cyclonic side opposite to past typical non-tornadic events,

· Low ρ_{hv} (High Z_{DR}) toward anticyclonic side.

Although, instantaneous cyclonic moving,

· EL 6.2° of Low ρ_{hv} (High Z_{DR}) with Low K_{DP} .

We need to investigate the bifurcation of these microphysical signals and tornado occurrence from other tornadic(non-tornadic) events.

Reference

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