Peculiar supercell tornadoes caused by Typhoon 'Neoguri'

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1. Introduction

Typhoon is one of major source of tornadoes in Japan. Two tornadoes simultaneously occurred near Kochi airport when the outer rainband of Typhoon 'Neoguri' passed through the Kochi Plain.The present analytical study aims to clarify the characteristics of their parent storm by using the data of the JMA radar and the polarimetric radars in Kochi University.

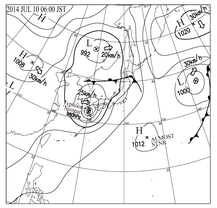

Fig.1:JMA Synoptic Chart at 06:00 JST.

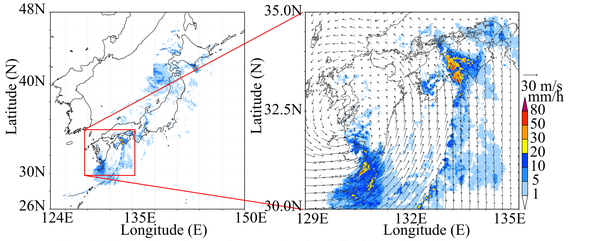

Fig.2:JMA-Radar echo and wind field at 06:00

2. Analysis and data

We observed the parent cloud of tornedoes by two polarimetric Doppler radars of Kochi University (Asakura Radar, Monobe Radar) and the Muroto Doppler radar of Japan Meteorological Agency (JMA). The observation ranges of these radars are shown in Fig. 3. We observed Reflectivity and Doppler velocity from PPI scans at lower elevation angles. We also used the initial GPV data of JMA meso scale model obtained from the RISH archives.

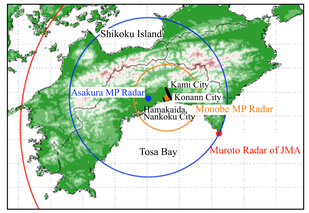

Fig.3: Observation areas of Radars. Black ovals indicate the damaged areas due to tornadoes.

3. Environmental Conditions

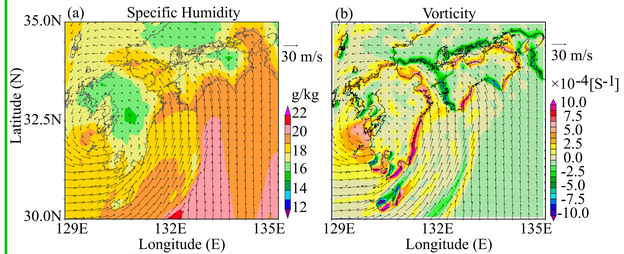

Fig.4:MSM-Data at 06:00 JST. (a) Specific Humidity (b) Vorticity

4. Results of radar analysis

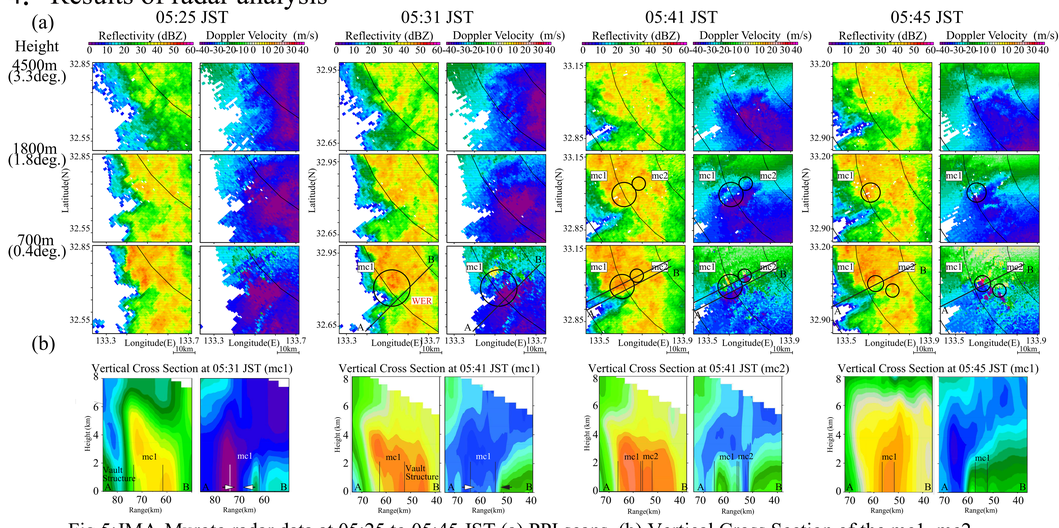

Fig.5:JMA-Muroto radar data at 05:25 to 05:45 JST (a) PPI scans (b) Vertical Cross Section of the mc1, mc2.

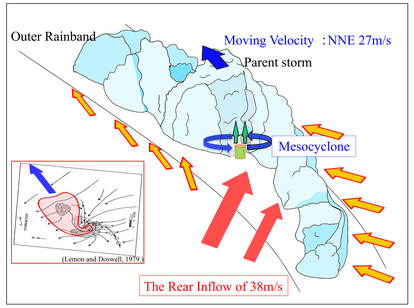

Fig.6:Schmatic diagram of parent storm. Red arroes indicate the rear inflow. Yellow arrows indicate the environment flow.

Table 1. Environment parameter in outer rainband.

	CAPE	SReH
Typhoon 'Neoguri'	287 J/kg	160 m^2/s^2
Supercell Tornado	253 J/kg (1)	150 m^2/s^2 (2)

(1) McCaul, 1987. (2) Davies-Jones et. al., 1990

Southwesterly and south winds converge to the outer rainband. The environmental indices showed the envirnment that supercell tornadoes may occur.

The first mesocyclone, mc1, appeared at 5:31JST. At this time strong wind of over 38 m/s in Doppler velocity approached to the parent storm from southwest and weak echo region was observed just south side of mc1. Moreover, the strong echo formed hook like echo pattern around mc1. Vault structure is clearly observed around mc1. These features imply that the parent storm is supercell, but the arrangement of hook echo is opposite to that of normal supercell.

Storm was moving in the outer rainband to the NNE at 27m/s in Fig.6. Warm and moist air mass flows from the front, i.e. NE, for ordinary supercells. The present storm, however, warm and moist air mass was supplied by strong southwesterly wind conversing outer rainband. Namely, the present supercell was generated by strong rear inflow.

Second mesocyclone, mc2, appeared just northeast of mc1 at 5:41JST. After this, mc1 rapidly reduced its diameter and vault structure disappeared.

Third mesocyclone, mc3, surrounding mc1 appeared at 6:11JST in Fig.7. Vault structure near mc3 was observed at 6:15JST. Moreover, gust front appeared at the south edge of the parent storm. Its direction and arrangement were diffrent from those of FFGF and RFGF of ordinary supercell. After landfall, mc3 and its updraft decay at 6:21JST. But, mc1 and mc2 still arrived and caused tornado damages.

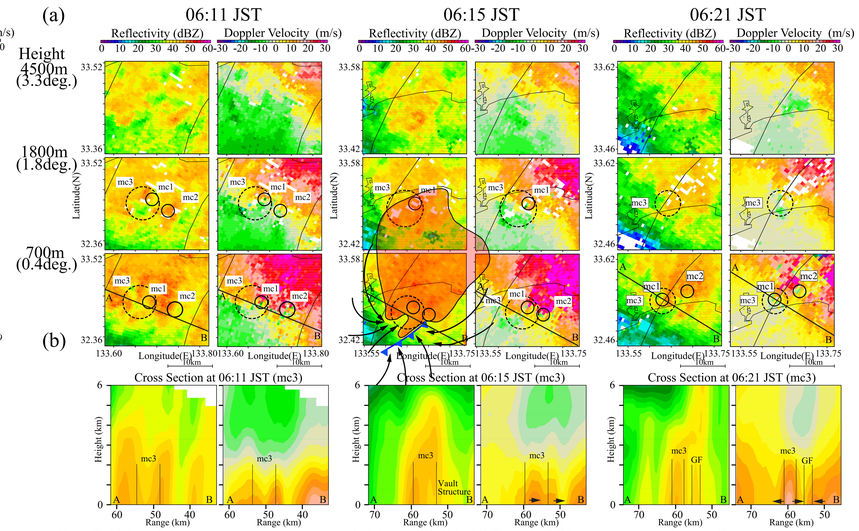

Fig.7:JMA-Muroto radar data at 06:11 to 06:21 JST. (a) PPI scans (b) Cross Section of the mc3. The schematic diagram of the air flow structure determined by dual analysis superimposed on the reflectivity at 06:15 JST.

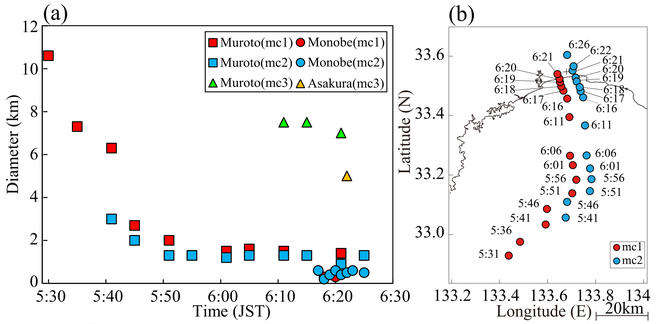

Fig.8:Temporal change of diameter (a) and trajectories (b) of the vortices, mc1, mc2 and mc3.

The vortices, mc1 and mc2 alived about 1hour and traveled along the outer rainband. When mc1 appeared at first, its diameter was about 10 km. At this time, the parent storm may be one of supercell though its arrangement is quite different from the ordinary ones. The diameters of mc1 and mc2 rapidly decreased after the genesis of mc2. The other mesocyclone, mc3, appeared before landfall. It may caused by strong rear inflow intruding parent storm again. Two tornadoes correspond to mc1 and mc2.

5. Conclusions

The parent storm was founded to have the feature of supercell at the initial stage. But, it was quite different from the ordinary classical supercell because it generated by strong rear inflow converging to the outer rainband. Such supercell was developed again before landfall. The tornado associated with mc2 survived for several minutes but mc1 and mc3 rapidly decayed after landfall.

Acknowledgments

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