CHARACTERISTICS OF MISOCYCLONES OBSERVED ON TOSA BAY IN JAPAN

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I. INTRODUCTION

Tosa Bay located at south side of Shikoku island in Japan is the area where tornadoes frequently outbreak as shown in Fig. 1. The plots show the locations of 24 tornadoes recorded in the tornado database of Japan Meteorological Agency including originally identified 4 tornadoes by our laboratory for 20 years from 1991. Especially, the number density of tornado encounter in the small area shown in the bottom right of the figure is 32 per 10^4 km^2 per year. Though most of tornadoes are weak than F2 scale, the number density is 11 times of that in the tornado in United States (Niino et al. 1997). The length of the coastline in this are is just 40 km. Therefore, we can observe the tornadoes every year without chasing more than many miles.

Our observational research aims to clarify the characteristics of tornadic and nontornadic misocyclones observed by Doppler radars in this area.

II. RADAR OBSERVATION

The observation period is from May 2008 to December 2010. The data of three Doppler radars were employed, that is, Muroto C band Doppler radar continuously operated by Japan Meteorological Agency, an X band Doppler radar placed only for early summer seasons by Meteorological research institute, and our X band Doppler radar operated at Kochi University from July 2010. The radial resolutions are 500 m for the C band and 75 m for two X band radars, but the azimuth resolutions are 0.7 deg. and 0.75 deg., respectively. We extracted misocyclones in which the difference of the Doppler velocity is more than 5 m/s from the PPI scan data at low elevation angles when the tornado watch was anounced by Japan Meteorological Agency. Though the characteristics of misocyclone depends on the resolutions of the radars, we do not corrected the data at this time. We employed 'Draft' developed by Meteorological research institute to process the radar data.

III. RESULTS AND CONCLUSIONS

We detected 30 misocyclones for the observation period. These trajectories are shown in Fig. 2. In this figure, red line indicates the tornadic misocyclones under which some damages were recorded. The misocyclones that born offshore in Tosa Bay are 77% of the total misocyclones. This fact shows that the circumstances in Tosa Bay are easy to occur tornadics storms. We think two reasons for this fact. One is that very wet and warm air mass on Black Tide, ocean current on the west side of the North Pacific Ocean, is advected from the south side of Tosa Bay. Another is that the terrain effect of Shikoku Mountains located east and west along the centerline of Shikoku Island. The average peak heights of Shikoku Mountains are 1500 m and the cold air mass cannot override such peaks returns south and forms local front in Tosa Bay. The mechanism of storm generation in Tosa Bay is our future subject.

The rotation direction of the misocyclones is cyclonic for 90% of all and anticyclonic misocyclones is only 4 cases. Main seasons of tornado outbreak in this area are spring and autumn according to the database of Japan Meteorological Agency. The seasonal variation of misocyclone detection is not clear at this time.

The diameter and vorticity of misocyclones were measured at each height and position. The relationship between them when they have maximum vorticity at about 1

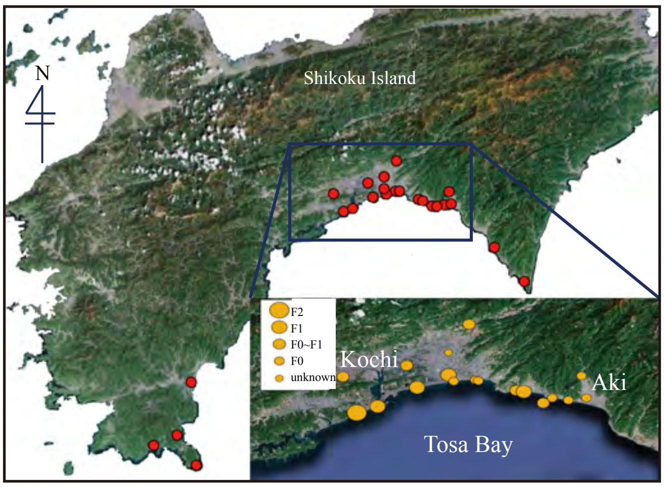

FIG. 1: The locations that tornadoes outbreak in Kochi prefecture.

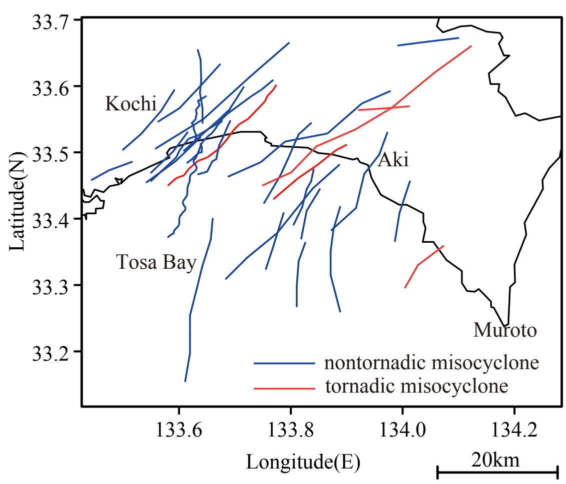

FIG. 2: Trajectories of misocyclones detected by Doppler radars

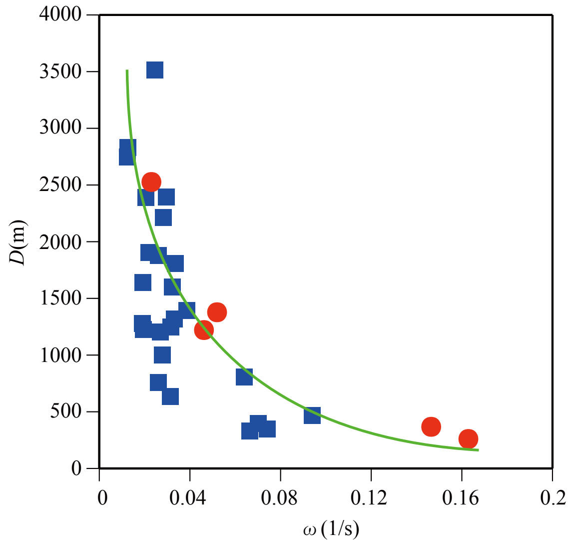

FIG. 3: Relationship between diameter and vorticity of misocyclones when their inetensities are maximum at 1 km high.

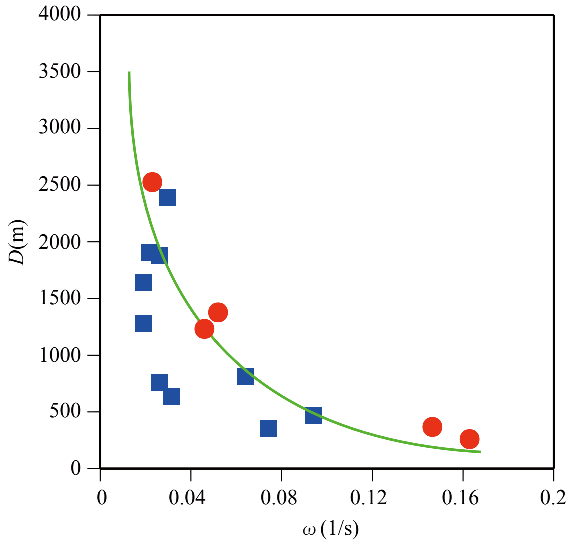

FIG. 4: Relationship between diameter and vorticity of misocyclones that landed.

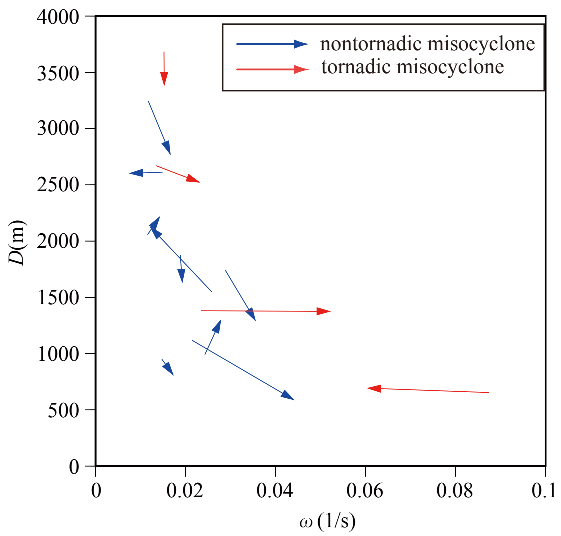

FIG. 5: Change in charactersitics of misocyclones when they landed from Tosa bay.

km high is shown in Fig. 3. These plots seem to align on the hyperbolic line shown in green curve, which shows that the circulation of misocyclone has almost same value. The tornadic misocyclones seem to locate at the upper side of the curve. Therefore, the hyperbolic line is defined as the criteria to distinguish tornadic and nontornadic misocyclones. Such feature is more remarkable for the misocyclones landed onshore shown in Fig. 4. We expect that the product of diameter and vorticity of misocyclones becomes an important index for nowcasting dangerous tornadic misocyclones after more samples are accumulated.

The change in characterisitics of misocyclone between onshore and offshore is shown in Fig. 5. The arrow points lower right of this figure denotes that a misocyclone is converged and enhanced when it land onshore. The misocyclones intensify when they land are 60 % of all. This may because the friction weakens the wind velocity near the ground and intensify the pressure-gradient force of misocyclone in comparison. Such friction effect is found to converge and develop misocyclone not to weaken its rotational velocity when it land. Shimose et al. (2010) showed the different tendency for the misocyclone after landfall.

IV. ACKNOWLEDGMENTS

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V. REFERENCES

Niino H., Fujitani T., Watanabe N., 1997: A statistical study of tornadoes and waterspouts in Japan from 1961 to 1993. *J. Climate,* 10 1730– 1752.

Shimoce K., et al., 2010: Numerical simulation of low-level misocyclones associated with winter convective cells: a case study from the Shonai are railroad weather project. Extended abstract for the 25th conference on severe local storms, Denver, USA. 175586.pdf