The Structure of a Multiple-Vortex Type Tornado Realized in a Supercell Simulator

Koji Sassa and Ippei Hamada *Kochi University, Akebonocho 2-5-1, Kochi, Japan*

1. Intordoction

Multiple-vortex type tornadoes often cause severe damages. The strucutre of these tornadoes has not been understood in detail. The present experimental study aims to clarify the structure of these tornadoes near surface.

Tsukuba tornado 6 May 2012

2. Experiments

Experiments were made in our original supercell simulator, which realizes rotating updraft of meso-cyclone and outflow from RFD as shown in FIg.1. The height and swirl ratio of mesocyclone can be changed arbtrary. Various tornadoes can be realized, depending upon these parameters as shown in Fig. 2. In the present study, we visualized multiple-vortex type tornadoes and measured them by using PIV method.

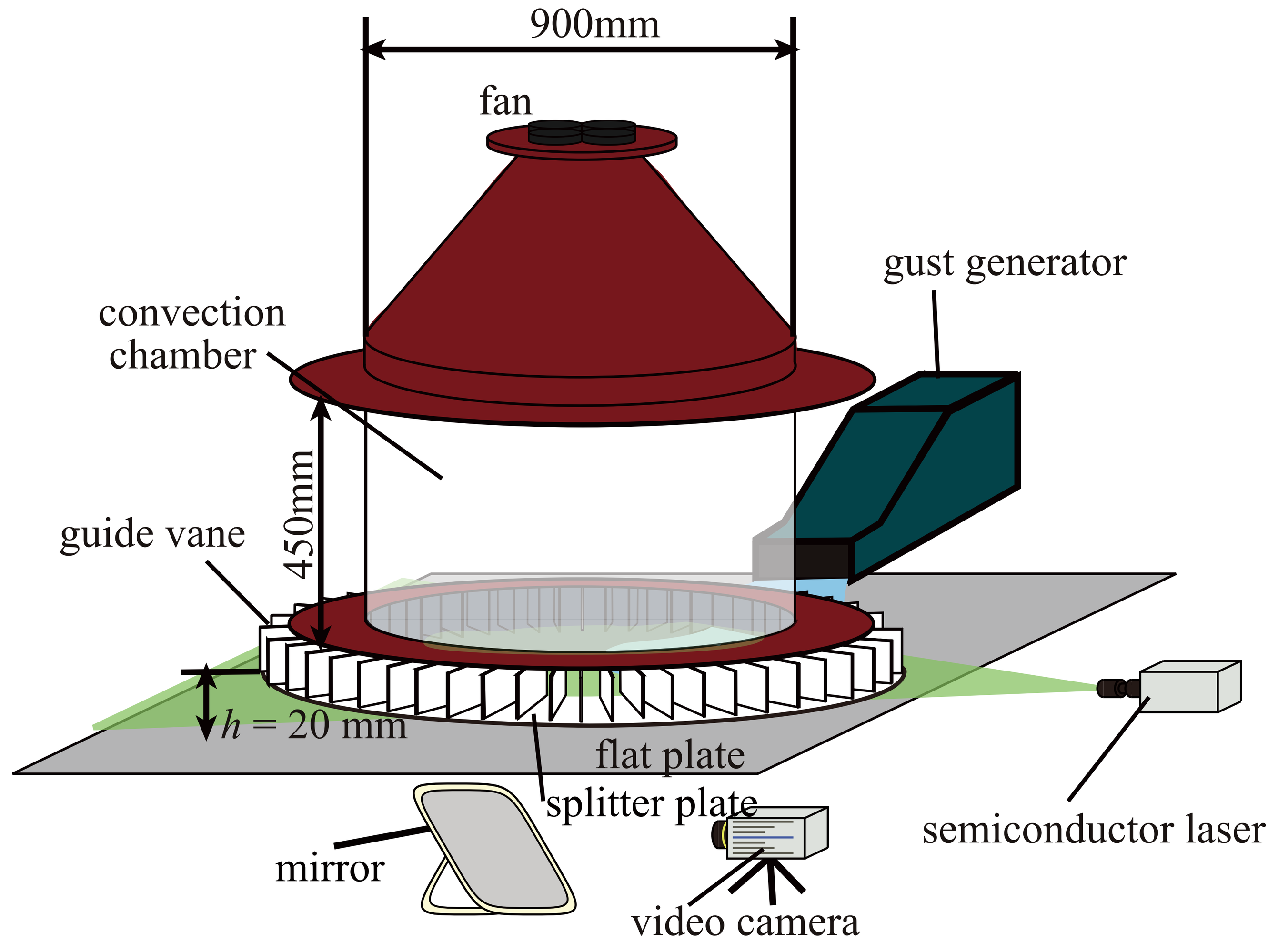


Fig. 1 Experimental setup

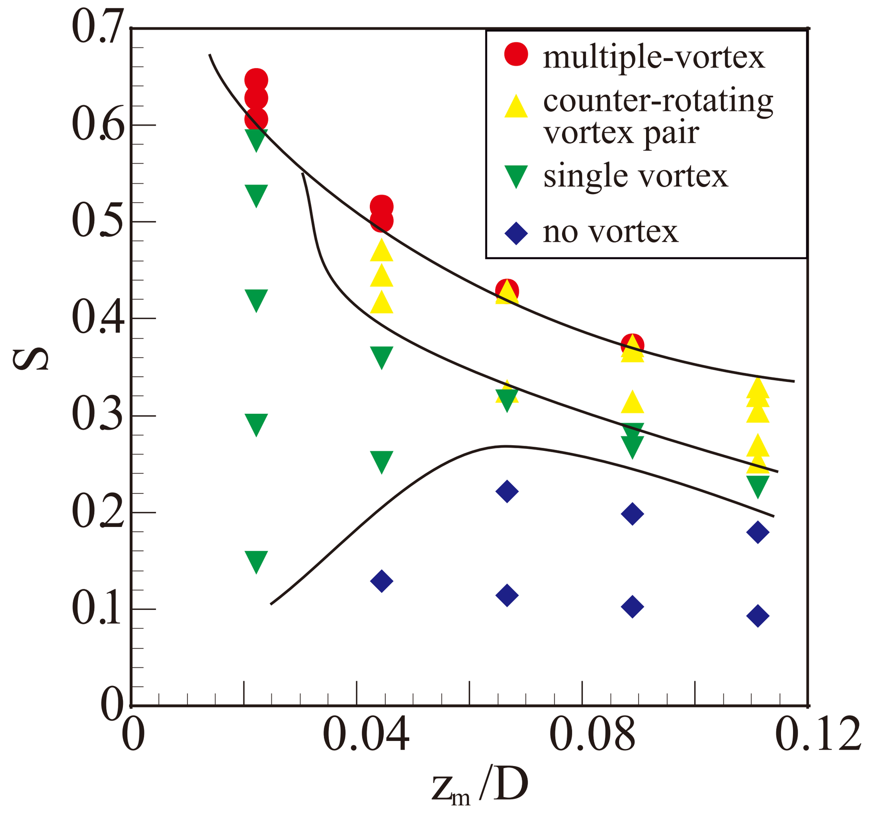


Fig. 2 Regime of flow pattern

3. Results

As shown in Fig. 3, 3 suction vortices are clearly observed. These incline outward and bend clockwise in upper layer. These features are quite similar to the actual multiple-vortex type tornadoes.

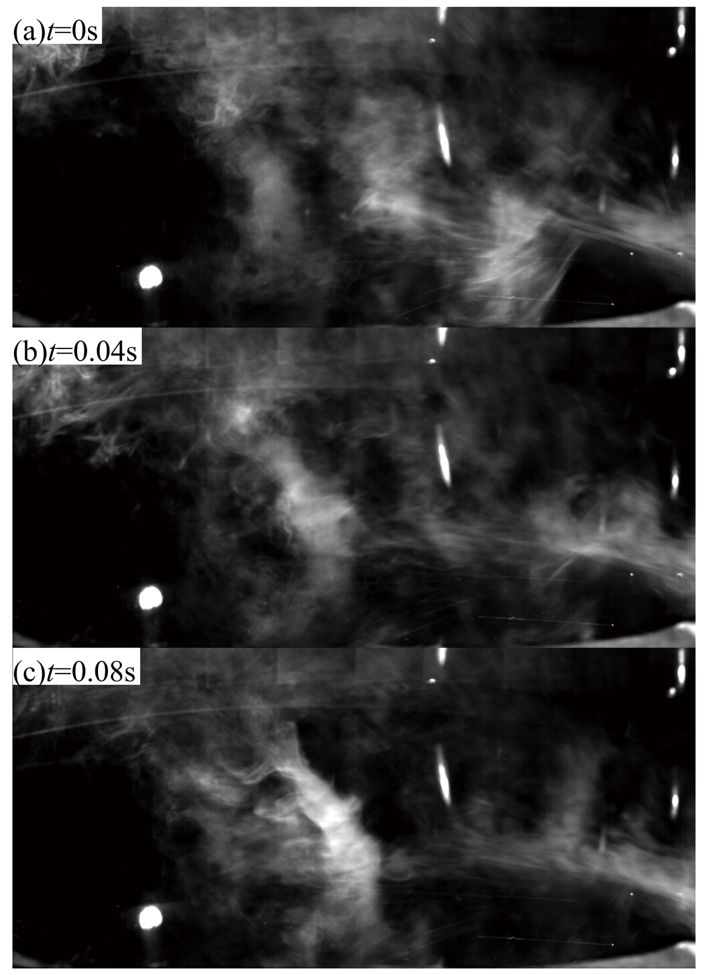
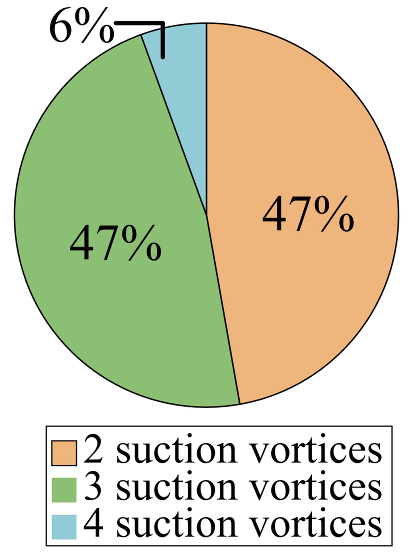


Fig. 3 Suction vortices.



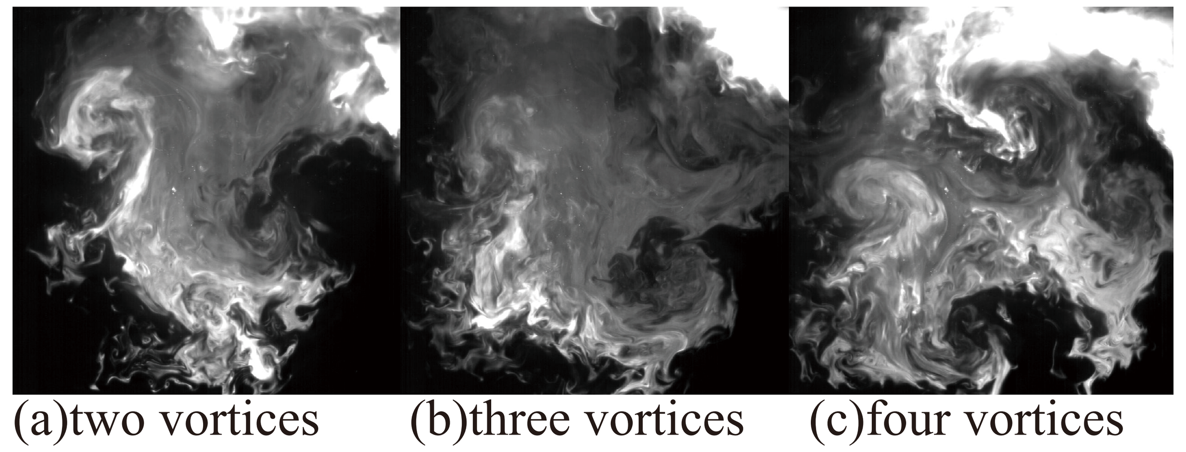


Fig. 4 Horizontal cross section

The number of suction vortex changes with time. But, the radius and the rotating velocity and so on of the suction vortices are almost same in three cases. Then, we sampled 30 suction vortices regardless of these cases.

Fig. 5 shows the typical example of the instantaneous velocity fields of suction vortices. From them, we evaluated the radius, maximum tangential velocity, location from the center axis and moving velocity of the suction vortices.

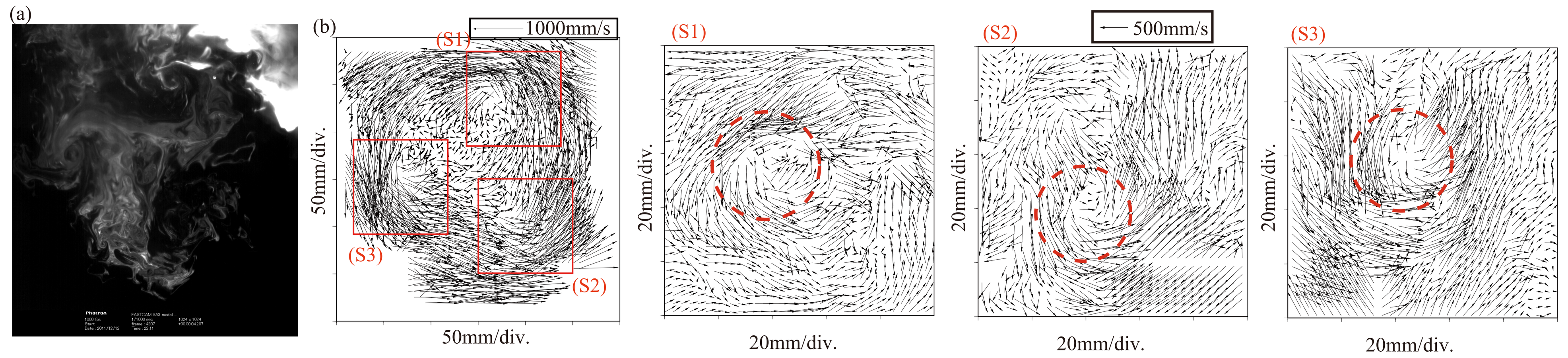


Fig. 5 Instantaneous velocity fields of suction vortices

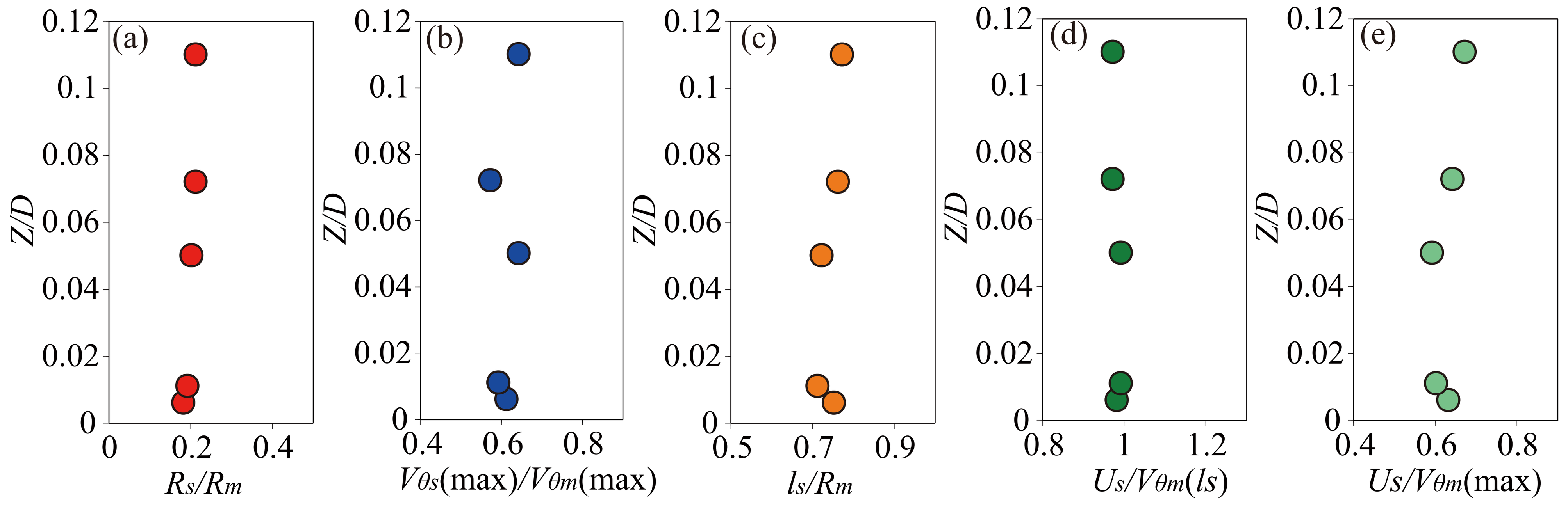


Fig. 6 Characteristics of suction vortices

The radius of suction vortices is 0.2 times of that of the main vortex. Maximum tangetial velocity increased up to 1.6 times of averaged tangential velocity by passage of the suction vortex.

4. Conclusion

The detailed structure of multiple-vortex type tornado is illustrated as shown in Fig. 7

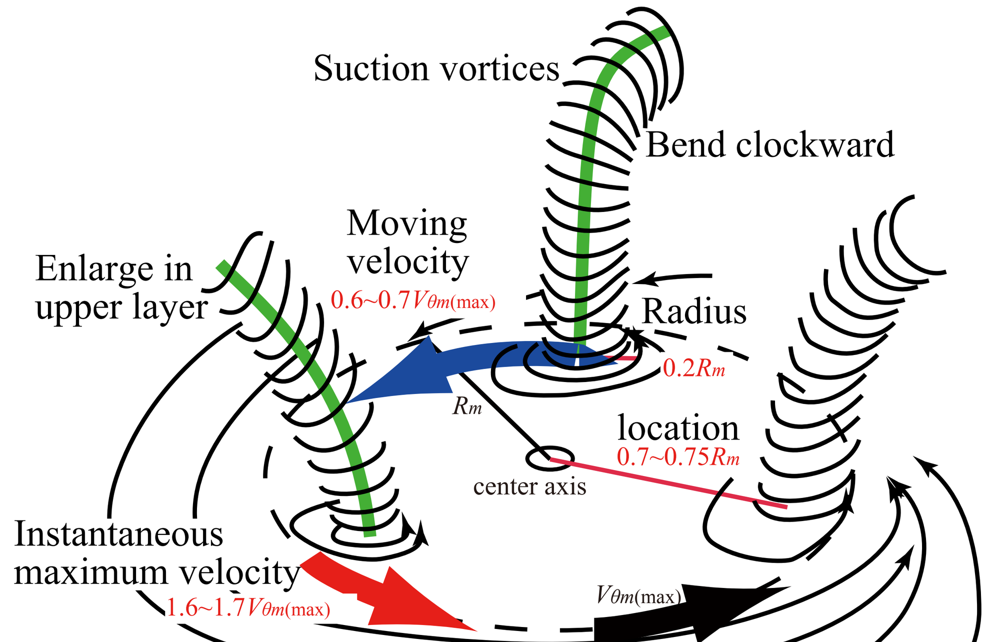


Fig. 7 Detailed structure

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