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# 3-D structure of non-supercell tornado at initial stage

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Common type of tornado is non-supercell tornado in Japan. Non-supercell tornadoes relatively weak but many damages are caused by them in Japan. Moreover, the prediction of non-supercell tornado genesis is quite difficult. The non-supercell tornadoes sometimes occur at the same time of the development of parent clouds without mesocyclones. We can relatively easily issue tornado warning or watch when supercells approach, because we can detect mesocyclones in supercells with Doppler radar. On the other hand, the non-supercell tornadoes already appear and damage clops, structures and even peoples when we detect vortices in the parent cloud by radar. Therefore, it is very important for prediction of non-supercell tornado genesis to understand its environmental condition.
We have made laboratory experiments to understand the flow condition of non-supercell tornado genesis for 10 years. The present experimental study aims to clarify 3-D structure of a non-supercell tornado at the initial stage.
Our experimental system is composed of the outflow simulator reproducing cold outflow from cumulonimbus, the environmental flow simulator and a fan generating updraft. The outflow simulator is a kind of blow down type wind tunnel having cooling system. We can easily control the velocity and temperature of cold outflow. The environmental flow simulator is also a kind of blow down type wind tunnel. The outflow simulator is set at 30 degrees in attack angle to the environmental flow direction. We made experiments under the several conditions, i.e. outflow, environmental flow and updraft velocities and so on. We observed vertical and horizontal cross sections of tornado-like vortices reproduced in our experiments by hi-speed cameras and obtained velocity fields by using a dynamic-PIV method.
We found the flow condition preferred for tornado genesis from our experimental results. Such condition is the outflow velocity is slightly larger than that of the environmental flow. In the horizontal cross section, not only updraft but also downdraft regions exist in the tornado-like vortex. This is because the horizontal vortex winding around the tornado-like vortex. Though main source of vertical vorticity of the tornado-like vortex is horizontal shear between cod outflow and environmental flow, the baroclinic torque at the side edge of cold outflow is also found to contribute to vorticity. Therefore, the lower layer of tornado-like vortex is not simple vertical vortex but is complex structure composed of vertical and horizontal vortices.