

Photogrammetric analysis of Tsukuba Tornado

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ECSS 2013

3-7 June, 2013



About noon of 6 May 2012

Tsukuba tornado: F3, 17km, 500m, 1 killed, 38 injured 438 houses destroyed

Chikusei tornado: F0, 21km, 600m, 3 injured, 10 houses destroyed Mooka tornado: F1, 31km, 650m, 11 injured, 137 houses destroyed





- Only Tsukuba tornado was filmed by high resolution digital cameras from many different locations and observed by MRI's dual polarimetric Doppler radar.
- High resolution Doppler radars are still few in Japan.
- Although photogrammetric analysis is a classical way to investigate the velocity field of tornado vortices (e.g. Hoecker 1960 and so on.), it is good way for tornadoes in the area there is not any radars.
- Moreover, the small scale detailed structure of tornado that cannot be captured without extremely high resolution radars can be measured with photogrammetric analysis.

This work aims to clarify characteristic feature of Tsukuba tornado qualitatively and quantitatively, with photogrammetric analysis.



Same spark from the electric cable cut by the tornado was observed in many movies.



filmed by Mr. Iida

filmed by Mr. Ohno

filmed by Mr. S.

12:49:37 of 6 May, 2012 (MRI Mr. Sato)







Fallen tree at Hojyo town

Fallen trees showing conversing flow

Trajectory of Tsukuba tornado





Aspect of tornado vortex





Multiple vortex with two suction vortices

Reconection of vortex

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Moving velocity at 100 m AGL The diameter of tornado vortex was 0.5 – 1 km at 100 m AGL (Yamauchi et al. 2013 Radar Conf.) Particle image velocimetry of tornado vortex Storm Lab.

Tracking of images of several pixels those cross correlations are high.

Velocity field in focal plane



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Observed velocity at 10 – 20 m AGL with correction of flame movement: 40m/s Tangential velocity of tornado vortex near ground: 56 m/s Maximum velocity of tornado vortex: 72 m/s Fujita scale: F3



- Trajectory of Tsukuba tornado with accurate time history was determined.
- The moving velocity of Tsukuba tornado was found to slow down from 18 m/s to 14 m/s.
- The diameter of Tsukuba tornado near ground became slim as it moved northeastward.
- The tangential velocity of Tsukuba tornado near ground was 56 m/s and maximum wind velocity was estimated to be 72 m/s.

This work is supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research, No. 24900001



- Developing correction method to estimate the velocity field of tornado vortex from debris pattern
- Measuring velocity field at the vertical cross section including updraft of tornado
- Estimating evolution of tornado intensity from the shape of funnel cloud.