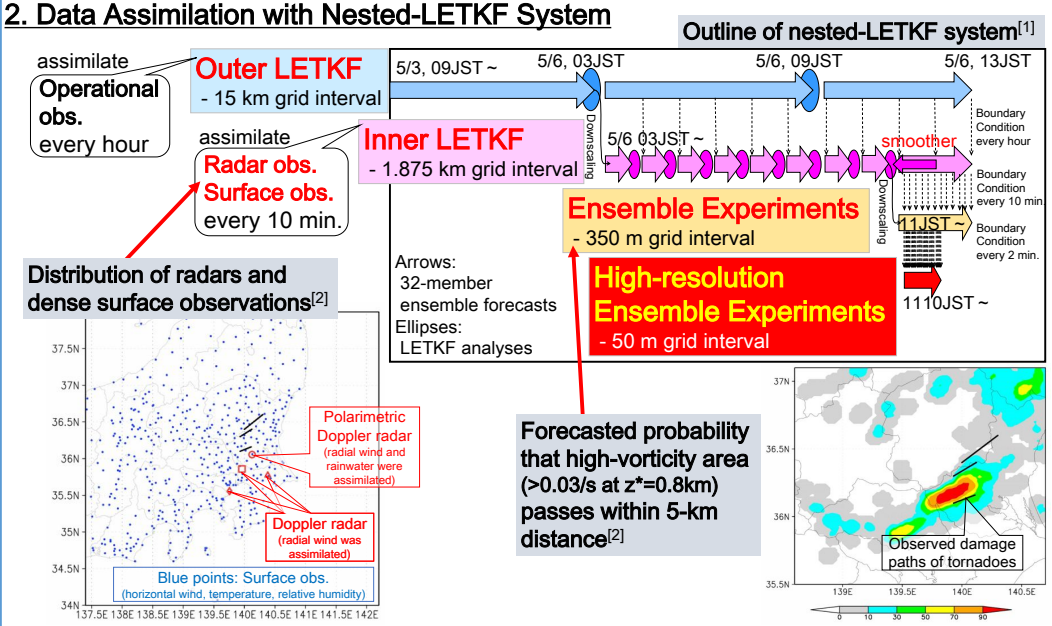
High-resolution Ensemble Experiments for the Tsukuba City Supercell Tornado in Japan on 6 May 2012

*[1]Sho YOKOTA, [1,2]Hiromu SEKO, [1]Masaru KUNII, [3]Hiroshi YAMAUCHI, and [4]Hiroshi NIINO ([1]Meteorological Research Institute, JMA; [2]JAMSTEC; [3]Observations Department, JMA; [4]AORI, The University of Tokyo)

1. Introduction

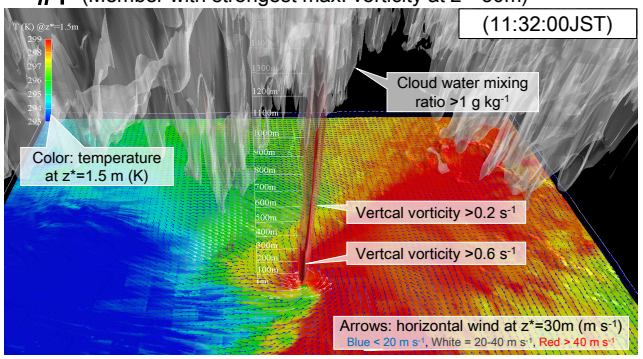
To clarify mechanisms of supercell tornadogenesis, it is useful to perform statistical analyses using ensemble forecasts of observed tornadoes. In the present study, we carried out **33-member ensemble forecasts with 50-m horizontal resolution** for a supercell tornado in Japan on 6 May 2012. With ensemble-based analyses, we examined **which variables are important for the tornadogenesis**.

2. Data Assimilation with Nested-LETKF System

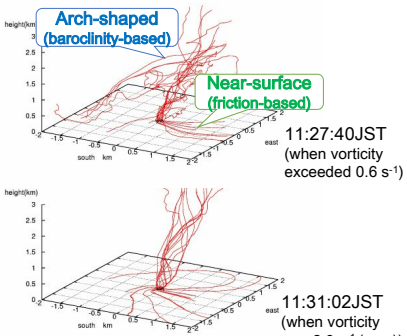


3. Forecasted Tornado

#1 (Member with strongest max. vorticity at z*=30m)



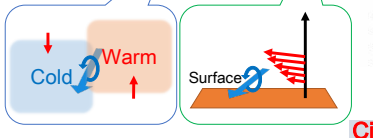
Vortex line passing nearby max. vorticity at z*=30m



4. Origin of Tornado Circulation

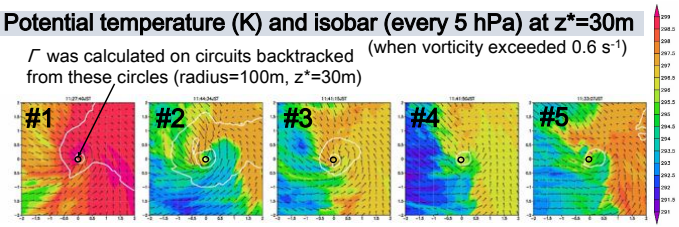
Circulation(Γ) Baroclinic Friction

$$\frac{D}{Dt}\oint_C \mathbf{v}\cdot d\mathbf{l} = -\oint_C \frac{dp}{\rho} + \oint_C \mathbf{F}\cdot d\mathbf{l}$$



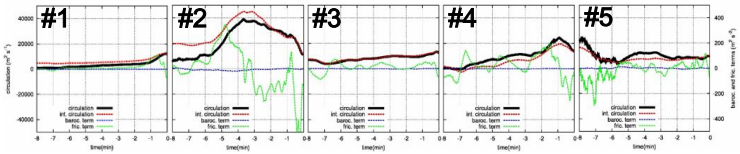
Potential temperature (K) and isobar (every 5 hPa) at z*=30m (when vorticity exceeded 0.6 s-1)

Γ was calculated on circuits backtracked from these circles (radius=100m, z*=30m)



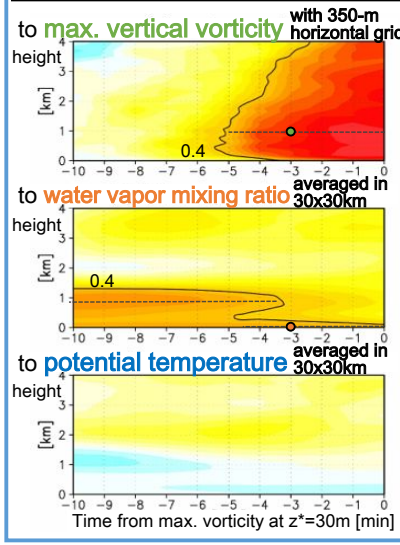
Which is more important for tornadogenesis, baroclinity[3] or friction[4]?

Circulation and baroclinic and friction terms of backtracked circuits

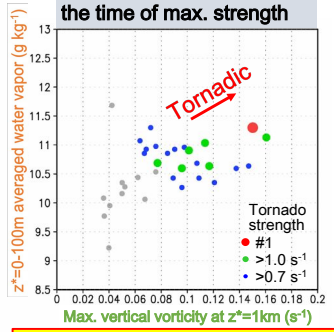


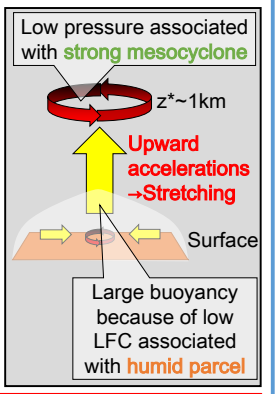
Friction contributes dominantly to change the circulation Γ (baroclinic term is small), but does not necessarily increase Γ.
→ Tornado strength does not depend on the origin of circulation.

5. Correlation of Tornado Strength (defined by 5-min moving ave. of max. vertical vorticity at z*=30m)



Scatter plot of vorticity and water vapor 3-min before the time of max. strength





Upward accelerations due to
1. Pressure grad. by low-level mesocyclone
2. Large buoyancy by near-surface humid air
are especially important for tornadogenesis

Acknowledgement

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