# Data Assimilation Experiments of Tsukuba Tornado on May 6, 2012 with the Nested-LETKF System

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# Introduction The Case

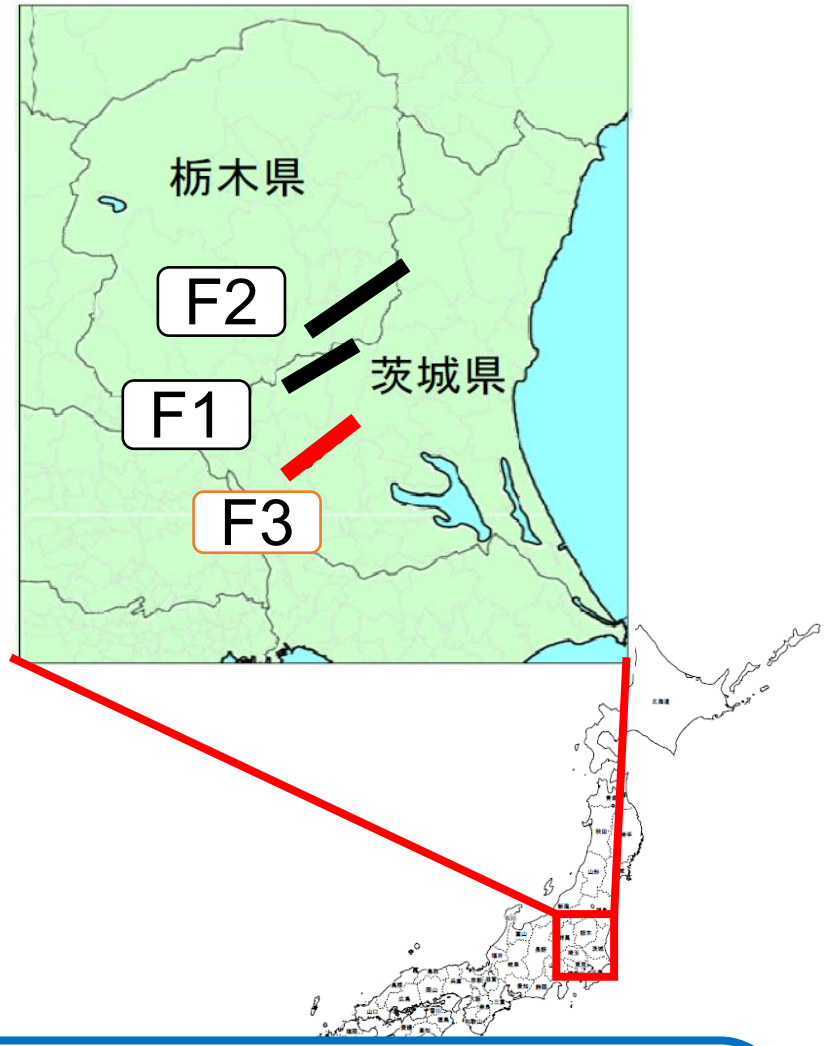
Three tornadoes were generated in 2012/5/6, about 12:30 JST.

Seko et al. (2013)

- Two tornadoes were reproduced in the data assimilation experiment. However, the sites of the south tornado shifted about 10 km north.

Yamauchi et al. (2012)

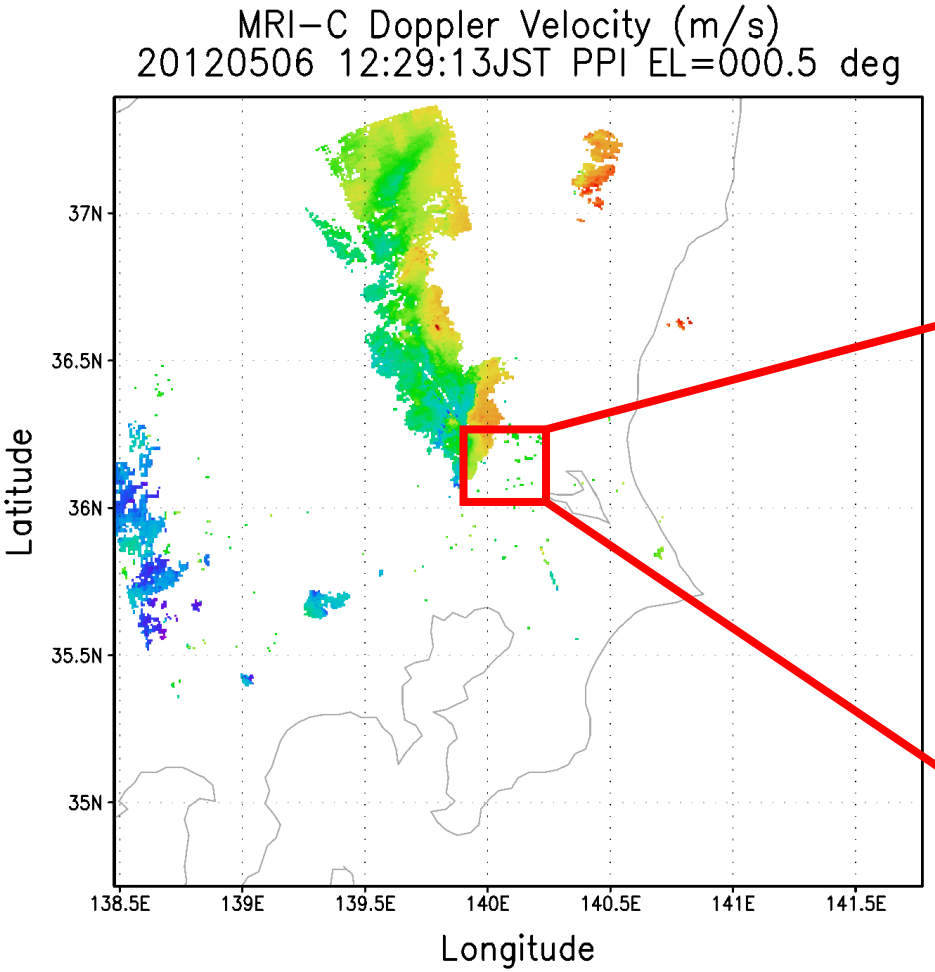
- The south tornado was observed by MRI Doppler Radar.



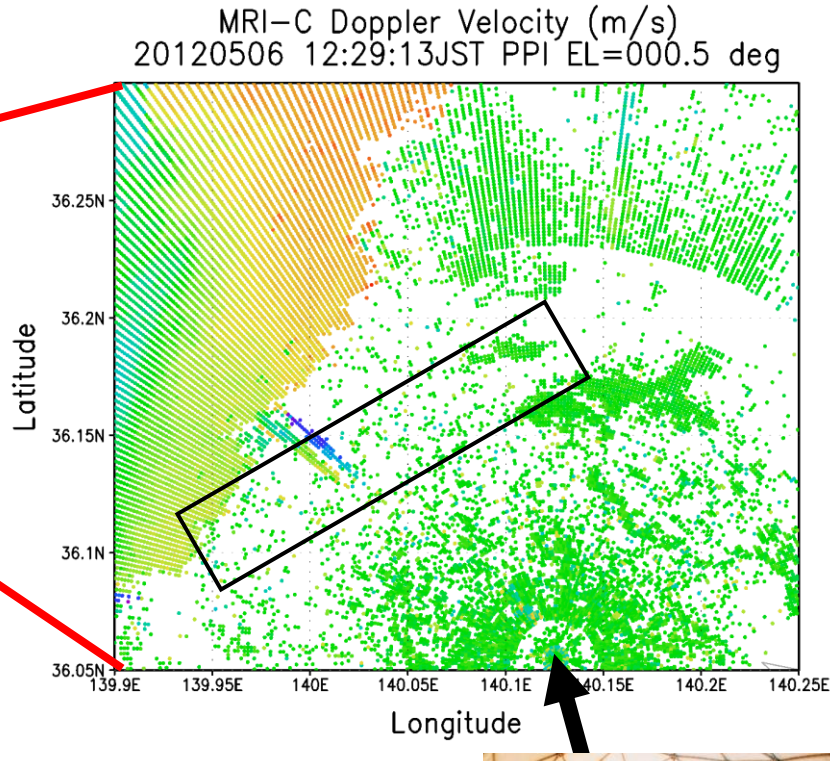

This Study

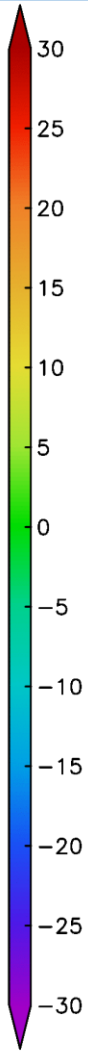
**Doppler wind observed by MRI Radar is assimilated and the impact of the assimilation is clarified.**

# Introduction The Vortex Observed by MRI-Radar

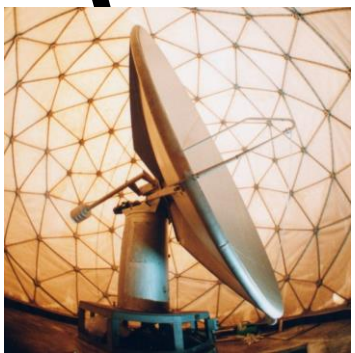



Doppler wind when this tornado was generated

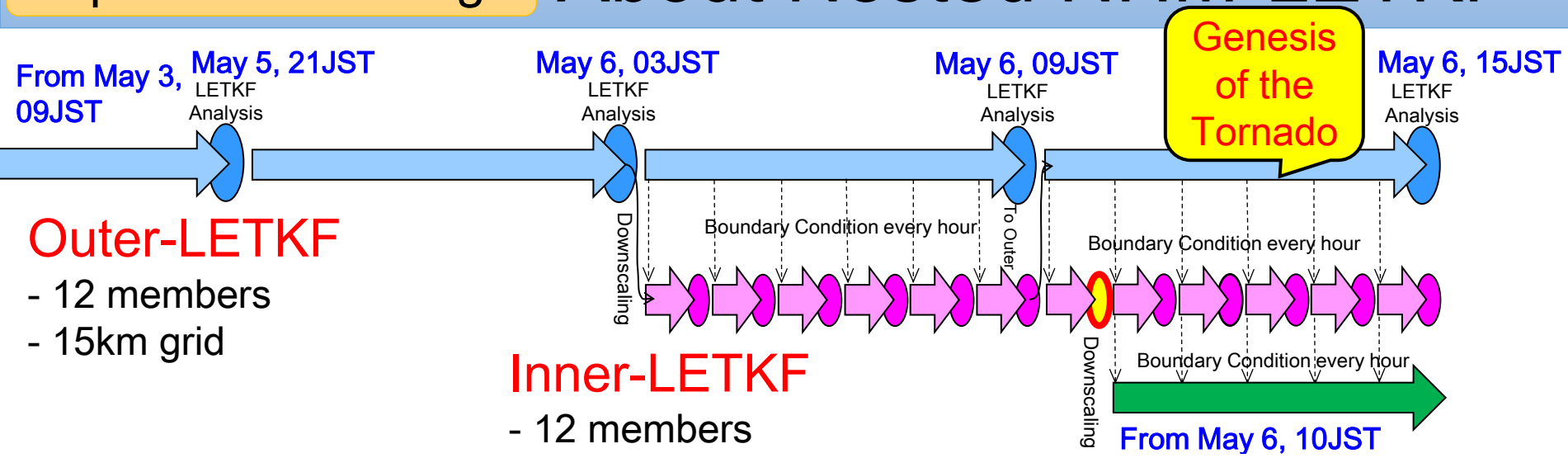



⇒ The tornado was **observed well** by MRI-Radar.



# Experimental Design About Nested NHM-LETKF




## Outer-LETKF
- 12 members
- 15km grid

## Inner-LETKF
- 12 members
- 1.875km grid

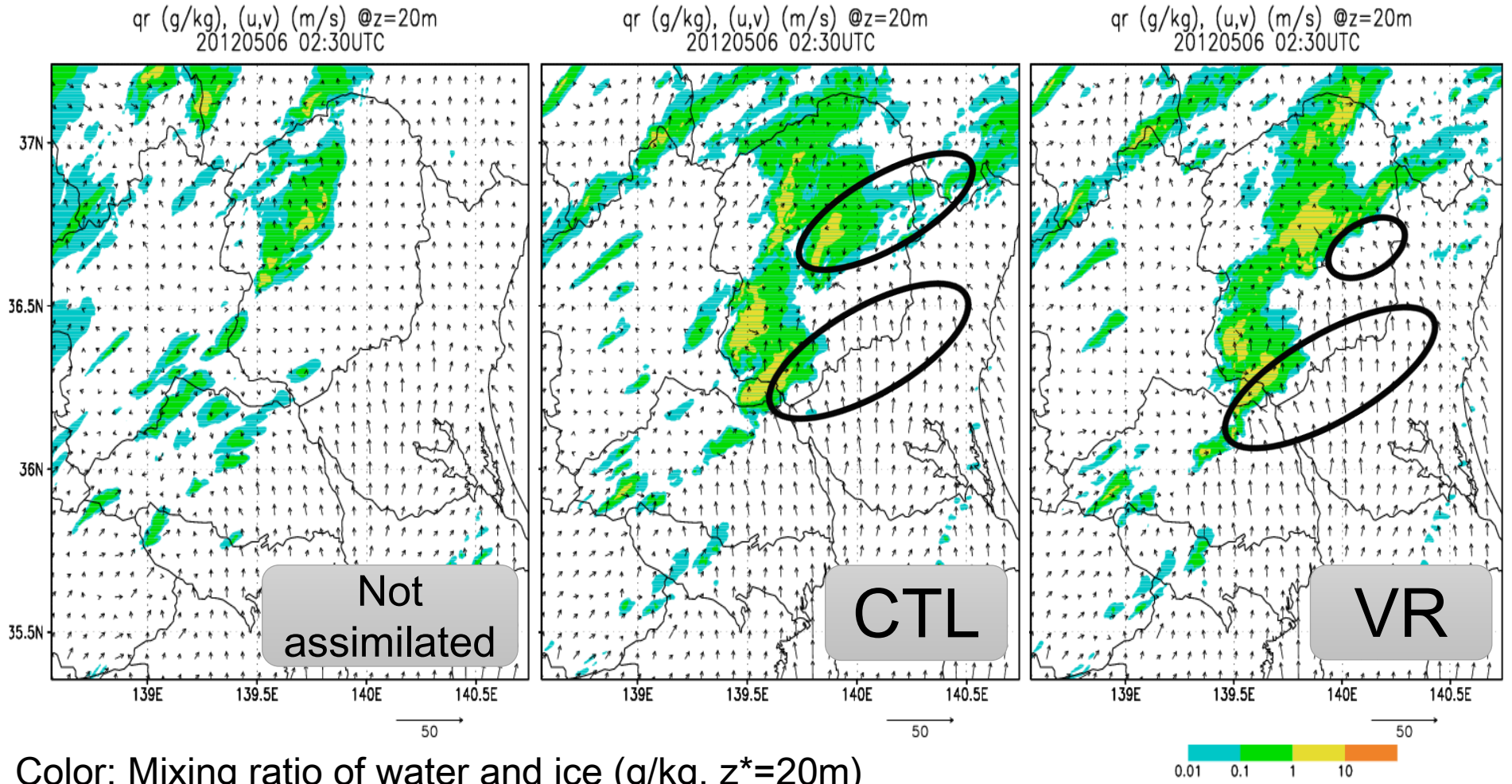
## Downscaling Experiments
- 13 members (12 + analysis)
- 1.875km and 350m grid

※Operational observation:
Surface (pressure), Radiosondes (wind, humidity, temperature), Planes (wind, temperature) and Wind profiler radar (wind)

| | Grid Interval | Initial Time | |
|---|---|---|---|
| **Outer LETKF** | 15 km | 5/3 09:00JST | Operational observation data of JMA (every 1 hour) are assimilated. |
| **Inner LETKF** | 1.875 km | 5/6 03:00JST | **CTL:** Only operational observation data of JMA (every 10 minutes) are assimilated.<br>**VR:** Doppler wind data is also assimilated |
| **Downscaling Experiments** | 1.875 km<br>350 m | 5/6 10:00JST<br>5/6 10:30JST | Initial and boundary conditions are analysis of the inner LETKF in both CTL and VR. |

Downscaling Experiments

# Genesis of Vortices



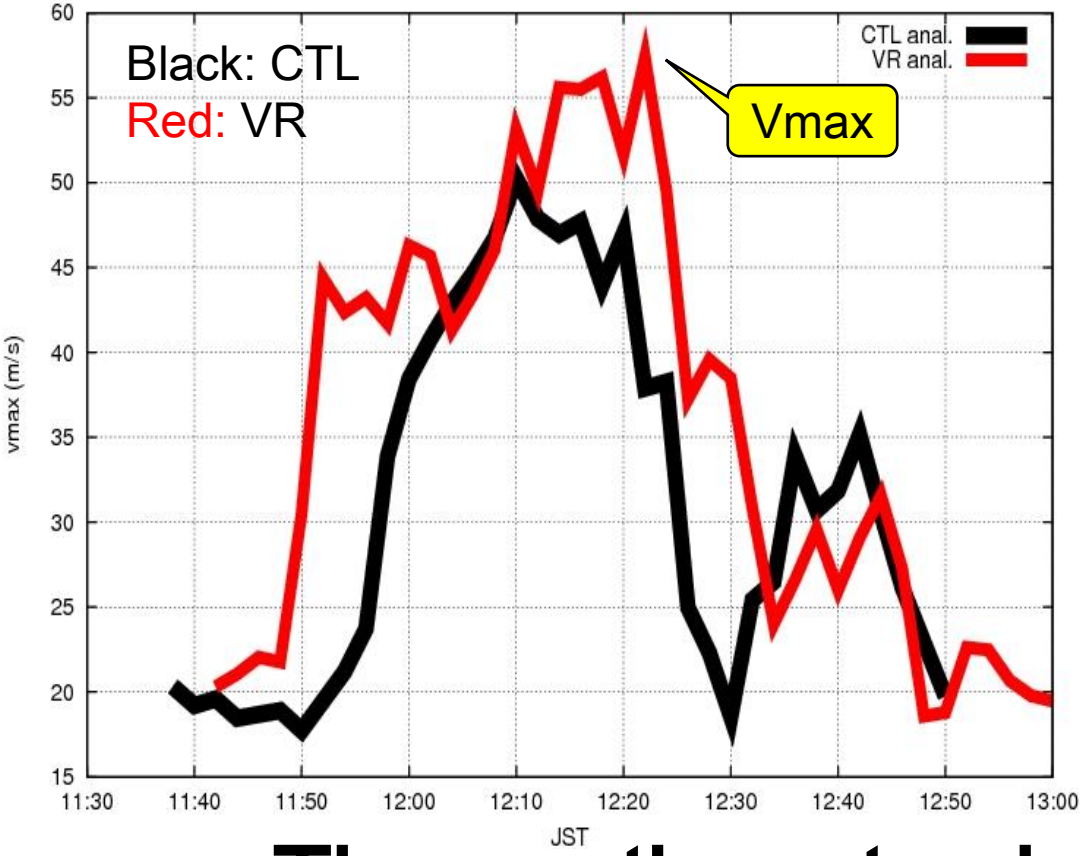

Color: Mixing ratio of water and ice (g/kg, z*=20m)
Arrows: Horizontal wind (m/s, z*=20m)
Red Point: High relative vorticity area (>0.03/s, z*=20m)

⇒ The vortex was generated at **south edge** of precipitation area.

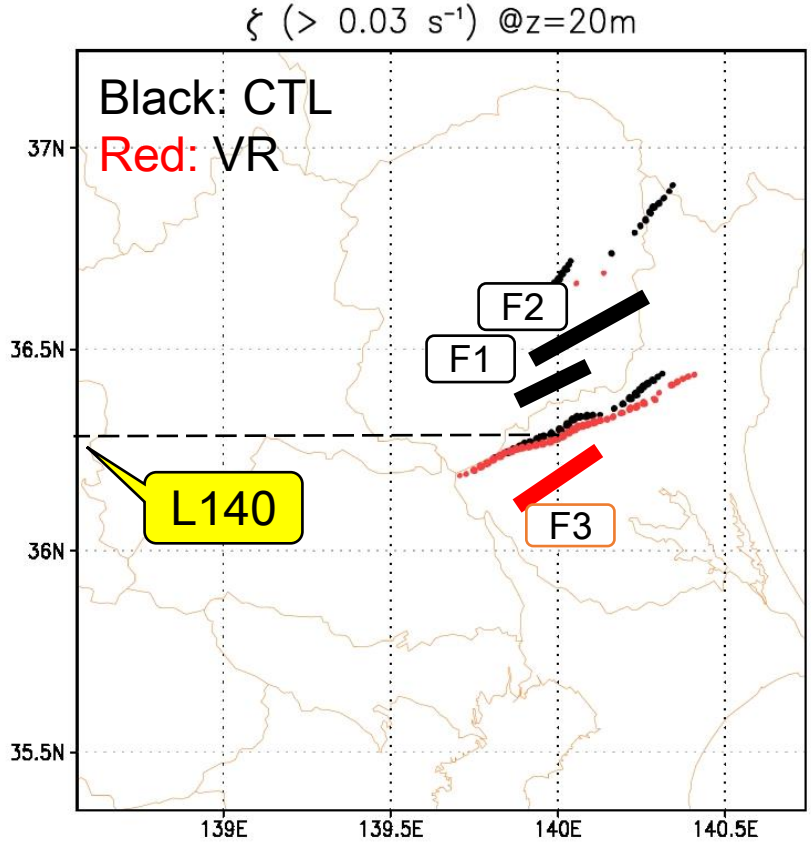
Downscaling Experiments

# Strength and the Path of Vortices

## Time series of maximum velocity around the south vortex (z*=20m)




## High relative vorticity area (>0.03/s, z*=20m)

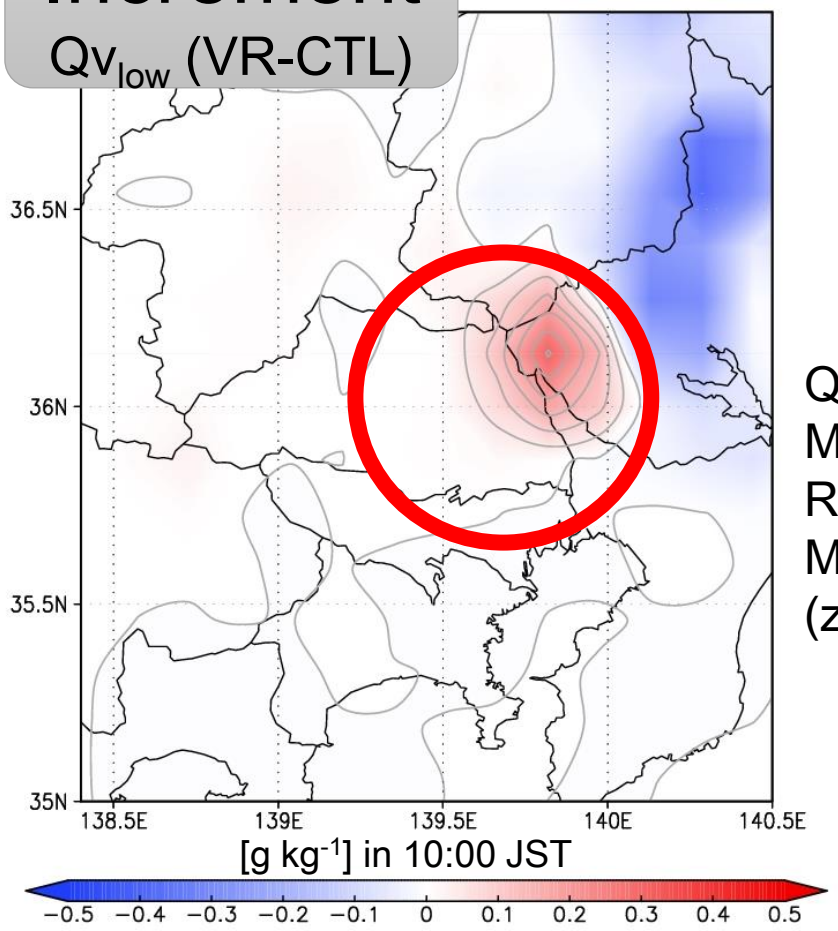



⇒ The south vortex in VR is **stronger** and the path **shifts to the south**.

# Correlation Analyisis What Decides **Strength** of the Vortex

## Increment

$Qv_{low}$ (VR-CTL)




[g kg$^{-1}$] in 10:00 JST

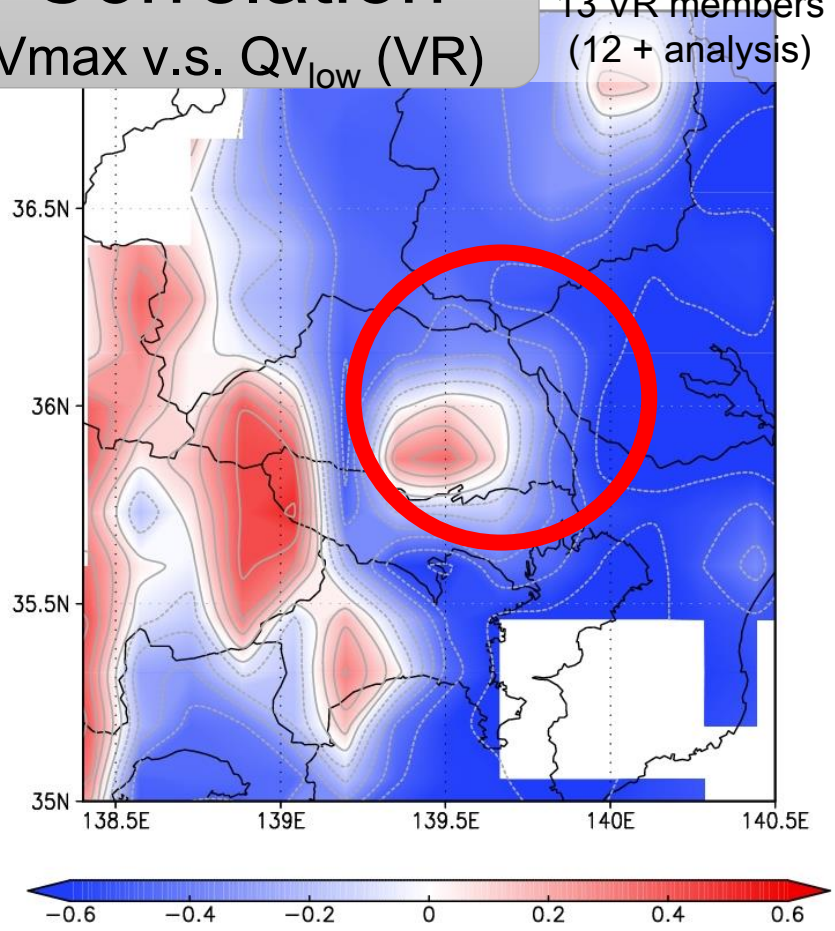



$Qv_{low}$: Mixing Ratio of Moisture (z*=20m)

## Correlation

Vmax v.s. $Qv_{low}$ (VR)

Calculated with 13 VR members (12 + analysis)





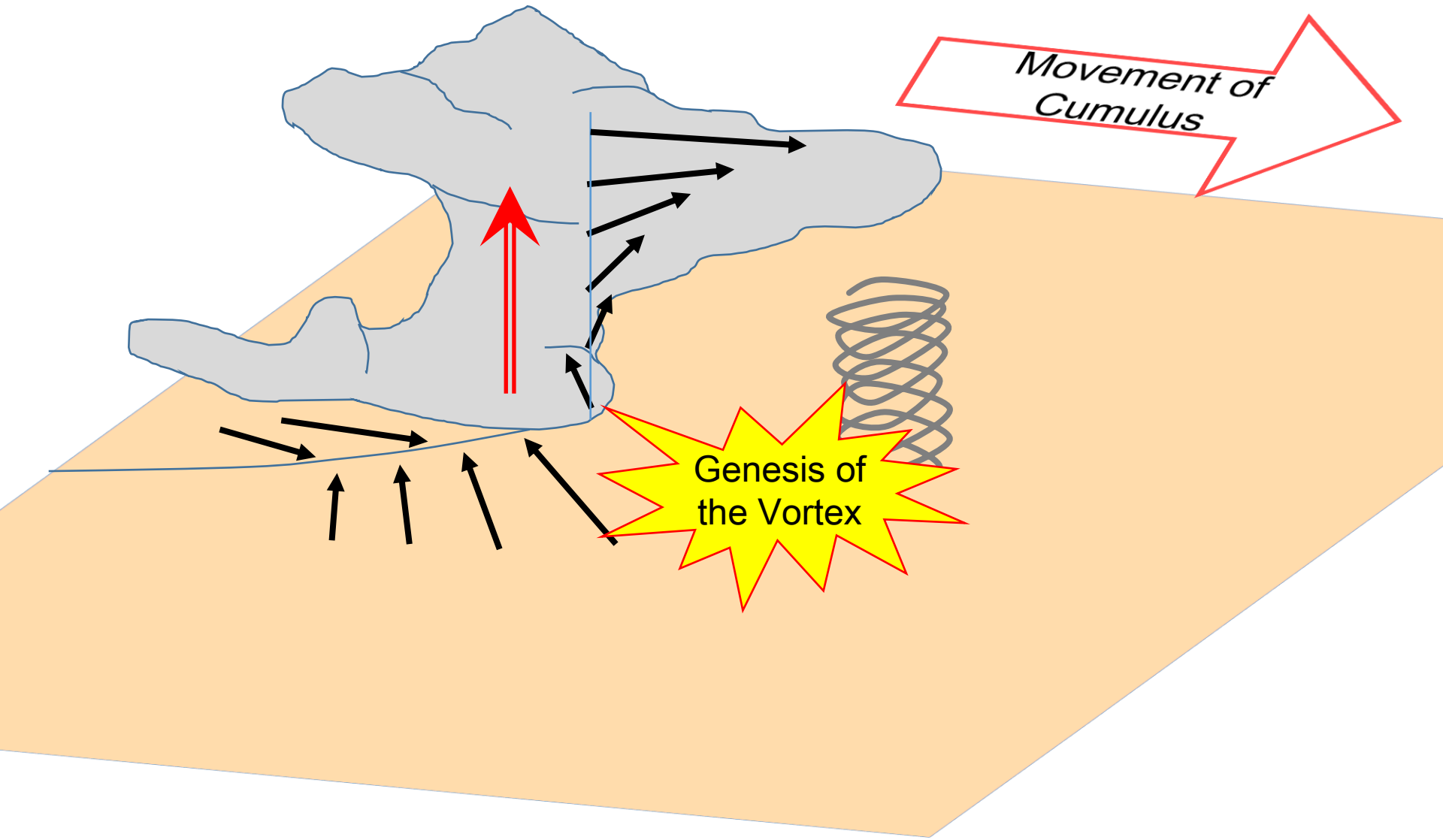


**Low-level moisture increases near the genesis point of the vortex.**

**The vortex becomes stronger.**

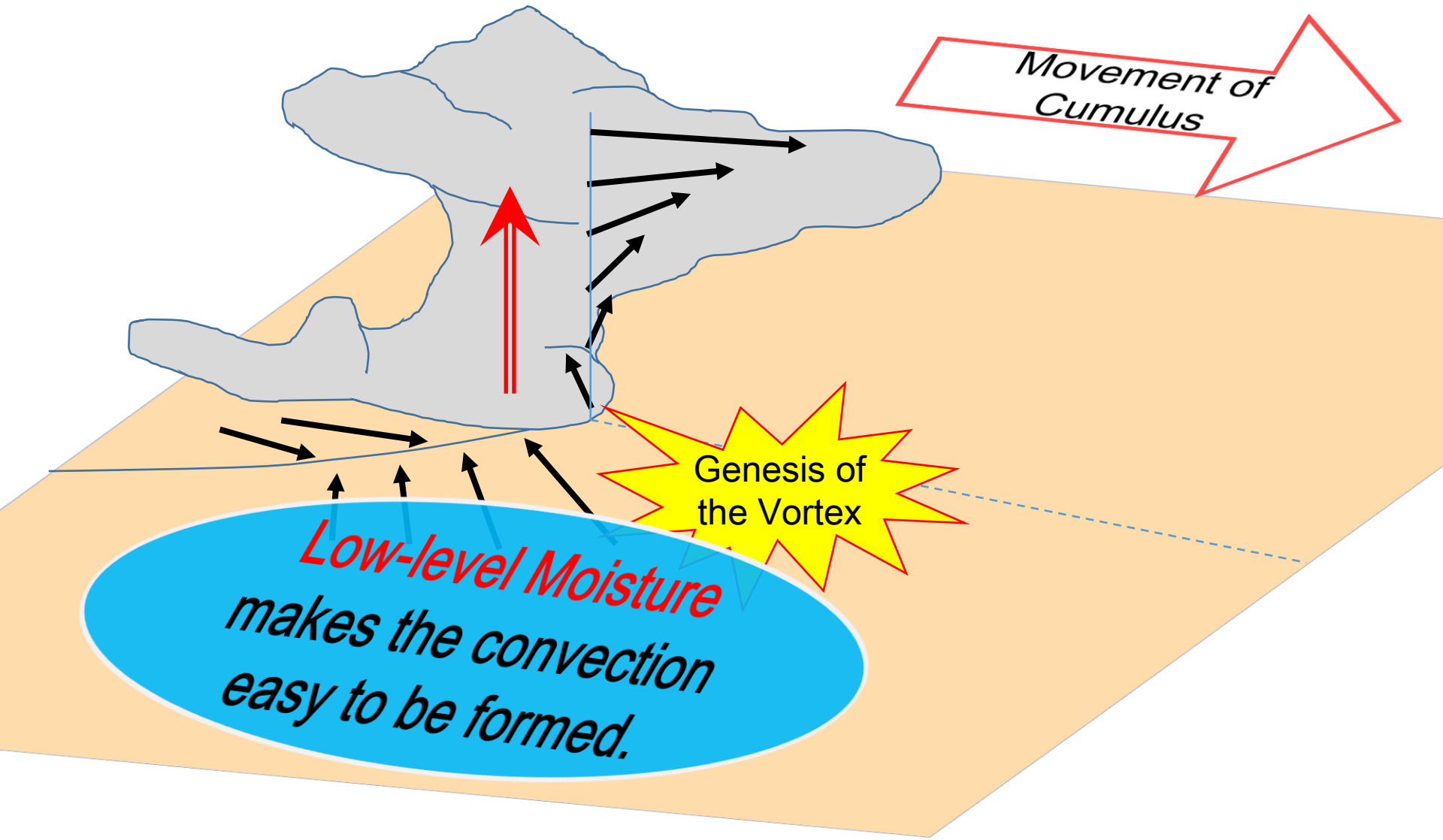
Correlation Analyisis

# What Decides **Strength** of the Vortex



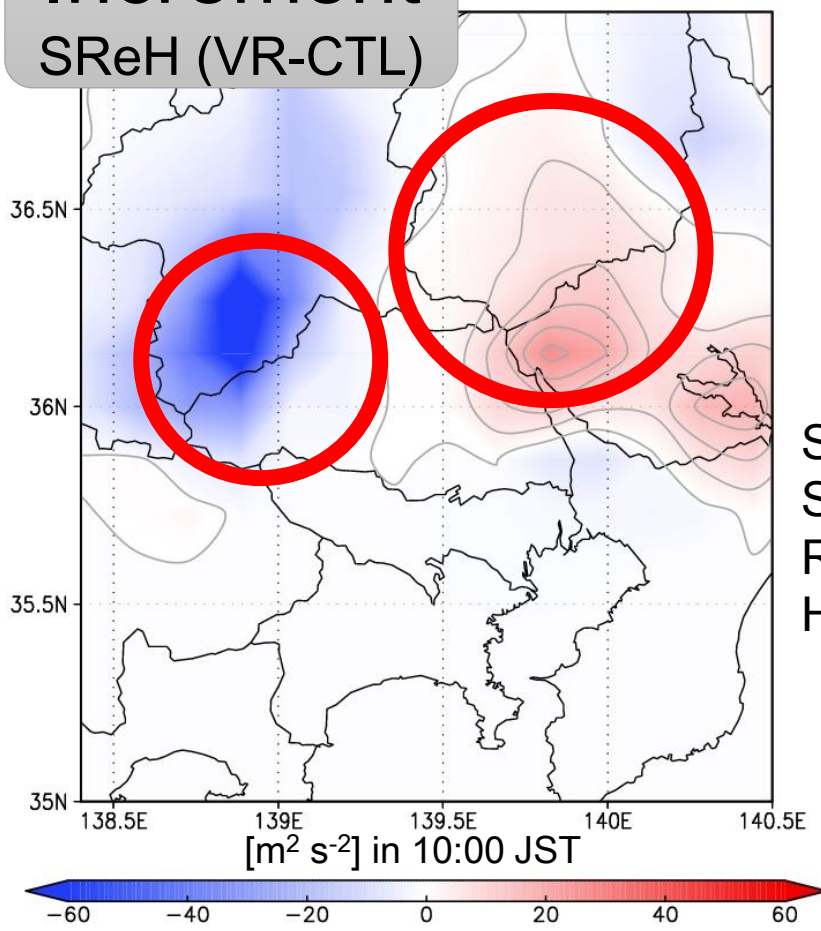
Correlation Analyisis

# What Decides **Strength** of the Vortex



# Correlation Analyisis What Decides the **Path** of the Vortex

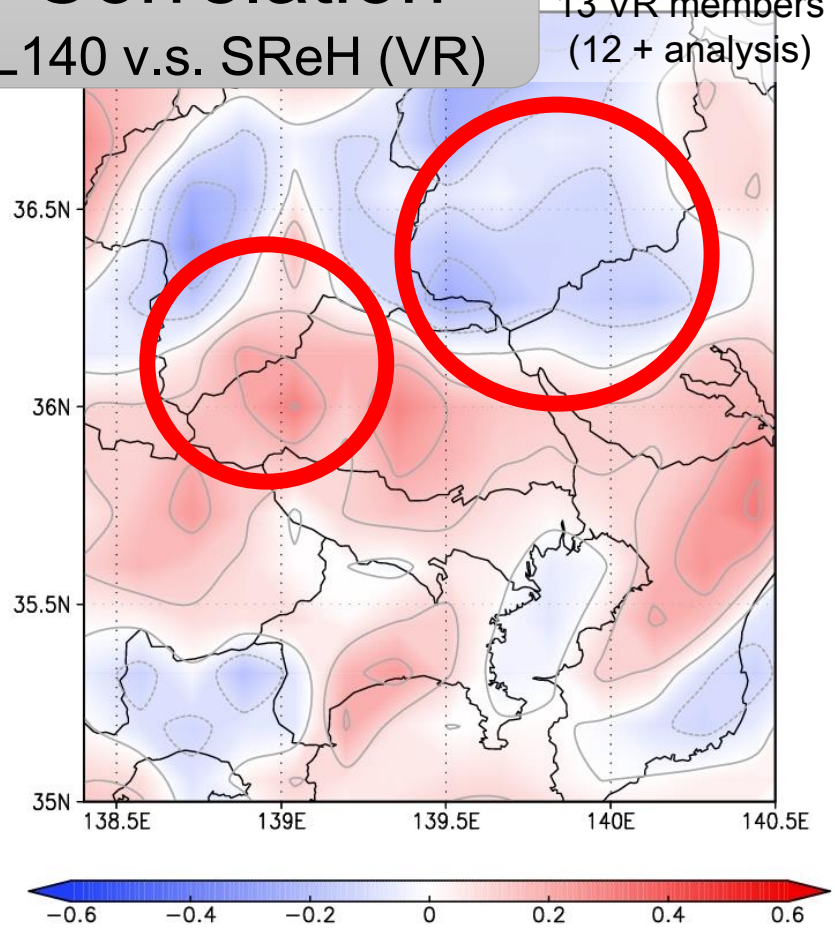
## Increment
SReH (VR-CTL)




SReH: Storm Relative Helicity

## Correlation
L140 v.s. SReH (VR)

Calculated with 13 VR members (12 + analysis)

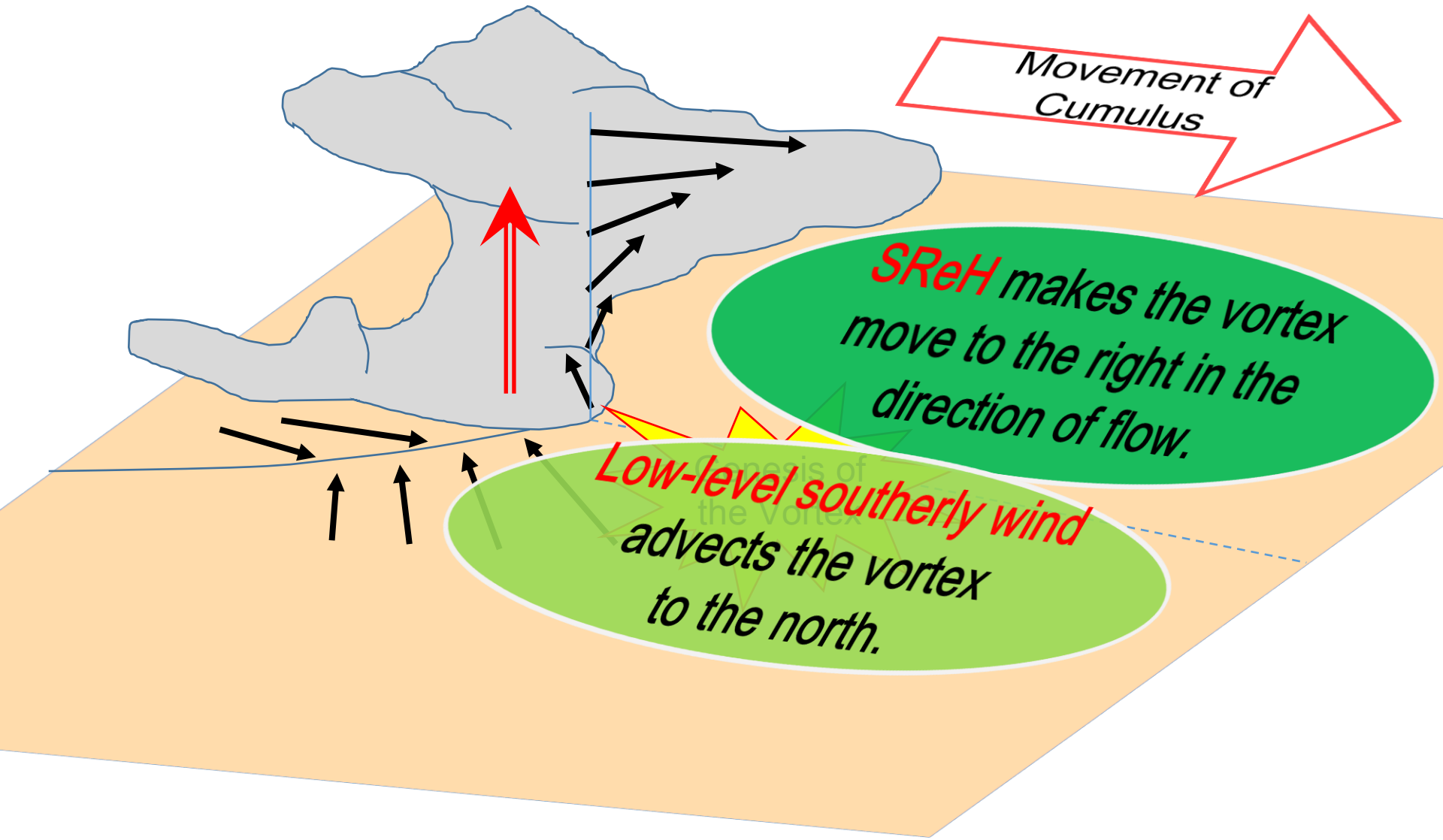



**SReH decreases at the south of precipitation area and increases at the path of precipitation area.**

**The vortex path shifts to the south.**

Correlation Analyisis

# What Decides the **Path** of the Vortex



# Summary

In the case of tornadoes in May 6, 2012, Doppler wind of MRI radar is assimilated with the Nested-LETKF system.

## Results

The south vortex became close to real because low-level moisture and SReH were corrected.

⇒ **Correction of wind and moisture at low level is effective to reproduce vortices.**

## Future Plan

Higher resolution LETKF, more members, more observations
(Ground Observation, Reflectivity, Dual-pol information of Radar and so on)

⇒ to improve the accuracy of the reproduction

⇒ to clarify the genesis mechanism of tornadoes