



NC STATE UNIVERSITY



Preliminary dual-Doppler Syntheses of a PERiLS QLCS Mesovortex

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The Mesovortex Genesis Problem

- QLCS mesovortices and the tornadoes they produce are notoriously difficult to predict
- Mesovortices are shallow, transient, and difficult to see on radar
- **The mechanism describing mesovortex development is still ambiguous** although several theories exist:
 - a. Downward tilting of horizontal gust front vorticity
 - b. Horizontal shearing instability
 - c. Tilting of frictionally-generated horizontal vorticity
 - d. Supercell-like processes

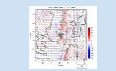
Different vortices may be produced by different pathways, including possibly a pathway not yet fully identified



Image Courtesy of National Weather Service Jackson, MS

Using Dual-Doppler Syntheses to Investigate Mesovortex Genesis

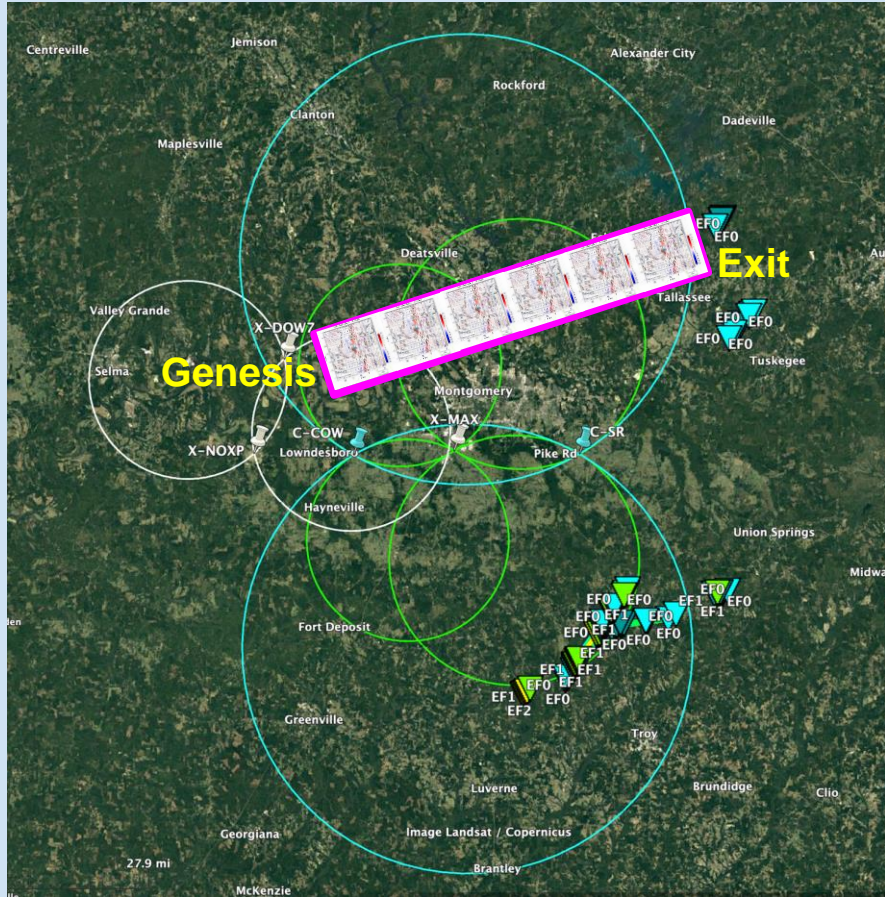
1. Compile a dataset of all well-sampled QLCS mesovortices in the dual-doppler lobes
2. Create time series of dual-doppler syntheses over the lifetime of a mesovortex (genesis through demise)
3. Look for patterns and features in the dual-doppler wind field that help describe mesovortex genesis and evolution



Dual-doppler synthesis



Track of a QLCS mesovortex from genesis to when it exited the dual-doppler lobes



The dual-doppler radar configuration from April 5, 2022 (Y1 IOP3)

Preliminary dual-Doppler Syntheses of a PERiLS QLCS Mesovortex

April 5, 2022 (Y1 IOP3) Case Overview

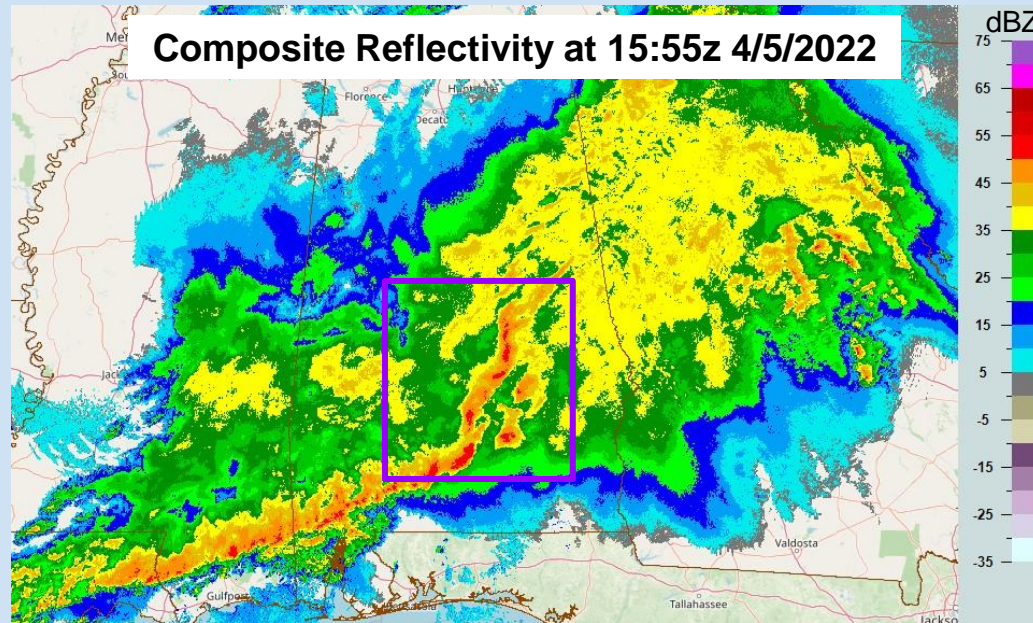
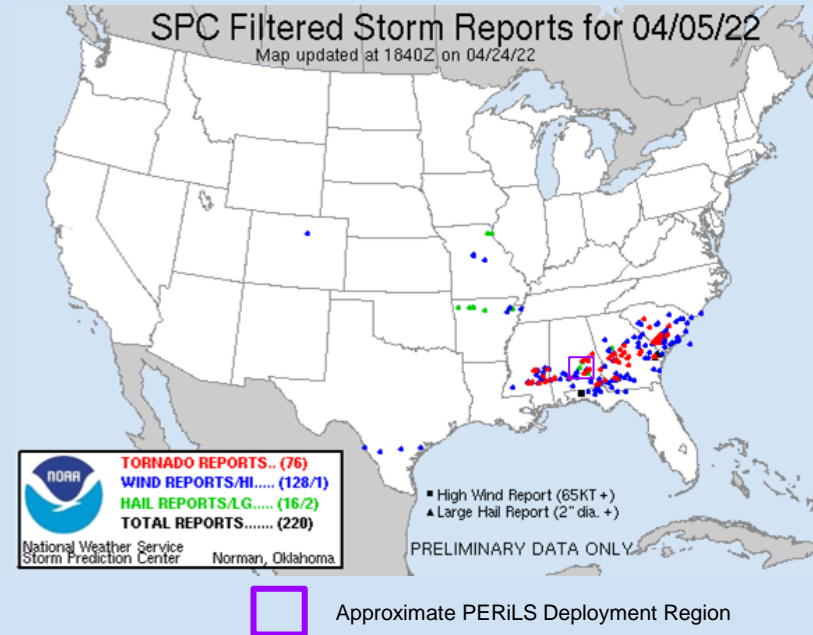


Image Courtesy of the NSSL Multi-radar Multi-Sensor (MRMS)



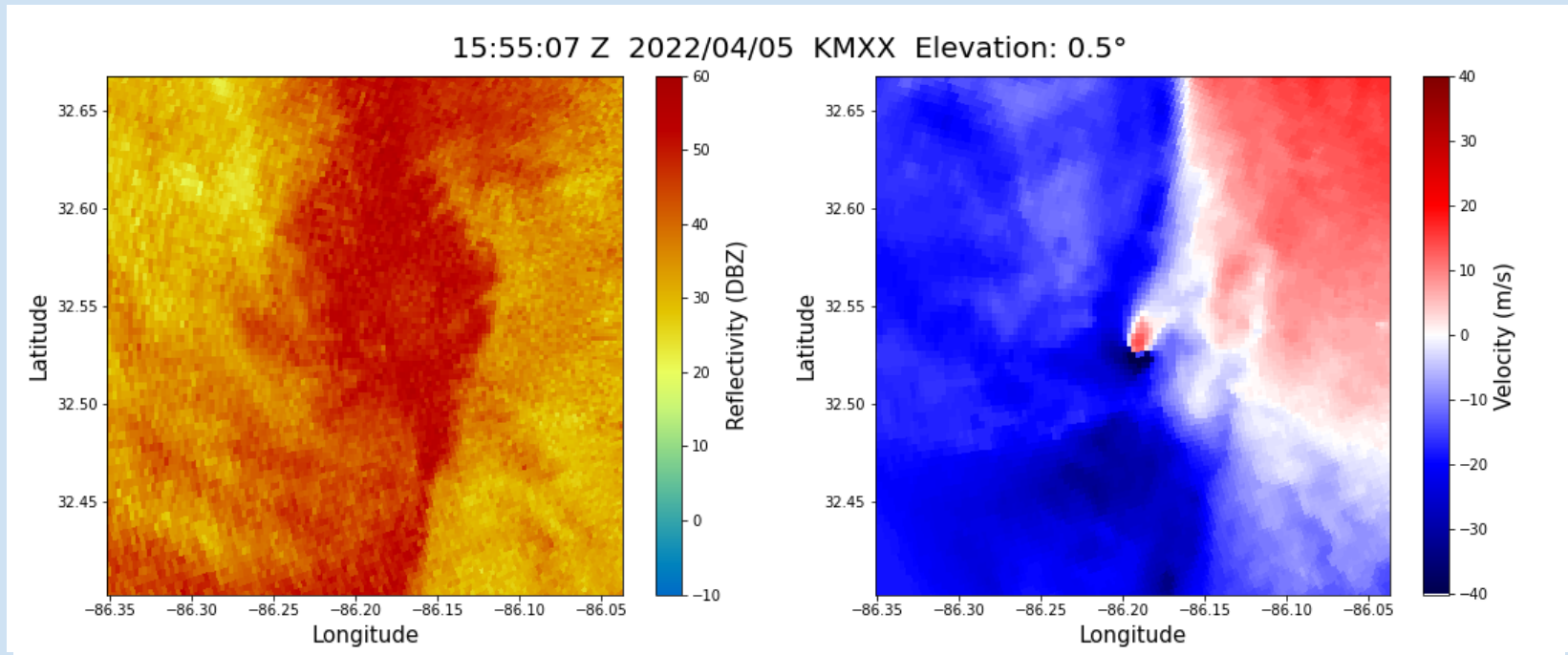
- **High Shear Low CAPE (HSLC):**

- 0-6 km shear in excess of 60 kts and 0-1 km SRH in excess of 400 m²/s²
- MUCAPE < 1000 J/kg

- **Strongly Forced:** Strong upper-level trough and jet streaks

The April 5, 2022 Wetumpka, AL Mesovortex

- A tornadic mesovortex occurred on April 5, 2022 at 15:55z near Wetumpka, AL (pink box)
- This mesovortex was particularly intense, well-defined, and well sampled by 3 different radars making it an excellent dual-doppler candidate
- A dual-doppler synthesis was possible in 2 different dual-doppler lobes: COW1/SR2 and KMXX/SR2

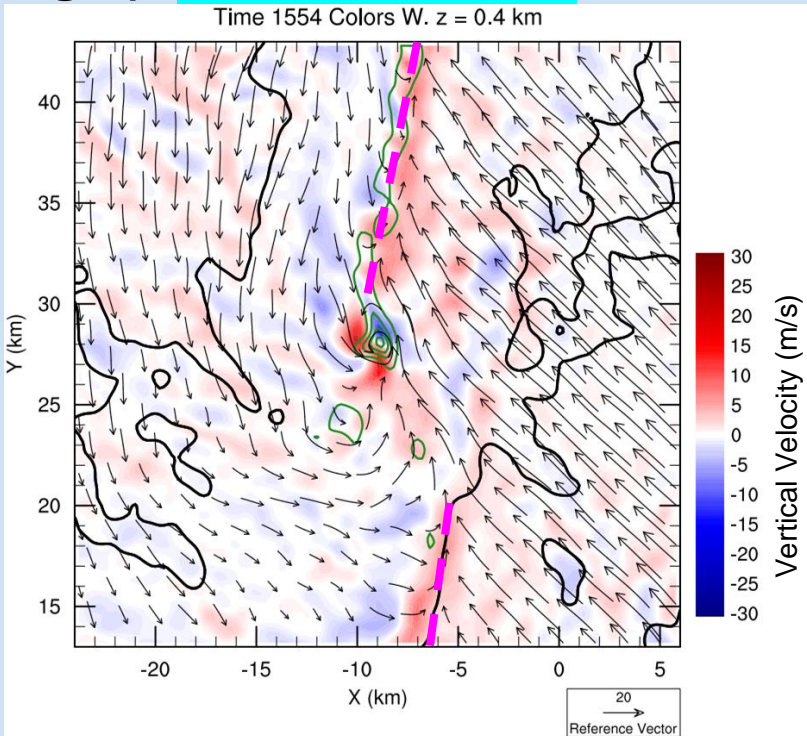
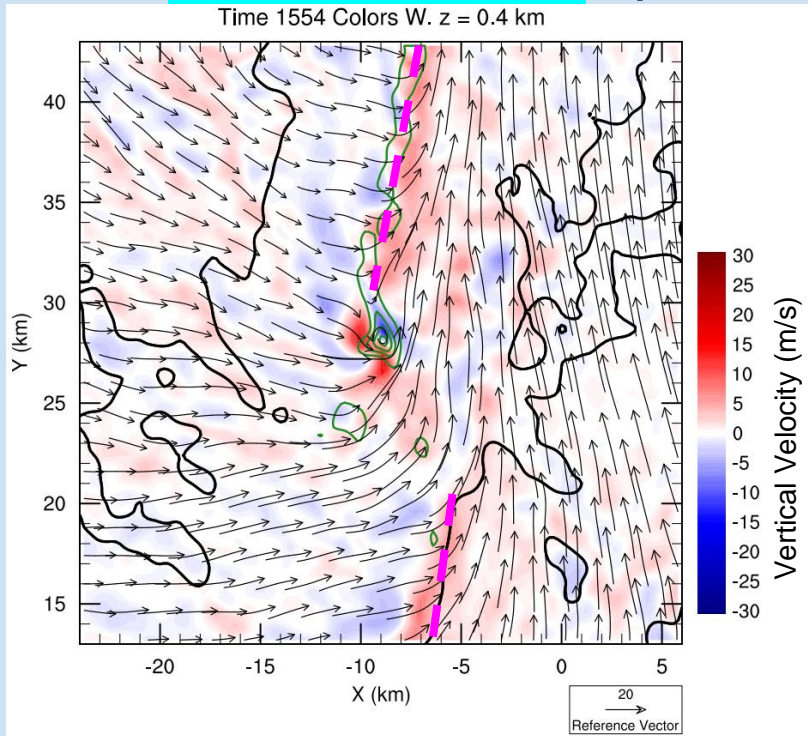


KMXX/SR2 Lowest Tilt Dual-Doppler Synthesis of the Wetumpka Mesovortex

Ground-Relative Winds

(Max Strength)

Storm-Relative Winds



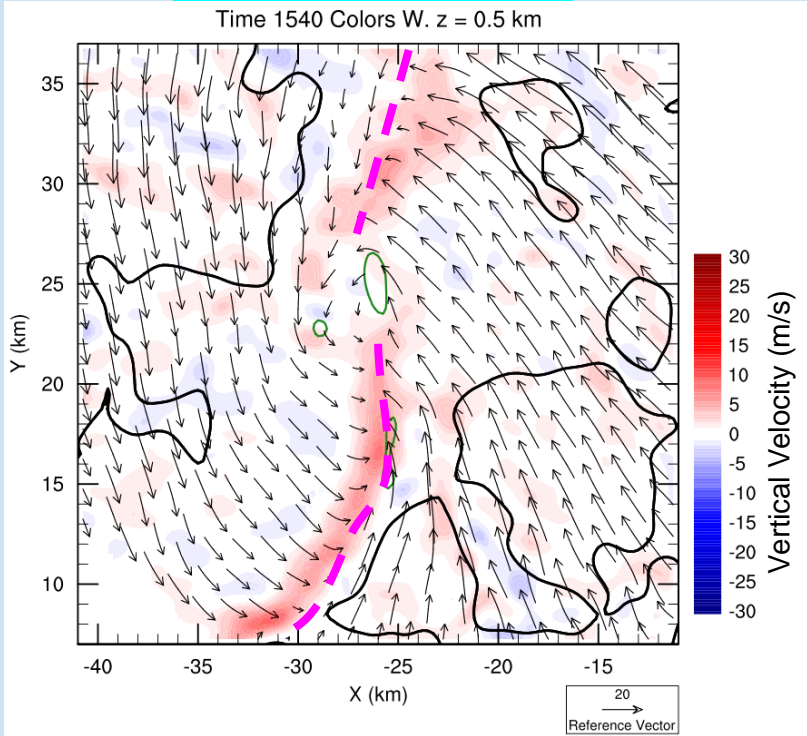
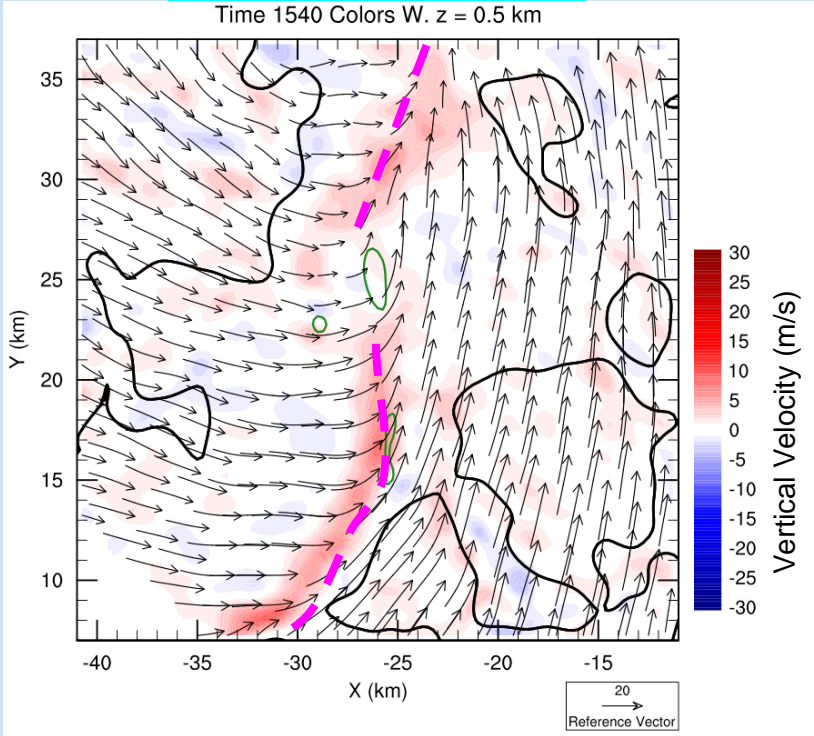
- **Very intense mesovortex** present at the edge of a break in the gust front and in heavy precipitation
- **Horizontal shearing instability (HSI)** implied along the northern gust front segment
- **Strong downdraft** just northeast of the mesovortex and a weaker one wrapping in from the west

KMXX/SR2 Lowest Tilt Dual-Doppler Synthesis of the Wetumpka Mesovortex

Ground-Relative Winds

(Development)

Storm-Relative Winds

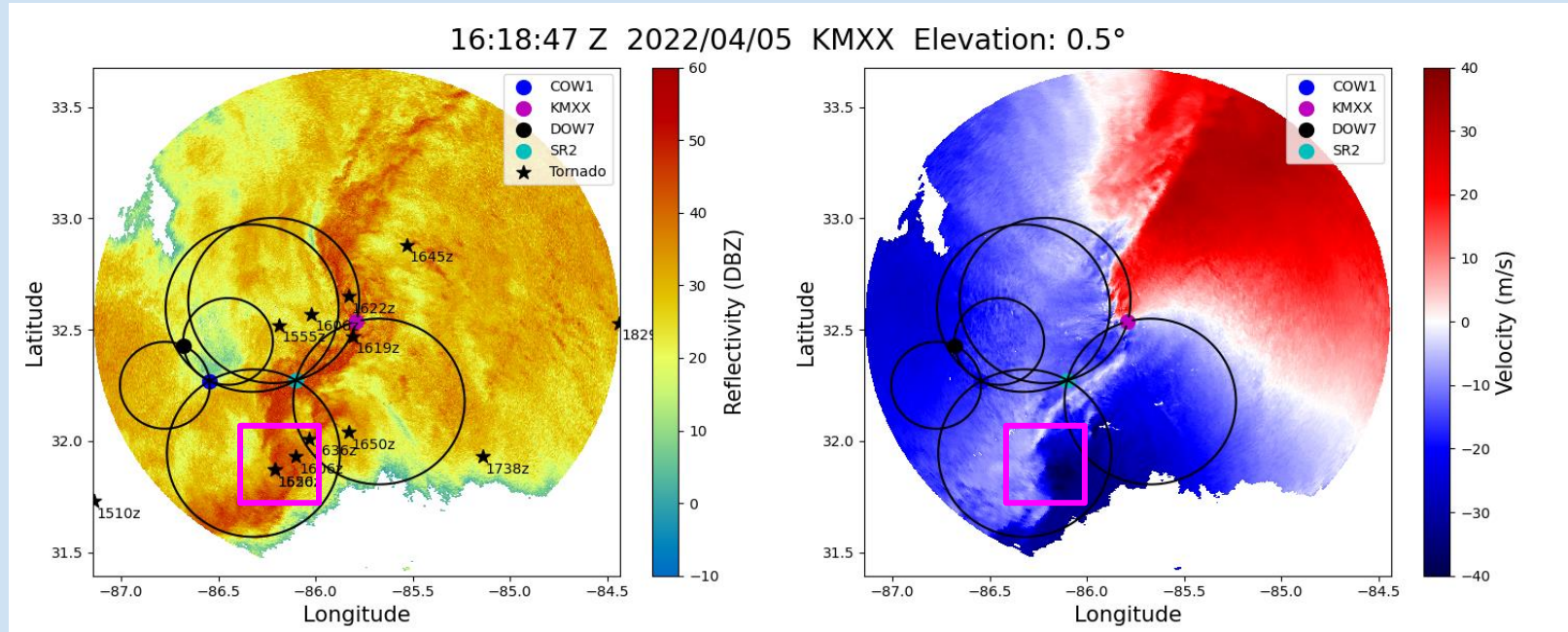


--- Gust Front
— 35 dBZ Reflectivity Contour
— Vertical Vorticity contoured at 0.015 s^{-1}

- **Broad circulation develops at a gust front break** and in heavy precipitation
- **Strong outflow surge** in southern line segment accompanies mesovortex genesis
- This stage of development is characterized by broad, weak rotation prior to stretching by an updraft

Next Steps

- Complete a time series of dual-doppler syntheses on the Wetumpka mesovortex from genesis to demise
- Develop dual-doppler time series for all well-sampled, intense mesovortices observed in the PERiLS project
- Analyze the dual-doppler time series for recurring features accompanying mesovortex genesis and evolution



Another example of a tornadic QLCS mesovortex occurring at 16:20z near Petrey, AL

□ Mesovortex Location and approximate dual-Doppler Domain