

(Preliminary) Observations of Tropical Storm Fay

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Outline

- I. Research Equipment
 - MIPS, MAX, KJAX (WSR-88D)
- II. Fay Overview
- III. MIPS Measurements
- IV. Dual-Doppler Analysis (Looking for Coastline Effects on Rainbands)
- V. Summary
- VI. Future Work

MIPS

(Mobile Integrated Profiling System)



915 MHz Wind Profiler



- Samples from ~120 m through the depth of precipitating system
- Collects Doppler spectra, calculates the spectrum moments (vertical particle motion W , return power or reflectivity factor Z , and spectral width s_v)
- Determines wind profiles at 5 min intervals, acquires vertically-pointing data at 20-30 s



**Jacksonville
WSR-88D (KJAX)**

Operated in VCP121
for this Case

MAX: Mobile Alabama X-Band

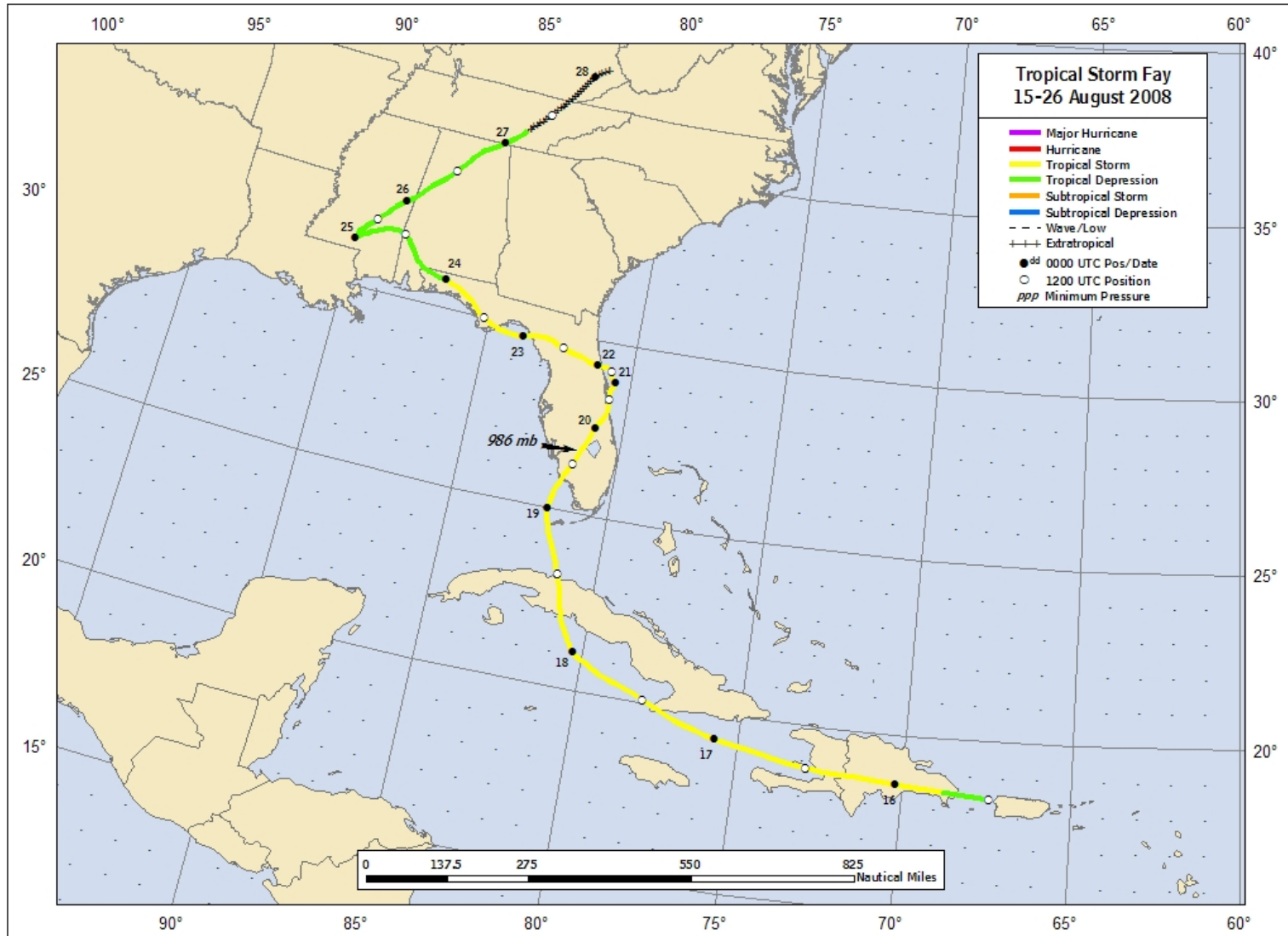
- Transmit frequency: 9450 MHz (H+V, H)
- Peak Power: 250 kW
- Pulse width: 0.4 – 2.0 μ s
- Min/Max PRF: 250 / 2000 s^{-1}
- Antenna Diameter 2.4 m (8 ft)
- Antenna Gain 44.5 dB
- Antenna Beam width: .95°
- Scanning: 0-360 Az., 0.5-90 Deg. El.
- First side-lobe: -31 dB
- Cross-pol isolation: <-36 dB
- Receiver polarization: RVP8
- Variables: Z, V, W, ZDR, ϕ_{DP} , KDP, ρ_{hv} , LDR
- Leveling System: Automatic, .01° Accuracy



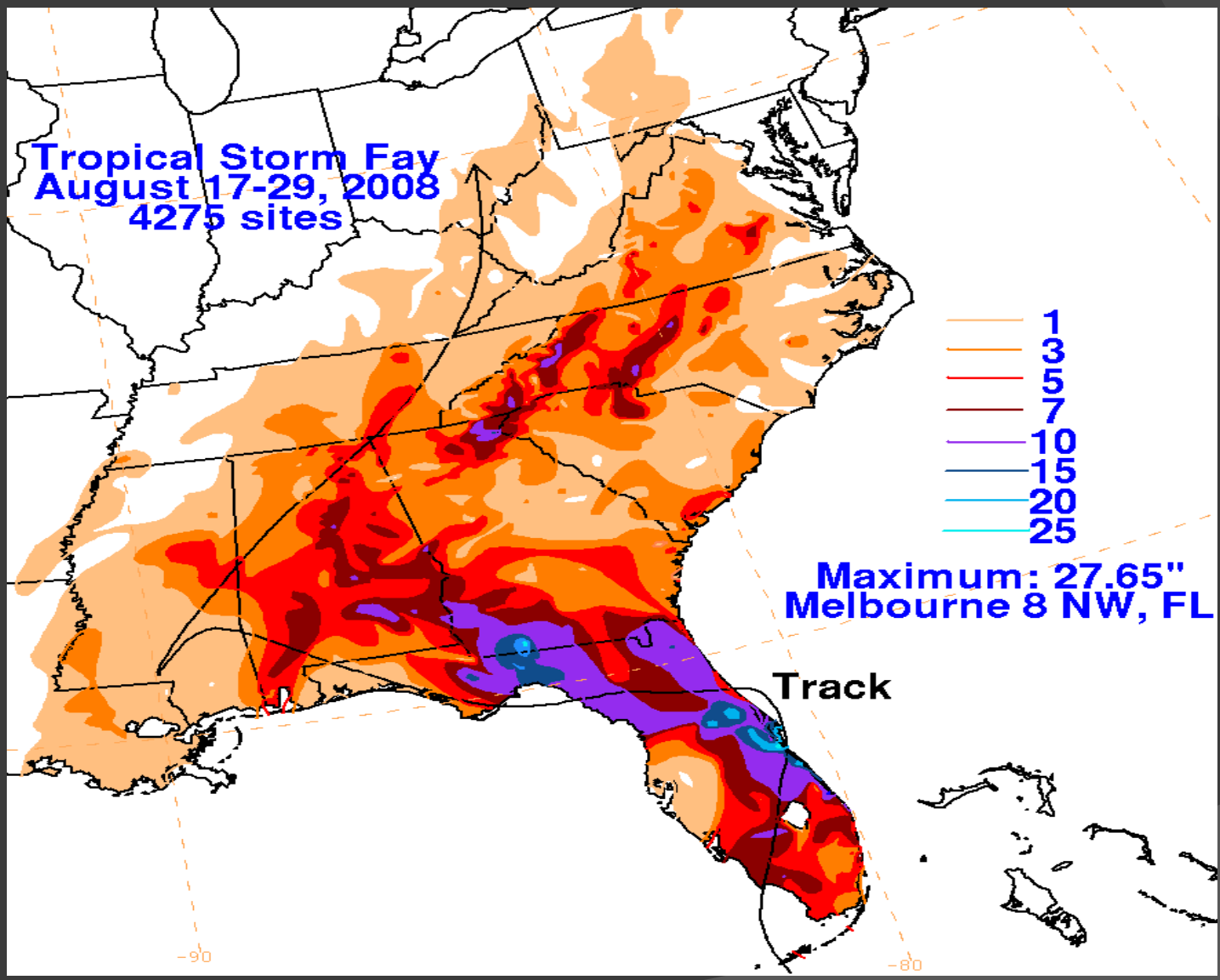
Tropical Storm Fay Facts

- Fay was a long-lived tropical storm that made eight landfalls – including a record four landfalls in Florida
- Thirteen fatalities: 5 in the Dominican Republic, 5 in Florida, and 3 in Haiti..
- Heavy rainfall resulted in more than 15,000 homes being flooded and more than 93,000 homes lost electricity in Florida due to strong gusty winds.
- Produced 81 tornadoes in five states: 19 in Florida, 17 in Georgia, 16 in North Carolina, 15 in Alabama, and 14 in South Carolina. Most were EF0 and EF1.
- Total damage in the U.S. ~\$560 million.

Track of Tropical Storm Fay



Rainfall Totals From Tropical Storm Fay

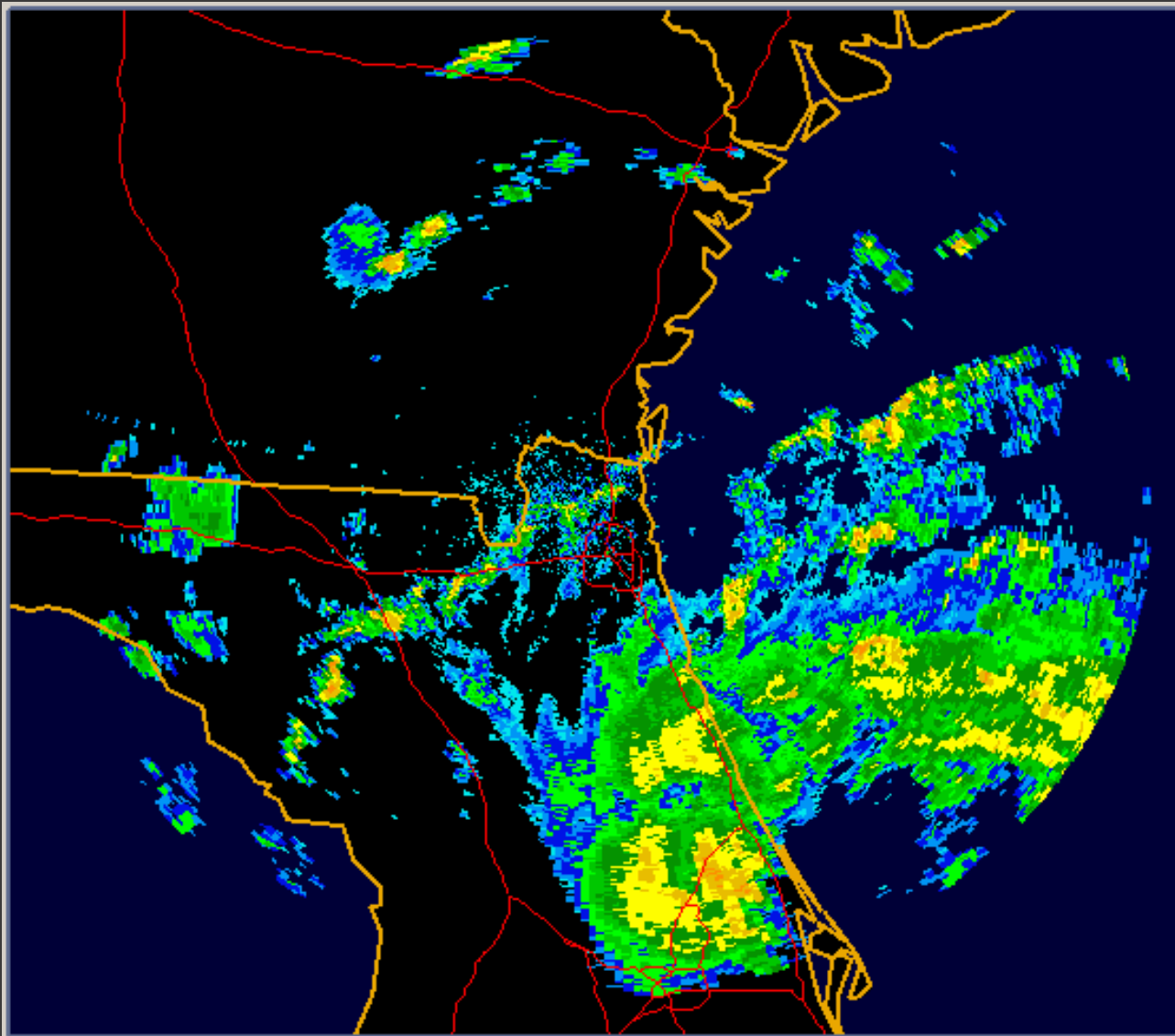


Rainfall totals associated with Tropical Storm Fay over the southeastern United States (graphic courtesy of NOAA/NCEP Hydrometeorological Prediction Center).

UAHuntsville Tropical Storm Fay Deployment

- Deployed at site near Jacksonville, FL at 00Z on August 20th, 2009
- Collected 57 hours (3,420 min) of continuous data waiting on TS Fay to make it's third landfall along the eastern coast of Florida... the "eyewall" was sampled for a long period of time
- Rainfall total: 10.73"
- Peak rain rate: 158 mm hr⁻¹
- Peak Wind Gust: 26 m s⁻¹ (59 MPH)

KJAX Radar Loop (8/21 00Z – 8/23 00Z) (3 Hrs)



NEXRAD LEVEL-III
BASE REFLECTIVITY
KJAX - JACKSONVILLE, FL
08/21/2008 00:00:00 GMT
LAT: 30/29/05 N
LON: 81/42/07 W
ELEV: 159 FT
MODE/VCP: A / 121

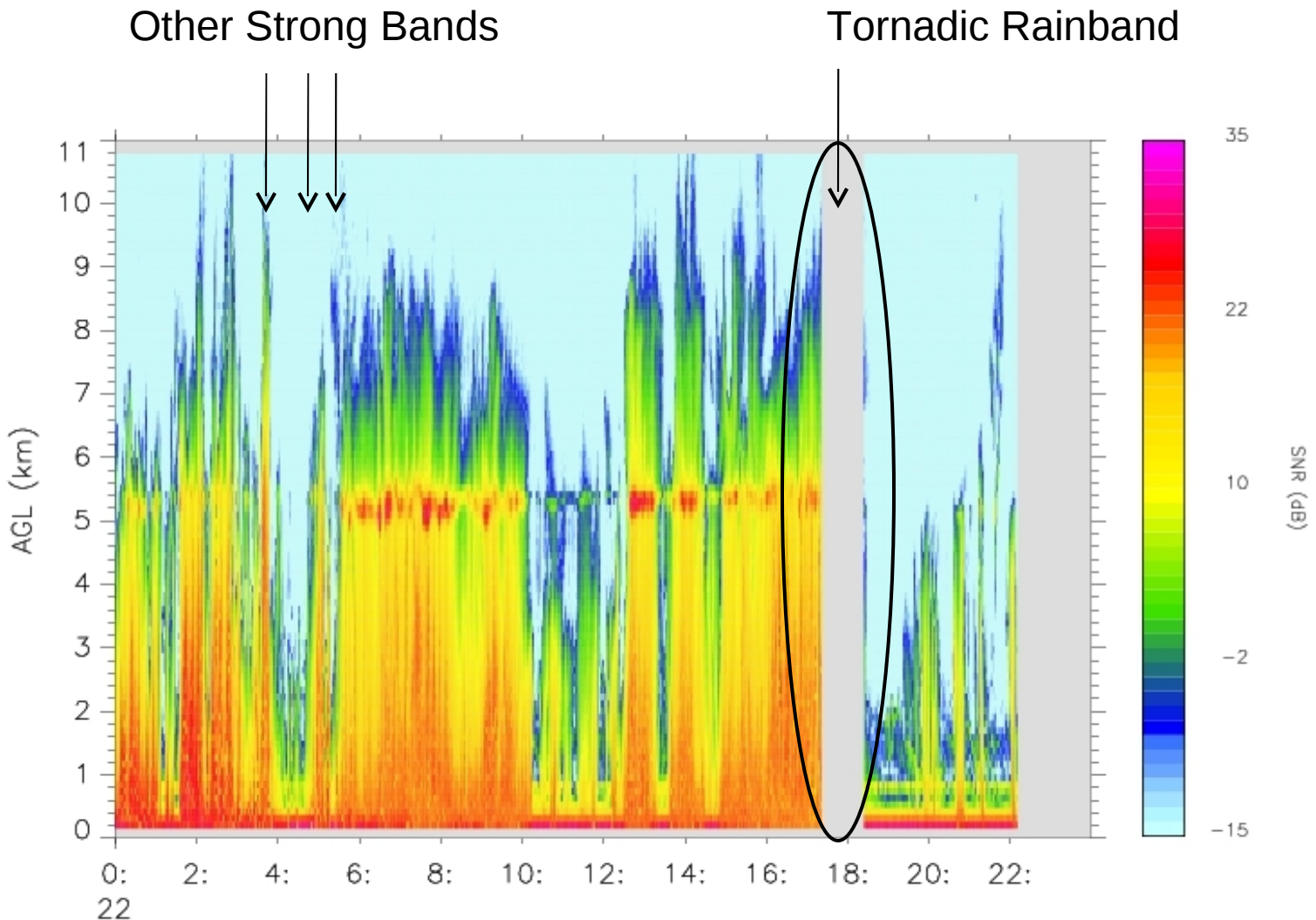
ELEV ANGLE: 0.50 °
MAX: 50 dBZ

Legend: dBZ (Category)

White	75 (15)
Purple	70 (14)
Magenta	65 (13)
Red	60 (12)
Red	55 (11)
Red	50 (10)
Orange	45 (9)
Yellow	40 (8)
Yellow	35 (7)
Green	30 (6)
Green	25 (5)
Green	20 (4)
Blue	15 (3)
Blue	10 (2)
Cyan	5 (1)

MIPS Observations

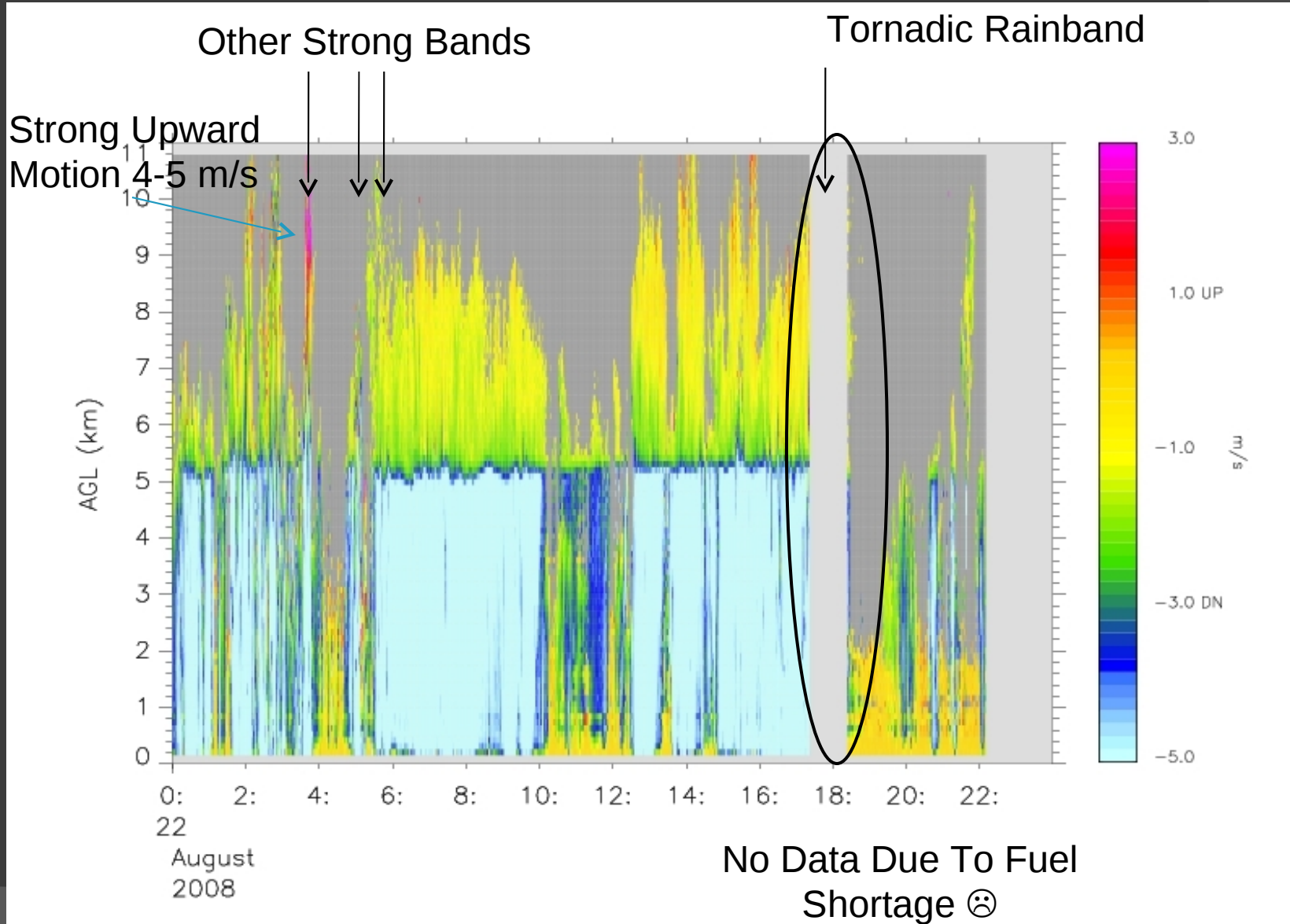
MIPS 915 MHz Profiler SNR



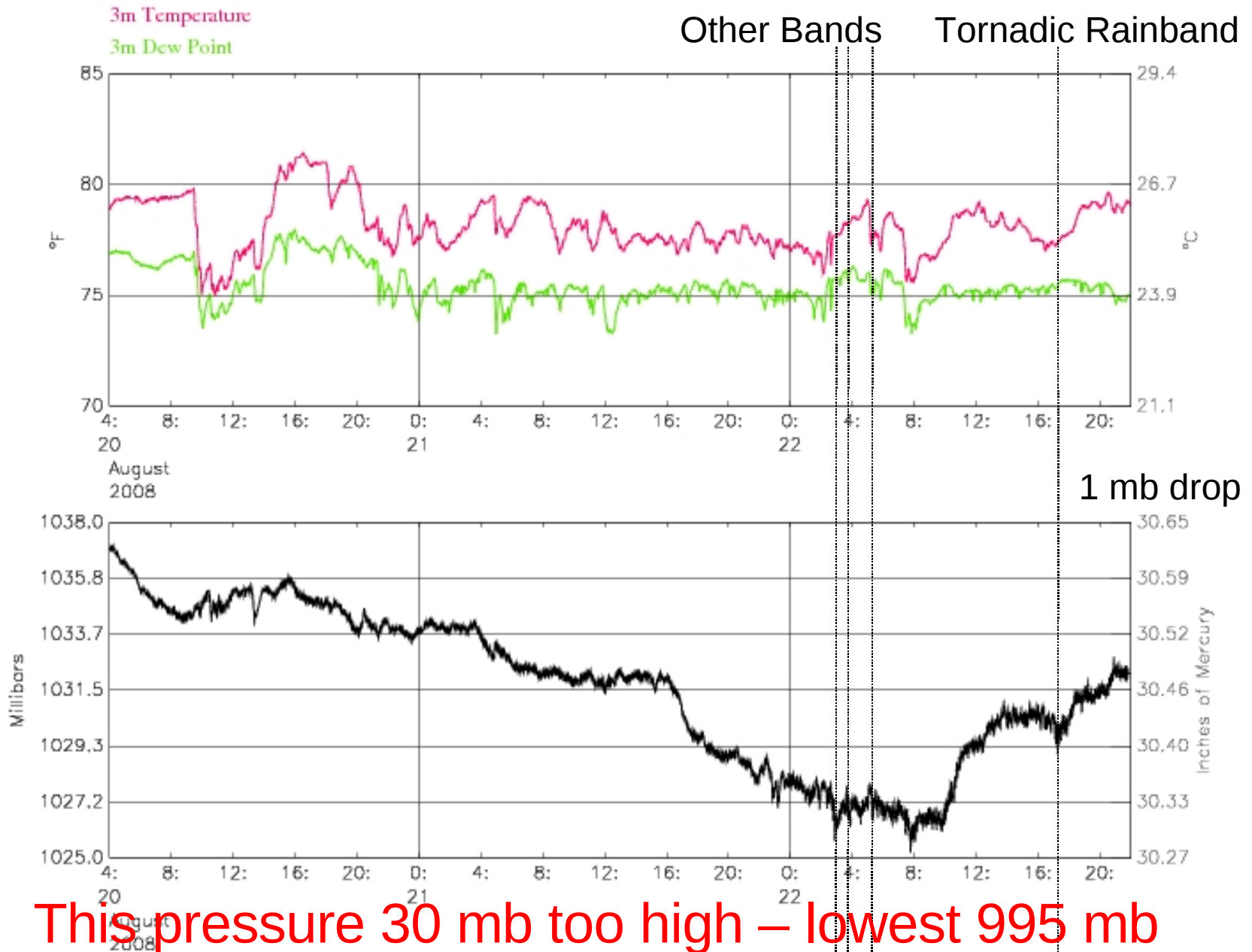
August
2008

No Data Due To Fuel
Shortage ☹️

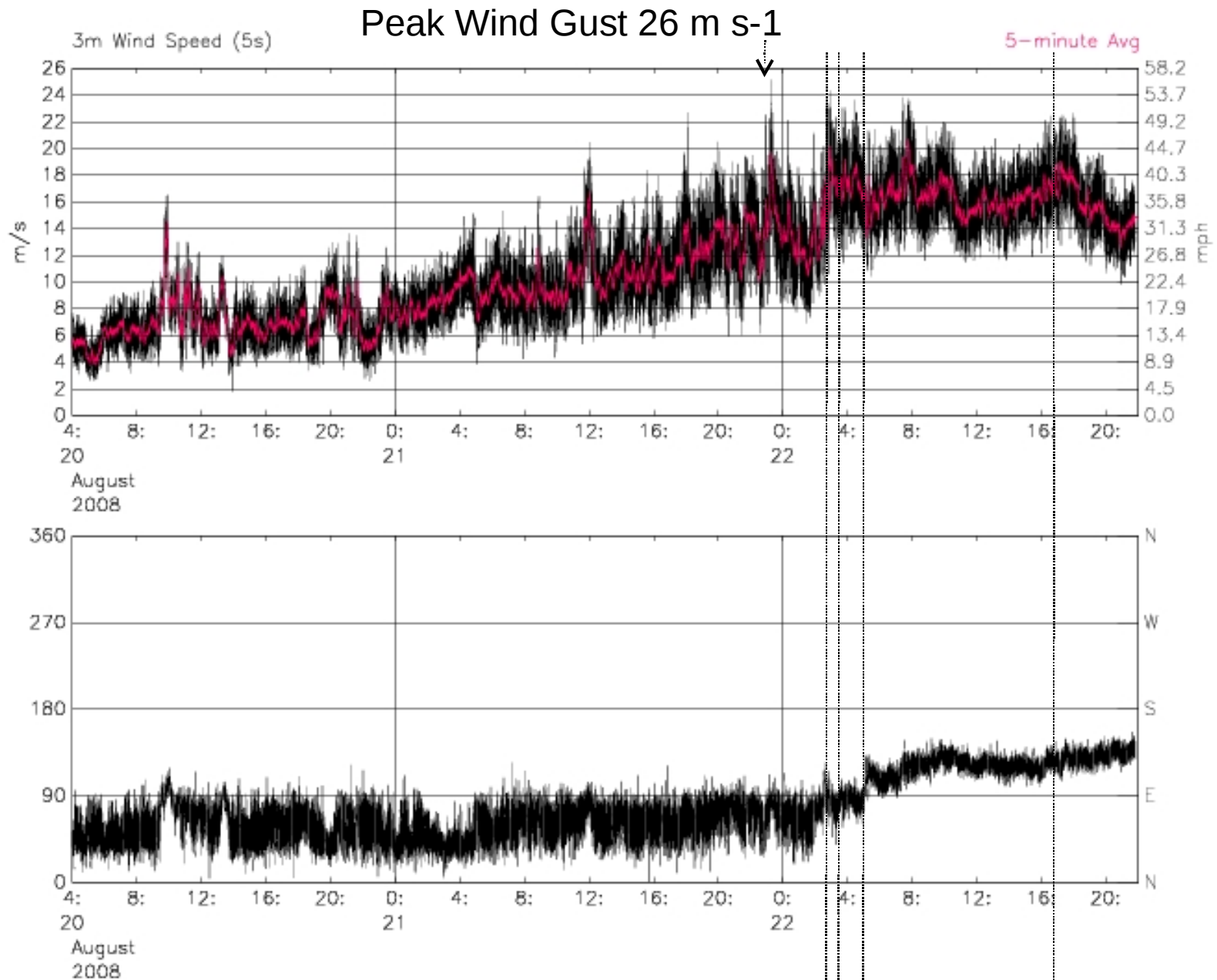
MIPS 915 MHz Profiler (W)



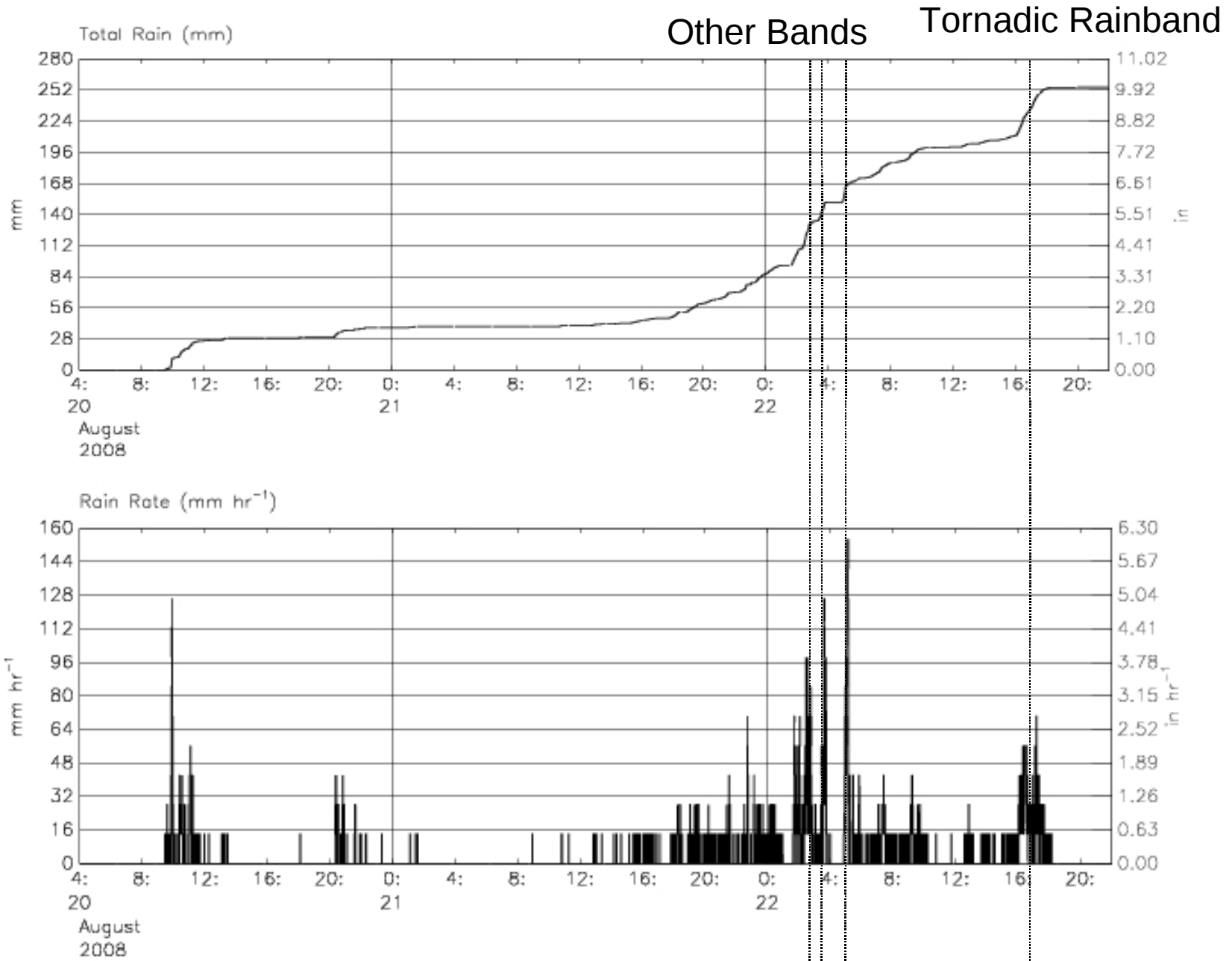
MIPS SFC T, TD and Pressure



MIPS SFC Wind Speed & Direction



MIPS SFC Total Rain, Rain Rate



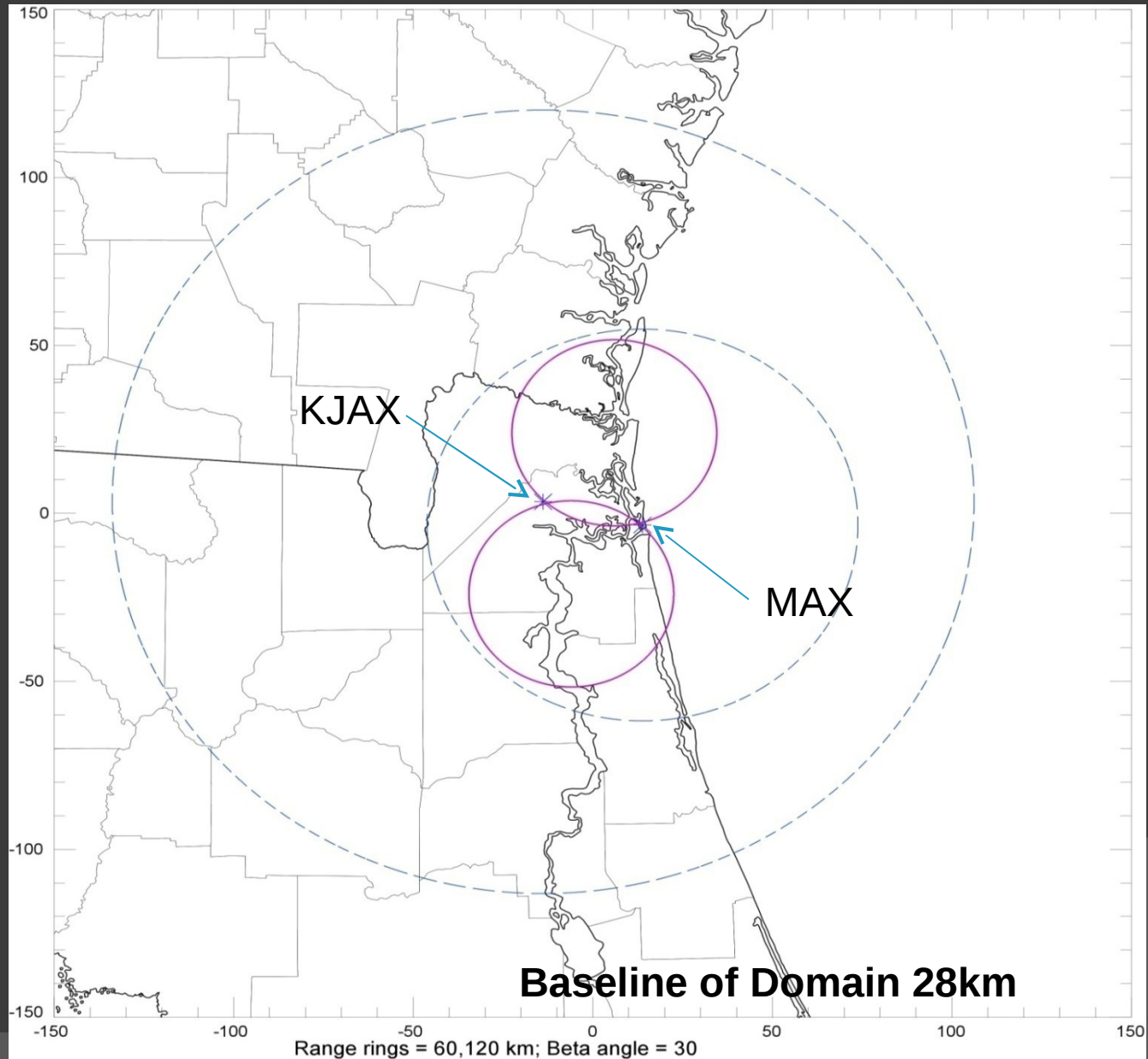
Dual-Doppler Analysis

MAX-KJAX

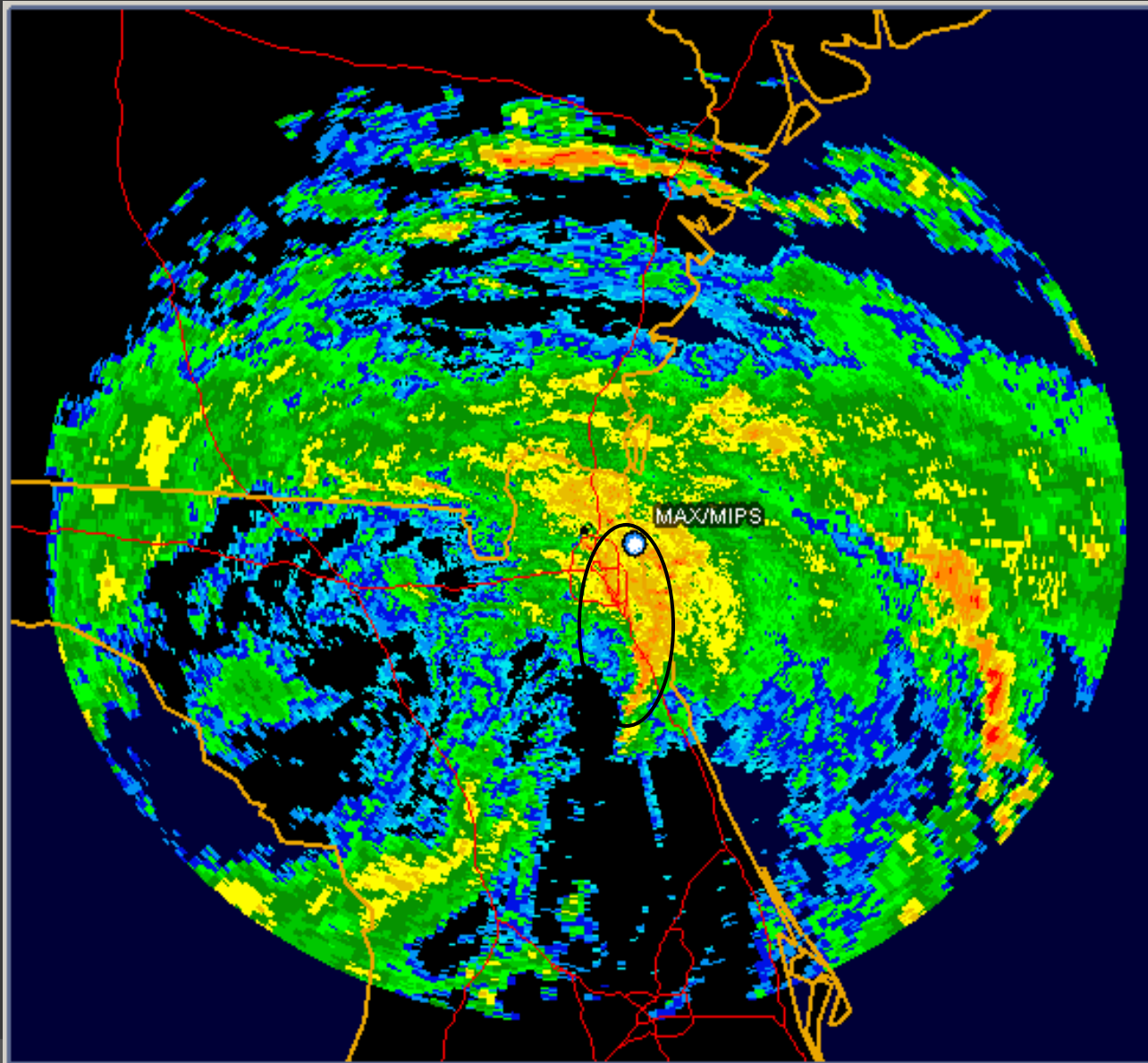
Dual-Doppler Setup

- Analyzed One Tornadic Rainband
- Analyze Four Time Periods During The Band Passage
 - 1703 UTC – First Tornado Reported Confirmed (1715)
 - 1712 UTC
 - 1721 UTC
 - 1748 UTC – Second Tornado Report Not Confirmed (1740)
- Only focusing on the southern lobe for this presentation
- For each image produced the MAX site was chosen as the center of the domain
- MAX being an X-band radar deployed in a hurricane, velocity aliasing proved to be an issue. With a Nyquist velocity of 9.5 ms^{-1} , unfolding MAX's velocity was time consuming

Dual-Doppler Setup



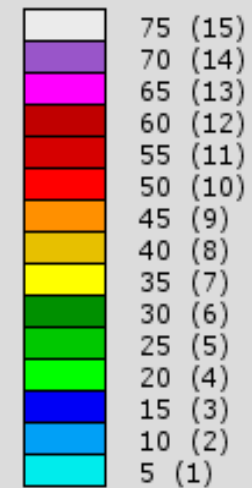
KJAX Reflectivity @ 1704 UTC



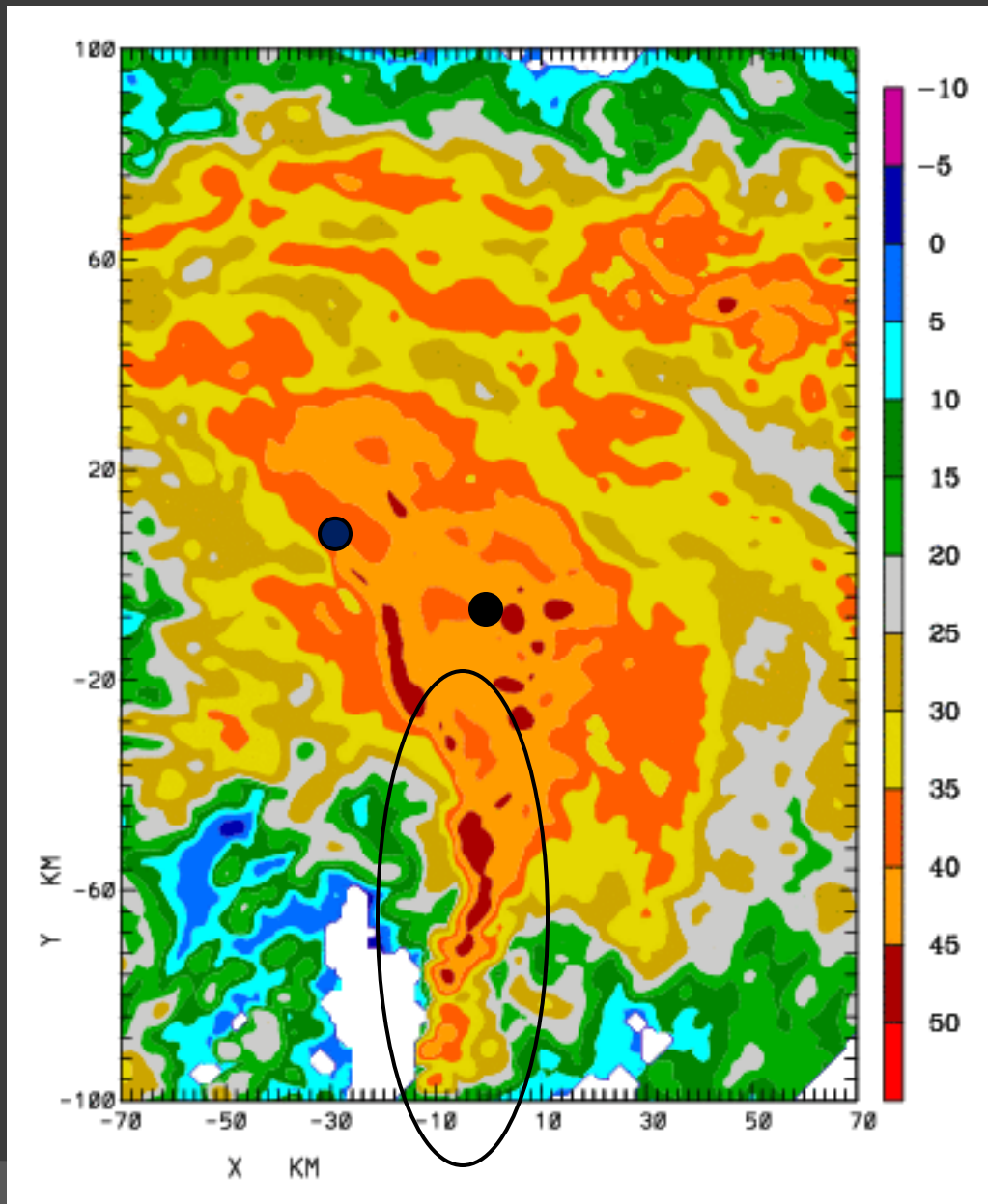
NEXRAD LEVEL-III
BASE REFLECTIVITY
KJAX - JACKSONVILLE, FL
08/22/2008 17:04:13 GMT
LAT: 30/29/05 N
LON: 81/42/07 W
ELEV: 159 FT
MODE/VCP: A / 121

ELEV ANGLE: 0.50 °
MAX: 55 dBZ

Legend: dBZ (Category)



Rainband of Interest



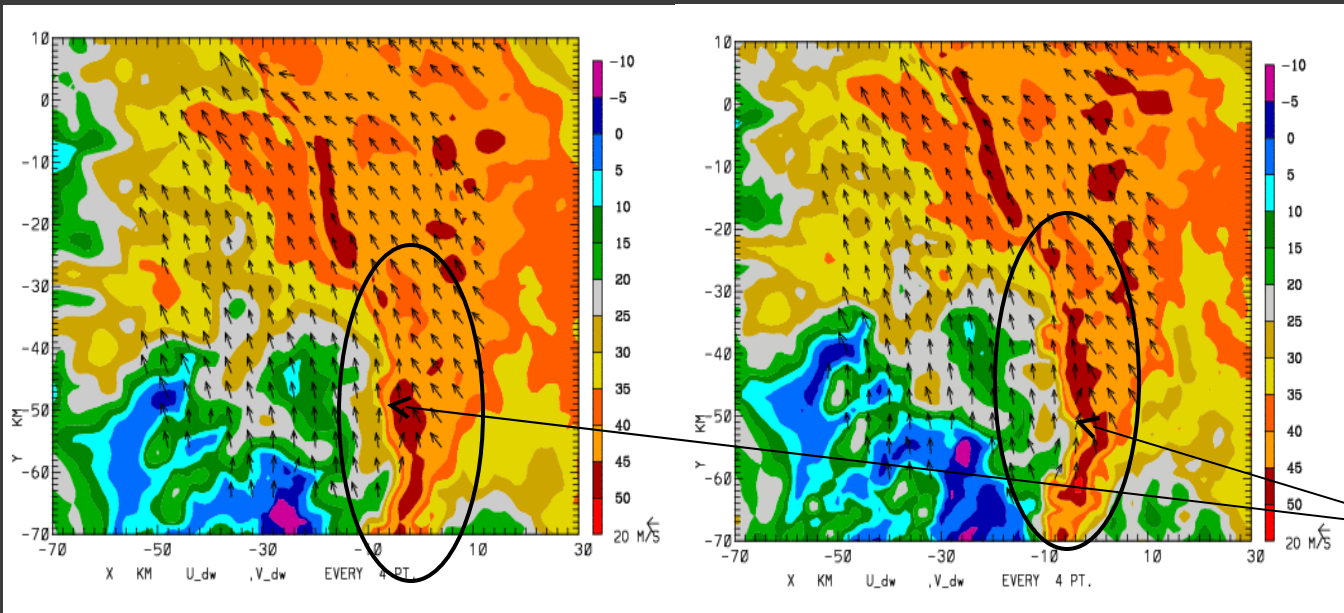
- Reflectivity Field From KJAX @ 1704 UTC (Blue Dot)
- MIPS/MAX Site Denoted By The Black Dot
- Tornadic Rainband Denoted In Circular Area
- Step Through 1712, 1721, and 1748 UTC

Method

Data from both radars are converted to universal format, then to sweepfiles for editing in NCAR's Solo II software. Both the MAX and KJAX Velocity data was folded and had to be corrected.

The data was then edited and gridded to Cartesian space using REORDER. CEDRIC was used to analyze the data and perform dual-Doppler processing to get horizontal and vertical winds, vorticity, convergence, and divergence.

Combined Reflectivity and Wind Vectors (.5km)

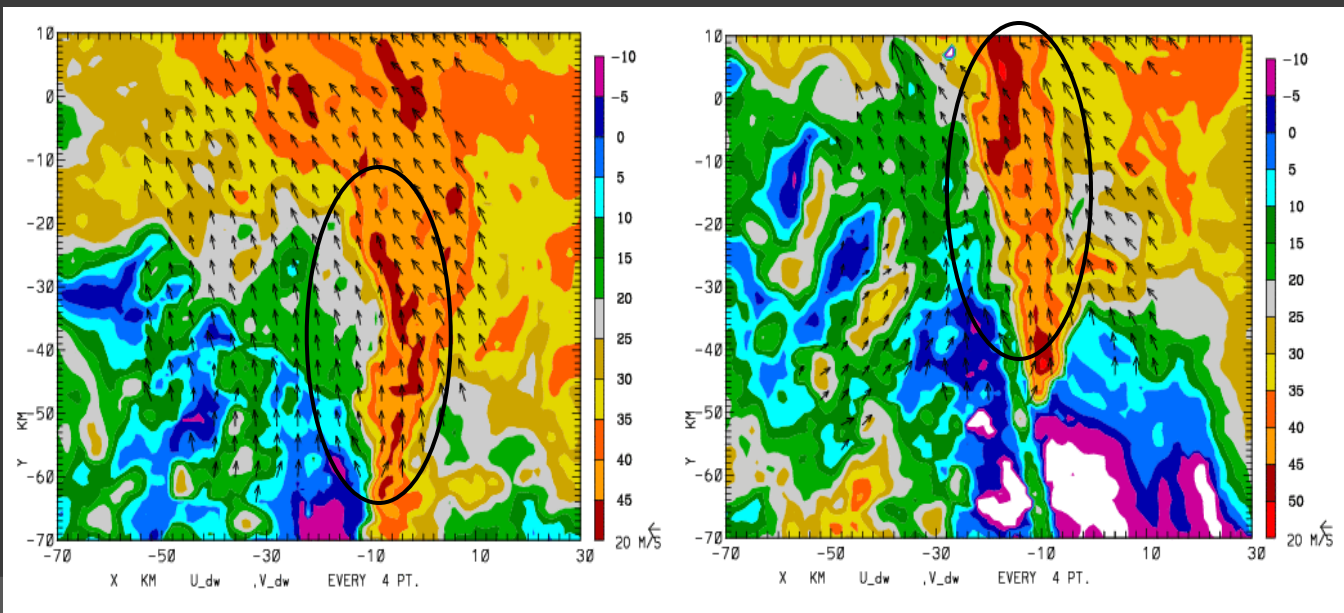


1703 UTC

1712 UTC

Reflectivity (dBZ, colors) with vectors (reference vector depicts 20 ms^{-1}) showing the derived horizontal wind field

Reported Tornado Location at 1715 UTC



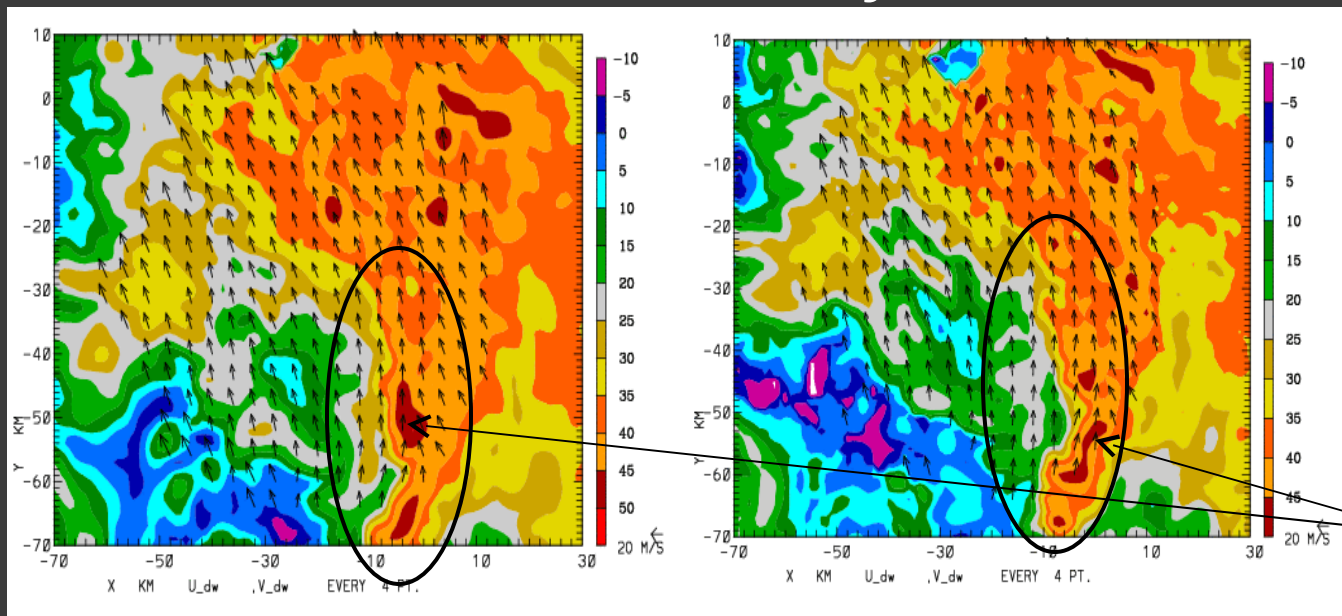
1721 UTC

1748 UTC

Wind Vectors on the order of 40 m/s along the eastern edge of the rainband.

Flow on the eastern side is from the SW while on the Western Side SE

Combined Reflectivity and Wind Vectors (2km)

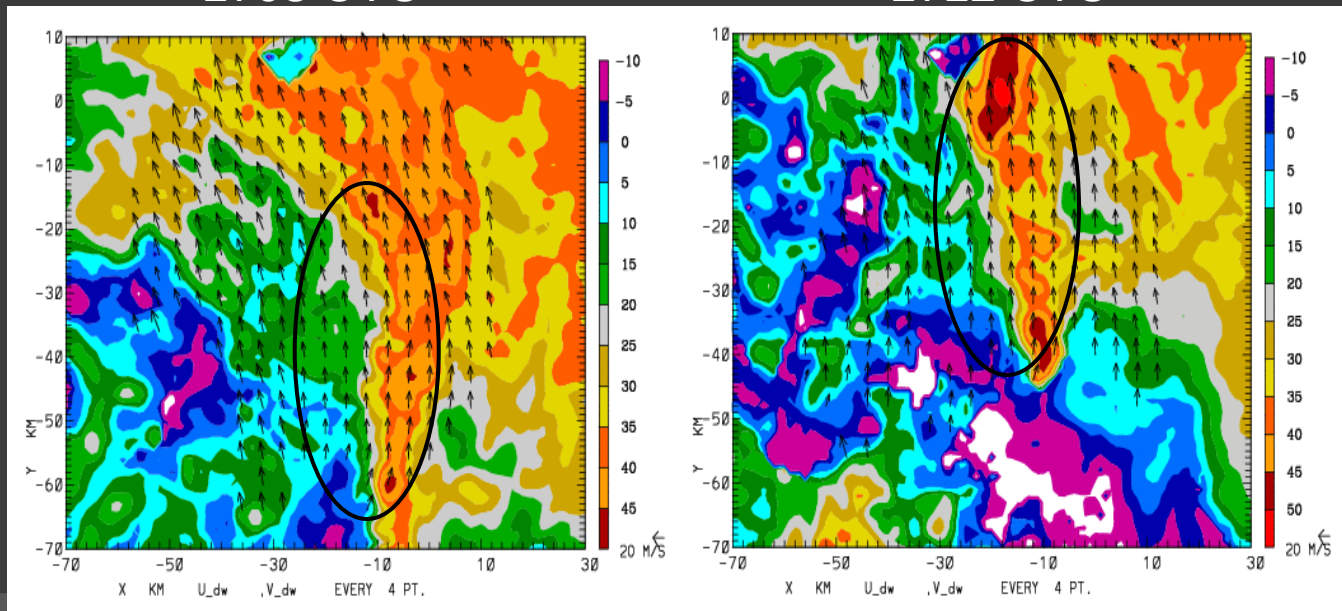


1703 UTC

1712 UTC

Reflectivity (dBZ, colors) with vectors (reference vector depicts 20 ms^{-1}) showing the derived horizontal wind field

Reported Tornado Location at 1715 UTC



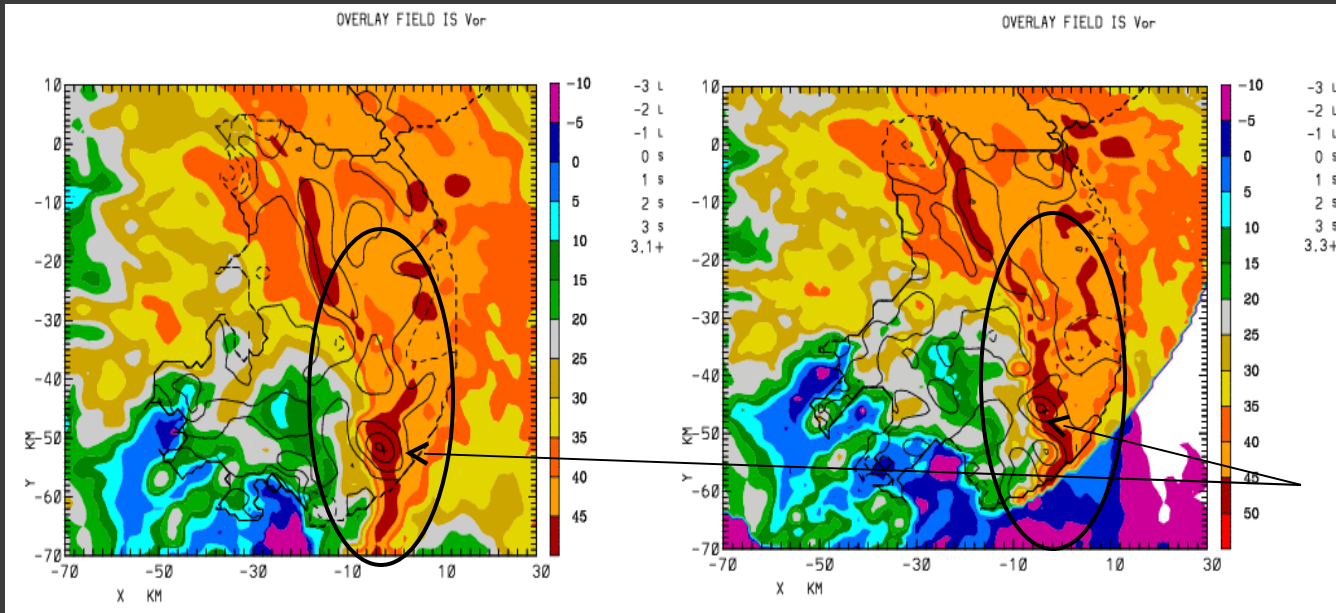
1721 UTC

1748 UTC

Wind Vectors on the order of 35-40 m/s along the western edge of the rainband.

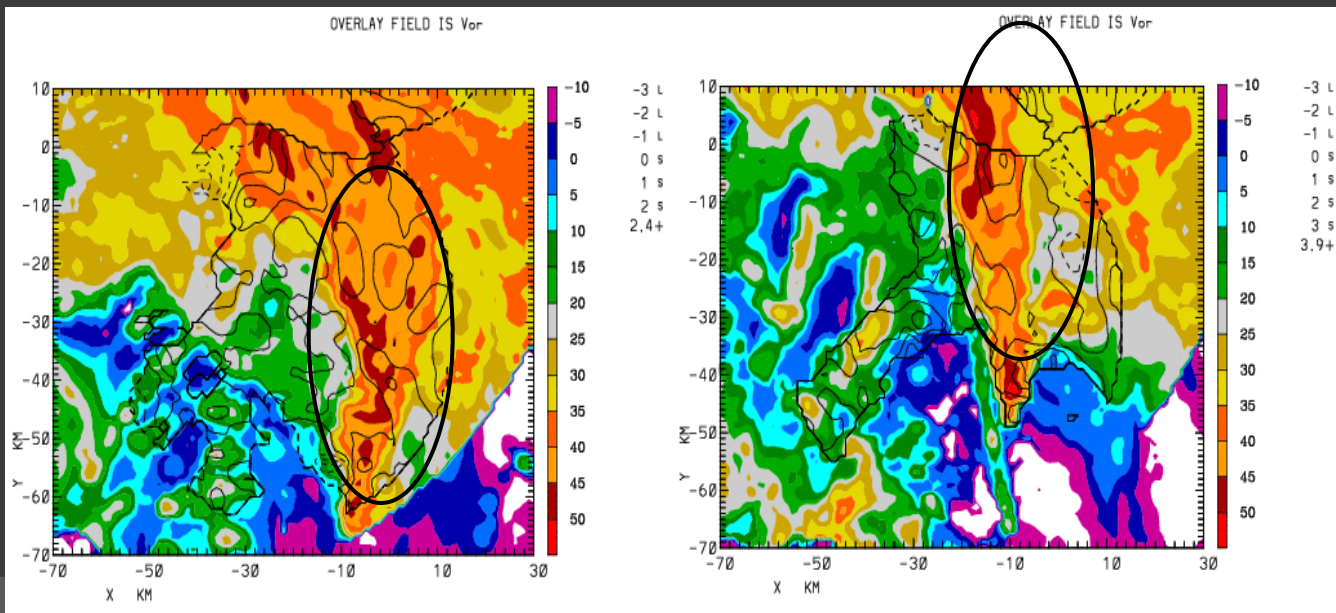
Flow on the eastern side is from the SE while on the Western Side NW (Not As Strong as at .5km)

Combined Reflectivity and Vorticity (.5km)



Maximum vorticity of near the reported tornado is $3.1 \times 10^{-3} \text{ s}^{-1}$ at 1703 and $3.1 \times 10^{-3} \text{ s}^{-1}$ at 1712 UTC

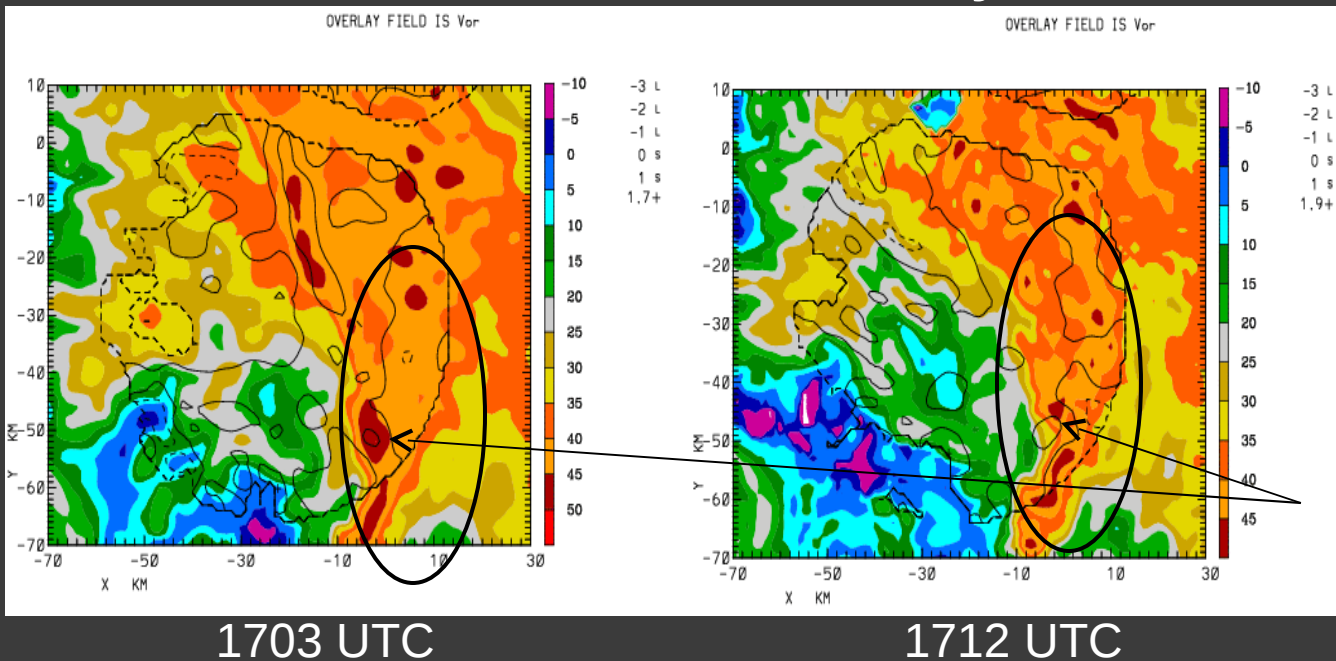
As time progresses the vorticity dissipates from the band.



At 1748 UTC there is no indication of vorticity near the second reported tornado

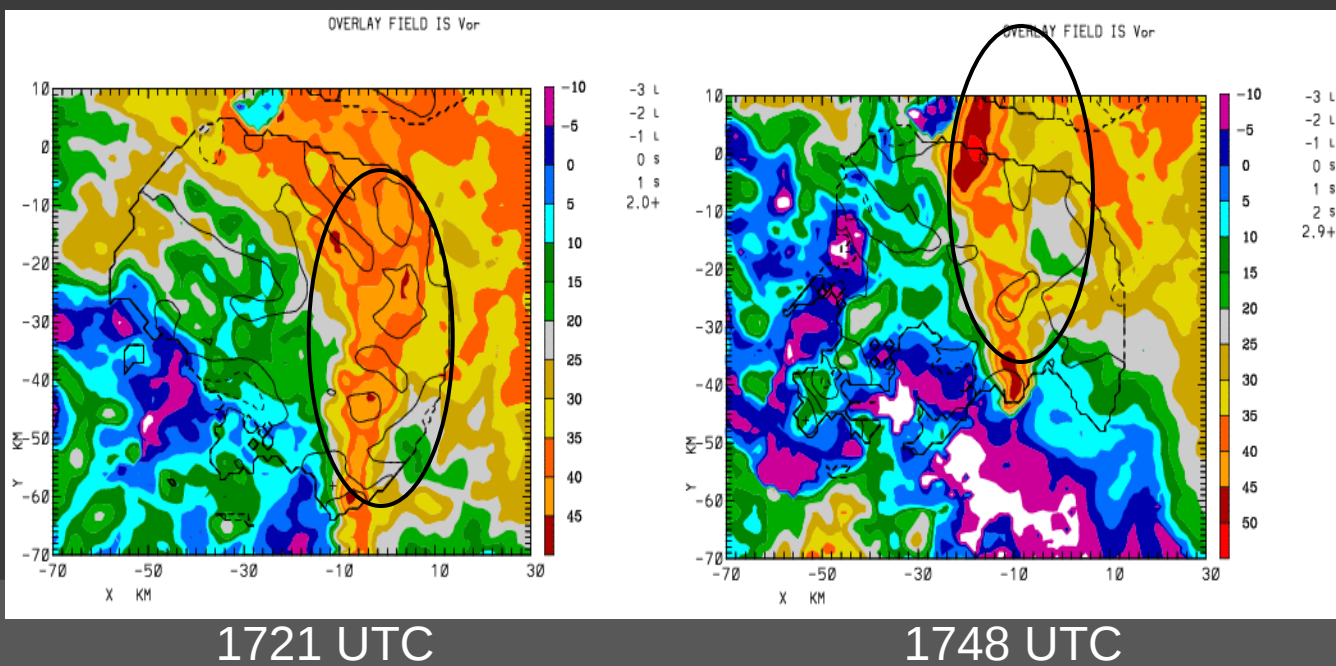
Reflectivity (dBZ, colors)

Combined Reflectivity and Vorticity (2km)



At 2km, Maximum vorticity near the reported tornado is much lower $1.1 \times 10^{-3} \text{ s}^{-1}$ at 1703 and $.8 \times 10^{-3} \text{ s}^{-1}$ at 1712 UTC

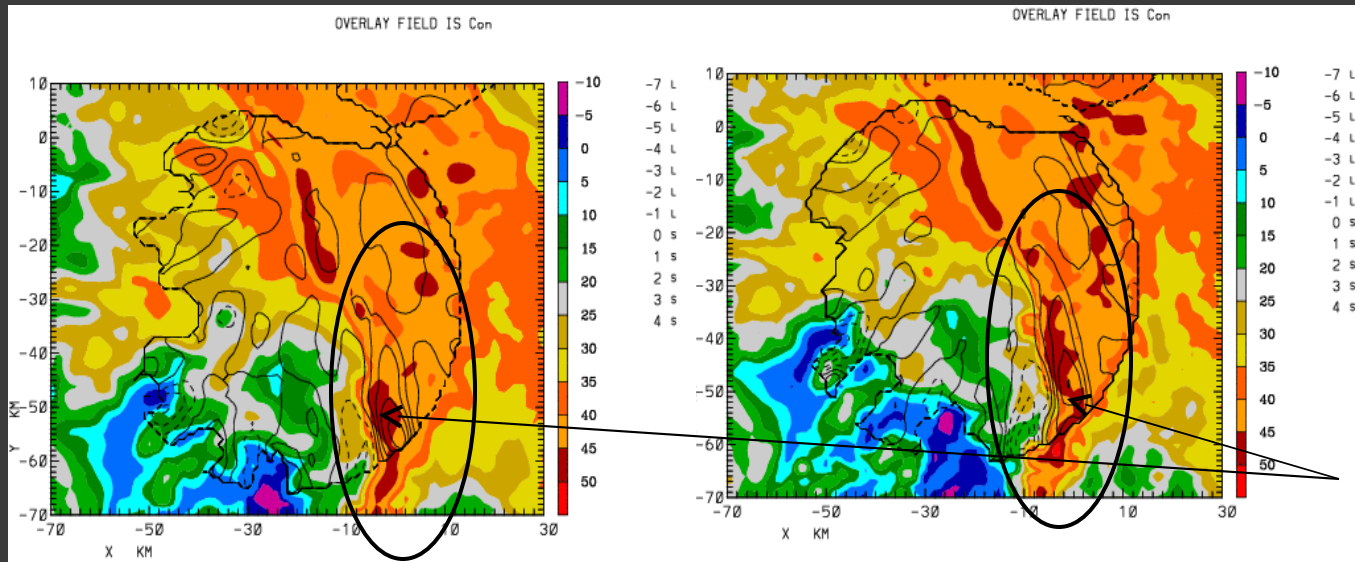
As time progresses the vorticity dissipates from the band.



At 1748 UTC there is no indication of vorticity near the second reported tornado at this level as well

Reflectivity (dBZ, colors)

Reflectivity & Convergence (.5km)



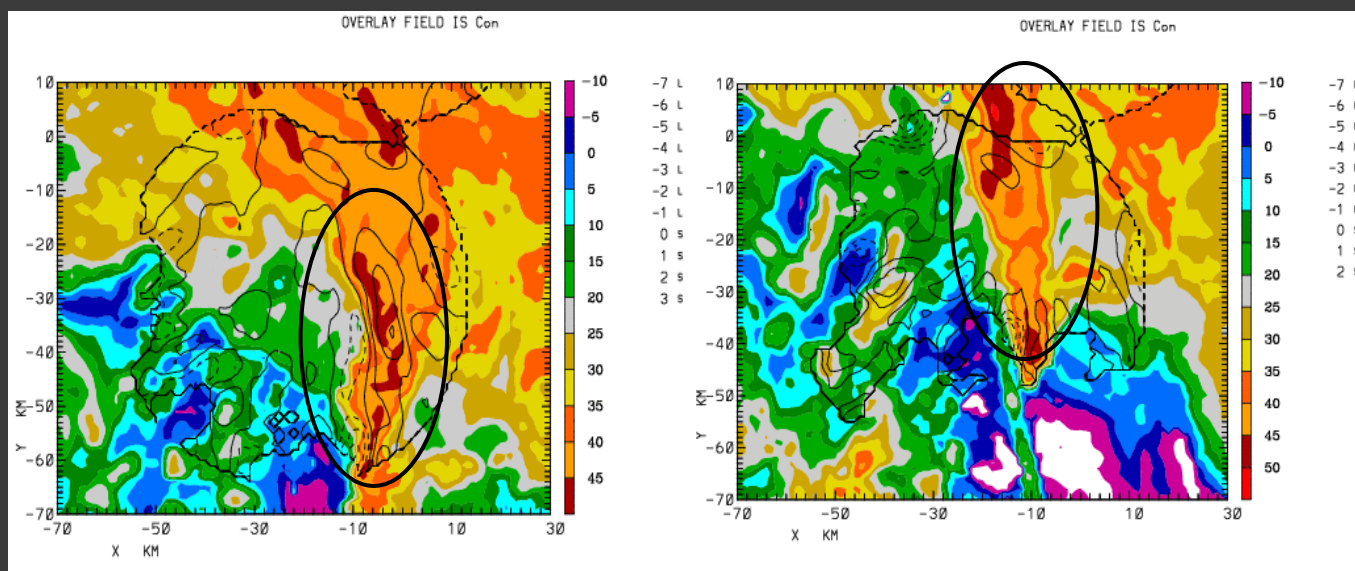
1703 UTC

1712 UTC

Reflectivity and Convergence (contours, s-1) at 0.5 km AGL.

Convergence is strongly with a peak of 6.7 s-1

This trend continues for 1712, but is weaker, Convergence at 5.78 s-1.

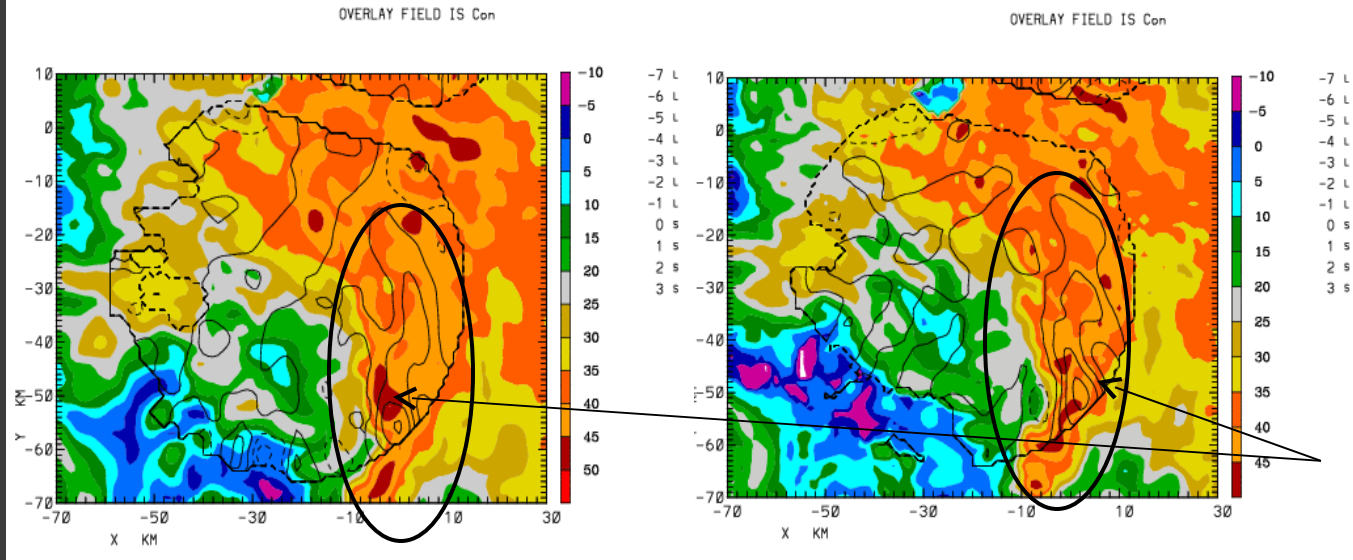


1721 UTC

1748 UTC

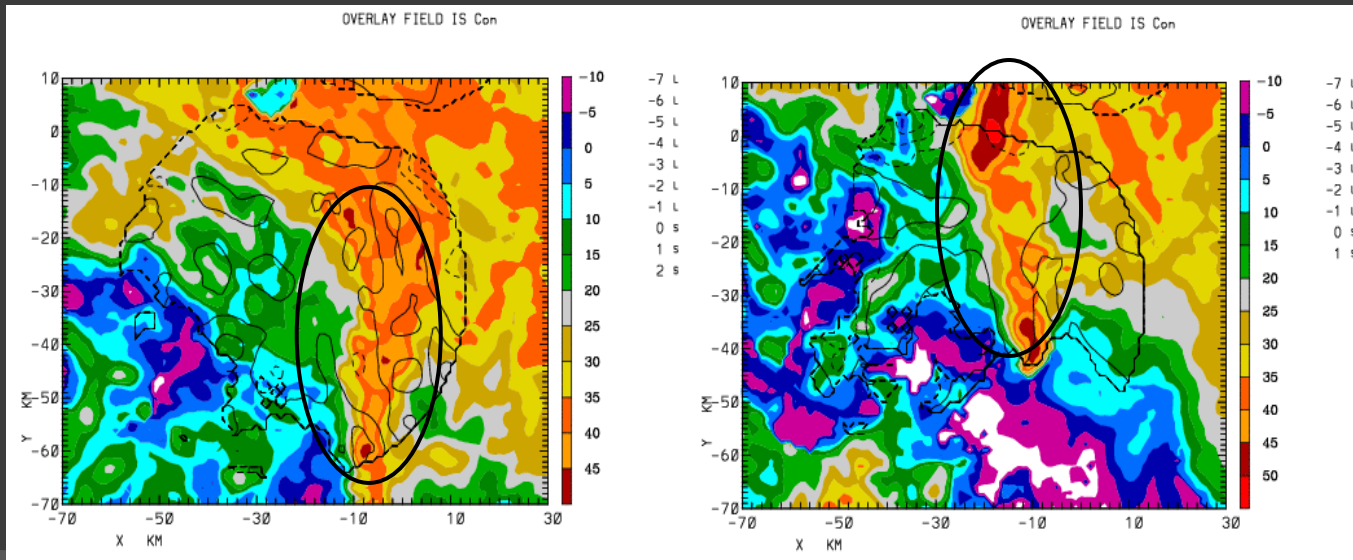
At 1721 and 1748 the convergence has all but dissipated from the band.

Reflectivity & Convergence (2km)



1703 UTC

1712 UTC



1721 UTC

1748 UTC

Reflectivity and Convergence (contours, s-1) at 0.5 km AGL.

Near the vorticity max and reported tornado location Convergence is strongly with a peak of 6.2 s-1 at this level

This trend continues for 1712, but is weaker, Convergence at 4.98 s-1.

At 1721 and 1748 the convergence has all but dissipated from the band.

Summary

- TS Fay was a long lived storm that produced a tremendous amount of rainfall across Florida and the SE.
- Multiple tornadoes were reported across the region, with two of those in our southern dual-Doppler Lobe.
- By performing a dual-Doppler analysis it was shown that the area near the confirmed report did have positive vorticity, strong convergence.
- The tornado, however could not be seen in the velocity data of either the MAX or KJAX. The MAX was attenuated during this passage, which could have had an impact on detection.
- It appears in this preliminary analysis that the proximity to the coastline may have played a role in the formation of a small tornado along this rainband (as the line moved away vorticity decreased)

Future Work

- Analyze RHI information obtained by MAX
- Look at vertical motion using the MAX Vertical Scans and 915 MHz Profiler
- Bring in multiple other instruments that were deployed at the site (MPR, Ceilometer, MMS, M3V, Disdrometer)
- Fully analyze all volumes and sector scans during this period, before it, and after it

Questions?

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<http://vortex.nsstc.uah.edu/mips>