

Time Evolution of Rotational Velocity in Supercells: IBW Implications

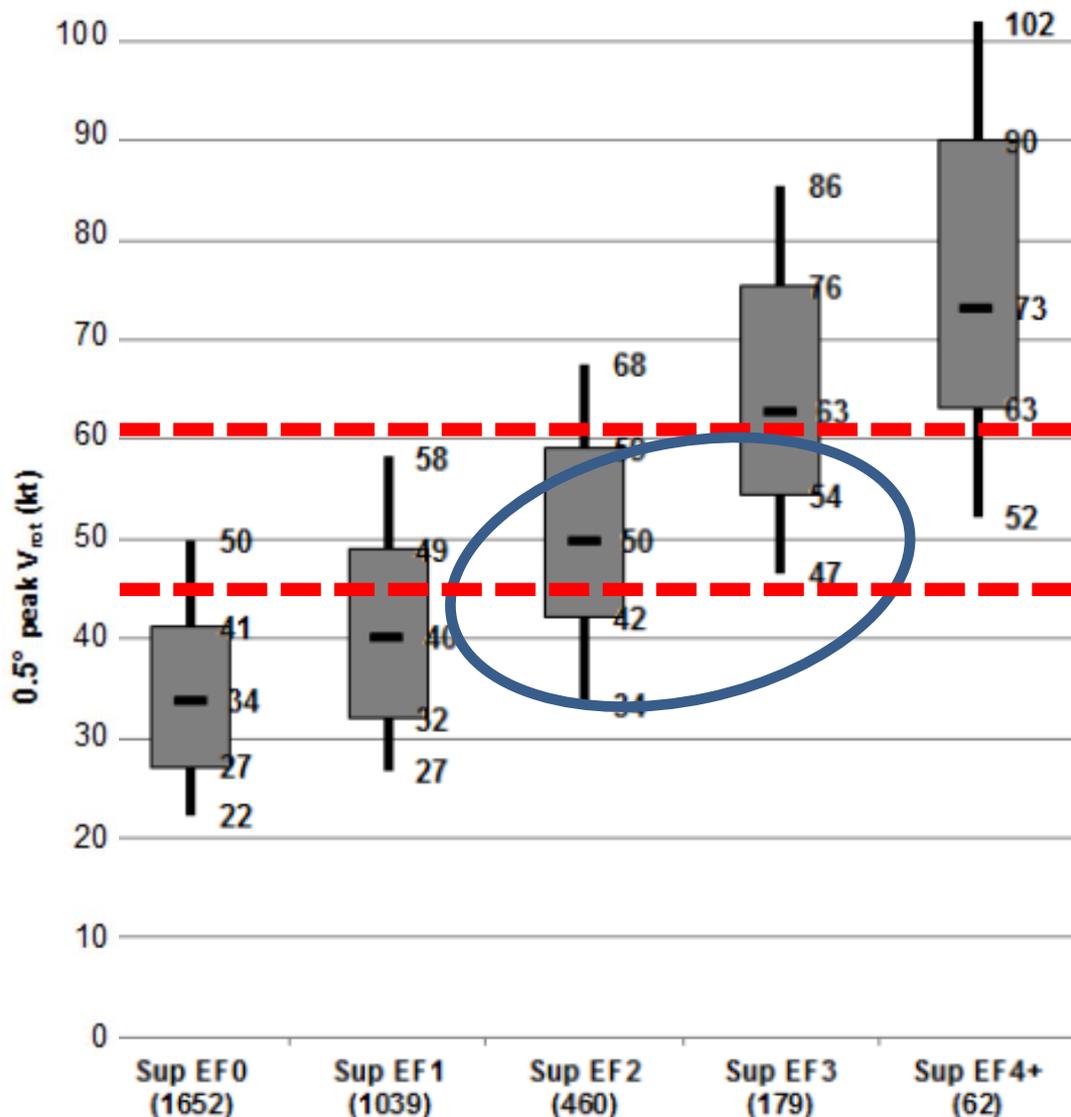
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Richard Wagenmaker
NOAA/NWS Detroit/Pontiac, MI



Trent Frey, Dr. Frank Marsik

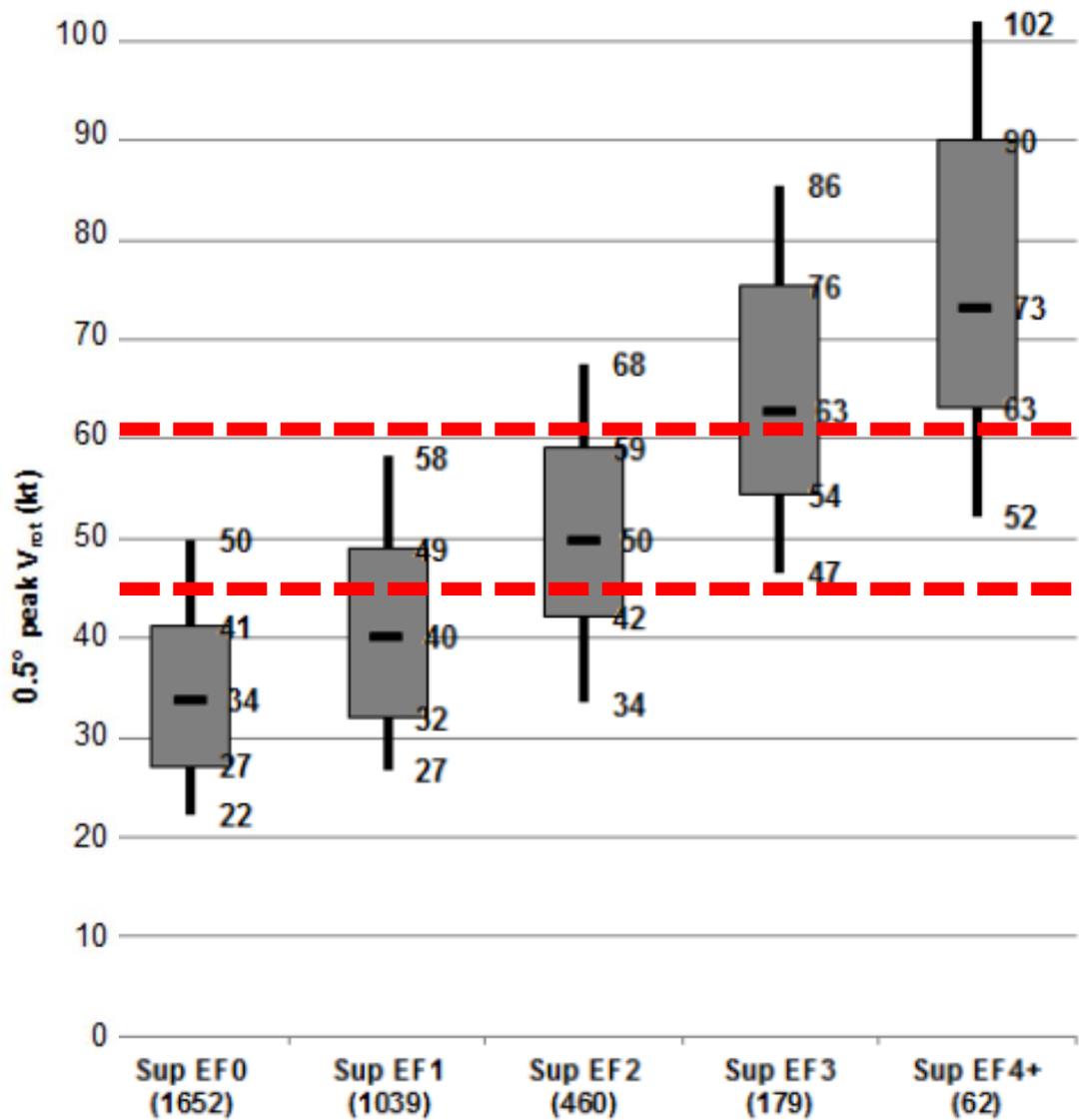
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Motivation: Prior Work



- Smith et al. (2014), Wagenmaker and Mann (2014)
- Recorded peak 0.5° Vrot, peak EF scale for all tornadoes 2009–2013
- Vrot = 60 kt is where EF2+ is most probable outcome
- However, a significant amount of EF2/3 are missed at 60 kt
- Normalizing/filtering dataset results in new threshold of 45 kt where EF2+ is most probable

Motivation: Prior Work



**IBW Considerable
Tag Strongly
Recommended**

**IBW Considerable
Tag Possible**

Smith et al. (2014),
Wagenmaker and Mann (2014)



Motivation: Prior Work



- We seek to build upon Smith et al. 2014 by:
 - Analyzing time evolution of Vrot and tornado damage for several significant (EF2+) supercell tornadoes
 - Interrogating 4 lowest-elevation scans
 - Including a sampling of null cases
 - Placing results in IBW context

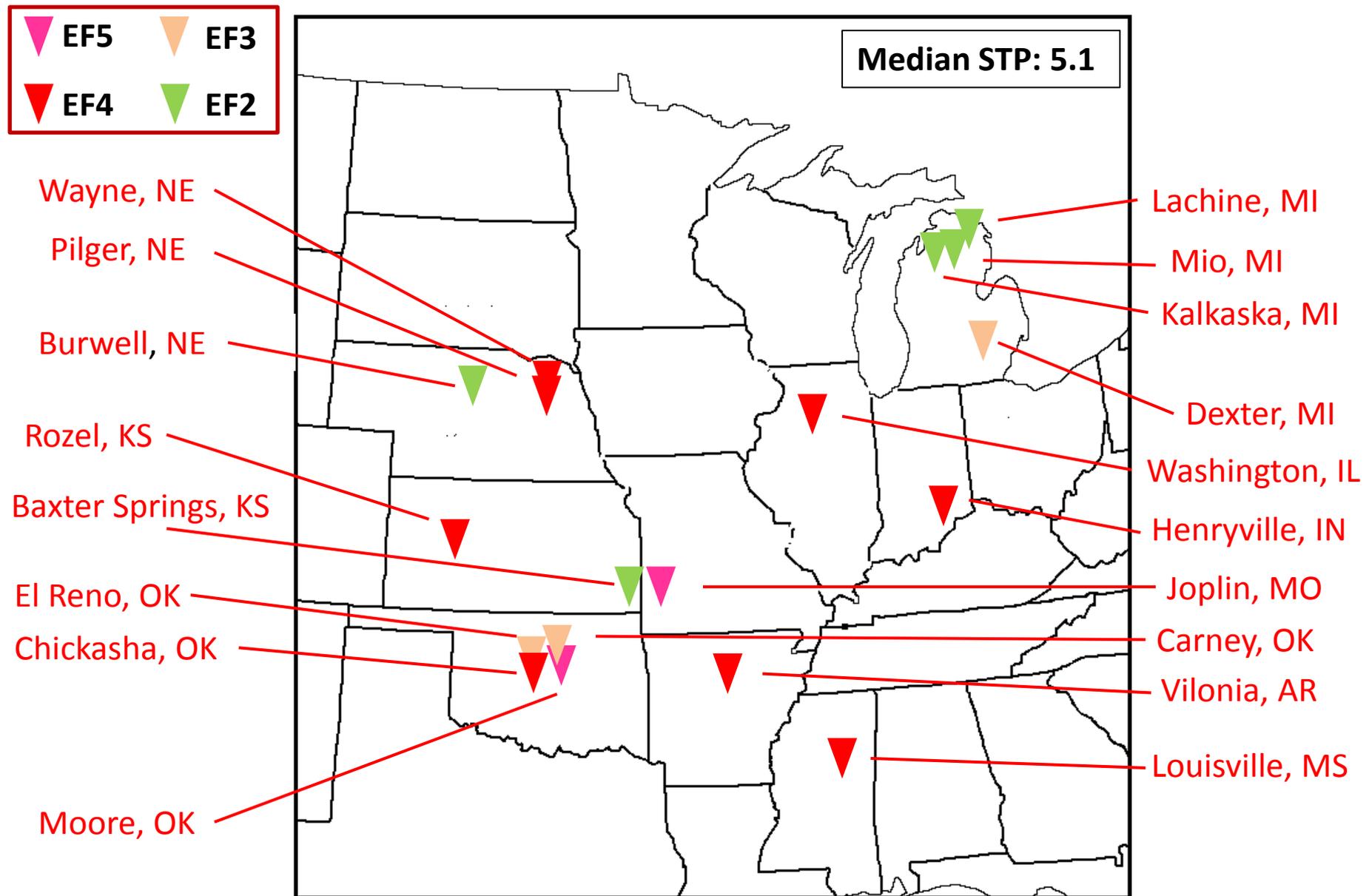


Data and Methods

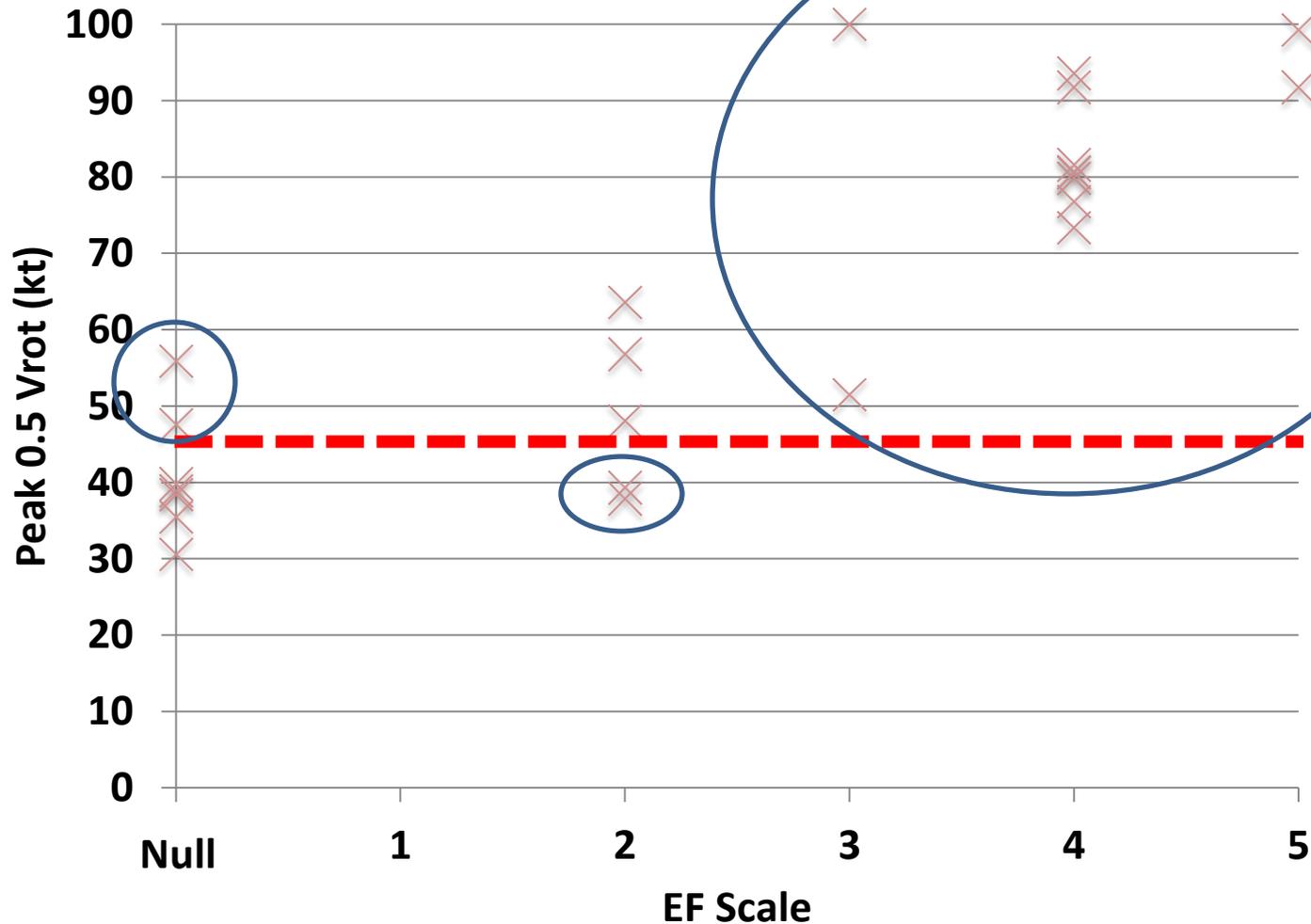


- Analyzed 18 EF2+ supercell tornadoes with high societal impact or local interest
 - Calculated Vrot at 4 lowest scans using GR2Analyst
 - Time evolution of tornado damage obtained from DAT
- Analyzed 8 null cases (paired with tornado cases)
 - Persistent mesocyclones in supercells that did not produce a tornado
 - Occurred in similar synoptic environment to tornado cases

Data and Methods – Cases Examined

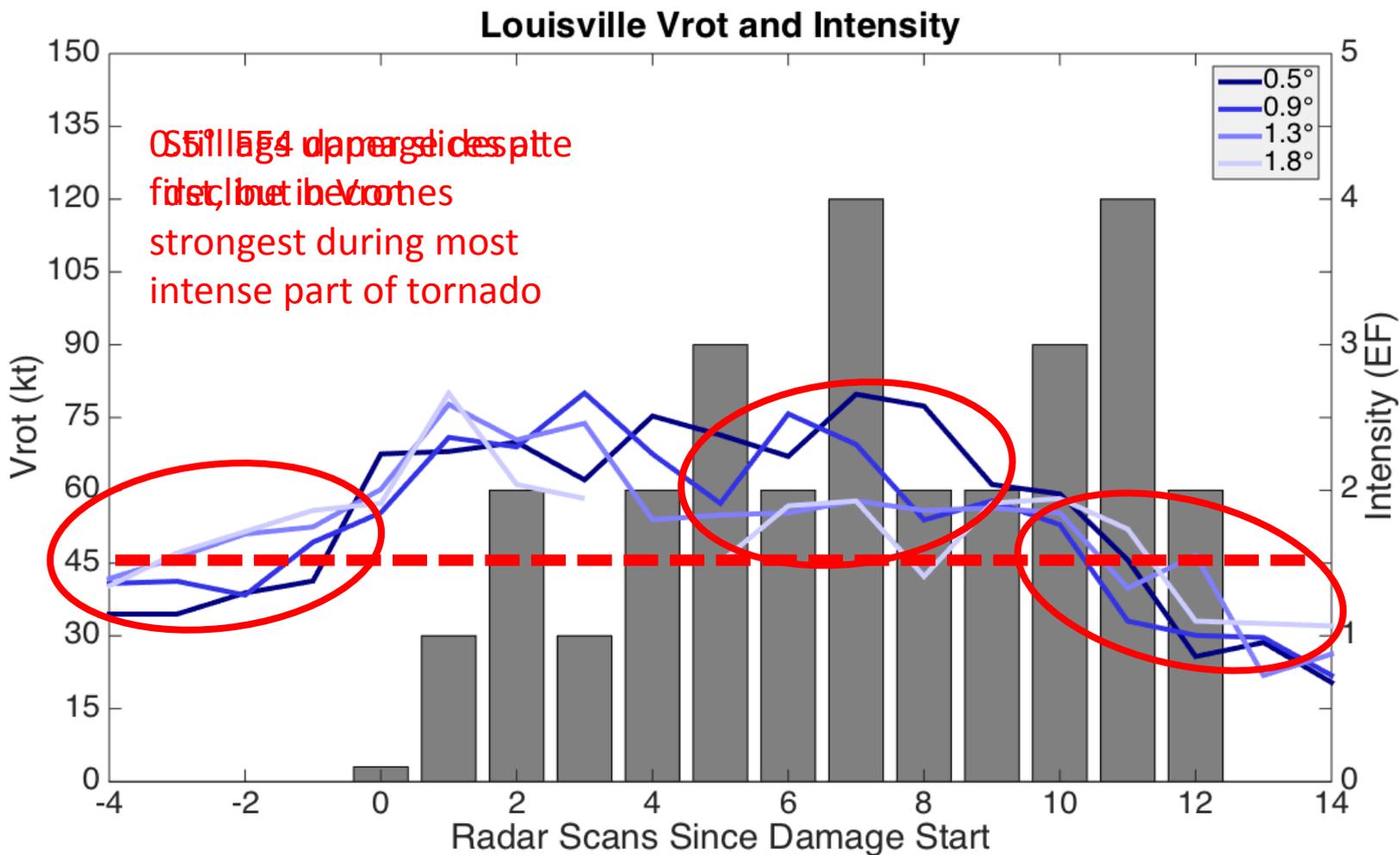


Peak 0.5 Vrot vs EF Scale

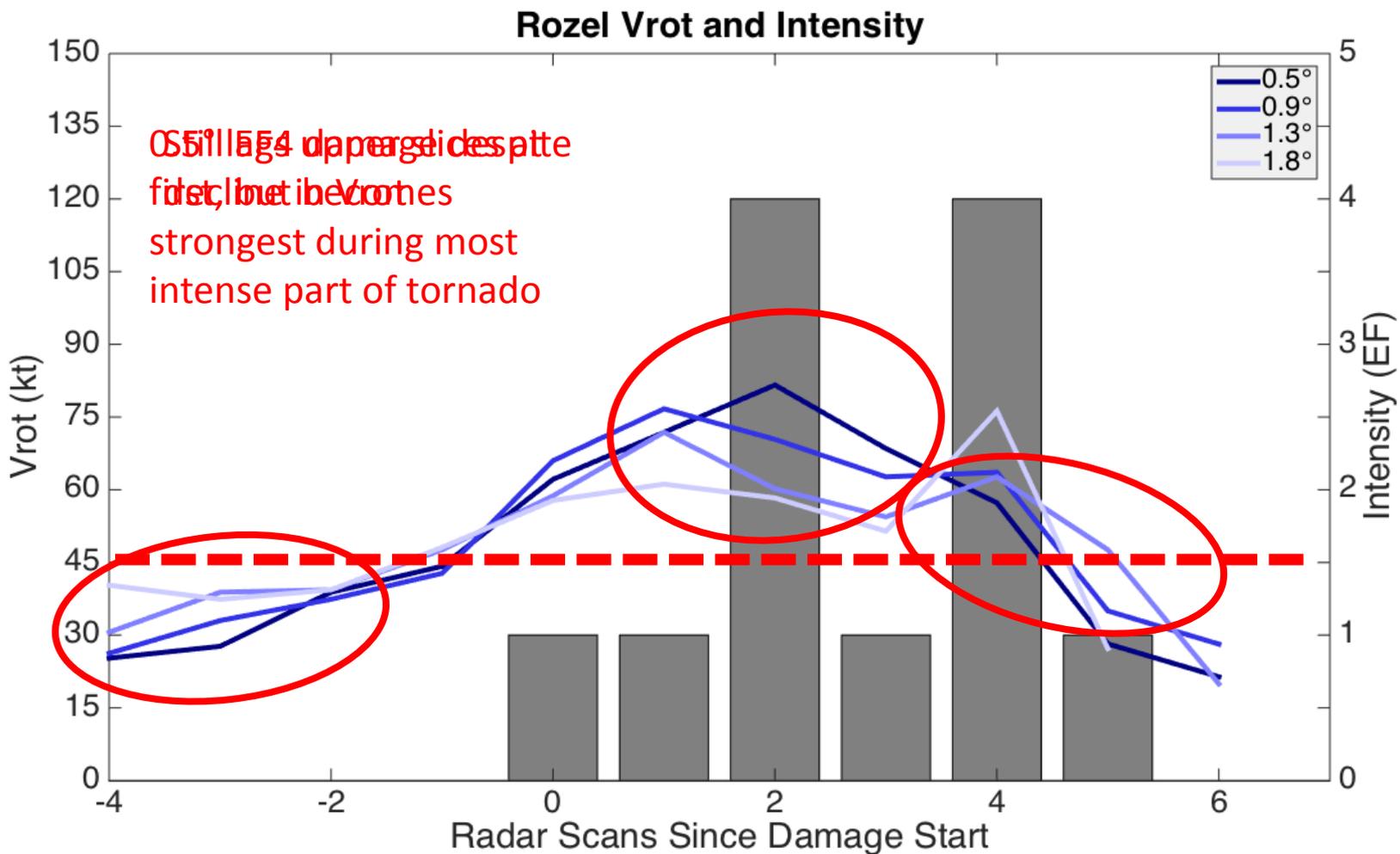


- 2/18 Tor < 45 kt
- 2/8 Null > 45 kt
- 13/13 EF3+ > 45 kt

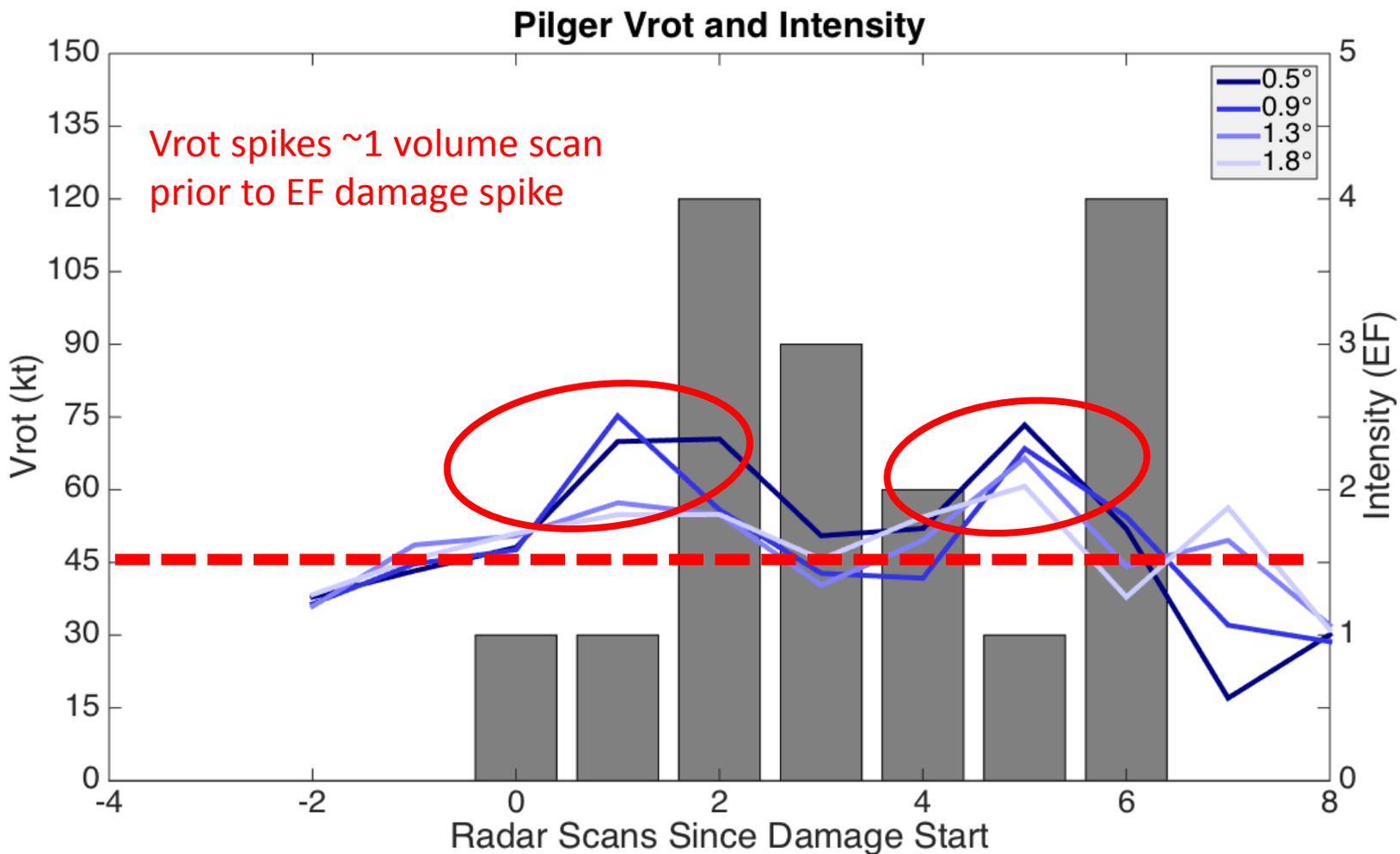
28 April 2014, Louisville, MS EF4



18 May 2013, Rozel, KS EF4



16 June 2014, Pilger, NE EF4



Results – Peak Vrot at Each Slice

When did peak Vrot occur compared with other angles?

	0.5°	0.9°	1.3°	1.8°
Joplin, MO	?	?	?	?
Moore, OK	2nd	2nd	2nd	1st
Chickasha, OK	2nd	1st	2nd	2nd
Henryville, IN	1st	2nd	1st	1st
Rozel, KS	2nd	1st	1st	3rd
Wayne, NE	1st	2nd	2nd	3rd
Washington, IL	3rd	4th	1st	2nd
Vilonia, AR	2nd	2nd	1st	3rd
Louisville, MS	3rd	2nd	1st	1st
Pilger, NE	2nd	1st	2nd	2nd
Dexter, MI	2nd	1st	3rd	1st
Edmond/Carney, OK	1st	2nd	1st	1st
El Reno, OK	2nd	2nd	1st	2nd
Lachine, MI	2nd	2nd	1st	1st
Kalkaska, MI	2nd	1 st	1st	1st
Mio, MI	3rd	3 rd	2nd	1st
Baxter Springs, KS	2nd	2nd	2nd	1st
Burwell, NE	3rd	2nd	4th	1st

- 76% of events had 1.3° and/or 1.8° peak before 0.5° peak

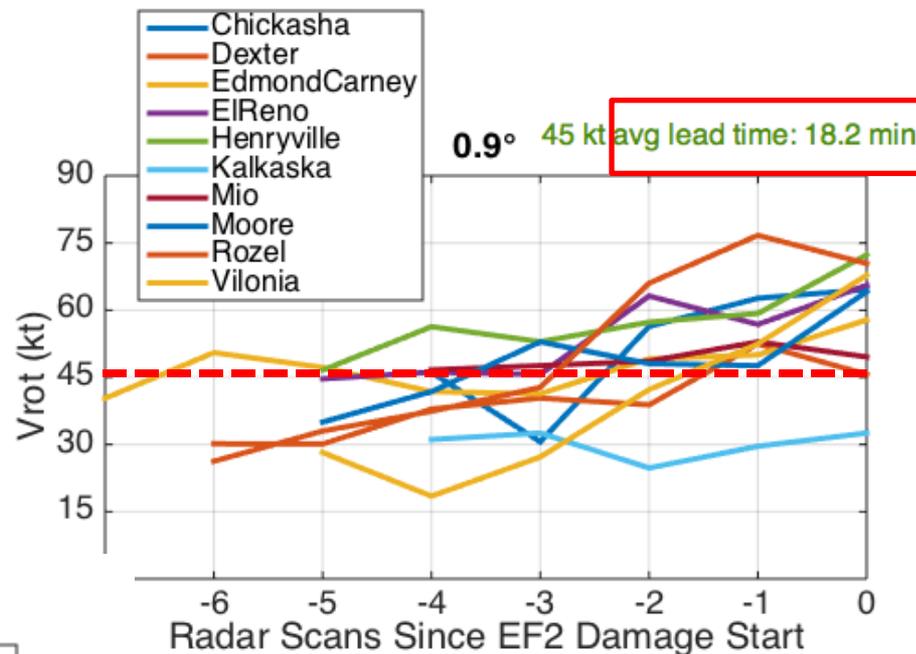
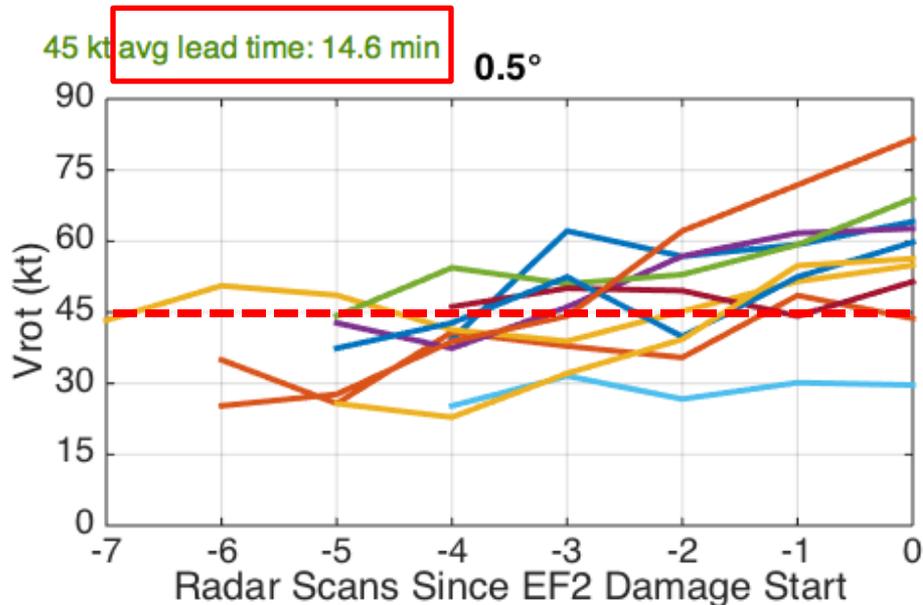
Peak Vrot vs Peak Damage Time Comparison

When did peak Vrot occur relative to peak EF scale?

	0.5°	0.9°	1.3°	1.8°
Joplin, MO	during	?	?	?
Moore, OK	before	before	before	before
Chickasha, OK	after	during	after	after
Henryville, IN	during	after	during	during
Rozel, KS	during	before	before	during
Wayne, NE	before	before	before	before
Washington, IL	during	after	during	after
Vilonia, AR	during	during	before	during
Louisville, MS	during	before	before	before
Pilger, NE	during	before	before	during
Dexter, MI	before	before	before	before
Edmond/Carney, OK	before	during	before	before
El Reno, OK	during	during	during	during
Lachine, MI	before	before	before	before
Kalkaska, MI	after	during	during	during
Mio, MI	during	during	before	before
Baxter Springs, KS	during	during	during	during
Burwell, NE	after	during	after	after

Results – Lead Time to EF2 Damage

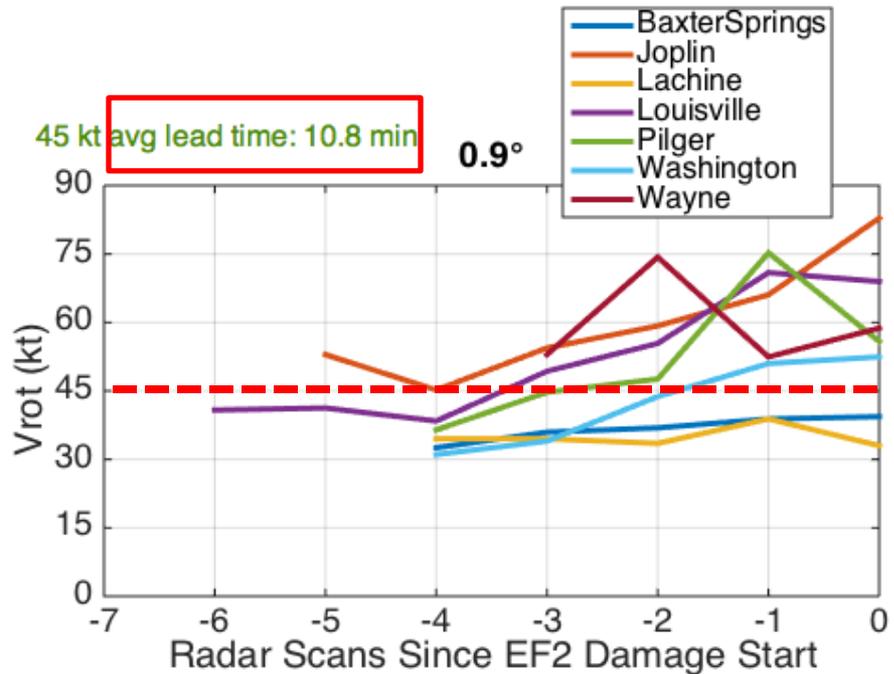
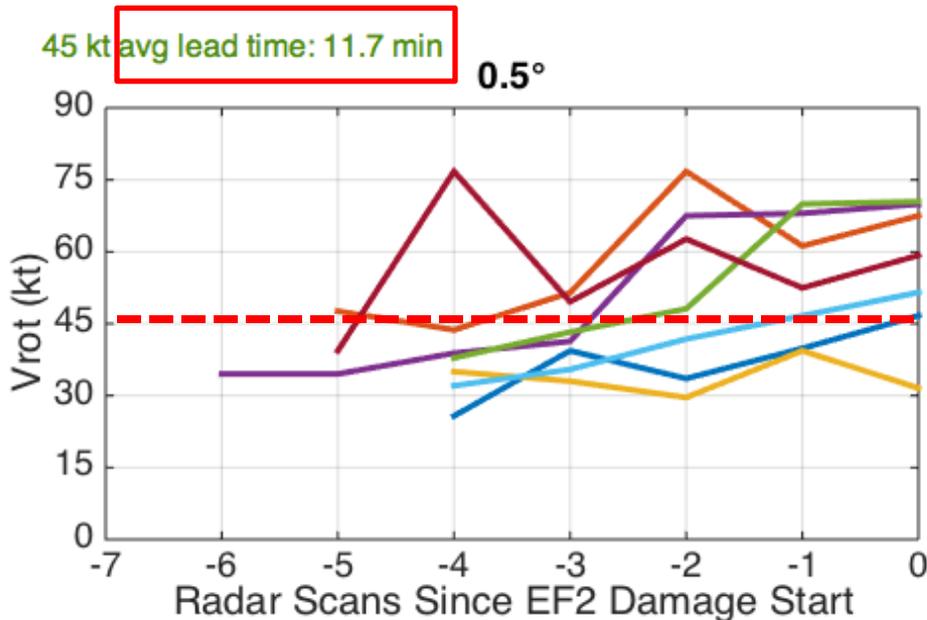
**Vrot prior to beginning of EF2 damage:
0.5° 0–2900' ARL**



- 9/9 tornadoes that reached 45 kt threshold did so ≥ 1 scan prior to EF2 damage

Results – Lead Time to EF2 Damage

**Vrot prior to beginning of EF2 damage:
0.5° 3000–5900' ARL**

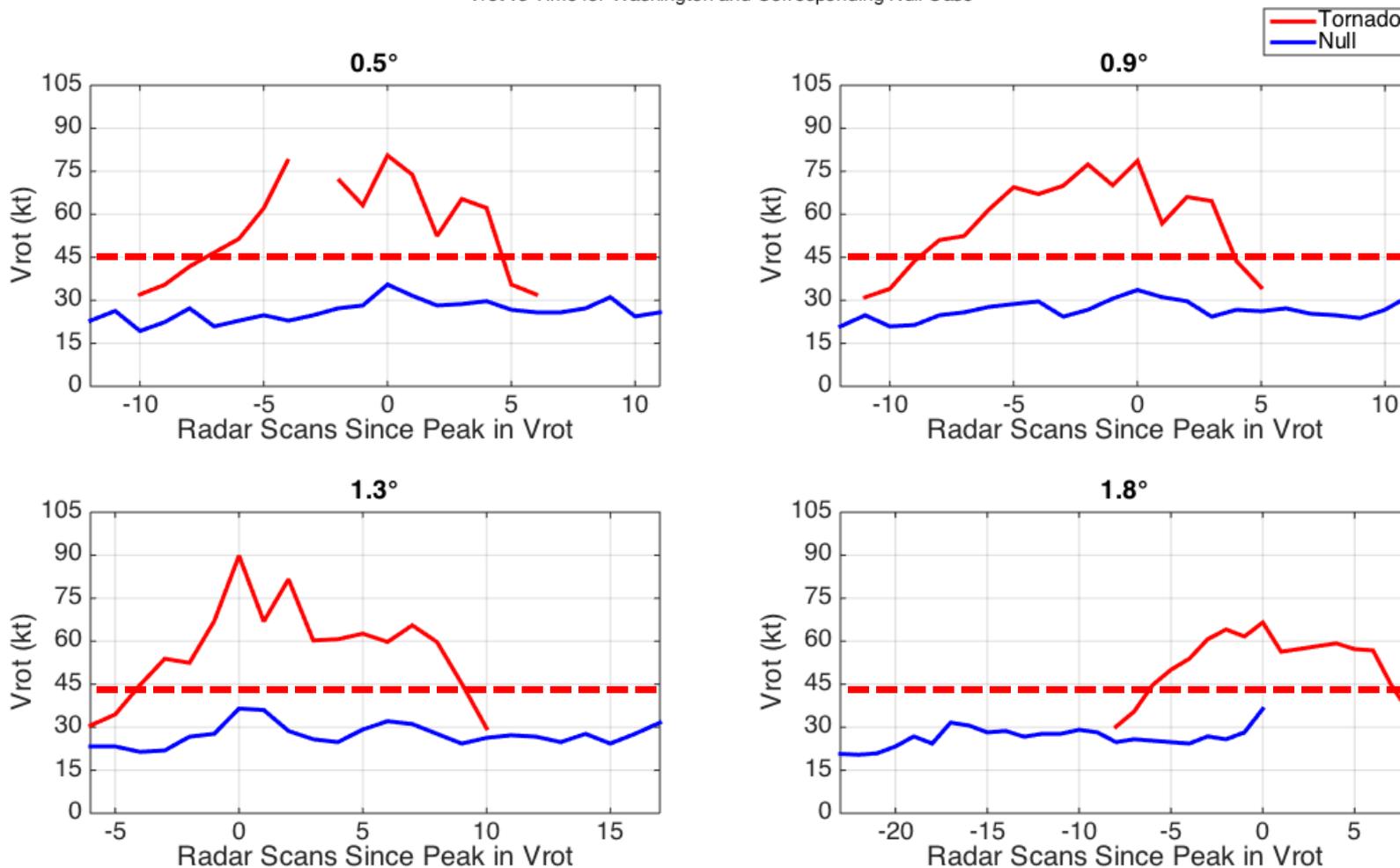


- 5/6 tornadoes that reached 45 kt threshold did so ≥ 1 scan prior to EF2 damage

Null/Tornado Comparison

17 November 2013, Washington, IL EF4 vs. N. IL/S. WI Null

Vrot vs Time for Washington and Corresponding Null Case

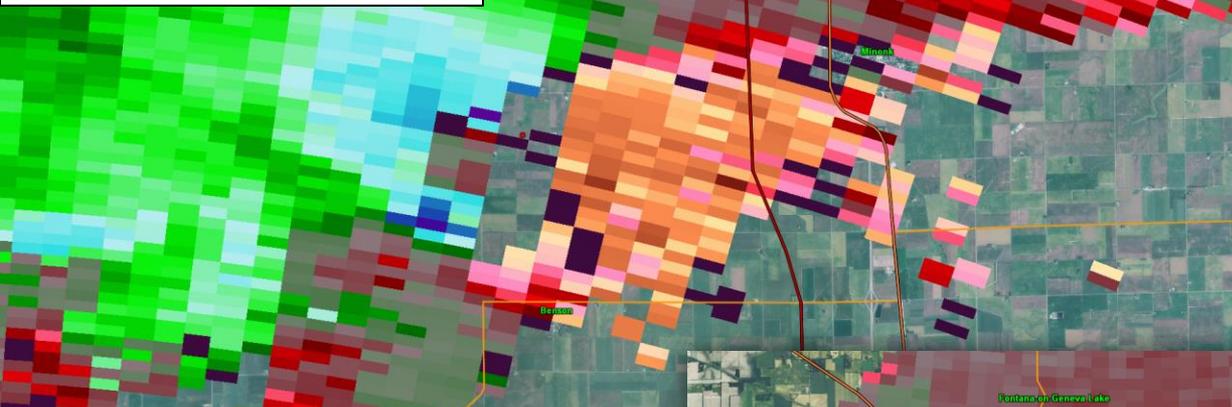


Null/Tornado Comparison

Washington EF4

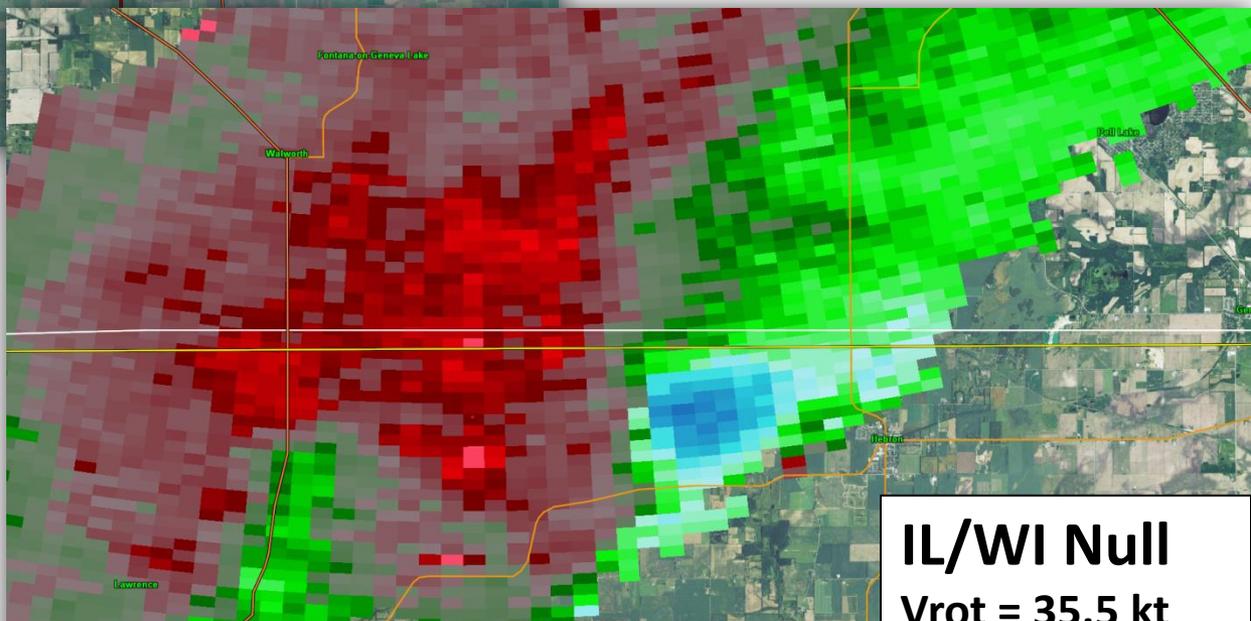
Vrot = 80.6 kt

Diam = 1.2 nm



Height = 3700' ARL

- Broader, convergent rotation in null case



Height = 2100' ARL

IL/WI Null

Vrot = 35.5 kt

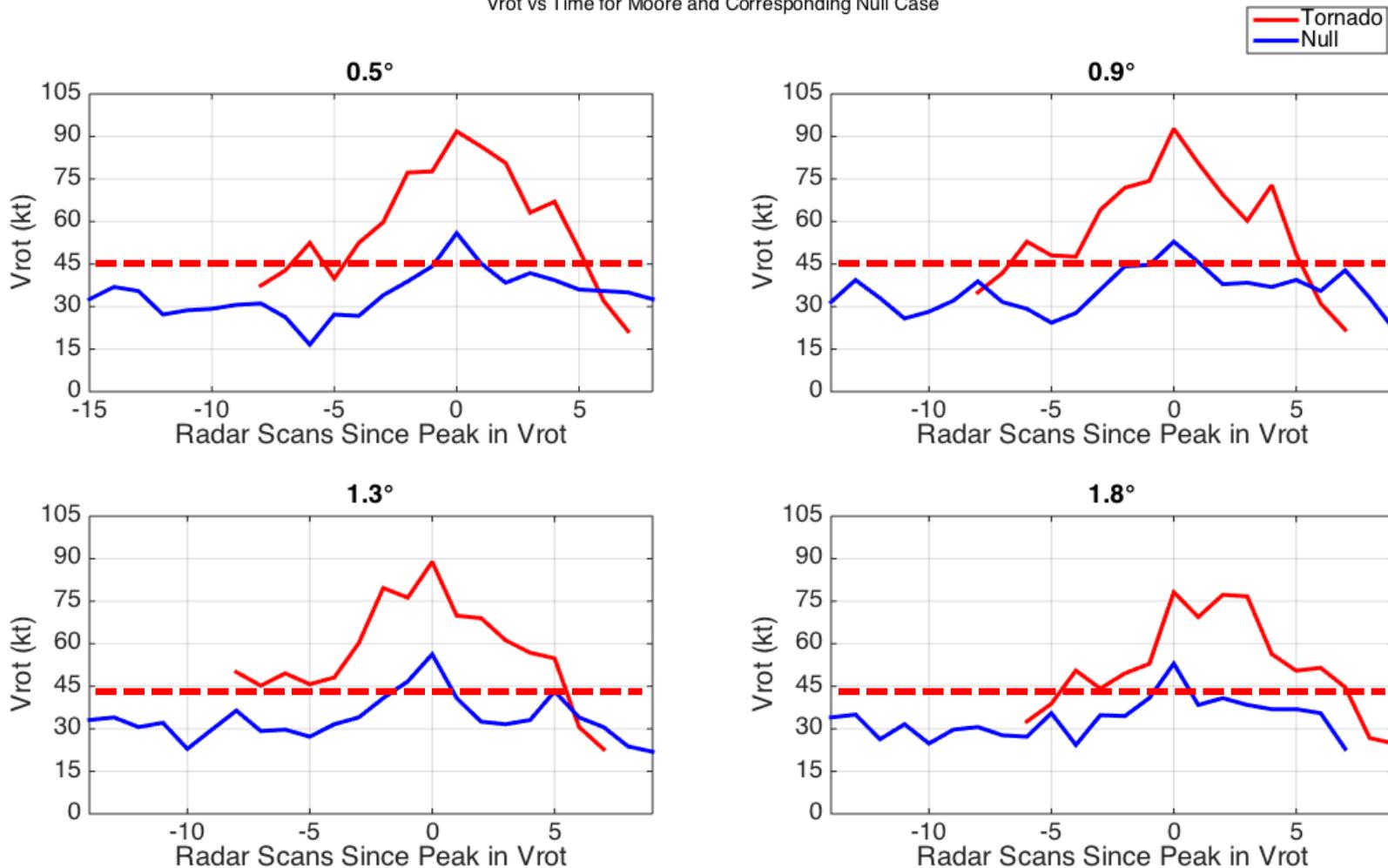
Diam = 2.6 nm

17 Nov 2013
0.5° Peak Vrot
Comparison

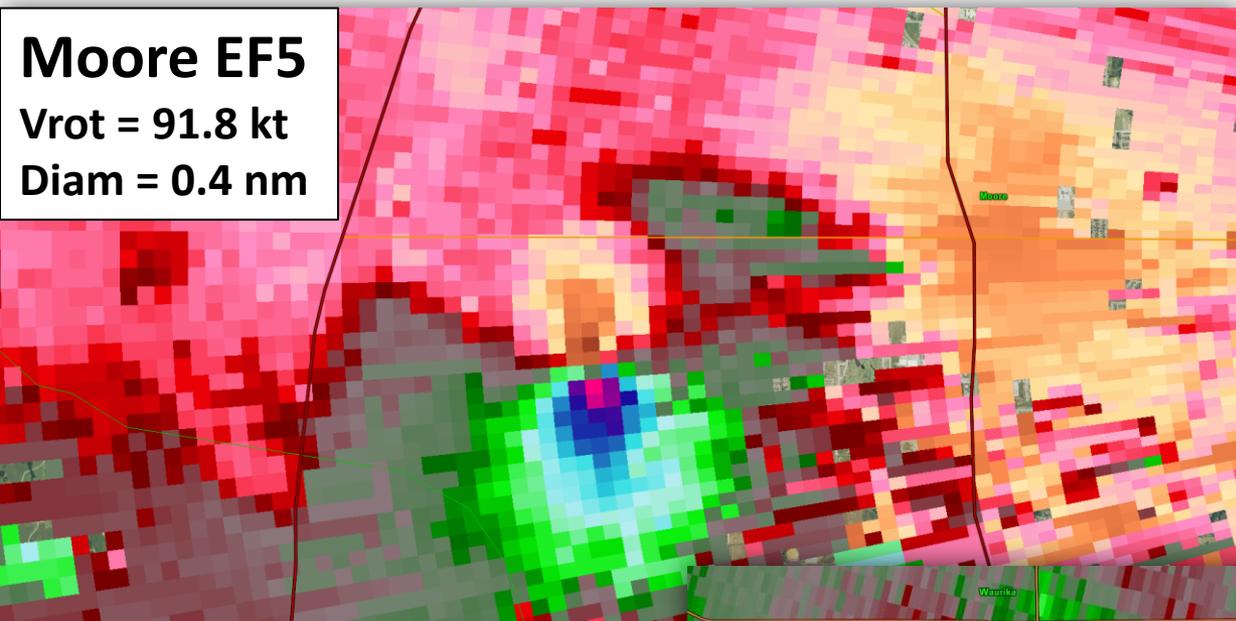
Null/Tornado Comparison

20 May 2013, Moore, OK EF5 vs. N. TX/S. OK Null

Vrot vs Time for Moore and Corresponding Null Case



Null/Tornado Comparison

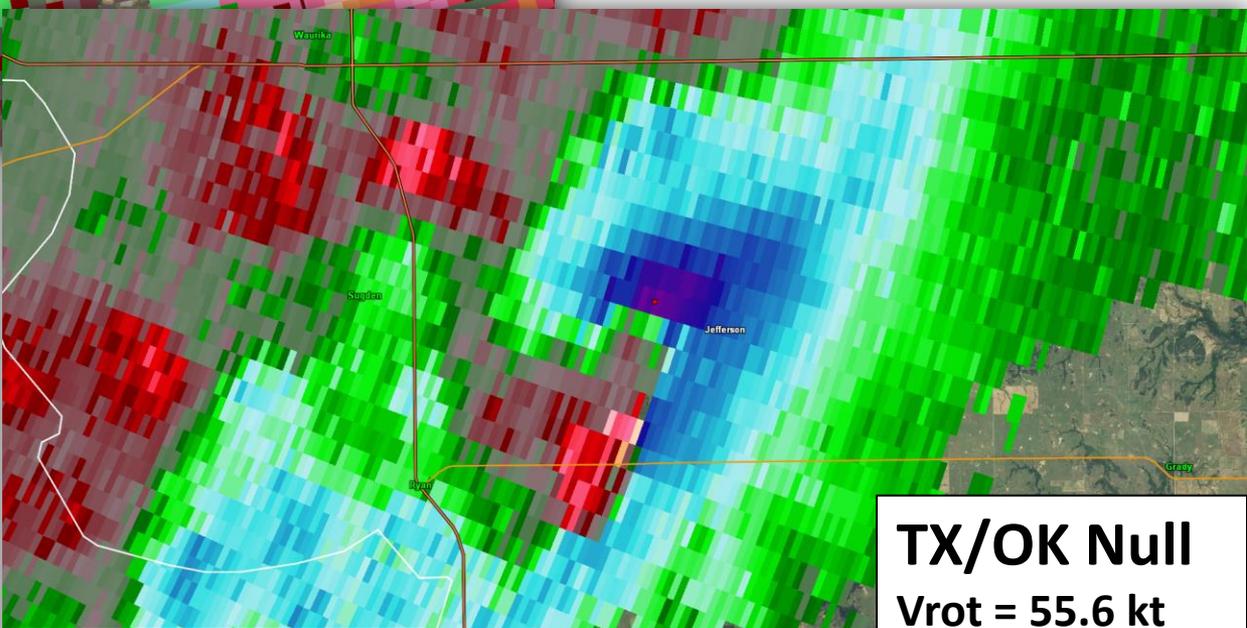


Moore EF5
Vrot = 91.8 kt
Diam = 0.4 nm

20 May 2013
0.5° Peak Vrot
Comparison

Height = 900' ARL

- Strong Vrot, but very broad rotation in null case



Height = 5500' ARL

TX/OK Null
Vrot = 55.6 kt
Diam = 3.1 nm



Summary



- Variety of behavior observed when comparing time series of Vrot and tornado damage
- Some common behavior:
 - 0.5° Vrot lagging other slices early, but becoming strongest during most intense part of tornado
 - Sharp increase in 0.5° Vrot just prior to or coincident with tornadogenesis or tornado intensification
 - Intense tornado damage despite decrease in Vrot
- Null cases shared at least one of the following:
 - 1) Unimpressive Vrot aside from short-lived peaks
 - 2) Convergent and/or broad rotation



Summary – IBW Implications



- 15/16 tornadoes with peak $0.5^\circ/0.9^\circ$ Vrot > 45 kt crossed this threshold ≥ 1 vol scan prior to EF2 damage
 - Average lead time of 10–18 min from Vrot = 45 kt to start of EF2 damage
 - Suggests that lead time can be attained when issuing “Considerable” tag
 - Especially when environment is favorable for intense tornadoes (e.g., high STP)

Thanks for listening.



March 15, 2012 2139Z

Dexter, Michigan

NICK NOLTE

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- Examine cases when Vrot diminishes but tornado damage remains intense
- Analyze time series of mesocyclone diameter

Vrot vs Time - Saginaw/Tuscola Tornado, 23 June 2015

STP = 6 | 0–1 km bulk shear = 30 kt
Avg. height ARL: 0.5° = 2700', 0.9° = 4200'

