Polarimetric Variability of Supercell Storms in Similar Environments

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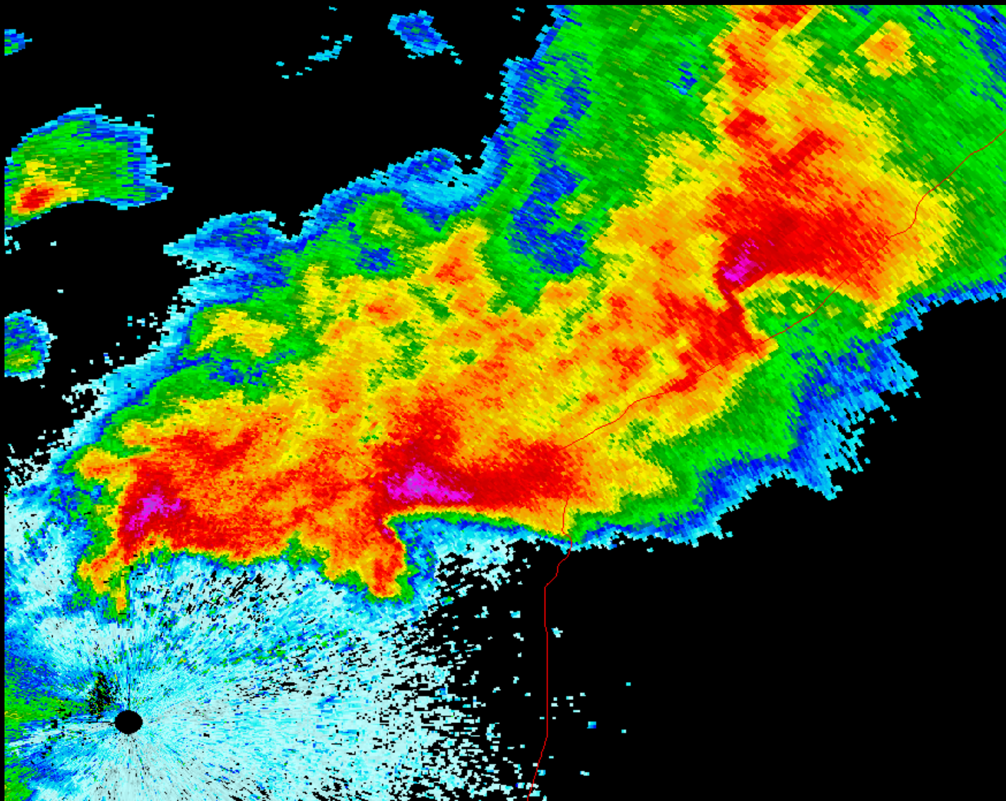

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Background

- Polarimetric radar observations used to infer microphysical characteristics of sample volumes; application to supercell storms (e.g., Loney et al. 2002; Kumjian and Ryzhkov 2008; Palmer et al. 2011; French et al. 2015)

- Radar metrics can be used to infer characteristics of supercell updraft and inflow

Research Question and Motivation

- ***How do polarimetric radar signatures of classic supercell storms vary by environment?***

- Do storms in similar environments have similar polarimetric signatures?
- Do these signatures vary significantly between environments?

Methods

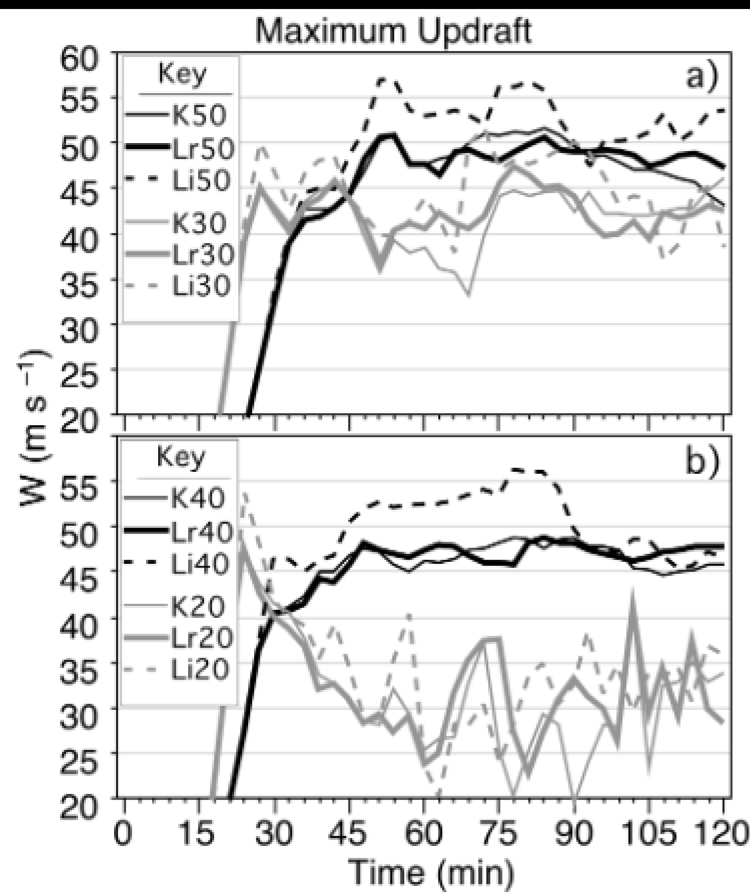
- CASE SELECTION
  - At least 2 classic supercell storms present
  - Environment with low spatial variability
  - Prefer storms with base scan <1 km altitude
- Analysis temporal period: well-defined classic supercell structure present
- ENVIRONMENTS: from RUC/RAP sounding at point representative of storm inflow

Cases Selected

Date	Radar Site	# Storms	# Sample Volumes	Tornado Status
2 March 2012	KHTX	2	30	Tornadic
3 March 2012	KFFC	2	25	Tornadic
15 April 2012	KTWX	2	20	Tornadic
18 February 2013	KSHV	2	14	Tornadic
17 April 2013	KFDR	3	53	Tornadic
22-23 April 2013	KVNX	2	21	Non-tornadic
27 April 2013	KTLX	2	25	Non-tornadic
30 May 2013	KTLX	2	23	Non-tornadic

Updraft Signatures

- Stronger vertical wind shear → *stronger* and *broader* updraft (e.g., Gilmore et al. 2004)

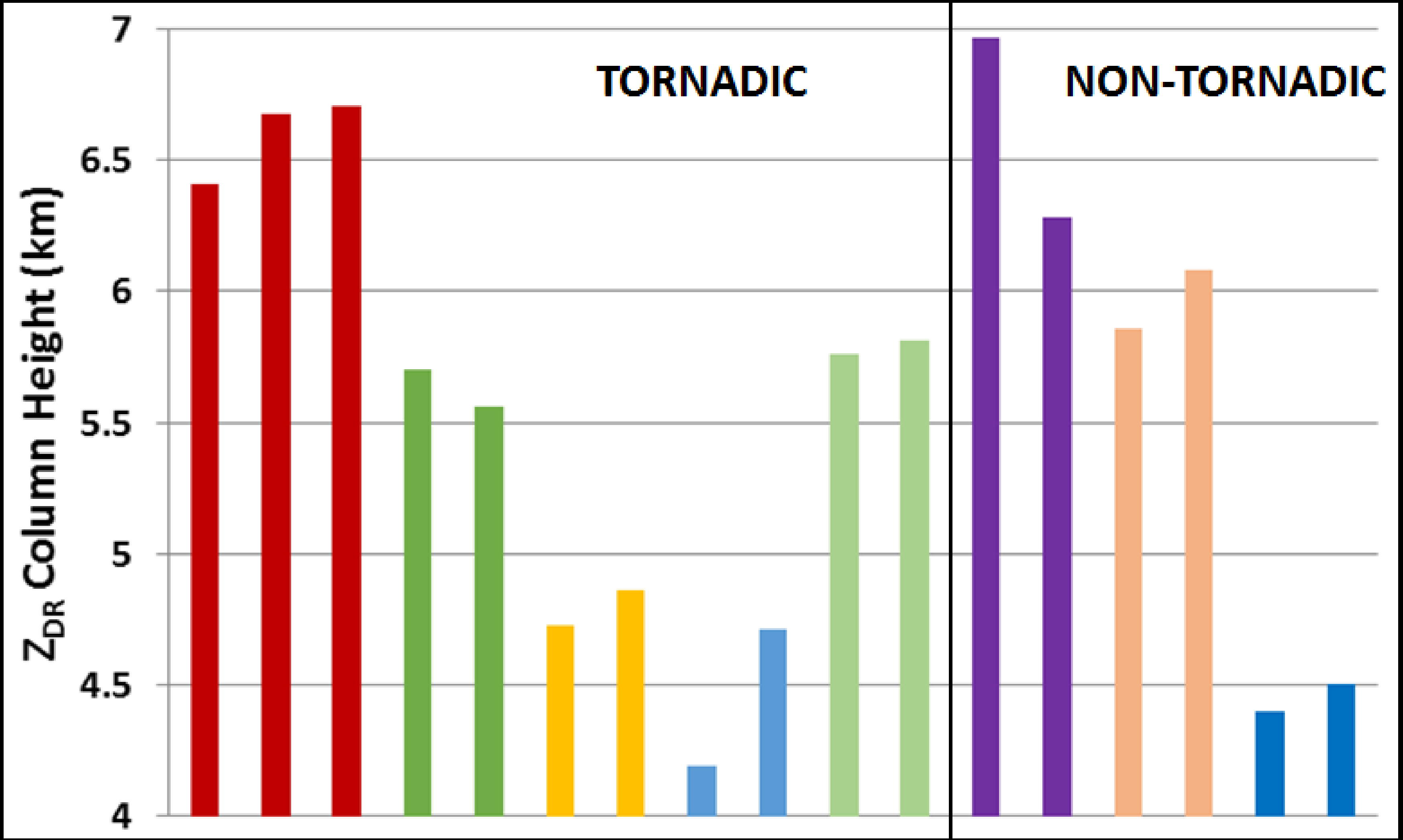


- Z_{DR} column metrics can be used to infer updraft characteristics

Gilmore et al. 2004

Updraft Strength

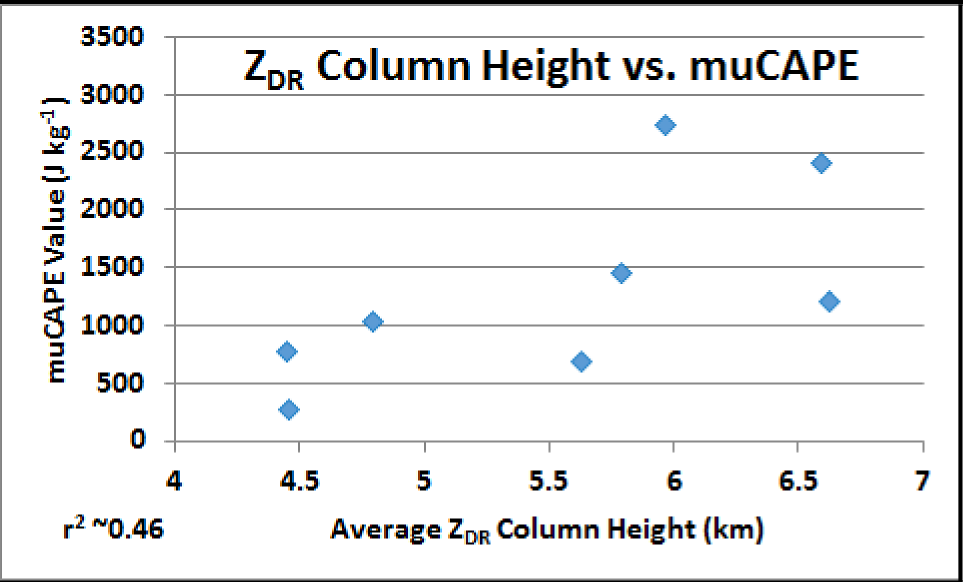
- Metric: ***1-dB Z_{DR} column*** maximum altitude

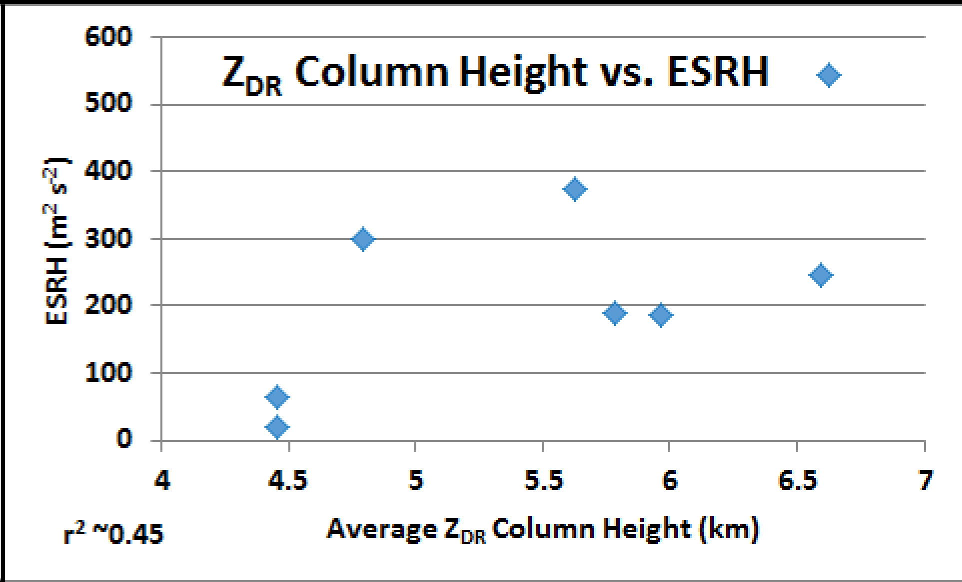


Updraft Strength

Wilcoxon-Mann-Whitney Test Results

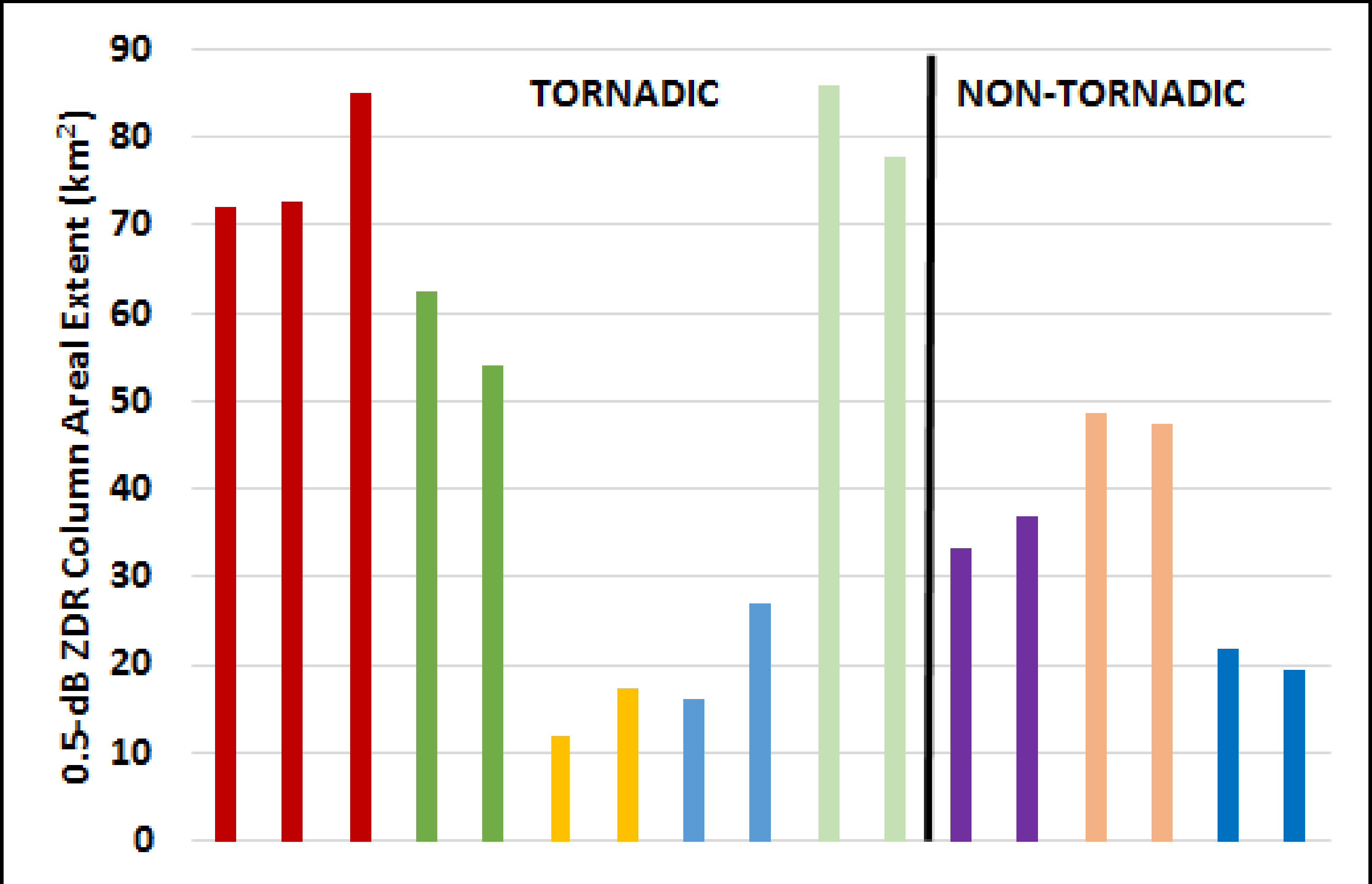
Storm Events	p, compared to other storm in same environment
D, E	0.330
H, I	0.198
L, M	0.078
N, O	0.468
1, 2	0.074
3, 4	0.109
5, 6	0.401





Updraft Broadness

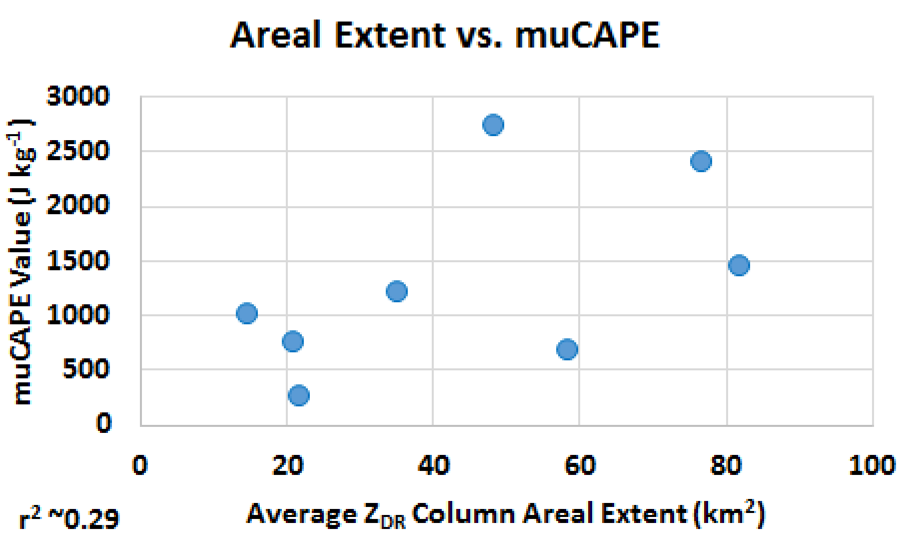
- Metric: ***0.5-dB Z_{DR} column*** areal extent at 0.75-1.25 km above the ambient 0°C level

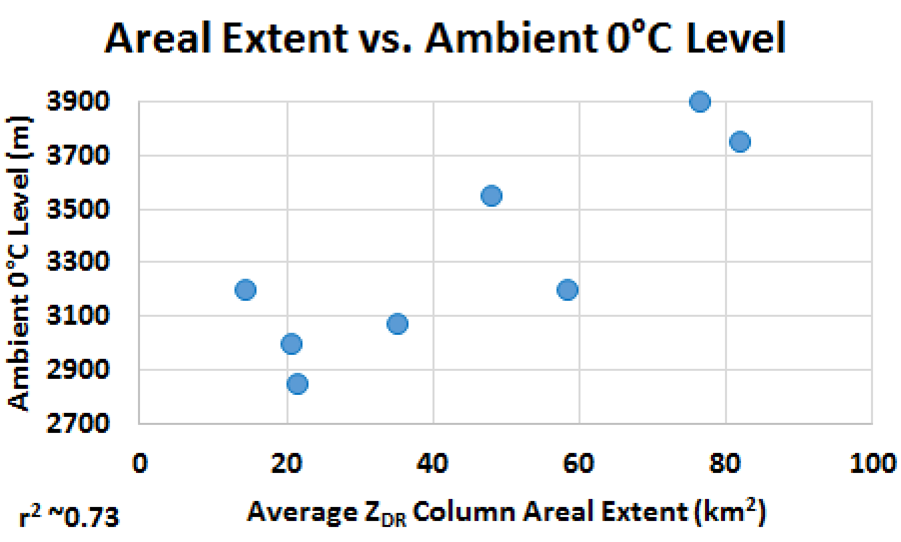


Updraft Broadness

Wilcoxon-Mann-Whitney Test Results

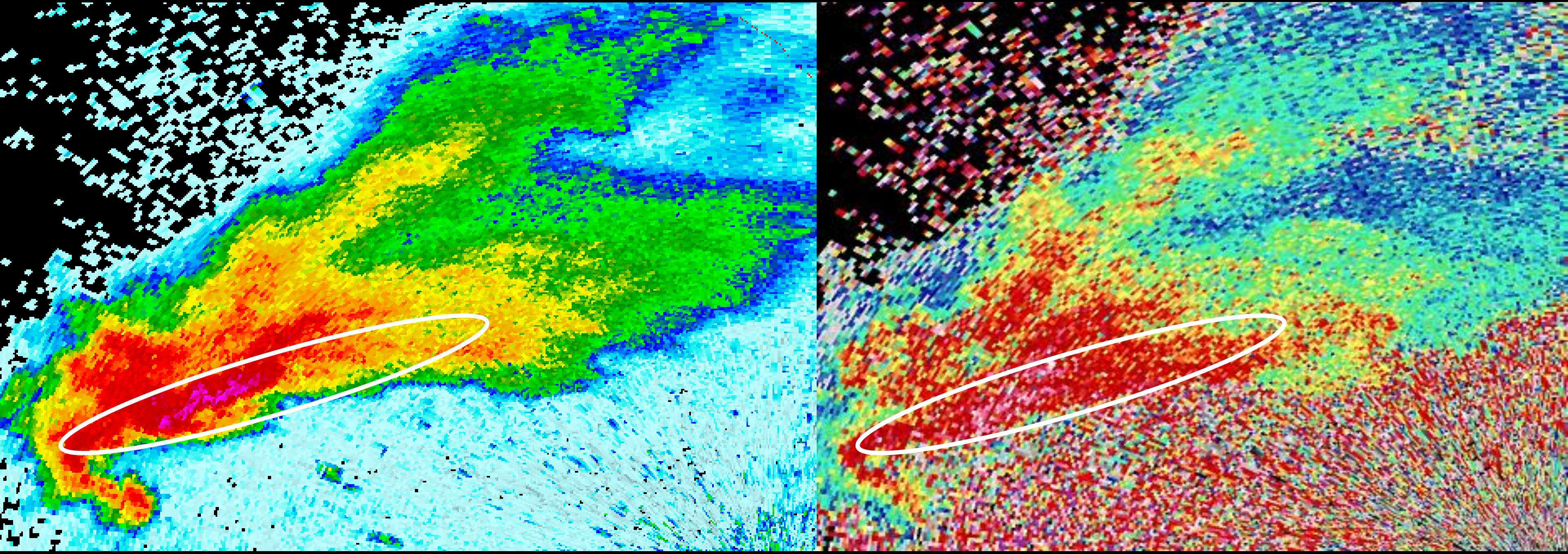
Storm Events	p, compared to other storm in same environment
D, E	0.131
H, I	0.030
L, M	0.136
N, O	0.189
1, 2	0.171
3, 4	0.464
5, 6	0.484





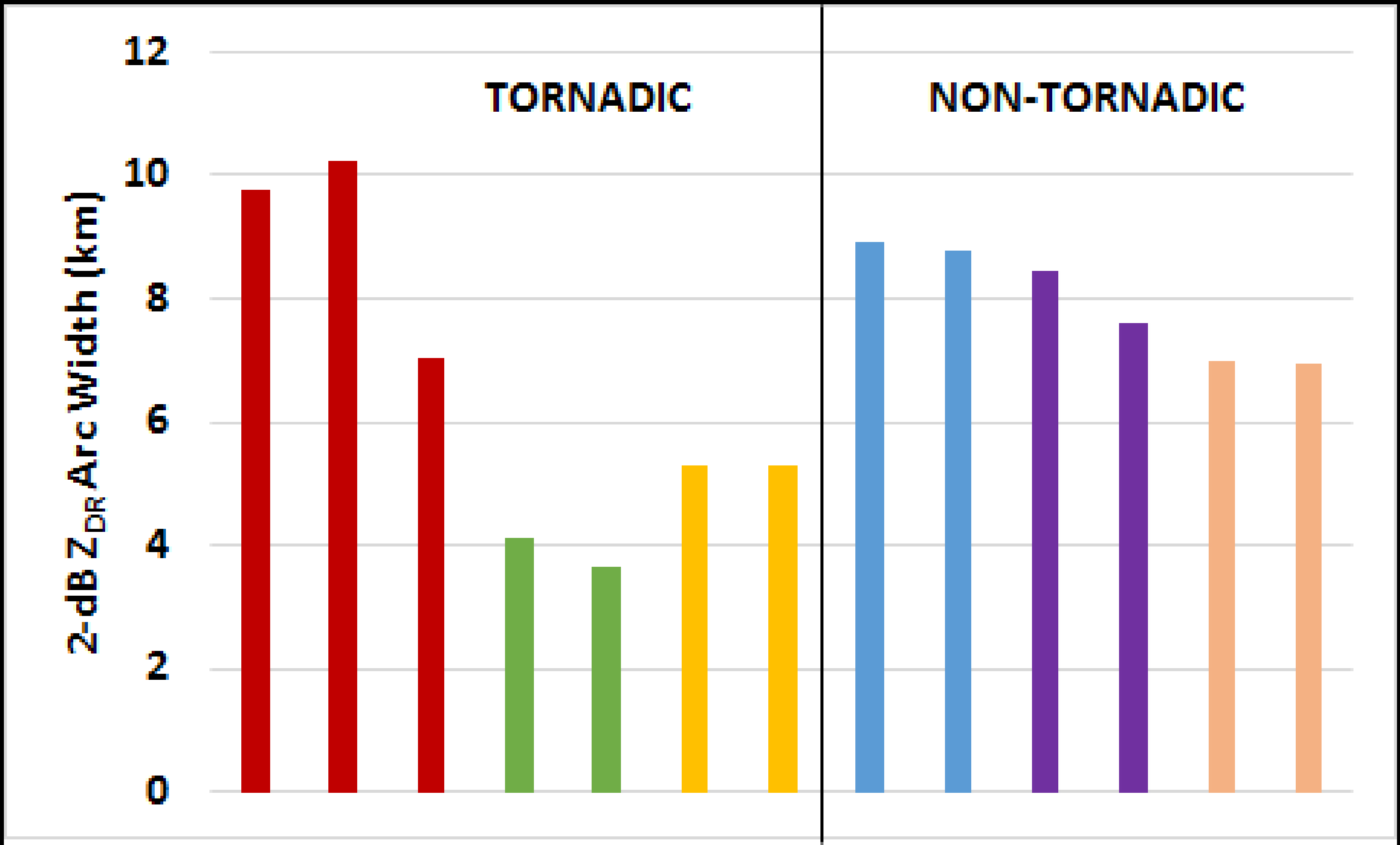
Inflow Signatures

- Size sorting along the supercell forward flank depends on *mean storm-relative wind over depth of the sorting layer* (Dawson et al. 2015)
- Leads to the Z_{DR} arc:



Inflow Metric 1: Z_{DR} Arc Width

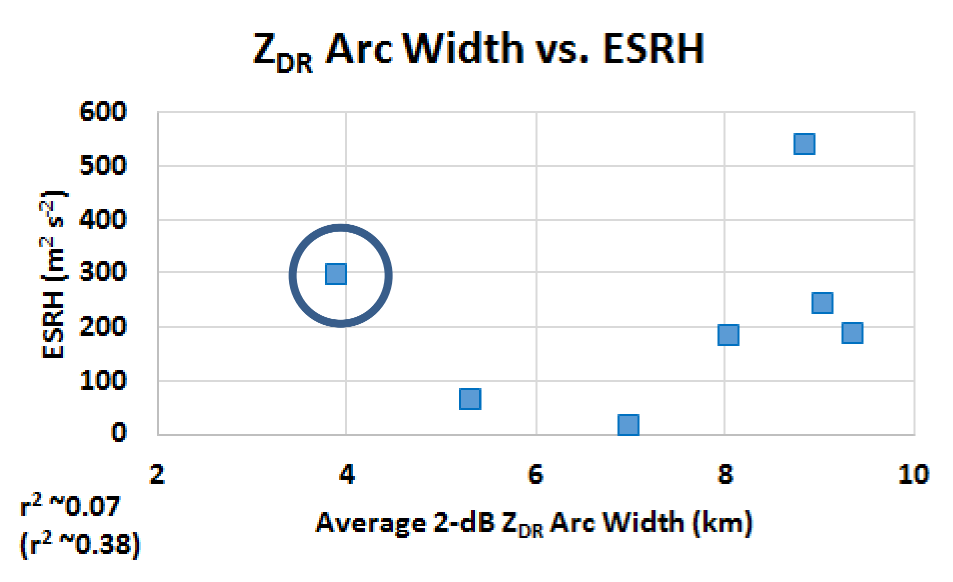
- Mean width of the ***2-dB Z_{DR} arc***, over all times in the analysis period

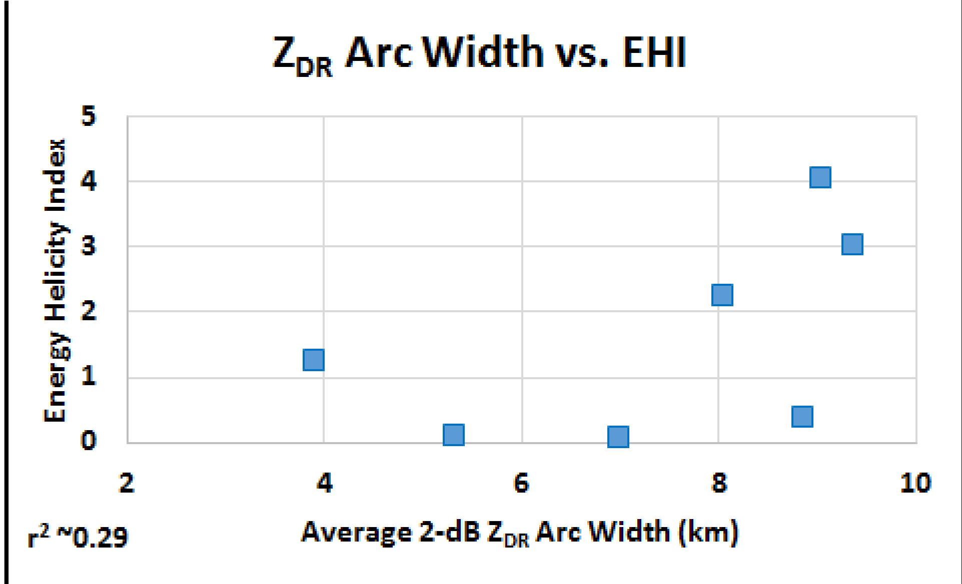


Z_{DR} Arc Width

Wilcoxon-Mann-Whitney Test Results

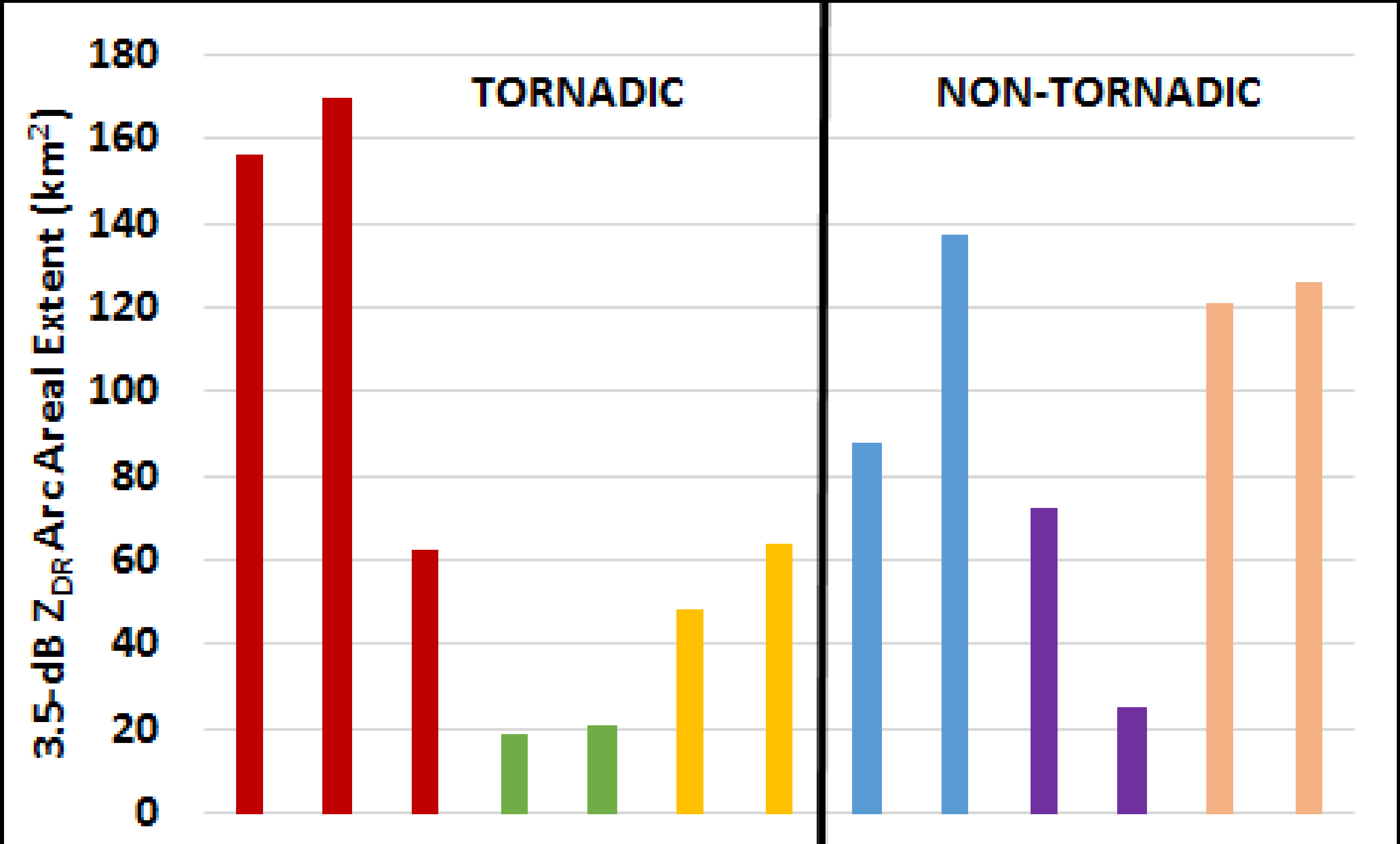
Storm Events	p, compared to other storm in same environment
H, I	0.095
L, M	0.476
1, 2	0.405
5, 6	0.312





Inflow Metric 2: Z_{DR} Arc Areal Extent

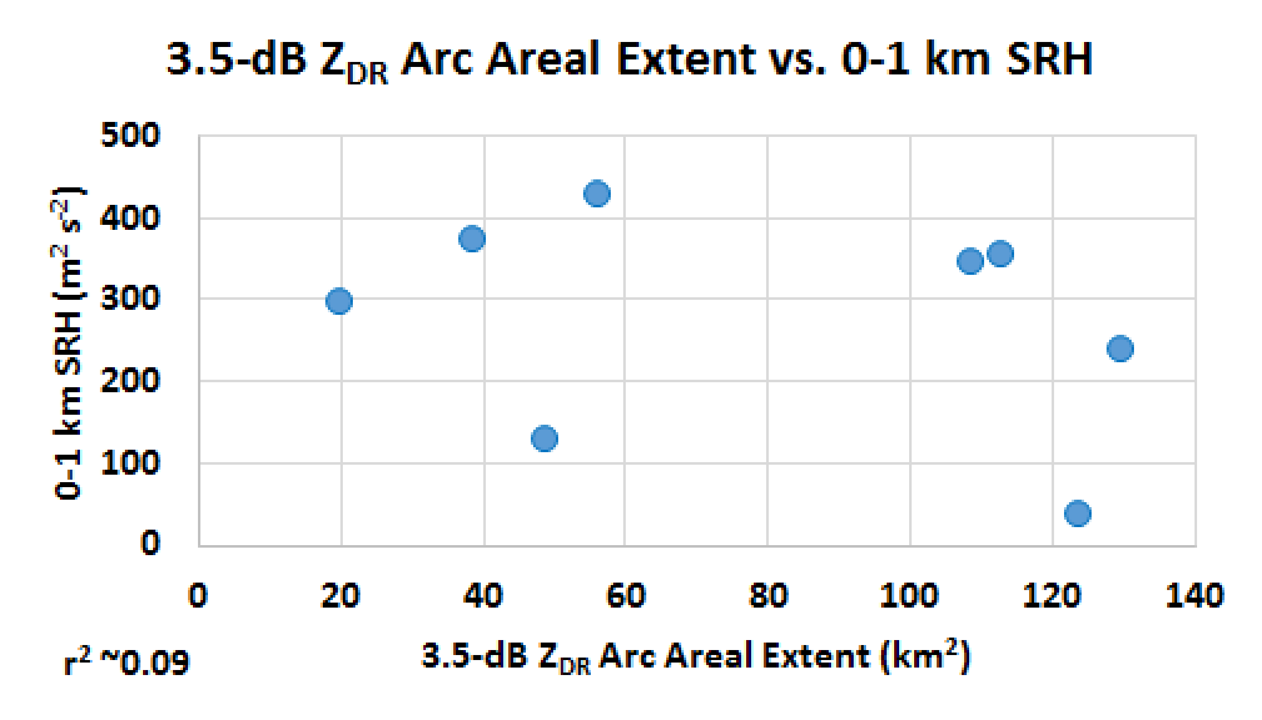
- Areal extent of the ***3.5-dB Z_{DR} arc*** region



Z_{DR} Arc Areal Extent

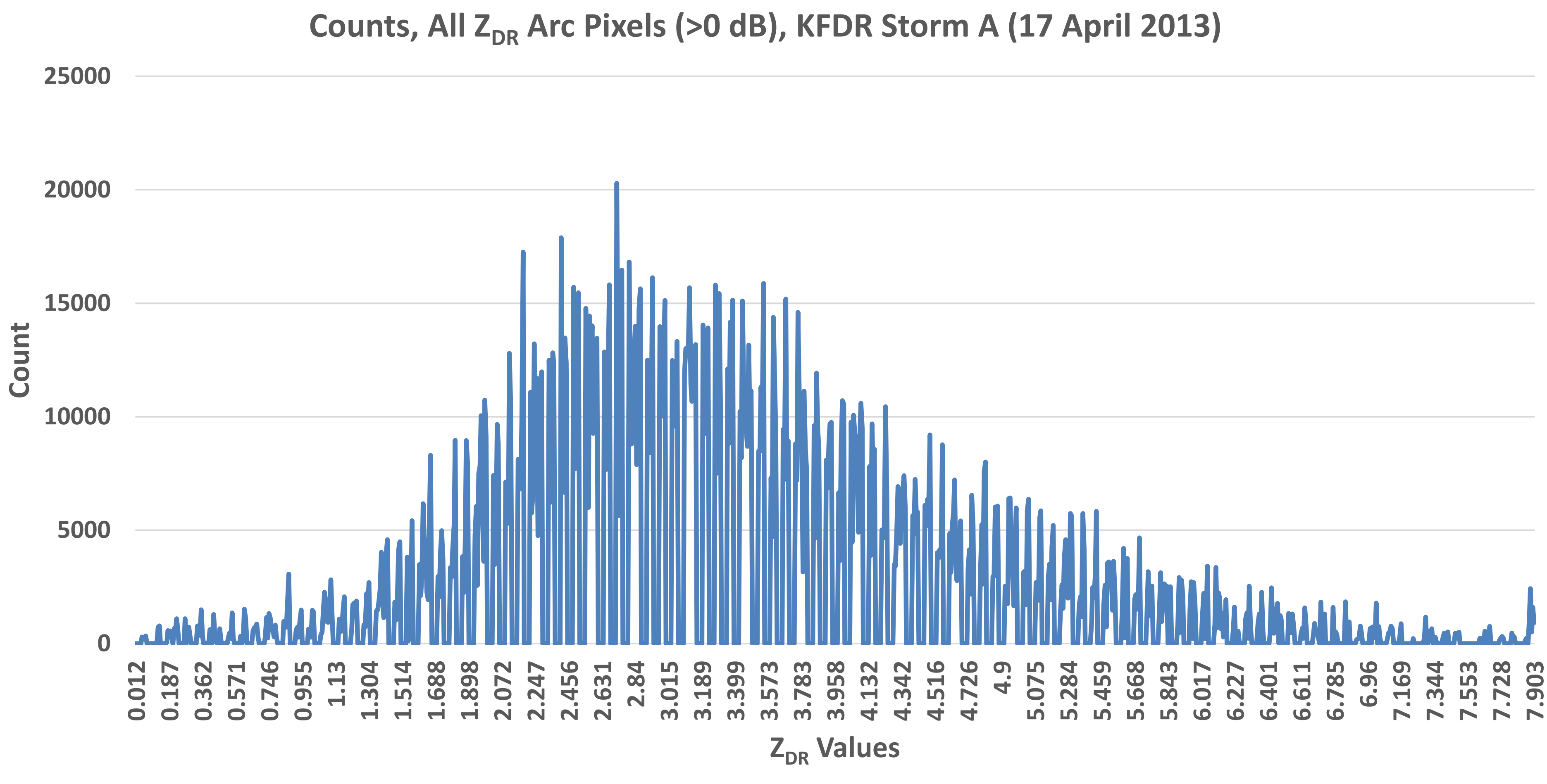
Wilcoxon-Mann-Whitney Test Results

Storm Events	p, compared to other storm in same environment
H, I	0.198
L, M	0.326
1, 2	0.002
5, 6	0.356

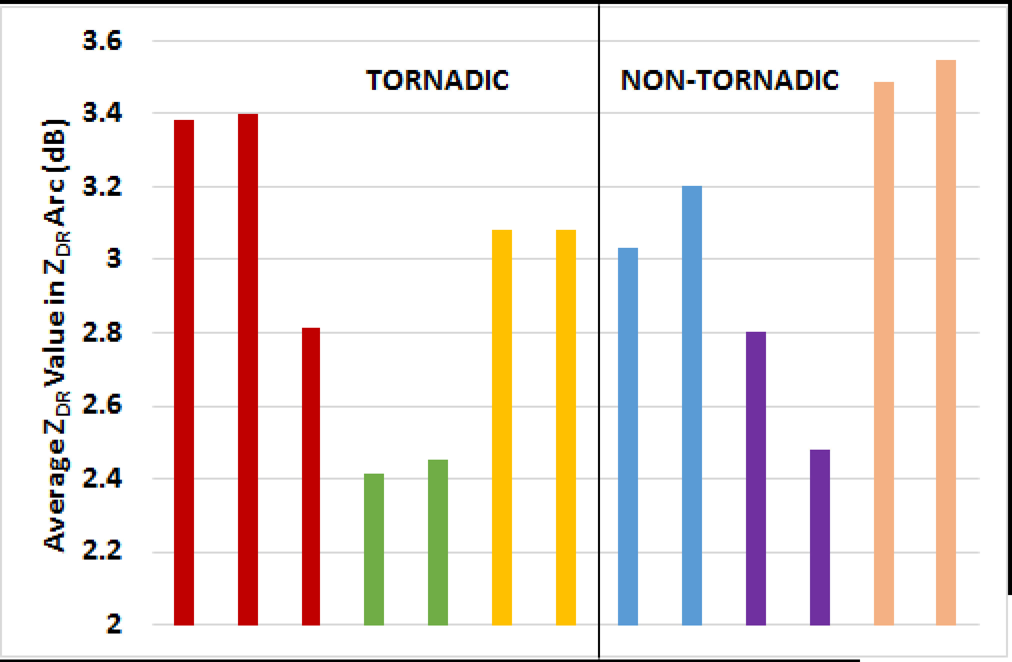


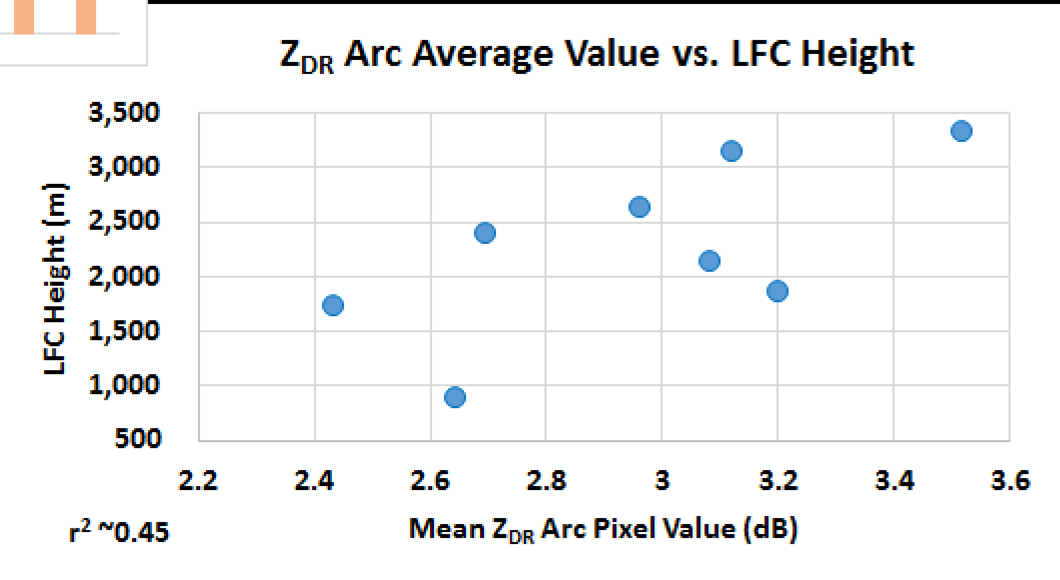
Inflow Metric 3: Z_{DR} Arc Values

- ***Mean Z_{DR} value*** within the Z_{DR} arc region, averaged over all analysis periods



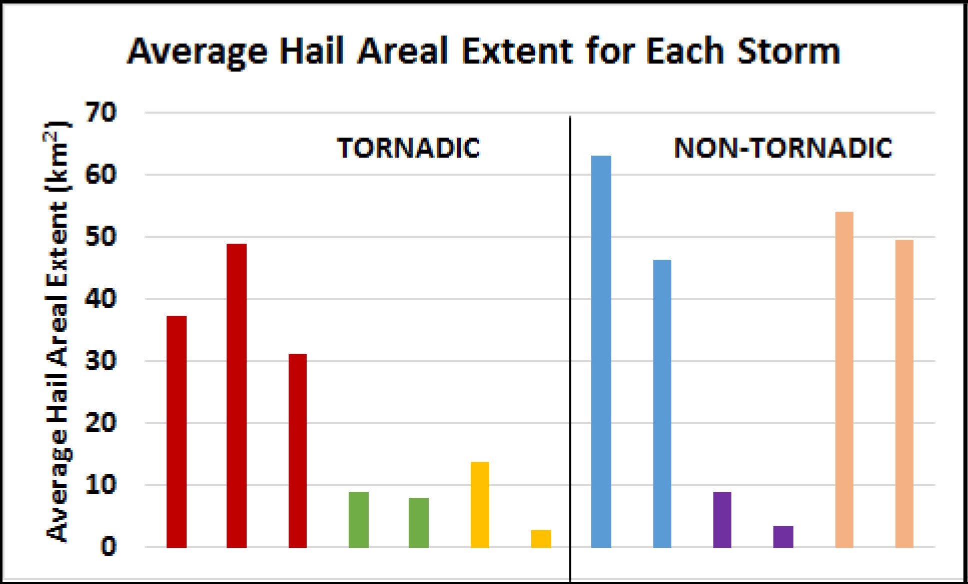
Inflow Metric 3: Z_{DR} Arc Values

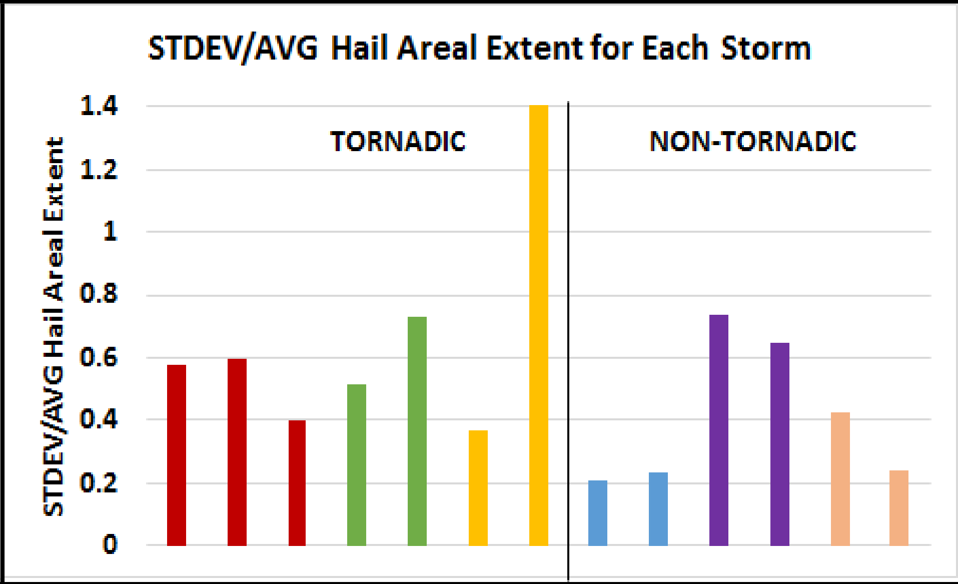




Hail Areal Extent

- Used mean polarimetrically-inferred ***hail areal extent***





→ Often larger hail extent in non-tornadic storms

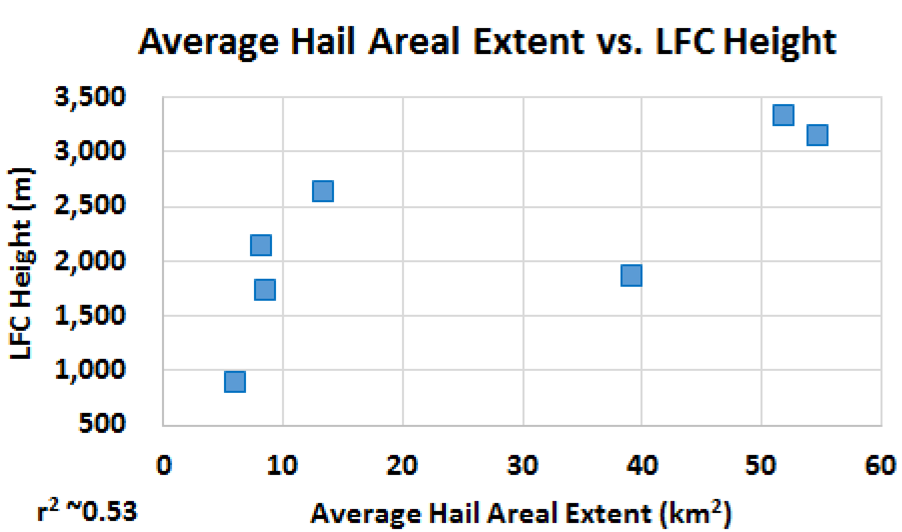
→ Hail often more cyclic in tornadic storms

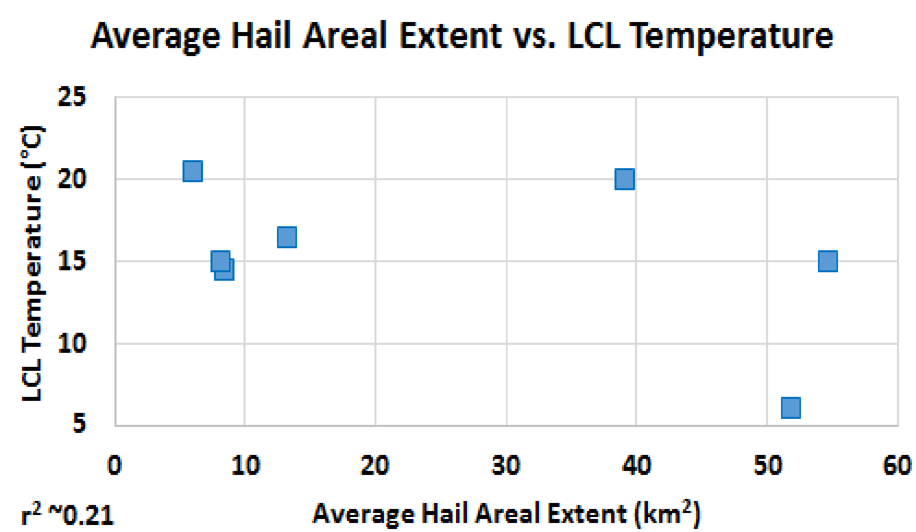
Hail Areal Extent

Wilcoxon-Mann-Whitney Test Results

Storm Events	p, compared to other storm in same environment
H, I	0.154
L, M	0.002
1, 2	0.016
5, 6	0.480

→ **Generally a less-similar metric between storms in similar environments**





Conclusions

- Many metrics are similar between storms for a given environment:
  - Z_{DR} column maximum altitude, areal extent
  - Z_{DR} arc width, mean values
  - Hail areal extent, fallout location
- A few metrics are *not* very similar:
  - Z_{DR} arc areal extent
  - Hail cyclicality?
- Indicates value in exploring variability by environment across a large sample of storms

QUESTIONS?

References

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Mesocyclone-relative Hail Placement

- Centroid of hail fallout area relative to midlevel mesocyclone center
- Non-tornadic storms generally more variable