THE TIME BETWEEN FIRST RADAR ECHOES AND FIRST VHF LIGHTNING RADIATION SOURCE LOCATIONS AS AN INDICATOR OF EVENTUAL STORM INTENSITY

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Rationale

- The time between the appearance of the first radar echoes above some threshold and the occurrence of the first few VHF source locations nearby as determined by an LMA ought to be in some measure related to the strength of convection.

- If the time is short, it stands to reason that the convection is strong and therefore, all else being equal, the storm would likely eventually be more intense than if the time had been longer.

Question

- How does one measure storm “intensity”?
  - Chose to avoid use of the term “severe”
  - Chose to avoid properties that are difficult to measure, e.g., manifestations reported in “Storm Data”
  - Chose properties that could be determined from radar and NLDN

Data

- WSR-88D Level-II Base Reflectivity (KTLX)
  - First echoes
  - Later storm development
- VHF radiation source locations from OKLMA
- Lightning ground-strike locations from NLDN
- Limited to discrete, convective storms

Definitions

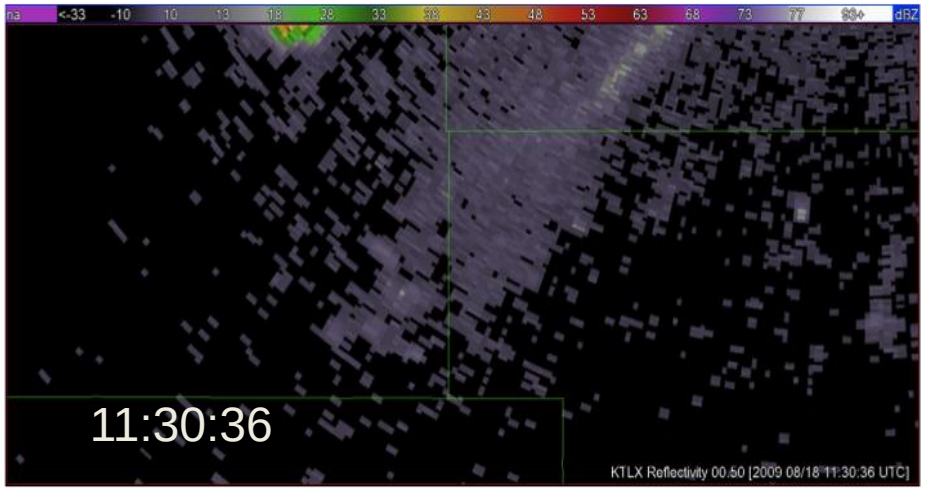
- First radar echo:
  - 30 dBZ echo at 0° C isotherm
- First VHF source points:
  - 10+ points in immediate vicinity of first echo

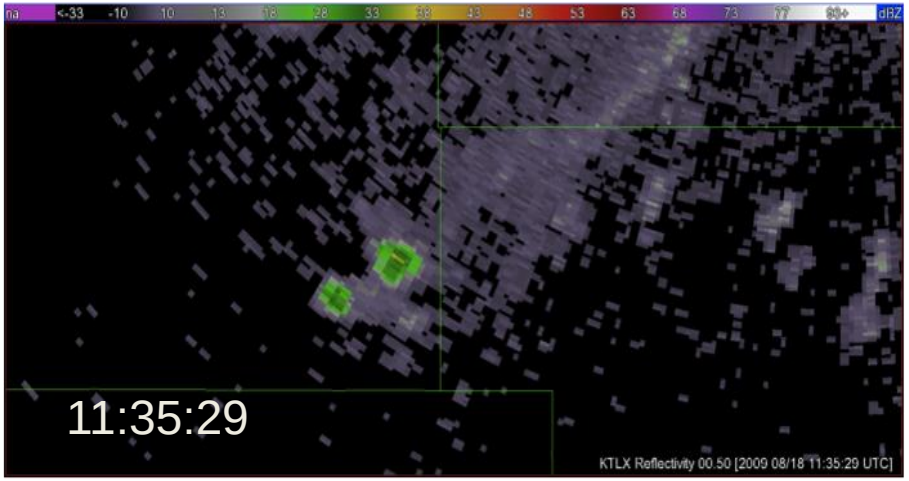
Procedure

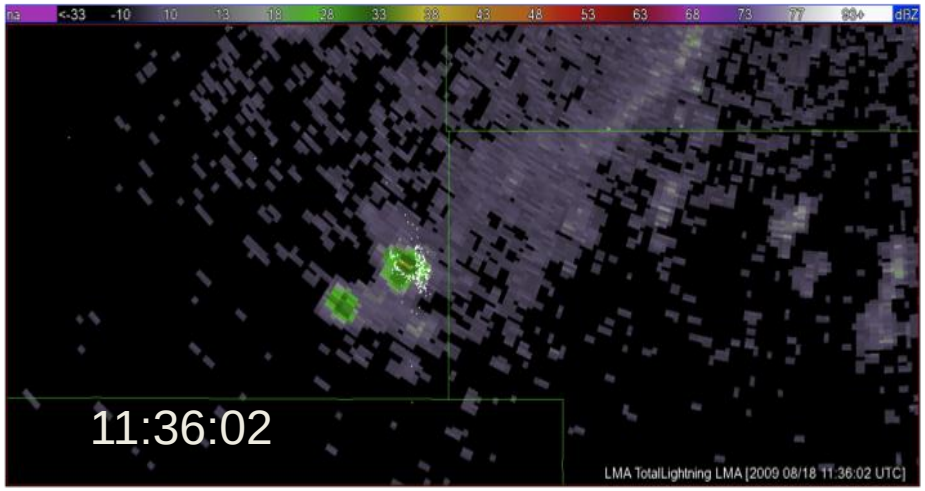
- Looked at spatial and temporal relationships among radar, VHF sources and CG ground strike data
  - Three seasons
    - Winter (December)
    - Spring (March)
    - Summer (August)
  - NSSL WDSS-II

- Considered several possible indicators of intensity
  - Maximum tops (MT)
  - height difference between MT and EL , MT and FL
  - number of CG lightning flashes
  - core radar reflectivity increases

- Determined time intervals between first radar echoes and first VHF source points
- Compared time intervals with chosen intensity indicators
- Also looked at time between first VHF source points and first CG

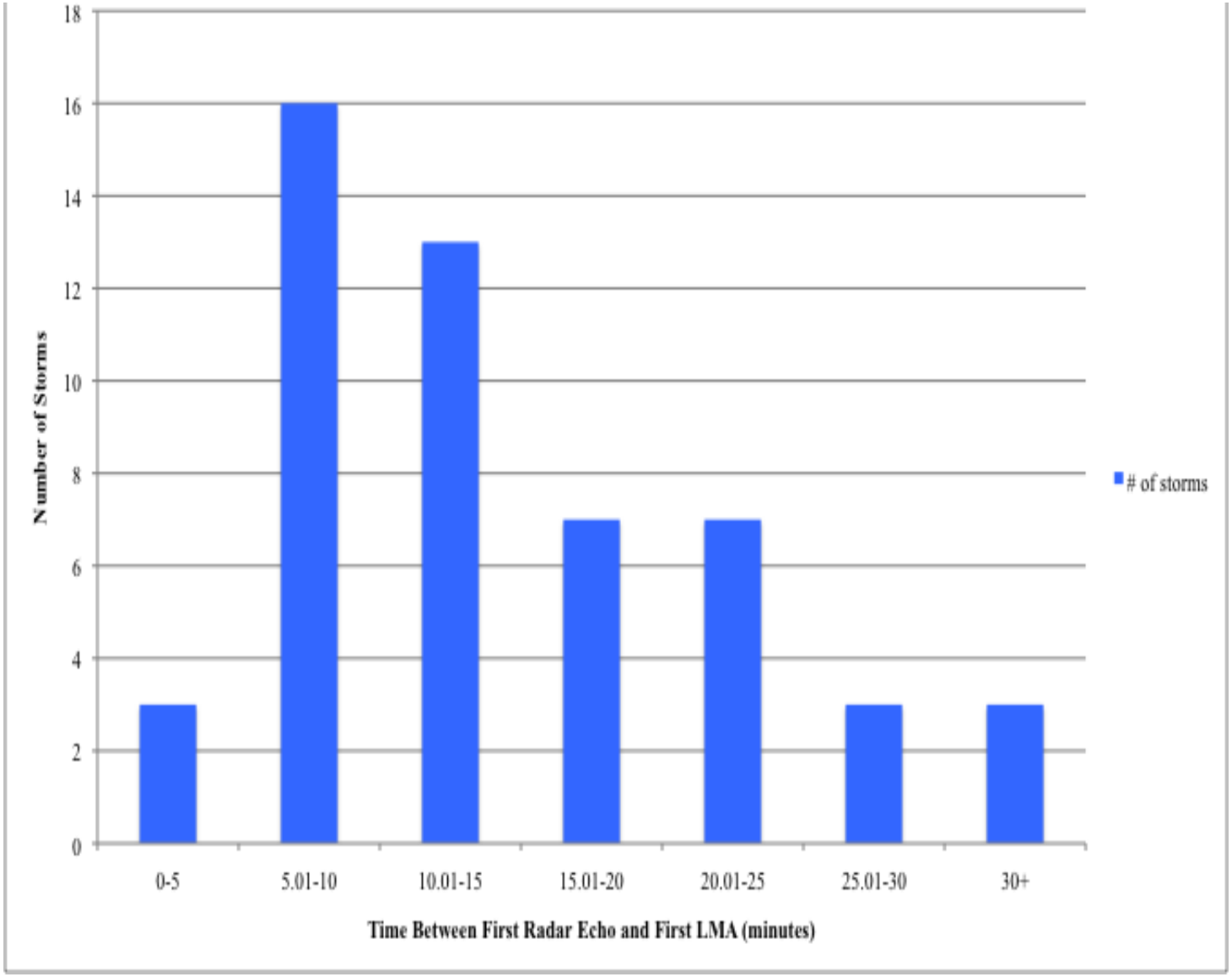

11:30:36
KTLX Reflectivity 00.50 [2009 08/18 11:30:36 UTC]


11:35:29
KTLX Reflectivity 00.50 [2009 08/18 11:35:29 UTC]

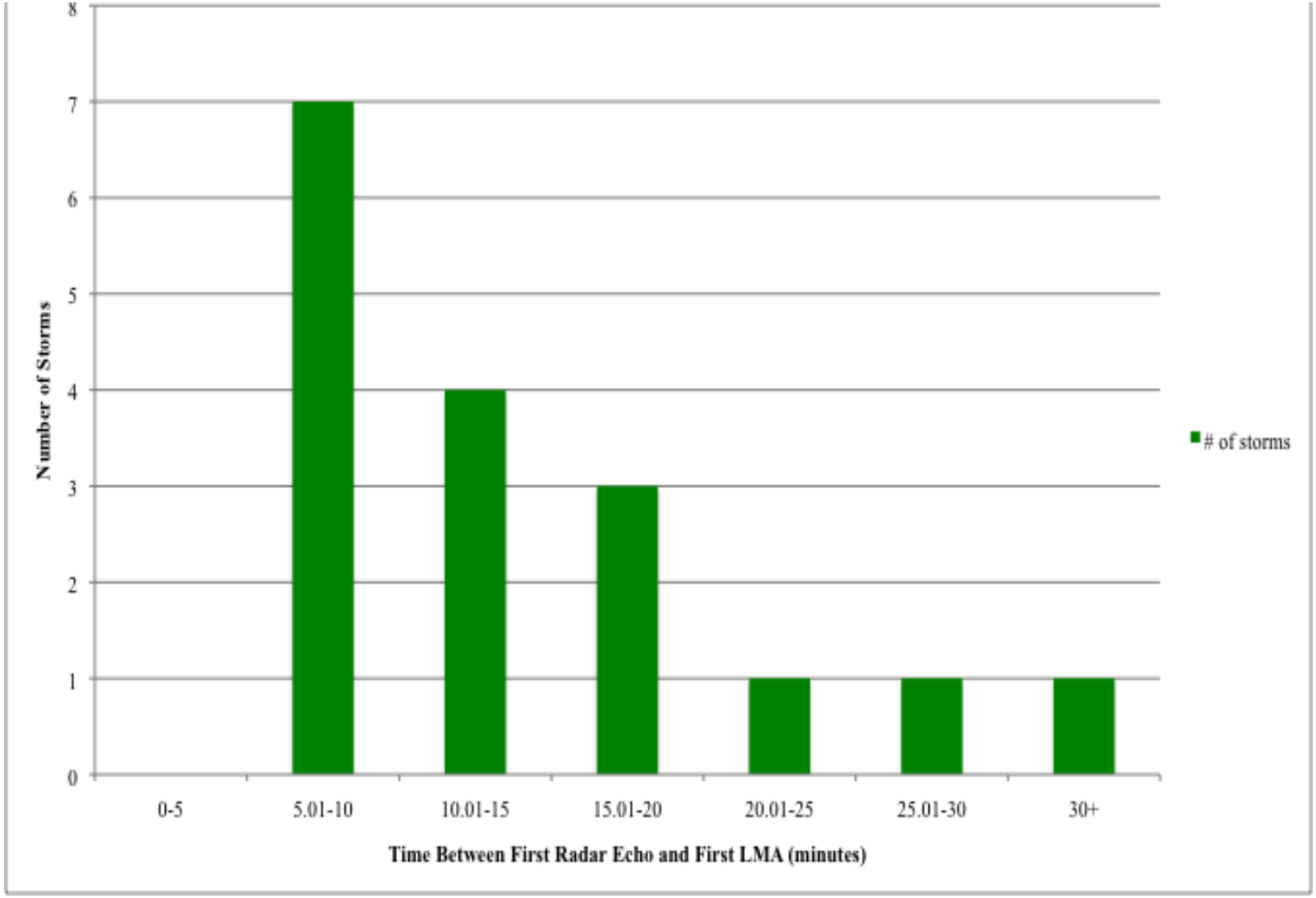

11:36:02
LMA TotalLightning LMA [2009 08/18 11:36:02 UTC]


11:37:28
NLDN Lightning National [2009 08/18 11:37:28 UTC]

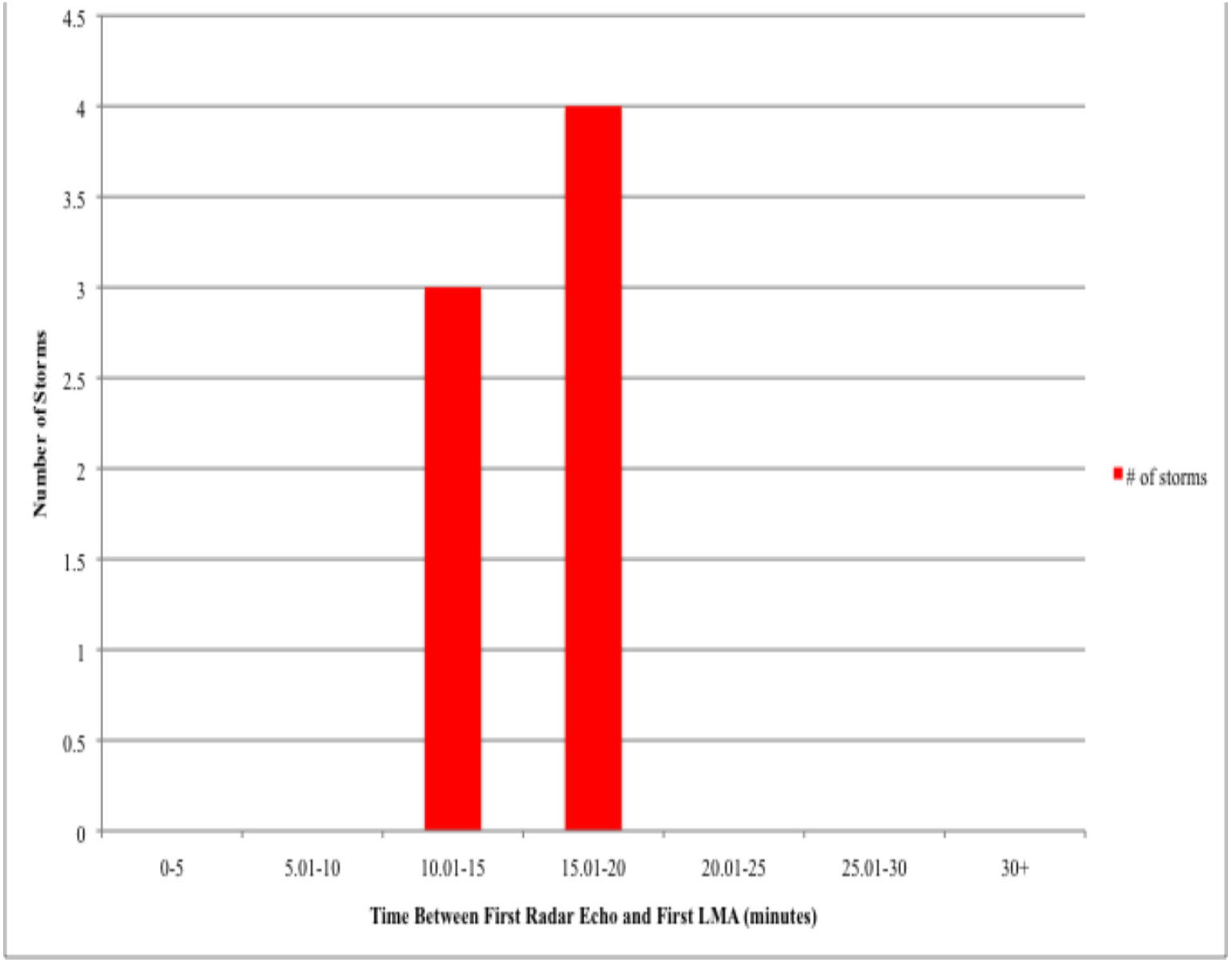
Number of cases having given time between first echo and first VHF source locations (August)

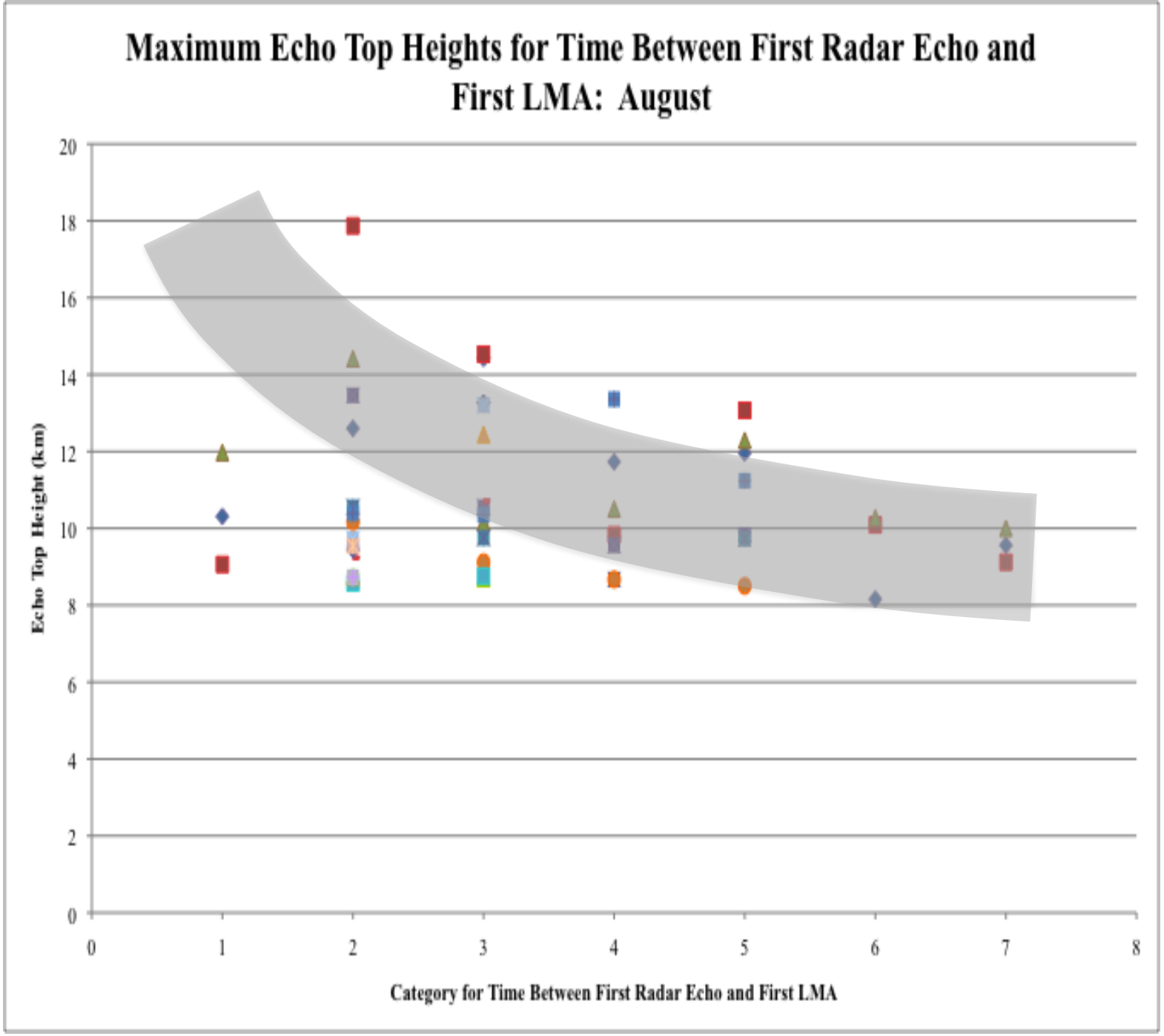


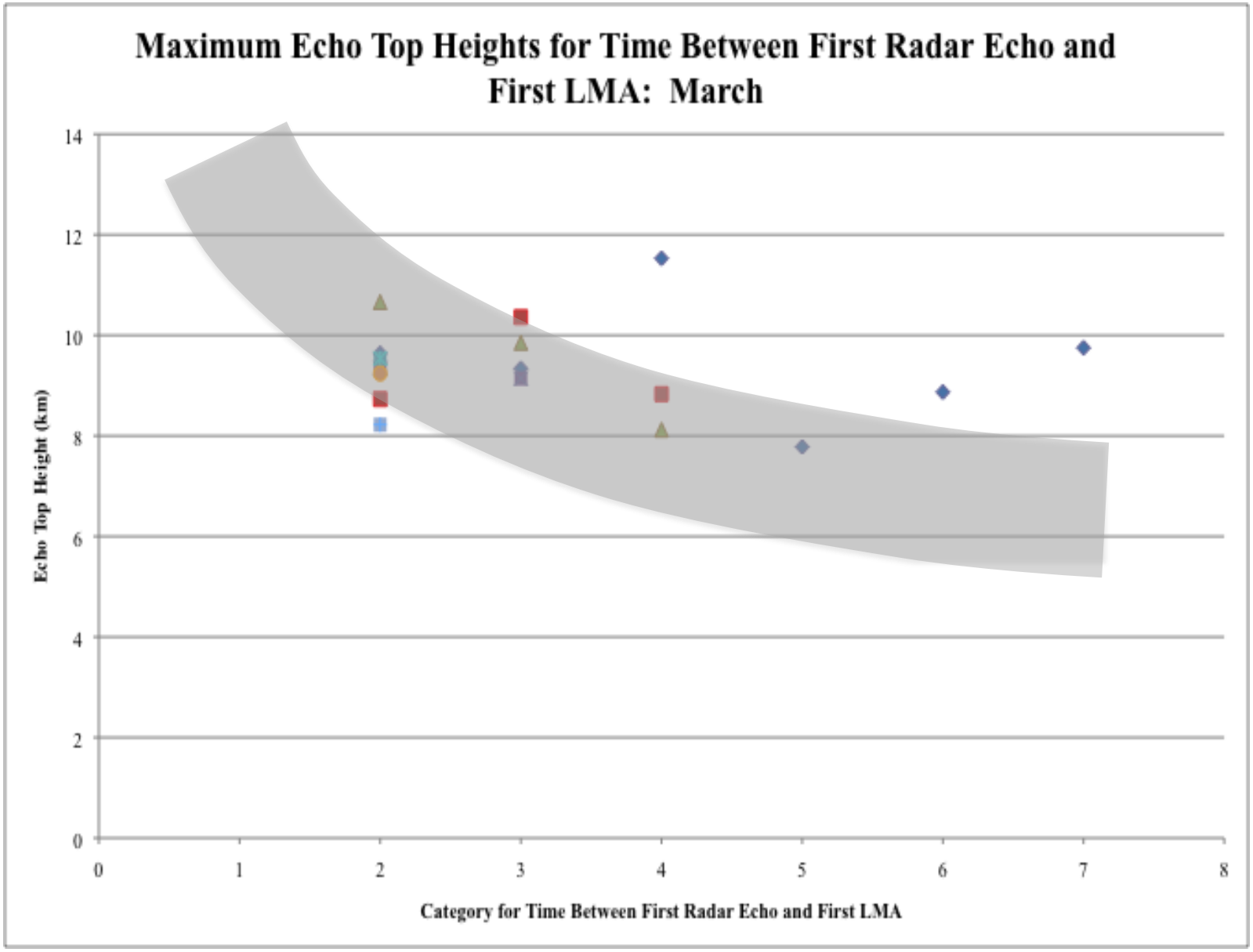
Number of cases having given time between first echo and first VHF source locations (March)



Number of cases having given time between first echo and first VHF source locations (December)




Maximum Echo Top Heights for Time Between First Radar Echo and First LMA: August
Echo Top Height (km)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
Category for Time Between First Radar Echo and First LMA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4
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7
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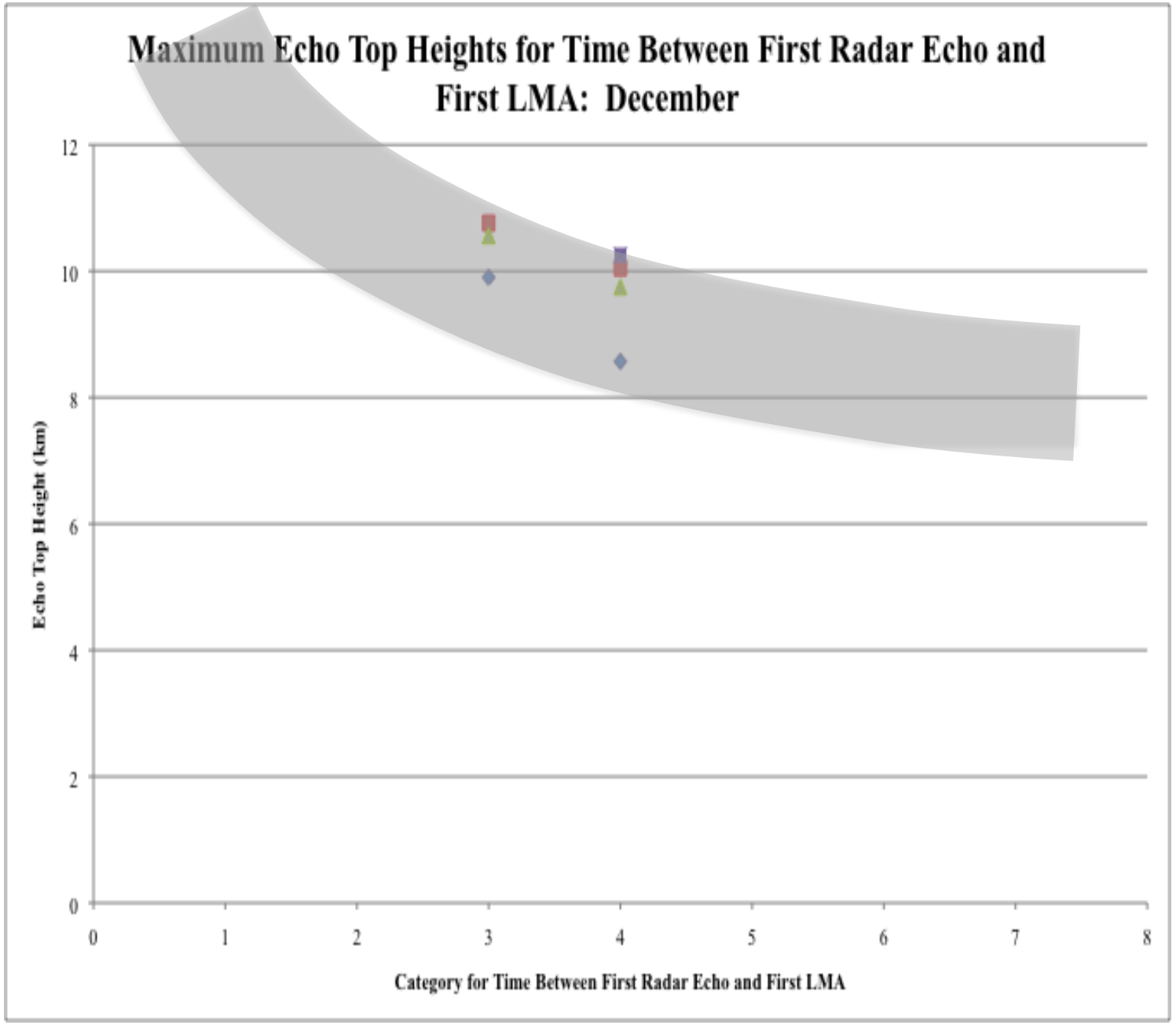
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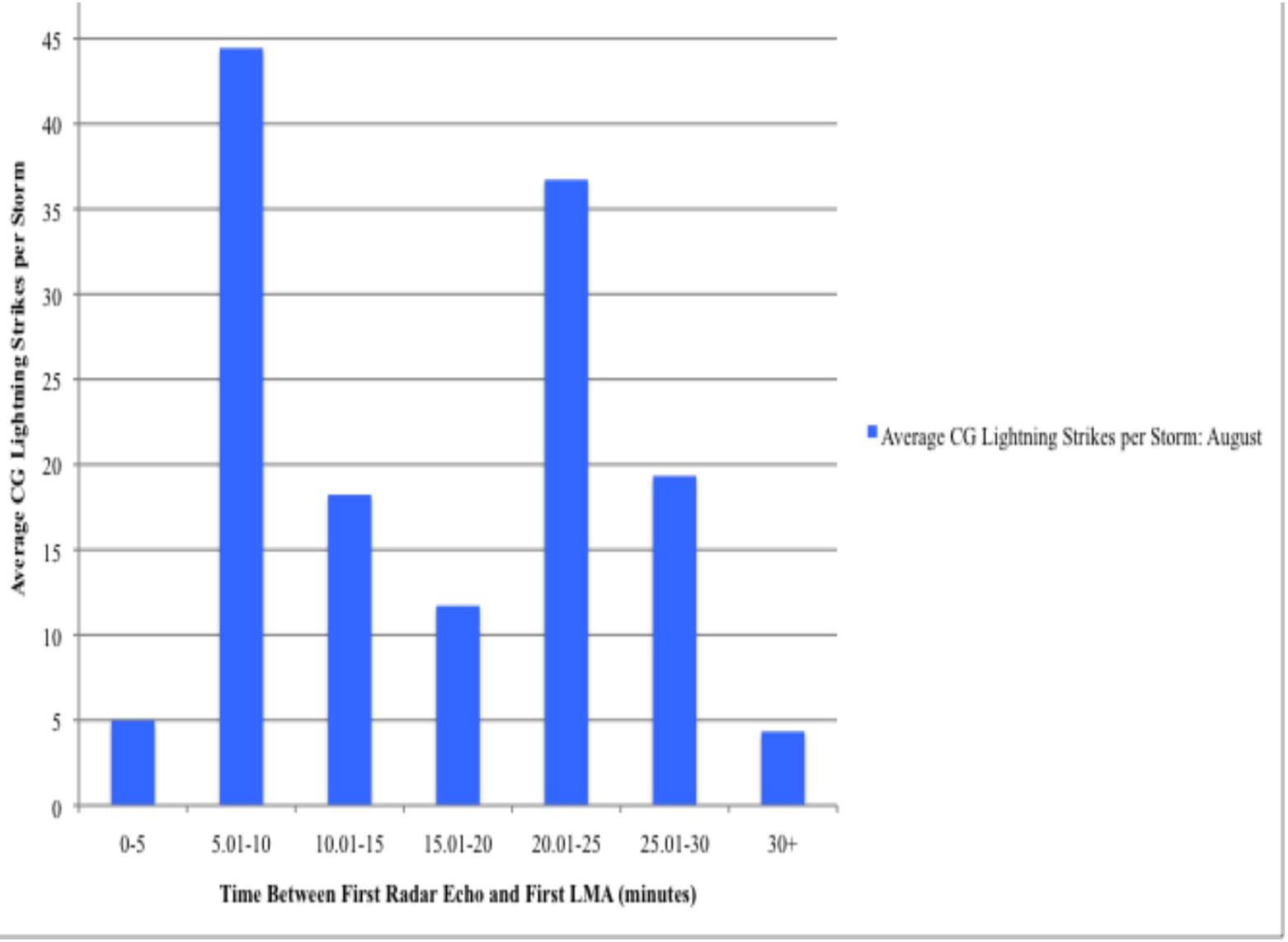
Echo Top Height (km)
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
Category for Time Between First Radar Echo and First LMA

Average Number of CG locations per storm case having given time between first echo and first VHF source locations



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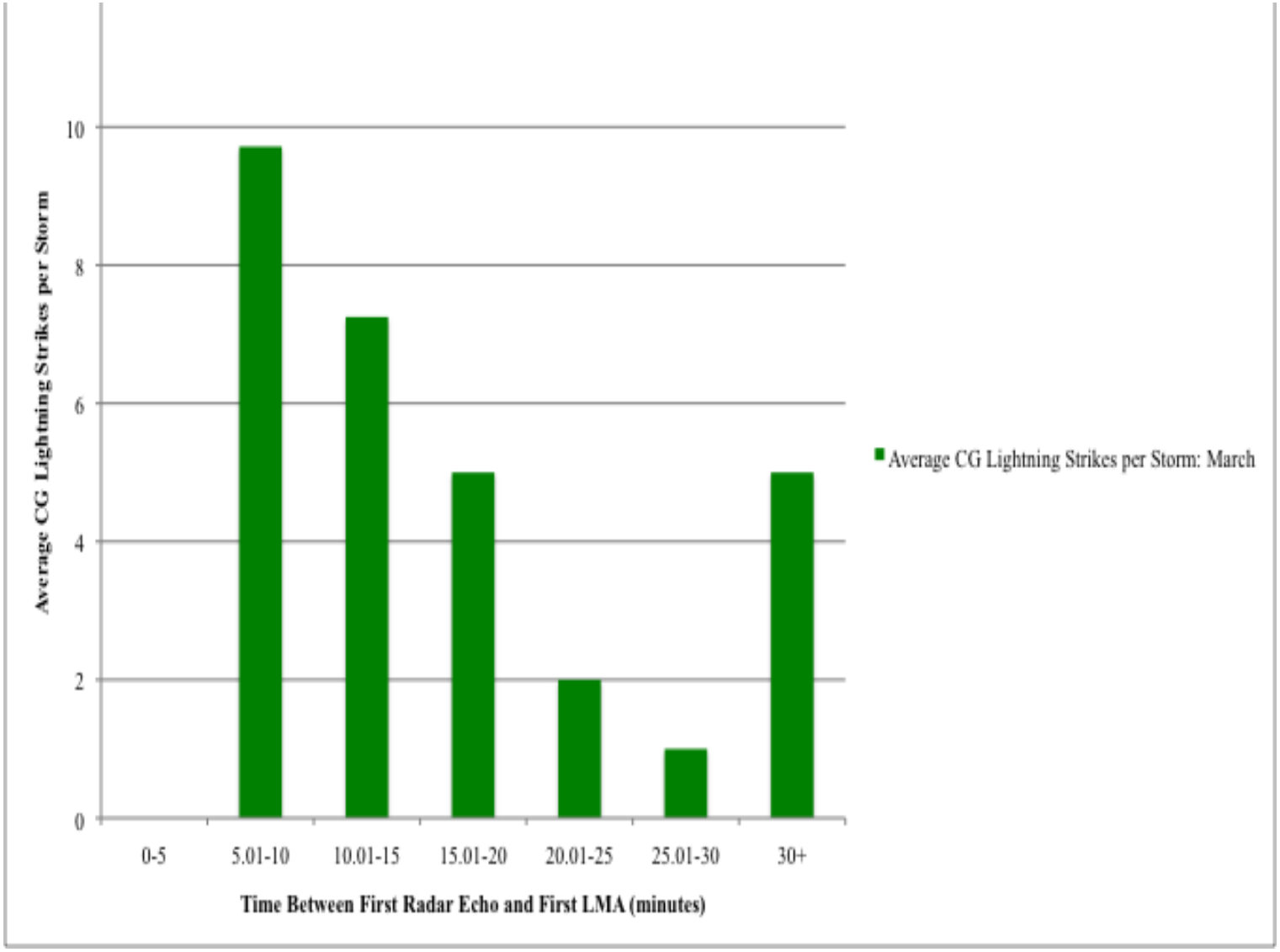

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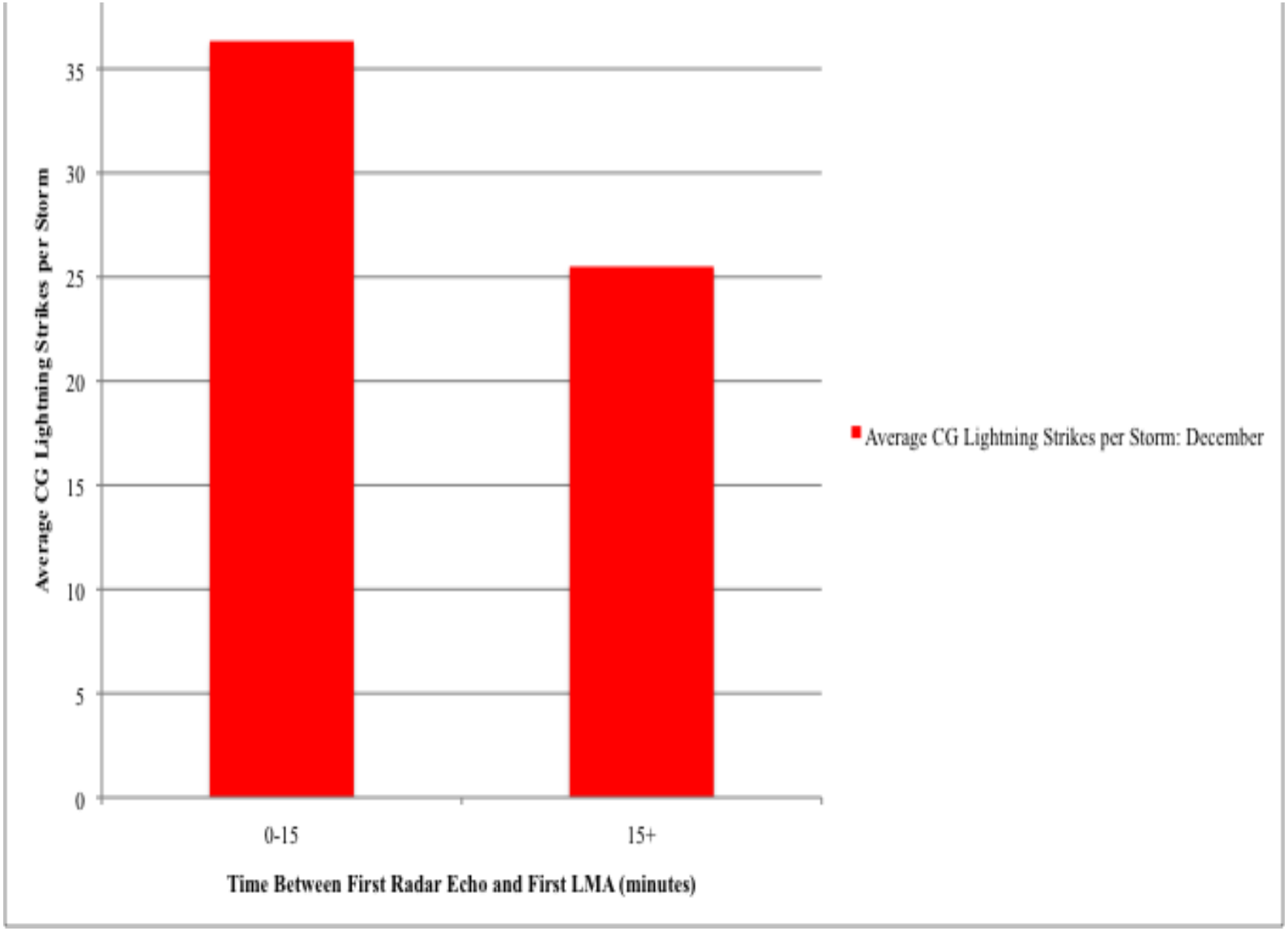
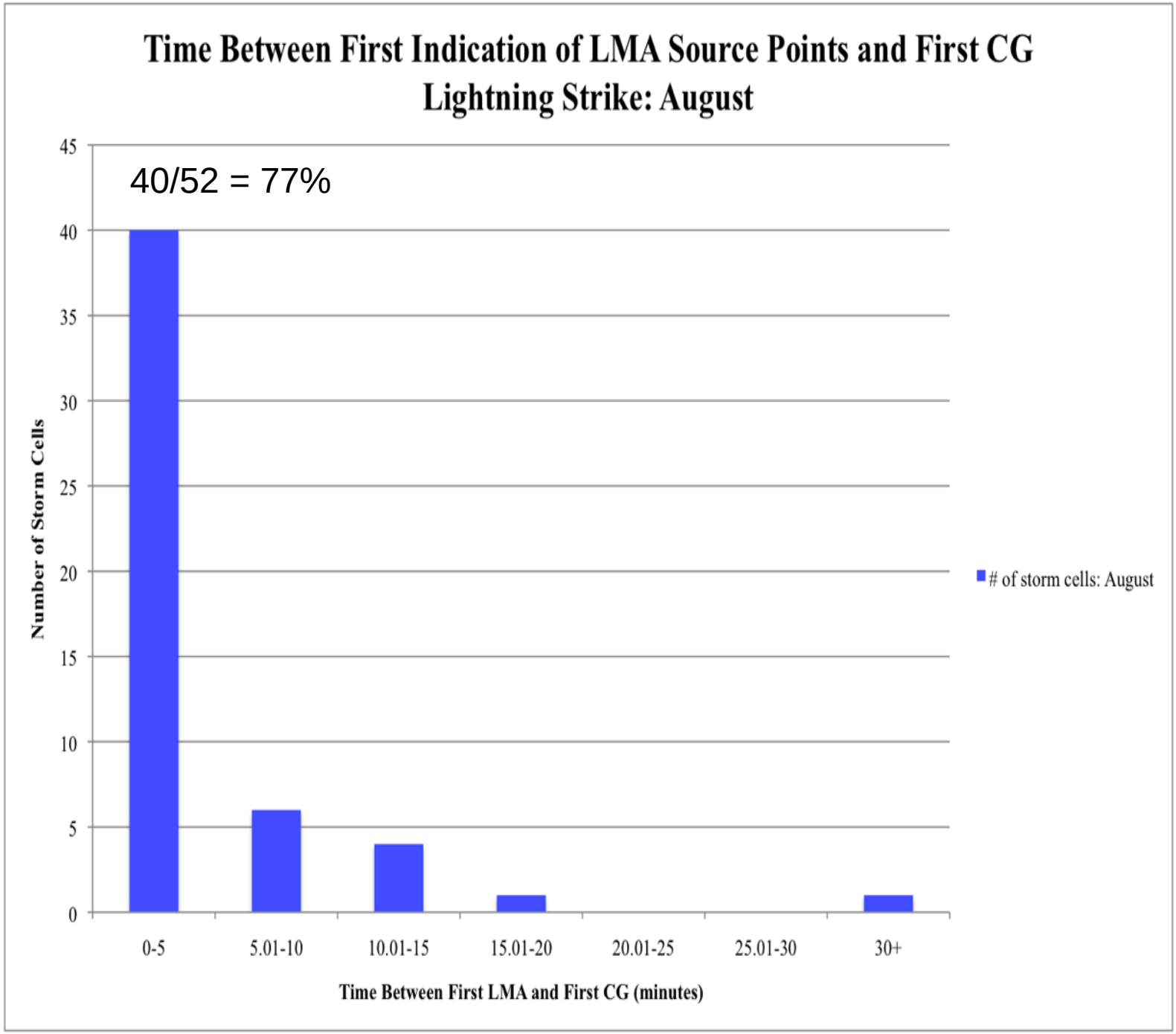
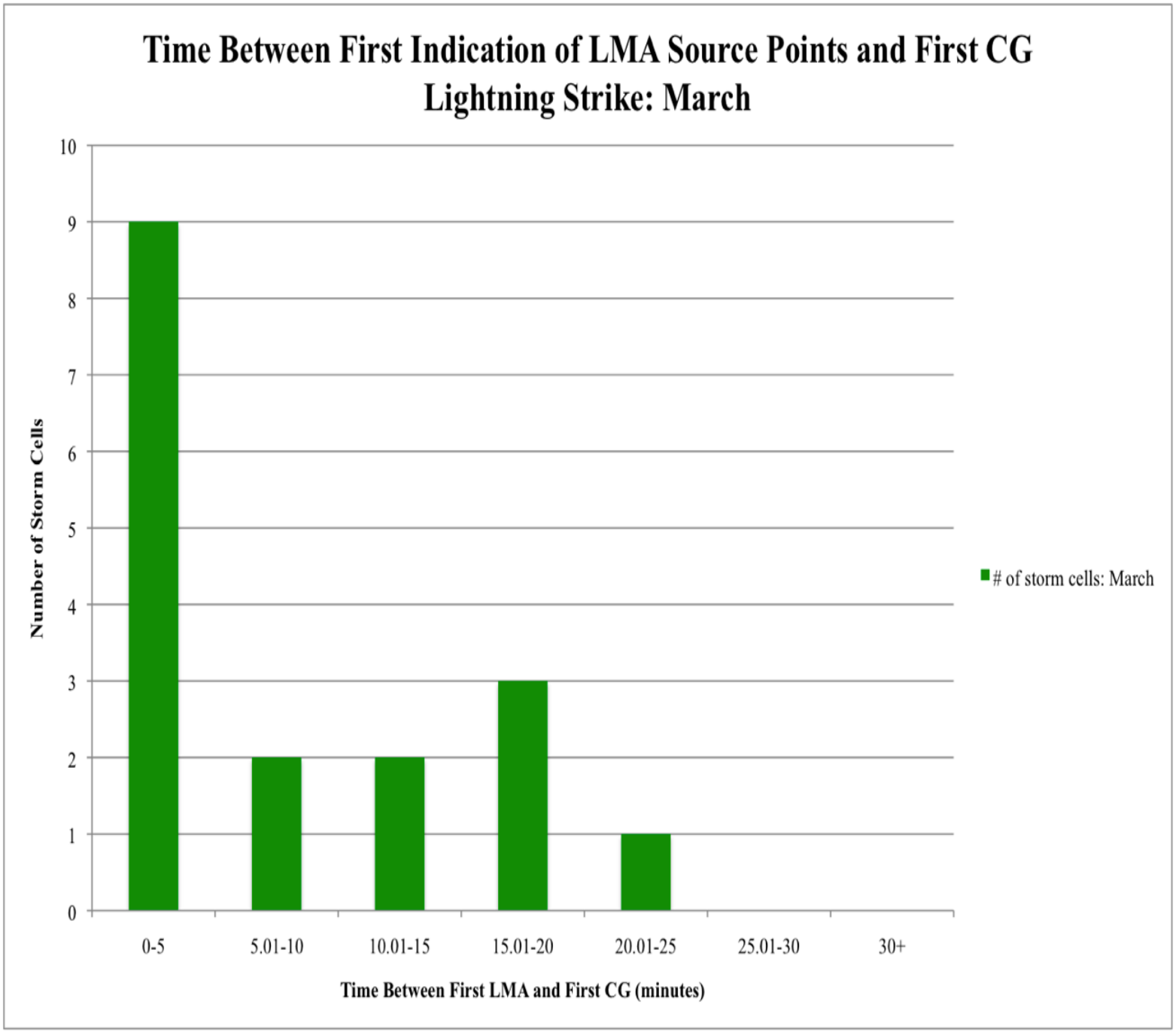
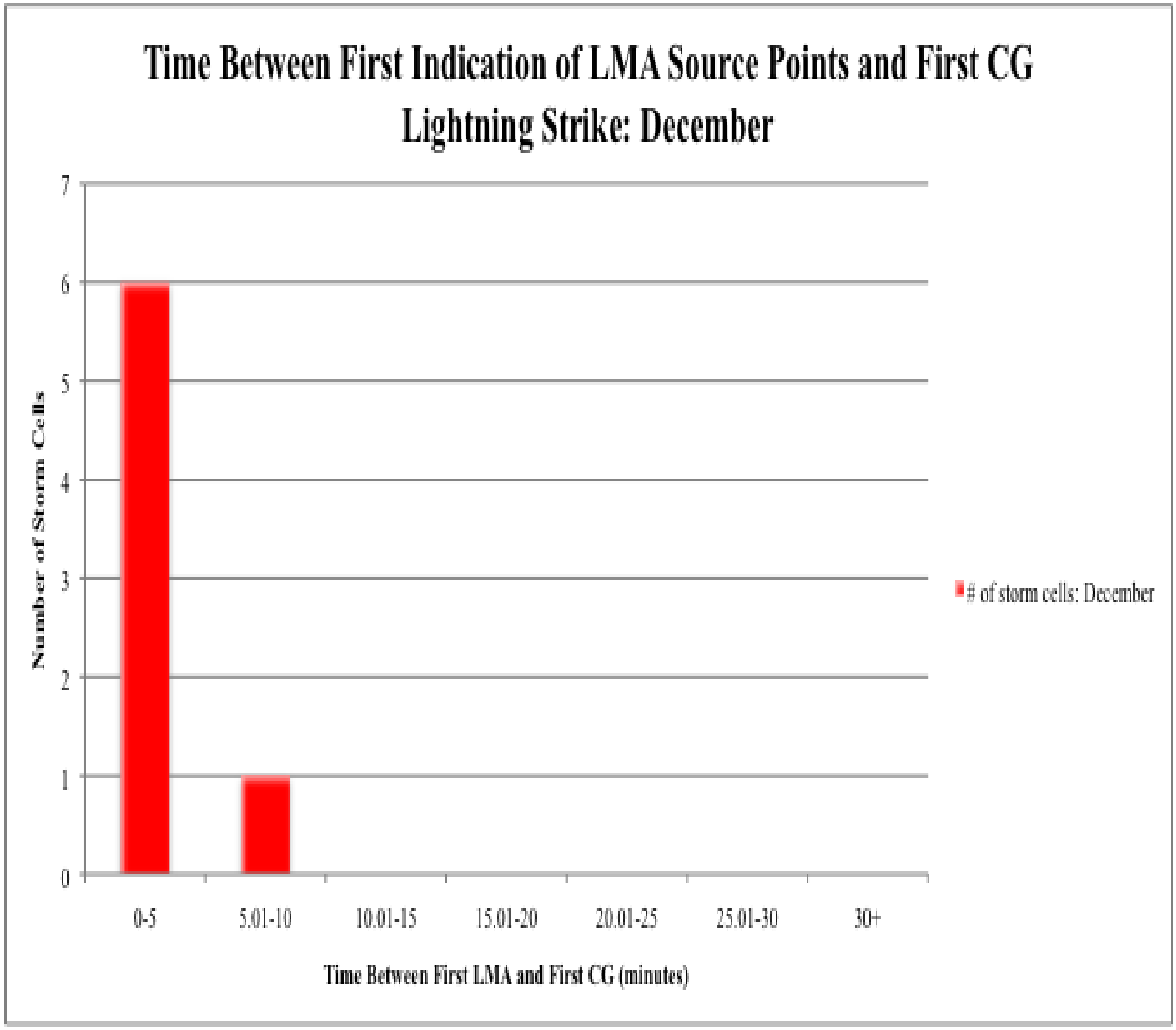



Time Between First Indication of LMA Source Points and First CG Lightning Strike: August
40/52 = 77%
Number of Storm Cells
45
40
35
30
25
20
15
10
5
0
0-5
5.01-10
10.01-15
15.01-20
20.01-25
25.01-30
30+
Time Between First LMA and First CG (minutes)
# of storm cells: August


Time Between First Indication of LMA Source Points and First CG Lightning Strike: March
Number of Storm Cells
10
9
8
7
6
5
4
3
2
1
0
0-5
5.01-10
10.01-15
15.01-20
20.01-25
25.01-30
30+
Time Between First LMA and First CG (minutes)
# of storm cells: March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Number of Storm Cells
0
1
2
3
4
5
6
7
0-5
5.01-10
10.01-15
15.01-20
20.01-25
25.01-30
30+
Time Between First LMA and First CG (minutes)
# of storm cells: December

Conclusions

- For more than half of cases the time between the first radar echo and the first LMA source points was 15 minutes or less.

- There was a tendency for the MT in each category to decrease with increasing time between first radar echo and the first LMA source points.

- There was no discernible pattern in the height differences of all the echo tops relative to the EL or FL as a function of time from radar to vhf sources.

- Average number of CG lightning strikes per storm was ambiguous indicator.

- For storms for which the time between the first radar echo and the first LMA source points was short, it was more likely that radar reflectivity would increase at least 5-10 dBZ following the first CG lightning strike.

- For 70% of cases, the time between first VHF source points and first CG lightning location was 5 minutes or less.