Observing Cloud-to-Ground Lightning In the Act: Prospects for Systematic Imaging of Lightning-Strike Contact Points

Karl D. Stephan
Ingram School of Engineering
Texas State University
San Marcos, TX

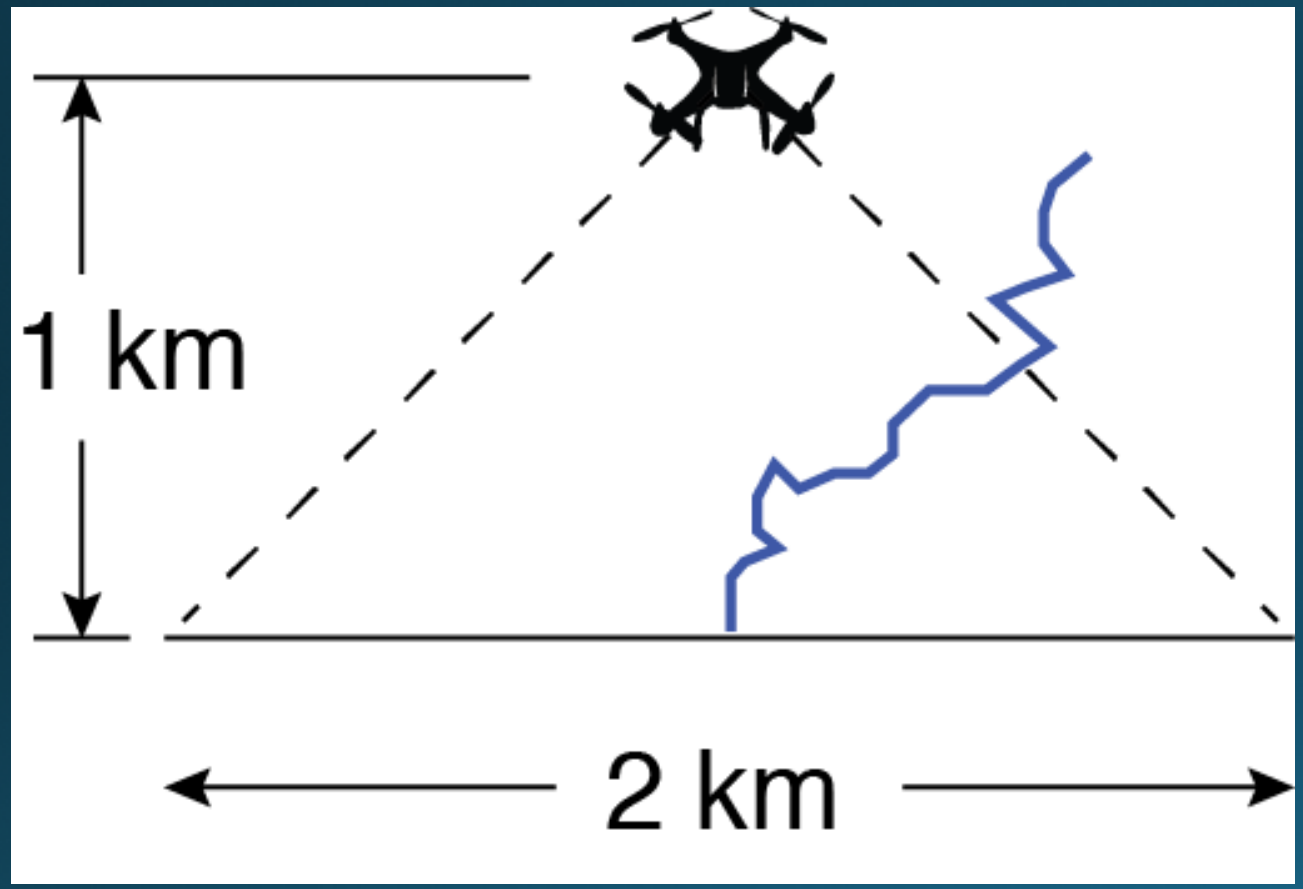
Outline

- Prospects for use of UAVs (drones), advanced imaging
- Coverage statistics
- Challenges
- Conclusions

Example of UAV: DJI Phantom 4 Pro+

- > 20 min. flight time
- 20 Mp camera
- Collision avoidance
- Cost: under $2K

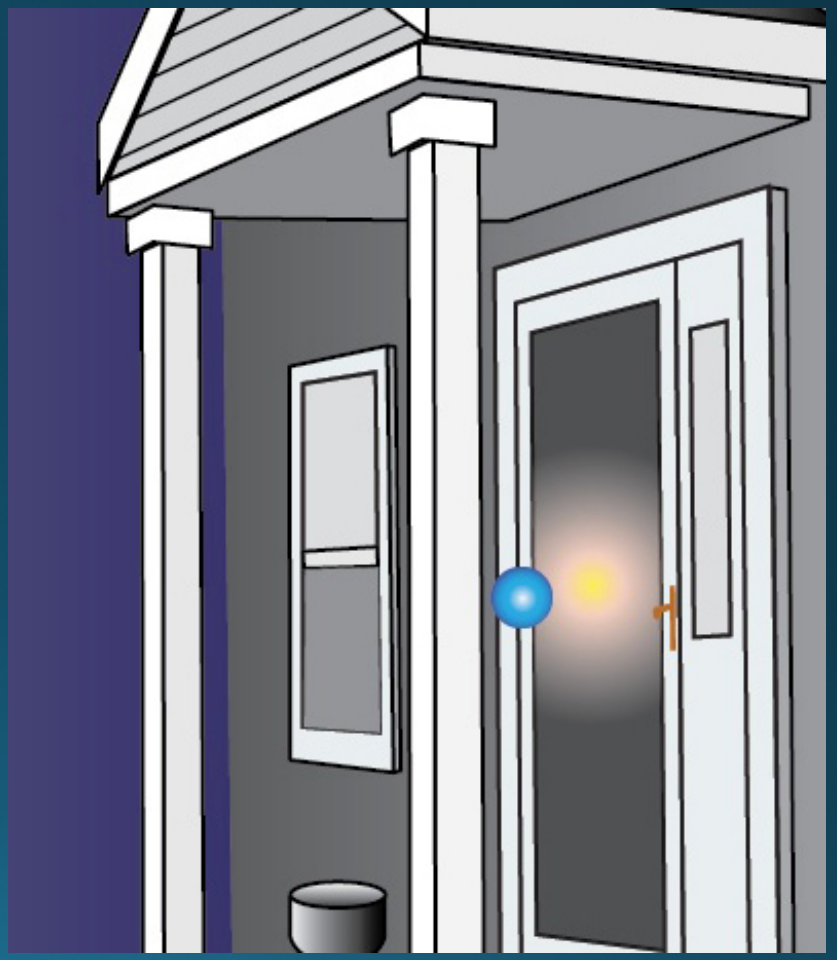
Coverage at 1-km altitude



- FAA Certificate of Authorization needed for >120 m
- Instantaneous field of view (~pixel size) is < 1 m at 1 km altitude

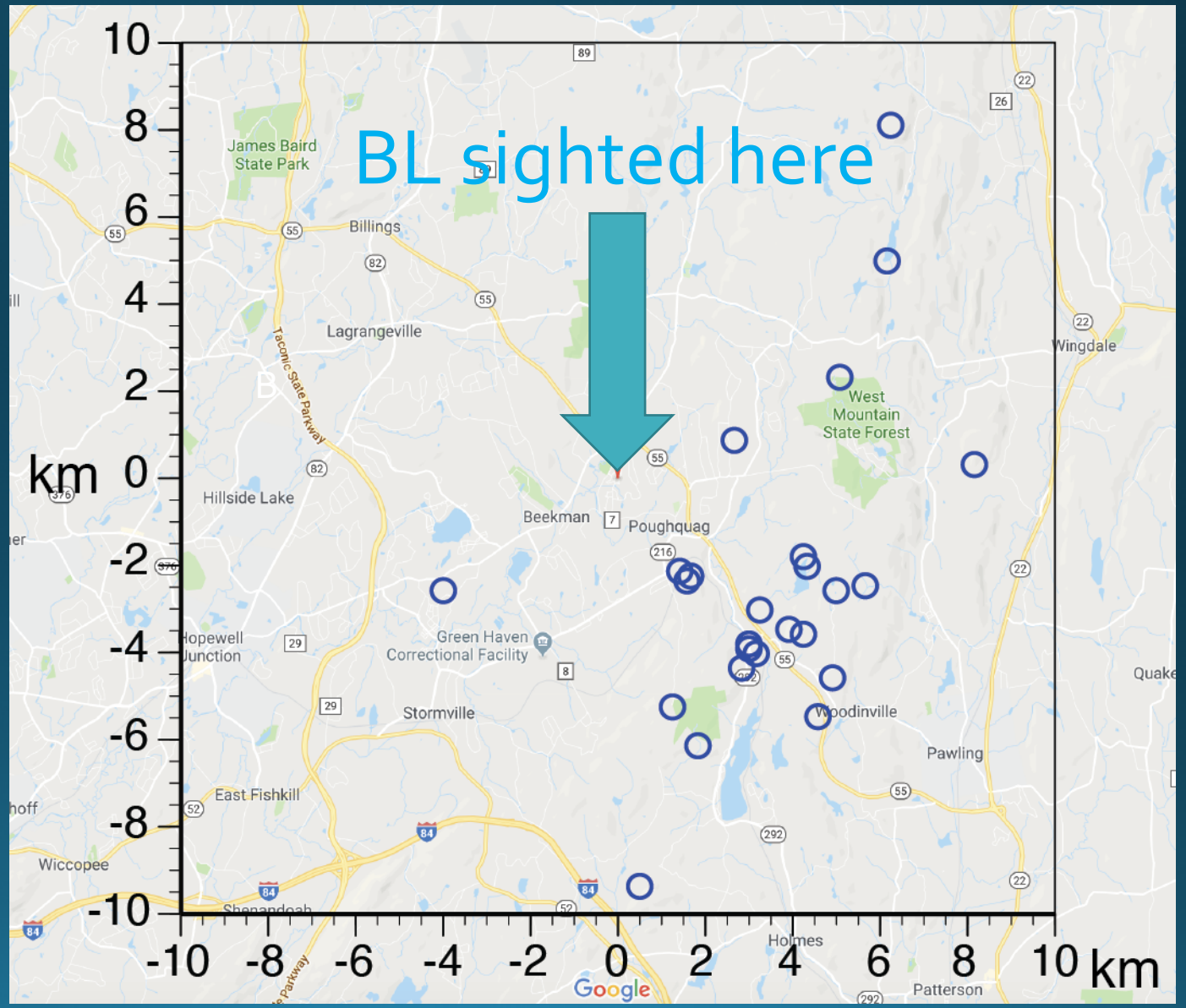
Hypothetical case uses lightning data from actual ball-lightning sighting

- Poughquag, NY, June 23, 2008, ~2100 hr local time
- Cantaloupe-size blue sphere caused door glass to fluoresce a different color
- Described in Stephan et al, *JASTP* **148**, 32 (2016)



NLDN CG lightning record 0000-0010 UTC

- Blue circles indicate CG strikes
- No CG strikes recorded within ~1 km of BL sighting
- Keul & Diendorfer (ICLP 2018): many BL events > 1 km distant from strike

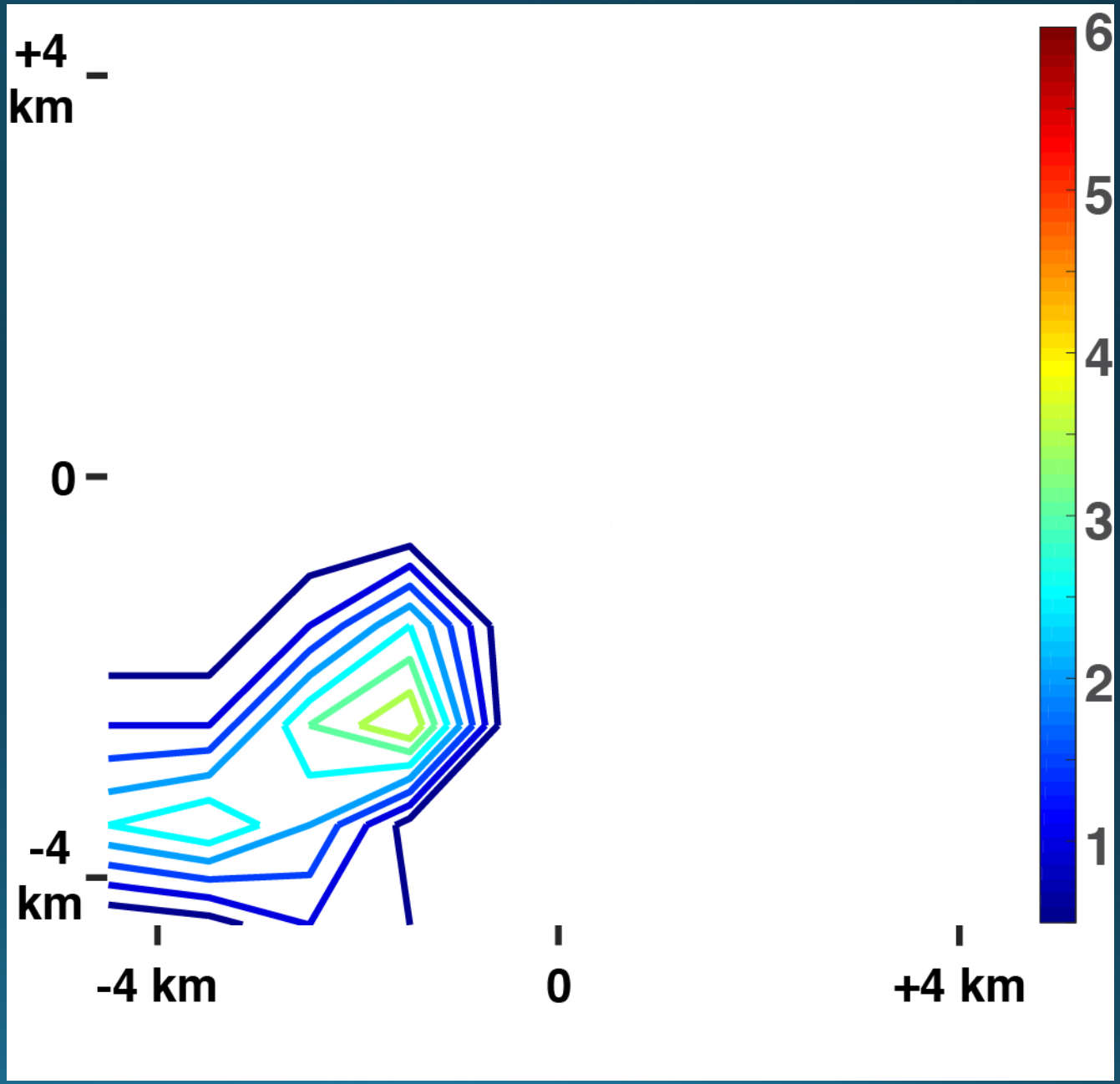


Jan. 10, 2019

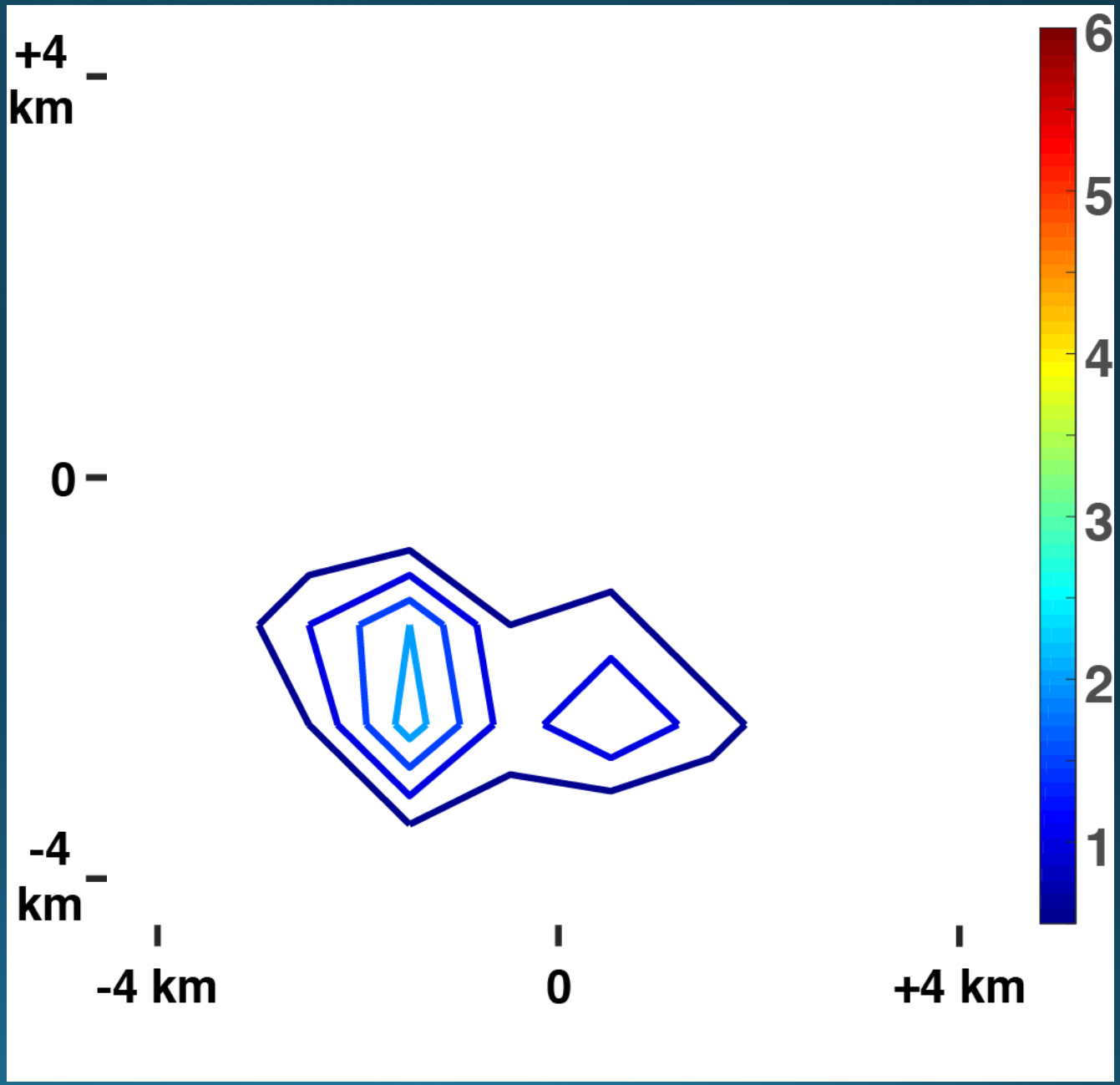
Probability contours of imaging CG strike

- Assume 2-km-dia. observation circle
- 10 min. at 1-km-altitude station
- Ignore visibility issues (rain, obstructions, etc.)

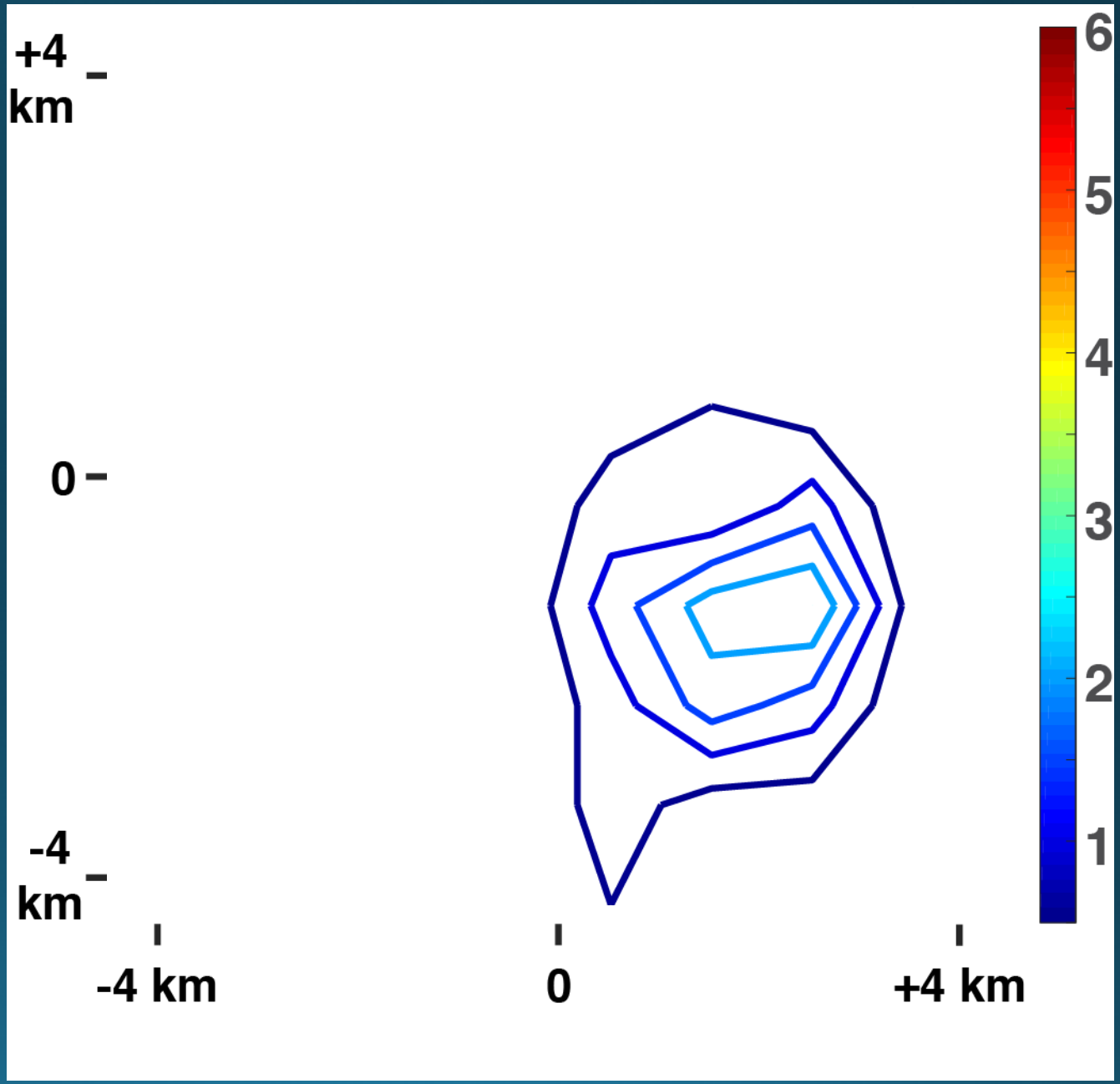
2340-2350 UTC



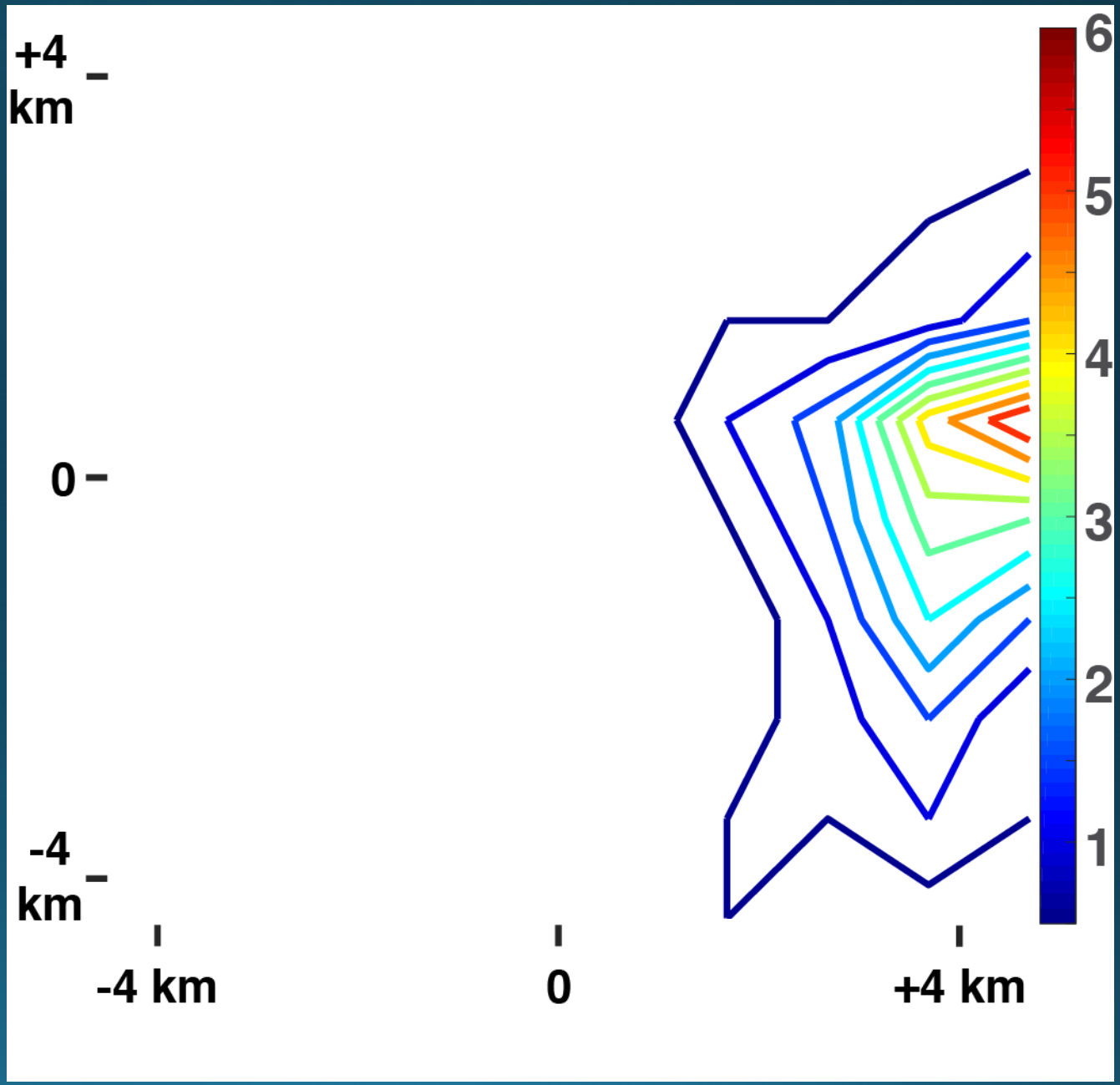
2350-0000 UTC



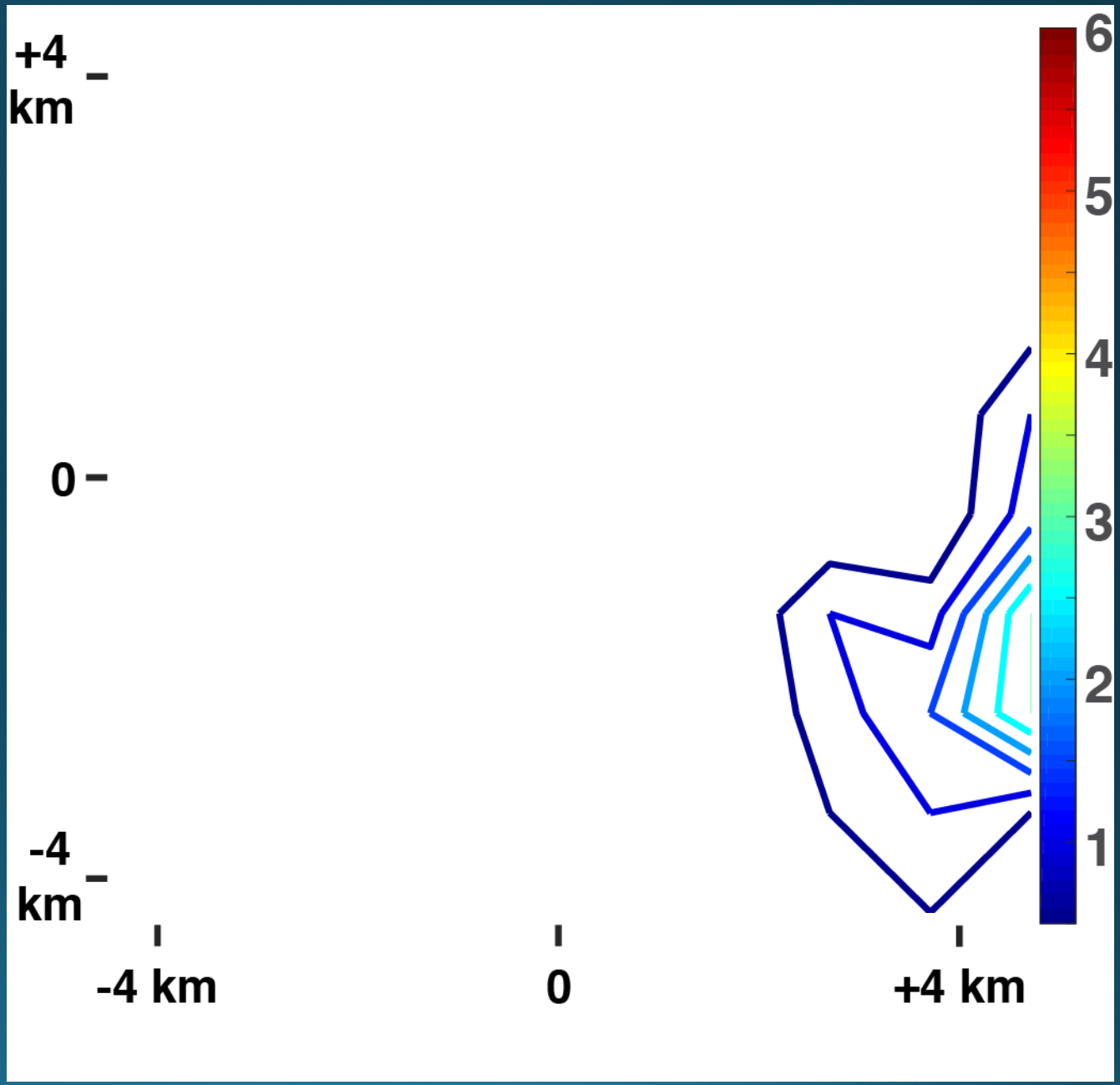
0000-0010 UTC



0010-0020 UTC



0020-0026 UTC



Challenges

- Rain rates >~15 mm/hr reduce visibility to < 1 km
- Wind reduces UAV battery life
- Timing rapidly-moving storm systems challenging
- Day (drone visibility) versus night (better contrast)
- Flight restrictions near airports (=most populated areas)

Conclusions

- UAVs have technical capability to image lightning impact points
- Many challenges make photography of lightning impact points with UAVs difficult
- Focused efforts may discover locations, techniques yielding numbers of lightning impact images

Acknowledgments

- Jennifer Jensen, Dept. of Geography, Texas State Univ.
- Chad Booth, Director, Ingram School of Engineering
- Julian Schwinger Foundation
- Lightning data courtesy Vaisala
- Title slide image courtesy NASA
- *Ad Gloriam Dei*