

North Alabama Lightning Climatology in Support of Lightning Safety Operations

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Introduction

- Lightning a major concern for NASA's Marshall Space Flight Center (MSFC)
- Concern for employee safety as well as protection of sensitive equipment.
- Region observes 4-6 cloud-to-ground strikes per km² each year.
- Can additional safety be achieved through the use of total lightning (cloud-to-ground and intra-cloud) observations from the North Alabama Lightning Mapping Array (NALMA; Koshak et al. 2004).
- NALMA's high resolution will compliment past and upcoming satellite-based lightning observations.
- Goals:
 - 1st of its kind total lightning climatology—Useful for data mining.
 - Understand lightning characteristics in this region.
 - Develop lightning tools for MSFC with potential application elsewhere

Data Used

- NALMA observations from March 2003—August 2015.
- NALMA observes very high frequency (VHF) "sources" to observe the entire lightning channel.
- Sources are combined into flashes with the McCaul et al. (2005) algorithm.
- Domain extends 240 km from network center, although detection efficiency drops with range.
- Flashes must consist of a minimum of 10 sources.
- Basic data set details:
 - 18,440,292 flashes were observed
 - ~1.4 million flashes (cloud-to-ground and intra-cloud) per year
 - ~4.7 billion individual sources observed

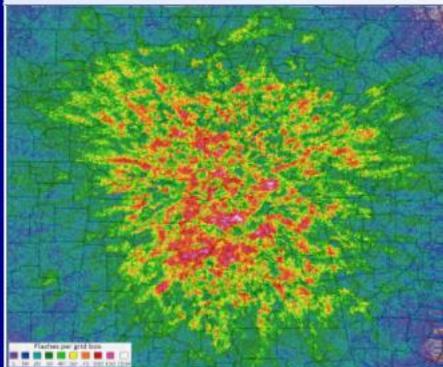


Fig. 1: The flash initiation point density at 2 km² for all 1.84 million observed lightning flashes. NOTE: Density drop-off with range an artifact of NALMA being a line of sight network, resulting in detection efficiency dropping with range.

Preliminary Results

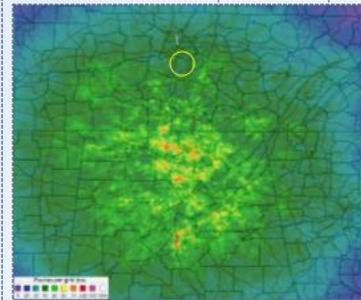
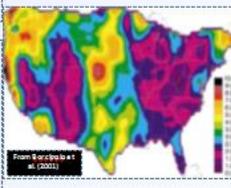
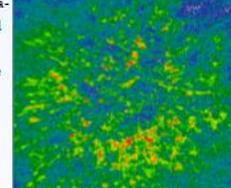


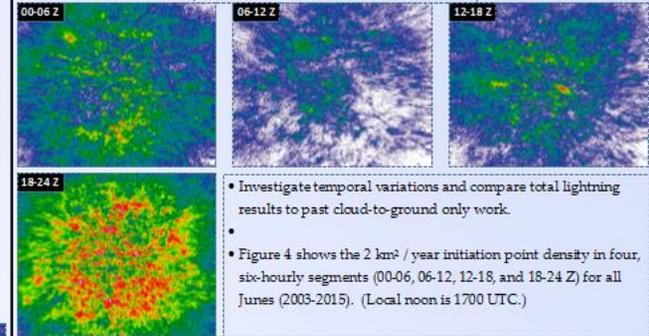
Fig. 2: The 2 km²/year flash initiation point density for the entire March 2003–August 2015 data set. Results comparable to Roccapigio et al. (2001) from satellite observations of 8-32 flashes / km² / year. NOTE: Circled feature is from broadcast tower in Nashville, Tennessee.



• A comparison of the intra-cloud to cloud-to-ground ratio from Roccapigio et al. (2001) [left] versus the same ratio for North Alabama using the high resolution NALMA data [right].



Time of Day Climatologies



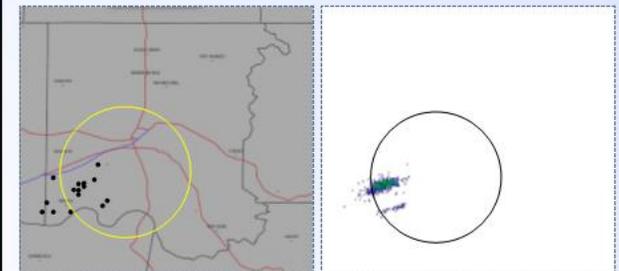
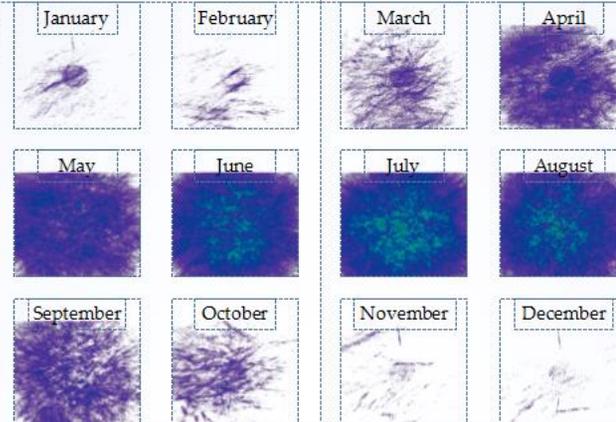
- Investigate temporal variations and compare total lightning results to past cloud-to-ground only work.
- Figure 4 shows the 2 km² / year initiation point density in four, six-hourly segments (00-06, 06-12, 12-18, and 18-24 Z) for all June (2003-2015). (Local noon is 1700 UTC.)

Lightning Extent

- Data set allows for investigating flash extent and "long" flashes.
- MSFC uses a 10 mile ring for points of interest (as used at Kennedy Space Center).
- Figure 5 (left) shows the initiation points of every flash that had some extent within 10 miles (yellow ring) of the center of MSFC on (insert date).
- Figure 6 (right) is the same, but shows the flash extent density of all flashes shown in Fig. 5.
- Note the number of flashes that initiate beyond the 10 mile ring.

Monthly Climatologies

- Broad view of where lightning occurs over region.
- Provides a basic seasonal overview of lightning activity.
- Figure 3 shows the 2 km² / year initiation point density for Jan. through Dec



Summary

- NALMA from March 2003-August 2015 processed into a unique total lightning climatology.
- Goal to develop lightning safety tools for use in real-time and derived from these archived data.
- Very preliminary but establishes a unique data set for data mining.
- Can investigate by many parameters (day, environment, season, etc.).
- Enable more in-depth analysis with respect to storm intensity.
- Combine with long flash work occurring at SPoRT to understand frequency of long flashes impacting points of interest
- Thanks to MSFC for supporting this work.

