Lightning Observations and Analysis of Storms Across the USA

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Mentor: Daile Zhang

1. University of Maryland
2. Arizona State University
3. University of North Carolina Wilmington
4. Texas A&M University

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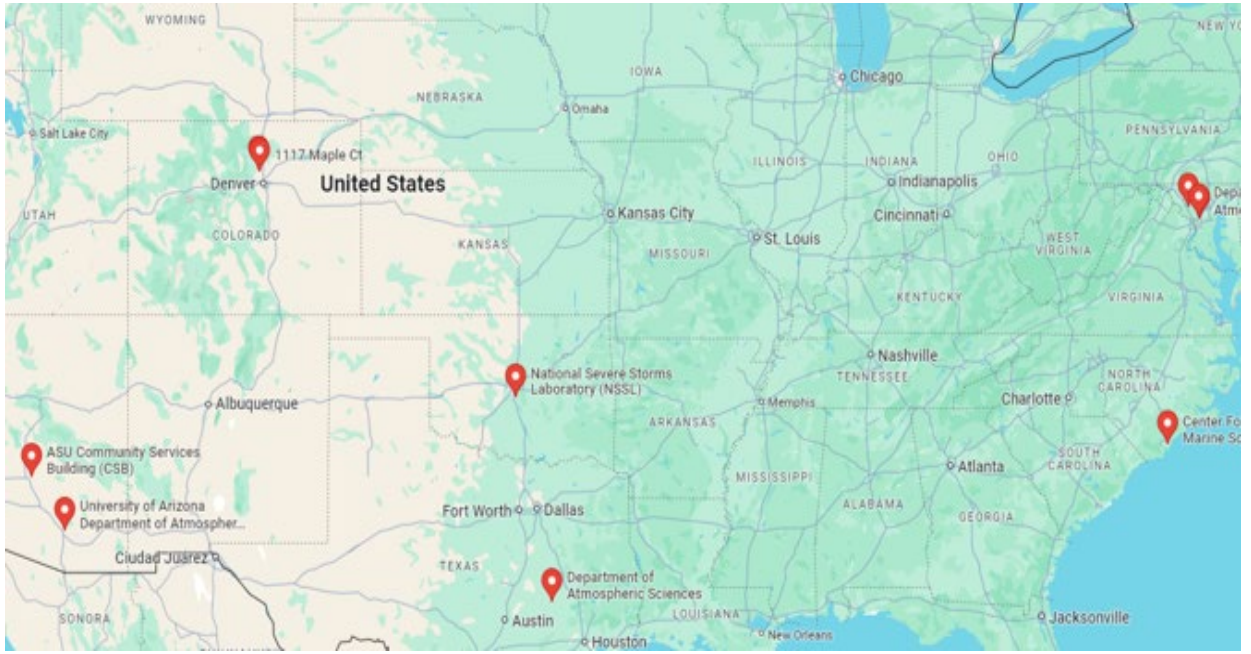
Overview

Research Objectives

- Using Raspberry Pi cameras to capture High Speed Videos of lightning for analysis (90 FPS)
- We want to build a ground-truth to evaluate our sources with other lightning networks including the GLM(Satellite) and NLDN(Ground Detection)
- Analyze physical properties of lightning, such as continuing current.

Locations of Cameras Currently



We have collected more than 400 videos in 2023
and still are collecting videos in 2024

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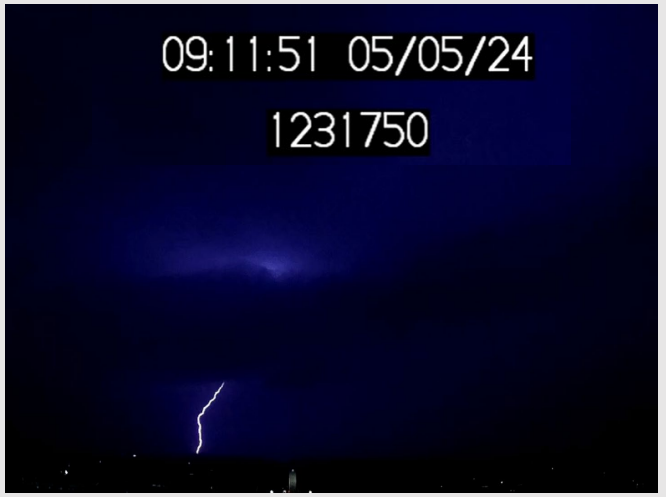
Overview

Examples of Continuing Current



Frame and Video Analysis Broomfield, CO

Bo Cheung

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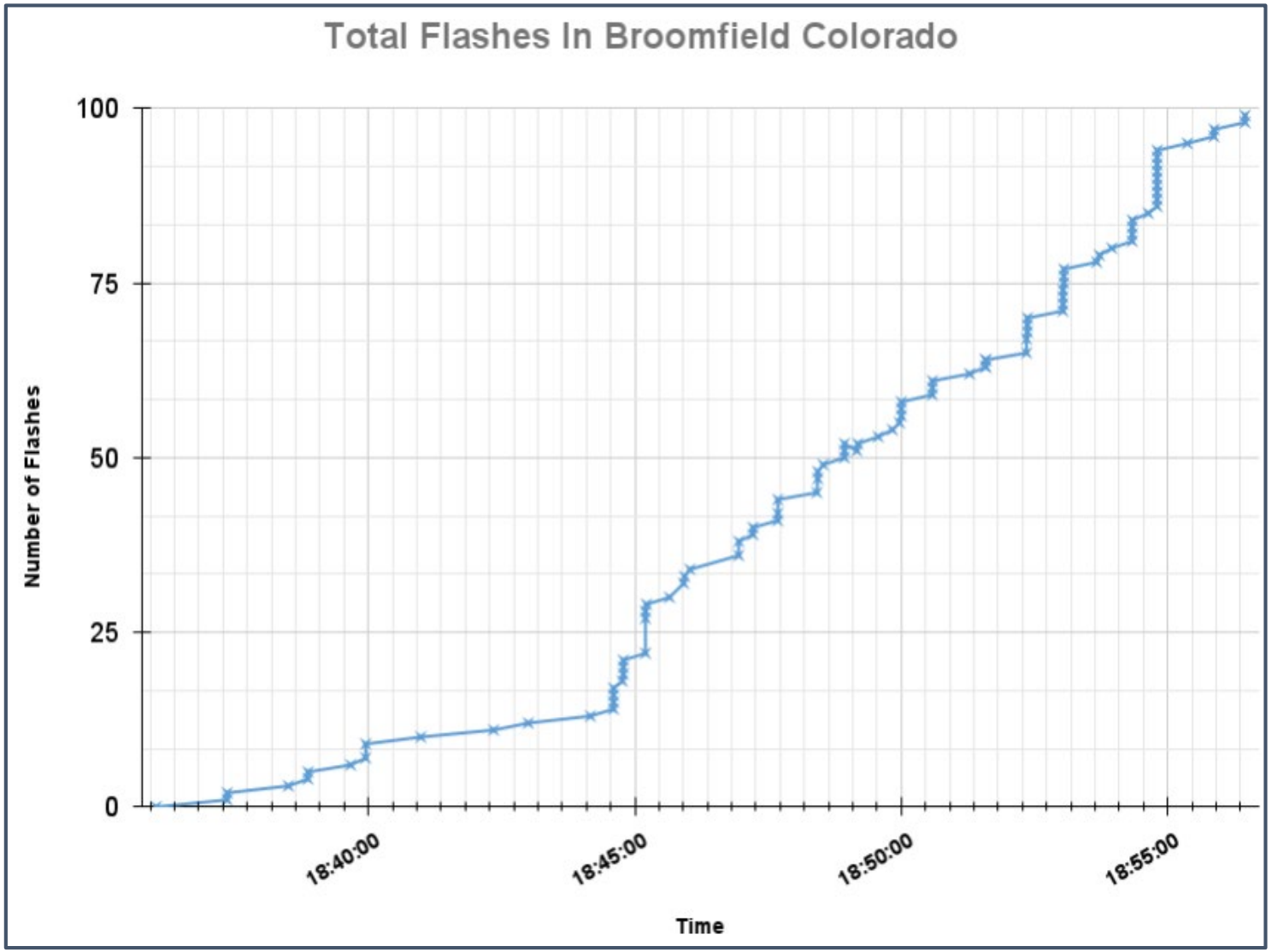
Results in Broomfield, Colorado

- During the Summer I analyzed over 100,000 frames
- I have found 99 flashes of lightning, all of which are IC lightning.
- Colorado as a state typically has more CG lightning ranking 19th in most CG lightning according to NOAA



Frame and Video Analysis Broomfield, CO

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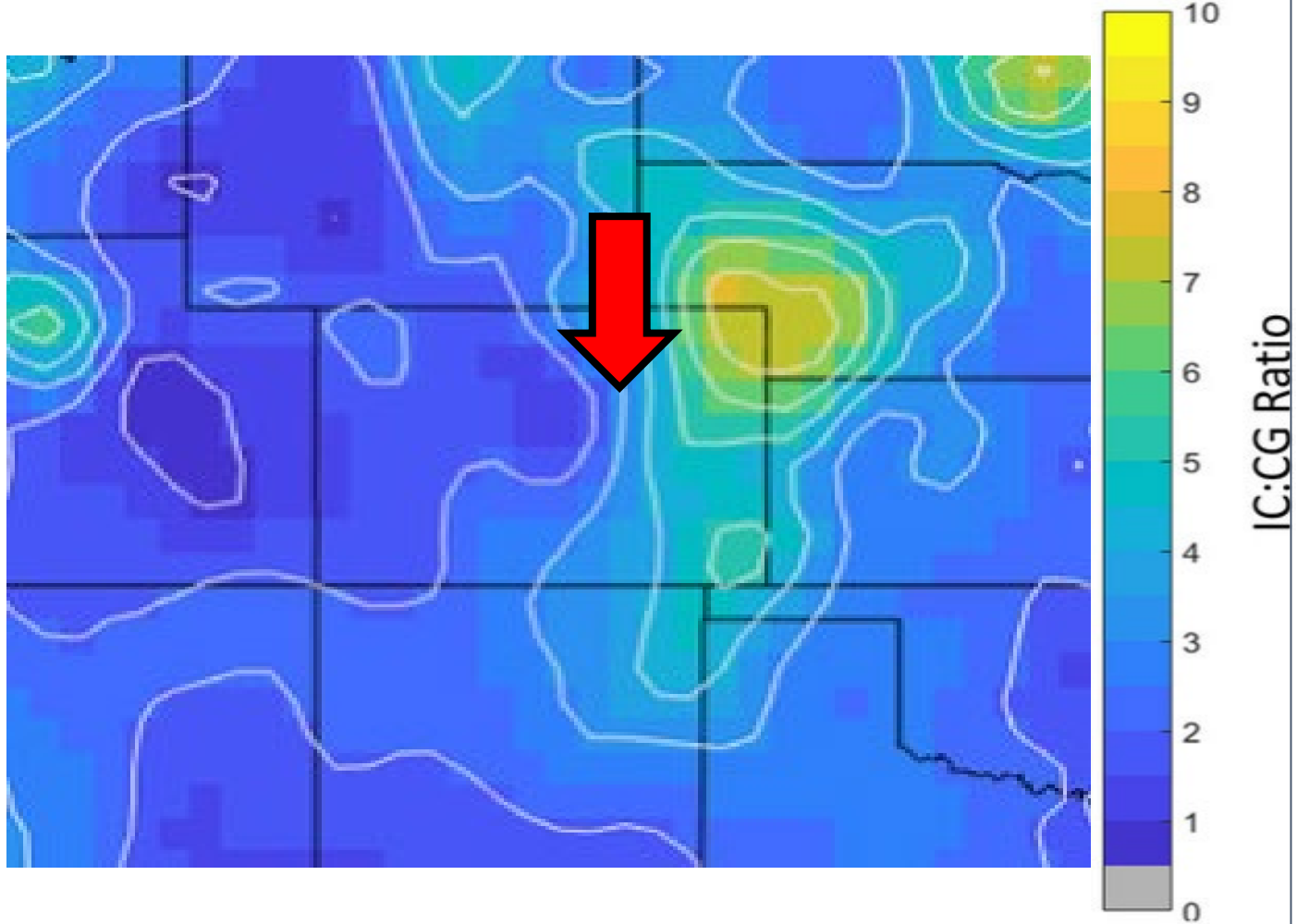
Limitations and Future plans for Broomfield, Colorado

- This storm is not a concrete on the conditions of colorado storms, more data is necessary
- Further analysis of Broomfield is necessary to learn more about typical storms in this area
- Comparisons with other collection networks is also necessary to verify their findings along with ours



Frame and Video Analysis

Bo Cheung

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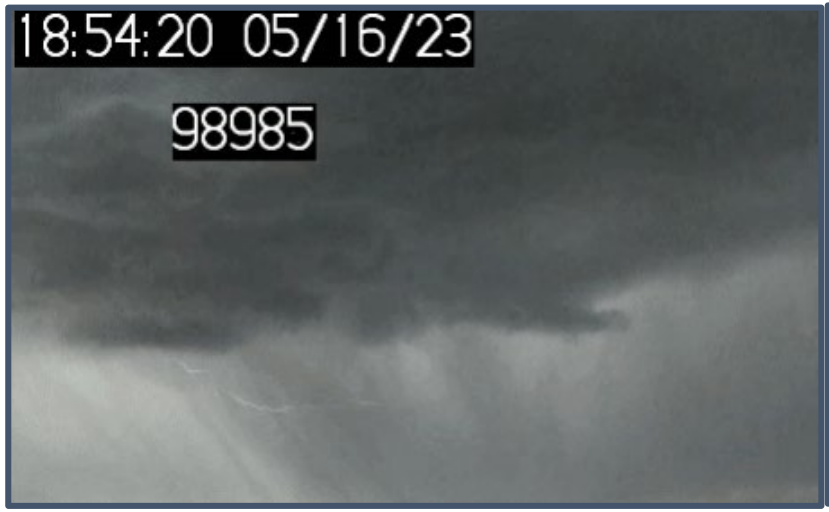
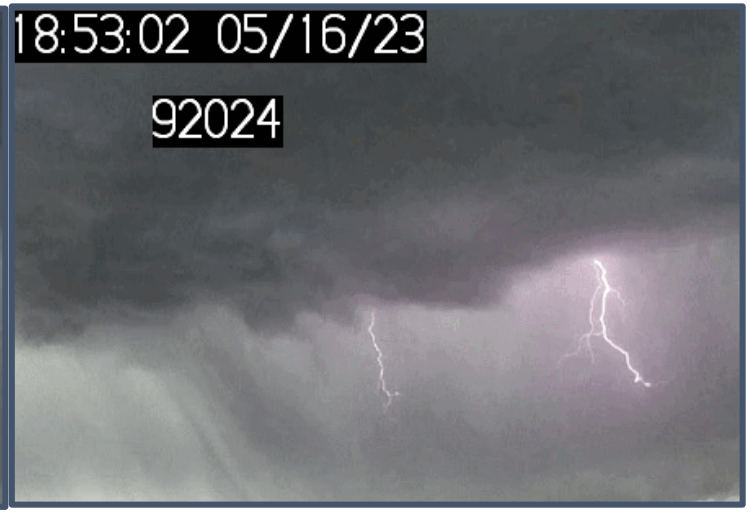
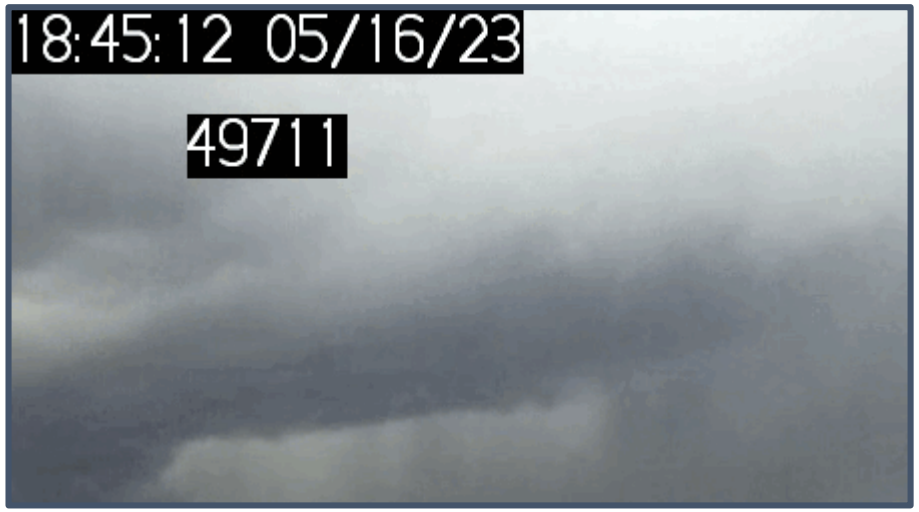


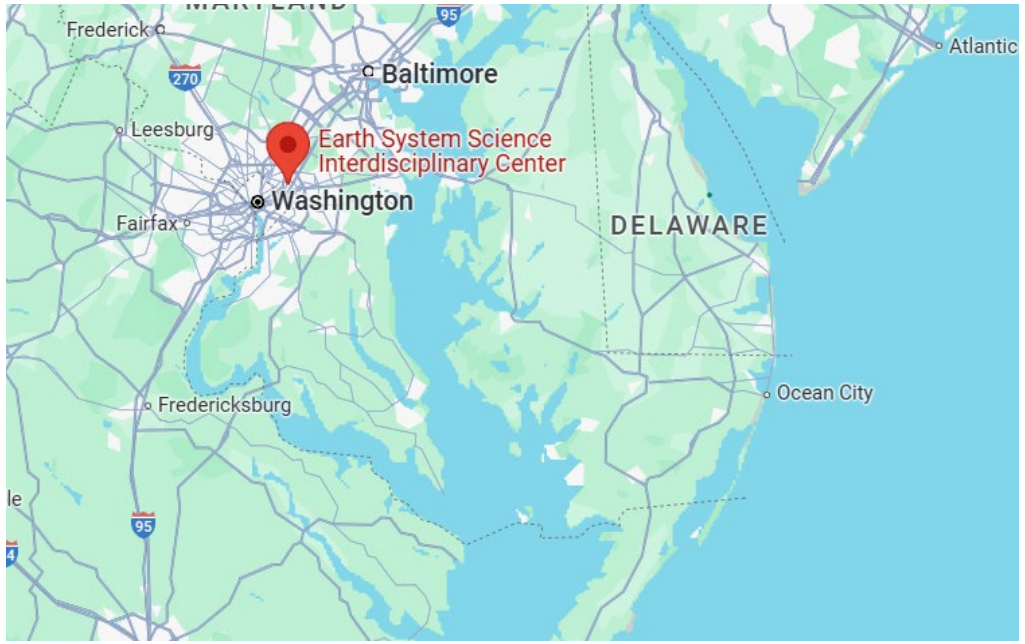




Maryland Frame and Video Analysis

Humberto Tolentino

- There have been 11 days of thunderstorms so far since beginning of the summer in College Park, MD.
- Maryland is located near the center of the GOES 16 GLM coverage. The goal is to establish a standard for other stations.



College park location located on the 3rd floor of the CISESS Building.

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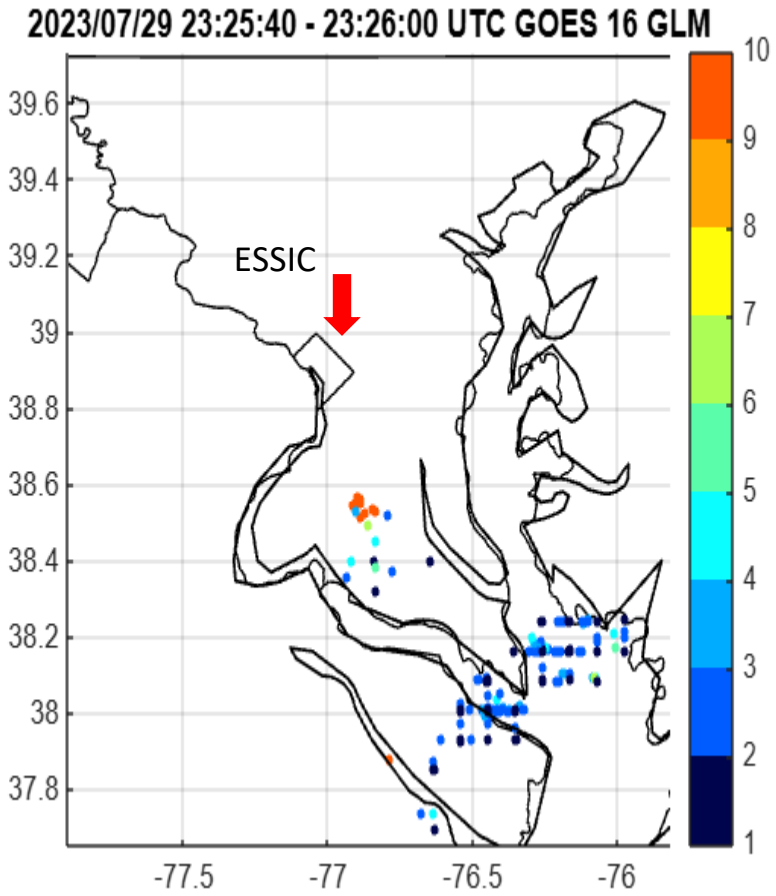
Results in College Park, Maryland

- 7 thunderstorms were recorded over the summer.
- Most of the storms observed during took place in the late evenings.
- However, due to an unfortunate error, all the video data I had gathered for the summer of 2024 has been lost.
- I instead will use footage from 2023.

Figure(s)



Lightning events from July 7th, 2023, scale displays amount of events GLM detected.

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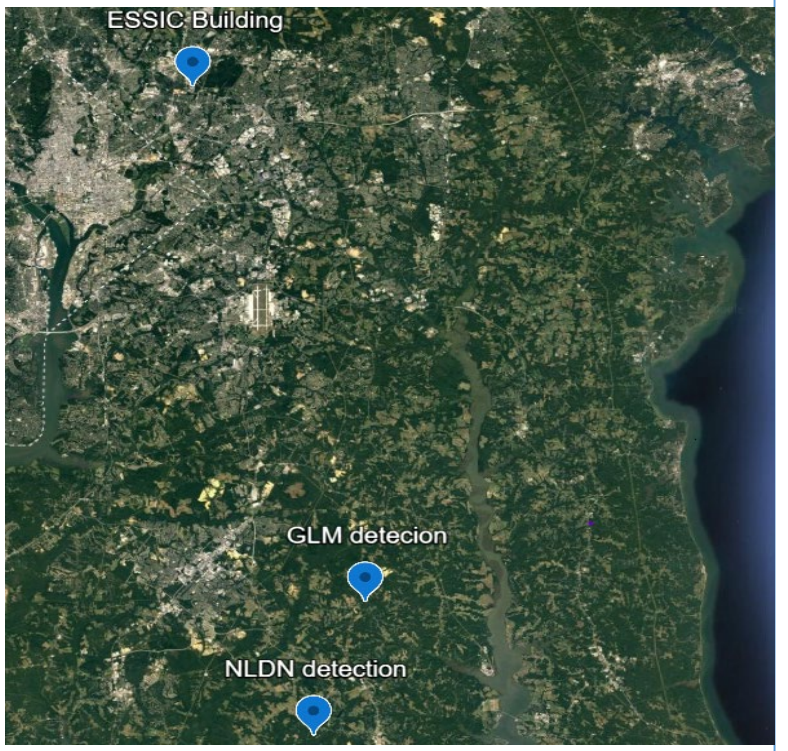
Results in College Park, Maryland

- Using NLDN data as the standard revealed that the GLM data often differed by several kilometers.

Figure(s)

Detection from both GOES 16 GLM and NLDN on July 7th, 2023, 23:25:42:056 UTC



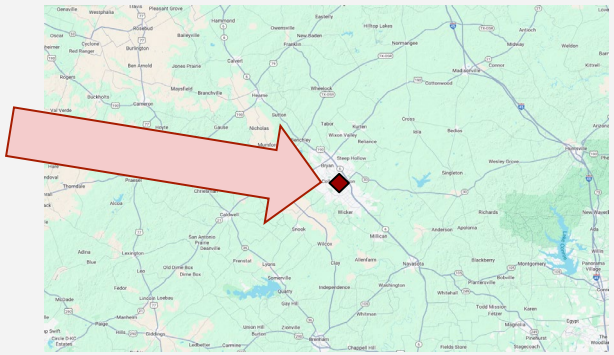
Detection from both GOES 16 GLM and NLDN on July 7th, 2023, 23:25:42:1132 UTC

Overview - College Station, TX

Methodology

Using low-cost, high-speed raspberry pi cameras to ground-truth the occurrence of lightning, five thunderstorms in May were documented.

Over the course of May 2nd, 5th, and 10th, 131 CG strokes were recorded with 29 being continuing current CG strokes. NLDN Ground-Sensor data was used to approximate CG location.



Process

- NLDN data was used for the precise location of all CGs processed given it's high detection efficiency and accuracy.
- To account for any erroneous results, the closest group centroid to the NLDN confirmed CG stroke within +/- 10 ms was used to estimate distance error.
- GLM Events correlated with the group centroid were also plotted to compare the accuracy of the highest energy event to the NLDN CG.

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Results

- Detection Efficiency during the day was low with 54% of strokes detected, compared to 81% overnight.
- Accuracy varied depending on the storm, but daytime had the highest accuracy with an average error of 6.6 kilometers vs. 7.7 kilometers overnight.
- Overall, the group centroid was more accurate than the maximum event energy.

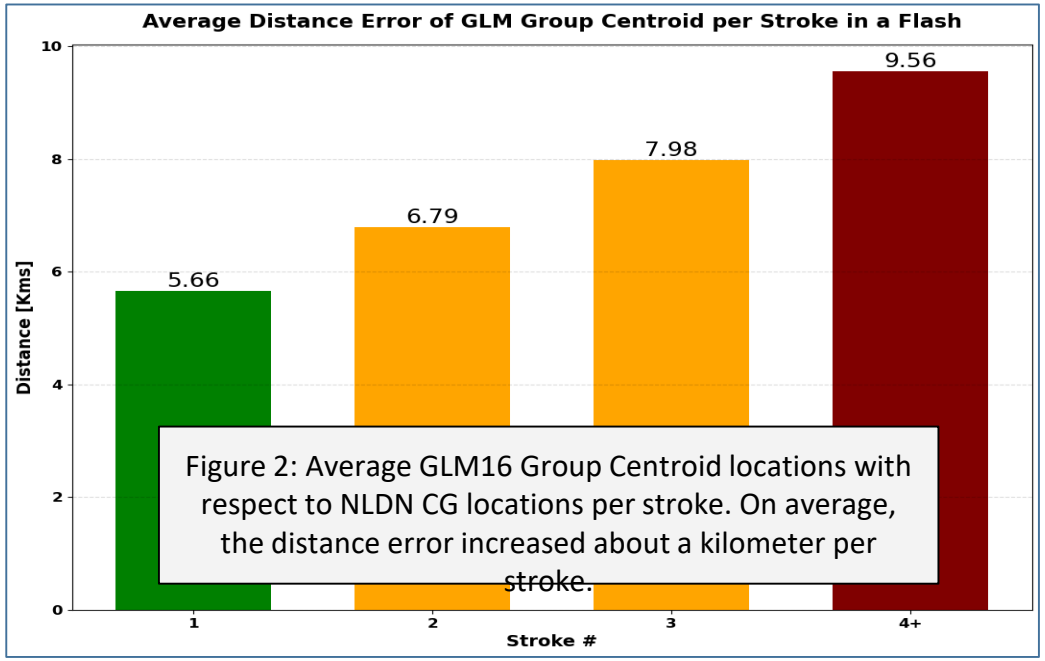

Figure 2: Average GLM16 Group Centroid locations with respect to NLDN CG locations per stroke. On average, the distance error increased about a kilometer per stroke.

Figure(s)

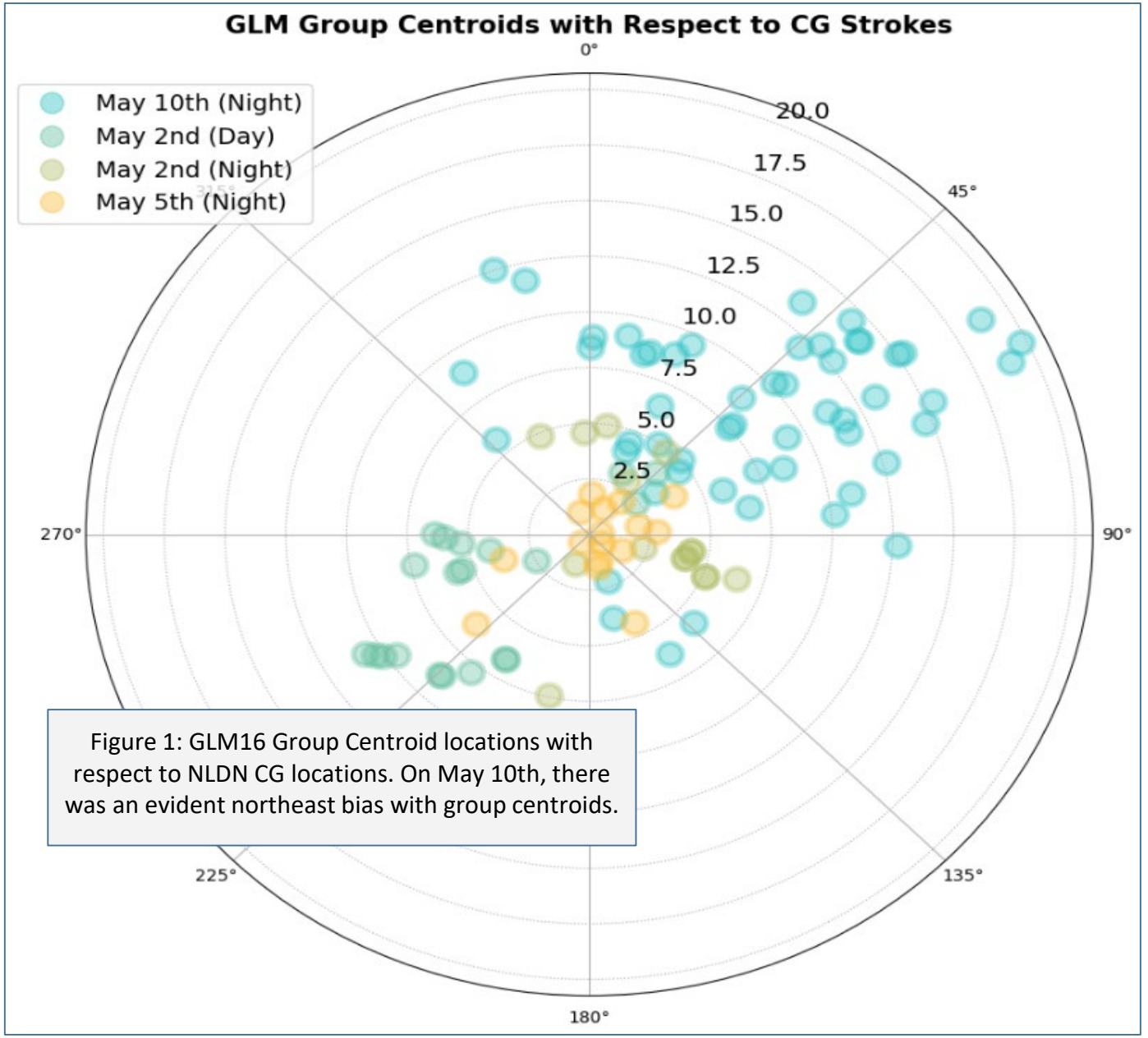

Figure 1: GLM16 Group Centroid locations with respect to NLDN CG locations. On May 10th, there was an evident northeast bias with group centroids.

Raspberry Pi Lightning Observations in Wilmington, NC

Bethni Aloka
Mentor: Daile Zhang

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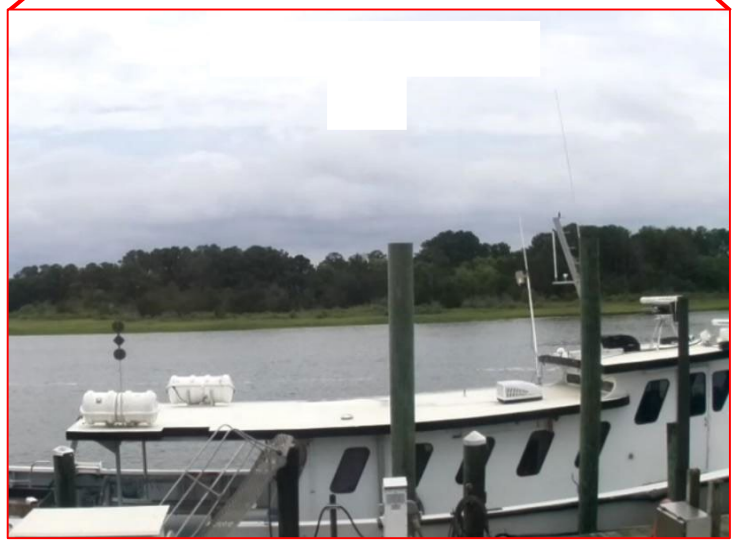
Significance of the Location

Only station facing to open water

Located right next to the ocean



The Raspberry Pi Camera field of view - On the Coast of Wilmington, NC, Camera aiming towards the open water

Raspberry Pi Lightning Observations in Wilmington, NC

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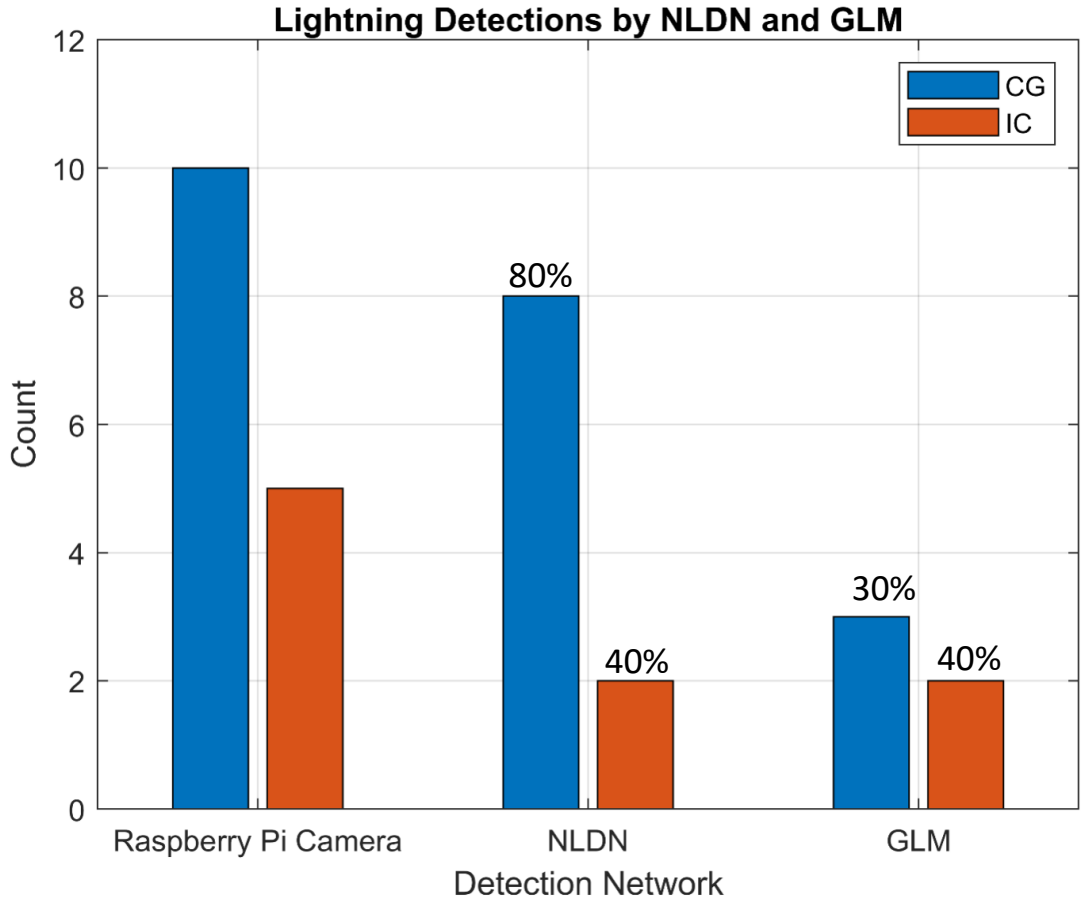
Results

- **6** thunderstorm days
- **10** Cloud-to-Ground (CG) strokes, **5** Intra-Cloud (IC) pulses and **260** reflection frames

- These results are based on a limited database
- Further data collection will be necessary



NLDN CG Detection Efficiency – **80%**
NLDN IC Detection Efficiency – **40%**

GLM CG Detection Efficiency – **30%**
GLM IC Detection Efficiency – **40%**

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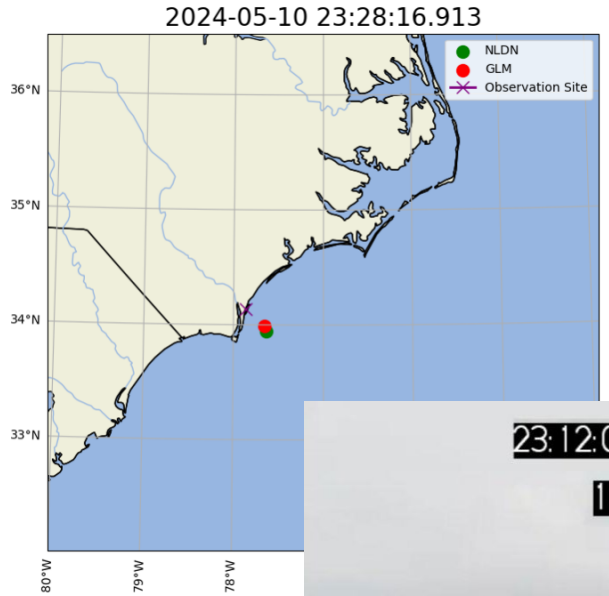
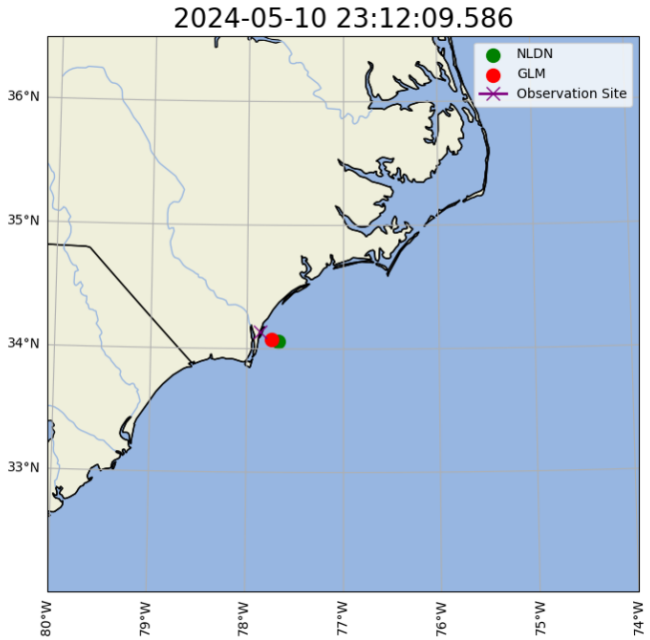


CG Stroke detected by both NLDN and GLM



IC Pulse detected by both NLDN and GLM

Raspberry Pi Lightning Observations in Wilmington, NC

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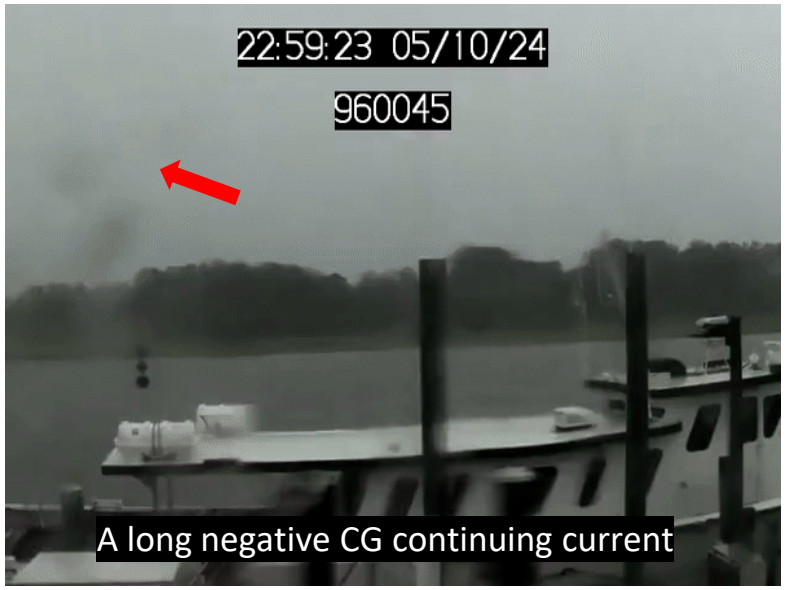
- Detection of a rare +CG lightning event in North Carolina

A rare positive CG stroke



A long negative CG continuing current

A three stroke multi striking point negative CG flash

A rare CG flash where both strokes missed by the NLDN

Raspberry Pi Lightning Observations in Tucson, AZ

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Mentor: Daile Zhang

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The North American Monsoon

This site follows the North American Monsoon, which is a seasonal reversal of winds often associated with an increase in rainfall in a region.

The North American Monsoon usually lasts between the middle of July and the end of September.

- Last year was an incredibly disappointing year for the arizona monsoon season, some even calling it a “non-soon”.
- Luckily, the 2024 monsoon season came swinging!
- Starting weeks before usual, it has been storming almost daily, with storms occurring during the late day to evening.
- I have collected 31 videos of storms and counting, some of which have more than 20 separate recorded lightning strikes!

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Raspberry Pi Lightning Observations in Tucson, AZ

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Day Strikes

Sunset Strikes!

Night Strikes

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