Optimizing the lightning warning radii at spaceport florida

Dawn Sanderson

Edward White

Andrew Geyer

William Order

Alex Gutman

Overview

- Background & Problem Statement

- Data & Methodology

- Results

- Empirical Validation

- Conclusion

Background

- **Lightning watch** – 30 minutes prior to thunderstorm within 5 NM radius of predesignated location or activity

- **Lightning warning** – in place once lightning occurs within a 5 NM radius, personnel seek shelter

- **45 Weather Squadron (45 WS) located on the central eastern coast of Florida**
  - Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center (KSC), Patrick Space Force Base (PSFB)
  - Weather safety for over 25,000 personnel and $20 Billion of resources
  - Thunderstorm capital of the United States
  - Over 2,500 lightning watches and warnings per year
  - 10 Lightning Warning Circles – 5 and 6 NM radii
  - Lightning warnings in particular cause large losses in productivity

Problem Statement

- 45 WS discovered a discrepancy in the methodology of past studies and the process of warning issuance

    - Past studies looked at distance from the center of the storm

    - 45 WS issues warning based on the edge of the storm

- **Research Question:** What is the shortest approximate distance from the edge of a preexisting lightning area that incorporates both the necessary safety requirements and risk of being struck?

Can we save time while maintaining safety of life and property by reducing the 5 NM warning distance?

Methodology – Game Plan

- Create boundaries around lightning storms and measure the distance lightning strikes beyond the edge of the boundary

- Find a distributional fit for the distance lightning strikes beyond the edge of the boundary

- Determine if a shorter distance (< 5 NM) can be safely used as the new standoff distance for lightning warnings

- Test the new distance using an empirical validation approach

Data

- Lightning Detection and Ranging II (LDAR) System

  - Produce a single 3D location and time for each lightning event (source point)

- Flashified LDAR data

  - Any two source points within 0.3 seconds and 3,000 meters are grouped as part of the same flash

  - Data contained: Date, Time, X, Y, Z coords

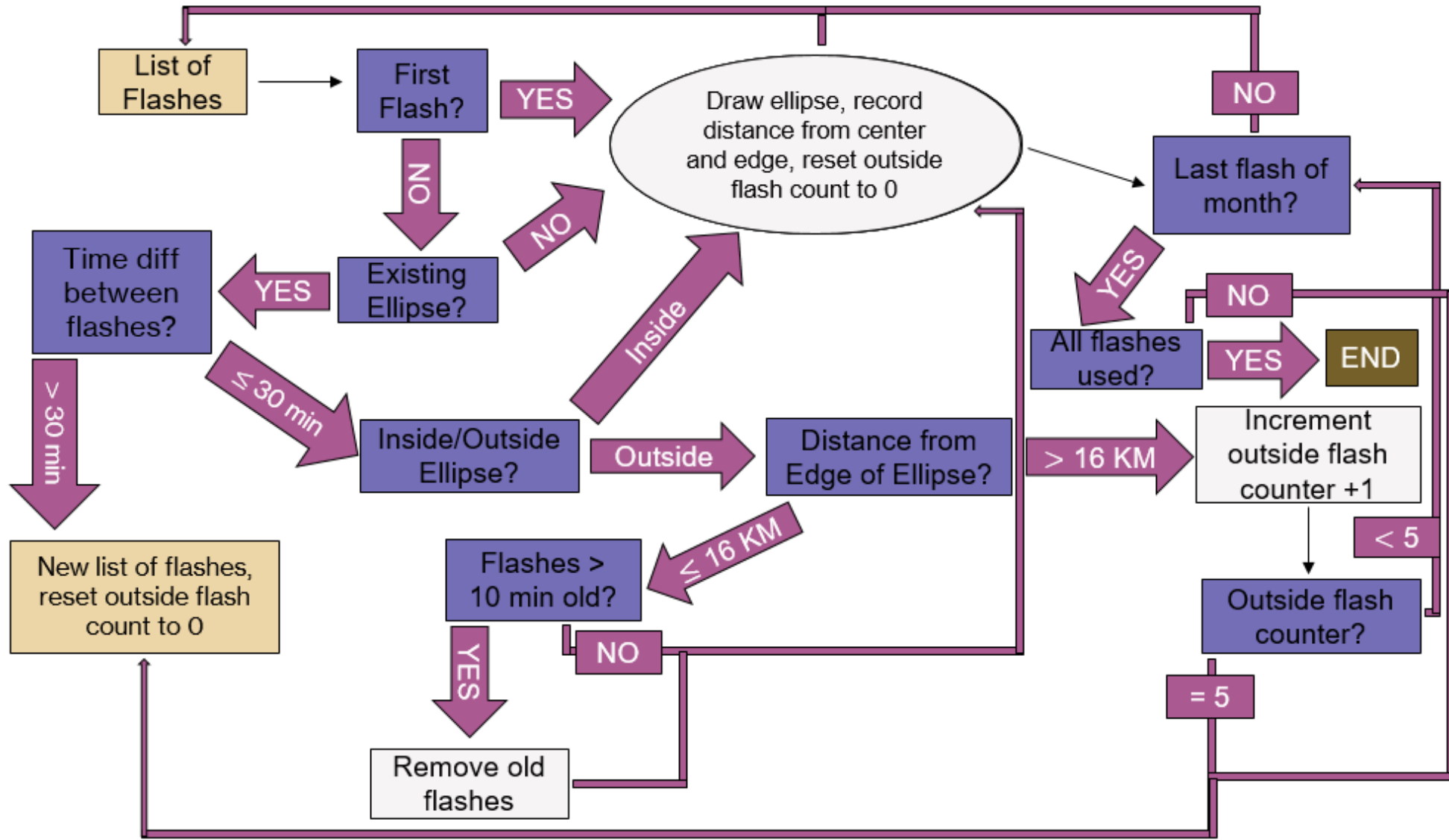 - Data reduction: May-September, 2013-2016 (20 Months), flashes with $\geq$ 5 source points, flashes within 25 NM radius
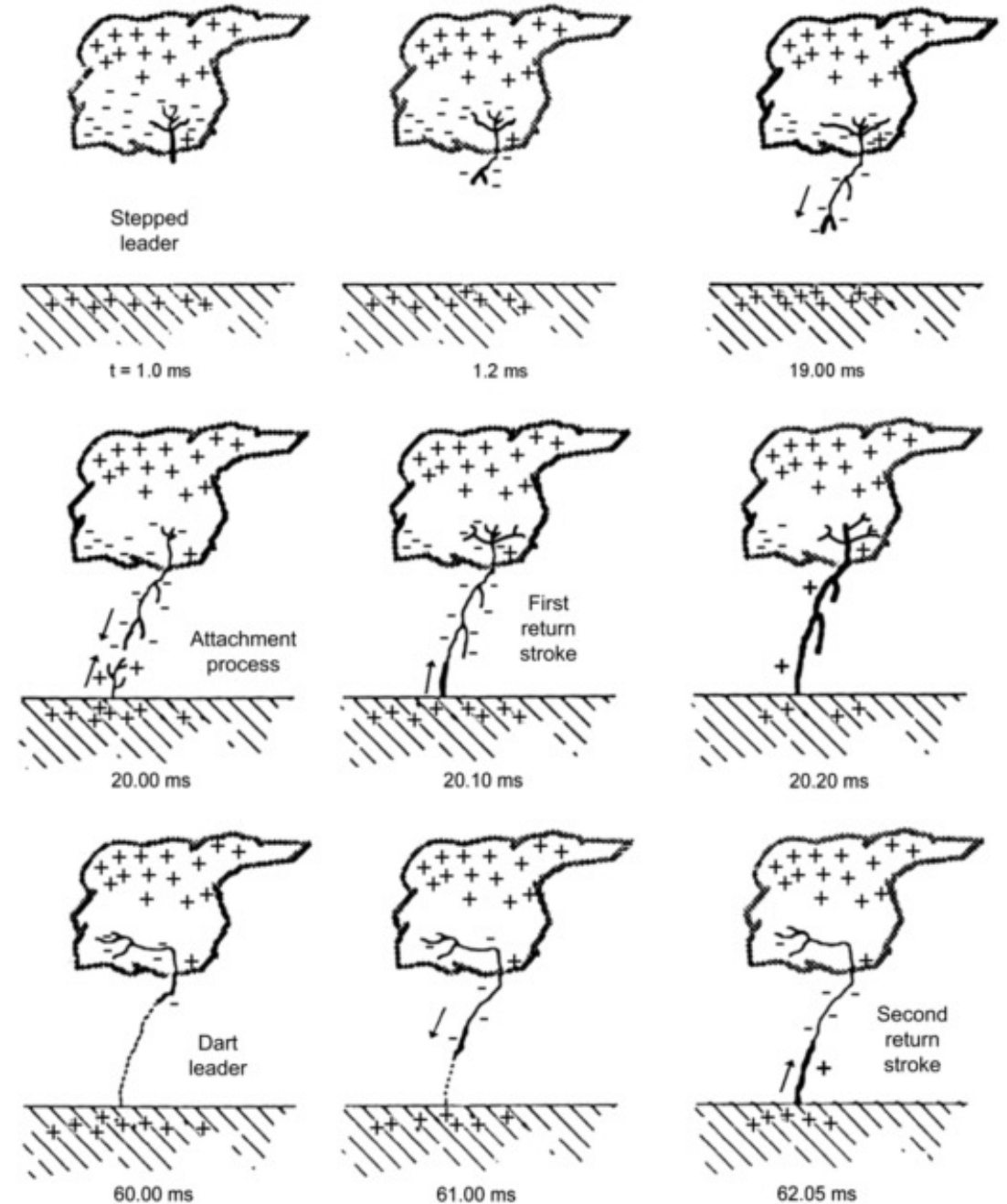
Data – Example

- Example of the largest flash from June 2013 with 1,321 source points

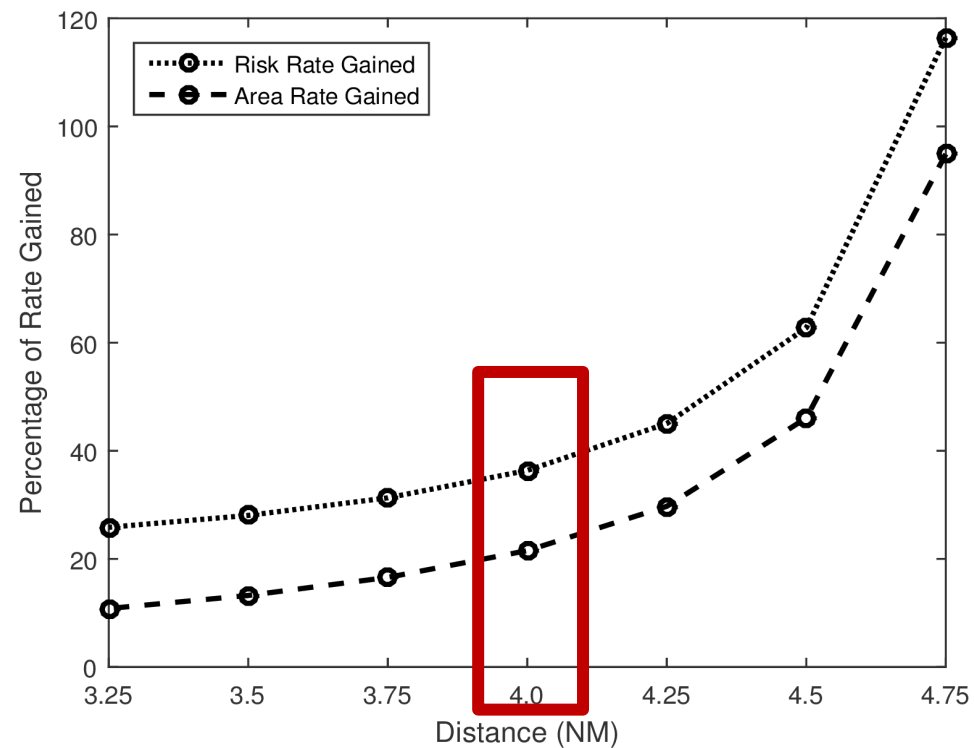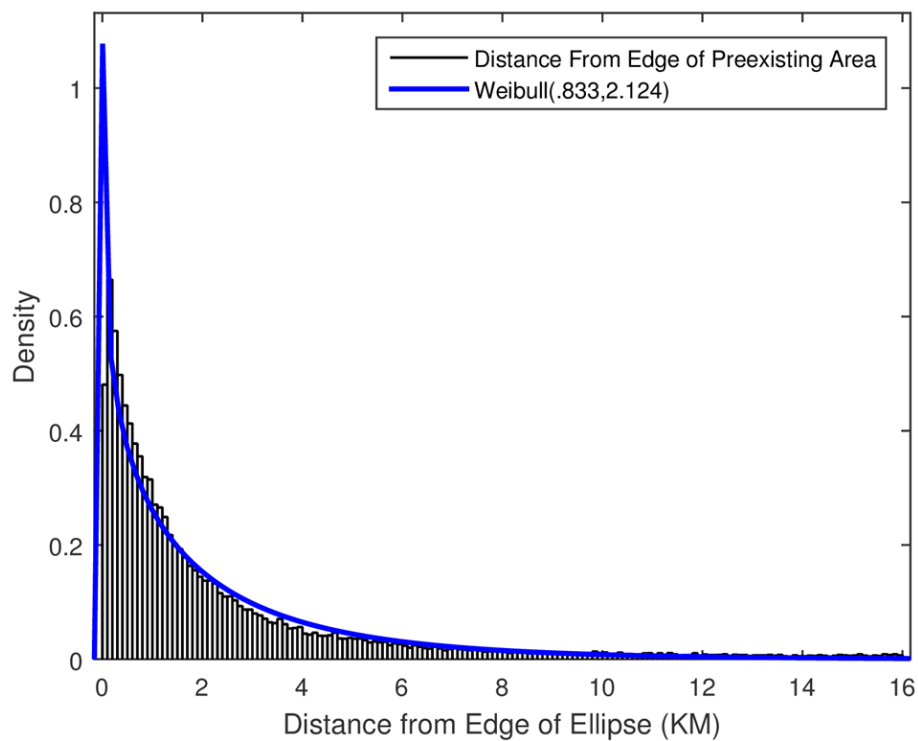- Extreme source points indicated in red – obtained using a convex hull
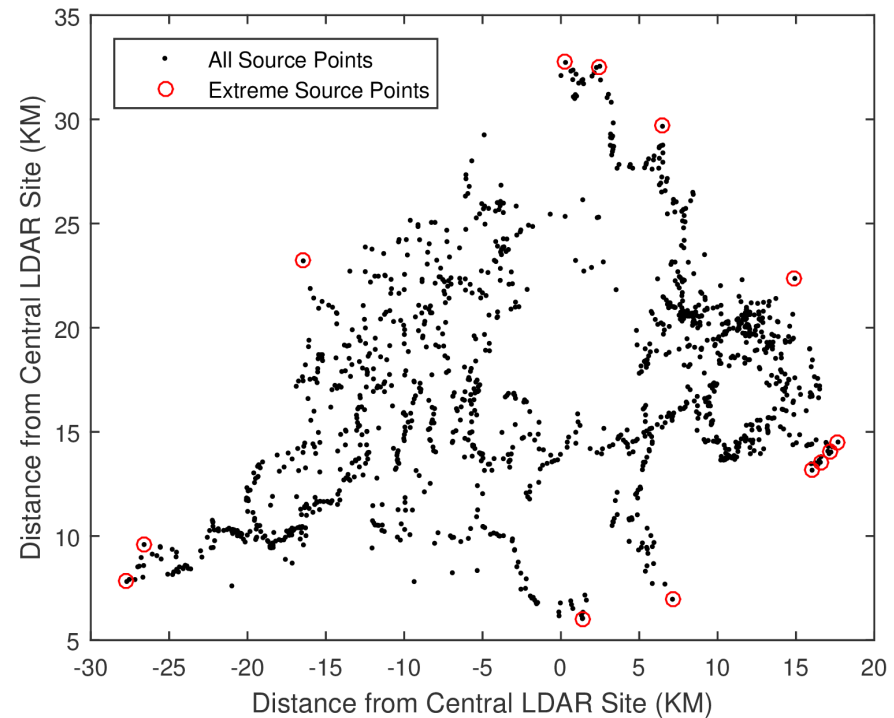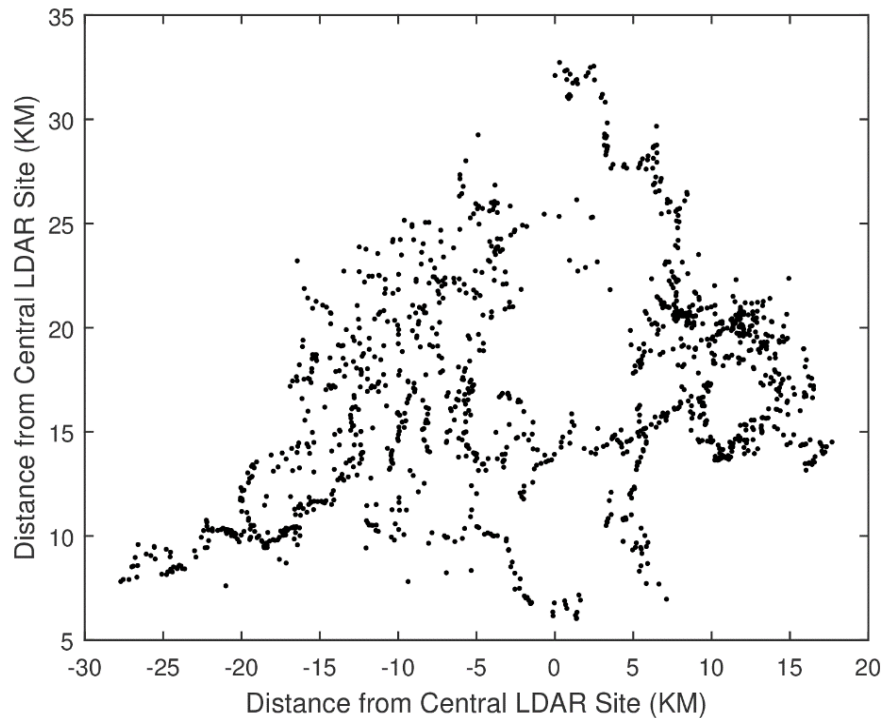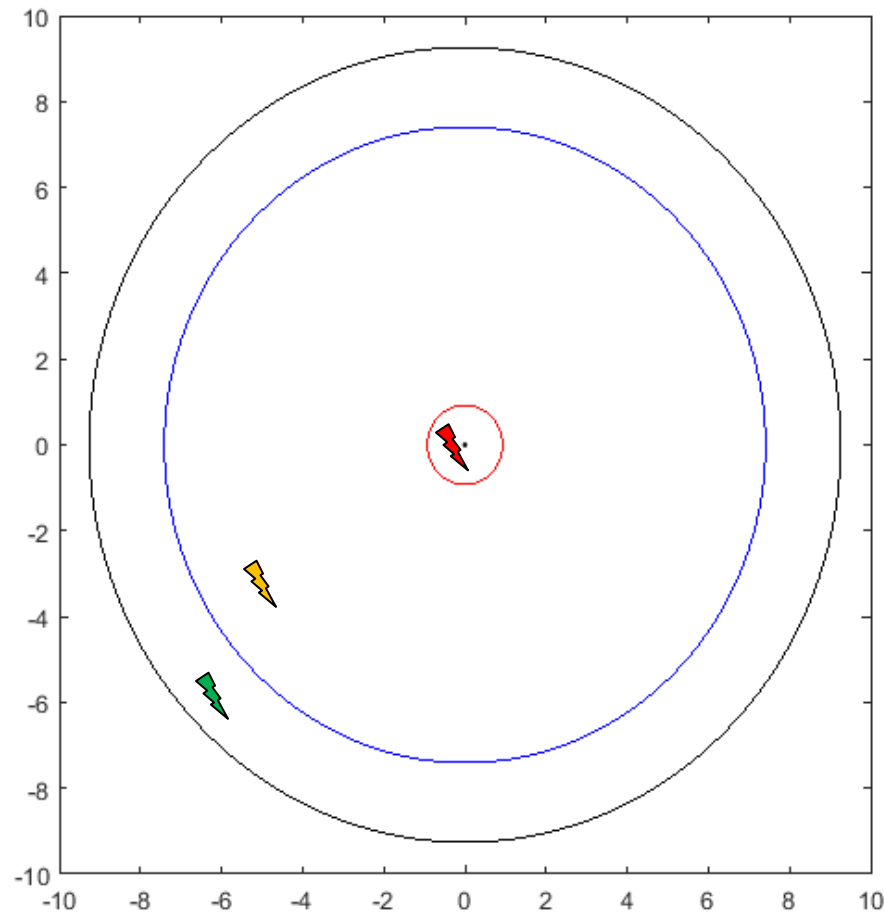
Methodology - Ellipse Fitting Algorithm

Results

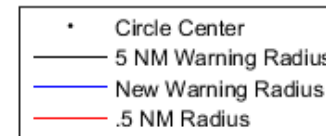| Total # Ellipses	Mean # Flashes in Each Ellipse	Largest # Flashes in an Ellipse
2,963	273	21,675

Empirical Validation

- How much time is saved using 4 NM vs previous 5 NM warning distance?
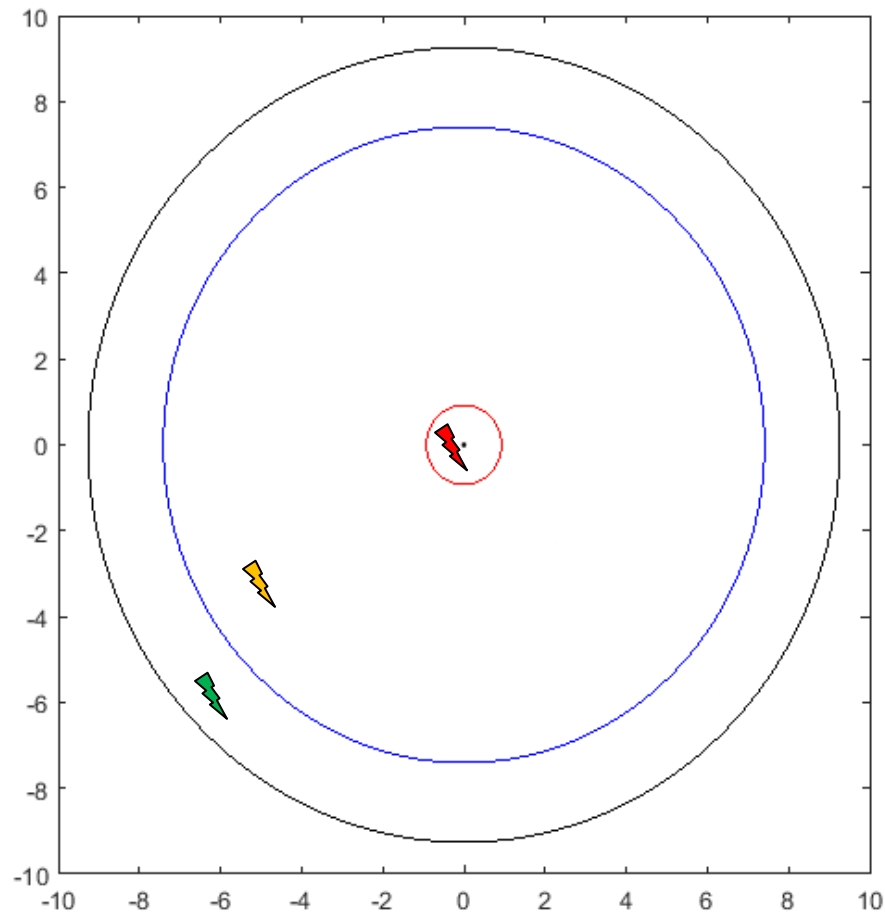

Issue warning at 5 NM
Issue warning at 4 NM
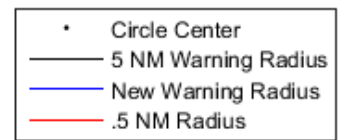Strike within .5 NM of center

Empirical Validation

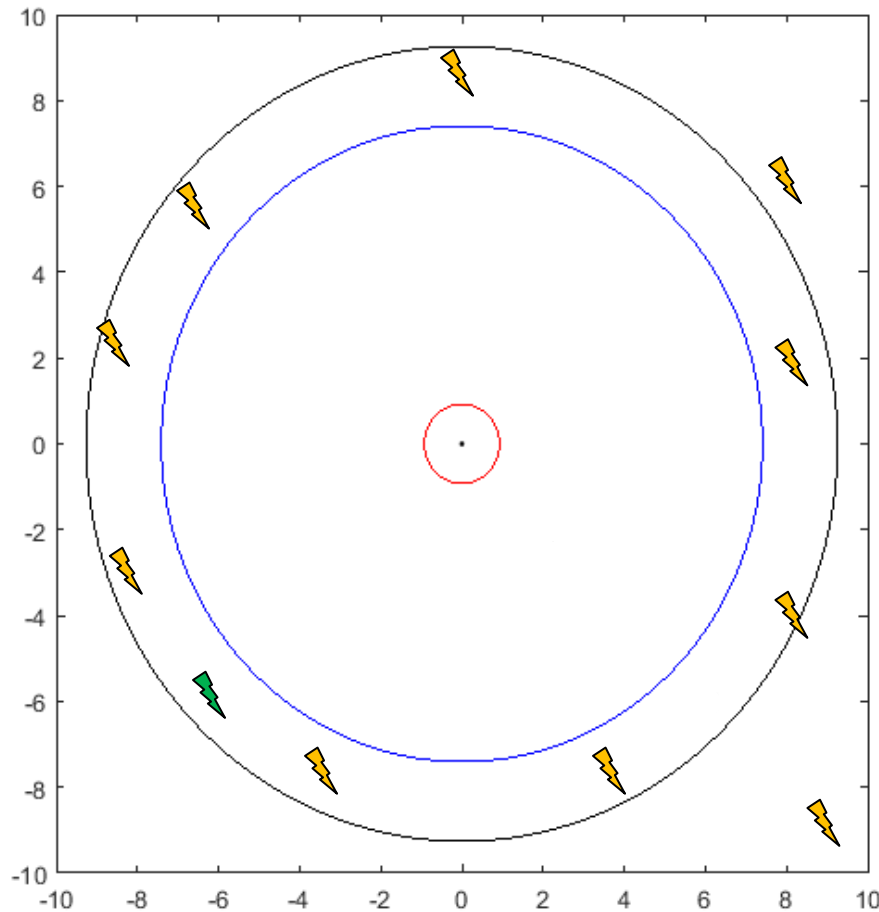- How many failures occur using 4 NM vs previous 5 NM warning distance?

Issue warning at 5 NM

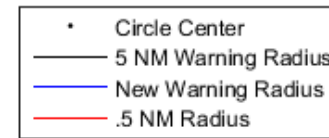Strike within .5 NM of center
Issue warning at 4 NM

Empirical Validation

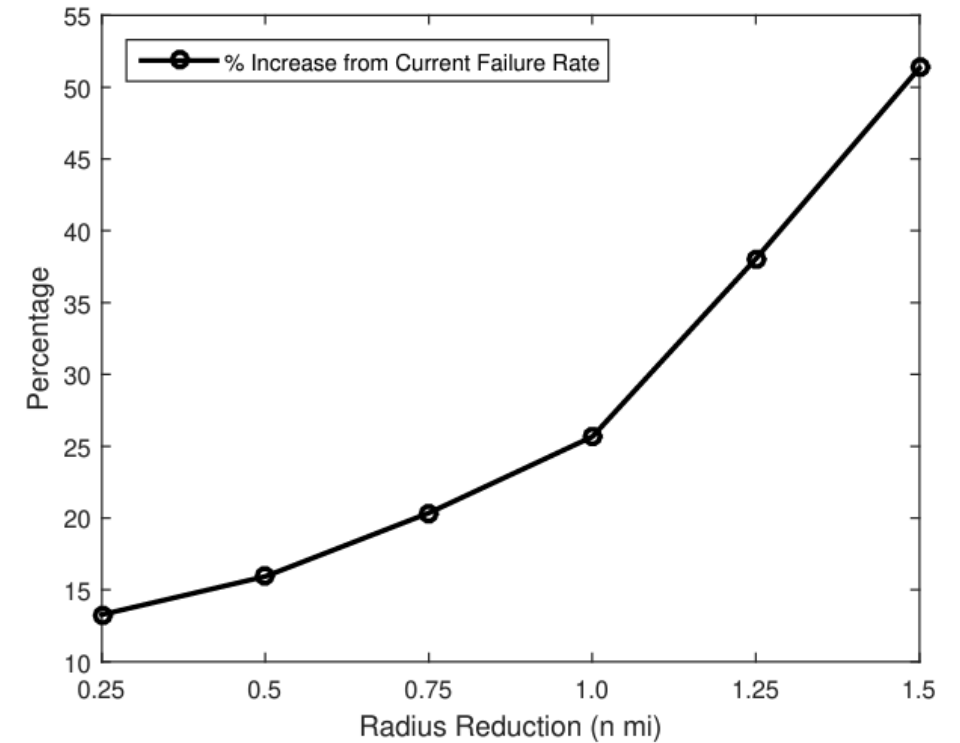- How many false alarms are saved using 4 NM vs previous 5 NM warning distance?

Issue warning at 5 NM
No strike occurs ≤ 4 NM

Empirical Validation

Hours Saved (8-hr man days)	Number of False Alarms Saved	Number of Failures	Percentage of Failures
502.58 (62.82)	523	142	3.58%

Conclusion

- Reducing the lightning warning radii by 1 NM would provide:

  - a savings of 15.7 eight-hour main days for 5 months per year on average

  - a savings of 130.75 false alarms saved for 5 months per year on average

- The amount of risk incurred with a 1 NM reduction is 3.58% (the current risk is 2.85%)

Given the results of this study, we recommend changing the safety regulations to reflect a 4 NM lightning warning radius

QUESTIONS?

Ellipse Fitting Algorithm