Understanding Frequent Lightning Environments over the NWS Albany, NY County Warning Area

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Project Overview

- The purpose of the study was to establish a climatology of the convective environment during "frequent lightning" events within the WFO Albany CWA.

- A frequent lightning event was defined as at least 5,000 cloud-to-ground strikes in a 24-hr period (05Z-05Z).

- This research expanded upon an earlier study spanning 2008-2017, adding events from 2018-2023.

- Results from both studies were combined to analyze the parameters and thresholds that characterize frequent lightning events during the 15 year period (2008 - 2023).

Motivation

- Lightning presents hazards to the public, including property and tree damage, injury, or loss of life, all of which are exacerbated when storms produce excessive lightning.

- Recognizing environments conducive to excessive lightning production is helpful to operational forecasters who brief emergency management partners, especially for large outdoor events.

- Armed with this climatology, forecasters can better anticipate frequent lightning environments and confidently message hazards, impacts, and safety information to the public and partners when frequent lightning will be present.

Data Acquisition Methods

- In Google Earth, the total number of lightning strikes for each frequent lightning day were mapped.
- Overlaid BUFKIT sites in Google Earth to determine which would best represent the frequent lightning environment.
- Convective parameters from RAP model soundings at each relevant site were assessed using BUFKIT.
- Model sounding sites: GFL, PSF, POU, CAN, SWF, ALB, UCA

Frequent Lightning Days

ALBANY · PITTSFIELD · CANAAN · POUGHKEEPSIE · 9/8/2023: 9603 strikes

8/21/2019: 5053 strikes
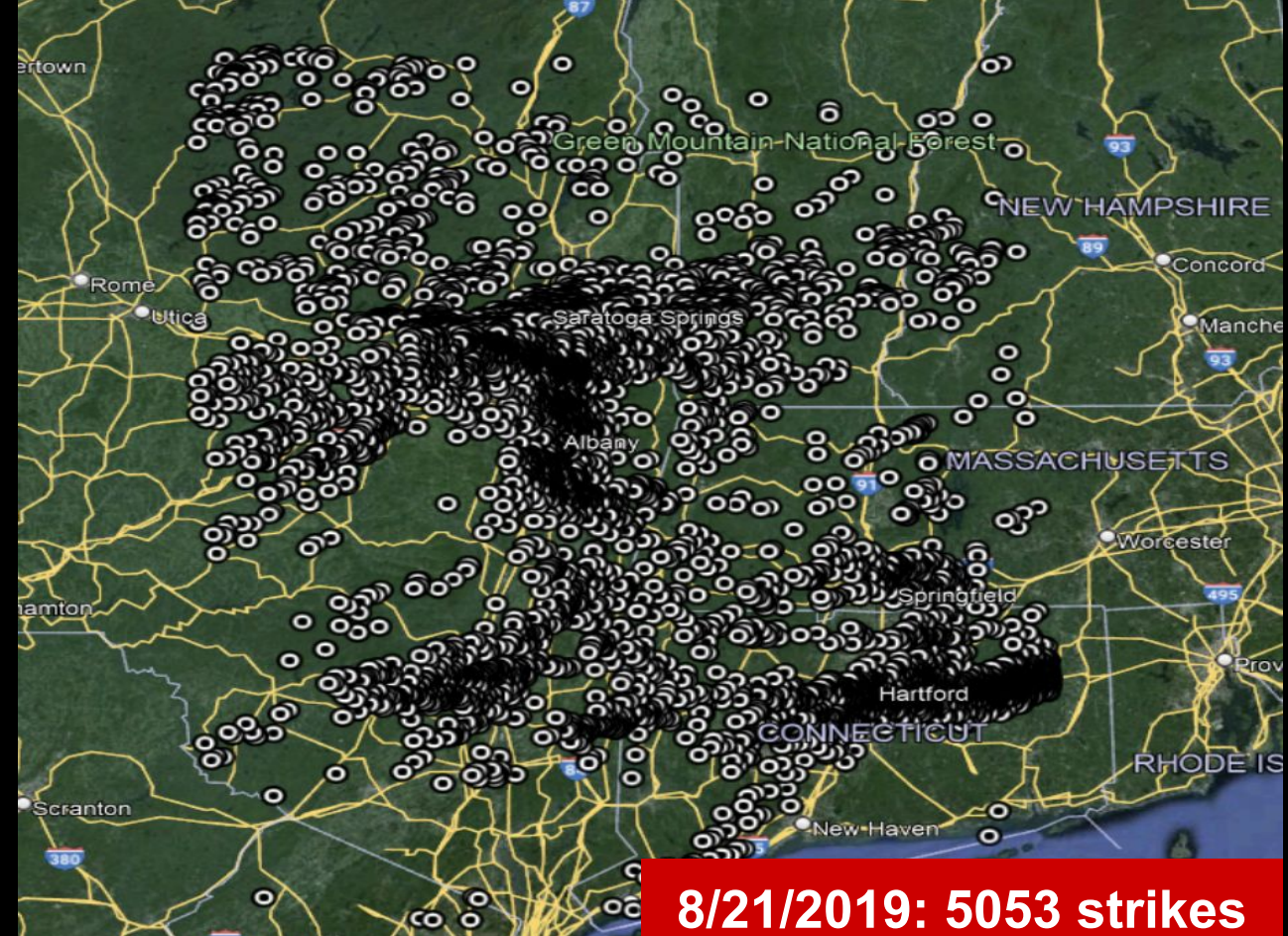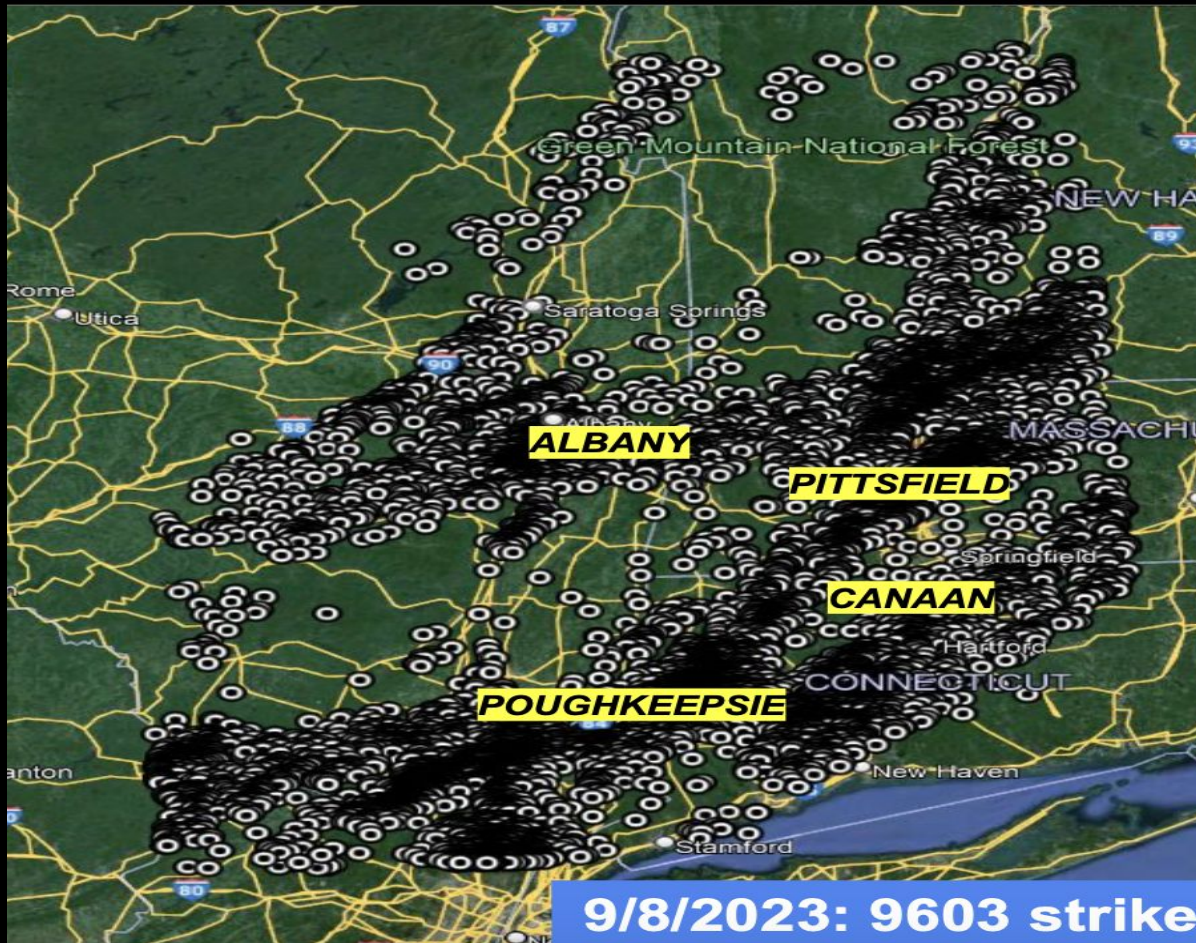
Analysis Methods

- All lightning event data from 2007 to 2023 were combined into one large dataset

- Box and whisker plots were made via Python and statistical values also from Python

- Lightning strikes gathered from NCEI archive of Vaisala's NLDN

- Python script (thanks Vasil Koleci!) collected total # of lightning strikes over the 15 year period

- Found 66 frequent lightning days
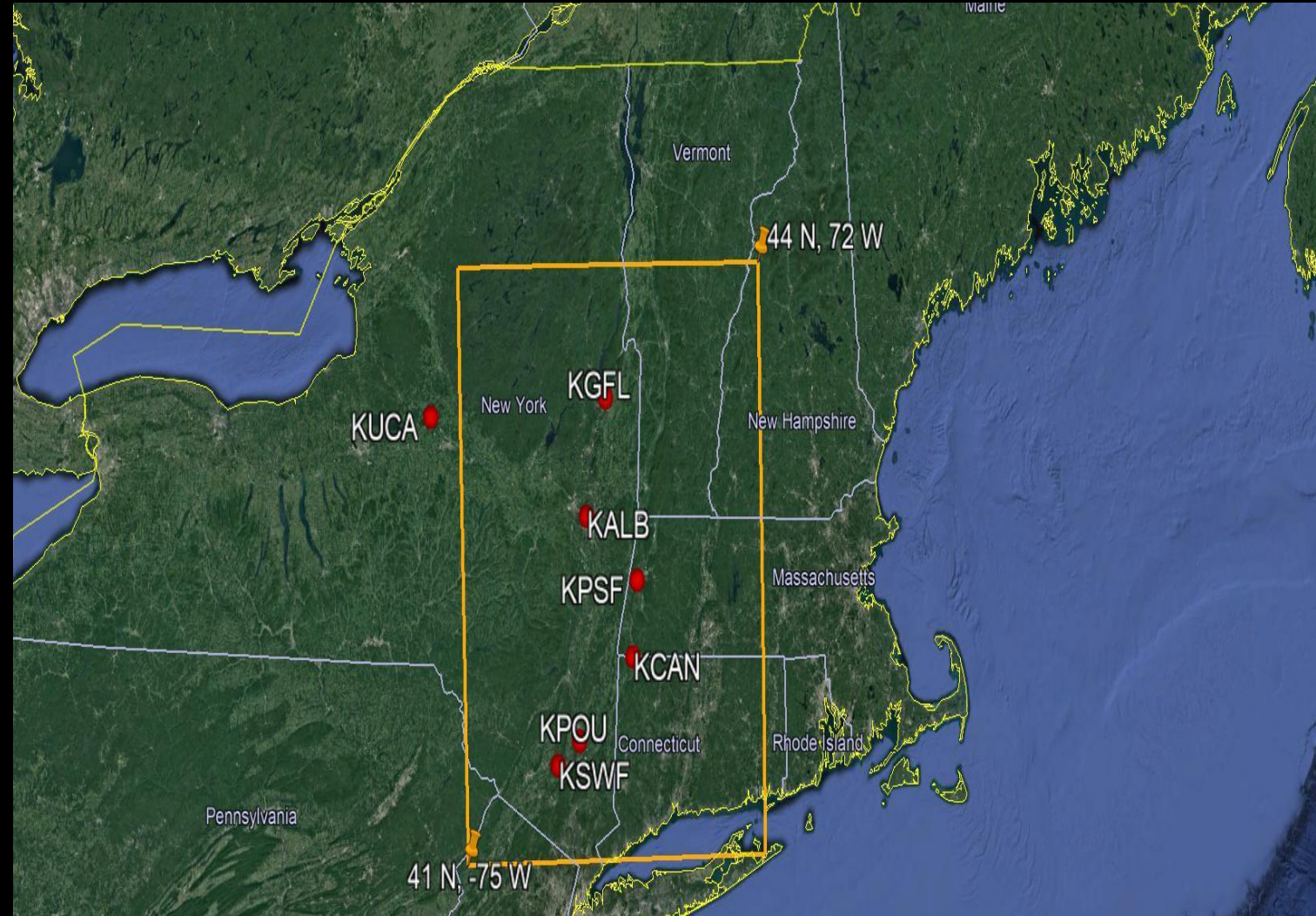
Parameters Analyzed

- CAPE, NCAPE (Normalized CAPE) , Hail CAPE
- Lapse rates (850 - 700hPa and 700 - 500 hPa)
- WBZ, Freezing Level, Equilibrium level and other sounding heights
- K Index
- PWAT
- Shear (0-1 km, 0-3 km, 0-6 km)

Results

- All events occurred between May – September
- Total of 66 frequent lightning days from 2008-2023

Number of Frequent Lightning Events per Month
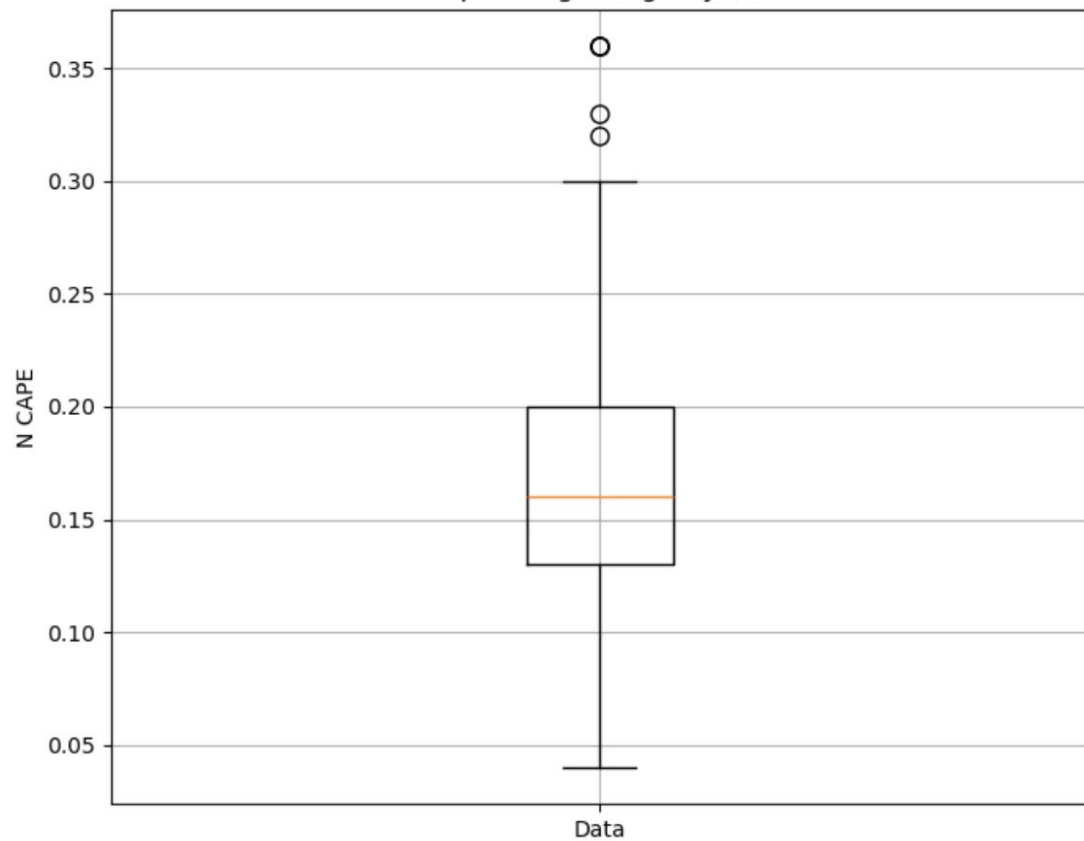2008-2023
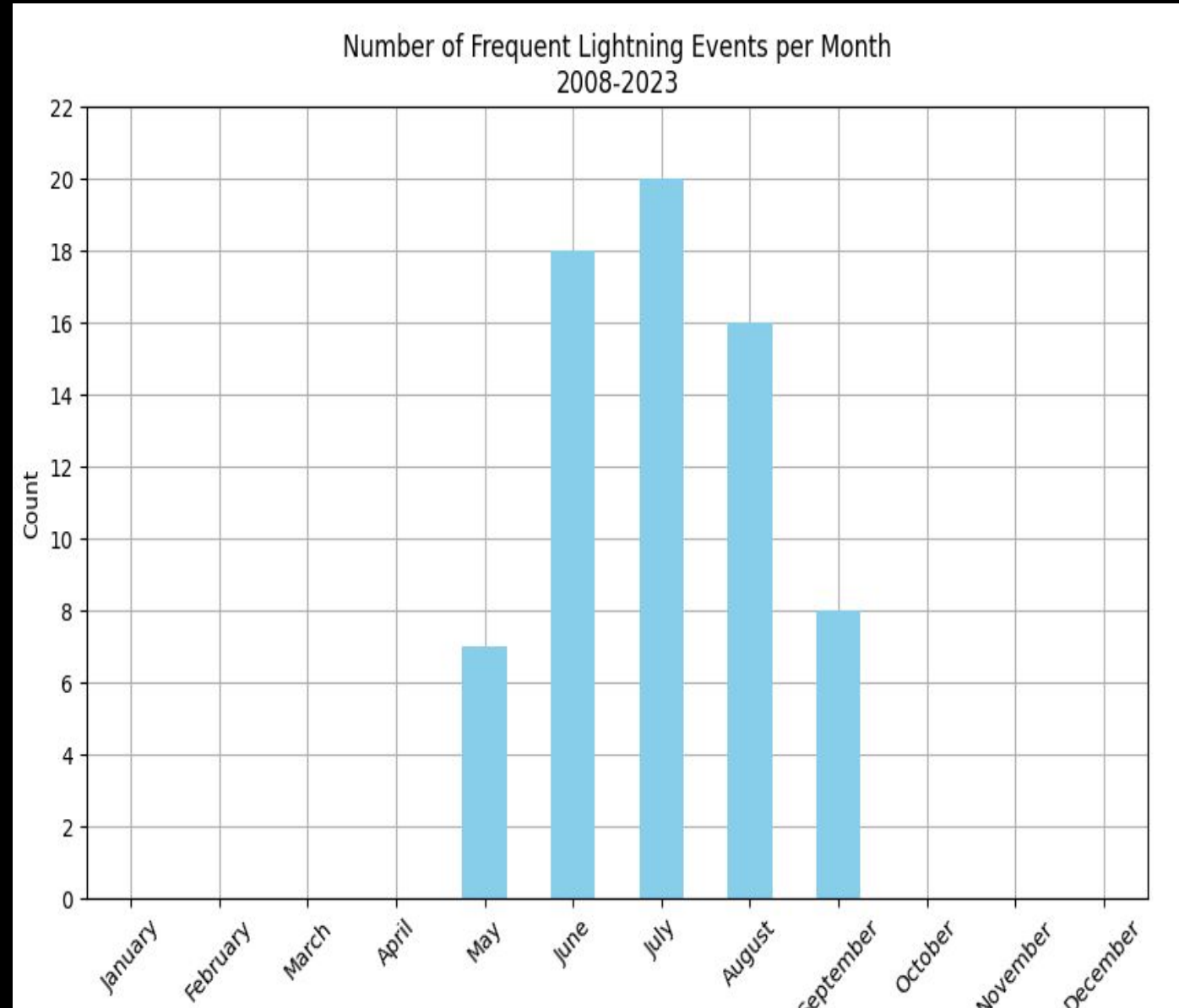
Results

Typical characteristics of the parameters studied

- Warm, moist air masses BUT PWAT < 2"
- High Freezing Heights
- Deep Buoyancy Layer (High Equilibrium Levels)
- NCAPE (Normalized CAPE) ~ 0.16
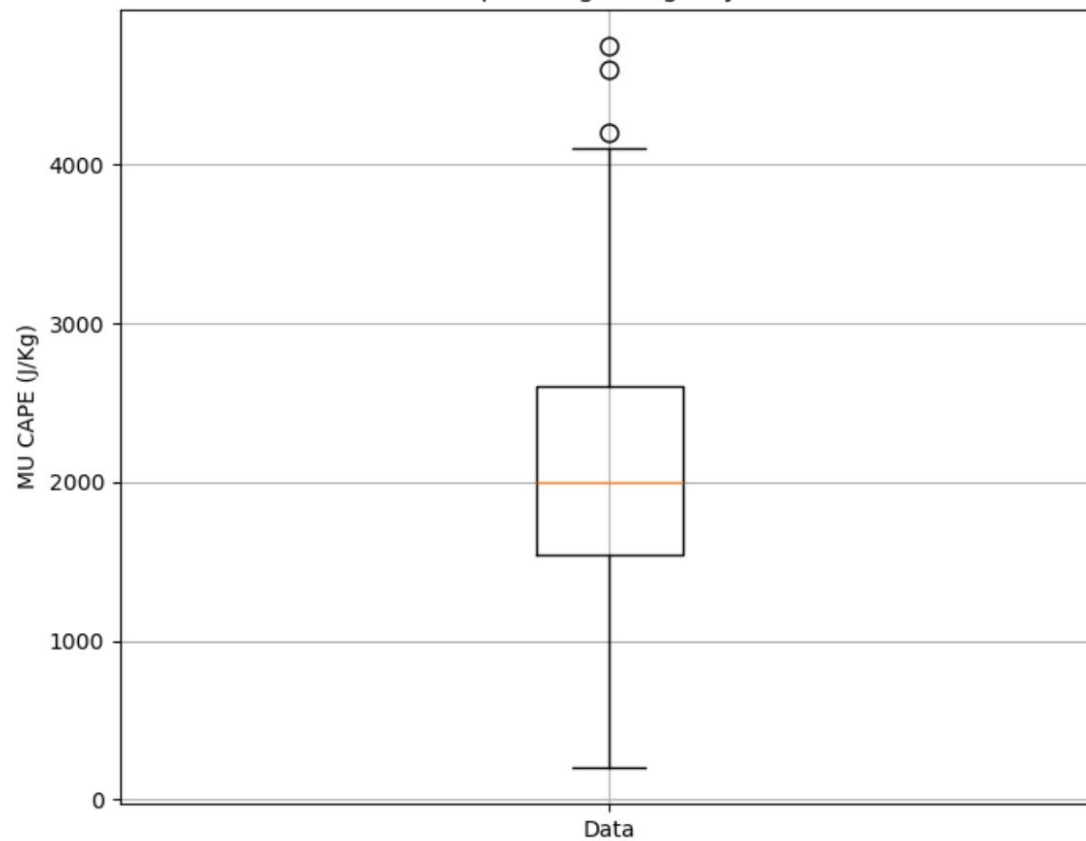- Steep atmospheric lapse rates

N CAPE Frequent Lightning Days: 2008-2023

Lower Quartile (25%): 0.13
Median (50%): 0.16
Upper Quartile (75%): 0.20
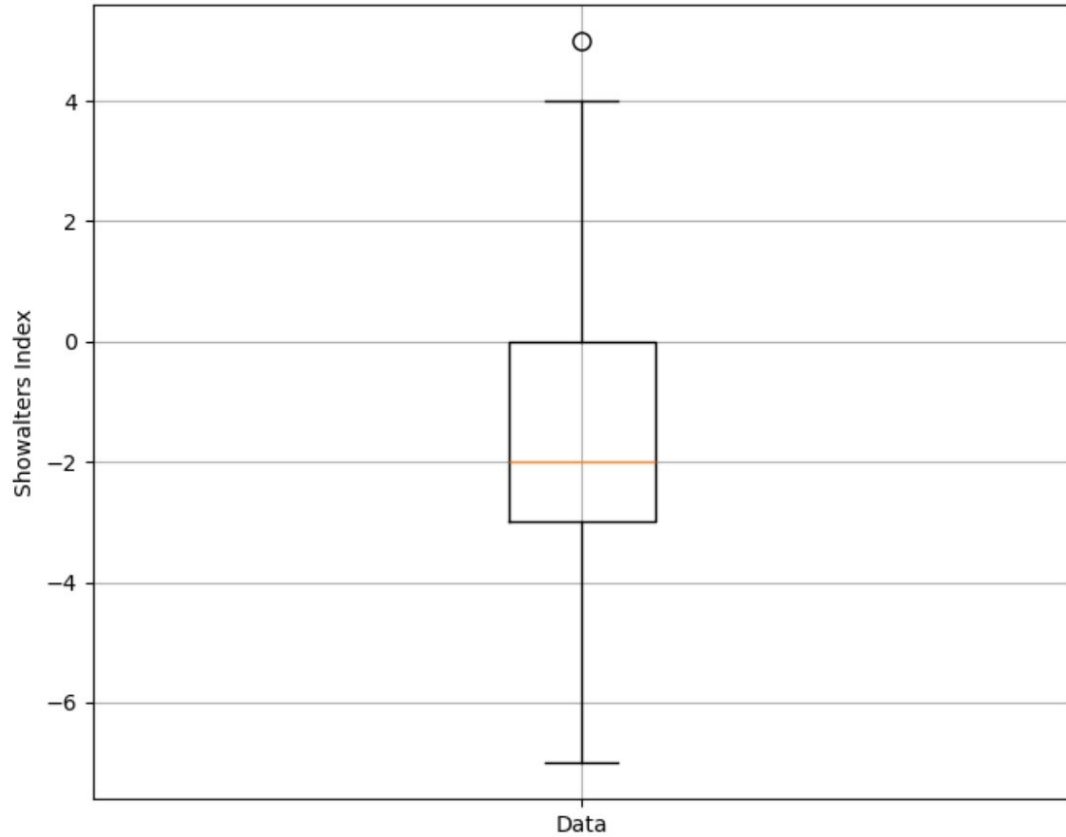
90%: 0.30
10%: 0.04

MU CAPE Frequent Lightning Days: 2008-2023

Lower Quartile (25%): 1537.50 J/Kg
Median (50%): 2000.00 J/Kg
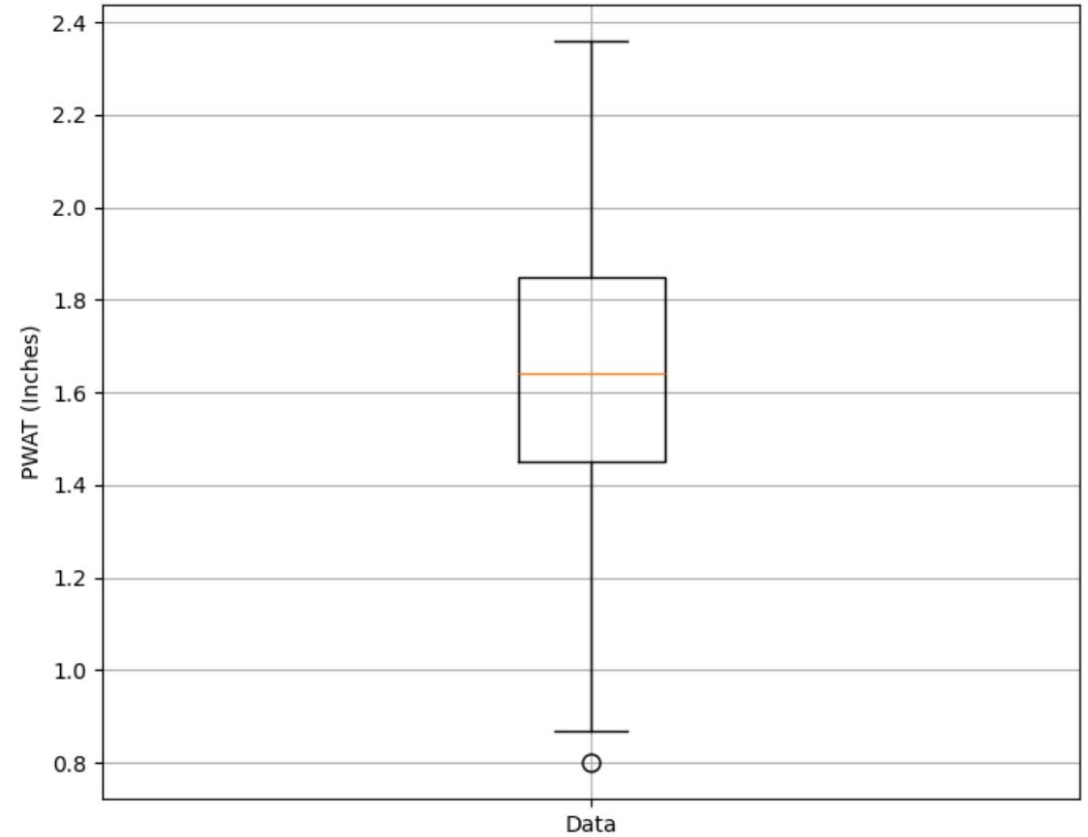Upper Quartile (75%): 2600.00 J/Kg

90%: 4100.00 J/Kg
10%: 200.00 J/Kg

Showalters Index Frequent Lightning Days: 2008-2023

Lower Quartile (25%): -3.00
Median (50%): -2.00
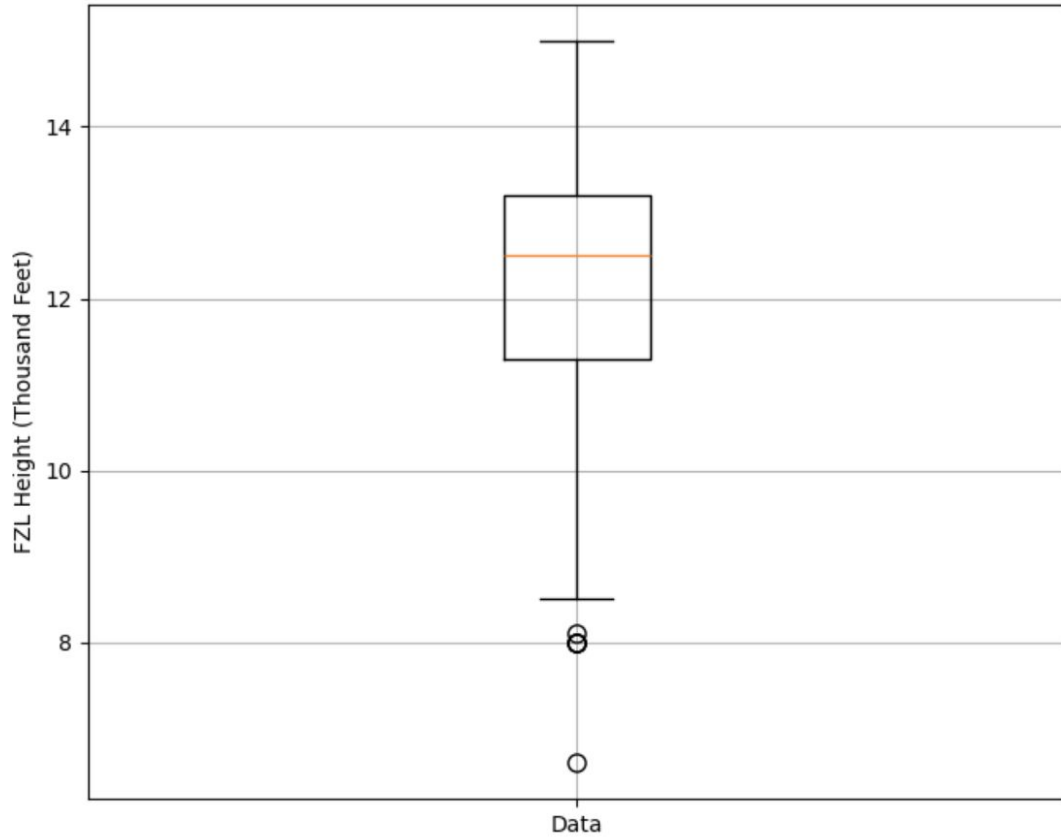Upper Quartile (75%): 0.00

90%: 4.00
10%: -7.00

PWAT Frequent Lightning Days: 2008-2023

Lower Quartile (25%): 1.45 Inches
Median (50%): 1.64 Inches
Upper Quartile (75%): 1.85 Inches
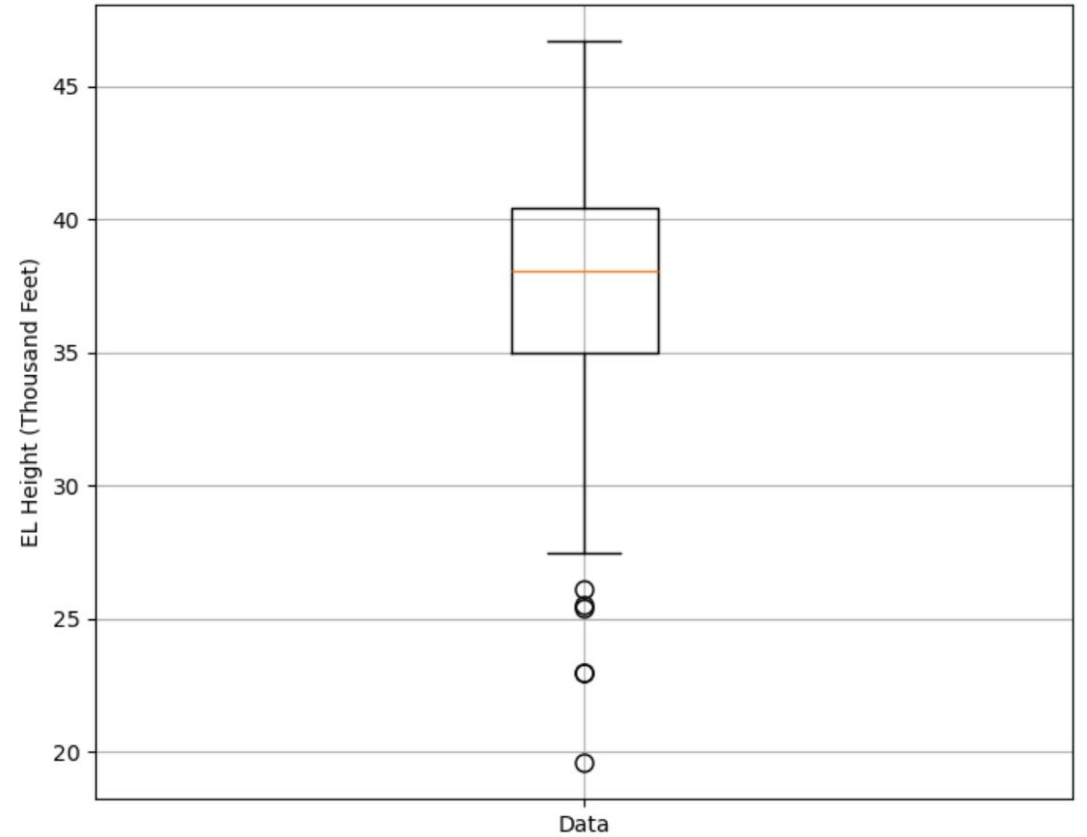
90%: 2.36 Inches
10%: 0.87 Inches

FZL Height Frequent Lightning Days: 2008-2023

FZL Height (Thousand Feet)

Data

Lower Quartile (25%): 11.3 Thousand Feet
Median (50%): 12.5 Thousand Feet
Upper Quartile (75%): 13.2 Thousand Feet

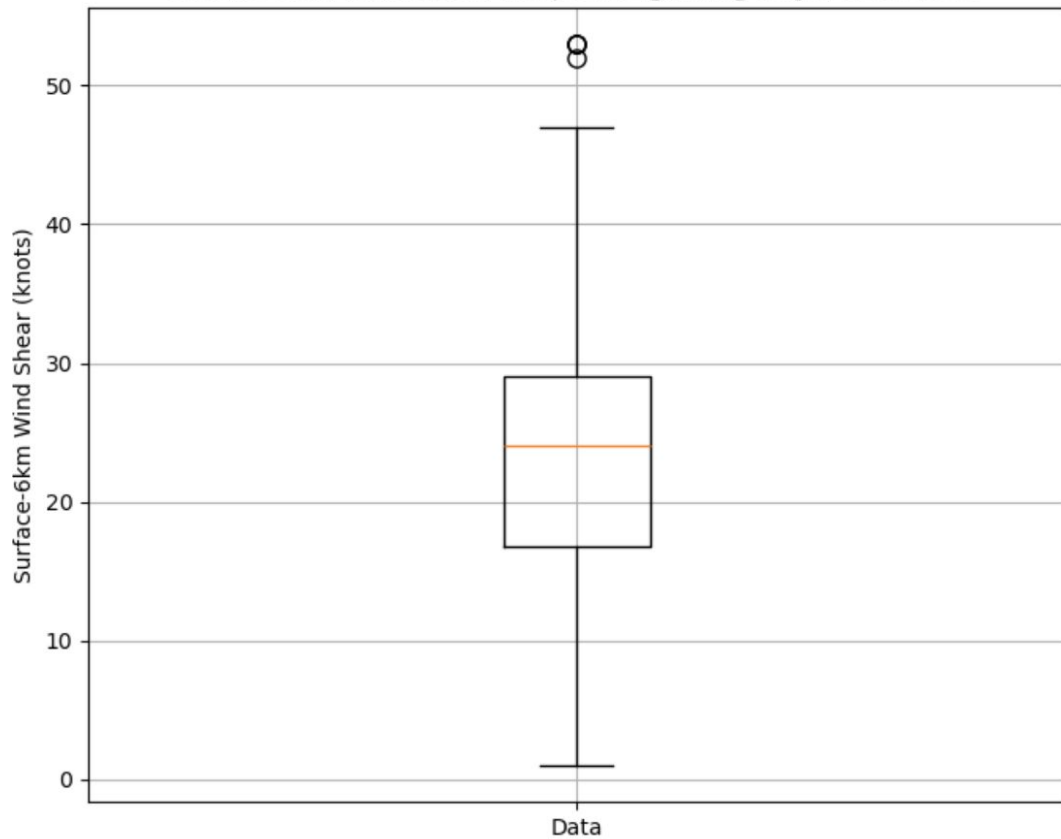90%: 15.0 Thousand Feet
10%: 8.5 Thousand Feet

EL Height Frequent Lightning Days: 2008-2023

EL Height (Thousand Feet)

Data

Lower Quartile (25%): 35.0 Thousand Feet
Median (50%): 38.0 Thousand Feet
Upper Quartile (75%): 40.4 Thousand Feet

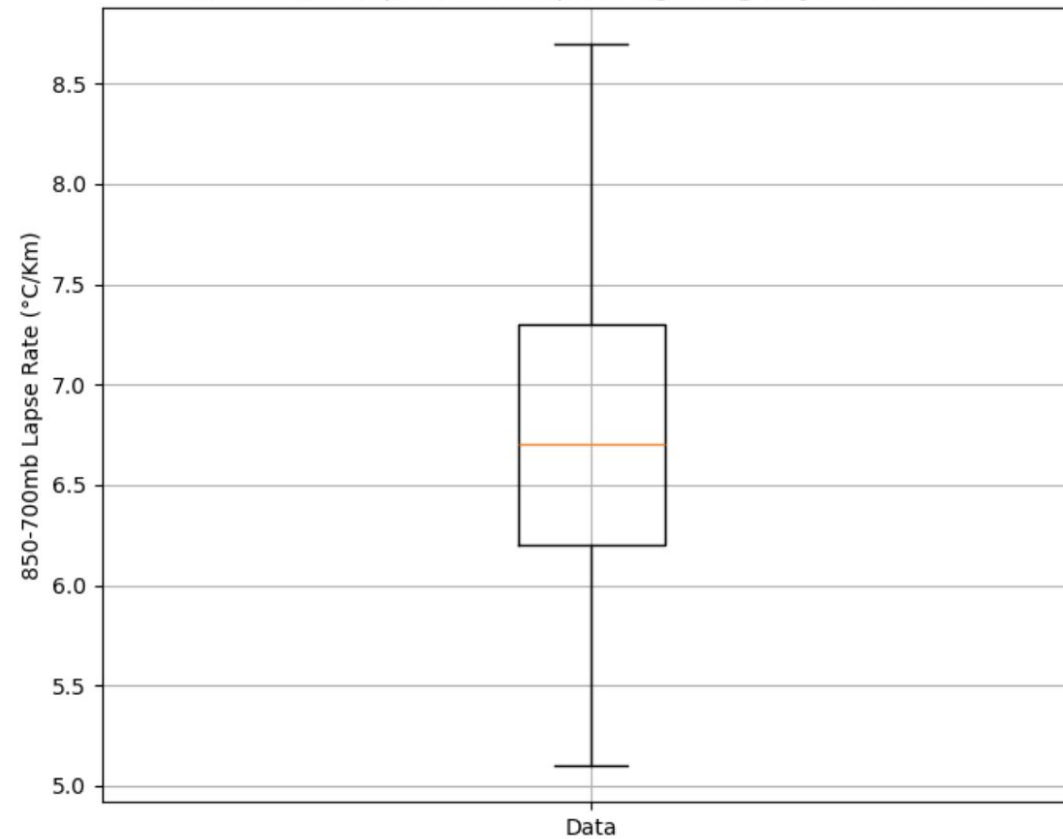90%: 46.7 Thousand Feet
10%: 27.5 Thousand Feet

Surface-6km Wind Shear Frequent Lightning Days: 2008-2023

Lower Quartile (25%): 16.80 knots
Median (50%): 24.00 knots
Upper Quartile (75%): 29.00 knots

90%: 47.00 knots
10%: 1.00 knots

850-700mb Lapse Rate Frequent Lightning Days: 2008-2023

Lower Quartile (25%): 6.20 °C/Km
Median (50%): 6.70 °C/Km
Upper Quartile (75%): 7.30 °C/Km

90%: 8.70 °C/Km
10%: 5.10 °C/Km

Future Research

- Identify top 50% of all lightning days within the warm season (April to October) between 2008 and 2023. This will be called "typical" lightning days.
- Repeat assessment from this study (recall 5000 lightning strikes represents top 5% of all lightning days)
- Determine which convective parameters and thresholds are statistically significant between top 50% and top 5% lightning days

What We Learned

- Google earth mapping techniques

- Operating Bufkit

- More experience using excel

- More experience using python for data analysis

- Using the NCEI archive

- How to better predict frequent lightning

Acknowledgements

- Vasil Koleci (ITO WFO Albany) - Python script
- Ron Murphy (WFO BGM ITO) - Archived RAP data before 2011
- Brittany Connelly and Ian Anderson (previous UAlbany student volunteers)