GEOG 4403
Project Proposal
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Modeling the Spatial Distribution of Lighting Strikes in the US Using Point Pattern Analysis

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1. Introduction

For this project, we intend to analyze the spatial distribution of lightning strikes in the US, utilizing cloud-to-ground lightning flash data provided by NOAA. Data of this nature poses a challenge for near-real-time monitoring because transient spatiotemporal events occur within a short interval of time, in a particular location. The unexpected nature of this type of data results in varying durations, frequencies, and intensities.

Therefore, utilizing point pattern analysis, we will be able to establish an understanding of lightning patterns, including spatial clusters and time of year in which lightning strike activity increases. Additionally, using space-time point patterns and Space-time clustering analysis, we will ultimately be able to draw space-time correlations between lightning strike locations. Pattern recognition using visualization, spatial statistics and geostatistics to identify the locations, magnitudes and shapes of statistically significant pattern descriptors, meaning searching for cluster or spatial patterns provides opportunity for further topical research.

According to the NWS Storm Data, over the last 30 years (1989-2018) the U.S. has averaged 43 reported lightning fatalities per year (NWS, 2018). Additionally, lightning poses public health and safety concerns. With temperatures exceeding 15,000 degrees F, lightning is a well-known cause of grass, building, and forest fires -- it has also set fire to autos, boats, and buried gas pipes(Cirma, *n.d*). With significant portions of the US experiencing conditions ranging from 'Exceptional Drought' to 'Abnormally Dry' (UNL, 2022), it is of increasing importance to monitor areas that are adversely affected by lightning strikes because of the severe negative consequences associated with drying conditions are lightning hotspots. For example, lightning is known to cause fires. In areas prone to high fire danger and flash storms, lightning strikes can exacerbate existing natural disasters, resulting in damage to infrastructure, loss of Internet connectivity, interruption of electrical power supply, and loss of life or property(Sibolla, 2021).

By identifying geographic regions with higher than average likelihood to experience lightning strikes, preventative measures and mitigation strategies can be implemented in order to limit negative impacts if drought conditions continue to worsen.   The clustering behavior of lightning strikes has been studied by numerous researchers, for the purpose of determining the long-term behavior of lightning strikes. In 2003, a review covering a two-decade-long time series of retrospective lightning events to determine clustering events that lead to wildfires was published, showing the benefits of understanding lighting behavior through clustering(Sibolla,2021).

Because of the transient nature of lightning, its impact on ecosystems and the perceived risk of natural disasters has been largely difficult to conceptualize and record. In this report, we hope to garner a basic understanding of the space-time patterns lightning storms follow over the course of a year in order to better predict and safeguard against these events.

2. Data Availability

The data we selected is sourced from the Severe Weather Database Inventory (SWDI) Lightning Tile Summaries provided by NOAA. This dataset summarizes the number of cloud-to-ground lightning flashes for each day in 0.10-degree tiles. These tiles are part of the NCEI Severe Weather Data Inventory and can be accessed using the SWDI GIS-based search tool or RESTful web services. The number of cloud-to-ground lightning flashes is calculated each day for U.S. counties and states. These summary reports are generated in the NCEI Severe Weather Data Inventory (SWDI), and contain counts of severe storm attributes detected by algorithms in the NEXRAD Weather Radar network. Through a contract with Vaisala, the raw data from NCEI is available only to NOAA users. However, NCEI is developing several derived products that are freely available for all users. These products include summaries of lightning flashes by county and state as well as gridded lightning frequency products. The gridded dataset we will be using covers the entirety of the continental United States.

3. Proposed Activities and Expected Results

We will be using point-pattern analysis to identify lightning ground strike clusters. The results from our data analysis will identify areas with observed, heightened risk of lightning strikes. This analysis allows better policy planning for damage mitigation, faster incident investigation and improved risk modeling. For future considerations, this data combined with storm progression radar mapping could be used to predict areas at higher risk of lightning strikes in real-time.

Upon analyzing this dataset, we expect to see trends in the data that depict zones of both exceptionally high and exceptionally low levels of lightning clustering. In areas of the US without highly prevalent climatic variables that enable lighting, there are expected to be relatively few observed clusters. Additionally, we expect these clusters to be smaller in diameter than those found in areas with large, plentiful lightning clusters. Using k-mean clustering, lightning strikes will be partitioned, showing potential correlation between lightning strikes and surrounding geographic features or climatic influence. By establishing this correlation, further research will be able to be conducted into the specific features or climatic variables that influence the probability of lightning clusters occurring in a specific geographic location.

4. References

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