Examining Spatial Distributions and Cumulative Sums of Cloud-to-Ground Lightning in the Caribbean

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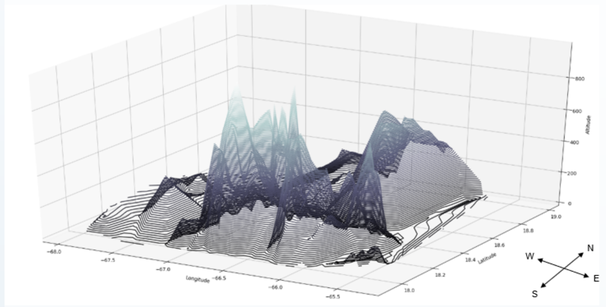
Introduction

This project is conducted for the purposes of analyzing lightning strike variability in the Caribbean region. Lightning sensor data is used to evaluate the spatial distributions, and the cumulative sum of total lightning strikes of cloud-to-ground (CG) and intracloud (IC) strike types from 2012-2016. Puerto Rico and the Virgin Islands are the target area of the study for the dry season, May-November, and the wet season, December-April. The total cumulative strike plots and the spatial distribution maps depict much higher strike counts of IC lightning when compared to the CG stroke types. Analysis from the total annual cumulative CG strike suggests that 2013 and 2016 were the years with the most total cumulative stroke counts from the 4-year study period. Preliminary analysis from the spatial distribution maps illustrates greater concentrations of CG lightning strokes over land masses than in oceanic regions. CG strikes in the Caribbean region can pose hazards to the public's health, outdoor activities or can negatively impact infrastructure. Understanding the local climatology and variabilities will help improve meteorological predictions and increase safety precautions in areas that experience higher lightning strike rates.

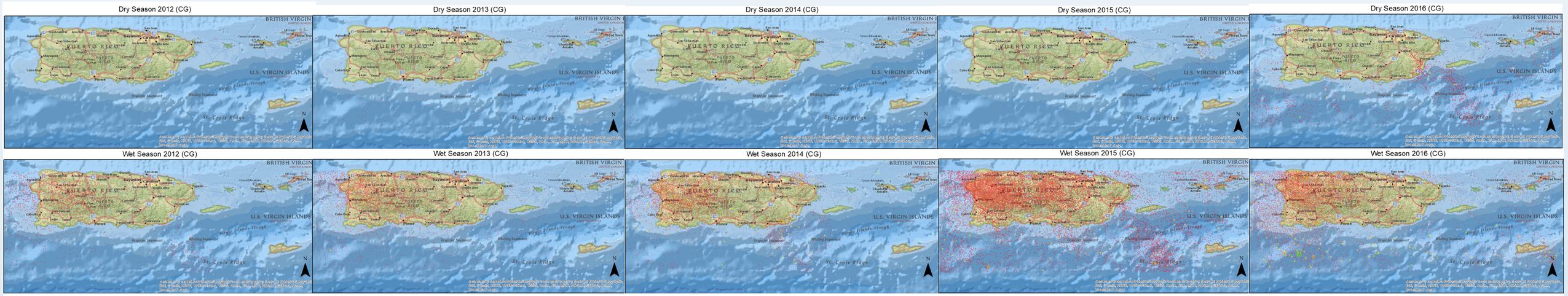
Methodology and Data

- Lightning sensor ENTLN data from years 2012 through 2016 for spatial distributions and cumulative sums.
- Obtaining descriptive statistics by calculating the cumulative sum of lightning strikes per month for each year.
- Develop a python script to create new arrays of wet and dry seasons for CG and IC lightning types for each year. Results are then outputted into separate text files.
- These new text files are then converted into point data in an XY table in Arc Map to create individual feature class layers.
- Symbolize spatial data with color gradients and graduated symbol to display spatial clusters and the number of lightning strikes per location based on geographic coordinates.

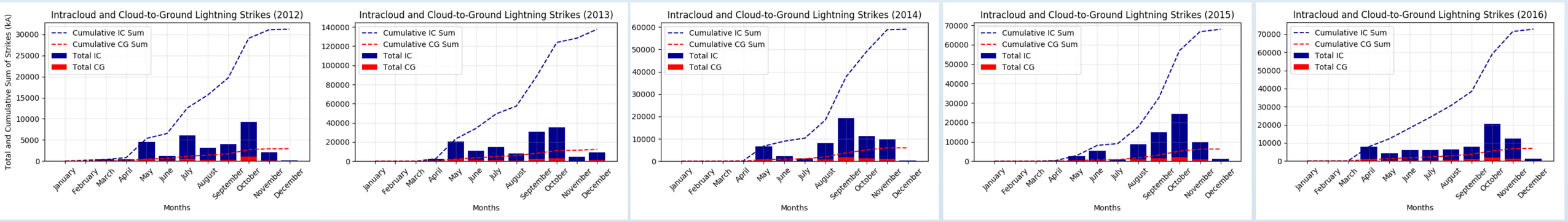
Elevation of Study Area: Puerto Rico



Results



Number of CG strikes per location for above spatial maps: 1-2 strikes; 3-4 strikes; 5-6 strikes; 7-8 strikes; 9-10 strikes; 11-12 strikes



Discussion

- Most consistent spatial cluster of CG strikes in the Northern and Midwest regions of Puerto Rico during the wet.
- Midwest region has higher strike counts of 3-4 strikes per location along the northern side of the mountain range near Mayaguez, San German, and Utuado, PR
- A spatial cluster of CG strikes observed SE from the Eastern coast of Puerto Rico over the Whiting Seamount and the Virgin Islands Trough during the wet seasons of 2012, 2014, 2015 and in the dry season of 2016
- Increase in the number of strikes for both CG and IC types during the wet season and both decreases significantly during the dry season
- No obvious spatial patterns are observed during the dry season.

Conclusion

- Total cumulative sum of CG lightning strikes are considerably less when compared to IC strikes. It appears that CG strikes may need more energy.
- The majority of CG lightning strikes are observed over land masses when compared to oceanic regions, which can be attributed to topography effect (i.e., lifting and convective activities).
- A spatial cluster forms in the northwestern and midwestern portion of the Island during the wet season, which may be related to prevailing wind patterns.
- 2013 had the highest number of cumulative strikes followed by the year 2016, which can be attributed to unusually stormy seasons.

Future Work

- Conduct point density analysis on the observed spatial clusters to statistically quantify the lightning strike concentrations identified in the spatial distribution maps.
- Hurricane tracks will be compared to the spatial lightning data to determine where in tropical systems the strikes occur.
- Total cumulative lightning values will be compared with elevation data from the study site to examine possible orographic effects on the total lightning climatology.

Acknowledgments

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