ELUSIVE AURORA BOREALIS: Geographic incidence of geomagnetic atmospheric disturbances in the Northern Hemisphere, terrain analysis, and multi-criteria suitability analysis for Aurora Borealis occurrence in Alaska

Introduction
Taking a trip to Alaska and do not want to miss the epic phenomenon of Aurora Borealis? The solar flares of the Northern Lights are a must-see multi-colored display that can be quite elusive as they form from interactions between the electrons from solar winds and the molecules in the Earth's atmosphere, and are typically only visible on dark, clear nights in high latitudes. Viewing on console and spatial data rather than chance will add the curious is increasing their chances of being in the right place and the right time to experience the auroral majesty.

Methodology and Data
The digitization and geo-visualization of Weeden's Aurora Borealis data was used as a base map to show the frequency and characteristics of Auroras Borealis observed in the Northern Hemisphere, while providing baseline locations of auroral arcs to run further proximity and spatial analysis. In order to determine suitable areas for viewing, raster data such as average percentage of clear nights, land cover type, terrain ruggedness, geographic coverage between AB as a 100km buffer zone were used in a raster overlay analysis to model multiple criteria. These results were then intersected with vector study areas that were determined by an overlay of mandatory criteria such as highway access, proximity to the 100% and 80% AB isolines, airports, proximity to towns of significant population, cell phone service, and the buffered 100% AB area. A weighted overlay was used to provide the most optimized zones for Aurora viewing based off of four separate factors: Areas with the least average cloud cover, within the viewing distance of the AB, view not obstructed by mountain, types of land cover, and terrain ruggedness for navigability. Cloud cover was weighted at 35%, as cloudy skies are most common impediment, snowfall was weighted 15%, land cover type was weighted 25% to ensure areas with the least vegetation obstruction and lack of built up spaces were given priority over densely vegetated or built up areas and watercourses. The terrain ruggedness index was also given a 25% to ensure that the viewable area is feasible to travel to. The Terrain Ruggedness Index measures ruggedness by taking slope and max statistics of cell elevation and the mean of the surrounding 8 cells in the raster calculator using the same classification as Fisher, 1993.

Northern Hemisphere Isocasm Map
Astrophysicist Harry Weeden's 1844 research "The Geographic Incidence of Aurora and Magnetic Disturbance, Northern Hemisphere" was based upon nearly fifty years of climate data collected for Aurora Borealis which produced the first accurate isocasm maps of equal frequency of auroral visibility. The study by Weeden's shows the potential of the auroral phenomenon. The Northern Hemisphere isocasm map divides the Earth into 10 distinct regions, each with varying intensity and distribution of auroral activity, as per the isocasm values.

Research Questions and Objectives
Geographically, where on the northern hemisphere is the weight of 60-100% of nights with possible Aurora Borealis? The isocasm map provided the weight of statistical auroral occurrence by percentage chance, with the 80-100% zone symbolized by a green transparency and the populated towns nearby. Taking into consideration cloud cover, navigable terrain, low density land cover, forest type, geographic-viewed barriers, and overall proximity to the highest value isocasm lines, where in Alaska is the most suitable region for the best chance of viewing the Aurora Borealis in March?

Monthly Kp Index and Visible Hours

Results: Largest, most likely areas for Aurora Borealis Viewing in Alaska

The result of the weighted overlay and intersection with the vector overlay produced one large contiguous area that envelops Fairbanks which is approximately 1,000 square miles. The suitability model produced the second best clustering of suitable areas scattered around Fairbanks, AK. We would like to give homage to Fairbanks as they are home to University of Alaska’s Climate Research Center which is a great source for geomagnetism and Aurora Borealis research.

Importance of the Kp Index

Weighted Overlay Analysis: A multi-criteria suitability model for Aurora Borealis viewing areas in Alaska, USA

Validation and Conclusions
Validating our findings required us to gather NOAA data that showed the location of the Aurora on March 18th on that could be within the middle of the month of our study period. In conclusion, we believe that we have found the optimal areas of viewing for the month of March, which is the most active month of Aurora viewing. Our findings run parallel with our original statement, along with showing what areas are better than others for viewing based on the parameters that we defined in our various analyses. For future researchers, we wish to create a spatial-temporal model for Kp index and AB migration.

Generalized Workflow

Digitizing Georeferencing (0-5 hours)
Interpolating Average Cloud Cover Data
Vector Overlays
Raster Weighted Overlay Suitability Analysis
Most Likely Alaska Location to view Aurora Borealis

Water Body

References

