

SHORT-TERM ANALYSIS OF AURORA BOREALIS ACTIVITY.

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Abstract

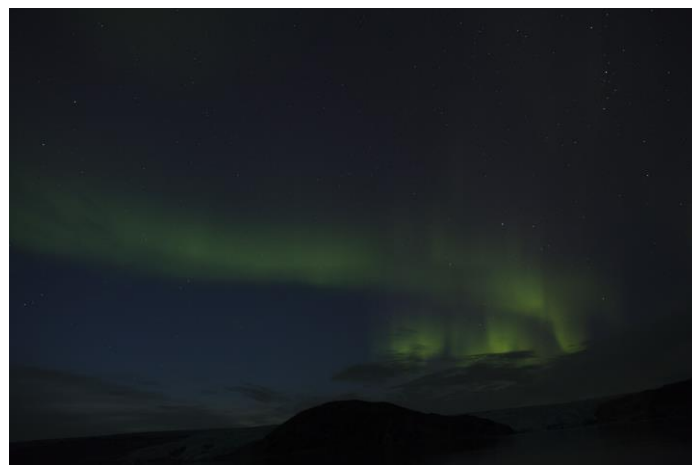
Aurora activity have always been difficult to study, it has always relied on the temporal average of the data collected. However, with modern cameras, we are able to collect large amount of information in just few second of exposure. In this research, we present a method to see small and quick changes in the brightness and area (thus activity) of aurora borealis. The implications of the results are large and the possible future research with satellite data looks promising; determining solar micro-cycles, quick peaks in wind fluxes, characterizing particles that affect most the brightness of an aurora, rate of shape-change in auroras, and much more.

Methodology

The images where captured with the commercial camera Canon EOS 5D Mark II with a 50mm lens at 1600 ISO, 2.15 aperture and 4 seconds of exposure. These settings were the same through all the set of images.

The sample set begins at 1:20 UTC hours of the 22 of August 2014, and ends at 1:36; it is composed of 217 images, giving the analysis a very high temporal resolution of the changes in the aurora activity.

The whole set was produced on the exact same spot in southern Greenland (60.9913889 Latitude; -46.679166 Longitude).

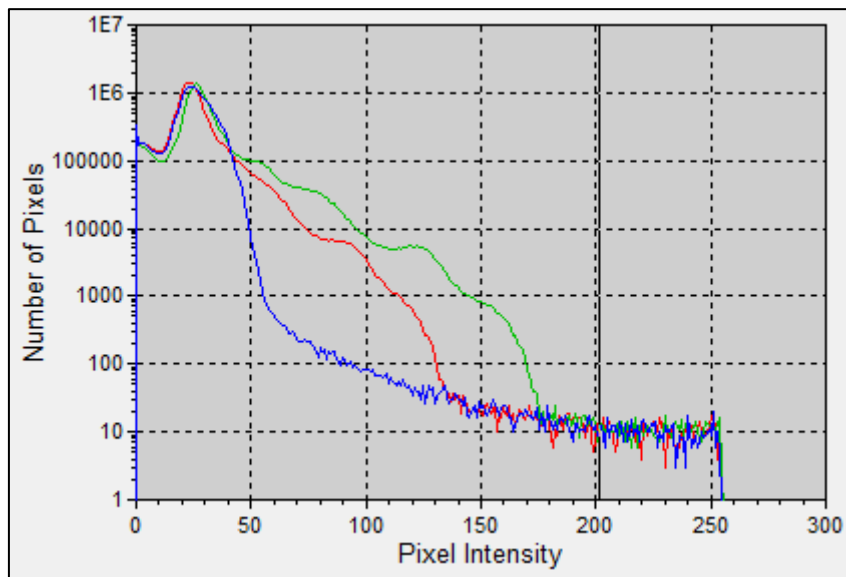


- First image of the set; property of Miquel Serra R. -

Analysis

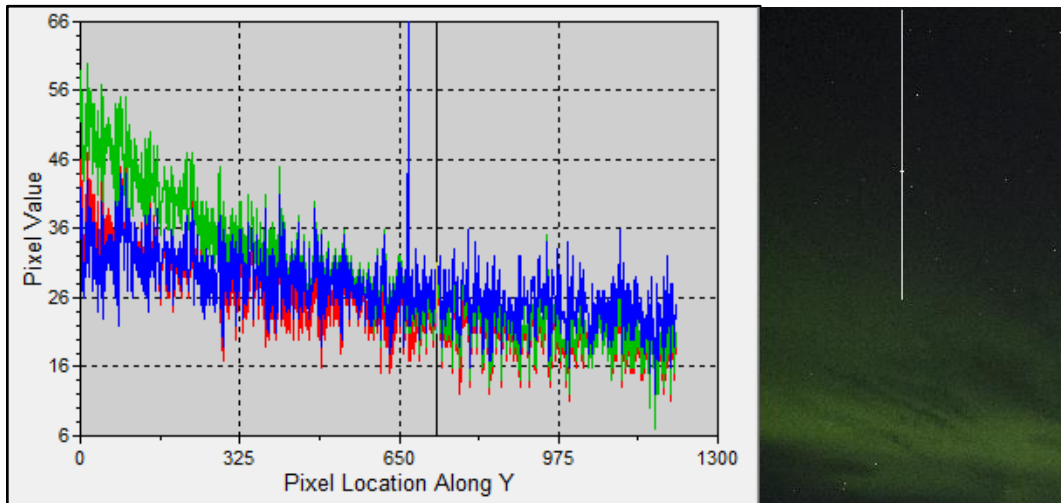
Using the software MaximDL 5, the RGB histogram of the images was extracted. For our purposes, only the green color was used, which is the predominant; when ionizing solar particles hit the upper layers of the atmosphere different colors are produced, but the great percentage of the light emitted falls into green wavelengths. Moreover, the blue couldn't be analyzed as certain parts of the sky were pale blues, therefore biasing the aurora. Also, reds were too dim to try to study them.

Compensation for the changes on the background light (sunset) was not necessary as the temporal interval within shoots was very small (16 minutes as a whole).

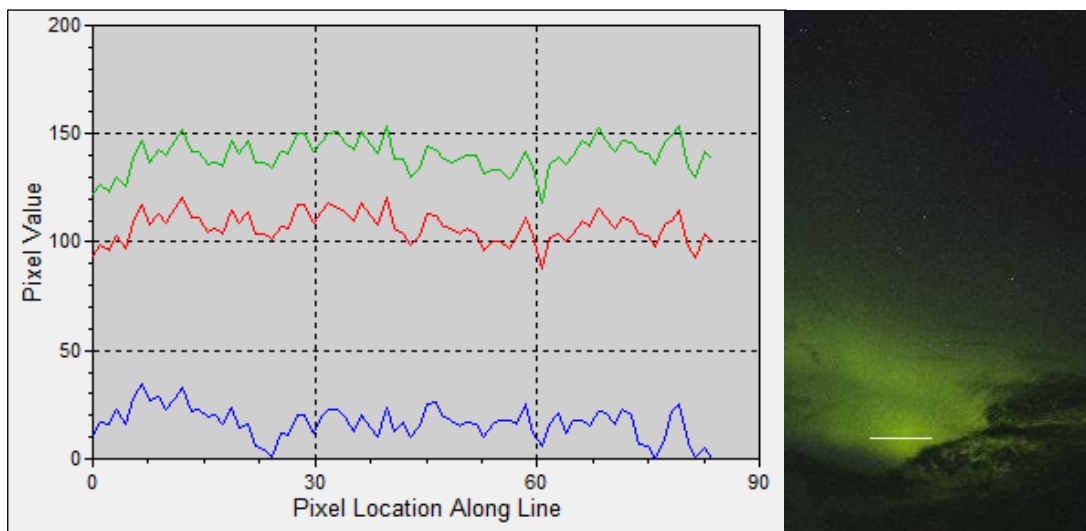


- Figure 1: RGB histogram of image 001 -

The elimination of non-Aurora green (background) was the next step. First, all pixels with green values lesser than 21 were eliminated from the analysis as they correspond to background green; as seen in figure 2.



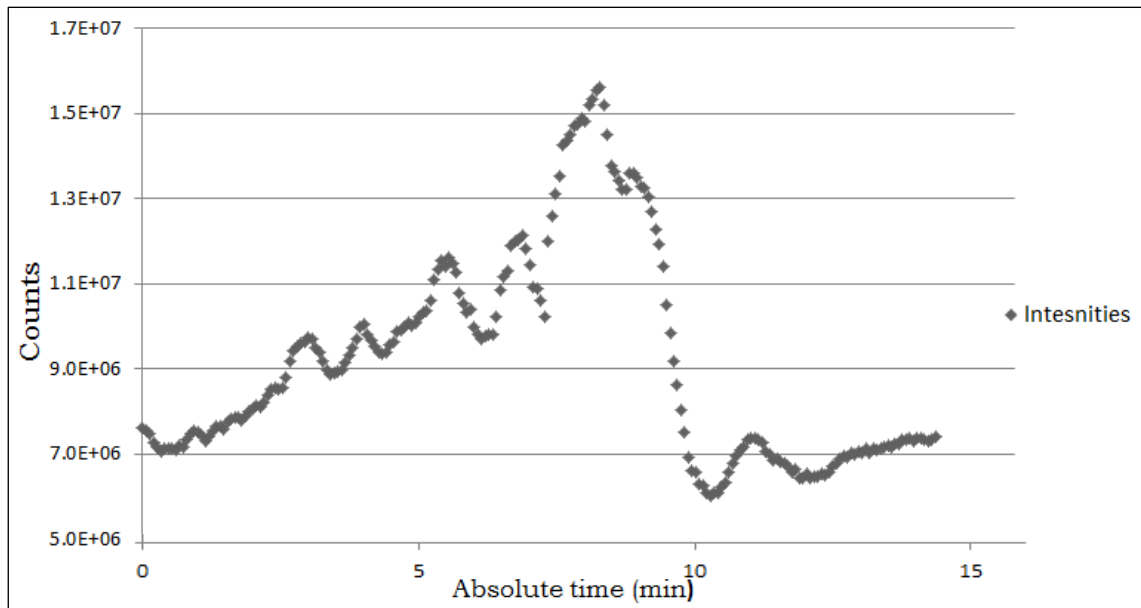
- Figure 2: Gradient of pixel intensities (left) along the white line (right) –



- Figure 3: Gradient of pixel intensities (left) along the white line (right) in the most intense area of the images –

Secondly, all the pixels with intensities above 160 counts were also ignored. As the area in the image with most aurora activity only arrived at 160 counts. Anything above that threshold are hot pixels and stars.

Afterwards, the “counts” (intensities) of the remaining green pixels of each images were summed up; and plotted along a time axis (figure 4):



- Figure 4 : Time from the first picture (min) vs. green counts (intensities)-

Results

It can be seen how fructuous this simple method of analyzing the aurora activity is. Moreover, it has been shown how smooth is the variance of brightness in the aurora. This research opens the door to analyse the correlation of brightness vs. time with current data of solar wind, which was the original purpose of this article. Only frustrated with the fact that high resolution data (60 second averages) of solar wind fluxes from different NASA satellites is not updated yet. Moreover, when this data becomes available, it will be easy to determine what particle (electron, proton or alpha particles), and what energy range (meV) affects more the activity of auroras in short period of times (of seconds).

Furthermore this type of method could be useful to study wind fluxes variations in very short periods of time because camera nowadays have a much shorter exposure time than that of space satellites that usually average hours of data.

References

- [1] Astroaula: astroaula.net/recursos-didacticos/actividades/aurorasboreales/
- [2] Images taken from: <http://goo.gl/seyRD3>