Practical 1
Aurora Borealis

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1 Objectives

TBD

2 Classification

TBD

3 Auroral Forecast

The purpose of this part of the assignment is to analyse data from different sensors and predict whether it is suitable conditions for seeing Aurora Borealis or not. However, by the time this report has been written (April 26, 2012) it was not possible to see the northern lights because it didn't get dark enough during the night time. For this reason, this section contains the analysis of the data taken from previous month and is compared to the images from the Auroral Large Imaging System (ALIS).
The data for analysis was taken from May 28, 2012 because it was quite a spectacular Aurora that day. As a source of images and scientific data the website of Swedish Institute of Space Physics (IRF) was used. The scientific data implies magnetometer and riometer measurements.

3.1 Magnetometer

Magnetometer is often used to measure long- and short-term variations. The Kiruna flux-gate magnetometers are used to measure short-term variations, which are due to electric currents flowing in the ionosphere and induced in the surface layers in the solid Earth. The time resolution for the data measurement of these particular sensors is 20 seconds. The key properties of the magnetic disturbance level are:

- K-indices: Quasi-logarithmic scale from 0 (very quiet) through 3 (moderately disturbed) to 9 (very disturbed).
- A_p index: A linear, daily index ranging from 0 (very quiet) through 15 (moderately disturbed) to 400 (very disturbed).
- A_E index: Index of auroral activity, derived from horizontal component of magnetic field variation at 10-12 auroral-zone observatories.
- D_{st} index: Index of ring-current (and global magnetic storms), derived from near equator observatories.

The flux-gate data from Kiruna's magnetometers is calibrated against the absolute measurments each month. Afterwards, quiet days are identified and the K-indices are calculated. In the geomagnetic measurements disturbance variations might be a sign of an aurora.

3.2 Riometer

The Relative Ionosphere Opacity meters (riometers) are used to measure the absorbtion of radio-noise from the starts in the ionosphere and they operate at 25-50 Mhz frequency. Radio waves of this frequency are absorbed at the altitude of 60-110 km if there is a significant number of electrons present in ionosphere. Riometers perform continuous observations of the noise-level and observe decreases in noise relative to the quite-day level when there is increased ionization due to the precipitation of the high energy electrons and protons. The typical auroral signature on the riogram is a sharp dip of few dB, followed by the slow regrowth. IRF has two riometers working at 30 and 38 MHz.

3.3 Analysis

The measurements taken from the archive for 28th of March are show in the figures below, where Figure 1 represents magnetometer measurements and Figure 2 represents riogram.
As it is seen in the magnetogram, there we quite some fluctuations from 00:00 to 08:00 at night of 28th of March. However, images are not recorded though the entire night because at the certain point it becomes to bright to see the aurora. Riometer has also some fluctuations during that time. Therefore, we can assume that there were a high probability of auroral display. However, to make sure that our assumptions are correct we decided to focus on the disturbances, occurred in the period from 20:00 to 22:00. The magnetometer clearly shows the variations in the magnetic field and the riometer has a dip, followed by the ramp of magnetic field recovery. Based on this observations, we conclude that there should have been a strong aurora during that period.

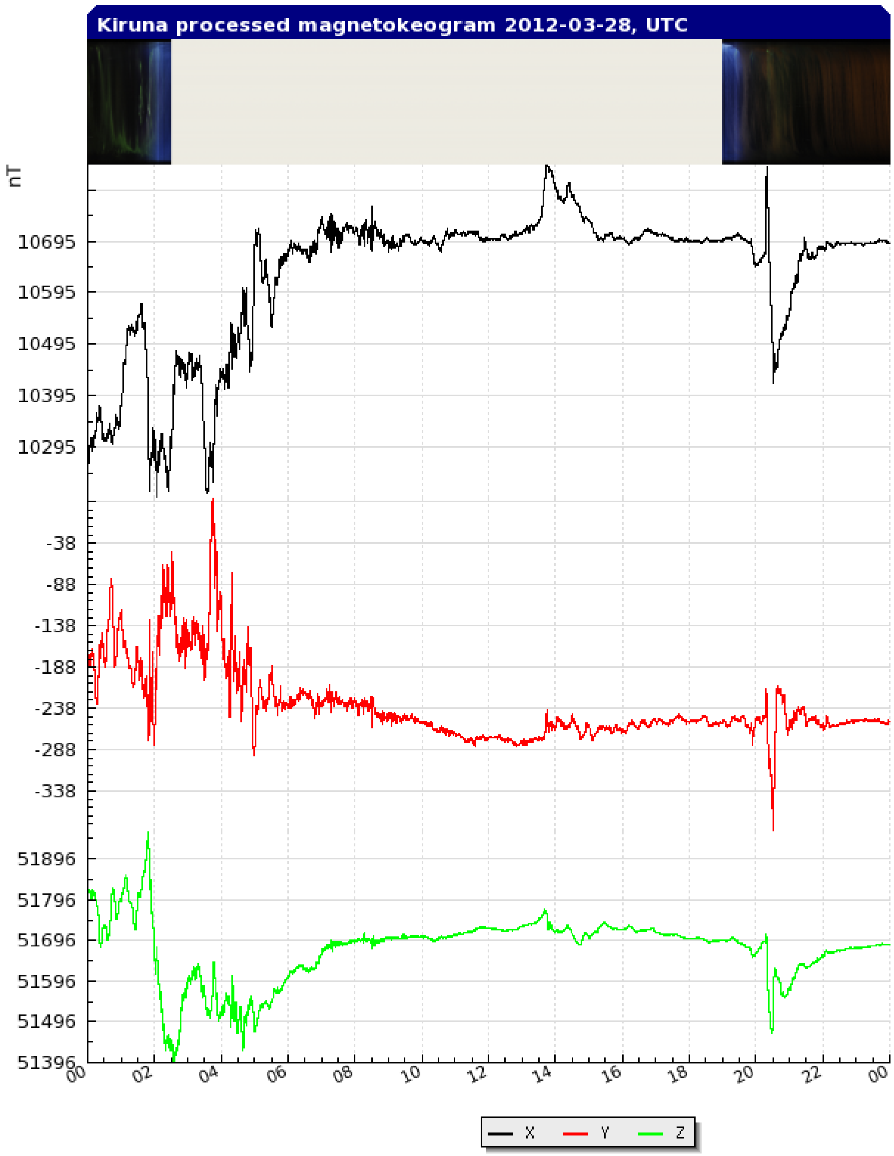

Figure 1: Magnetogram for the 28th of March, 2012.

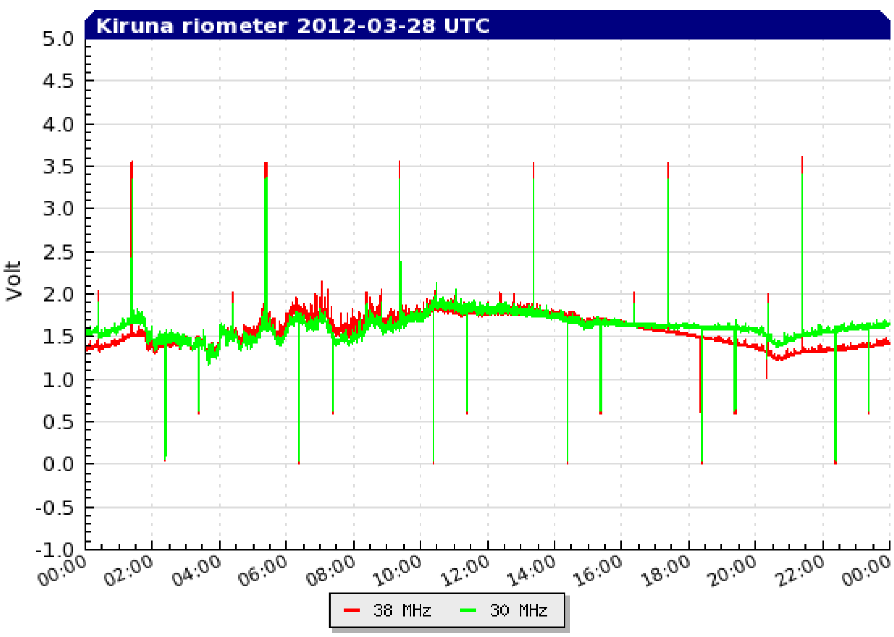

Figure 2: Riogram for the 28th of March, 2012.

To check if the predictions were correct or not the pictures from the archive were taken for the period we are interested in. Compilation of 12 images from ALIS is shown in Figure 3. According to the datagrams the auroral peak was around 21:00. On the ALIS images, the one taken at 20:51 is the brightest which is approximately at the same time as expected. To sum up, it is seen that the measurements reflect the real auroral probability correctly.

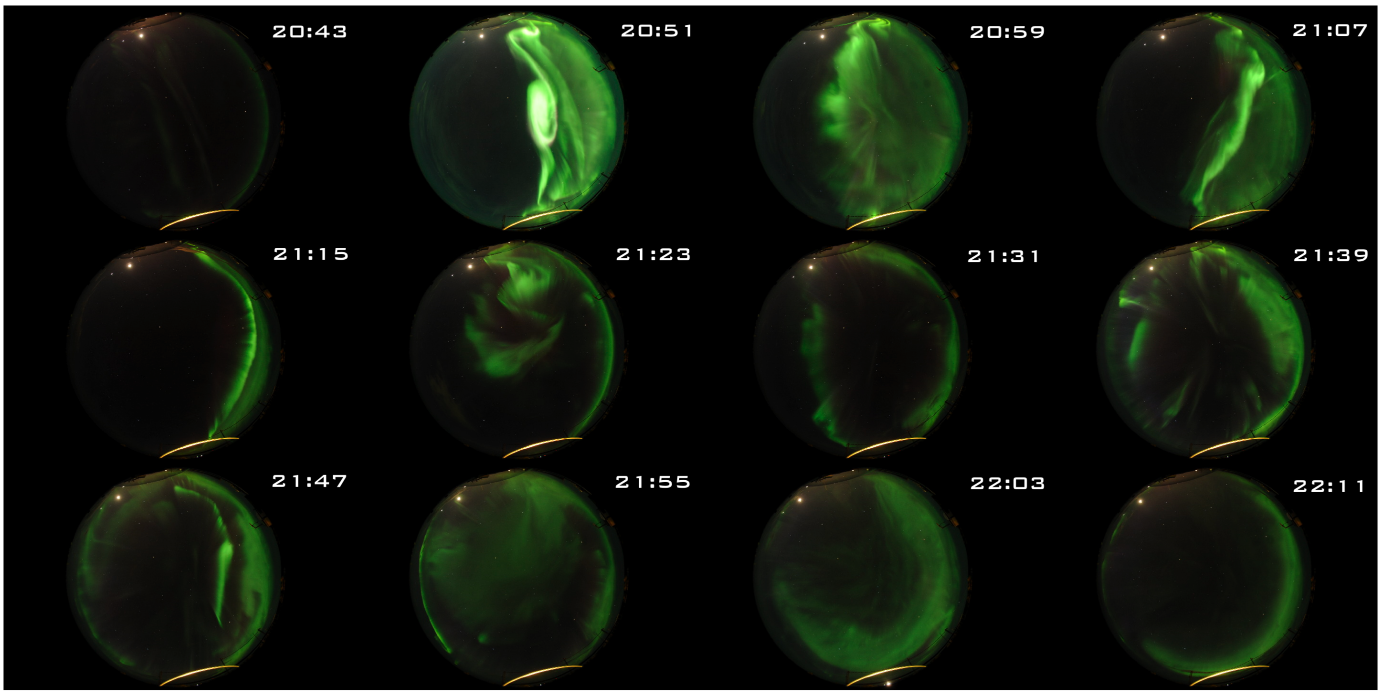

Figure 3: ALIS images compilation between 20:30 and 22:30 of March 28, 2012. The time in the upper right corner of each single picture represent the time it was taken.

4 Results and Conclusions

TBD for the first part

The date of the environment was chosen based on personal observations. During the experiment, datagrams from the magnetometer and riometer were compared to the images taken by ALIS. All the data was fetched from the IRF archives. The analysis showed that the highest probability of the aurora took place at the same time as there was the brightest aurora according to the images. As a result, we conclude that we have understood the principle how the predictions are made based on the data analysis and what processes are responsible for studied behavior.

References

[1] Stenberg, G. (2012). *Practical 1. Aurora Borealis.* Swedish Institute of Space Physics, Kiruna, Sweden.

[2] Kivelson M. G. and Russell C. T. (1996). *Introduction to Space Physics.* Cambridge University Press, Melbourne, Australia.