Team Name: SciMag

Chosen theme: Life on Earth

Organisation name: “ Spiru Haret “Bucharest National College, International Computer Highschool Bucharest

Country: Romania

Contributors: Maria-Ana Stănescu, Mihai-Cezar Titianu, Alexandru Peticaru, Ioan Alexandru Mirică, Alexandru Ivan, David Cristian Ghiberdic

Introduction

Have you ever wondered why life came to be as it is in this very moment? Apart from luck which conducted to a series of fortunate events one of the reasons why we were offered the chance to exist and to discover the world is the magnetic field of our planet. Because it protected the atmosphere that fostered the right circumstances for our species to evolve, the magnetic field has been crucial to the emergence of intelligent life on Earth. This is why we chose it as the focal point of our experiment, with the goal of learning more about the "magic-shield" that defends us from any harmful radiation sent toward our planet and examining any potential influences in its behaviour. The magnetic field originates in the Earth's second core, where molten metals (mostly iron) form the field lines. The following are the experiment's goals Measuring the intensity of the magnetic field nearest to the poles and the equator, and observing any notable discrepancies between these regions.

Method

The first step in our experiment was the gathering of necessary data. In order to have everything ready for the postprocessing of the data back on earth, we created a .csv file that saved snapshots of the situation every half a second. As the memory limit was taken into consideration, the pictures that accompanied it were taken only every 20 seconds and on other special occasions. We had a bug with the volcano distance calculation on board but we managed to recalculate everything back on earth with a corrected algorithm.

After receiving the data on Earth, we decided to collect all pictures in a single folder and link them with their respective snapshot. A noteworthy comment is that due to the noisy nature of the magnetometer data, we used an exponential smoothing algorithm to clean the data based on the time upon it was taken. The recursive formula for the exponential smoothing was the following:

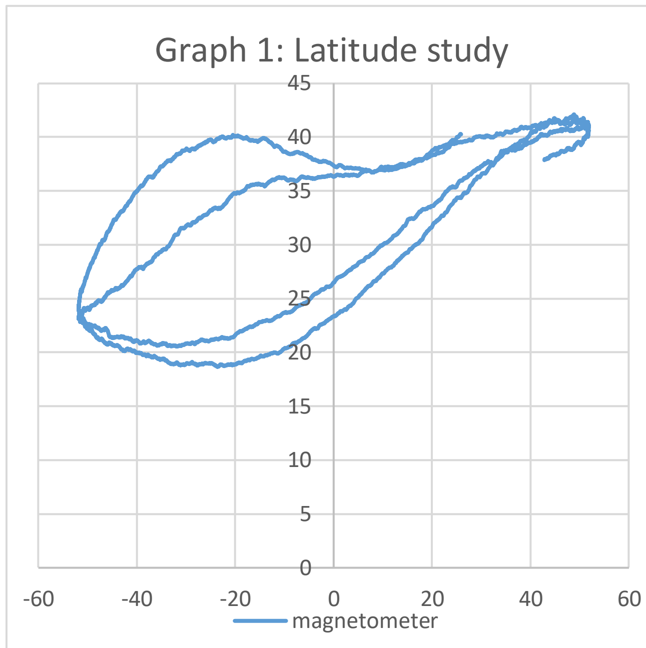
$$V_n = V_{n-1}K^{-\Delta t} + R_n(1 - K^{-\Delta t})$$

Where V_n is the smoothed value, K is a smoothing coefficient, R_n is the raw magnetometer value and Δt is the time difference between two consecutive snapshots.

Note: a GitHub repository with all the code and excel sheets can be found here.

Results

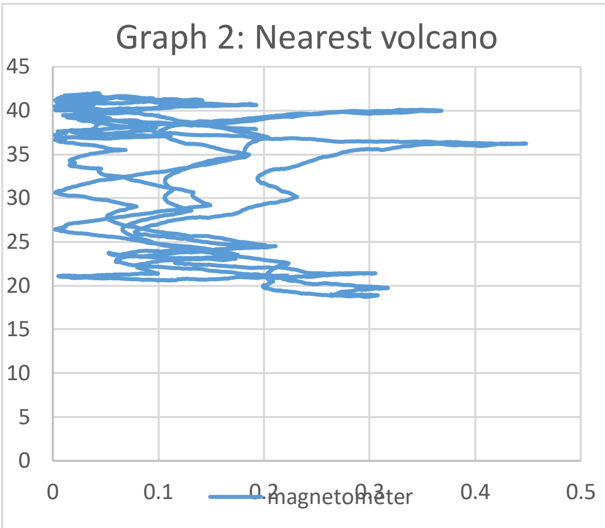
Task 1: Measuring the magnetic field in relation to latitude

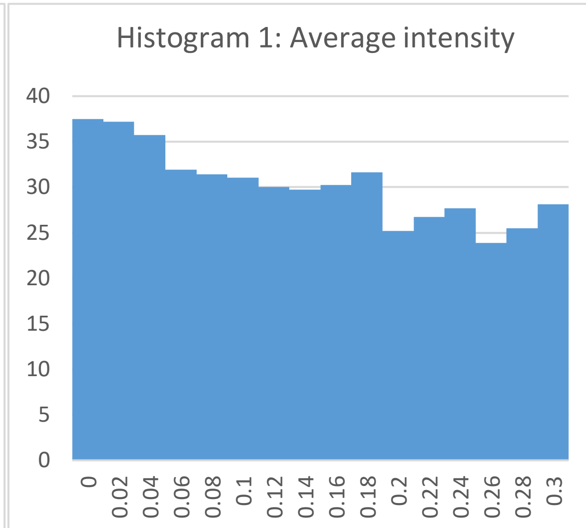


For the first task we plotted the smoothed magnetometer data in relation with the latitude of the ISS at that moment (*Graph 1*). For the north side of the planet, a consistent rise in the amplitude of the magnetic field in relation to the latitude can be infered, but in the southern hemisphere a more complex behaviour arises, with an apperent maximum or minimum at around -20 degrees, depending on the longitude. This phenomenon proves that the simple aproximation of a uniform magnetic field given by a theoretical perfect magnet is erroneous and thus, a complete map, depending on both latitude and longitude, is required for precise aproximations.

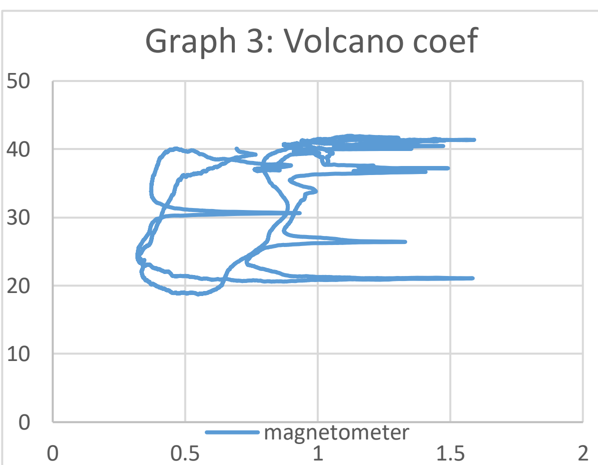
Task 2: Measuring the magnetic field in relation to volcanoes

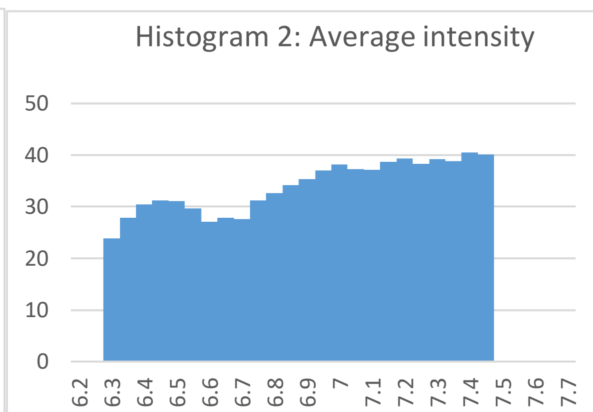
For the second task, we used two similar approaches. For our purposes, the value we're interested in is the influence that volcanoes have upon the magnetic field, and thus their proximity to the sensor at one point in time. Thus, we plotted the intensity recorded with two values:





First, we calculated the distance between the nearest volcano and the sensor at a given time. The unit is radians in relation to the earth. The results can be found in *Graph 2.* In order to interpret the data, we created a histogram, with buckets of size 0.02 radians (*Histogram 1*) and plotted the averege value of the magnetometer for every bucket. The result was a clear tendency for the intensity to drop with the distance to the volcanoes, which was expected. A noteworthy comment is the fact that some of the buckets contained very few entries so we disregarded everything under 300 snapshots.





The second value is a coeficient, being the sum of the inverse distance to every volcano in the database, expressed as a logarithm for ease of use. The distance this time was the chord on the globe, not the arc, in order to beter aproximate the behaviour of the magnetic field in relation to distance. The plot can be seen in *Graph 3*, shifted by 6 units. After this, the method was similar to the previous one, where we created buckets, this time 0.05 units in size, plotted the average in *Histogram 2* and disregarded every bucket with under 50 entries. The final result this time is a tendency for the intensity to increase with the coefficient, which is to be expected due to the inverse nature of the coefficient with distance.

Note: the final excel with all the tables and calculations can be found here.

Conclusion

This is perhaps the most important section of them all. In the conclusion, you should talk in more detail about your main results. Are they what you expected to find? Why, or why not? If your experiment did not produce any valid results, please explain what you think went wrong and what you would do differently next time. This section is limited to 200 words.

The results for the first task were surprising and upon further study, it appears that we recorded the South Atlantic anomaly. The results were still mostly expected for the northern hemisphere, so with a different timing of the experiment, our opinion is that we would have had similar results in the two hemispheres. For the second task, the presence with the anomaly is a possible disturbance factor in the data, and in order to reach high certainty for the corelation of the magnetic field and volcanoes, an experiment over longer time durations with regard to the uneven nature of the magnetic field is required. That being said, a relation could still be found with the limited data, and further study is required. For the third task, unfortunately the pictures in daytime and over solid ground were very few and thus the study of the NDVI coefficient was disregarded.