Mission Space Lab Phase 4 Report

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Chosen theme: Life on Earth

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1. Introduction

Our experiment aims to study the changes of the Earth's magnetic field intensity along the ISS orbit and try to establish if it's affected by altitude and day or night time, by comparing the data with values obtained from the Worldwide World Magnetic Model (WMM). We also intend to investigate if the geomagnetic field was influenced by solar activity during the experiment and, if possible, detect the South Atlantic Anomaly (SAA), which is a region on Earth's surface where the intensity of the magnetic field is particularly low.

2. Method

Our code collected the data from the magnetometer for the X, Y and Z axes to study the magnetic field intensity. The Inertial Measurement Unit (gyroscope and accelerometer sensors inside the Astro Pi) was also used to record the orientation and accelerometer readings of the X, Y and Z axes, every 3 seconds. Simultaneously, the light sensor determined the brightness to evaluate whether it was day or night and Astro-Pi's visible-light camera took photographs of the Earth's surface and stored then with a date/time stamp to confirm the accuracy of the ISS location and time of day.

3. Experiment results

According to the log file, our code ran on May 4 from 03:57:30 to 06:52:43 (UTC). The measurements from the sense hat were written to a CSV file every 3 seconds, making a total of 3380 entries and 64 photographs were taken.
We used Google Earth and Google Maps to show the two orbits of the ISS during our experiment and display the data acquired from each entry (Figures 1 and 2).
The all data can be viewed at:
https://www.google.com/maps/d/viewer?mid=1UtmBldfV-OkEsd7SPVWMfv6WrAmlWe4&usp=sharing

Figure 1: The two ISS orbit's on Google Earth

Figure 2: The two ISS orbit's on Google My Maps

we calculated the total intensity of the magnetic field (*B*) from its components using the formula: $B=\sqrt{B_x^2+B_y^2+B_z^2}$, and then we plotted the total intensity of the magnetic field and the latitude, along the entries. Since the accuracy of the ISS's position depends on the precision of the TLE data and the models used by the library, we compared the time stamp and coordinates of the data recorded with the photographs and discovered discrepancies between predicted and actual positions. So we corrected the coordinates of the data of the magnetic field intensity according to the location seen in the photographs. This gave us more accurate results.

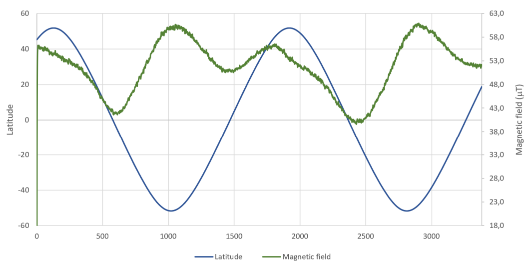

Figure 3: Latitude and Magnetic field

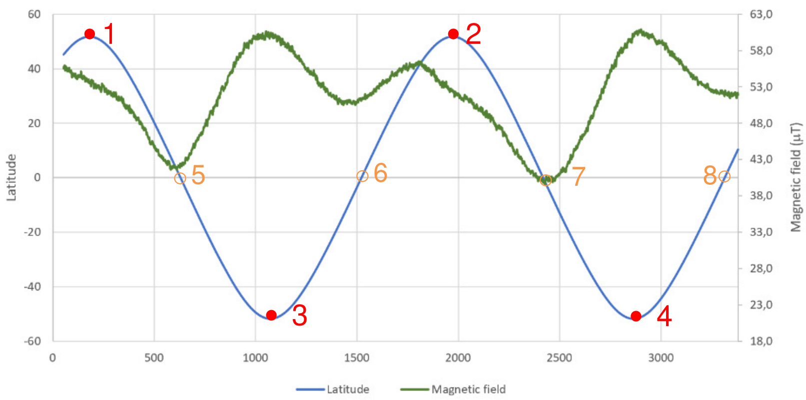

Figure 4: Latitude and Magnetic field (corrected data)

As the ISS orbits the Earth, it traverses a range of latitudes, experiencing variations in the Earth's magnetic field intensity accordingly. When the ISS passes near the magnetic poles (1 and 2 – near the north pole; 3 and 4 – near the south pole), it encounters stronger magnetic fields, whereas when it crosses the equator, the

magnetic field strength is weaker (5 and 7 - over the Indian Ocean; 6 and 8 over the Pacific Ocean).
Overlapping the Google My Maps image with the map of Earth's Magnetic field intensity, in 2015, developed by NOAA/NGDC & CIRES (http://www.ngdc.noaa.gov/geomag/WMM), we detected that our data are approximately 5 μT higher. Nevertheless, they are still very good results.

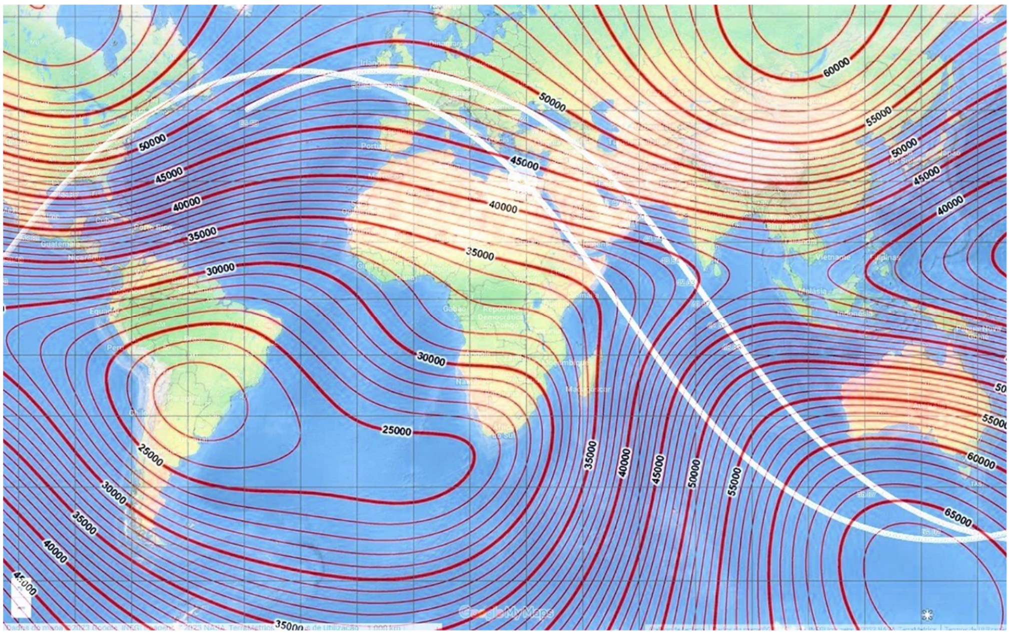

Figure 5: ISS orbit and Earth's Magnetic field intensity (nT)

4. Learnings

We learned a lot about python coding. We also learned more about Google Earth and Google My Maps to get the ISS orbit. We also used Excel to analyse data.

We didn't have a lot of time to write this report, as the data was received towards the end of the classes, but we are pleased with the results.

5. Conclusion

The changes in the Earth's magnetic field intensity is primarily influenced by the latitude. The Earth's magnetic field lines are not perfectly aligned with the planet's rotational axis but are tilted at an angle. This tilt is responsible for the variation in magnetic field intensity across different latitudes. We were able to verify that the highest magnetic field intensities are typically observed near the magnetic poles, while the lowest intensities are found near the equator.

There were no magnetic anomalies detected in our data that could be due to Solar activity and according to USAF/NOAA Solar Geophysical Activity Report, until 7th May, the Solar activity was at moderate levels.

As the ISS orbit did not pass over South America, we were unable to detect the South Atlantic Anomaly (SAA).

All project data and code can be found at:
https://github.com/Robotica2022/DAHspace2023