Mission Space Lab Phase 4 report outline

Team name: Equinox

Chosen theme: Life On Earth

Organisation name: Robone Robotics Club

Country: Germany

1. Introduction

This experiment aims to investigate:

- Whether or not NDVI is related to the Earth's magnetic field, climate change and various gas emissions.
- Whether or not the Earth's magnetic profile has a relationship with the climate and its effect on Near Earth Object (NEO) behaviour in Low Earth Orbit (LEO).
- Whether or not on-board machine learning is viable, using the Coral Artificial Accelerator (AI XLA) for classification of images gathered during the experiment.

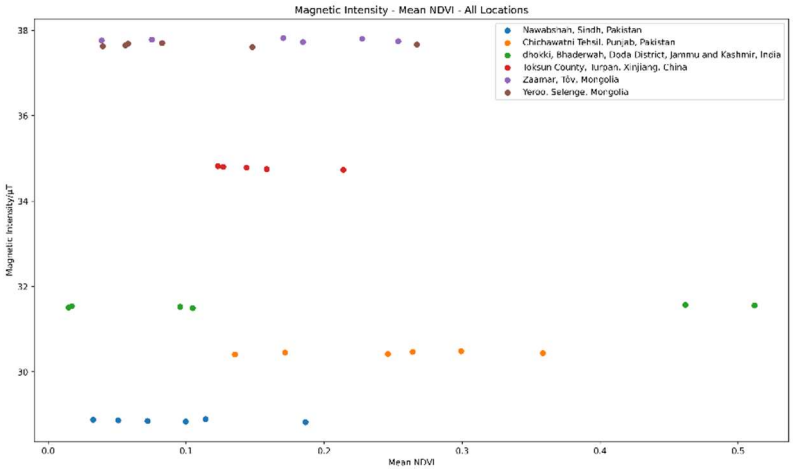
This experiment aims to look at these relationships through data obtained on the International Space Station (ISS) as well as historical data obtained back on earth.
With our world being on the brink of an environmental catastrophe, we thought that it would be interesting to see the relationship between the NDVI and other climate change-related data, like gas emissions and climate. We also decided to investigate the magnetic intensity as an extension of our experiment from last year.
While investigating the relationship between the NDVI and CO2 and Methane, we expected to see an inverse correlation between the two.

2. Method

The IMU sensors were used to record magnetic intensity, acceleration, and angular velocity, as well as the HQ Camera to take NearIR images of the Earth, for which the average NDVI for each was calculated, and which were classified into different categories during the night. Location data was obtained using the skyfield library. Data was then saved in both NPY and CSV formats.
The experiment was conducted on 6 chosen locations. For each location, the past 5 years (2017-2022) of weather, NDVI and gas emission data was acquired using World Weather Online API, Open Weather Map API and Climate Analysis Indicators Tool API respectively. 2022 NDVI data was obtained on-board.
The magnetic field values for the last 5 years were calculated using the magnetic field intensity decay given the assumption that the magnetic field is not moving. Noise filtering was then applied to the IMU readings. Then comparisons and correlations between the all data were carried out. Moreover, we calculated the autocorrelation for IMU data to test for randomness and patterns present within.

The [GitHub repository] contains the noise filtering algorithm, as well as the graph plotting script, and the main code that executed the analysis of the data.

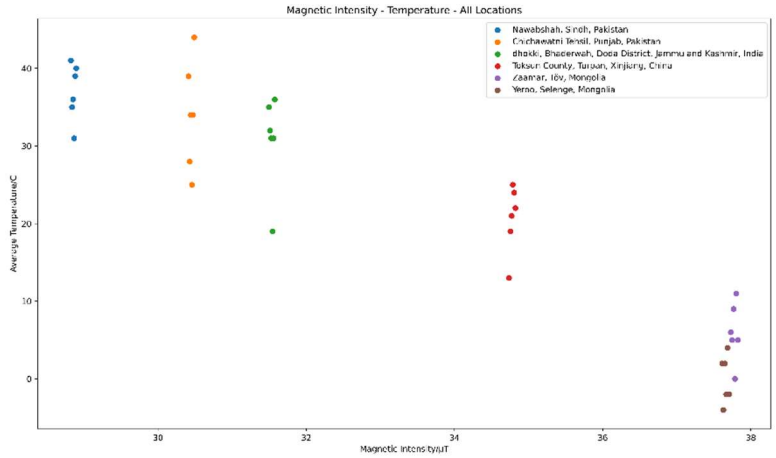
3. Experiment results



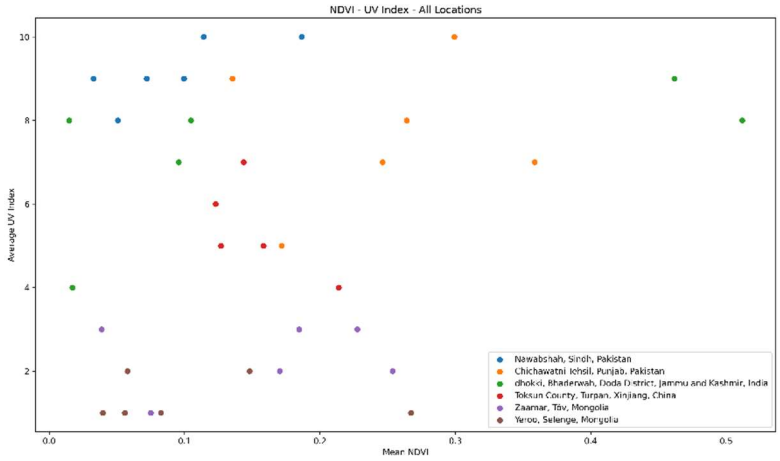
As we can see from this graph, the NDVI and magnetic intensity don't correlate at all. Each location has a cluster of points, however, the clusters are all spread out. This is contrary to what we were expecting due to the fact that an increased magnetic field has been proven to assist and hasten germination and root growth thus increasing the NDVI.

Location	Sindh, Pakistan	Punjab, Pakistan	Jammu and Kashmir, India	Xinjiang, China	Tov Mongolia	Selenge, Mongolia
NDVI	0.114110287	0.299268094	0.461776125	0.122953655	0.170330146	0.082598729
CO2 Emissions/Kt	0.14	0.14	69.07	nan	1.5	1.5
CH4 Emissions/Kt	147.58	147.58	53.22	161.84	18.1	18.1

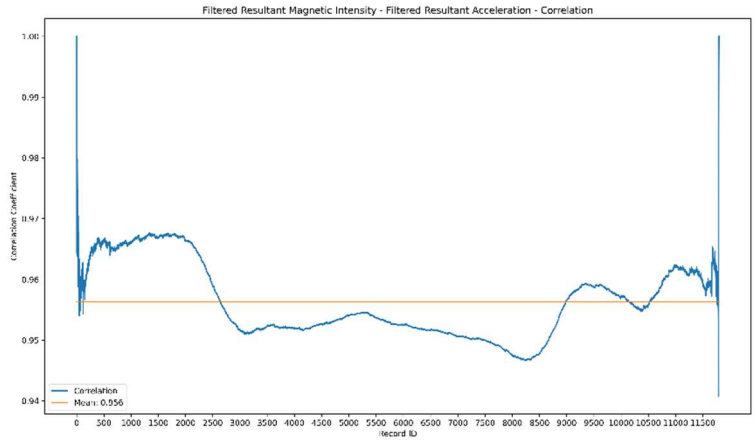
As shown in the table above, there is no correlation between NDVI and the emissions of carbon dioxide and methane. This is contradictory to our initial hypothesis as an increase in NDVI would mean an increase in the rate of photosynthesis in a location. This would in turn reduce the levels of carbon dioxide. Additionally, places with high NDVI readings are most likely to be cultivated lands or natural forests, jungles, plains, etc. This would also mean a lower amount of industrialization in that area and thus, lower carbon dioxide and methane emissions.



The graph above shows a strong negative correlation between the average temperature of a location and its magnetic intensity. The data points are also clustered into their own respective cities.

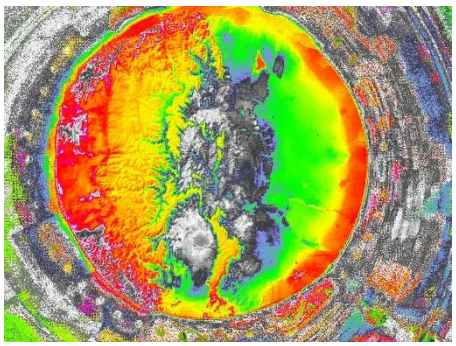


The graph above shows that there is no visible correlation between the average UV levels and the mean NDVI. Points corresponding to each location are also not clustered and appear to be scattered randomly across the graph.

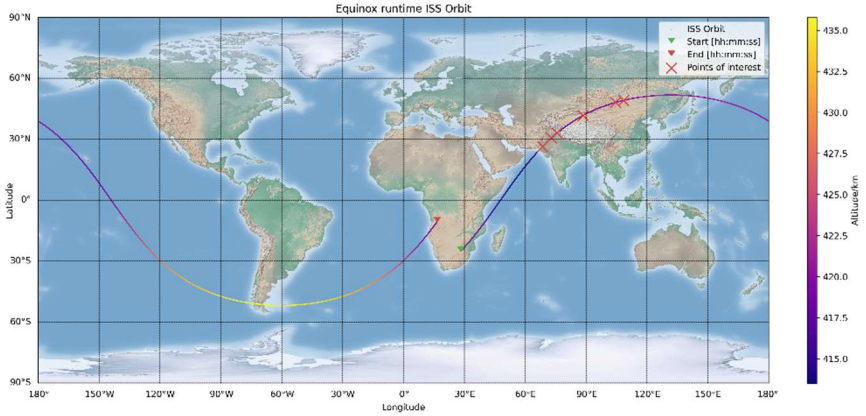


This graph shows that there is an extremely high correlation coefficient between the magnetic intensity and the absolute acceleration of the ISS, the lowest point being approximately 0.94 and the mean being 0.956. These high values indicate that there is a strong relationship between the two.

Without NDVI applied



With NDVI applied



ISS orbit

4. Learnings

● We planned our work according to a work breakdown structure

● For this experiment, we faced many disadvantages that affected the analysis as the datasets available were limited; however, we managed to come up with decent results with the available data.

● We learned more about machine learning and the Google Coral, as well as about NDVI and how it is affected by our world.

● Next time we hope to get better dataset availability, as well as produce more precise and decisive results.

5. Conclusion

For this experiment, we faced many disadvantages that affected the analysis as the datasets available were limited.

However, we came up with valuable results with the available data.

- We found that the NDVI calculation did not correlate with most of the data it was compared to. Nevertheless, NDVI and gas emission data overlap was very limited and so we deem it inconclusive.
- Magnetic intensity and temperature seem to have a negative correlation; however, no causation is proved as magnetic intensity doesn't seem to have a solid correlation with climate as a whole.
- On the other hand, the magnetic intensity seems to have a solid correlation to metrics like acceleration and angular velocity, the most prominent being with acceleration as shown in correlation graphs.

Learned that clouds can affect the NDVI readings drastically which also affected our model.