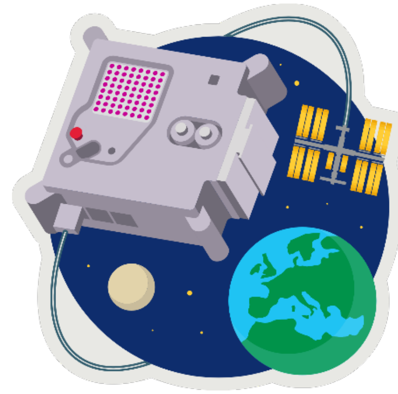
Mission Space Lab Phase 4 Report



Team Name: Team PiHeads

Chosen Theme: Life On Earth

Organisation: Altrincham Grammar School for Boys

Country: England - United Kingdom

Introduction

Our project aim was to investigate plant growth within different biomes and climates of the Earth. We decided to use $NDVI$ analysis to calculate plant coverage as a percentage of the total land area and also the average plant health – all using the near-infrared reflective index of the earth below. We set out to use this data alongside an autoregressive model, using similar historical $NDVI$ imaging to create a prediction forecast for the future changes in the vegetation for that land area alongside an interactive GUI explaining our findings (screenshot below).

We hoped that this would enable us to accurately create a model for the vegetation coverage and health of plants around the globe and see where the impacts of desertification/deforestation would be most prevalent. This information would provide us with insight into which biomes and countries are most at risk of losing its vegetation and could be used to focus nature reservation campaigns to protect the detrimental loss of our world's primary producers and "lungs". We believe that predicting the future changes to biodiversity is crucial in order to help protect our precious and precisely balanced one-in-a-million planetary ecosystem - which is why we feel that our project would be of great interest and use within modern science.

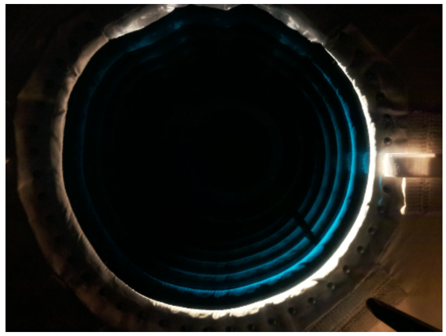
Method (GITHUB)

Within our program, we included several functions that would aid us in our post processing and allow us to gain valid and accurate results: the Near Infrared Noir camera would take photographs of the Earth approximately every 30 seconds in order for us to obtain a plethora of data for us to analyse; the Latitude and Longitude allowed us to match the images collected from ISS to real world locations using $Google\ Maps$ and $ArcGis$ software; the time in conjunction with whether the ISS was in 'darkness' allowed us to match up the images onto the GUI accurately. For the processing of data (see the experiment result section): we completed most of the processing on Earth due to intensive machine learning, we attempted to use the $Coral\ USB$ with custom $Tensor-Flow\ lite$ models, however, we found that Google Collab was better suited to our needs: more powerful & interactive (using $Jupiter\ NoteBooks$.)

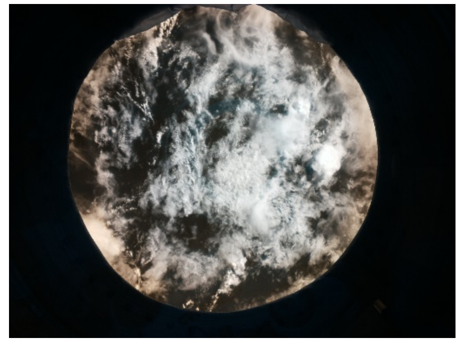
https://github.com/Aiyush-G/astroPi/tree/main

Experiment Results

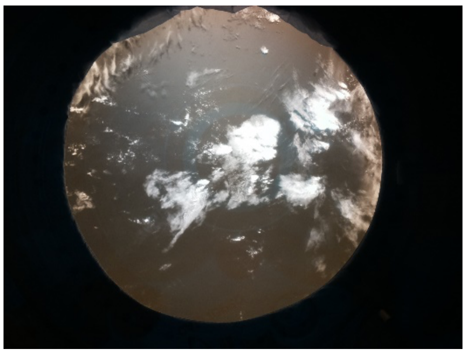
Tibetan mountains



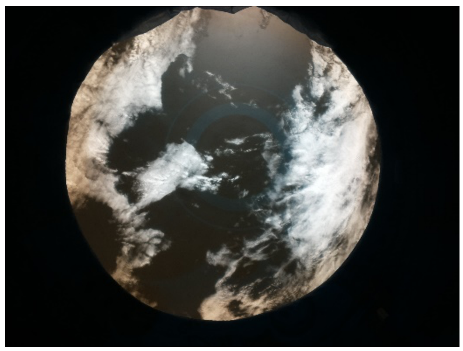
Sunlight reflection



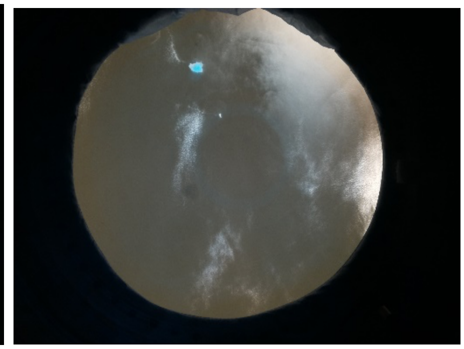
Altocumulus clouds



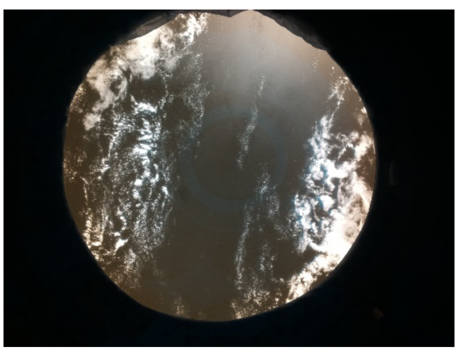
Edge of Madagascar



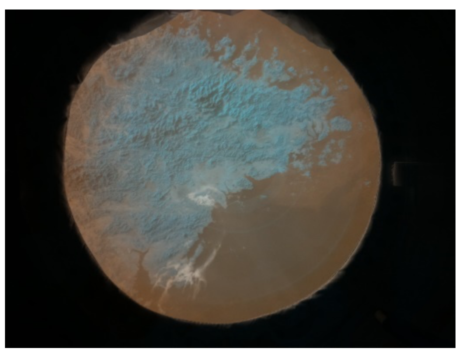
Atlantic Ocean



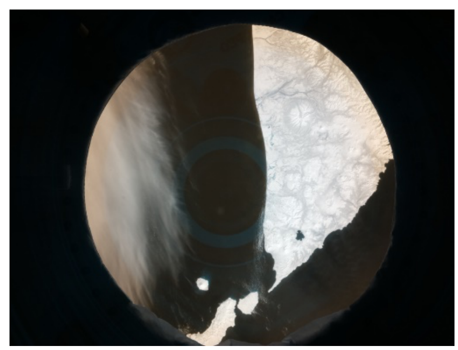
Oceanic Island



Pacific Ocean



South Korean Peninsula



Okhotsk Headland

The pictures above show the range of data obtained from the camera mounted on the AstroPi, varying from pictures of mountainous landscapes to oceans and some areas of land covered in clouds along the orbit. The program was designed to only take pictures in the light, therefore there is a range of excellent pictures of the Earth that can be clearly seen. However, it would have been better to factor in areas along the orbit where it may have been dark for a period of time, as many of the photos taken in the middle of the orbit were blacked out. This meant only around 50% of pictures were in light, and only about 20% of those had land imagery, which restricts the scale of analysis we could potentially carry out. However, the pictures that were usable were very distinct and although obscured slightly by cloud cover sometimes, they were predominantly clear.

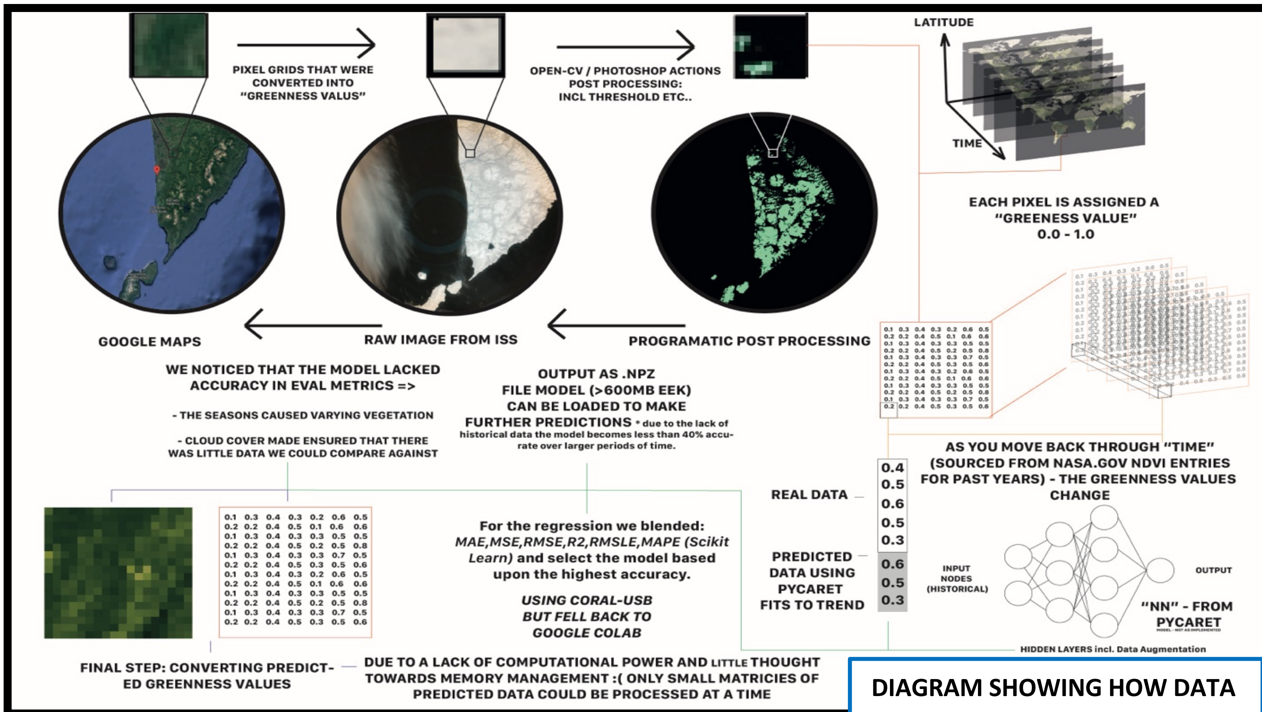
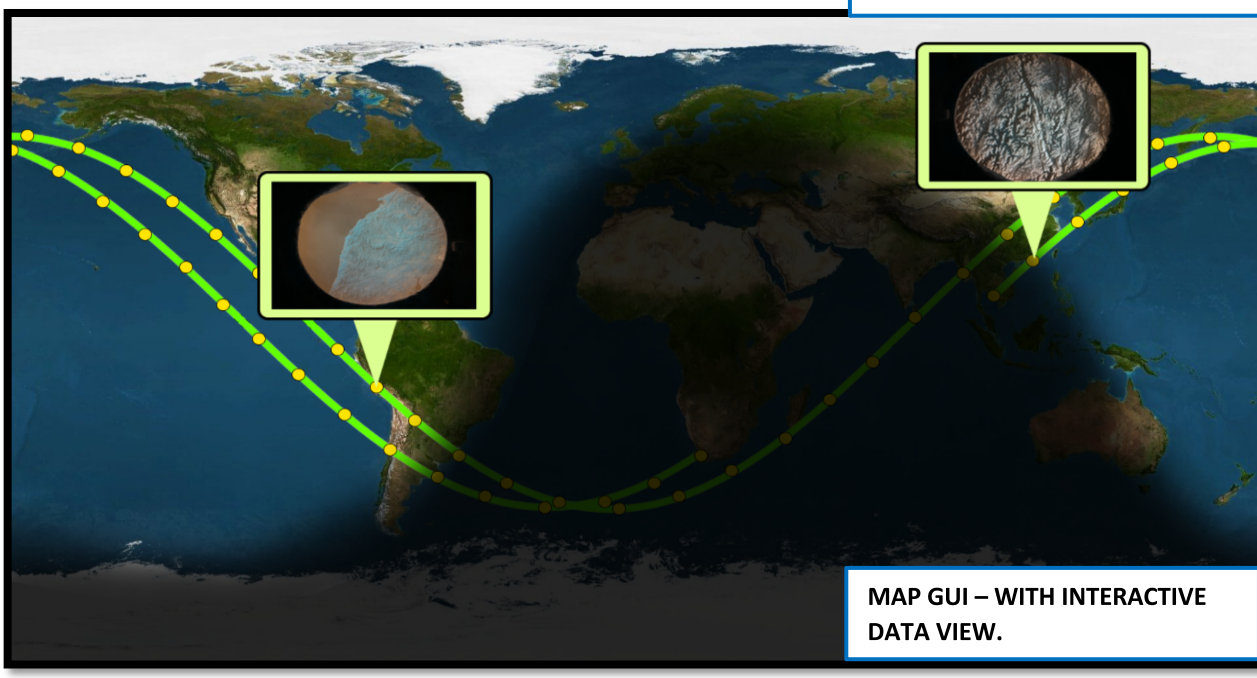


DIAGRAM SHOWING HOW DATA & RESULTS ARE PROCESSED



MAP GUI – WITH INTERACTIVE DATA VIEW.

Above is shown an image of how our data has been presented within an interactive Graphical User Interface (GUI). This shows the exact pathway of the ISS during the runtime of our program (created using the precise .csv file coordinate system) along with several key imagery taken on our flight. This also shows the night-time darkness pattern present at the time of our experiment running – which was also recorded within the file (19/04/2022 21:30:08.3 – 20/04/2022 00:21:41.1). Unfortunately, as shown above, the majority of our flight path was above water or in complete darkness.

Learnings

Obviously working as a team has been wonderful, collaborating initially through the idea, then the plan and finally transforming it into usable code, and to see the final project work form space is sensational. We were able to collaborate well, meeting up to assemble the kit and begin development on the code, setting out a clear timeline. However, after receiving data, the whole team was in the middle of GCSE exams meaning handling data wasn't as efficient as we could have hoped. Despite this, we managed as best as we could to analyse what we could in the time constraints.

As a team, the project taught us time management to meet the strict deadlines and we evolved to become a more efficient team. We also learnt a lot of useful technical skills, such as utilising the specialist kit equipped specifically for the AstroPi, as well as learning how to operate all the various components such as the Coral USB accelerator. As well as the hardware, conducting these components through use of the software provided a learning experience, trying to make use of certain functions to capture the data we required. We would next time hope to adapt code to discard areas of darkness, allowing more usable data in the storage limit, as well as make more use of the Corol USB accelerator.

Conclusion

Our aim was to analyse the vegetation coverage along the orbit – simply put – through various pictures captured through an autonomous program, and the code executed this perfectly, allowing us to make mostly useful analysis. We wanted the NDVI analysis from various environments scattered around Earth on the orbit of the ISS at the time, to correlate with previous data collected, allowing us to make predictions of future "vegetation safety", whether the plant cover is sustainable or detrimental.

Next time, we would hope that more of our data could be used, reducing the proportion of darkened pictures, however, this was redeemed by the usable photos which were useful in reaching our conclusion: the data shows a decline in cover on average overall in the pictures analysed, therefore most areas we found were delving into unsustainable plant coverage, as we expected. The only obstacle to exercise the most utility of our data was the high proportion of unhelpful pictures, so obviously this would be the main element to improve to increase the validity of our conclusions.

As well as the data, the AstroPi hardware provided an exciting learning experience, and sparked a great collaboration within our team in order to produce this data set, as we had wanted.

Final Note

Thanks to the Astro-Pi staff without whom this project would never have been realised & to our Physics teacher for his support throughout the project.