Mission Space Lab Phase 4 report

Team name: Trivials

Chosen theme: Life on Earth

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1. Introduction

This experiment uses the Astro Pi's Near Infrared camera aboard the International Space Station (ISS) to assess and monitor various aspects of Earth's environment. The primary focus is on analysing forest cover using the Normalized Difference Vegetation Index (NDVI). By capturing imagery from space, we aimed to determine the percentage of land covered by forests and vegetation, as well as evaluate the impact of recent forest fires on foliage concentration over large areas of the planet. Furthermore, we seek to identify variations in vegetation coverage surrounding urban areas, comparing these findings to previous surveys conducted by NOAA satellites to understand the effects of urbanization on vegetation.

In situations where land vegetation data is not available or inconclusive, our experiment also includes monitoring the size of garbage patches in the ocean. This is accomplished by measuring the presence of algae on the water's surface. By combining these different areas of analysis, we hope to gain insights into the state of Earth's ecosystems and better understand the impact of human activities on the environment. The results of this experiment can contribute to informed decision-making for conservation efforts, urban planning, and addressing environmental challenges on a global scale.

2. Method

For this experiment, we wrote code to take pictures of the Earth periodically and do the necessary processing. By enhancing contrast, calculating NDVI, and applying colour mapping, our code enables the analysis and visualization of vegetation coverage.

The process starts by reading an image and applying contrast stretching to enhance

subtle changes. This is followed by calculating the NDVI, which measures the health and density of vegetation based on the reflectance of red and infrared radiation. The NDVI image is then further contrast-stretched to improve visibility.

To visualize the results, a colour map is applied to the NDVI image. The colour mapping enhances the representation of vegetation by assigning different colours to different NDVI values. This colour-mapped image provides a visual depiction of vegetation density.

Additionally, there is a function to process multiple images in a specified directory, ensuring each image is processed only once and saving the processed images with appropriate filenames. During our testing, we saw that the optimal time between images would be approximately 48 seconds, allowing the pictures to be processed automatically during the experiment run-time. Our code and testing files are available here.

3. Experiment results

While this experiment primarily hoped to be able to identify areas affected by forest fires, the data obtained didn't allow any conclusion in this regard, as many of the images were either taken during nighttime or were obstructed by clouds, and those where a clear view was obtained didn't show any areas recently affected by wildfires.

Some images showed a clear difference in NDVI values between urban centres and the surrounding areas, with cities like New York and Bissau presenting different changes in NDVI relative to the surrounding environment, as can be seen below.

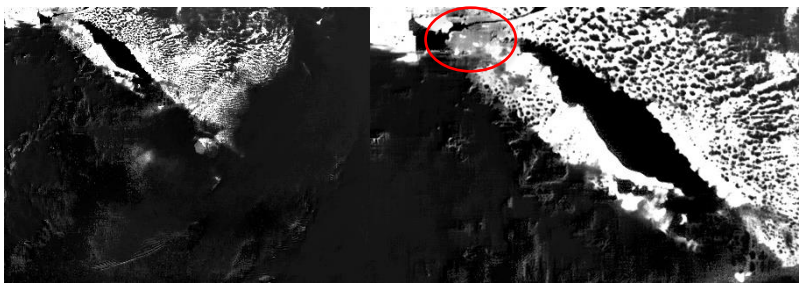

Figure 1 - NDVI map of New York City and surrounding area. Urban centre highlighted.

Figure 2 - NDVI map of Bissau and surrounding area. Urban centre highlighted.

Though we meant to compare NDVI values of urban areas with the past, relying on NOAA's NDVI surveys (available here, 08/06/2023) to do so, the difference in resolution of our mapping and the existing NOAA data made such a comparison unreliable. Using that data, we were still able to identify an increase in vegetation density in most of the Northeastern United States, as shown in the following pictures, which map NDVI values for the region from 1983 to 2018, with 5-year intervals between images (data referring to the same day of each year – 24th of April). In these images we can also see that, despite the increase in overall vegetation in the area represented, New York City (marked in blue) remains with a low vegetation index due to its high degree urbanisation, as corroborated by our data.

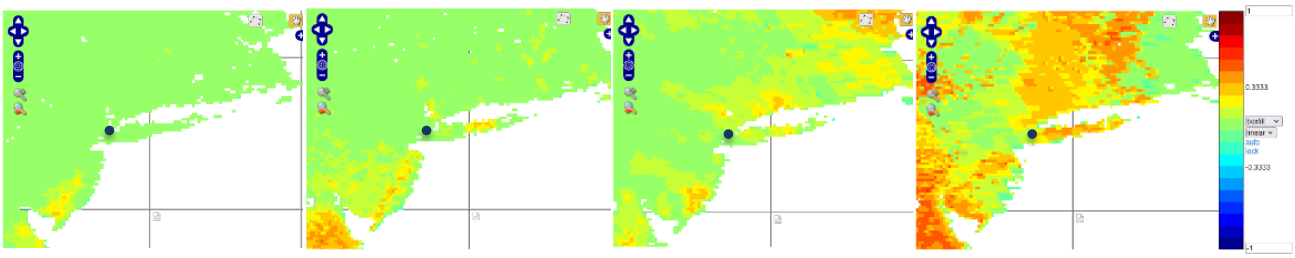

Figure 3 - NDVI maps of the Northeastern United States between 1983 and 1998 (5-year intervals).

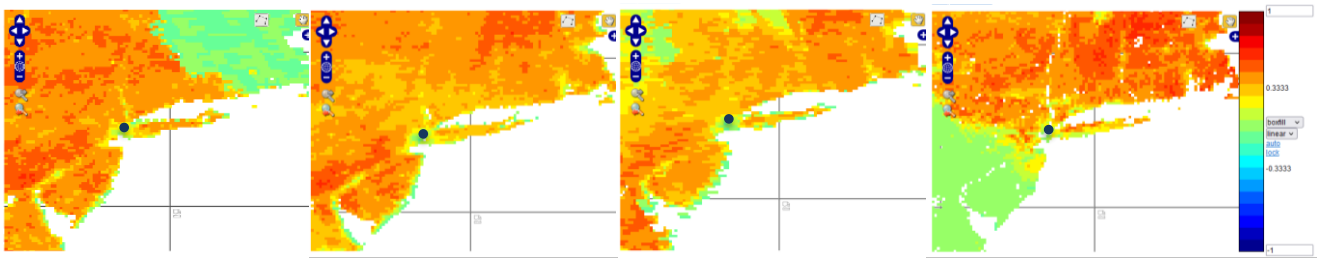

Figure 4 - NDVI maps of the Northeastern United States between 2003 and 2018 (5-year intervals).

4. Learnings

This project presented us with many challenges, ranging from organisation as a group to the writing of our code and data analysis. This was an opportunity to develop a greater understanding of the limitations of space-based observation of our planet due to weather and distance from the surface. It also provided a chance to learn how to write code as well as document it, along with an opportunity to familiarise ourselves with different tools, both for learning and to write our code. Lastly, we were able to see how each of us approached the analysis of our data in different ways and learn new methods and practices from each other.

This experience also allowed us to learn how to divide tasks and coordinate with one another to work towards a single goal as efficiently as possible, as well as to better manage our time.

5. Conclusion

Our experiment aimed to identify forest areas burned by wildfires and the impact of urbanisation on vegetation coverage through the capture of pictures with Near Infrared

radiation that allowed for NDVI calculations. We weren't certain if our goals would be successful due to the scale of the images, as well as the potential for obstruction by weather events.

While we couldn't find any burned areas through our data, we were able to identify multiple cities and observe the associated drop in vegetation density. Namely, with New York City we were able to show that, despite an increase in vegetation density in the Northeastern United States, the amount of vegetation surrounding the city has stayed approximately the same for the past 40 years. This kind of analysis can provide important insights into the expansion of urban areas and potential changes in surrounding ecosystems.

Despite these findings, there were many images we were unable to use in our analysis due to cloud obstruction and the large number of images taken during the nighttime. Our attempt to identify algae on the surface of the water (surrounding garbage patches) was also unsuccessful despite the large number of photos showing our oceans.