Mission Space Lab Phase 4 Report

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Chosen theme: Life on Earth

Organisation name: Independant

Country: France

1. Introduction

We were interested in checking in what regions of Earth the vegetation was most healthy. We had the idea that the areas with highest humidity and heat (tropical or temperate climates) were ideal for vegetation growth. And if we could be precise enough, maybe we could predict climate characteristics by looking at vegetation data.

As the Astro-Pi project offered the possibility to measure NDVI using the near-IR camera, this looked like an interesting matter to study.

2. Method

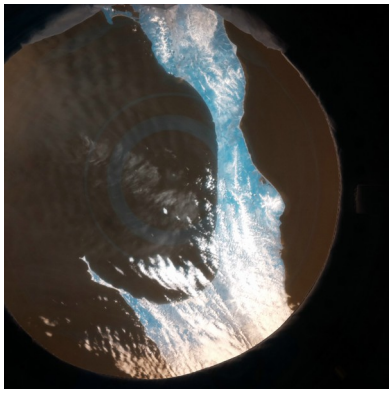
We decided to measure NDVI values taken from pictures with the near-IR camera. Using the sample data provided when preparing the project, we decided that taking one picture every 10 seconds was a good tradeoff to have enough, non-duplicated data, and not filling the 3GB of disk space.

We made captures only when the ISS was on the day side. For every capture, we stored a companion json file with metadata such as capture date, time, coordinates and measurements. Using this data, we would be able to replay the whole experience on ground.

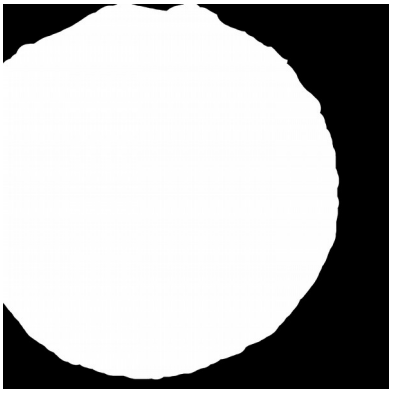
We also provided a map of the climates on the Earth, based on the Köppen climate classification (https://en.wikipedia.org/wiki/K%C3%B6ppen_climate_classification), as a png with climate zones encoded as grey levels.

For each image, we made the following processings:

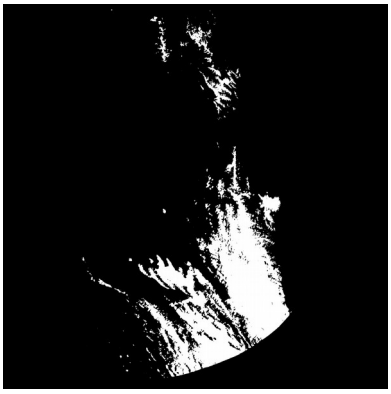
- removed the porthole using a predefined mask
- removed the clouds or snow using thresholding in luminance
- removed the water areas using thresholding in the blue channel



The original image. A little part is lost due to camera not being centered as we expected from the preliminary data.



The porthole mask (hand-drawn). The black points will be ignored in the original image.



The clouds mask. The white points will be ignored in the original image.

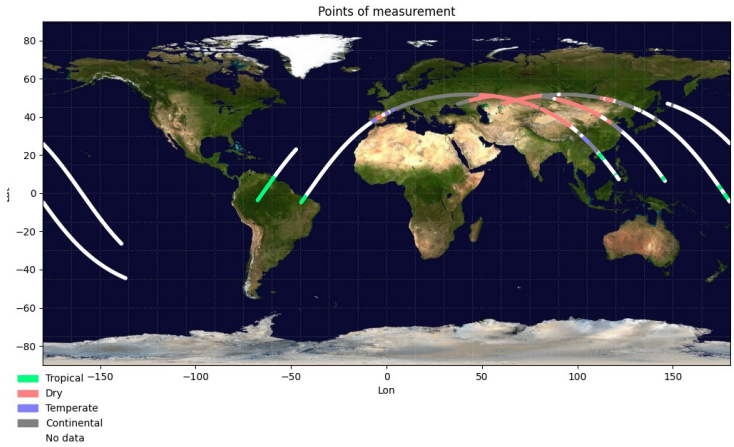
The land (non-water) mask. The black points will be ignored.

The final mask: land minus clouds.

On the remaining points, we computed NDVI (without dynamic range adjustments, which could bias) in a [0, 10] range. And we computed the average NDVI and standard deviation.

3. Experiment results

First of all, to have an overview of the data collected, we plotted the coordinates where we took measurements.

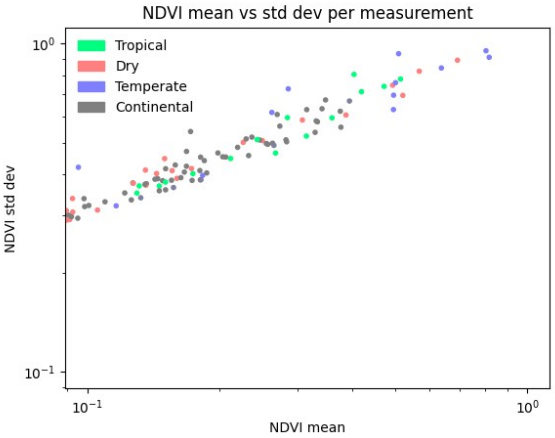


Points of measurement, with the actual climate zone. There is no vegetation on the white areas.

We observe that:

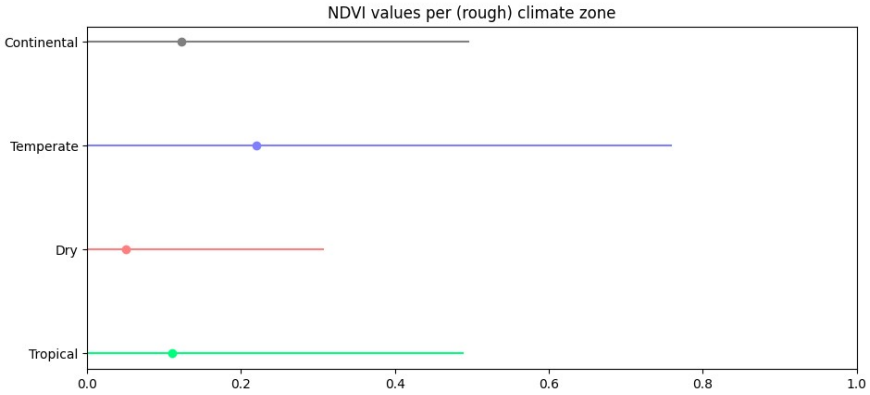
- The climate zones collected are consistent with the theoretical values. This confirms that our categorisation algorithm seems reliable.
- We do not have a fair repartition of samples among all possible climate zones. Most of our samples are in dry and continental zones.

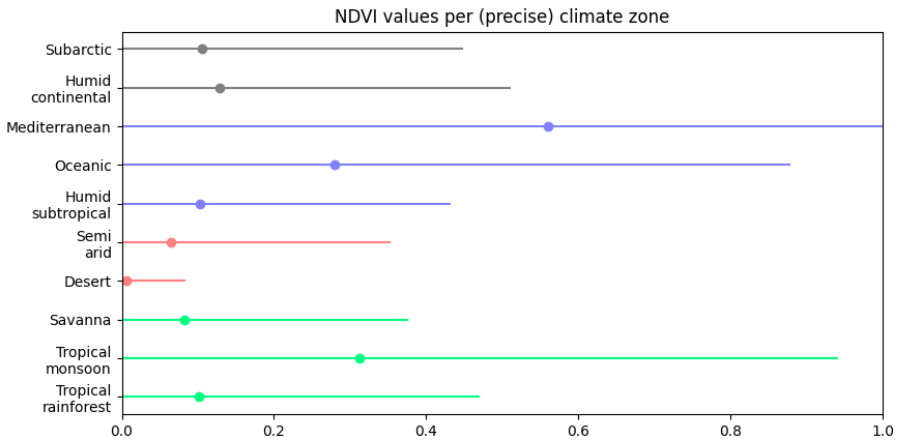
The following plot shows every measurement point (picture) in terms of NDVI mean value and standard deviation.



We observe that although, quite as expected, dry areas show lower values than temperate areas, the spread of measurement values does not allow to discriminate between climate zones.

To confirm this, we plotted the overall average and standard values per climate zone . The average value is shown as a dot, and the spread (std deviation) is the half-width of the line:





We observe the global tendancies that we expected, with temperate climates providing healthier vegetation than continental or dry areas. As for tropical zones, we intuitively expected them to be as healthy as temperate zones. This would require further investigation, and this might be linked to the low amount of temperate or tropical samples.

4. Learnings

It was harder than expected to work as an informal team. We met on week-ends, but this proved complicated by the sanitary context, and we only managed to gather the whole team on a few occasions. The Discord software happened to be very useful.

Finding the study idea was the toughest part actually. After this, we planned carefully and managed to meet our deadlines. We already had a Raspberry Pi + camera before receiving the hardware, which allowed us to start coding and testing in real conditions early.

5. Conclusion

This was a great experience as a team, as the members learnt to conduct a study from start to finish for the first time, with decent results: we actually observe what we hoped we would.

We believe that our study could be further refined and provide better results with a better coverage of the world, and more precise mask generation (removal of clouds and water areas).

Word of the mentor: one of the biggest hurdles was that most documents were in English. French students at this level are not good enough, and I spent a lot of time explaining what they would have otherwise worked by themselves. Same for the writing of this document, that I had to do after they gave me their instructions…

Thanks a lot to the Raspberry Pi Foundation and the ESA!