Mission Space Lab Phase 4 Report

Team name: Vioneers

Chosen theme: Life on Earth

Organisation name: Tudor Vianu National High School of Computer Science

Country: Romania

1. Introduction

Building upon our findings from participating in the previous Astro Pi challenge, this year, our team has decided to further study the spread of vegetation fires with help from the images provided by the near infrared camera. Today, as a result of global warming, forest fires have become much more frequent and devastating. Thus, developing more accurate tools for predicting their spread is increasingly important for giving early warnings to the people that might be affected. We aimed to contribute to this by trying to create our very own forecasting method for vegetation fires while also evaluating their immediate effects on local vegetation.

Simultaneously, light pollution is an issue of utmost importance nowadays. Also known as artificial light at night, this topic has a huge impact not only on the wildlife patterns or human sleep, but also on the increase of carbon dioxide in the atmosphere and obscuring the stars. For all these reasons, we believe it imperative to take action regarding this matter, and, thus, we expected to observe the most affected areas globally.

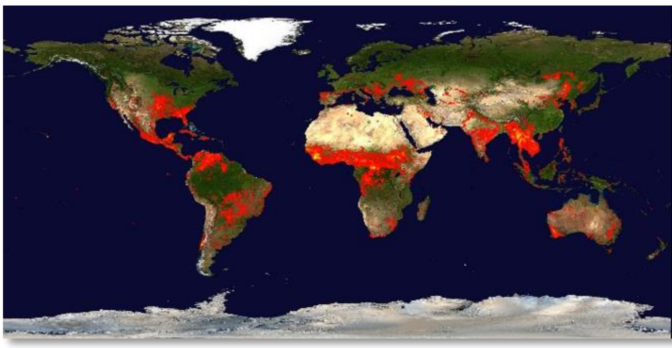

Figure 1: [Global Fires Map]

Figure 2: [Global Light Pollution Map]

2. Method

In [our Python program](), we used the new high quality IR camera to take a picture every 40 seconds which was embedded with EXIF tags representing the current latitude, longitude, date and time. Additionally, we collected data regarding the conditions inside the Columbus Module (with the help of the Sense HAT set of environmental sensors) and added the values to the csv file in order to notice whether potential significant changes of these parameters occur when the ISS is above certain areas of Earth.

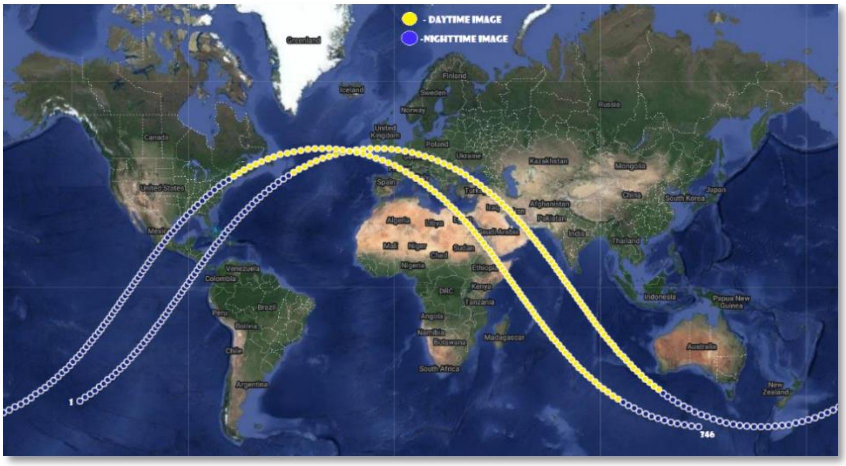

Figure 3: Route of the ISS during the run of our code (April 24, 2022)

When running on the ISS, our code produced 346 images (178 – daytime, 168 – nighttime), along with the csv file. Afterwards, using Google MyMaps, we managed to plot the route of the ISS in the running time of our code, our map being available here. (also see Figure 3).

Furthermore, we pursued our aim of studying forest fires with the help of spectral indices such as NDVI (normalized difference vegetation index) and NBR (normalized burn ratio), other instruments of use being Sentinel EO browser custom scripts and EOSDIS Worldview, as well as additional Python programming done by our team.

3. Experiment results

After taking a first look at the photographs received from the ISS, we identified multiple interesting features, our top picks being the Nile River and the Danube's Delta in our country, Romania.

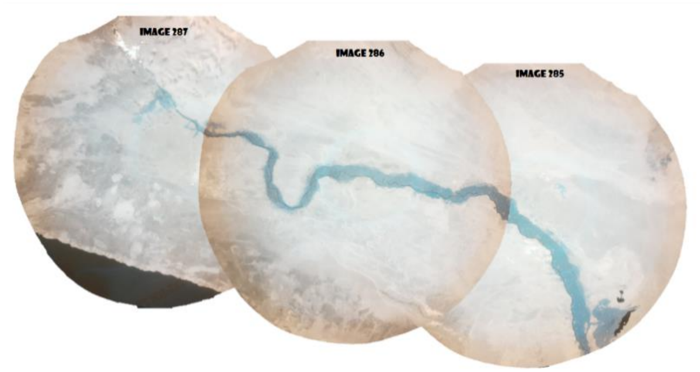

Figure 4: The Nile

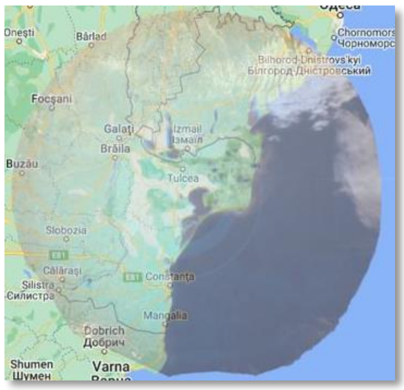

Figure 5: Danube's Delta – Image 91 on Map

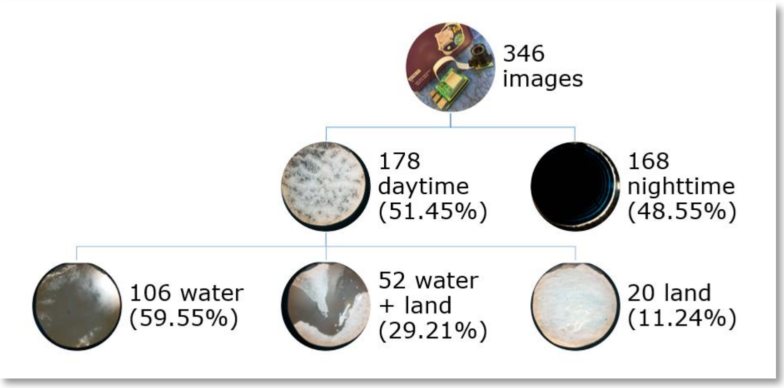

Figure 6: Distribution of Our Images

To begin with, the temperature surrounding the Astro Pi varied between 39.0883 and 40.4135°C, whilst the humidity ranged from 49.0390 to 50.9977%, the differences thus not being relevant. Unfortunately, even though we expected the improved camera to detect nighttime lights, we failed to capture any useful information that would have enabled us to study light pollution.

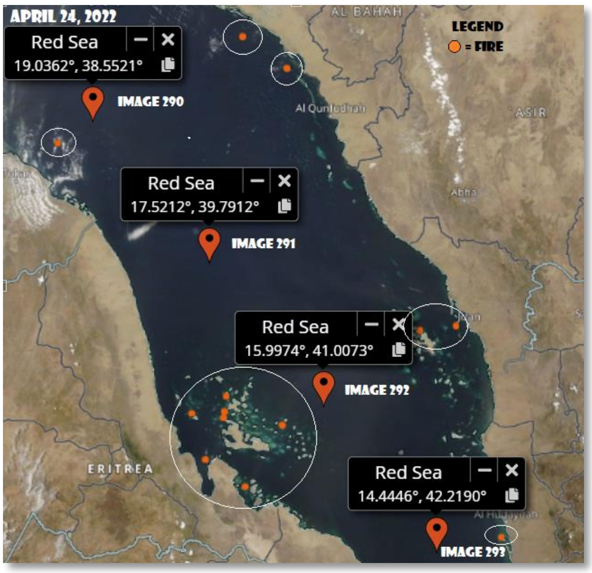

Figure 7: Fires in Images 290-293

Looking on the bright side, we carried on investigating the spread of forest fires. We first wrote a Python script to calculate the NDVI for each of the photos taken (results available [here](#)). Then, even though there were no signs of vegetation fires within our pictures at first glance, we made use of EOSDIS Worldview to identify wildfires that might not have been captured by the camera on board the ISS.

We also employed the Normalized Burn Ratio for the locations of these fires, which we calculated thanks to the data provided by the Sentinel-2 satellite. Consequently, we were able to broadly gauge the impact of the identified fires on the local vegetation.

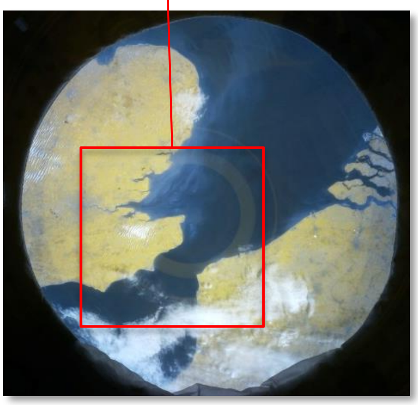

Figure 8: The English Channel

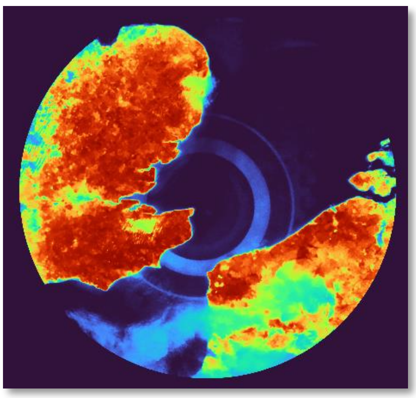

Figure 9: NDVI ([our Python script](#))

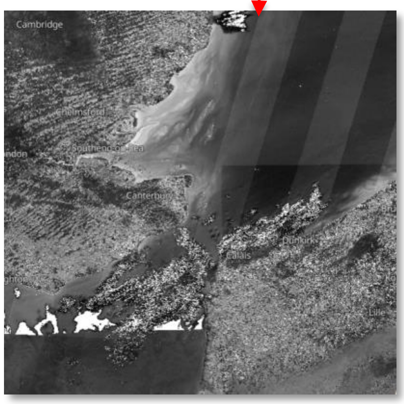

Figure 10: NBR (Sentinel)

Thus, our results consisted of the processed images, which could become a means of analysing vegetation on a larger scale. When talking about wider fires, this method would prove to be even more successful and could also help notice any patterns and therefore predict the further spread of specific fires.

4. Learnings

Since September when we started the project from scratch, we are confident saying that the Astro Pi Mission Space Lab enabled us to boost our Python programming skills, as well as knowledge on spectral indices such as NDVI and NBR in terms of analysing forest fires. Not only did we gain real insight into the daily work of a scientist, but we also had hands-on experience improving our team spirit.

To be clearer, the planning was a crucial part: we took advantage of each member's qualities, and created balanced smaller groups, such as the keen coders, attentive analysts and writing department, groups that collaborated efficiently as a team. Moreover, we balanced remote working with in-person meetings where we secured a tighter bond within the team.

Still, our toughest challenge was the fact that, despite the improved camera, we were not able to see any light pollution and thus were forced to concentrate only on the vegetation component of our initial idea. Therefore, when coming up with our experiment ideas for next year's edition, we have decided to pay more attention to what can and cannot be done with the available hardware on board.

Figure 11: Setting up our kit

5. Conclusion

Although the data we collected fell somewhat short of our initial expectations, hindering our ability to study light pollution, we did our best to make the most of the pictures taken. As such, we calculated the NDVI for each image and attempted to examine the aftermath of the vegetation fires identified thanks to Worldview. Making use of the NBR, we looked at the state of relevant areas pre, during and post fire.

Initially, we expected to see the local vegetation devastated by the analysed wildfires. However, upon close inspection of our images we were surprised not to find acute signs of burning. This was most likely because the fires were too small to be detected even with the better resolution of the AstroPi's high quality camera. Nevertheless, if we had the opportunity to photograph larger vegetation fires, our analysis would have yielded better results.

We believe that analyses such as ours could enable scientists to create better early warning systems for people in areas affected by wildfires while also studying them from a safe distance. With better hardware, we could detect even smaller fires, giving us more time to take action to stop them before becoming an immediate threat.