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(Don't worry, any unused figures will be ignored)

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Chosen theme: Life on Earth

Team members: Mia Gauci and [redacted]

School: St Monica School Birkirkara

Introduction

In this investigation, our team proposed to analyse the environmental parameters aboard the International Space Station and how these vary according to the station's position around the Earth. For this analysis, we paid attention to how the environmental parameters vary with the degree of exposure of the ISS to the sun and the Earth's shadow; as well as how the Earth's magnetic field can be detected aboard the ISS. From the data gathered, we expect to find substantial stability in the parameters of humidity, temperature and pressure due to flight systems which stabilise living conditions for the safety of the crew and nominal conditions for scientific research: Environmental Control and Life Support System (ECLSS) and Thermal Control System (TCS) including others, have just this task.

Despite this, we assume that readings should vary slightly in exposure to the sun by a few milli digits. If the variation is considerably great, this implies that some operations might malfunction and could risk causing health problems for the crew.

Day and night map for 5th April 2019 13:15 to 16:01 (UTC)

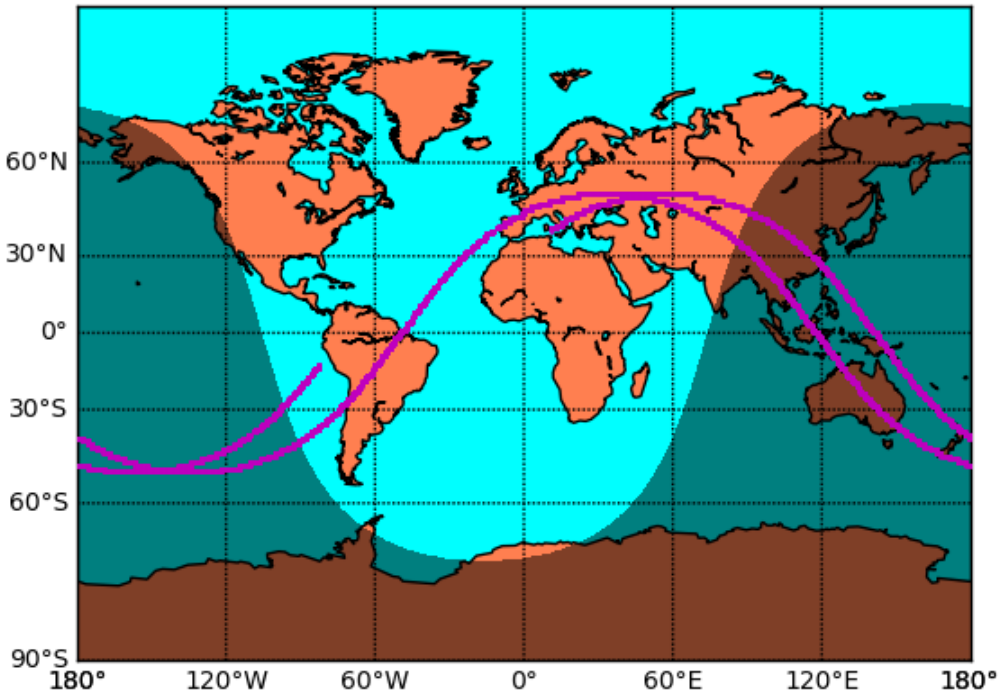

Figure 1: ISS flight path during the 3 hours long experiment

Method

The data was collected through a program built in Python 3 which is able to keep time, thus enabling a continuous collection of data accompamied by a time stamp. All the data were logged per second as a CSV file. Thus, the risk of loss of data 9s redusced, if Izzy would have malfunctioned. Using the onboard camera, photos were taken every minute and saved in the SD card. These were useful for complementing the data collected, and to confirm that the calculations of daytime, night time, and geographical position are correct. The raw data are interpreted in relation to the ISS's time and position. The collected data were imported from the CSV file into a spreadsheet for further analysis and graphs were plotted for overview of data of all variables recorded: (see Figure 2)

1. Atmospheric Pressure (mbar);
2. Humidity (%);
3. Temperature (·C);
4. Accelerometer ;
5. Magnetometer;
6. Gyroscope;

Further analysis of data, using mathematical formulae and construction of detailed graphs, were carried out using Matplotlib and Plotly whilst the recreation of the ISS flight path were constructed using PyEphem and Basemap.

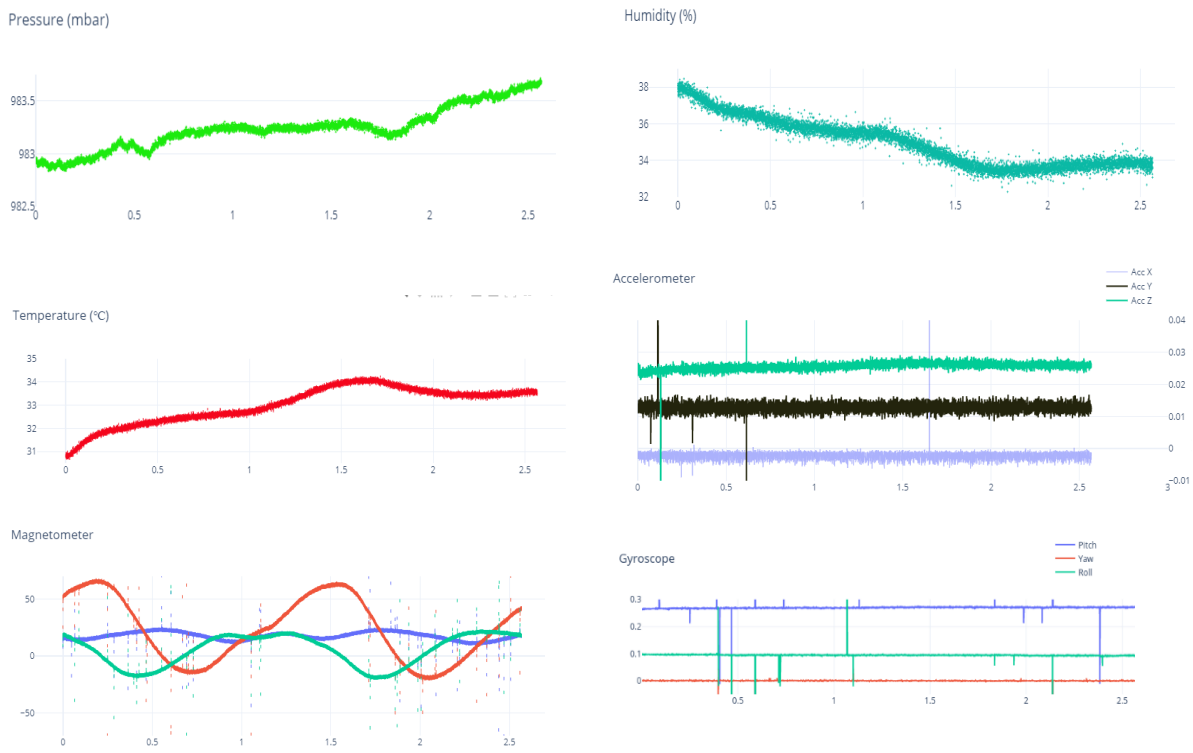

Figure 2: Overview of data collected

Results

Our experiment took place from 13:15 to 16:01 (UTC) on 5th April 2019, thus assuming that it was a normal Friday afternoon and the crew were carrying out their daily routine.

At first glance of the measurements collected of the environmental parameters obtained within the atmosphere of the ISS, we noticed that pressure was constantly stable throughout the 3 hours and only varies by a few tenths of a millibars. These slight variations might be caused by the crew's regular operations, namely the air circulation system aboard the ISS as well as the opening and closing of compartments, which allow air at different temperatures to enter or escape. Thus, these variations may also be attributed to the change in temperature as stated by Gay-Lussac's gas law (temperature is directly proportional to pressure). Therefore, when temperature increases, the pressure also increases, or vice-versa. As the temperature rose, so did the pressure. Consequently, the level of humidity fell, as it is inversely proportional to temperature and pressure, shown in Figure3.

The ISS speed was calculated using simple high school mathematics formulae which resulted to be 8.8 km/s thus in close comparisons to the actual value which is 7.66km/s. In the graph showing the relationship between magnetism and time (hours), the magnetic field appears to have been consistent throughout (see Figure 4). This implies that magnetism can be detected accurately using sensors from about 400km above earth.

During the first 2 hours, the temperature rose, implying that at this time the ISS is exposed to the sun. However, after 2 hours the temperature began to fall. This implies that during this time, the ISS is in the Earth's shadow. We found that daytime and night time are cyclic; and each period lasts 46 minutes as expected. This is proved using the program PyEphem, inserting GPS coordinates of the ISS and using updated Two-Line Element Set (TLE) data (see Figure 5).

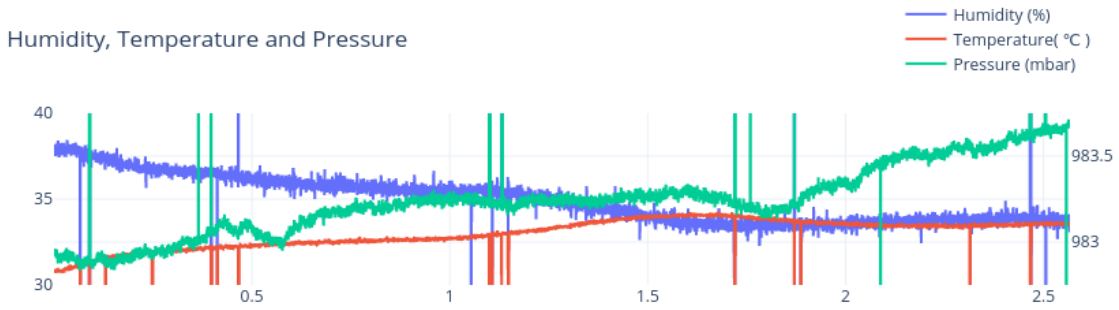

Figure 3: Relation between Humidity, Temperature and Pressure

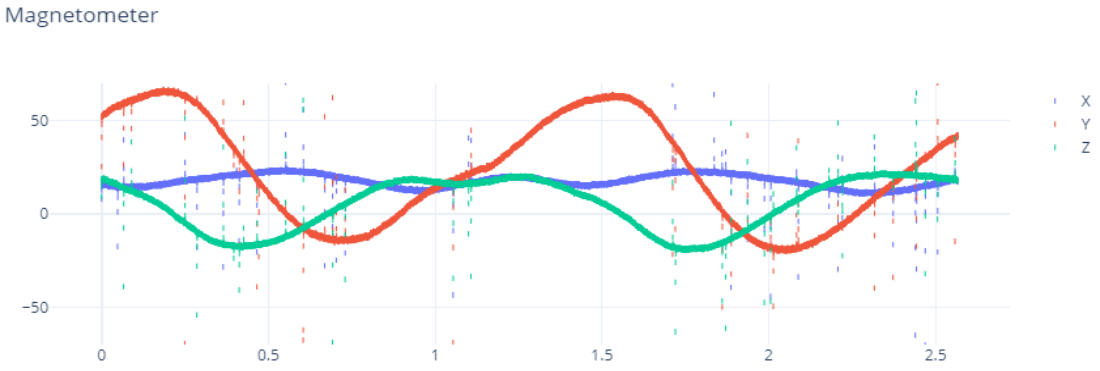

Figure 4: Accurate readings from Magnetometer

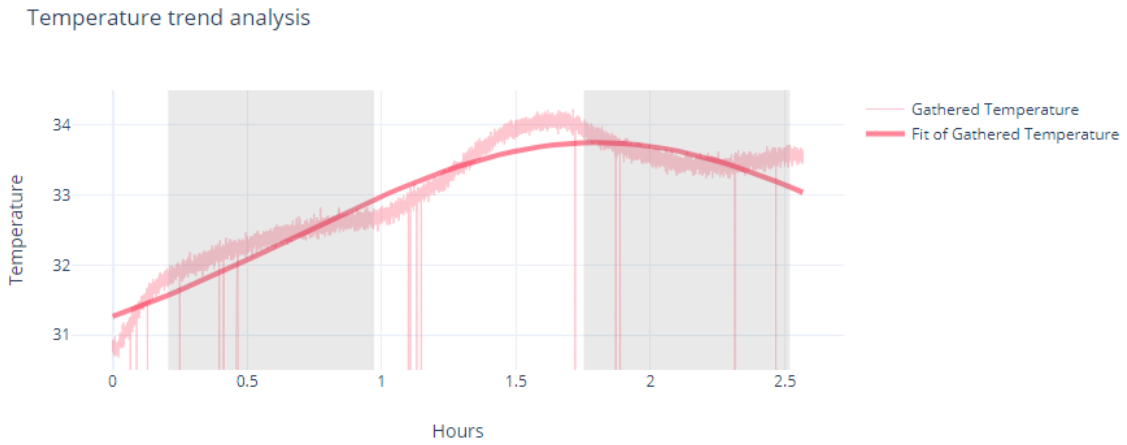

Figure 5: Temperature trend analysis and exposure to sun

Conclusion

The results obtained were better than those originally projected since the temperature changed according to the ISS position. Moreover, the observed intersection between temperature, humidity and pressure resulted a correlated subquery.

The initial hypothesis was that when the ISS is in direct exposure to the sun, the PTCS (Passive Thermal Control System) will trigger and the temperature is stabilised. This resultant data shows that the ambient temperature of the ISS rose by a few degrees as clearly depicted in Figure 6 which shows the shaded regions for the duration of the ISS in the earth's shadow. As expected the duration of the ISS in daylight and night shade are cyclic due to the ISS speed in relation to the earth's spin and speed.

Although the measurements seem consistent throughout the allocated time, the variation was so slight that active computers, electronic equipment and movement of the crew close to Izzy could have affected the readings hence our results could have been improved by obtaining data from different areas within the ISS. We can't explain why glitches occurred in the collected data, yet these could be attributed to the slight movement of Izzy or a millisecond malfunction within its operating system. Unfortunately, we do not have sufficient data to pinpoint the cause of the nature of these results.

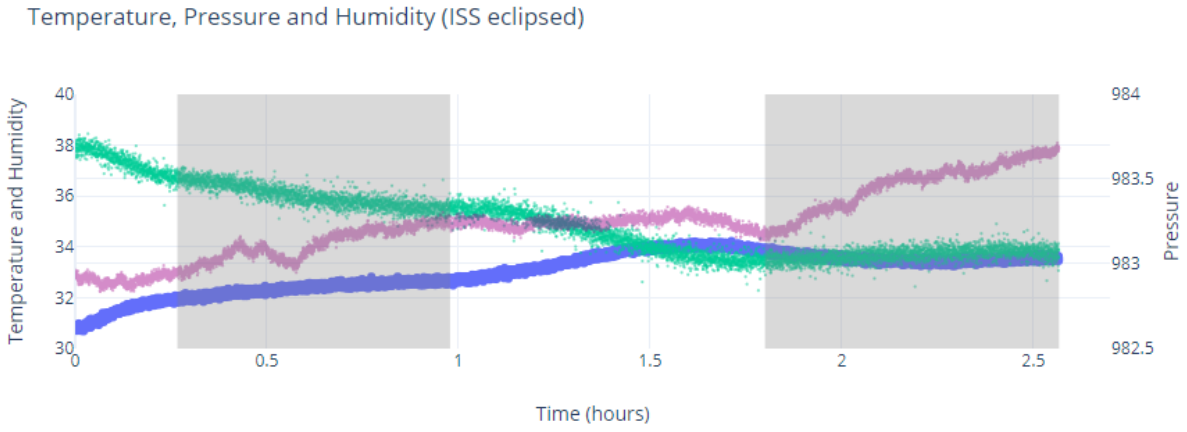

Figure 6: Temperature, Pressure and Humidity in exposure to the sun