Reliable and Sustainable Observations in Atmospheric Research

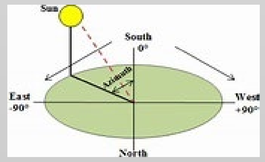
Jordan Boe, Roberto Navarro, and Hayden Dohaniuk
Pima Community College, Tucson Arizona

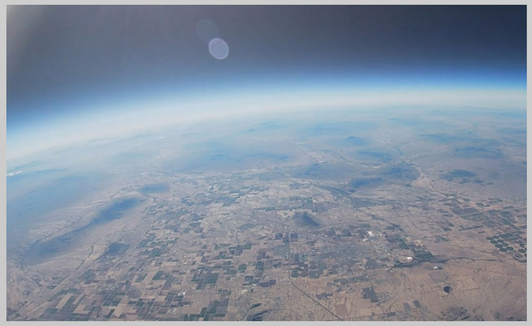
Abstract

Atmospheric research is a key component in understanding our global environment. Understanding how we can collect data to further understand our environment is essential.
Sustainability includes reusing hardware to have equivalent outcomes. A goal of this project is to collect atmospheric data with multiple launches to support the accuracy of data and components that have been exposed to outer atmosphere conditions. Currently the investigation is 4 flights which include: the main body and the electronics, sensors, and experimental data. The CubeSat design was selected for its ease of design and PLA used for the CubeSat which is an area of investigation based on PLA is considered an inferior material in which we are testing. We have found that PLA is satisfactory based on our testing and design.
This research will aid both in tracking atmospheric trends and in long-term recycling and sustained use of components in high-altitude experimentations.

Objectives and Definitions

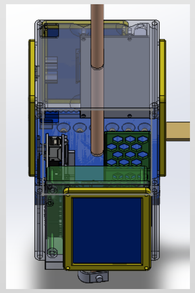
- Record data to collect temperature, altitude and pressure information.
- Record video for flight from ground to approximately 100,000 ft
- Build a CubeStat similar to the NASA design that withstands low pressure, high altitude, below freezing temperatures, and extreme conditions such as air velocity and high force impact due to high wind (jet stream, etc) and being able to land violently and maintain integrity.
- AZMUTH: Direction measured in degrees clockwise from north on an azimuth circle. This circle consists of 360 degrees. 90 degrees corresponds to East, 180 degrees is South, 270 degrees is West, and 360 degrees and 0 degrees are both North. (see figure below)

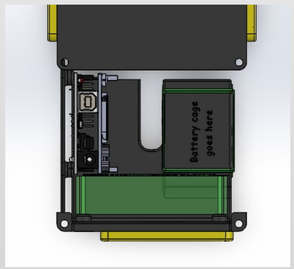


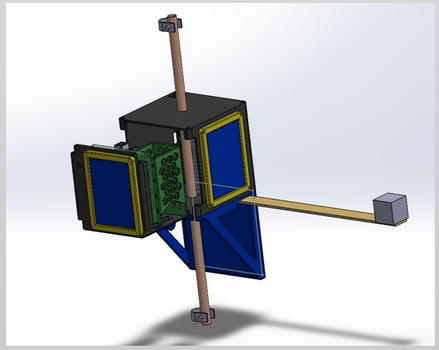


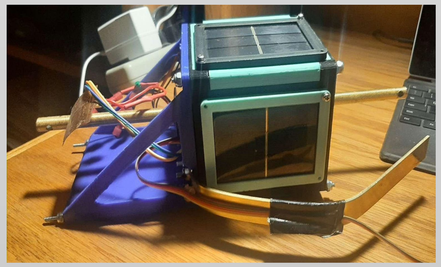
Payload Design

This iteration of the project uses a custom CubeSat format. All parts are designed to be modular in nature, consisting of a 100mm x 100mm identical base that can be paired with other units. A lamp rod is placed centric to the modular base with ⅛ inch threaded rod cinching up the corners. This payload is designed to be highly modifiable and interchangeable so that many different experiment could be run without needing a complete overhaul. The main unit in this cubesat is responsible for collecting and logging data using arduino compatible electronics. This data is then saved as a text file to an SD card contained within the the main unit. The experimental unit below the main unit houses several different types if plastic rod for a material strength experiment. It also has a brass rod supporting a magnetometer to measure the earth's magnetic field. The rod is brass because it had to be non-magnetic for the sensor to take accurate data.









After Spring 2025 Flight

<u>Top section electronics Tray</u>: Contains sensors & Arduino.

<u>Bottom Section:</u> Contains Camera
Metal bar extension contains Magnetometer

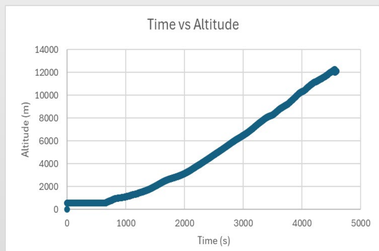
Payload Electronics

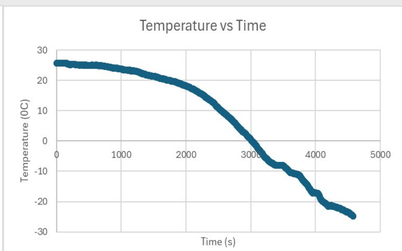
MPL3115A2 Sensor
Records Temperature, Altitude, and Barometric Pressure

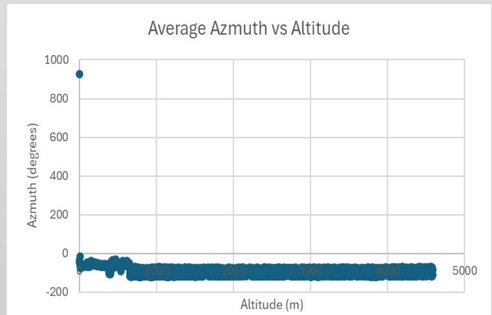
Arduino UNO
Data Logger

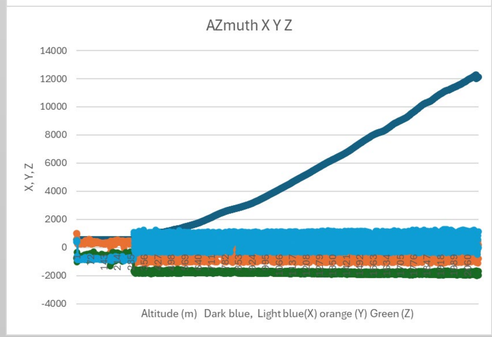
GoPro Hero Session-Camera
Magnetometer: QMC5883L

Results (note >1000 data points were recorded)









Conclusion

This project has been an incredible success. The data collected over several semesters of research has supported the accuracy of our sensors compared to flight data from ANSR and our peers. This CubeSat design has proven to be extremely rugged, light-weight, and space efficient. The main parts of this design have been sent on four launches with very little need of repair. The payload is made entirely of 3D printed PLA filament. PLA is thought of as an inferior material for this application, however, we have seen that PLA is sufficient for this application as the CubeSat design was successful over multiple launches. Due to its modular design, it is to add, modify, adjust, and create custom experiments.

The data that was successfully collected in the upper atmosphere is important in helping our understanding of our climate and how it is changing, Furthermore, our magnetometer was successful in measuring the Earth's magnetic field. The values did not change much but they did change proving that there is merit to including this sensor on our payload.

The spring flight was highly unusual. The flight showed a very sloy ascent and extremely high wind speeds upwards of 100mph. The normal flight time is 90 minutes but we were in flight for excess of 180 minutes due to the unusual conditions experienced. The payload collected 87 minutes of data which is a good representation of the conditions of the fight and the atmospheric conditions. This launch data can be compared to previous launch data which indicates that our sensors were working properly.

The payload design and electronics has been successful and the data collected similar to many launches which indicates the reliability of the payload and its systems.

Acknowledgements

Arizona Space Grant Consortium
Arizona Near Space Research
NASA

Mentors:
AnnMarie Condes
Ross Waldrip