Colorado Space Grant Consortium

In The Ozone

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"In the Ozone's" overall goal was to successfully plan, design, assemble, and launch a Demo-weather satellite in the hopeful quest of collecting data and video footage that would enable us to translate atmospheric conditions into a real-world understanding of our climate's current economy. Goals throughout this mission include:

- To gain real-world experience in engineering, science, project completion, and teamwork.To
- Learn basic engineering skills such as structure construction, wiring, soldering, programming, and testing.
- To successfully launch and recover our boxes
- To have a great time
- To gain real-world experience in engineering, science, project completion, and teamwork.
- To learn basic engineering skills such as structure construction, wiring, soldering, programming, and testing.
- Determine the concentration of select greenhouse gasses over the launch site.
- To observe the relation of greenhouse gases to atmospheric conditions.
- To compare our gas sensor readings to readings taken during similar projects before new guidelines were implemented.
- The state of Colorado is no exception to climate change due to the increase of greenhouse gases, although guidelines are in place to reduce emissions by 2020, and again by 2050.
- To provide effective logs, records, data, and purpose for future demo-sat team projects.

The design and construction of two payloads were completed using foamboard, polyethylene tubing, paper clips, aluminum tape, hot glue, and identification stickers. A simple box design was chosen, as well as the power supply of 9V batteries. Box 1 was fitted with the following data sensors: methane, carbon dioxide, ozone, and internal/external temperature sensors. Additionally, this payload was fitted with a GoPro camera subsystem. Box 2 was fitted the following data sensors: humidity, accelerometer, pressure, and internal temperature sensor. Each payload received heating subsystems in order to stabilize internal heat during external temperature fluctuations. On each payload, LED indicators and power switches were wired and externally attached for each subsystem: Arduino(Sensors), Heat, and Camera. All systems were carefully installed to minimize spin along flight string. The weight of our combined payloads was approximately 1350g, well under our allotted weight allowance.

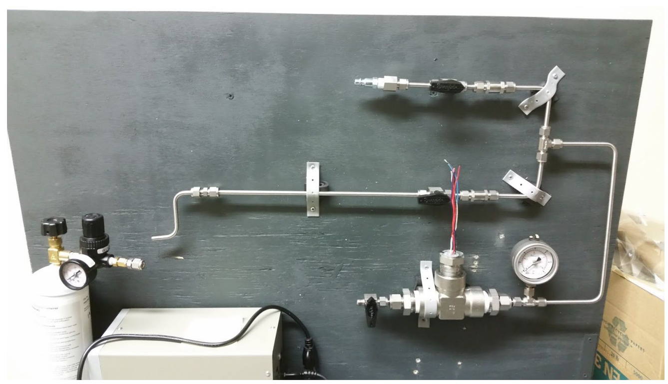
We had one of the payloads, Box 2, complete in plenty of time to do a full round of tests. The first was the vacuum test. Our box fit nicely into the chamber and did well throughout the test. We then subjected the box to the cooler test, where dry ice brought the external temperature to 4 degrees Celsius. The internal temperature was maintained slightly under room temperature. There were a few failures during the structural testing of the box. During the whip test, the cotter pin became dislodged, the washer came off, and the flight tube began to slide out. This problem was solved by reinforcing the cotter pin and hot gluing the washer to the box. The payload was also dropped about 35 feet down a stairwell. During impact a battery came loose and knocked one of the sensors out. The sensor survived and was reinstalled. The batteries were fixed with larger pieces of velcro. With the exception of these two issues, testing on box 2 went very well.

Complications with the SD write function in Box 1 put us behind on its testing. However, we were able to use what we learned during Box 2 testing to make structural reinforcements. We were also able to complete our gas stand, which we will use in the future to test the functionality of our gas sensors.

loose flight tube

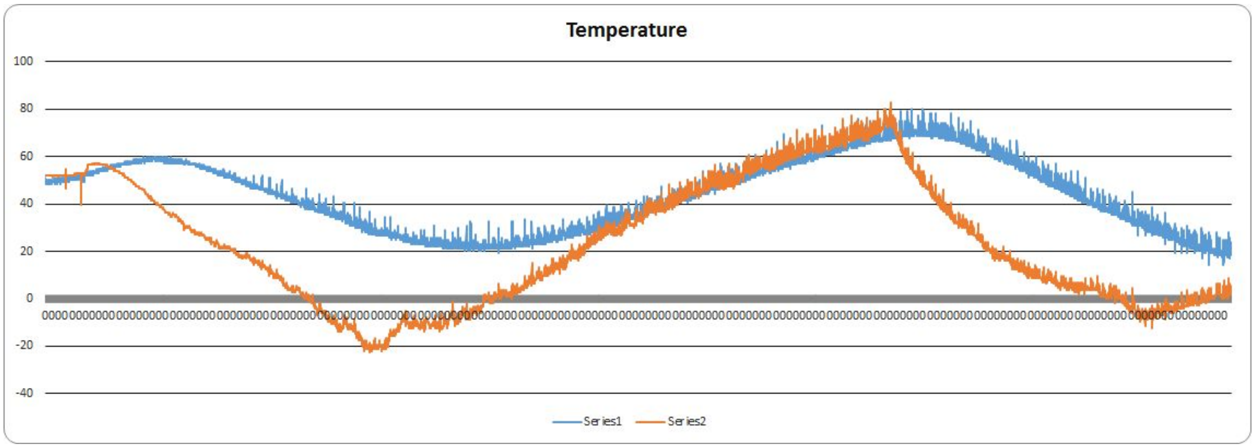
cooler test

vacuum test

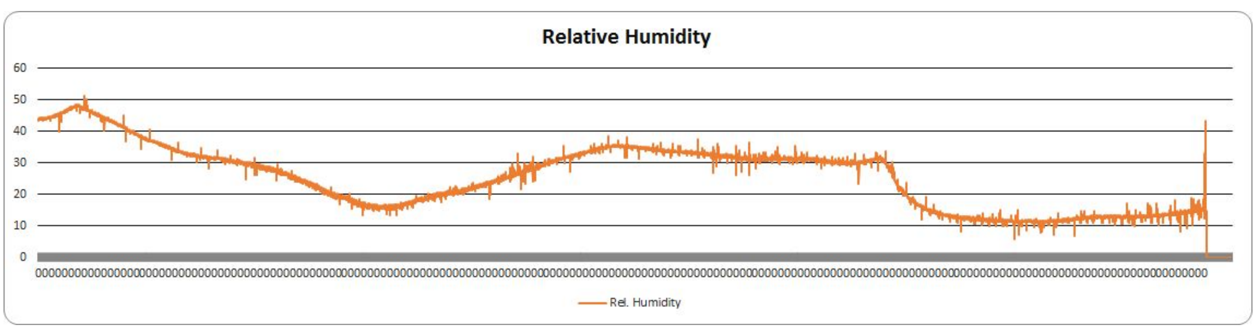


gas stand for testing gas sensors

Box 1 - Data Sensors

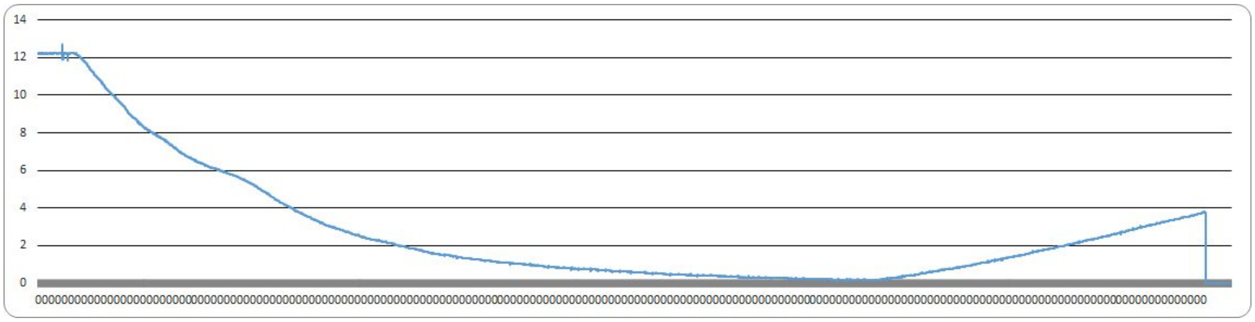


Our temperature graph clearly shows a steady drop in outer temperature as the box begins to reach higher altitudes eventually dropping to a low of roughly 21º Celsius, while its evident that the heaters inside are able to keep the box warm as the temperature read from their graph is a much slower decline and reaches a low of only 18º Celsius. We can also observe what we believe to be the moment the box breaks the cloud line as the temperature begins to increase due to the box's exposure to direct sunlight. The temperature of the box reached a suprising high during this time period with an upper temperature of 80º Celsius. As the temperature peaks we can also observe the moment when the balloon pops and begins to drop as the temperature drops as well. We can also see the effect of the heaters during this time as well, as the inner temperature is able to hold much steadier than the outer temperature.

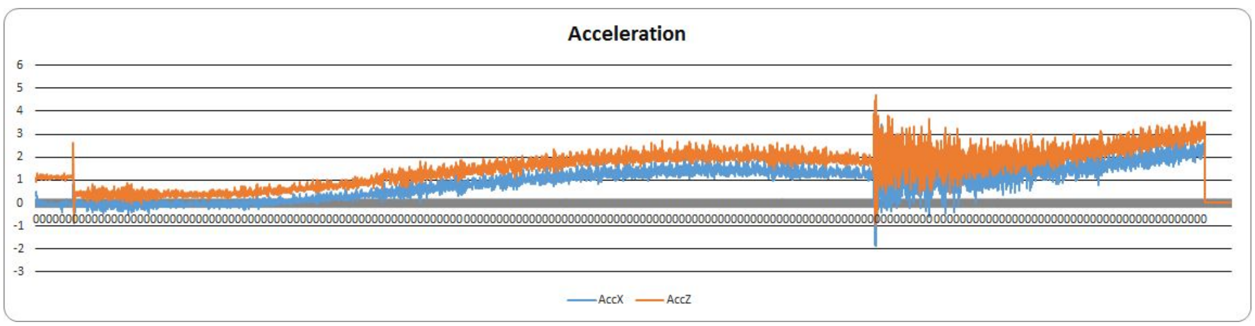


As our boxes rose through the atmosphere, the relative humidity dropped and then increased again, plateauing out until the balloon popped. It dipped again as it fell back to the earth. Where it landed had a much lower humidity than where we launched because the weather was much clearer.

Pressure



The pressure decreased steadily as the boxes rose, almost reaching zero PSI. Again the pressure was lower when it landed because of the difference in the weather.



The accelerometer data gives us a good representation of the how the balloon, and thus the box, picked up speed as it began to rise. It then began to shake a greater and greater amount as it was moved by wind and the shifting of the balloon. Roughly three fourths of the way into the graph we are able to clearly see the moment when the balloon pops as the box shakes violently for a moment before settling down slightly, though still moving much more than before the pop. We can also see the moment when the box lands as there is a sudden drop in movement followed by nothing.

Overall, all of our primary missions were successful, and all but one of our secondary missions were successful. Box #1 showed functionality in all systems prior to launch; however, we were unfortunately unable to recover its flight data due to (still) unknown complications. We believe that part of the failure in Box #1 can be attributed to overloading the arduino's ~900mA circuit capacity. In the future, providing an independent power supply to the sensors that draw high amounts of current could potentially resolve the suspected overloading issue. We were able to complete the design and build process through fantastic teamwork and dedication. After the build, we were able to put one of our boxes through several tests before flight and make the necessary adjustments to be flight ready. We had a wonderfully successful flight, almost making it all the way to Nebraska. Through this project, we have learned a lot about the process of designing and fabricating a basic atmospheric probe, while gaining significant insight along the way that will certainly be helpful for future projects.