Learning to Fly: Initial Experiments in High Altitude Ballooning

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Project Summary

The Bluegrass Community and Technical College's (BCTC) Balloon Sat Project trained students and faculty to design, build, and fly balloon-borne atmospheric data collection payloads. Students and faculty attended NASA's Balloon Sat four day workshop and balloon launch at Marshall Space Flight Center in Huntsville, Alabama. During the Spring 2015 semester, the student team launched two balloons with sensors on board that measured atmospheric temperature, pressure, altitude, humidity, and carbon dioxide concentrations.

Flight 1

The first flight of BCTC's Balloon Sat team was conducted in coordination with teams from the University of Kentucky and Hopkinsville Community College. This flight took place in Hopkinsville, KY (36.882528, -87.487502) on April 26, at approximately 12:30 p.m. CDT. BCTC's payload contained:

- Weather shield (temperature, pressure, humidity, altitude)
- Carbon dioxide sensor
- GoPro Hero camera
- BalloonSat Experiment Sensor Board (designed by RadioBro Corp.)
- Heating pad
- SD card shield
- 3 lithium ion battery packs.

The payload container was made from a small Styrofoam cooler, which was tied to the flight string and secured using zip ties and duct tape. The flight duration was approximately two hours, landing in a wooded area west of Scottsville, KY (36.753378, -86.190542). The team then used a baseball attached to fishing line and ropes to pull the payload down from the ~ 40 ft. tree canopy.
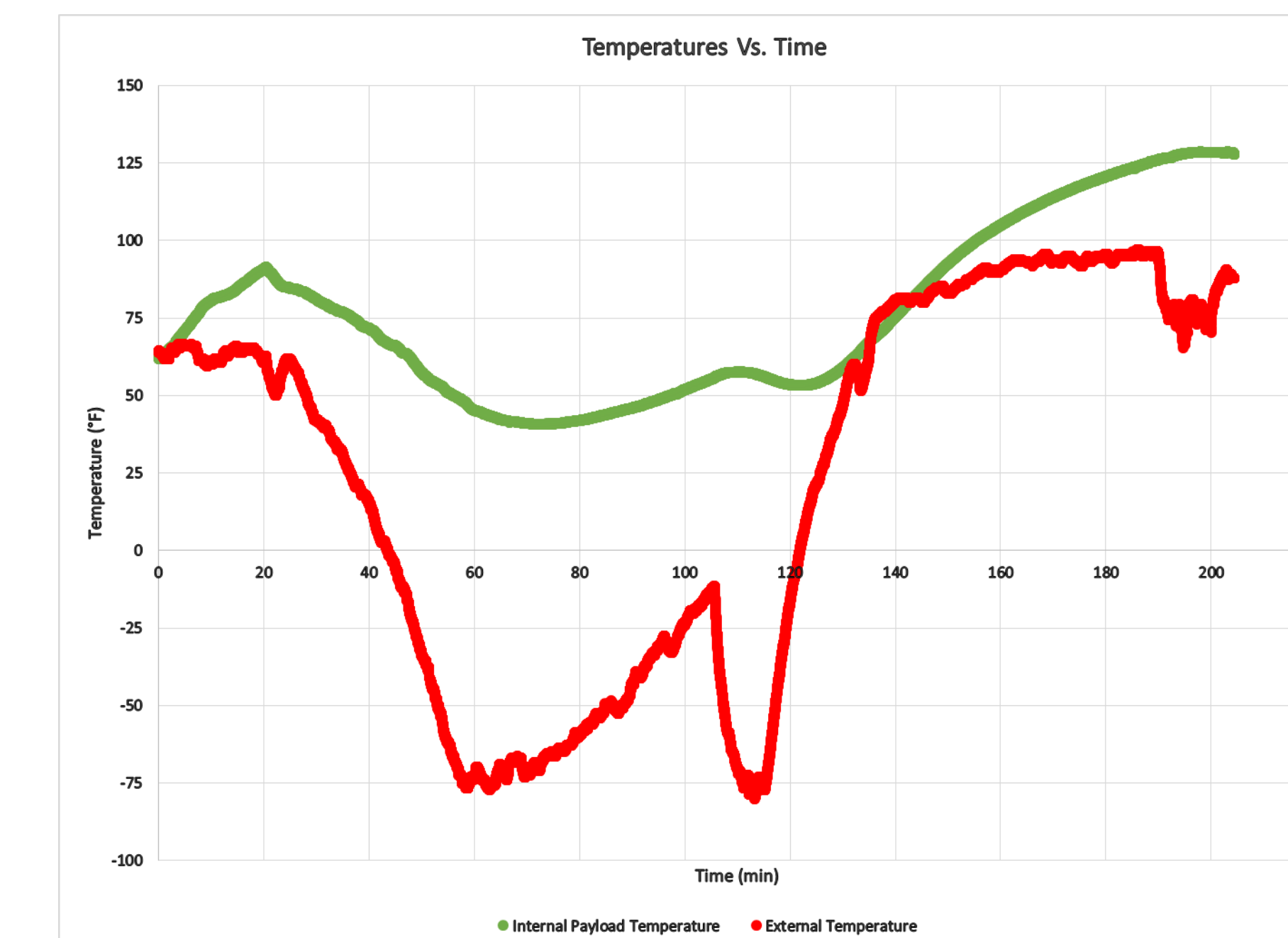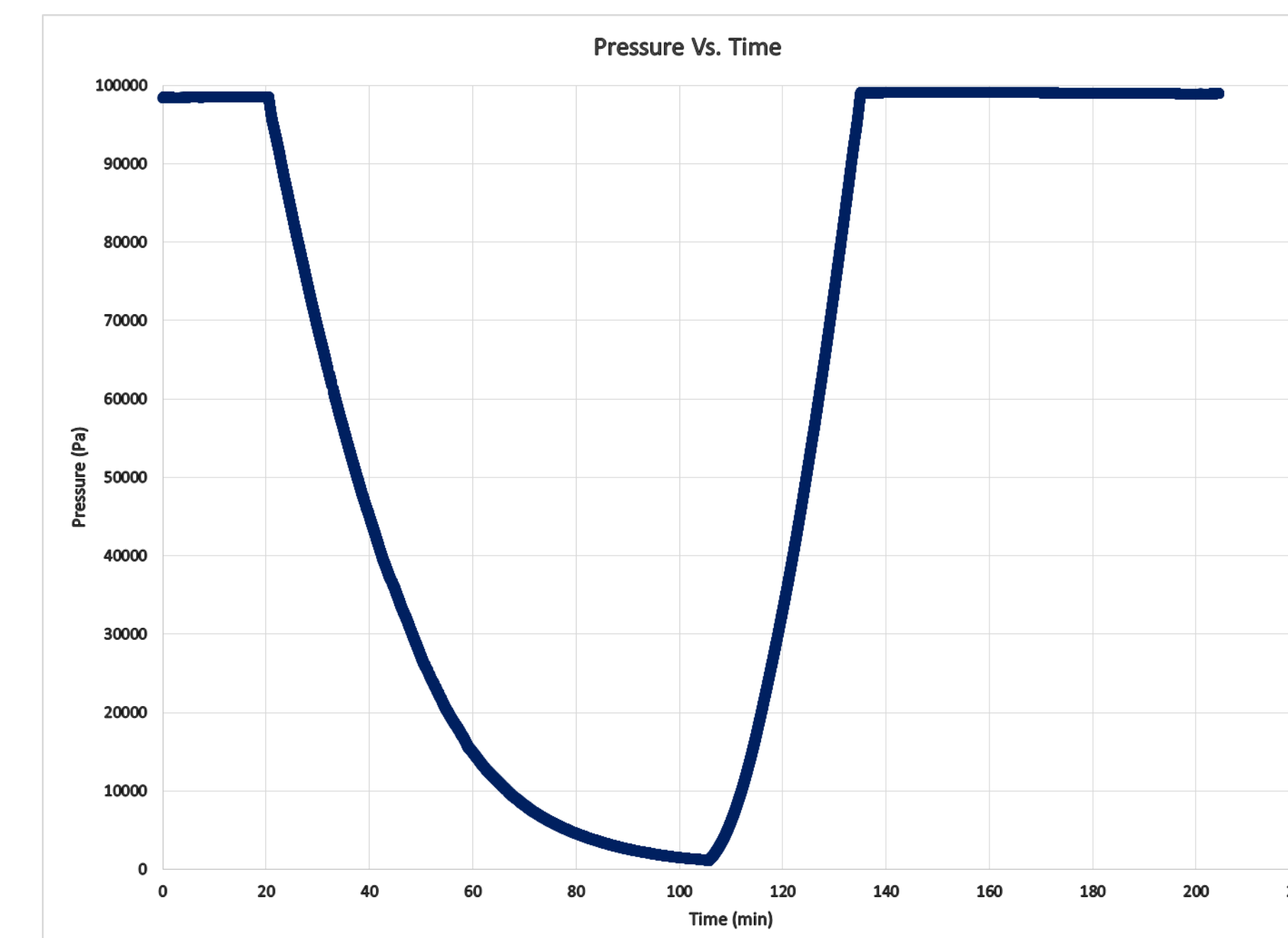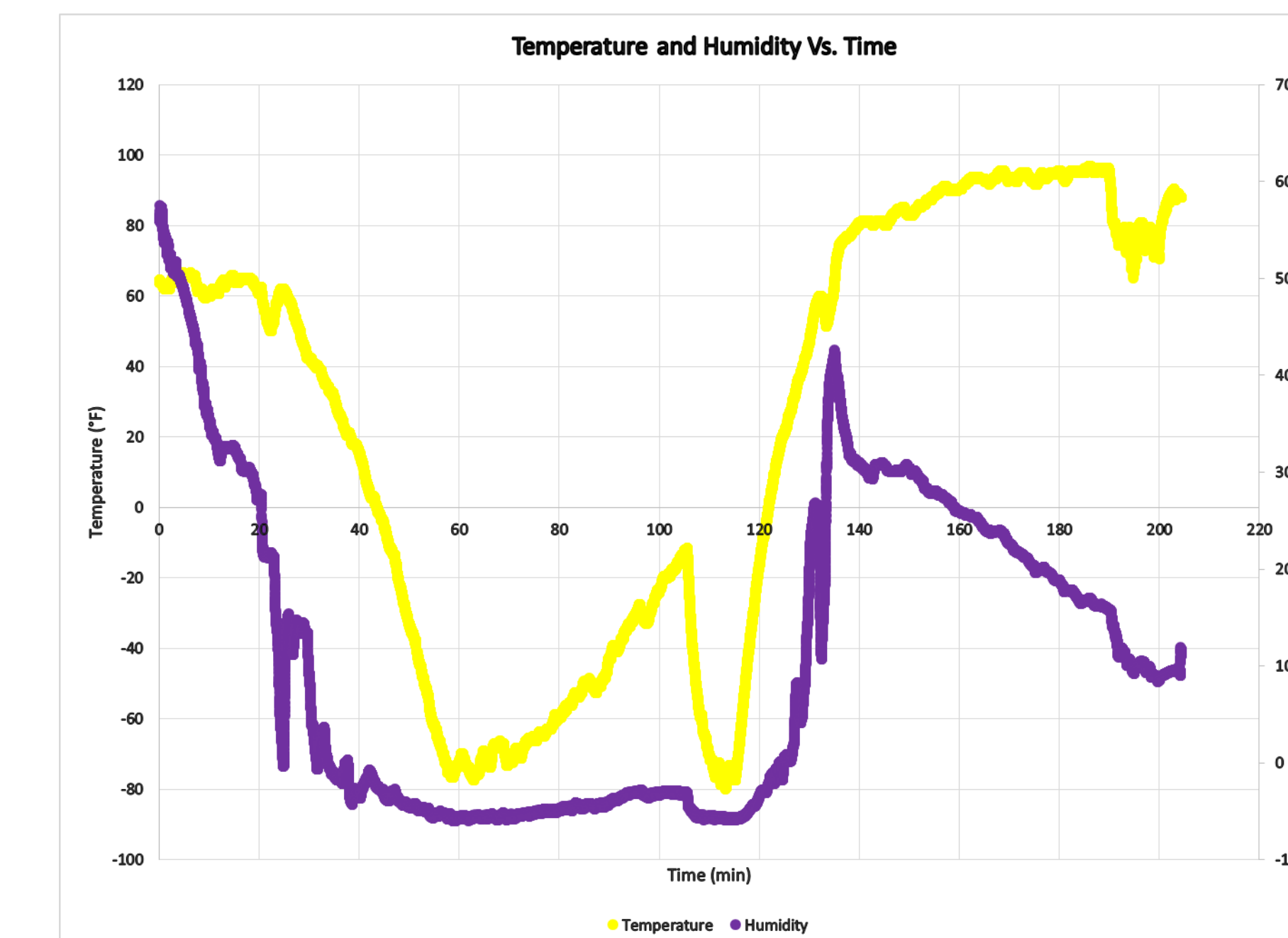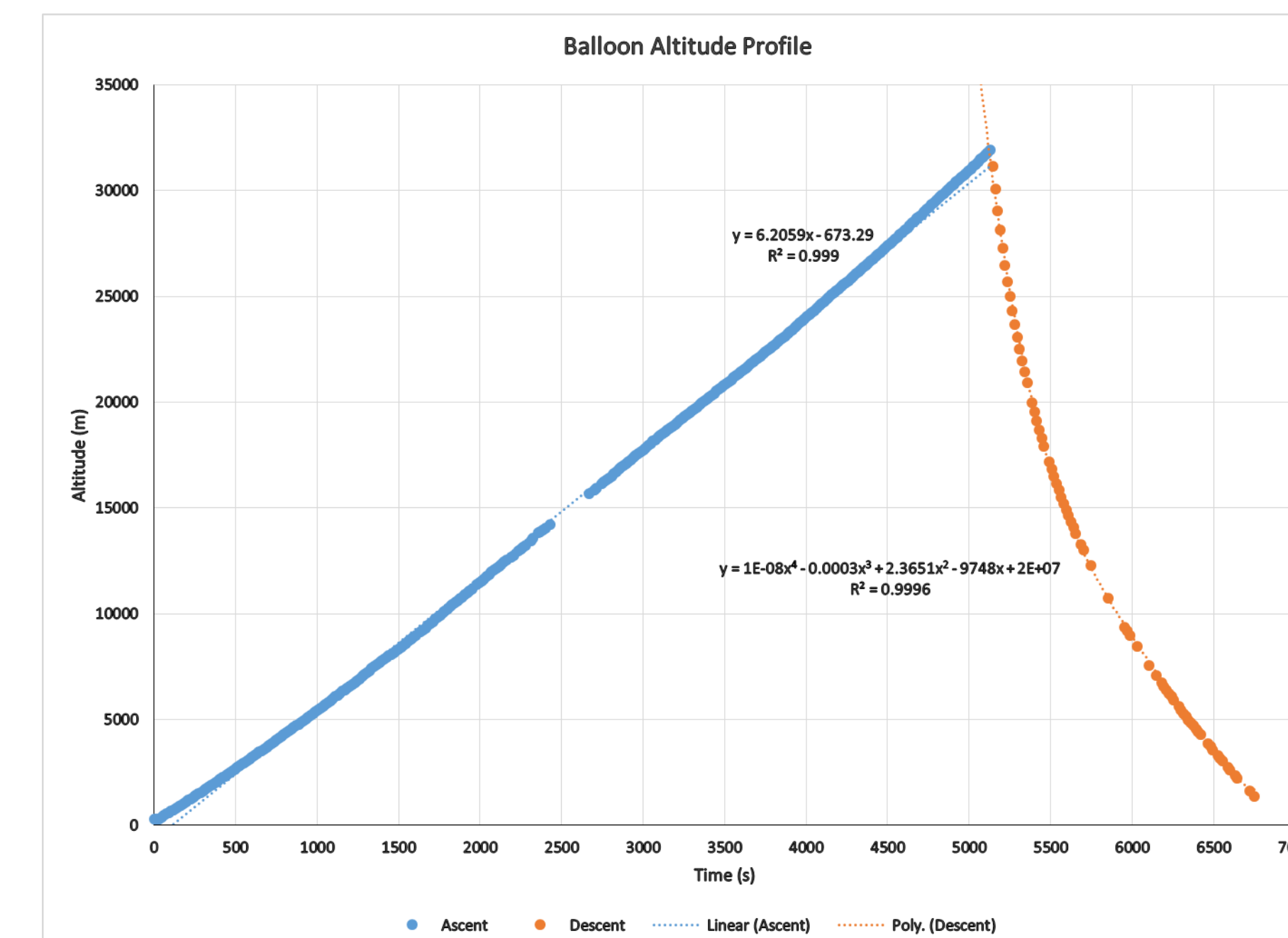
Subsequent data extraction revealed that only the first 6 minutes of data collected was recorded to the SD card. During Flight 1, the pressure sensor after six minutes read -999.9 Pascals which according to our Arduino programming would indicate no flight and shut down our data collection. After testing the pressure sensor and observing that over time it would randomly read -999.9 Pascals, we removed the stop measuring code and put in language to reset and continue collection of data whenever a negative value appeared. This improvement was made for the next flight.

Flight 2

Our second flight was from the BCTC Newtown Campus located in Lexington, KY (38.06177, -84.49741) on May 20, at approximately 10:15 AM EDT. On Flight 2, we measured altitude, pressure, temperature, humidity, and carbon dioxide using the same sensors as on Flight 1. The team successfully recovered the payloads in a grassy field, approximately 50 miles east just across the border into the Daniel Boone National Forest near Preston, KY (38.054649, -83.724806). The readings from the CO_2 sensor continuously increased and only collected data for approximately nine minutes until it shut down. Aside from the CO_2 sensor, all other sensors recorded values. 31,761 measurements were recorded. Graphs of the data collected are displayed above. The balloon altitude profile was linear on the ascent and fit a fourth order polynomial on the descent. Temperature readings declined overtime as the balloon climbed, increased as we entered the warmer stratosphere, decreased rapidly at burst, then climbed gradually on descent. Unexpected negative humidity readings were collected making us question the functionality of the sensor. We also simultaneously tracked the temperature inside and outside the payload container to ensure that the camera and sensors were not exposed to sub-zero temperatures.

Future Flight Plans

The BCTC Balloon Sat Team will launch a third balloon during the upcoming Fall 2015 semester. After adjusting the weather sensor code, we hope to collect altitude data simultaneous to all other data. We also plan on changing or repairing the CO_2 sensor, adding a ozone sensor, and possibly collecting gas samples for laboratory analysis of atmospheric mercury. Website: www.bctchab.org