High Altitude Payload for CUBESAT Aeroboom Development (HAPCAD)

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Abstract
The intent of this research project is to create a comprehensive flight plan for a high altitude balloon flight. The Get Away Special team is designing a cube satellite in which an inflatable, UV curable boom is deployed. The balloon flight will further validate the design of the Get Away Special Passive Attitude Control Satellite, GASPACS. Using previous flight information from the Weber State HARBOR program, approximate altitude versus pressure measurements were taken using a multisensory and a gas unit. The data was compared with a real time clock within each device. It is essential for the GASPACS payload to deploy in a pressure lower than the internal boom pressure for experimental success. This pressure is approximately 100 torr. The most effective window of time to deploy the GASPACS payload was determined to be between 70,000 feet and 80,000 feet. It was necessary to determine how long it would take the boom to deploy and cure, and assure there was sufficient time for such procedures before balloon burst. It takes about 10 minutes for the balloon to travel from 80,000 feet to 90,000 feet, which gives the balloon an extra ten minutes for contingencies. Most balloons burst after 90,000 feet. The HAPCAD flight is scheduled to launch the summer of 2015.

Introduction
The purpose of the Get Away Special Passive Attitude Control Satellite is to obtain reasonable control over the tumble rates of a small satellite without the use of mechanical hardware. This control will be obtained through the use of an extended boom from one end of the satellite after launch into low earth orbit. The boom will be deployed using residual air and a nichrome cut wire assembly. The boom will then be rigidized by a UV curable epoxy which will be coated along the length of the boom. Collaborating with the HARBOR program of Weber State University will give the GAS team an opportunity to verify the design of GASPACS. The near-space environment provides low pressure, variable temperatures, better UV light, and an opportunity for the system to be fully independent. In addition, a successful flight will increase the technology readiness level of GASPACS.

HARBOR data sheets for 4 flights were obtained and examined for pressure and altitude measurements. There were two excel sheets per flight, one for the multi-sensor array and one for the gps data. The temperature changes and the nature of microcontrollers cause shifts in the real time clocks, and the data needs to be taken with this error in mind. The time was noted at altitudes starting at 50,000 feet to 90,000 feet, increasing by 5,000 feet each measurement. This same time was then taken to the other data sheet and pressures were noted at those altitudes. Again, with a 5-20% error in mind.

The average time for the balloon to travel between 80,000 and 90,000 feet was also noted. Additionally the uncalibrated pressure was also compared to the absolute barometric pressure, and differentials were resolved through additional research.

With respect to boom testing, team members built a boom and allowed it to expand in a vacuum chamber several times, and took an average pressure where the boom was considered "fully inflated".

Methods

Results/Conclusions

• At least 100 torr is required to inflate boom via residual air.
• Majority of balloons burst after 90,000 feet.
• It takes an average (measured) of 10.5 minutes for the balloon to travel between 80,000 and 90,000 feet.
• It takes 12 minutes according to the ascension rate given by the data set from 8/9/14.
• Majority of flights are 2 hours to burst and 3 hours to landing
• The uncalibrated pressure is not an exact pressure. It is a differential pressure measured by voltage differentials and is only linear to approximately 150 torr. The non-linear calibrations have not been model yet.
• Since the pressure requirement is met well before burst, the boom could technically be deployed as early as ~45,000 feet. However, the epoxy will cure in the UV light and cause the boom to harden. In order to preserve the integrity of the boom, deployment will be at approximately 75,000 feet.

Flight Plan

References

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