Colorado Space Grant Research Symposium

DemoSat-B

Team CSU-V Rays

Colorado State University

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DemoSat-B Challenge Description

To design and build a payload that will enter the edge of space via a weather balloon while conducting an experiment of the team’s choosing.

Requirements set by Colorado Space Grant:

- Mass of payload < 1500g
- Budget = $1,000
- Flight string must pass through the center of the payload through a non-metallic tube
- Center of gravity must be as close to the center of the payload as possible
- The payload must be electrically self-contained
- Teams must conduct structural, environmental, and functional testing of payload in order to be allowed to launch
Mission Considerations

• Temperatures can reach -80 C during flight
  Must keep the electrical elements (especially the batteries) warm enough to maintain functionality

• Condensation may form on payload
  Need to protect electrical components from water damage

• Near vacuum conditions at maximum altitude
  Should avoid including pressurized materials

• Loads can exceed 15 g’s when the balloon bursts and 5 g’s upon landing
  All components must be tightly secured
  Extra padding may need to be included to prevent damage from impact
Mission Statement for Experiment

To collect quantitative data in order to better understand how ozone concentration throughout various altitudes of the atmosphere affects UV radiation intensity.

Taylor Morton  David Kimmey  Heidi Potton
Importance of Research

The sun’s ultraviolet (UV) rays are harmful to life on Earth
  UV-A radiation can cause sun burns after long exposure
  UV-B radiation can cause skin cancer
  UV-C radiation would cause severe damage to humans, plants, and animals if allowed to reach the earth’s surface

The ozone layer provides protection by absorbing the majority of ultraviolet rays
Experiment Objectives

- Collect and record ozone concentrations with altitude
- Collect and record UV-A and UV-B intensity with altitude
- Collect and record total UV (UV-A and UV-B) intensity with altitude
- Collect visual data of the flight from the camera
- Analyze data for any correlations

These objectives are meant to help further knowledge about the correlations of ozone, UV-A, and UV-B in the atmosphere.

http://www.visitfortcollins.com/about-fort-collins/horsetooth-reservoir/
Payload Design
Sensors Used

- UV-A Sensor (320-390 nm)
- UV-B Sensor (290-320 nm)
- Combined UV-A and UV-B Sensor (280-390 nm)  
  Creates analog signal proportional to UV Intensity
- Ozone Sensor
- Altimeter
**Inspiration for Design:** CSU Summer 2014 “Vertical CO2 Profile”

**Improvements made for Summer 2016:**
1. Pump - stronger, altitude dependent-integration
2. Heating chamber - 3D printed, more insulation
3. Power - pump was given its own LIPO battery
Layout of Payload

- UV Sensor
- UV- A Sensor
- UV- B Sensor
- Air Intake
- Power Switch
- Camera Mount
- Washer
- Lid Fastener
- UV Sensor
- Space Blanket Protective Covering
Integration of Control Panel

Lid
UV-A and UV-B sensors
Control Panel
Camera Mount
Housing
Ozone Control Panel

Air intake from exterior tube

Filtered air flows to heating chamber

Heated air drawn into ozone sensor

Pump intake
Electronics Control Panel

- Arduino Mega
- H-Bridge Shield
- SD Shield
- Logic Level
- Altimeter
- Heating Ceramic Resistor
Step 1:
Set up preheat
80 min before flight

Step 2:
Insert preheat
60 min before flight

Step 3:
Turn camera on
21 min before flight

Step 4:
Remove preheat and secure camera in payload
20 min before flight
Testing
Testing

Stair
Drop test down several flights of stairs with fully functional system

Whip
Phone used to record maximum g’s during whip test

Drop
Dropped from 2 stories, large impact force on corners

Vaccum
Ozone created at minimum vacuum pressure

Cooler
Range: 5C-40C
Ideal: 20C
Budget Summaries
Monetary Summary

Starting Budget
$1000.00

Amount Spent
$944.03

Amount Remaining
$55.97

Mass Summary

Mass Allotment
1500 grams

Total Mass
1352 grams
Launch Day
Launch Readiness Considerations

Preparations

1. Assemble all parts into payload and double check component function
   - 1 day
   - YES

2. Recheck function of all components and wiring stability
   - 120 min
   - YES

3. Secure lid
   - 120 min
   - YES

4. Insert preheat mount with hand warmers through camera slot
   - 60 min
   - YES

5. Turn on main power supply for ozone sensor warmup
   - 60 min
   - YES

6. Turn on heating resistor power
   - 17 min
   - YES

7. Turn on camera power
   - 11 min
   - YES

8. Remove preheat mount
   - 10 min
   - YES

9. Insert camera mount
   - 9 min
   - YES

10. Secure camera
    - 8 min
    - YES

Launch Site

Preflight Checklist

<table>
<thead>
<tr>
<th>Step</th>
<th>Operation</th>
<th>Initiation Time Before Launch</th>
<th>Task Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assemble all parts into payload and double check component function</td>
<td>1 day</td>
<td>YES</td>
</tr>
<tr>
<td>2</td>
<td>Recheck function of all components and wiring stability</td>
<td>120 min</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>Secure lid</td>
<td>120 min</td>
<td>YES</td>
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<tr>
<td>4</td>
<td>Insert preheat mount with hand warmers through camera slot</td>
<td>60 min</td>
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</tr>
<tr>
<td>5</td>
<td>Turn on main power supply for ozone sensor warmup</td>
<td>60 min</td>
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<tr>
<td>6</td>
<td>Turn on heating resistor power</td>
<td>17 min</td>
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<tr>
<td>7</td>
<td>Turn on camera power</td>
<td>11 min</td>
<td>YES</td>
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<td>8</td>
<td>Remove preheat mount</td>
<td>10 min</td>
<td>YES</td>
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<tr>
<td>9</td>
<td>Insert camera mount</td>
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<td>10</td>
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</tr>
</tbody>
</table>
Launch Day

EOSS (Edge of Space Sciences) crew and navigation system used for monitoring weather balloon location and payload recovery

Preparation for weather balloon launch with attached payloads

Group member, David, watching the balloon through binoculars at 104,000ft
Payload Recovery

Colorado State University - 2016 NASA Space Grant Teams with advisor Betsy Farris after payload recovery
Results
Temperature

Temperature vs. Altitude

![Temperature vs. Altitude Graph]

- Payload Ascent
- Heating Chamber Ascent
- Payload Descent
- Heating Chamber Descent

Altitude (m): 0, 2000, 4000, 6000, 8000, 10000, 12000, 14000, 16000
Temperature (%): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50
Altimeter

Altitude vs. Time

Altitude vs. Pressure
UV Results
Ozone

- The blue line represents the peak altitude the payload is expected to reach.
- The ozone concentration initially decreases because of the excess ozone near the surface that is caused by pollution.

Lessons Learned

• Order parts early and be prepared for unexpected malfunctions
• Order parts from well-reputable companies
• Testing takes far longer than expected

Message to Future Teams

• Finalize your project idea in the first week
• Lead times can have a serious impact on the progress of your project
• Find ways to keep yourselves busy while waiting for parts
• Enjoy the project and learn as much from it as you can!
Special Thanks!

Dr. Azer Yalin
Opportunity and guidance

Betsy Farris and Laurie McHale
Step by step help through all logistical aspects of project

Jarrod Zacher
Coding and technical support with ozone sensor

NASA Space Grant and The Colorado Space Grant Consortium
Funding and supporting the academic research community

Bernadette Garcia
Pre-launch preparations and launch day activities
Works Cited


Questions?

https://www.google.com/search?q=uv+a+b+c&source=lms&tbm=isch&sa=X&ved=0ahUKEwiz28zc-M3NAhWE6yKHfWwSC0oQ_AUICCGg8&biw=944&bih=937#imgrc=iwxU6gyvALnS8M%3A

Thank you!