High-Altitude Balloon Challenge for Cadets
Post Balloon Launch Data Access and Analysis Guidance

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How Civil Air Patrol Cadets Can Access and Analyze High-Altitude Balloon Data

Civil Air Patrol cadets participating in the High-Altitude Balloon Challenge have the opportunity to work with real-world flight data collected during their balloon launch day mission. This guide explains how to access, interpret, and analyze the data to draw meaningful scientific and engineering insights.

1. Accessing the Data

Each balloon flight produced two spreadsheets of sensor data, one from the command pod and one from the Microbit sensor pod, as well as an online visualization in the mission portal. The portal and the spreadsheets provide complementary perspectives:

- **Spreadsheets** (posted on the CAP HAB Challenge web page) can be downloaded there:

  Each file corresponds to one balloon's command pod or Microbit module and contains detailed time-series data.

  The spreadsheet names indicate which balloon and sensor pod the data in spreadsheet is from. E.g. CAP 1 - Command Pod Data.csv contains the command pod data from Balloon 1.

- **Online Portal**:

  Displays the command pod data but in an interactive format, with a map of the balloon track and plots of altitude, temperature, and irradiance. Hovering over points reveals the values at specific timestamps. Below are the links to the flight portals:

  CAP 1
  https://data.nsldata.com/console/balloonDashboard.php?a=kbBz8y2cMze2EfAG3noIFh8SGypeLJ

  CAP 2
  https://data.nsldata.com/console/balloonDashboard.php?a=1fozYkPRqRNgS0Mo1CXs8UVJnIfVaD

  CAP 3
  https://data.nsldata.com/console/balloonDashboard.php?a=eHBb3kKbysA0a1UWYNzaTPacZMDGrR

2. Understanding the Spreadsheet Columns

Only a subset of the spreadsheet columns is useful for cadet analysis. The other columns are for NSE engineering and system data and *can be ignored*.

Command Pod Sensor Data

- **radioViewName** – identifies which command pod generated the data.
- **gatewayTS** – timestamp (UTC, in date, minutes and seconds) **Note:** *The first entries will be from testing the pods the day before launch.*
- **Lat / Lon** – geographic position of the balloon.
- **Alt** – altitude in meters above sea level. Multiply by 3.28 to convert to feet.
- **S4 Temp** – internal circuit board temperature (***not*** the environmental temperature).
- **IR** – solar irradiance (W/m²).
- **UVA** – ultraviolet irradiance (W/m²).

For Light, Temperature, and Acceleration, the command pod records **10 measurements per packet**:

- **Light (0–9)** – and **Temperature (0–9)** – *should be ignored as the sensors are no longer accurate.*
- **Acceleration (0–9)** – vertical G force acceleration.

Data Cleaning Tip: To improve accuracy, cadets may either:

1. Average all 10 readings, or
2. Sort the 10 values, discard the highest and lowest, and average the middle 8 (reduces outlier influence).

Microbit Pod Sensor Data

Note: The Microbit has sensors contained on the Microbit board as well as external sensors. These are distinguished by either MM or a numeral in the microbitID column respectively. *Temperature on lines marked MM should be ignored* as they are internal circuit board temperature (**not** the environmental temperature).

- **Light** – the sensor measures ambient light levels on a linear scale from 0 to 255. This is an arbitrary number, not a standard scientific unit like lux. A reading of 0 means total darkness, and 255 means maximum brightness detectable. Readings stay capped at 255 even if the light gets brighter.
- **Temperature** – measured in degrees Celsius.
- **Pressure** – Atmospheric pressure measured in Pascals.

3. Using the Portal for Quick Analysis

The mission portal provides:

- **Ground Track Map** – balloon's horizontal path.
- **Altitude Plot** – ascent and descent profile.
- **Ascent/Descent Rate** – automatically calculated.
- **Environmental Conditions** – irradiance, UV, and light levels.

By moving the cursor over the plots, cadets can extract exact values at a given timestamp. This is a fast way to answer questions like:

- What was the maximum altitude?
- At what altitude did the balloon burst?
- How did irradiance or UV change with altitude?

4. Example Cadet Analysis Tasks

Cadets can use the spreadsheets to practice real-world data science and scientific inquiry. Some suggested projects:

1. **Altitude Profile**
   - Convert "Alt" from meters to feet.
   - Plot altitude vs. time.
   - Identify max altitude (balloon burst).
2. **Temperature with Altitude**
   - Plot external temperature vs. altitude.
   - Look for the expected drop in the troposphere and warming in the stratosphere.
3. **Light & Irradiance Trends**
   - Compare IR, UVA, and Light values as the balloon ascends.
   - Discuss why values fluctuate (swinging sensor, cloud cover, changing solar angle).
4. **Acceleration Analysis**
   - Average the acceleration values.
   - Look for spikes that may correspond to turbulence, balloon burst, or landing impact.
5. **Geographic Track**
   - Plot latitude and longitude.
   - Reconstruct the balloon's flight path on a map.
   - Compare predicted (shown on the portal) vs. actual landing site.
6. **Correlate Flight Conditions to Experiment Results**
   - Use the balloon data to help explain any changes in your experiment payload.

5. Tips for Cadet Reports

When writing up results:

- State **which balloon** you're analyzing.

- Explain **how** you cleaned or averaged the data.
- Discuss possible **sources of error** (sensor orientation, noise, packet loss).
- Compare results between the three balloons to see if patterns repeat.
- Explain how changing environmental conditions affected your experimental payload.

6. Summary

By combining the portal for quick visualization with spreadsheets for deeper analysis, cadets can engage in authentic scientific investigation. The process reinforces STEM skills including:

- Data cleaning and averaging
- Unit conversion (meters to feet, °C to °F, if desired)
- Graphing and trend analysis
- Drawing scientific conclusions from real-world measurements

This interactive approach not only teaches aeronautics and atmospheric science but also builds confidence in handling complex data sets—an essential skill for future engineers and scientists.

Instructor Notes

- Encourage cadets to use Excel/Google Sheets for graphing.
- Ensure cadets convert altitude to feet before plotting.
- Remind cadets to describe sources of error (sensor orientation, noise, data packet dropouts).