

# High Altitude Ballooning at Central Lakes College

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## Introduction

Beginning Fall semester 2010 geoscience and physics faculty at Central Lakes College (CLC) began collaborating with faculty at Bemidji State University for flying High Altitude Balloons (HAB). Since that time we have made 12 flights. Two of these flights have been made independently, without BSU collaboration.

Central Lakes College HAB flights have involved students in the following Geoscience department classes:

- Earth Science and the Environment
- Astronomy
- Nobel Conference Honors Cosmology
- Honors Earth Science and Environment

The HAB projects at CLC meet the following geoscience course outcomes:

- Correctly operate modern field and laboratory analytical equipment.
- Perform field based investigations using standard geoscience techniques.
- Describe and explain observations in the context of contemporary Planetary and Geoscientific theories.
- Demonstrate written communication skills in science lab reports.

HAB projects at CLC also have the following components:

- They attempt to provide an authentic geoscience research experience, involving hypothesizing, experimental design, fieldwork, experience with GIS, and data collection and analysis.
- Interdepartmental and intercollegiate collaboration, and student teamwork
- Outreach and STEM recruiting

## Geoscience Fieldwork

HAB projects meet the following geoscience educational goals.

### Experimental design

- Students work in teams to design an experiment that tests expected phenomena encountered as the HAB platform ascends to near-space (typically 30,000 m)



Above: March, 2014 student-designed HAB experiments in flight.

### Field work

A typical HAB flight follows this agenda:

1. Meet early at the college, load the vehicles, and travel to the launch site
2. At the launch site, set up the balloon and payloads.
3. Test electronics, verify, tracking.
4. Inflate balloon and release.
5. Track and chase balloon to landing location.
6. Retrieve HAB, payloads



Above: Helium being dispensed for May, 2014



Above: CLC students preparing HAB for May, 2014 launch.



## Geographical Information Systems

Preflight: Flight path predictions are made beginning days before the flight using freely available online software:

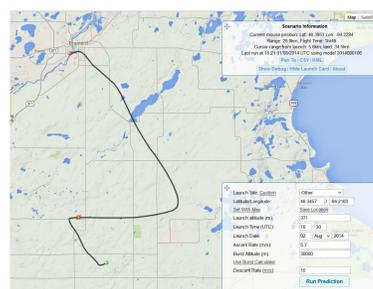
<http://predict.habhub.org/>

During the HAB flight: three independent tracking systems are employed on board the HAB. This level of redundancy assures the precious student payloads will not be lost.

- 900 MHz proprietary tracking software sold by Stratostar Corp (<http://www.stratostar.net/>)
- Automated Packet Reporting System (aprs), transmitted in a frequency band of HAM radio. This tracking is collected and relayed by HAM repeater towers, and can be viewed by anyone with an internet connection at [aprs.fi/](http://aprs.fi/). To use this system, one must acquire a HAM radio license.
- SPOT GPS. Made for hikers, this small, lightweight unit attaches anywhere to the HAB payload, and displays the HAB position on a website map: <http://www.findmespot.com/en/>



Above and above right: 900 MHz tracking software display carried in a chase vehicle.



Above: Preflight prediction using online software



Above: KMZ file track of HAB flight, displayed on Google Earth

## Data collection and analysis

In-flight data collection routinely includes:

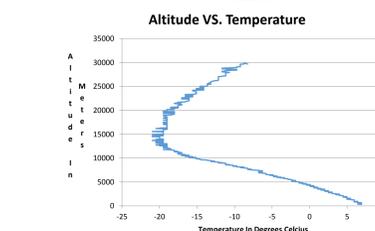
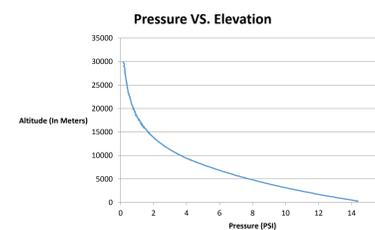
- Temperature
- Pressure
- Humidity
- Geiger Counter
- Accelerometer
- Gyroscope
- Cameras-video and still

### Others

- Solar observations
- Near space particle collection
- Cosmic radiation
- lidar

### Analysis

Data files are downloaded, processed, and analyzed using Microsoft Excel or similar software.



Above two graphs: Student-produced graphs from March, 2014 HAB flight data.



## Collaboration

How collaboration facilitates CLC HAB projects

### Interdepartmental

- Geoscience and physics faculty and students contribute with different knowledge, interests, and skills.
- Physics students take the lead in wiring and software testing.
- Geoscience students take the lead with experimental design, geographical knowledge, and knowledge of atmospheric phenomena.

### Intercollegiate

- All CLC-BSU HAB flights are supported by a grant funded by the Minnesota Space Grant Consortium. The P.I. for this grant is Dr. Timothy Kroeger, Geoscience Faculty, BSU.

### Student Teamwork

- Teamwork is assigned but also arises naturally, especially as the launch day approaches. There is so much preparation for an HAB that students quickly realize they must take charge in making it happen.
- It is common for students to naturally specialize according to their interests and skills. For example, while some students have an interest in setting up and using the tracking software, others are more comfortable with the hardware of the HAB.
- On ground cameras are always encouraged to get a complete photographic record of the project.

## Outreach and STEM recruiting

### Middle-school participation

With each flight, one middle school 8<sup>th</sup> grade class is invited to participate. Levels of participation varies with the school but typically involves:

- Student presence on the day of the flight. Often this involves an entire 8<sup>th</sup> grade class (one of more busses full of students). They come for the launch, chase, and retrieval.
- Payloads attached to the HAB. Classes are invited to develop a payload to run their own experiments during the flight.
- Flight tracking. Using aprs.fi anyone, anywhere can track the HAB. This can be beneficial in the event that flight tracking ability is lost in the chase vehicles. For classes that choose not to participate in the launch and chase, but have a payload attached, they still can track the flight on aprs.fi.



Above: Menahga Middle School 8<sup>th</sup> grade class ready for the May, 2014 HAB flight.



Above: Sequence of video frames showing balloon burst at over 30,000 m altitude.