



## National survey of high-altitude ballooning by higher education institutions

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### Abstract:

I have conducted a survey to document the amount and types of high-altitude ballooning being done by higher-education institutions around the nation. Questions were asked about (a) ballooning for higher education curricular use (including listing which departments offer classes that involve ballooning), (b) ballooning for higher education non-curricular use (especially for research), and (c) ballooning done by higher education institutions for non-higher education audiences (especially pre-college teachers and their students, as well as general public outreach). In addition, the survey requested names of volunteers willing to serve as a contact for higher education ballooning (one per state). In addition to numerical answers, states were encouraged to submit a one-slide promo for the higher education ballooning they do, plus information about particularly noteworthy curriculum, websites, publications, etc. associated with their higher education ballooning programs.

### Introduction:

High-altitude ballooning, henceforth just called ballooning, employs latex weather balloons or zero-pressure balloons filled with helium or hydrogen to lift science payloads (AKA “near-space craft”) into the stratosphere (AKA “near-space”). This engaging activity, sometimes called “amateur spaceflight,” can involve people of a wide variety of ages, but is especially useful at the college/university level to motivate interest in STEM (Science, Technology, Engineering, and Mathematics) fields in general and interest in aerospace and outer-space-related careers in particular.

The NASA Space Grant program, with consortia in all 50 states plus Washington D.C. and Puerto Rico, has made effective use of ballooning to motivate higher-education students around the nation to grapple with the challenges of spaceflight and to better appreciate the accomplishments of NASA and other space agencies. The Colorado Space Grant, for example, has collaborated with other Space Grants to offer ballooning workshops for several years which have spawned dozens of ballooning programs around the country that ultimately engaged thousands of college students. More recently Taylor University in Indiana, supported in part by the Indiana Space Grant, has held workshops and helped start an annual ballooning conference to promote the implementation of ballooning in higher-education curricular settings.

Many references exist to learn about ballooning, such as the “Near Space” column in Nuts and Volts (and on-line text by the same name) by Paul Verhage [1], with regular installments since 2004, and the overview of ballooning by Shane Larson, John Armstrong, and the late Bill Hiscock, published in AJP in 2009 [2]. Conference proceedings from the Academic High-Altitude Conferences (AHAC) at Taylor University (summer 2010) [3], Iowa State University (summer 2011) [4], and Trevecca Nazarene University (summer 2012) [5] are good resources to learn about what higher-education institutions are currently doing with ballooning.



### The Survey:

In the spring of 2012 I conducted an on-line survey to help characterize the amount and types of ballooning being done by higher-education institutions around the nation. The survey had questions about (a) ballooning for higher education curricular use, (b) ballooning for higher education non-curricular use (especially for research), and (c) ballooning done by higher education institutions for non-higher education audiences (especially pre-college teachers and their students, as well as general public outreach). The survey also solicited faculty volunteers (one per state) willing to serve as a contact for higher education ballooning in their state. Respondents were also encouraged to submit a one-slide promo for the higher education ballooning they do, as well as information about particularly noteworthy curriculum, websites, publications, etc. associated with their higher education ballooning programs.

The survey questions are included at the end of this article. Inquiries about survey responses and trends not explicitly discussed below are welcome.

### Respondents:

Surveys were circulated nationally through the Space Grant e-mail network, encouraging Space Grant directors to nominate one faculty member in their state (not necessarily at a Space Grant institution) to characterize state-wide ballooning activity by their state's colleges and universities and to potentially serve as a higher-education ballooning contact for their state. States not currently doing much ballooning at the higher-education level were encouraged to explicitly opt out of the survey.

Survey responses were received from the following 15 states, listed alphabetically: Arizona, Colorado, Florida, Illinois, Indiana (partial response), Iowa, Maine, Minnesota, Montana, New Hampshire, New York, North Dakota, Tennessee, Utah, and Washington.

The following 9 states, plus Washington, D.C., reported that they are not currently doing much higher-education ballooning: Kansas, Missouri, New Jersey, North Carolina, Rhode Island, South Dakota, Texas, Virginia, and Wyoming.

Since there are 52 Space Grants, this is a response rate of about 50%, though it would be presumptuous to conclude that the survey captured only 50% of the nationwide higher-education ballooning activity because survey respondents are self-selected. I suspect the survey results to date characterize about 75% of higher education ballooning activity nationwide. Readers familiar with higher-education ballooning in states that have not yet completed the survey are encouraged to contact me and participate even now (up through the fall of 2012), to provide a more-complete picture.

### Summary of Results for General Ballooning Questions:

The states completing the survey reported 54 institutions involved in flying about 100 balloon flights annually in the three categories mentioned above. Considering the fact that each balloon flight can carry multiple payloads, this is a significant amount of activity. Figure 1 shows that the number of states participating in each category is quite evenly split (interpret that figure as "Nearly all states have activities in all three categories.") but Figure 2 and Figure 3 show that about twice as many institutions and about half of the total number of flights are dedicated to research-type activities, with ballooning courses and outreach flights accounting for about equal (lower) levels of activity. Individual flights were uniquely categorized into just a single category, but bear in mind the fact that some institutions participate in more than one category.



### States doing ballooning, by category

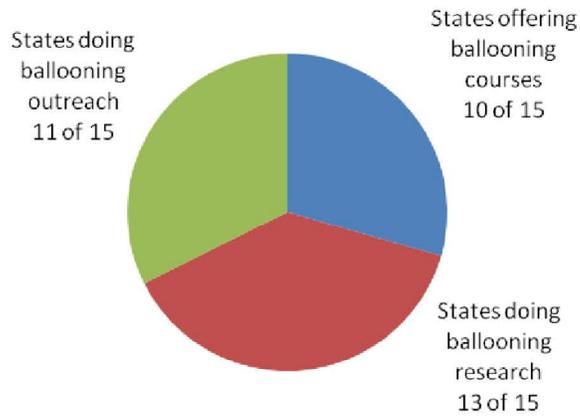


Figure 1: This illustrates that similar numbers of states are engaged in each of the three categories of ballooning activities described by the survey. In fact, most states are involved in all three categories.

### Number of annual flights, by category

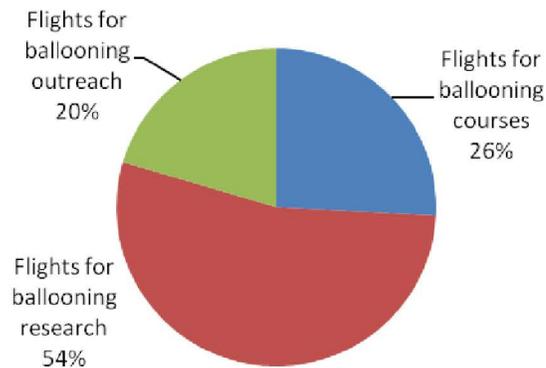


Figure 2: Survey respondents classified each of their balloon flights into just one of the three categories. This chart shows that research-oriented flights are in fact more common than class and outreach flights combined.

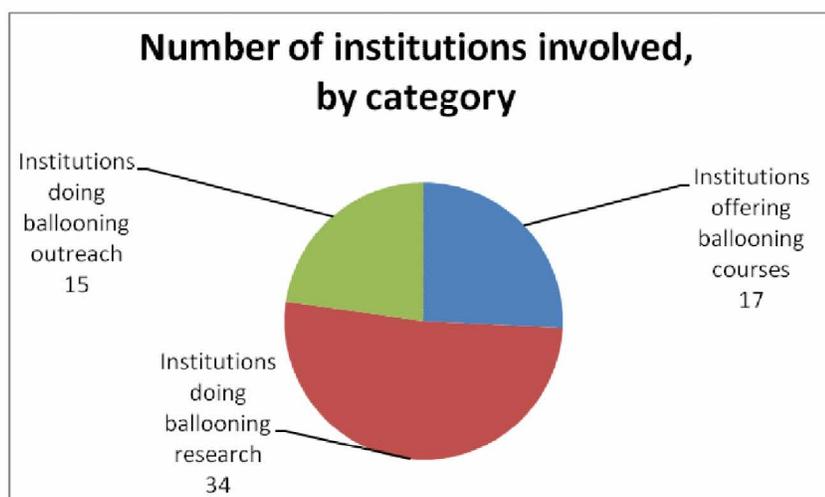


Figure 3: This chart shows that about twice as many institutions are engaged in research-oriented ballooning as in outreach ballooning or in offering classes that include ballooning. Some institutions do more than one type of ballooning.

Of the 54 institutions involved, 49 do their own balloon flights whereas 5 were reported as dependent on external launch providers, including other higher-education institutions. Only 4 non-higher education launch providers were mentioned:

StratoStar Systems based in Indiana [<http://www.stratostar.net/>]

Edge of Space Sciences (EOSS) in Colorado [<http://www.eoss.org/>]

High Altitude Student Platform (HASP) in Louisiana [<http://laspace.lsu.edu/hasp/>]

Arizona Near Space Research (ANSR) in Arizona [<http://www.ansr.org/>]

*Personal note – Here in Minnesota I could benefit from having a launch-for-hire provider. This might be a future growth area, in support of educational ballooning at the higher education and pre-college levels.*

#### Summary of Results for Ballooning Classes Questions:

Survey respondents from 10 states (out of 15) reported a total of 17 institutions offering 21 courses annually which have a ballooning component, taught by 24 faculty or staff members and enrolling over 280 students annually. A total of 24 balloon flights per year, about one quarter of the total number of flights, are primarily for high-education class purposes. Classes range from standard lab science classes with a ballooning laboratory module to pre-engineering and freshmen seminar classes focused on ballooning to advanced technical electives for science and engineering majors in which students develop multi-balloon communications systems.

The departments that offer classes involving ballooning include Aerospace Engineering and Physics (most popular), plus Astrophysics, Electrical and Computer Engineering, Computer Science, Atmospheric Science & Chemistry, Mechanical Engineering Technology, Natural Science, and STEM Studies. This supports the claim that Taylor University has made for years – that ballooning activities can benefit students in a wide variety of STEM disciplines, not just ones that look like aerospace or space science – and also supports their curriculum development and collaboration initiatives between institutions in different states.



Curricular ballooning in higher education has grown in recent years and it might be interesting to redo this survey in a few years to document whether the curricular use of ballooning in higher-education continues to grow. Ballooning is, by nature, cross-disciplinary, allowing it to spread more easily than many other activities. No state reported ballooning classes being supported by more than 3 departments (statewide), so there may be room for additional curricular growth even in states that already offer classes involving ballooning.

#### Summary of Results for Extracurricular/Research Ballooning Questions:

The most common category of ballooning reported by higher education institutions was “extracurricular ballooning for higher-education” which, in most cases, meant ballooning for research and/or for out-of-class higher-educational projects. Survey respondents from 13 states (out of 15) reported a total of 34 institutions and 52 faculty or staff members engaging over 213 students annually in this type of ballooning. (Note – some of these students might also be counted in the ballooning classes mentioned above.) A total of 50 balloon flights per year, about half of the total number of flights, are primarily for extracurricular/research purposes.

The departments engaged in extracurricular/research ballooning include Aerospace Engineering and Physics (again the most popular), plus Space Studies, Mechanical Engineering, Electrical Engineering, Computer Science, Mathematics, Engineering Physics, and Atmospheric Science & Chemistry. The fact that this list differs from the list of departments offering classes with ballooning components suggests another growth opportunity – these departments might consider incorporating ballooning into their classes since they already use ballooning for research, and departments that teach classes involving ballooning might consider expanding their use of ballooning into their research programs.

#### Summary of Results for Pre-college/Outreach Ballooning Questions:

Some of the most interesting survey results, at least to me personally, pertained to ballooning activities offered by higher education faculty and students to non-higher-education audiences, such as pre-college teachers, pre-college students, informal education groups, and the general public. Survey respondents from 11 states (out of 15) reported a total of 15 institutions offering “other extracurricular” ballooning engaging 24 faculty or staff and over 90 higher-education students annually. A total 19 of balloon flights per year, about one fifth of the total number of flights, are primarily for these pre-college/outreach purposes. These activities involved nearly 40 pre-college teachers and over 220 students from over 30 pre-college schools but, interestingly enough, only 2 informal education programs. Six states reported having programs working primarily with middle school / lower high school students (grades 6 to 9) and 7 states (some of the same states) reported have programs primarily for upper high school students (grades 10 to 12). Only New Hampshire reported a program designed primarily for upper elementary students (grades 4 to 6). No states reported programs primarily aimed at lower elementary students (grades 1 to 3).

The departments involved in this type of ballooning include Aerospace Engineering and Physics (again the most popular), plus Space Studies, STEM Studies, Natural Science, Education, Toxicology (interesting!), Astrophysics, and Atmospheric Science & Chemistry. The fact that only one state (Maine) mentioned Education faculty and students being involved in this type of ballooning suggests another possible growth opportunity.



### Summary:

Although the response rate to my ballooning survey was lower than I was hoping for, the results were enlightening. I found the lists of departments involved in doing the various types of ballooning particularly interesting, as well as the total number of faculty, students, and the relative number of flights dedicated to the three categories.

I hope the list of ballooning contacts for higher education (see below) will be useful to the ballooning community and I thank those willing to be listed.

The preponderance of research-oriented ballooning and the general paucity of Education departments involved in ballooning suggest to me potential growth areas, especially for currently research-only departments to get engaged in curricular ballooning and outreach ballooning and for Education departments to do ballooning with both pre-service and in-service STEM teachers. I believe the ballooning community could benefit from more launch-for-hire providers, allowing higher-education and pre-college institutions alike to start with payload-building-only programs.

I will continue to seek additional respondents, and possibly more details from the original respondents, through the fall of 2012. If you would like to contribute to the survey data or have your state included in my “Ballooning (Promo) Book” (see next section), please contact me.

### Promo Slides:

Here are the 1-page promo slides I have received to date – only 5 so far. Additional slides from other states are welcome. If I receive enough I plan to generate a “Ballooning (Promo) Book” which could be used to promote higher-education ballooning around the Space Grant network and in ballooning (and potential-ballooning) circles nationwide. An electronic version of these promo slides is available upon request.

## Higher Ed. High-Altitude Ballooning in Colorado

**CO Colleges/Universities involved**

- Pikes Peak Community College
- Trinidad State Junior College
- Colorado State University
- University of Northern Colorado
- Colorado School of Mines
- Community College of Denver
- Metropolitan State College of Denver
- Community College of Aurora
- University of Colorado, Boulder
- Colorado State University – Pueblo
- Western State College
- Fort Lewis College

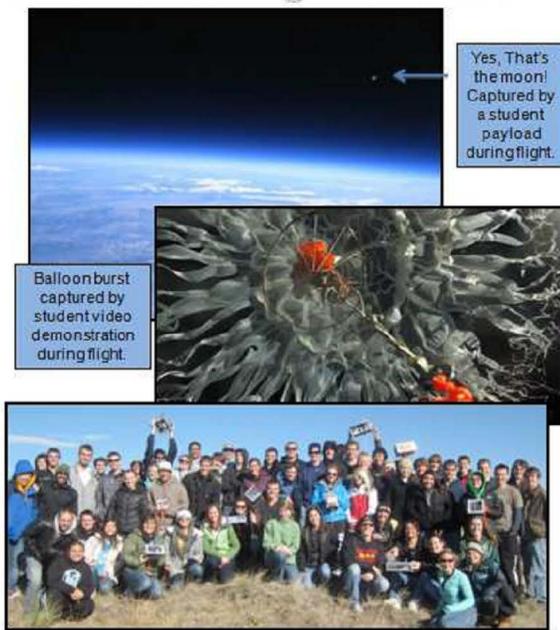
**On-going higher-ed. ballooning activities**

- Student research opportunities through statewide DemoSat program
- Gateway To Space (Aerospace projects class, cross listed with Astrophysics)
- Introduction to Space class in Mechanical Engineering Technology department
- Balloon flight with CU PreCollegiate Development Program

**Collaborations with**

- Edge of Space Sciences
- National Oceanic and Atmospheric Administration (NOAA)
- Southwest Research Institute
- Air Force Research Laboratory

For more information, contact Bernadette Garcia, CO Space Grant [bgarcia@colorado.edu](mailto:bgarcia@colorado.edu)





ACADEMIC  
HIGH-ALTITUDE  
CONFERENCE

## Higher Ed. High-Altitude Ballooning in Iowa

### IA Colleges/Universities involved

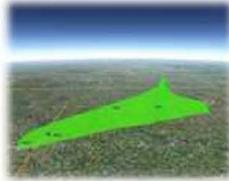
Iowa State University – Ames, IA



### On-going higher-ed. ballooning activities

AerE 265 – High Altitude Ballooning class

High Altitude Balloon Experiments in Technology (HABET) group



### Collaborations with

Grout Museum, Waterloo, IA



For more information, contact Matthew Nelson, Iowa State University, [mnelson@iastate.edu](mailto:mnelson@iastate.edu)

## Higher Ed. High-Altitude Ballooning in Minnesota

### MN Colleges/Universities involved

U of MN – Twin Cities, Minneapolis

Concordia College, Moorhead

St. Catherine University, St. Paul

U of MN – Morris, Morris

Augsburg College, Minneapolis

Bemidji State Univ. & Central Lakes College, Bemidji



### On-going higher-ed. ballooning activities

Freshman seminars: Intro. to Spaceflight with Ballooning

Upper division technical elective ballooning class

Ballooning modules in experimental physics classes

Physics research in and from "near-space"

Balloon flight opportunities for MN middle schools



### Collaborations with

Wild Midwest Amateur Radio Coalition (WMARC)

Stillwater Amateur Radio Association (SARA)

Balloon-based High ALTitude Digital Imaging (BHADI)



For more information, contact James Flaten, MN Space Grant, [flaten@aem.umn.edu](mailto:flaten@aem.umn.edu)



## Higher Ed. High Altitude Ballooning in Tennessee



### Tennessee Colleges/Universities involved

Trevecca Nazarene University, Nashville  
Bryan College, Dayton  
King College, Bristol



### On-going higher-ed. ballooning activities

Gen Ed classes with curriculum integrated flights  
Science courses developed around stratospheric projects  
Physics majors building and testing new flight systems  
Science research in and from "near-space"  
Collaborative balloon flight opportunities with K-12 schools



For more information, contact Matthew Huddleston at  
Trevecca Nazarene University, [mhuddleston@trevecca.edu](mailto:mhuddleston@trevecca.edu)

## Higher Ed. High-Altitude Ballooning in Utah

### Utah Universities involved in HARBOR (High Altitude Reconnaissance Balloon for Outreach & Research)

Weber State University, Ogden  
Utah State University, Logan



### Active HARBOR Projects

Monitoring of stratospheric: ozone, particulates, and flow dynamics  
Near Earth atmospheric sampling and measurement of particulates  
Climate change and pollution studies  
Infrared and visible imaging for geospatial analysis  
Outreach programs for elementary through high school  
Flight hardware and flight control system development

98,432 ft ASL - 19 July 2009  
[space.weber.edu/harbor](http://space.weber.edu/harbor)

For more information contact John Sohl, Weber State U., Physics, [jsohl@weber.edu](mailto:jsohl@weber.edu)



ACADEMIC  
HIGH-ALTITUDE  
CONFERENCE

#### Ballooning Contacts:

Here are the individuals who have agreed to serve as a higher-education ballooning contact for their states. I welcome additional volunteers to help cover states not listed below.

- Colorado: Bernadette Garcia, CO Space Grant at University of Colorado – Boulder, [bgarcia@colorado.edu](mailto:bgarcia@colorado.edu)
- Florida: Jaydeep Mukherjee, FL Space Grant at University of Central Florida, [fsgc@ucf.edu](mailto:fsgc@ucf.edu)
- Illinois: Bernhard Beck-Winchatz, DePaul University, [bbeckwin@depaul.edu](mailto:bbeckwin@depaul.edu)
- Indiana: Howard Brooks, DePauw University, [hlbrooks@depauw.edu](mailto:hlbrooks@depauw.edu)
- Iowa: Matthew Nelson, Iowa State University, [mnelson@iastate.edu](mailto:mnelson@iastate.edu)
- Maine: Terry Shehata, ME Space Grant at University of Southern Maine, [terry.shehata@msgc.org](mailto:terry.shehata@msgc.org)
- Minnesota: James Flaten, MN Space Grant at University of Minnesota – Minneapolis, [flaten@aem.umn.edu](mailto:flaten@aem.umn.edu)
- Montana: Randy Larimer, MT Space Grant at Montana State University, [rlarimer@ece.montana.edu](mailto:rlarimer@ece.montana.edu)
- New Hampshire: James Koermer, Plymouth State University, [koermer@plymouth.edu](mailto:koermer@plymouth.edu)
- New York: Sherman Austin, Medgar Evers Coll., City University of New York, [shermane.austin@gmail.com](mailto:shermane.austin@gmail.com)
- Tennessee: Matthew Huddleston, Trevecca Nazarene University, [mhuddleston@trevecca.edu](mailto:mhuddleston@trevecca.edu)
- Utah: John Sohl, Weber State University, [jsohl@weber.edu](mailto:jsohl@weber.edu)
- Washington: Robert Winglee, WA Space Grant at University of Washington, [winglee@ess.washington.edu](mailto:winglee@ess.washington.edu)

#### Survey Questions:

Contact information for survey respondent.

Willing to be listed as a higher education ballooning contact for your state?

Total # of balloon flights (always insert “for or by colleges and universities in your state in a typical year”)

# of colleges/universities that both build and fly balloon payloads

# of additional institutions that only build payloads, but have others fly them

Names of non-higher-education balloon launch providers used by colleges/universities in your state

Curricular-Ballooning for higher education:

# of higher education institutions that offer college-level classes with a ballooning component

# of higher education courses with a ballooning component

# of higher education faculty/staff involved in offering such courses

# of higher education students who do ballooning in such courses

# of balloon flights primarily for higher education curricular ballooning

Names of higher education departments offering such courses

Extracurricular-Ballooning for higher education (e.g. research ballooning):

# of higher education institutions involved in extracurricular ballooning

# of higher education faculty/staff involved in extracurricular ballooning

# of higher education students involved in extracurricular ballooning

# of balloon flights primarily for higher education extracurricular ballooning



Names of higher education departments doing extracurricular ballooning

Extracurricular-Ballooning for non-higher-education purposes (e.g. pre-college or outreach ballooning):

# of higher education institutions involved in non-higher-education ballooning

# of higher education faculty/staff involved in non-higher-education ballooning

# of higher education students involved in non-higher-education ballooning

# of balloon flights led by higher education institutions primarily for non-higher-education ballooning

Names of higher education departments doing non-higher-education ballooning

# of informal education programs (not pre-college schools) involved in non-higher-education ballooning

# of pre-college schools involved in non-higher-education ballooning

# of pre-college teachers involved in non-higher-education ballooning

# of pre-college students involved in non-higher-education ballooning

Primary grades of such pre-college students

# of other adults (not pre-college teachers) involved in non-higher-education ballooning

Reminder to advertise your state's higher-education high-altitude ballooning activities by contributing a page to the "Ballooning Book" being compiled by James Flaten.

Opportunity to volunteer additional materials about your particularly noteworthy high-altitude ballooning materials, websites, etc. (This may be done separately by e-mail as well.)

#### References:

1. L. Paul Verhage, *Near Space* column (since 2004), Nuts and Volts and on-line text "*Near Space*" available at <http://www.parallax.com/tabid/567/Default.aspx>.
2. Shane L. Larson, John C. Armstrong, and William W. Hiscock, "*The first frontier: High altitude ballooning as a platform for student research experiences in science and engineering*", *Am. J. Phys.* 77 (6), June 2009.
3. 1<sup>st</sup> annual Academic High-Altitude Conference Proceedings, Taylor University, June 2010.
4. 2<sup>nd</sup> annual Academic High-Altitude Conference Proceedings, Iowa State, June 2011.
5. 3<sup>rd</sup> annual Academic High-Altitude Conference Proceedings, Trevecca Nazarene University, June 2012.