New Hampshire Space Grant Consortium
Lead Institution: University of New Hampshire (UNH)
Director: Professor Antoinette Galvin
Telephone Number: (603)-862-3511
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The New Hampshire Space Grant Consortium is a Designated Consortium funded at a level of $575,000 for fiscal year 2012.

PROGRAM GOALS

The strategic goal of the New Hampshire Space Grant Consortium (NHSGC) is: *To stimulate and enhance awareness and understanding of our nation's continuing quest into space by providing 1) Support to New Hampshire's college and university students in space-related fields; 2) Space-related educational materials, programs, and resources to the State's educators; and, 3) Greater access to space-related information and technology for the benefit of the State, its businesses, and citizens.*

Particular emphasis and priority are given to the following goals:

- Providing fellowships, scholarships, and internships to the State's graduate and undergraduate (including community college) students pursuing studies in NASA-relevant science, engineering, and technology disciplines
- Providing resources, information, and training to the State's and region's educators in science, math, and technology
- Creating increased access to NASA-relevant science and technology through informal educational institutions and other programs oriented towards the general public
- Providing support for the State's community colleges
- Creating a greater impact on recruitment of underrepresented groups
- Providing pre-service and in-service science teacher training
- Supporting informal education/public service programs
- Fostering New Hampshire's new EPSCoR projects

The NHSGC partners are the University of New Hampshire (UNH), the UNH Cooperative Extension, Dartmouth College, FIRST Place, the Community College System of New Hampshire (CCSNH), the McAuliffe-Shepard Discovery Center (MSDC), Plymouth State University (PSU), the Mount Washington Observatory (MWO), the Margret and H.A. Rey Center, and BAE Systems of North America.

The Consortium SMART objectives established in the award year three proposal (June 8, 2012 – June 7, 2013) are:

Proposal Metrics for Outcome 1 SMART Objectives

- Match or exceed New Hampshire's non-Asian/non-Pacific Islander minority higher education enrollment of 5.4% in ethnic diversity in fellowship and scholarship awardees
- Match or exceed New Hampshire's full-time female higher education enrollment of 39% in fellowship and scholarship awardees
- Provide 5.5 graduate fellowships
- Provide 30 undergraduate scholarships
- Provide travel support or research supplies support for 15 students
- Support 16 internships in NASA related STEM disciplines, including informal education
- Provide up to 25 plasma science seminars reaching 25 participants each
- Expand access to, and use of, remote imagery in New Hampshire through at least one new data set made available through a web image service
- Expand access and use of remote imagery through the use of at least one new data set in at least 1 UNH Cooperative Extension workshop or course. Revise and deliver a 1-day workshop called "What's in a Pixel", serving 10 participants.
- Provide longitudinal tracking of significant awards using the NSGF Tracking System

Proposal Metrics for Outcome 2 SMART Objectives

- Support two Earth science/engineering design teacher workshops for ten teachers
- Support Forest Watch/Maple Watch in holding four 3-day teacher workshops and training of 32 new or returning teachers for the studies of white pine and tropospheric ozone
- Support Forest Watch in archiving 21 years of data and making the data accessible online
- Provide MWO in-school and distance learning programs reaching 2000 participants
- Provide WMCC GIS Summer Camp for 10 middle school students (also germane to Outcome 3)
- Increase the number and quality of Dartmouth College outreach activities (also germane to Outcome 3)
- Support two NH high schools to participate in the FIRST Robotics competitions
- Sponsor one eStart course with 10 participants and one instructor through CCSNH
- The Rey Center will deliver 50 supplemental science programs in NH schools, serving an average of 10 or more students per program

- Rey Center staff will lead at least 15 after school programs in 2012-2013, engaging more than 200 school children

Proposal Metrics for Outcome 3 SMART Objectives

- Support a two-day Aerospace festival reaching more than 500 members of the general public
- Evaluate MSDC exhibits and activities
- Support 4 informal educators in attending professional development conferences/workshops
- Provide hands-on citizen science programs in rural New Hampshire to 300 or more participants

PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, & 3)

Highlight for Outcome 1: C. Huston, a UNH Mechanical Engineering Student, participated in the 2012 RockOn workshop at the NASA Wallops Flight Facility. Huston blogged his daily experiences for the NHSGC website, and had this to say about the launch:

> "*We had a successful launch on Thursday and were able to recover our payload and data with great success. I'm still in awe of the fact that I had the opportunity to send something that I worked on into space. Being a part of the launch preparations was a great experience and we even got the opportunity to see the Orbital Sciences facility where they were assembling two Antares rockets for future missions to the International Space Station. … I am really grateful for the support that the New Hampshire Space Grant Consortium provided in making the workshop happen. The entire experience was incredible and my excitement about future space related research and projects has definitely grown!"*

Highlight for Outcome 1: Many Community College students are non-traditional college students -- they may have a family, a mortgage, and be juggling one or two jobs along with their coursework. Or, as in the case below, they may be veterans returning to civilian life. The cost of full time tuition at the Community Colleges, not including textbooks, is approximately $6,300. Therefore, a $1,500 scholarship goes a long way toward making higher education possible for these students. Some students share their stories, such as:

> *"At the beginning of my senior year of high school, I decided to join the Air Force. College was right around the corner and since I didn't want to burden my parents with my college expenses, I needed a way to pay for college. The Air Force seemed a good option. I now realize serving in the military is the best decision I've made because the Air Force has helped put me on a path to success, thus beginning my career as an aircraft mechanic. I've enrolled at Nashua Community College and will pursue an Associate's Degree in Aviation Technology. While I am pursing my studies I will also be serving the State of NH*

as well as my country as an Airman in the Air National Guard. Two years ago, I didn't know what I wanted to do, I now have solid goals." S. Schenkelberg, Londonderry NH

Highlight for Outcome 1: Engineering graduate student E. Cousins is the poster child for Space Grant at Dartmouth College. She started as a WISP (Women in Science Project) intern funded by Space Grant, completed her undergraduate degree and commenced a Master's degree in the space physics area. She switched to the Ph.D. program, also doing research in space physics. She published 4 first author papers while being supported by Space Grant and another as a co-author that stemmed from a one-term visit to Virginia Tech. She presented her research several times at the plasma seminar and was a regular attendee of professional meetings and workshops including: AGU (American Geophysical Union), CEDAR (Coupling, Energetics, and Dynamics of Atmospheric Regions), the SuperDARN Workshop and GEM (Geospace Environment Modeling). She was also active in the Thayer School where she was a teaching assistant for undergraduate courses. She was instrumental in the construction of the multi-radar facilities in Hays, Kansas and Christmas Valley, Oregon. She completed her dissertation on the topic of investigations of ionospheric variability using SuperDARN radars, and she has since taken a competitive post-doctoral position at HAO/NCAR (Boulder, Colorado) working with Art Richmond and Tomoko Matsuo. In her own words:

"The Space Grant program allowed me to participate in a space-related research assistantship that I was interested in. This experience has reinforced my interest is space related research, and has contributed to my decision to pursue a MS in a space-related field."

PROGRAM ACCOMPLISHMENTS

Outcome 1: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.*

Achieved Metrics for Outcome 1 SMART Objectives

- The consortium awarded 8.3% (10.3% of significant awards) in fellowships and scholarships to under-represented minorities, exceeding our minimum goal of 5.4% (based on National Center for Education Statistics (NCES) tables at the time of the proposal) as well as the most recent NCES entry of 7.6% for New Hampshire.
- The consortium awarded 39.6% in fellowships and scholarships to women, meeting the NASA goal of 40%. Long-term initiatives (e.g. WIST Forum, Outcome 2) were started with the objective of increasing female participation.
- 16 graduate fellowships were provided through UNH, Dartmouth College, and PSU.
- 33 undergraduate scholarships were provided through UNH, CCSNH, and PSU.
- Travel and research support was provided to 19 students.
- 31 internships were supported in NASA related STEM disciplines, including informal education.
- 10 plasma science seminars were supported, reaching 30 participants each.

- Expanded access to, and use of, remote imagery in New Hampshire through three new data sets made available through a web image service.
- Expanded access and use of remote imagery through three workshops: ArcGIS Drivers Permit, GIS on Pennies a Day: Test Drive, and Introduction to ArcGIS. Delivery of a 1-day workshop called "What's in a Pixel", serving 10 participants, is pending for this spring.
- Provided longitudinal tracking of significant awards using the NSGF Tracking System.

Using Space Grant funds, we support student education and research in fields related to space physics, astronomy, remote sensing, aerospace engineering, mechanical engineering, Earth science, meteorology, technology, and other areas related to NASA interests. Dartmouth College, the University of New Hampshire (UNH), Plymouth State University (PSU), and the Community College System of New Hampshire (CCSNH) offer graduate fellowships and undergraduate scholarships. Dartmouth, UNH, PSU, and the McAuliffe-Shepard Discovery Center (MSDC) offer internships. At the graduate level, the objective is to attract a high-quality, diverse graduate student body in these fields. At the undergraduate level, the objective is to attract and retain students in these fields and to enhance their education by providing opportunities for them to supplement their standard classroom education by participating in authentic, cutting-edge research. Such activities include internships and conference travel.

1.1 Workforce Development -- Graduate Student Fellowships

UNH. The University of New Hampshire (UNH) awarded three new Space Grant fellowships to students in Natural Resources and Physics, and continued two more fellowships. Fellow S. Coster is pursuing a Ph.D. in Natural Resources and Earth Systems Science (NRESS). She uses DNA and genetic markers from frogs and salamanders in combination with remote sensing data to answer ecological questions regarding the influence of landscape features (such as roads, forestry, lakes, development, slope and fragmentation) on population connectivity. Fellow J. Williams, a Master's student in Natural Resources, is studying stress indicators following hemlock woolly adelgid (*Adelges tsugae*) infestation on eastern hemlock (*Tsuga canadensis*). Combining indicators of healthy versus infested hemlocks with Landsat satellite data he is determining geographic areas affected by the woolly adelgid. Fellow C. Ertley, a Ph.D. student in Physics, is analyzing data from **NASA's balloon-based Gamma-RAy Polarimetry Experiment** (GRAPE) to learn more about energy release in solar flares, one of the principle goals outlined in NASA's Strategic Plan. A. Underwood's continuing fellowship enabled her to complete the bulk of her remaining graduate classes. She started her research on autonomous surface navigation on extraterrestrial surfaces using observer-based control (based on the **NASA Celestial Navigation,** CelNav, project). During this year, she also served as the graduate advisor for the UNH Lunabotics Team and the **NASA Magnetospheric MultiScale** (MMS) TableSat IB Team. As an outreach activity, she volunteered for the Noble Middle School 8th Grade Career Day.

PSU. One graduate fellowship was awarded in the Plymouth State University (PSU) Applied Meteorology Program. She started the Program in the fall of 2012. She had been an undergraduate student at PSU and as an undergraduate had received scholarship support and performed a NASA summer internship at the **NASA Kennedy Space Center** (KSC)/Cape Canaveral Air Force Station (CCAFS) during the summer of 2010. For her graduate research, she will be working once again at KSC over the summer on a project to test and validate a low cost lightning detector being developed by a New Hampshire Company.

Dartmouth College. Space Grant Fellowships supported 4 students in the Physics Department, 2 in the Thayer School of Engineering, and 4 in the Department of Earth Sciences at Dartmouth College. Physics graduate student M. Mella completed her dissertation on the topic of electron and ion measurements in the aurora, resulting in multiple publications in the *Journal of Geophysical Research* and presentations at American Geophysical Union (AGU) meetings. She has since taken a competitive post-doctoral position at the Swedish Institute for Space Physics in Uppsala, Sweden, for further training for a career in space physics.

Dartmouth Physics graduate student I. Ginsburg, supported by Space Grant, garnered a lot of attention with his work on hyper-velocity stars in the galactic center, which was cause for a press release picked up by over 80 news channels and featured in *Time* and *National Geographic*. Ginsburg also won the Neukom Prize, a campus-wide award for outstanding work by a graduate student.

Space Grant sponsors two awards given annually at Dartmouth College to selected graduate students in the space science, engineering or remote sensing fields, from among candidates nominated by faculty members. One award goes to a Ph.D. student and the other to a Master's degree candidate. The goal is to recognize excellent students, thereby encouraging excellence among our students and giving the best students an award to list on their curriculum vitae. The award has become quite competitive with many nominations in a typical year. The 2012 award was the most difficult decision ever, as four highly qualified students were nominated, two from Physics, one from Earth Sciences, and one from Engineering. The Ph.D. award went to Engineering graduate student E. Cousins, a Space Grant Fellow whose outstanding achievements are described above in the "Highlights".

1.2 Workforce Development -- Undergraduate Scholarships

CCSNH. The Community Colleges of New Hampshire Foundation continued its popular Space Grant Scholarships program. The goal of the program is to encourage careers in STEM disciplines, including graduates with degrees of interest to NASA. The scholarship program strives to attract underrepresented and minority students. Public Service Company of New Hampshire (PSNH) has supported the Community College System as the business partner match in this scholarship program for the past 12 years, enabling nearly 400 scholarships to be awarded. In FY 2013 the Foundation received 33 applications and made 25 x $1,500 awards to 25 students.

UNH. During this past year, R. Lawrence (an undergraduate at a Minority Serving Institution) has worked on his senior research project under the direction of UNH Earth Science Professor R. Varner. His poster on "Light Effects on Chamber Measurements of Methane and Carbon Dioxide Fluxes and their Isotopologues in a sub-Arctic Mire" was presented at the Fall 2012 American Geophysical Union Meeting, under support by Space Grant. His senior project is an outgrowth of a REU project conducted at UNH and the Abisko Scientific Research Station (Sweden) under the mentorship of Dr. R. Varner (UNH) in the summer of 2012.

PSU. During the past grant year, PSU funded six undergraduate scholarships to students majoring in meteorology. The one senior will be graduating in June with one of the highest Grade Point Averages (GPAs) ever earned by any PSU meteorology major and has already received acceptances and graduate assistantship offers from several graduate programs around the country. The one junior recipient was selected for a NOAA Hollings Scholarship and will be doing a summer 2013 internship in Alaska. The other undergraduates are all completing their sophomore years and continuing to maintain sterling GPAs and remain highly motivated in their STEM discipline.

1.3 Workforce Development – Higher Education Hands-on Experience

Internships. Internships provide hands-on activities that engage and sustain students in NASA-related STEM fields. These internships take place both within New Hampshire institutions of higher learning and at NASA Centers. Internships are carried out and completed under the supervision of sponsoring researchers. With summer internships at a NASA center, we also enhance connections and collaborations between New Hampshire research institutions of higher learning and the NASA centers. In the cases of many of the undergraduate interns the culminating experience is completing a poster to display at the Wetterhahn Science Symposium (Dartmouth, May of each year), the Undergraduate Research Conference (UNH, April of each year), or at a professional conference.

As recently reported and exemplified by Space Grant-supported intern L. Santini (UNH, 2006):

> *"The experience was life altering. The mentors I had while at [Marshall Space Flight Center] MSFC/NSSTC were excellent models of supportive mentors, and wonderful people. The opportunity they afforded me, by taking me on, changed my life and gave me a chance at a career. "*

UNH. UNH undergraduate students J. Chabot, M. Johnson, and J. Kelley are taking part in a team internship providing hand-on experience with the development, construction, and testing of TableSat IC, a tabletop test bed (TableSat) for the **NASA Magnetospheric MultiScale** (MMS) Mission. The prototype has limited 3 degrees of freedom (full spin and limited nutation). They are also continuing to develop an attitude control system for the prototype and to investigate the resulting dynamics of the spacecraft booms and its effects on the MMS spacecraft bus. They have authored and presented a paper on their

research at the AIAA/AAS Space Flight Mechanics Symposium in Hawaii this past February. It is expected that they will also have enough material to submit a paper for admission to the 2013 AAS Astrodynamics Specialist Conference in August 2013.

B. Cannon is a Physics undergraduate at UNH who is now completing his senior year and applying for graduate schools. He has worked for three years on the problem of "Why are magnetic waves due to interstellar pickup ions so rare?" By combining kinetic theory of wave growth rates with turbulence concepts leading to the destruction of the waves he has been able to show that under "typical" conditions the turbulence is too strong to permit the wave amplitude to reach observable levels. Cannon went to **NASA's Jet Propulsion Laboratory** (JPL) last summer as a Space Grant NASA intern to work with JPL scientist Dr. Neil Murphy who has developed a data base of 502 pickup ion wave observations. The student refined the numbers and built a similar set of control observations. Two preliminary papers exist in conference form while two more journal articles are in their final stages of development. Cannon is writing his senior thesis at UNH on the subject.

UNH Mechanical Engineering student K. Donohue, having just finished her freshman year, did a summer 2012 research internship on the **NASA Celestial Navigation** (CelNav) project (for extraterrestrial surface navigation). She outfitted a UNH LunaCats lunabot with an indoor sensor that mimics star sensor output (attitude). She also designed a smaller version of the outfitted servo system to be used for a remotely controlled XBee tankbot.

C. Huston, UNH Mechanical Engineering senior was supported by Space Grant to attend the June 2012 RockOn Workshop at **NASA Wallops**. He also received support to attend the NASA Advanced Rocketry Workshop (developed in partnership with the Alabama Space Grant Consortium) in Huntsville, Alabama in July 2012. These activities have helped prepare Huston to lead the UNH team participating this year for the NASA University Student Launch Initiative (USLI) competition.

M. Carlson is an Environmental Science Ph.D. candidate at UNH who interns with the Forest Watch program, discussed under Outcome 2.

Two infrastructure undergraduate interns (J. Logemann and W. Winslow) and a staff member support the development of web-based interfaces for the UNH Earth Systems Research Center GIS Laboratory. These interfaces are for storing, displaying, and distributing varying types and sizes of geospatial data, including vector data and raster-based remote-sensing imagery.

MSDC. A. Ricciardi, a Game Design and Development student at Southern New Hampshire University (SNHU) who had just completed his sophomore year, created an interactive online game focused on Martian geology for the McAuliffe-Shepard Discovery Center (MSDC) website, and a quiz on MSDC exhibit content in the form of a phone app. He was able to receive college credit at SNHU for his work, in addition to

being a paid MSDC intern. Ricciradi is in his junior year and is continuing his STEM studies at SNHU. He plans to go into the computer gaming field.

PSU. Space Grant supported two summer internships at the **NASA Kennedy Space Flight Center** (KSC/CCAFS) for a PSU graduate student and a PSU undergraduate student with a PSU faculty mentor. The graduate student's research was to explore the use of dual polarization radar for convective wind forecasts and other parameters for the Florida Space Coast area and the undergraduate student added onto and refined the KSC/CCAFS convective wind climatology, which was started back in 2005 and has continued as more data are gathered. One of the students, C. Scholten, is now in the final stages of completing his M.S. thesis and will be graduating in May. The information, generated by both students, is being used for training of forecasters that support the KSC/CCAFS range operations.

Dartmouth College. Space Grant supported several undergraduate internships at Dartmouth College, including 6 in the Physics Department, 11 in the Women in Science Project (WISP), 3 in Engineering, and 1 in Earth Sciences. These internships cover a variety of opportunities, as indicated in the examples below.

Space Grant awarded full support (stipend plus travel) to Dartmouth undergraduate S. Pasternak, who spent the fall of 2012 at **NASA Johnson Space Flight Center** in Houston, Texas. She was assigned to the team working on Active Response Gravity Offload System (ARGOS), which involves simulating reduced gravity environments such as lunar gravity or microgravity. Sarah gained experience designing, manufacturing, and assembling components. She made some real contributions in the design area, and she also got to move around in simulated Lunar and Martian gravity. "I've practically moonwalked," writes Sarah.

N. Utterback (Dartmouth class of 2014), with Space Grant support, built software controlling an experiment to measure radio emission from aurora. This enabled him, with alternative support, to take a field trip to Sondrestrom, Greenland, to assist in deploying the experiment.

Two Dartmouth undergraduate interns in the Thayer School of Engineering, E. Skarin and S. Brookes, are helping to fabricate components of the radars planned for installation in the Azores this Spring and Summer. At least one of them will get the opportunity to travel to the radar site in the Azores to help with the construction.

Dartmouth Woman in Science Project (WISP) intern L. Jing analyzed 18 years of radio data from Churchill, Manitoba, discovering a slight trend towards increased thunderstorms in spring and fall seasons, presented at the Wetterhahn Symposium at Dartmouth College.

1.4 Workforce Development -- Higher Education Support for Seminars, Conferences, Research Supplies

Travel and Research Support. Dartmouth double engineering and physics major W. Dunlap-Shohl completed a senior honors thesis in June 2012 on "Modeling Proton Precipitation in the LFM Global MHD Simulation". He continued work on the project after graduation while also completing work on his capstone engineering design project. With travel support from Space Grant, he presented a poster on his senior thesis results at the 2012 Fall AGU Meeting in San Francisco in December. A publication is in progress.

Dartmouth Physics major M. Chilcote completed a senior thesis in June 2012 on "Numerical and Experimental Investigations of Ionospheric Sounding Using AM Radio." This project entailed setting up antennas in Massachusetts, New York, and New Hampshire to triangulate the location and motion of traveling ionospheric disturbances; a publication with the student as first author is in progress.

Dartmouth WISP interns receive support to participate in the Wetterhahn Symposium.

Two PSU KSC intern students received support to present poster papers at the 12th Student Conference of the American Meteorological Society (AMS) Annual Meeting, which was held in January 2013 in Austin, Texas.

Nine UNH LunaCats students received travel support for the NASA Annual Lunabotics Mining Competition at **Kennedy Space Center** in 2012. Three other undergraduates and two graduate students also received support related to their research.

Plasma Seminar. Plasma seminars contribute to both higher education and research infrastructure by providing a regular forum for discussing ideas and inviting outside researchers to discuss ideas. With associated faculty, post-docs, students, and staff, there are 30-40 scientists and engineers in the space science discipline at Dartmouth. The plasma seminar is the most important weekly event that brings together this scientific community. It plays a critical role educating students, initiating new collaborations and enhancing existing ones, and disseminating the newest knowledge in the field. There are 30 seminars per year, with varied topical speakers. This past year, the Space Grant-sponsored seminars included guest speakers from St. Michael's College, Boston University, Johns Hopkins University, the MIT Haystack Observatory, UNH, Stanford University, the University of Newcastle, the Bartol Research Institute, and the University of Maryland.

1.5 Higher Education Faculty Curriculum Support

Revised Course. Space Grant matching funds supported the revised course "Introduction to Space Plasma Physics", UNH course PHYS 712 (seniors) and PHYS 812 (early-year graduate students) taught by Professors A. Galvin and C. Farrugia in the Physics Department during the fall semester of 2012. Eleven students completed the four-credit course. Course topics included the magnetosphere, ionosphere, heliosphere, and solar physics.

eDesign. Online courses are becoming increasingly popular as they enable students to have greater access to education and training, while learning at their own pace and at times that are convenient for them regardless of geography, weather, family, and work demands. Online learning also reinforces a high level of interactivity since all students must participate in discussions and all of the assignments. However, designing high quality online learning communities is critical to student success and retention. In order to keep pace with and improve the quality of 100% online science courses, the Community College System's Department of Distance Education developed *eDesign*. eDesign is a course quality assurance rubric with a fully populated accompanying online instructional design resource center for faculty. The eDesign resource center provides access to a variety of tutorials, videos, documents and research to enhance an instructor's knowledge, skills, and attitudes towards teaching online, as well as a framework for reviewing the quality of online course design. NASA Space Grant funding was used for eDesign software and a consultant who specializes in the program, reviewed courses with the rubric, and instructed in the resource center. The consultant worked directly with Community College science, math, and technology faculty to improve the quality of their 100% online courses.

1.6 Higher Education Faculty Professional Development

Visiting Young Scientist. Space physics, remote sensing and related disciplines can be effectively combined with teaching in small college settings for general training of students and for attracting students into areas of national need. Because these disciplines fall in between or outside of mainstream departments defined at most small colleges, scholars in these areas are often disadvantaged when applying for positions. Teaching experience can make a big difference in making these scholars attractive to small college faculties. Dartmouth College initiated the Visiting Young Scientist program specifically to offer an opportunity for scholars within five years of having received their Ph.D. to obtain teaching experience. As a secondary objective, the visiting scholar benefits Dartmouth faculty and students directly by collaboration in research as well as teaching. In 2012, with five applications, the fellowship went to A. Halford, a U.S. citizen who did her Ph.D. in space physics at the University of Newcastle in Australia. Halford was in residence starting Aug 1, 2012. She co-taught the plasma physics course, developing a library of new examples involving space physics. She also has organized the Plasma seminar one term. On the research side, she contributed to the success of the recent first phase of the BARREL mission in which twenty balloons were launched from two Antarctic sites. Halford helped develop and operate the ground station at Dartmouth for tracking the balloons. She attended the 2012 Fall American Geophysical Union meeting, several radiation belt workshops, and participated in outreach activities. Halford's fellowship is being extended with other research grant funds. She shows great promise to be a long-term contributor to space physics and is a perfect fit to the VYS.

Last year's VYS, J. Ouellette, accepted a tenure-track faculty position as Assistant Professor at Vermont Technical College where he is teaching and developing courses on computer security and systems analysis and computational physics, supervising sophomore-level engineering projects and advising students on career planning. His

appointment as a Dartmouth VYS and the course on space systems engineering he co-developed and co-taught at Dartmouth in 2012 made him an especially attractive candidate for this new position.

1.7 Research Infrastructure

Image Data Sets. A number of new image data sets have been incorporated in a web-based mapping and data visualization tool at UNH GRANIT (http://granitview.unh.edu). These include National Agriculture Image Program (NAIP) imagery (2003-2011), high-resolution true color and color infrared orthoimagery (2005-06 and 2010-11), and coastal LiDAR. All data sets are linked to appropriate metadata records, providing information necessary to appropriately access and use the data. Web Mapping Services (WMS's) for each of the above data sets, as well as some topographic derivatives from the LiDAR, have been developed and are now being hosted on the GRANIT servers (http://www.granit.unh.edu/data/onlinemapservices/mapservicesoverview.html). UNH GRANIT is supported by the UNH Cooperative Extension, which assists GRANIT in expanding its user base by developing user "help" materials. Specific topics for help videos have been determined through feedback from current users of the site as well as the GRANITView support staff. Help videos to be developed in the next several months include: basic layer management, how to print maps, the use of the drawing/measurement tool, and an explanation of the variety of base maps and imagery available for use for map backgrounds.

GIS Training and Workshops. Existing and newly created NH GRANIT imagery web services were incorporated into GIS training materials, effectively promoting the use of imagery to a wide range of GIS users in NH. Specifically, the 2010-2011 statewide high resolution aerial photography (both true color and color infrared), the 2011 NAIP imagery, the USGS quadrangle scans, and the Coastal LiDAR dataset have been introduced into training materials. UNH Cooperative Extension workshops that teach participants to use these imagery web services include: ArcGIS Drivers Permit, GIS on Pennies a Day: Test Drive, and Introduction to ArcGIS. Plans are underway to hold a "What's in a Pixel" event in late May/early June in seacoast NH (likely at UNH). While data/products will not be directly distributed at the workshop, participants will be directed to resources (local and otherwise) where the products are available. Types of data to be referenced will include **Landsat**, **NASA MODIS**, and **NASA Earth Observatory Hyperion**. The workshop will likely involve presenters from a number of institutions and organizations, including UNH, Dartmouth, several NH towns/cities, NHView, eXtension (the Extension geospatial technologies community), and regional planning commissions.

1.8 Longitudinal Tracking

The National Space Grant Foundation Tracking System is used to longitudinally track our NHSGC students receiving significant awards. The percentages of students who have been successfully tracked to their "next step" are: 58% for 2006; 91% for 2007; 87% for

2008; 93% for 2009; 100% for 2010; and 100% for 2011. For the compiled 2006-2011 student tables, 82% of the students have been successfully tracked to their next step.

Of those students receiving significant support, 86% have gone into a "next step" within a STEM discipline.

Outcome 2: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.*

Achieved Metrics for Outcome 2 SMART Objectives

- Supported two Earth Science/Engineering Design teacher workshops in the summer of 2012. Eleven teachers attended the first workshop (learning science through engineering design principles) and six teachers attended the second workshop (land cover).
- Supported Forest Watch/Maple Watch in holding 1 3-day teacher workshop and 2 1-day workshops, one student conference, and the training of 12 new teachers for the studies of white pine and tropospheric ozone.
- The Forest Watch 21-year archiving effort was not completed. A major website update and redesign did take place, which includes public access to the 2010-2011 data (http://www.forestwatch.sr.unh.edu/).
- Provided MWO in-school and distance learning programs reaching 3500 participants.
- WMCC's STEM Summer Camp 2012 was attended by 19 middle school students.
- Six Dartmouth College students engaged in K-12 and public outreach activities (also germane to Outcome 3). A new series of "science cafés" were held at a junior/senior high school.
- Supported one NH high school participating in the FIRST Robotics competitions (only one high school applied for support).
- Ten high school students and a community college instructor were supported for the "Biology 1" eStart online course for high school students, provided through CCSNH.
- The Rey Center delivered about 60 supplemental science programs in NH schools, serving an average of 10 or more students per program.
- Rey Center staff led 19 after school and summer programs in 2012-2013, engaging more than 350 school children in hand-on STEM educational experiences.

2.1 Pipeline Activities -- K-12 Teacher Development and STEM Curriculum Enhancement

Earth Science/Engineering Design Workshops. In the initiative "Science Teacher Training North Country", Space Grant supported Education and Science faculty and graduate students from the University of New Hampshire in a partnership with personnel from New Hampshire's North Country Educational Services to create teacher professional development workshops for upper elementary school and middle school science teachers in rural northern New Hampshire. The two-day workshops for the Science Teacher Training North Country initiative were team-taught by scientists and

teacher educators to insure an integrated approach to how to successfully teach science to under-served public school students. Northern New Hampshire is an area of high need as it is a rural, impoverished area of New Hampshire. Many of the middle school science teachers do not have a certification in science and they have stated a strong desire for professional development in the area of science content. Two workshops took place in the summer of 2012, one focused on engineering design principles and the other on land cover/use. Taught by a research professor in Astrophysics from UNH, the new engineering design workshop examined engineering principles to teach science concepts through an engineering design challenge. The eleven teachers developed a method to send data from one remote location to another without a physical connection. They also learned more about the **NASA Lunar Reconnaissance Orbiter** (LRO) mission and the rationale for studying the effects of cosmic rays on the Earth. In order to support the transfer of successful science teaching in the classroom, teachers learned from a science educator and an educational psychologist (from the UNH Department of Education faculty) how to use instructional techniques featured in the workshop to motivate early adolescents for science learning. The land cover/use workshop was taught with the help of a doctoral student in the Natural Resources and Earth Systems Science Ph.D. program. The workshop focused on how to monitor the landscape for signs of change through inquiry including both field-based techniques and the use of satellite images. This workshop had been offered last year and was fine-tuned based on last year's evaluations. The land cover materials were couched in a real-world example of school expansion. The six teachers were divided into two school board committees whose job was to use the data collected around the North Country Education Services building to propose how to use the grounds to support student learning, recreation and athletics. Four of the teachers had taken the learning science through engineering design principles workshop held earlier in the summer. As a follow-up to gauge the effectiveness of the workshops, an online survey was sent to the teacher participants. In both workshops, a great majority of the teachers would be extremely or very likely to recommend the workshop to other teachers (Landcover Workshop 83.8%; Engineering Design Principles—88.8%). The majority of the teachers also thought the materials were presented extremely or very clearly (Landcover--83.3%; Engineering Design Principles—100%). Sixty to sixty-five percent of the teachers from both workshops reported that they were extremely or very likely to use what they had learned in their classrooms. In addition, the astrophysicist has submitted the engineering design challenge created this summer to be included on NASA's website for educators. It is currently under review.

Forest Watch – Engaging Teachers and Students in Basic Research. Forest Watch conducts basic and applied research on forest systems in New England, with data collected by K-12 teachers and students within the region. Research for the past 22 years has focused on the impacts of tropospheric ozone on white pines, *Pinus strobus*, a keystone species in the New England forest and a tree that grows in almost every schoolyard. The educational objective of Forest Watch is to build K-12 students' interest in and aptitude for science, technology, and math by engaging them in authentic science using 21st century technology. The program has regularly been evaluated by the participating K-12 teachers as well as educational consultants. Space Grant supports teacher workshops and student conferences for this program and it funds a graduate

student intern who manages laboratory analysis of samples and data and outreach to teachers. During the past year, 14 schools submitted samples and data to Forest Watch. These included schools in Maine, New Hampshire, Vermont, Massachusetts and Connecticut. Forest Watch trained 12 new teachers in its protocols. Eighty students visited UNH for a student convention in May 2012. Six teachers pioneered a new workshop called Teacher Enrichment Day last June 2012, visiting laboratories in the Institute for the Study of Earth, Oceans and Space to meet researchers and learn about new advances in science. A 3-day Forest Watch teacher workshop was held at UNH August 8-10, 2012. The most recent workshop was held at UNH on February 18th of this year (2013). The Forest Watch program was presented to members of the New Hampshire Science Teachers Association at both spring and fall conferences. We estimate that Forest Watch has reached approximately 80 teachers in the past year, each teaching 20 to as many as 120 students.

Weather Workshops for K-12 Teachers. Through workshops and program demonstrations offered in person and via distance learning capabilities the education staff of Mount Washington Observatory (MWO) provided informative programming for middle school teachers to help create exciting and interactive ways to teach weather in the classroom. Each winter MWO conducts a 2-day workshop specifically for teachers. During this workshop teachers spend an overnight at the Mount Washington Observatory while immersed in sessions focusing on bringing STEM activities into the classroom. Nine participants (maximum space was nine) took part in this year's two-day teacher workshop. Educators of the New Hampshire Teachers Association and MWO led the workshop. The two days were filled with lecture sessions and hands on activities to help support curriculum and enhance the students' learning experience. During the spring of 2013 MWO will offer another three one-hour workshops for NH teachers (K-12) focusing on program development in STEM education. An evaluation form is designed for our 2-day workshops offered at the summit of Mount Washington. The information received has been critical in the design of the programs we offer. Although evaluations are primarily positive it is helpful to receive feedback, which includes thoughts of additional programming possibly offered by MWO staff.

Rey Center STEM Curriculum Enhancement and Support. The objective of the Rey Center's science curriculum enhancement programs is to augment and improve the life science, Earth/space science, chemistry/physical science and inquiry components in science education in New Hampshire's K-12 schools. The Rey Center science programs are developed in collaboration with teachers and meet New Hampshire Frameworks for Science Literacy Standards, and are aligned to the New Hampshire SAU 48 science curriculum. The Rey Center staff is directly involved in the implementation of in-classroom supplemental science curriculums, engaging teachers both pre- and post-implementation. Use of Space Grant supported materials is confirmed through discussion with Rey Center staff and direct observation by Rey Center staff. The Rey Center delivered approximately 60 supplemental science programs to Waterville Valley Elementary School's K-8 students between June 2012 and (planned) June 2013, equivalent to 600 contact hours with its 40 students. 22 of these programs were specifically targeted toward middle school students (grades 6-8). Additionally, the Rey

Center provided weekly science curriculum support to two students requiring supplemental science content to stay on track with their peers, equivalent to 144 contact hours over 36 sessions.

Participating as Lecturers at Workshops. In June 2012, Dartmouth graduate student I. Ginsburg participated in a teacher-training event held at our MSDC affiliate. There were between 20-25 people at the talk, where Ginsburg gave a brief overview of galaxies, black holes, super-massive black holes, and finally culminated with hypervelocity stars. He also spoke about his recent work on hypervelocity planets. The talk went very well; the audience was attentive and asked lots of questions.

2.2 Pipeline Activities -- K-12 Student Hands-on STEM Learning Activities

Rey Center After School Education and Outreach. The objective of the Rey Center's After School Education and Outreach program is to bring STEM-related educational experiences to K-8 students participating in after-school programs and summer camps. The program goal is to hook kids on science. Programs are hands-on and participatory, emphasizing fun but rooted in science. Students explored the nature of plants, insects, animals, weather, and more. In 2012-2013, the Rey Center delivered 16 After School programs to regional schools engaging approximately 190 students. Hands-on science programs are also delivered to K-8 students through Rey Center summer programs. In 2012-13, three programs were delivered to 173 participants.

White Mountains Community College STEM Summer Camp. Middle school students (grades 6-8) mixed science and fun at a Science, Technology, Engineering, and Mathematics camp last June at White Mountains Community College. STEM camp provided hands-on, fun-filled activities meant to be introductory, interactive, and project-based. In 2012 the camp hosted 19 students, including 7 females.

On-site and Distance Learning Programs - Weather. Mount Washington Observatory (MWO) has served over 3500 students and teachers through educational outreach and workshops via distance learning capabilities and in person presentations, which are offered in the classroom or at the Weather Discovery Center (Mount Washington Observatory's interactive science center located in North Conway, NH). Through our Distance Learning program we have the opportunity to bring students, virtually, to the MWO weather room located at the summit of Mount Washington. Students see first-hand the current weather conditions at the highest peak in the Northeast as educators dive into one of many topics that focus on: weather observations, fundamentals of climate, alpine environment, or technology used to record weather at higher elevations. Educational Outreach programs give MWO educators the opportunity to deliver content in person, whether at a school or at the Weather Discovery Center. The outreach programs include images and video clips to provide visual aides to support program content. This program also includes hand-on demonstrations that allow students to better understand complex concepts such as air pressure. For each program presented to students, their teacher receive an evaluation form. In-classroom and distance learning programs include pre and post on-the-spot assessment questions for the students. These forms are used to provide Mount Washington Observatory educators with the necessary feedback to help

understand if the program met the expectation of the students and teacher. As two 2nd grade students remarked on the Distance Learning experience:

> *"Thank you for teaching us more about weather. It was cool when Mr. Brian showed us the picture of the guy who had a lot of clothes on. It was also cool when he showed us all the gadgets that you use to measure weather. Sincerely, Matthew"*

> *"Thank you for teaching us new science words. I never knew that there were so many different science words. Some day I want to be a meteorologist! Sincerely, Lucas"*

Science Workshops for Age 16 and Over. MWO offers two-day and one-day educational programs for ages 16 and up presented at the summit of Mount Washington. One-day workshops are also offered at the Weather Discovery Center, Mount Washington Observatory's interactive museum located in North Conway, NH. Our Winter Day Trip program is designed for participants to experience Mount Washington in the winter. MWO educators provide a guide-tour as the group ascends the Mt. Washington Auto Road via a snow cat. The group is intended to visit the Observatory at the summit of Mount Washington to learn more about how the meteorologists work at this scientific institution. Although not all trips make it to the summit due to the conditions of the weather, the educators provide brief talks as the snow cat makes multiple stops on the road. Participants of the trip can see first hand the different environmental zones that exist on Mount Washington. The number of participants in the one-day program was 150; in the two-day program, the number of participants was 100.

First Robotics. Oyster River High School First Robotics Team, in Durham, NH, was supported through Space Grant. Working in concert with mentors in technical fields, including a staff scientist from UNH, the team developed a variety of skills, including: mechanical design, materials procurement, construction and testing of drive trains and mechanisms needed to accomplish the competition task, electrical wiring, programming of the robot's function, development of a system for controlling the robot, troubleshooting systems under the time pressure of the competition, and teamwork and collaborative skills. ORHS students on FRC Team #3499 *themselves* also work to mentor younger students. Through a NASA Summer of Innovation grant they were able to supply all the materials needed to start a *FIRST* LEGO League team – serving middle school students – at the Newmarket Jr/Sr High School.

Project SMART. Project SMART is a Summer Institute at the University of New Hampshire (UNH) that challenges, educates, and motivates talented high school students in science and mathematics while acquainting them with the environment and resources of the University as a place for higher education and research. UNH Project SMART brings high school students to the UNH Durham campus and has, for the past 5 years, included the launch of a high-altitude balloon payload carrying a scientific package for cosmic ray studies and a video camera. This spring Space Grant is supporting up to 3 launches to photograph the aurora and fly Geiger counters. We have developed a new

strategy for onboard data collection and commanding that we first flew last summer and continue to refine. This should permit us to adopt a "plug and play" approach to new experiments in the future.

e-Start. Since 2008, the Community College System of New Hampshire has partnered with the Virtual Learning Academy Charter School (VLACS) to offer "e-Start" courses in which students earn dual high school and college credits. VLACS is New Hampshire's first statewide, on-line high school. e-Start courses are taught by credentialed instructors. The goal is to use the latest Internet technologies to provide students with anytime, anywhere access to a rigorous, personalized education. On-line learning is one of the fastest growing segments of the Community College curriculum. e-Start courses are geared toward engaging high school learners through a discounted rate, transferable credits, and flexibility. The NASA Space Grant supports a STEM e-Start course, Biology 1. The course provides an introduction to the basic principles of biology, including the structure of cells, cellular respiration and biochemistry, physiological processes, genetics, and heredity. This is a fast-paced course in which students are expected to spend a minimum of 10 hours a week on reading and on course assignments. The course was taught the Fall 2012 semester through the Great Bay Community College. Ten students and an instructor were supported.

2.3 Pipeline Activities - STEM Recruitment in Middle and High School

WIST Forum. Space Grant supported FIRST Place in their bi-annual Women in Science and Technology (WIST) Forum, which took place November 2, 2012 in Manchester, NH. The WIST Forums provide middle/high school women with a unique opportunity to meet, listen to, and talk with professional women who have successful careers in science, engineering and technology. The NHSGC director served as a panelist at the event. There were 260 high school girls, plus their coaches and teachers in attendance for the full day event. A similar event is planned for April 2013, hosted by the White Mountains Community College in rural, northern New Hampshire.

Girls Technology Day. NHTI - Concord's Community College, hosted their first annual Girls Technology Day on March 14, 2013. More than 175 girls signed up for this event, focused on grades 8-10. After a key-note address the students attended hand-on workshop sessions including: 3D modeling, Building Mobile Apps with HTML, CSS and jQuery, Careers in Technology Round Table, Cisco VoIP demo / class, Cyber-Security, Game Programming with Greenfoot, Inventing Apps for Android Phones, Kodu Game Lab, Making Ethernet Cables 101, and VEX Robotics.

Dartmouth Student Outreach. The objective of Dartmouth Outreach is to benefit the broader community by sponsoring Dartmouth students to participate in outreach events, instilling in them the value of communicating space science to the public. Four graduate students, one undergraduate, and one postdoctoral scholar took part in outreach events aimed at both K-12 students (Outcome 2) and the general public (Outcome 3). An event of special note was a series of "science cafés" held at a junior/senior high school. Graduate students J. Skinner and S. Cohen led discussion with students on the topics of

exoplanets and black holes. Students were engaged, asking great questions, and interested in attending more cafes. A third café is planned to discuss the Big Bang.

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.*

Achieved Metrics for Outcome 3 SMART Objectives

- Supported a two-day Aerospace festival (MSDC) reaching more than 665 members of the general public, and an Astronomy festival (UNH) reaching more than 330 members of the general public.
- Evaluation of MSDC exhibits and activities is slated for April-May 2013 (pending).
- Two informal educators attended the Conference of the Association of Science-Technology Centers; two educators visited the NASA Glenn and Great Lakes Science Center; one educator met with education staff at the Air Force Museum in Dayton, OH; and one educator participated in the New England Museums Association Annual Meeting and Conference in Burlington, VT.
- Hands-on citizen science programs in rural New Hampshire were provided to 1,566 participants.

3.1 Priming the Pump -- Engaging the General Public

Aerospace Festival MSDC. MSDC held Aerospacefest, a two-day Aerospace festival, in which 665 people (consisting primarily of families with preschool, elementary and middle school aged children) participated in a wide variety of STEM activities. MSDC was joined in this event by NHSGC lead institution UNH (MMS TableSat activity) and affiliates Plymouth State University (weather balloon launches and tracking), the Margaret and H.A. Rey Center (kite- and parachute-making), BAE Systems of North America (engineering activity), and the Community College System of NH (use of NHTI quad for activities and landing of Blackhawk and commercial helicopters and NHTI fields for radio-controlled helicopters and rocket launches). Other participating groups/high-tech companies/institutions included Raytheon, iGlobe, Squam Lakes Natural Science Center, New England Air Museum, NH Aviation and Space Education Council, Fliskits Model Rockets, Mars Foundation, Mad Science, NH Astronomical Society and many more. Keynote speaker was NASA Astronaut (retired), Richard Searfoss, who presented awards to the 2012 winners of MSDC's annual high school Astronomy Bowl and Space Camp Scholarship competitions. This festival engaged 124 science organizations, aerospace companies and individuals in STEM fields, and engaged families and youth in active STEM learning opportunities.

Astronomy Festival UNH. Space Grant teamed up with the UNH Department of Physics and the NH Astronomical Society to host the second annual New England Fall Astronomy Festival (NEFAF), a two-day event held at the UNH Observatory September 21-22, 2012. There was participation by affiliates UNH, the Rey Center, MSDC, MWO, PSU, and sponsorship by affiliates BAE and UNH. This year's keynote speaker was Alex Filippenko from UC Berkeley, on the topic "Dark Energy and the Runaway Universe".

There were also telescope observing, hands-on activities for all ages, weather balloon launches, and several speakers. Over 330 members of the general public attended the event.

Rey Center Citizen Science. The Rey Center's citizen science programs are hands-on participatory programming that create meaningful learning experiences, improving participants' science literacy, and developing knowledge and motivation that enables citizens to actively engage in making informed decisions about the natural environment. The Rey Center delivered an array of citizen science and science outreach programs in 2012-13. Through the Welch Ledges Stewardship and Citizen Science Program, over 1,370 contacts hours were made with hikers by stewards who educate them on the unique alpine-like communities on Welch Mountain in Thornton, NH. Two citizen science volunteers learned to conduct vegetation surveys and acquired an in-depth understanding of the unique ecology of this environment. 44 students and campers participated in the Welch Ledge Stewardship Hike and were introduced to the ecology of the northeastern forest along an elevation transect, the fragility of alpine mountain environments, and individual responsibility for stewardship. The Rey Center also implemented its Water Watchers program, a rich citizen science opportunity for the public to monitor the overall health of important local water sources. Staff and volunteers conducted 12 water-quality monitoring sessions. The Dark Sky Nights program engaged over 150 participants in observations of the night sky in Waterville Valley, NH.

Social Media. The Facebook page "NHWomeninScienceandTechnology" focuses on events of potential interest to female students in science and technology, including profiles of NH women in STEM (Science, Technology, Engineering, Mathematics) careers. In its second year of operation, there are 214 "friends" recorded.

MSDC intern A. Ricciardi developed a free mobile phone app on MSDC exhibits. Ricciardi also developed a free Mars geology online game in which participants learn more about the composition of rocks on Mars. Both interactives will be available via the MSDC website www.starhop.com after a site upgrade in late spring 2013. The purpose of the mobile phone app is to engage MSDC visitors more fully in MSDC STEM exhibits. The purpose of the Mars game is to reach out beyond MSDC's four walls to the larger community and engage them in STEM learning even if they are unable to visit MSDC or in addition to a visit.

Marketing and external promotion activities by the Community College System are intended to build strategic partnerships and linkages between STEM formal and informal education providers and promote STEM post-secondary education and initiatives at the Community Colleges. The Community Colleges of New Hampshire Foundation increases visibility of the Community College's NASA Space Grant opportunities through its website and in-print media, such as pamphlets, posters, and press releases distributed to newspapers state-wide.

3.2 Priming the Pump -- Informal Educator Development

Informal Educator Conferences. Three MSDC staff engaged in professional development that allowed them to create/strengthen networks with colleagues and NASA Center staff, as well as to gain new STEM knowledge and new ideas about reaching young minds through education and public outreach. Education Coordinator (Exhibits) T. Taber and Executive Director J. Gerulskis traveled to Columbus, OH for the Annual Meeting and Conference of the Association of Science-Technology Centers. While there, Taber and Gerulskis participated in presentations and activities on astronomy, aviation, space and earth science, involving the community in exhibit design and content, outside school programs, maker fairs, engineering activities for youth, and more. MSDC was featured in a presentation by the Museum of Science on accessibility in exhibits and programs. Taber and Gerulskis also traveled to Cleveland for a daylong combined session at **NASA Glenn** and Great Lakes Science Center, and Gerulskis also met with education staff at the Air Force Museum in Dayton. Education Director D. McDonald participated in a presentation on science center collaborations in distance and on-site education at the New England Museums Association Annual Meeting and Conference in Burlington, VT with NHSGC affiliate Mt. Washington Observatory as well as Squam Lakes Natural Science Center and Seacoast Science Center.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:**

During the third year of the performance period, Total Significant Awards = 46; Fellowship/Scholarship = 39; Higher Education/Research Infrastructure = 7; 4 of the F/S significant awards (10.3%) are underrepresented minority F/S funding. During the third (FY12) program year, 15 students moved onto their "next step" and are now pursuing advanced degrees in STEM disciplines, 12 have accepted STEM positions in industry, and 3 have accepted STEM positions in academia. The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award.

- **Minority Serving Institutions Collaborations:**

NHSGC maintained its initiative with Elizabeth City State University, a historically black university (HBCU) in North Carolina. One student participated this past year, working on his senior project under the direction of UNH faculty member Prof. R. Varner. Two ECSU students are registered for the upcoming UNH URC program, which will take place this April. The URC program is sponsored by Space Grant, and travel support has been offered to the ECSU students.

- **NASA Education Priorities**

  - *Authentic, hands-on student experiences in science and engineering discipline*

All graduate fellowships at Dartmouth College, University of New Hampshire, Plymouth State University and graduate and undergraduate internships from these institutions as

well as from the McAuliffe-Shepard Discovery Center include significant elements of authentic hands-on experience in cutting edge STEM research for higher education students. These activities include the mentorship of faculty engaged in the research. Sample activities include the Magnetospheric Multi-Scale Mission TableSat prototype, design of lunar rover components, and weather research for KSC launch operations.

The Rey Center's K-12 supplemental science (K-12) curriculum programs, MWO field trips, FIRST Robotics Competition, and UNH's Forest Watch incorporate hands-on learning and concept integration of scientific methodology and engineering practices for pipeline (pre-college) students.

- *Diversity of institutions, faculty, and student participants*

Institutions, Faculty. The NHSGC Director and Assistant Director are female. MSDC Executive Director and program Director are both female. The MWO Director of Education is female.

Students. New measures implemented to recruit for diversity in the MSDC Space Grant intern program did not meet with success and so efforts will be ramped up for the spring (2013) internship. The availability of the Space Grant MSDC internship was promoted to the New American (refugee) community. The person from the community who applied, a STEM undergraduate at New England College who is a Bhutanese refugee, was not eligible for the Space Grant internship due to his citizenship status (green card only). MSDC hired him as a temporary staff member, and he was able to strengthen our ties with the Bhutanese immigrant community in Concord and encourage Bhutanese middle and elementary school students to participate in our summer camps. This was an unanticipated side benefit of the Space Grant internship program. Both the intern and the non-intern were encouraged by their experience at MSDC to continue in their fields.

To enhance future recruitment, the Community College System of New Hampshire initiated this past year and will continue as an annual event one or more Women in Science and Technology (WIST) Forums at their White Mountains and Great Bay campuses. This is a long-term strategy to increase the pool for the community college NASA scholarship program.

Targeted funds for a summer internship went to a female mechanical engineering student at UNH, and to supporting the senior thesis project and conference travel for a MSI student working under the mentorship of a UNH female faculty member.

The mission of the Women in Science Project (WISP) at Dartmouth College is to collaborate in creating a learning environment where women can thrive in science, engineering, and mathematics. Space Grant provided funding support to 11 WISP interns this past year.

- *Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise*

Through workshops and program demonstrations offered in person and via distance

learning capabilities the education staff of Mount Washington Observatory provided informative programming for middle school teachers to help create exciting and interactive ways to teach weather in the classroom. The MWO education staff provided a variety of programs to middle school students through in-classroom visits, field trips at the Weather Discovery Center and distance learning (live videoconference with MWO staff). The content presented offer an understanding of data collection, weather patterns, instrumentation used to make a weather observation, climate system, alpine environment, and the use and maintenance of remote technology (automated weather stations).

Although the topic of MWO programming primarily focuses on atmospheric sciences, this past year MWO staff customized a program for a middle school teacher, who teaches a 7th Grade Math Honors class. The content integrated science, technology, engineering and mathematics. This program helped to explain how math skills are applied to understanding the data that are collected for a weather observation, as well as show students the types of graphs used to collect the data. With some graphs the results are evident, but with other graphs we must apply a mathematical formula to know the end result. Students were able to understand how mathematics plays a role in a STEM career. As a result of this program, a second customized program has been requested by this middle school teacher.

The "Science Teacher Training North Country" initiative provided hands-on exposure for middle school teachers to UNH scientists engaged in NASA research for the purpose of curriculum enhancement; 60% reported they would be incorporating the materials into their classrooms.

- *Summer opportunities for secondary students on college campuses*

White Mountains Community College summer STEM camp is on campus and designed for students entering grades 6 through 8. At UNH, Project SMART brings high school students to campus.

- *Community Colleges*

White Mountains Community College initiative for the WIST Forum at WMCC has created new relationships with FIRST Place, UNH, and Dartmouth College students and faculty.

- *Aeronautics research*

Thesis and intern projects sponsored by Space Grant include attitude control for the NASA MMS Mission and lunar rover components.

- *Environmental Science and Global Climate Change*

Two UNH graduate fellowships went to students in Natural Resources, and four Dartmouth fellowships went to students in the Department of Earth Sciences.

- *Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities*

The *Visiting Young Scientist* program at Dartmouth College enables young faculty by supporting research infrastructure activities and early-career teaching opportunities relevant to NASA.

IMPROVEMENTS MADE IN THE PAST YEAR

The Physics Department at Dartmouth College was awarded a Graduate Assistance in Areas of National Need (GAANN) traineeship grant that complements the NH Space Grant graduate fellowship program. In 2012-2013, eight students doing research related to areas of interest to NASA were awarded GAANN traineeships. These include three space physics students: S. Hatch and R. Clayton, who are promising beginning students working on rocket experiments with Professors LaBelle and Lynch, respectively, and L. Thatcher who recently completed a Ph.D. dissertation on heliospheric physics. Three astronomy students and one cosmology student are also among the GAANN fellows. In the past, the top GAANN fellows have gone on to become Space Grant fellows. Space Grant and GAANN fellows are both required to take P256, a two-term course in mentoring teaching techniques, and encouraged to participate in workshops on STEM teaching run by the Dartmouth Center for the Advancement of Learning.

The McAuliffe-Shepard Discovery Center has become a non-profit organization (it was previously a state agency).

From 2009-2011, MSDC invited both vendors and educational groups and institutions to set up booths at their annual aerospace festival; some booths were interactive, many were not. This year, MSDC eliminated the concept of booths, and required that all participating educational groups/institutions and vendors have an interactive STEM activity for children and families to participate in. Participation in Aerospacefest increased by 28.4% over the prior year (2011), and the experiences were more engaging, educational and inspiring for the participants.

MSDC had the Space Grant intern focus both on onsite MSDC interactives and an interactive available to anyone in the U.S. whether they are able to visit MSDC or not. This will make the MSDC reach beyond New England.

In the past year, the Mount Washington Observatory has employed new educational staff. The new staff members have taken the place of former educators who have moved on to other endeavors. New staff members offer experience in informal education with a focus in meteorology and the environmental sciences. Together their skills help to strengthen programming in STEM disciplines with their combined knowledge of science, technology, engineering and mathematics. Other improvements made in the past year include the design in the delivery of the distance-learning program. During the program students are introduced to two educators who offer a team-teach format throughout the presentation. This format has proved to be effective through student interaction and program evaluations provided by teachers.

The Community College System has committed to increasing the number of graduates in STEM fields. Representatives from the University System of New Hampshire (USNH)

and the Community College System of New Hampshire (CCSNH) recently signed a letter of commitment that sets out steps they will take together to meet the goal of increasing by 50% the number of STEM educated graduates by 2020 and doubling that number by 2025. Specific steps will include:

- Creation of new transfer pathways for students in STEM fields
- Collaboration on program development and delivery
- Promotion of STEM career opportunities
- Sharing of facilities, equipment, technology, and staff and faculty expertise
- Identification of resources to support STEM field education
- A commitment to expand access to education and opportunities in STEM fields for all state residents, across all regions of the state and all socio-economic groups
- Other initiatives in partnership with NH employers

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The NHSGC has nine members. The lead institution is the University of New Hampshire, including UNH Cooperative Extension, with associate Dartmouth College, and affiliates FIRST Place, the Community College System of New Hampshire, the McAuliffe-Shepard Discovery Center, Plymouth State University, the Mount Washington Observatory, the Margret and H.A. Rey Center, and BAE Systems of North America.

The University of New Hampshire (UNH), located in Durham, NH, is the state's flagship research university, enrolling 11,942 undergraduates (55% female) and 2,257 graduate students. Research and PhD programs relevant to aerospace are offered in physics, engineering, math, computer science, and a cross-college program in natural resources and Earth system science.

A part of UNH is Cooperative Extension that provides NH citizens with research-based education and information, enhancing their ability to make informed decisions that strengthen communities, sustains natural resources, and improves the economy. Space Grant collaborations are in the areas of geospatial technology and applications, resource management, and workforce development.

Dartmouth College, located in Hanover, NH, is a private liberal arts college (ninth oldest in the nation) and a member of the Ivy League. The college has 4,200 undergraduate students and 1,900 graduate students. Aerospace-related undergraduate and doctoral degree programs are offered in physics and astronomy, engineering, computer science, and Earth science. Extensive research is conducted in solar-terrestrial physics, astronomy, satellite remote sensing, robotics, and computer science applications.

The Community College System of New Hampshire (CCSNH, formerly the New Hampshire Community Technical College System) is New Hampshire's statewide system of two-year colleges, offering associate degrees, professional training, and transfer

pathways to four-year degrees. CCSNH is comprised of seven colleges within the state: Great Bay Community College in Portsmouth; Lakes Region Community College in Laconia; Manchester Community College in Manchester; NHTI-Concord's Community College in Concord; Nashua Community College in Nashua; River Valley Community College in Claremont and Keene; White Mountains Community College with locations in Berlin, Conway, and Littleton. CCSNH is the primary provider of skilled workers and technicians in the State. Space Grant supports a NASA scholarship program for STEM students, linked to the private sector and also supports STEM curriculum development within the college system.

Plymouth State University (PSU), located in Plymouth, NH, is part of the University System of New Hampshire and has a current student enrollment of 4238 undergraduates and 2500 graduate students. Space Grant funding provides research-oriented scholarships and fellowships in the meteorology program, with an emphasis on providing support to women undergraduate students.

FIRST Place is an innovative R&D facility in Manchester, NH, linked to Dean Kamen's nationwide FIRST robotics programs. It provides students, teachers, and the general public an encouraging environment for exploring concepts of science and technology. FIRST Place collaborates with UNH in curriculum development for pre-college science teachers. UNH and BAE Systems provide mentors and support for NH school teams involved in FIRST competitions.

The Mount Washington Observatory (MWO), in the White Mountains of NH, is a non-profit organization providing environmental observation and education while supporting scientific research. Current research projects address summit weather and climate, regional air quality, and global tropospheric chemistry. MWO, UNH, and PSU work together on many Space Grant activities, including internship and research projects.

The mission of the McAuliffe-Shepard Discovery Center (MSDC), located in Concord, NH, is *to educate, incite, and entertain learners of all ages in the sciences and humanities by actively engaging them in the exploration of astronomy, aviation, and Earth and space science*. As many as 60,000 school children and other visitors explore the Center annually, and another 10,000 are reached through offsite outreach programs, such as the portable planetarium. The Center is NASA's Educator Resource Center for NH. Space Grant supports internships, the development of planetarium shows and exhibits, teacher workshops, and space science fairs, often in collaboration with other NHSGC affiliates.

The Margret and H.A. Rey Center, in the Waterville Valley, honors the legacy of Margret and Hans Rey, authors of Curious George books and *The Stars, a New Way to See Them*, among other works. The Rey Center provides initiatives in environmental stewardship and informal educational programs in the astronomy and local ecological systems. NHSGC resources are used by the Rey Center to initiate several citizen science community outreach programs and cooperative research initiatives. Among these are the Tecumseh Overnights Program, Tecumseh Vegetation Phenology Research Transect, the

Lorenz Weather Station, and the Water Watchers water quality-monitoring program.

BAE Systems of North America is part of an international company that develops and supports advanced defense and aerospace systems, and is headquartered in Nashua, NH. BAE Systems supports and mentors teams for FIRST Robotics, FIRST Tech Challenges, and FIRST Lego League.

The National Space Grant Office requires two annual reports, this Annual Performance Data Report (APD) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.