

Rocky Mountain NASA Space Grant Consortium
University of Utah
Dr. Dwayne R. Westenskow, Director/PI
(801) 581-2478 or (435) 797-3666
<http://utahspacegrant.com>
Grant Number: NNX10AJ77H

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 Rocky Mountain NASA Space Grant Consortium is a Designated Consortium funded at a level of \$845,000 for fiscal year 2010.

PROGRAM GOALS

Outcome 1: To demonstrably contribute to the development of the STEM Workforce with programs, projects and activities that are in direct alignment with NASA's stated education strategic goals, missions and with her defined outcomes, objectives and PART measures.

SMART Objectives:

- 1:** Increase the percentage of our Space Grant Fellowships and Scholarships given to female students from an average of 32% in 2005-2009 to 34% in 2010-2014. Increase the percentage of awards to minority students from an average of 27% in 2005-2009 to 30% in 2010-2014. This will maintain greater diversity in our Space Grant program compared to the demographics of the State, where 23% of the students are female and 13% are minorities. This will keep our percentages well above the NCES Digest Statistics, where 22% of the students are female and 11% are minorities.
- 2:** a) Standardize the process throughout the Consortium by which Fellowships are announced, applications solicited, applications competitively reviewed, awards made, administered and tracked. b) From 2005-2009 we awarded an average of 22 Fellowship awards each year. In 2010 we plan to award 17 Fellowships at the graduate student level. All of these awards will be above \$5,000 tracking level. The number of Fellowships awarded in 2010 is less than

in 2009 due to the total Space Grant funding in 2010 being \$575 K rather than \$785 K in 2009. c) From 2005-2009 students and faculty published an average of 34 scientific reports each year. From 2010-2014 we plan to publish an average of 34/year.

- 3:** Each year target at least three project areas to focus Space Grant interdisciplinary research and development selected from [1] space systems engineering (ESMD-spacecraft), [2] life support in space (SOMD-crew health, safety, medical ops), [3] space vehicle propulsion (ESMD-propulsion), [4] remote sensing by optical, infrared and microwave imaging (SOMD-space comm.) in direct alignment with NASA Enterprise priorities.
- 4:** From 2005-2009 we awarded an average of 25 undergraduate Scholarships each year. From 2010-2014 we plan to award 29 Scholarships at the undergraduate level each year. Of these awards, 8 will be above \$5,000 and 11 will be below the \$5,000 tracking level.
- 5:** Increase the number of minigrants awarded to junior faculty members of our Consortium as an investment in their space-related research and career development. From 2005-2009 we made an average of 2 awards. In 2010 we plan to make at least 3 awards to junior faculty members.
- 6:** Increase the number of student Internships at space-related NASA Centers and her contractors from 10 in 2009 to 11 in 2010.
- 7:** From 2005-2009 7% of our Space Grant students graduated with STEM degrees and entered the STEM workforce. From 2010-2014 we plan on 9% of our students graduating with STEM degrees and starting their careers in the STEM Workforce. From 2005-2009 16% of our Space Grant students graduated with bachelor degrees and entered graduate school declaring a STEM major. From 2010-2014 we plan on 18% of our students graduating with degrees and entering advanced degrees declaring a STEM major.
- A1:** Use augmentation funding to support 4 innovative graduate student projects at Utah's three major research universities.
- A2:** Support 8 graduate students as they write 14 STEM peer reviewed journal publications and presentations at major research meetings.
- A3:** Use augmentation funding to support two innovative space related research programs thereby encouraging the research universities to prepare four research proposals from NASA funding.
- A4:** Use augmentation funding to support 25 undergraduate students as they conduct NASA related research resulting in 5 students receiving summer internships at NASA Centers and NASA contractors.
- A5:** Use augmentation funds to support 25 undergraduate students as they conduct NASA related research resulting in 10 students who graduate with STEM degrees and two students that begin aerospace and space-related careers.
- A7:** Award at least 23% of our Space Grant Augmentation funding to female students and 14% to minority students to maintain an appropriate balance commensurate with the demographics of the State.

Outcome 2: To attract and retain students and teachers in the STEM disciplines who have a solid understanding of the subject material.

SMART Objectives:

- 8:** From 2005-2009 we conducted an average of 9 teacher career development workshops each year. From 2010-2014 we plan to conduct 10/year.
- A6:** Use augmentation funding to support 5 teacher workshops, 8 live interactive programming educational modules, 5 senior project plans and 8 field trips to the planetarium.

Outcome 3: Conduct an Informal Education program to form strategic partnerships and linkages between STEM formal and informal providers leading to an expansion of the nation's future STEM workforce through awareness of the mission of NASA and the promotion of STEM literacy.

SMART Objectives:

- 9:** From 2005-2009 we supported the activities of 3 informal STEM education partnership collaborative projects each year. From 2010-2014 we plan to support 4 informal educational collaborative projects each year.
- 10:** Annually develop 4 sets of informal education standards-based STEM materials to enrich visual and activity experiences by informal education providers. Support satellite facilities that make this material available to teachers.

Management:

SMART Objective:

- 11:** Provide only two points of formal Consortium contact for NASA: Program Director/PI and Contracts Officer.

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

Outcome 1:

- On May 12, 2010, twenty-two graduate students each formally presented a professional-level paper on their research in a symposium conducted on the campus of USU to which the public was invited. In addition, 23 undergraduate students presented posters on their undergraduate research. The students came from four research universities of our consortium. The papers were collated into bound proceedings and distributed to the participants and their mentors.
- 400 years to the day of the anniversary of Galileo's discovery with his new telescope of the moons of Jupiter, a "First Light" dedication was conducted by students and staff of the 20-inch Corrected Dall-Kirkham (CDK) astronomical telescope in the USU Observatory. The aspiration is that this observatory will integrate with the multi-consortium observatory network.
- Professor David Long of Affiliate BYU transported to NOAA his SG Fellowship team's QuikSCAT enhanced resolution backscatter code for hurricane wind/rain observations. With European ASCAT data this enabled the SG team to help track the extent of the 2010 Gulf Oil Spill.

- A student team from our consortium affiliate Brigham Young University won 2nd place in the 5th annual ESRA Rocket Launch Competition held at Green River, UT on June 16-18. Embry Riddle University from the Florida Consortium won 1st place. The banquet speaker was industry expert Bob Ammons from Aerospace Corporation.
- Nine (5 on-board, 4 ground crew) fellowship students of the consortium's Get-Away-Special student team flew on the microgravity aircraft at NASA Johnson Space Center June 16-27, 2010. They conducted a nucleate boiling experiment FUNBOE on the flight under NASA's 2010 Reduced Gravity Student Flight Opportunities Program. As a result, the team also received notice that their competitive proposal to fly FUNBOE 2.0 will be awarded.
- "I have learned a great deal through this program about what it takes to be an Engineer. Gaining first-hand experience with hard deadlines, project management, finding funding, writing proposals and journal papers, and how to teach myself new subjects. The experience gained from this program has made a tremendous impact on my academic and professional life. Both of the jobs I have had in STEM related fields have been because of my work in this program."
(Robert Barnett - on 12/21/10, 2010 GAS/MRT Summer Studs, Affiliate Space Dynamics Laboratory)

Outcome 2:

- Seventeen public school teams participated in the January, 2010, VEX robotics competition held on the campus of USU under the mentorship of Professor Gary Stewardson and two SG fellowship students. Fourteen teams from Utah, two from Colorado, and one from Idaho entered the competition. A FIRST Robotics competition (FRC) has been organized at Affiliate UU as a Utah Regional event April 8-9.
- Idaho and Utah SG consortia partnered in the 2010 Summer of Innovation pilot program under the leadership of Aaron Thomas, John Vanderford and Duane Merrell. Workshops were conducted at seven separate precollege locations with a total number of 210 students and 69 teachers participating. Emphasis was given to Native American participation.

PROGRAM ACCOMPLISHMENTS

Outcome 1: Development of STEM Workforce

SMART Objectives:

I & A7. During FY 2010 we awarded 40 fellowships and scholarships (augmentation plus base). Thirteen of these were awarded to female students (32.5%) and 9 were awarded to minority students (22.5%). We are slightly below our base funding goal of 34% for female students and below our goal of 30% for minority students, however, we are above our augmentation goal of 23% to female students and 14% to minority students. Also, these statistics are only for year 1 base and augmentation

funding. We expect to reach these goals for the averages in 2010-2104 by the end of the five-year award.

2, A1, & A2. A web page for all fellowship and scholarship applications has been implemented on the consortium web site to standardize the application process. A review board at each affiliate chooses the recipients. Awards are made, administered, and tracked by each individual Affiliate and our Program Coordinator works with each Affiliate regularly to maintain the database of all awards and student information to feed into the longitudinal tracking system of the National Space Grant Foundation. We awarded 23 graduate fellowships, thus exceeding our objective to use base funding to provide 17 graduate fellowships and augmentation funding to provide 4 graduate fellowships. All 23 graduate fellowship awards were above the \$5,000 tracking level. A total of 36 papers were submitted or published by our students. Twenty two papers in the Proceedings of the 16th Annual SG Graduate Fellowship Symposium were published plus a total of 14 professional paper and conference submittals were made to professional journals and institutes appropriate to the relevant scientific or engineering specialty. These included Propulsion and Power, IEEE, SPIE, J. Appl. Physiol, JGR, J Fluid Mech, J. Chem Phys, Anal Chem, ApJ, Anesthesiology, J. Acoustic Soc. Am, AIEE J, Science. Our goal of 48 papers (34 base and 14 augmentation) was not met this year.

3. When awarding fellowships and improving research infrastructure the University of Utah targeted life support in space; Utah State University targeted propulsion and remote sensing engineering technology; Brigham Young University targeted space systems engineering and remote sensing. We met our objective by focusing on these three areas of research.

4. We awarded 18 undergraduate scholarship awards in FY 2010 but did not meet our goal to award 29 undergraduate scholarships. This was due to the fact that we received many more outstanding applications for graduate awards than for undergraduate awards. We made the decision to increase the number of graduate awards than was initially planned. Of these 18 undergraduate scholarship awards, four were above the \$5,000 tracking level. Although we did not meet our goal of having eight above the \$5,000 tracking level, we have determined that an additional four students should be reported as significant due to the fact that the funding they received made an impact on their ability to stay in school and be supported financially.

5. Minigrant awards were given to the University of Utah's Geology Department web project, rocket club, and robotics team. At Utah State University awards were given to the astronomy observatory and the ITE robotics projects. Therefore, we exceeded our goal of three minigrant awards for FY2010.

6: We plan to use FY 2010 funding to support 8 internships during the summer of 2011. We have made commitments to 2 NASA Academy interns, 2 LARSS interns, 1 at NASA GSFC, 1 at Space Dynamics Laboratory, and 2 others yet to be determined. Some of the commitments we made to fund internships at NASA GSFC and LARSS fell through due to either no mentors being matched with the particular student we intended

to fund or that the student had already accepted another position by the time the announcements were made in late spring. Therefore, we only funded 4 interns during the summer of 2011 with FY 2010 funds. We also sent one student to the RockOn Workshop at NASA Wallops Flight Facility in June 2011 with these Higher Education funds.

7: Seven students made their next career steps in FY10 (SG participation supported from FY06-FY10 funds). One accepted a STEM position at a NASA contractor, four accepted STEM positions in industry, and two accepted STEM positions in academia. We had 9% of our students graduate with STEM degrees in FY10. In FY10 we had 10% of our students graduate with STEM degrees and pursue an advanced degree with a STEM major. This did not meet our goal of 18% for FY 2010-2014, although we expect our average to be 18% over this five-year award period.

A3: Our Research Infrastructure development activities included supporting the formation of a Center for Terrestrial Analogs at the University of Utah which pooled expertise in sedimentary geology and geomorphology to examine terrestrial environments similar to those on Mars. As the evidence for water on other planets is collected, the focus will be on physical and chemical environments where water existed and could support microorganisms in the characterizations of those environments. Some interior regions of the West preserve continental paleoenvironments that produced dunes, lakes, rivers, and playas analogous to the types on the Martian landscape. Another research infrastructure project supported was the networking of small college observatories project at Utah State University. Through the network observers can remotely carry out observations in concert. We used augmentation funding to support two innovative space-related research programs and these two groups prepared EPSCoR proposals.

A4: A total of 29 undergraduate students were supported through our FY2010 augmentation funds higher education programs thus exceeding our objective to support 25 students. The Body Shirt project at UU involved 5 students, Cubesat project at USU involved 5 students, astronomy and physics project at UVU involved 3 students, biology and physical sciences education programs at Dixie State College involved 16 students and Leonardo science program involving 5 students. The five undergraduate students supported by the Leonardo/UU Bioengineering program went on to complete summer internships.

A5: Of the 29 undergraduate students listed in A4, 16 graduated with STEM degrees and two began aerospace and space-related careers. We exceeded our SMART objective of 10 and two.

Outcome 2: Attract and retain students and teachers in the STEM disciplines

SMART Objectives:

8: We conducted 10 teacher workshops. Four Pathway to Mars workshops were organized and conducted in concert with the Idaho Consortium Summer of Innovation program. These four workshops emphasized Native American schools. The venues were: Granite Morningside Elementary, USU Regional Campus (Vernal), Clark Johnson

Jr. High School, White Horse Jr. and Sr. High School, Brigham Young University, White Rocks, Eagleview Elementary, Providence Elementary, Utah Valley University, and Northwest Middle School. The total number of workshops was 10 which met our goal of conducting an average of ten workshops/year during the 2010-2014 award period.

A6: Augmentation funding was used to support five additional teacher workshops. The venues were: Society of Women Engineers Regional Conference (4 states), Pine View Middle School, Providence adult teachers, and Jordan School District. We supported the development of eight interactive learning modules at Clark Planetarium through the *Digistar 3* control system, five senior projects at Dixie State College in the biology and physical sciences program, and eight field trips for K-12 students and teachers to the Ott Planetarium at Weber State University.

Outcome 3: Informal Education program to form strategic partnerships/linkages SMART Objectives

9: New partnerships were established with Campbell Scientific, with L-3 Communications, and with Canyon, Granite and Jordan School Districts. We facilitated four new STEM informal education partnership/linkages this past year as stated in our objective.

10: We developed and distributed four sets of educational materials on-line in the areas of planetary/lunar lander systems, systems engineering, electrical energy engineering, electro-optics, solar system and the cosmos. The Department of Geology at the University of Utah prepared a web page giving the general public access to terrestrial analog material. Utah Valley University mentored two students who prepared STEM/NASA materials to present at area high schools. A set of educational materials including astronomy, plate tectonics, meteorites, moon phases, and the solar system were developed and distributed to community groups and affiliates within the consortium. We met our objective to develop and distribute four sets of STEM educational materials.

Management

SMART Objective

11: The organizational structure of the consortium was modified to have one Space Grant/EPSCoR Director/PI and one University Sponsored Projects Office Director as the two formal points of administrator contact with the NASA HQ Space Grant/EPSCoR Office.

NASA 2010 Education Priorities

Authentic hands-on student experiences in STEM. A practical learning experience was created and implemented for students to design, assemble, and test a solar energy system for generating, controlling, and storing electric energy on a tethered blimp. A project was established for students to engineer, assemble, test, and operate an irradiance meter to monitor and record solar flux in real time. A project was implemented by students to engineer, test and operate an automatic solar tracker to observe at wavelengths from which atmospheric vapors and particles could be monitored.

A multidisciplinary student team designed and fabricated a fluids nucleation chamber for flight on a satellite. They tested it on a microgravity aircraft flight at JSC.

Engage middle school teachers in hands-on curriculum development. Our consortium was a team member of the multi-consortium Summer of Innovation pilot program which successfully engaged numerous middle school teachers with hands-on curriculum enhancement experiences, materials and capabilities.

Aeronautics. The consortium is fully engaged in the aeronautics curriculum and applications by staff and students. This includes pilot training, ground maintenance, and flying aircraft-borne imagers, both optical and radar, for research purposes.

Environmental Science and Global Change. Graduate students analyzed NASA data derived from their TIMED satellite which specifically addresses the earth-sun energy budget. NASA LaRC has made the multispectral and derived atmospheric data available for over more than a full half-solar-cycle to identify trends.

Diversity of institution, faculty and student participants. WSU and SLCC provided a large number of hispanic American participants in our Space Grant programs, Westminster College provided a propensity of women participants, SLCC provided African-American and hispanic American participants, and USU provided Native-American participants.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- ***Longitudinal Tracking:*** The services of the National Space Grant Foundation were engaged starting in 2009 to assist our consortium in this important endeavor. We have continued to work closely with the foundation staff to report all student award information. Total awards = 27; Fellowship/Scholarship = 27, Higher Education/Research Infrastructure = 0; 4 of the total awards went to underrepresented minority students. During the FY10 program year, one student accepted a STEM position with an aerospace contractor, four accepted STEM positions in industry, and two accepted STEM positions in academia. We plan to support eight interns (Higher Education) and four GAS/MRT students (Research Infrastructure) with FY2010 funds this summer. They will be entered into our longitudinal tracking system at that time.
- ***Course Development:*** A new course was developed (Advanced Electrical Energy Engineering) with emphasis on renewable energy sources and systems, with particular attention to solar energy (ECE 6930). In concert with affiliate SDL, course offerings in applied electro-optics have been upgraded. The astronomy course offerings have been upgraded and now offer hands-on student experiences at two new astronomical observatories within our affiliates plus the facilities of the Clark Planetarium. USU course improvements aided by Space Grant were MAE 5930, Rocket Systems Design, and MAE 4800, LPLSRV Design. Astronomy courses at USU and the UU have been upgraded and function in concert with newly established networked observatories. As part of the new course developments, students participated in trips

to KSC, JSC, SDL, hydroelectric plant, gas-fired power plant, solar energy plant, a fiber optics communication center, astronomy observatory, and electrical power substation.

- **Matching Funds:** Our consortium received matching funds in the amount of \$610,000, adding to the \$845,000 award from NASA. The ratio of funds leveraged by NASA funding support is 72%. The lead institution and the affiliates provide matching funds through in-kind support, volunteer efforts, matching of fellowship/scholarship awards, and waived indirect cost.
- **Minority-Serving Institutions:** There are no designated minority-serving educational institutions in Utah. However, Weber State University and SLCC have large hispanic student populations with whom we have joint activities. Also, we collaborate with Hampton University (HBCU) on NASA research projects.

IMPROVEMENTS MADE IN THE PAST YEAR

In 2010 we added Utah Valley University as an affiliate. The College of Eastern Utah became an affiliate of Utah State University and thus became a member of our consortium.

We upgraded our Space Grant 508 compliant home page [<http://utahspacegrant.com>]. We added application forms for those students wishing to apply for fellowships and scholarships.

We streamlined our formal consortium contact with NASA through having one director/P.I. as the point of contact for the NASA Space Grant EPSCoR programs and the Space Grant consortium.

We formalized the process of verification of matching funds. Invoices from affiliates for subcontracts require matching documentation with each submittal.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Education and Research Universities:

- (1) Utah State University provides graduate student mentors in space vehicle propulsion.
- (2) University of Utah provides graduate student mentors in life sciences.
- (3) Brigham Young University provides graduate student mentors in remote sensing.

Industry:

- (4) ATK Aerospace Systems provides internship opportunities and workshops for women.

Education Institutions:

- (5) Weber State University delivers a summer outreach program for women.
- (6) Southern Utah University provides undergraduate and graduate student mentors in the STEM fields.

- (7) Snow College is a two-year college which prepares students to go onto a four-year university in the STEM fields; they also work with the K-12 schools within their region.
- (8) Dixie State College is a four-year college which focuses on preparing K-12 teachers in biology and physical sciences in our Higher Education programs.
- (9) Utah College of Applied Technology emphasizes the importance of technical training and improving skills in the workplace today.
- (10) Salt Lake Community College provides mentors for undergraduate minority students in physics and astronomy.
- (11) Westminster College provides a summer program for precollege women students.
- (12) Utah Valley University provides mentoring for physics students to assist K-12 teachers in the STEM fields.

Government Centers:

- (13) Idaho National Laboratory provides summer internships for students.
- (14) Space Dynamics Laboratory provides matching funds and internships for students in space vehicle propulsion.
- (15) Hill Air Force Base conducts teacher workshops and also provides tours and information for the public as informal education.

Outreach Institutions:

- (16) Clark Planetarium provides teacher workshops and outreach to the community.
- (17) Aerospace Heritage Foundation of Utah/Hill Aerospace Museum provides teacher workshops and public outreach.
- (18) North American Native Research & Education Foundation conducts Summer of Innovation workshops for Native Americans.
- (19) The Leonardo science center provides public outreach and internships.
- (20) Rocky Mountain NASA Fellows Association helps with longitudinal tracking of alumni.