North Carolina Space Grant Consortium (NCSG)
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Director: Christopher S. Brown
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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 North Carolina Space Grant Consortium is a Designated Consortium funded at a level of $575,000 for fiscal year 2013.

PROGRAM GOALS

NCSG's goals and objectives (listed below) are part of the Consortium's five-year strategic plan (FY2010-14) and are aligned with NASA's Education Framework:

Goal 1: To deliver a competitive Fellowship/Scholarship program that provides research and education opportunities to students in science, technology engineering, and mathematics (STEM) disciplines at NCSG Affiliate institutions. (NASA Outcome 1)

Objectives: (1.1) Support Graduate Research Fellowships and Undergraduate Research Scholarships; (1.2) Support Undergraduate Scholarships; (1.3) Support Community College Scholarships; (1.4) Support STEM Teacher Education Scholarships; (1.5) Ensure competitive distribution of F&S funds; (1.6) Leverage support from industry, research organizations, and other Space Grant partners for other F&S projects.

Goal 2: To strengthen North Carolina's aerospace-related research infrastructure and capabilities. (NASA Outcome 1)

Objectives: (2.1) Provide start-up funding to early career faculty; (2.2) Encourage research collaborations between faculty and NASA centers/industry; (2.3) Ensure competitive distribution of research funds.

Goal 3: To provide groups of students with opportunities to engage in NASA-mission and STEM-based academic research and coursework. (NASA Outcomes 1 and 2)

Objectives: (3.1) Engage student groups in NASA-related research/design projects; (3.2) Develop STEM courses aligned with NASA's research direction and corresponding Mission Directorates; (3.3) Ensure competitive distribution of higher education funds.

Goal 4: To deliver activities that facilitate the National Space Grant College and Fellowship Program's focus on involving underrepresented groups and persons with disabilities in all higher education program areas (NASA Outcome 1-3).

Objective: (4.1) Pursue and increase the participation of women, underrepresented minorities, and persons with disabilities in NC Space Grant program areas of Fellowship/Scholarship, Student Research and Course Development, and Research Infrastructure.

Goal 5: To equip NC pre-service and in-service educators with tools to inspire the future STEM workforce to pursue education and careers in aerospace-related fields. (NASA Outcome 2)

Objectives: (5.1) Provide professional development opportunities for precollege educators; (5.2) Ensure competitive distribution of precollege education funds.

Goal 6: To increase interest in and understanding of NASA-mission and STEM activities by inspiring and engaging individuals of all ages throughout North Carolina. (NASA Outcome 3)

Objectives: (6.1) Provide professional development opportunities for informal educators; (6.2) Ensure competitive distribution of informal education funds.

Goal 7: To expand the geographic diversity and awareness of NC Space Grant.

Objectives: (7.1) Increase the number of Affiliates and Partners; (7.2) Increase the funding base for NCSG to allow for expanded programming; (7.3) Increase public awareness of NCSG activities.

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

The following anecdotes/highlights demonstrate the impact of NC Space Grant programs in North Carolina:

Outcome 1 – Higher Education:

"This summer, before I entered my second semester as a Junior, I was granted the opportunity to attend the 2013 Helicopter and Unmanned Aerial Vehicle Workshop hosted by Central Connecticut State University. Here, thanks to NASA and both the North Carolina and Connecticut Space Grant Programs, I was able to put into practice the leadership principles and theories I have learned in the classroom. I also found time to work on my leadership skills both during scheduled and unscheduled time.

I am on track to graduate from North Carolina State University with a Bachelor of Science in Mechanical Engineering Systems in May 2015. I look forward to graduation and I hope to soon be employed as an engineer. I am now interested in a career with Sikorsky Aerospace Services, thanks to the wonderfully informative introduction to the facility I received this past week. I plan to take advantage of my remaining time at North Carolina State University to put to practical use the education gained at the UAS Workshop.

As anyone attending college knows, the cost of fees, books and materials, and living expenses are daunting. The benefits awarded sometimes mitigate the financial burdens, and the experience I received from attending the 2013 NASA/Connecticut Space Grant Helicopter and UAS Workshop was a tremendously rewarding experience which I would like to thank you for. I believe it is essential to illustrate to students real world applications of their newly gained knowledge, and I believe it is paramount to continue this opportunity in order to encourage students to achieve their goals." (Lesley Whaley, 2013 NCSG Higher Education Award Recipient to participate in the 2013 Helicopter/UAV Workshop in Hartford, Connecticut, in collaboration with the CT Space Grant Consortium.)

Outcome 1 – Fellowship and Scholarship:

"Space Grant has opened my eyes to amazing research and technological advances in STEM and space-related fields. It is great to be a part of and to meet other people in the field who willingly give you their support in pursuit of a career in engineering. As a student, my contributions consist mainly of outreach activities to the general community, and space exploration related research in radiation induced osteoporosis. I currently investigate the molecular and cellular causes of radiation induced bone loss, which is directly applicable to space radiation research. Discovering what causes bone loss in the space radiation environment will lead to preventative and restorative measures that will help enable deep space exploration. I also perform several outreach activities each year aimed at teaching people about space research and improving their skills in technology." (Angelica de Rosa, NC Space Grant Graduate Research Fellow – FY12 and FY13)

Outcome 2 – Precollege Education:

The feedback below was provided by Dr. Mark Jolly, Mechanical Research Manager, LORD Corporation in the video clip produced by the NC New Schools entitled *Teaching Tomorrow's Workforce – Industry-Linked Learning for Teachers*. NCSG provided funds to LORD to leverage support in the development of the NC STEM High School Externship Program (described in Program Accomplishments – Outcome 2):

"Laura King, High school teacher at Wayne School of Engineering in Goldsboro, NC, and 2013 Teacher Extern at LORD Corporation stated that, "It's important for teachers to understand what's going on in industry so we [teacher] can relay information to students when they [students] ask, "Why do I need to know this?"" Ms. King was given a project to work on that was meaningful to LORD in an effort to connect classroom learning with real-world experiences. As such, she was treated as an engineer at LORD, not a teacher. Ms. King translated the information learned into a curriculum to take back to her classroom."

PROGRAM ACCOMPLISHMENTS

This report summarizes NCSG's FY 2013 program accomplishments as they relate to NASA Education Strategic Framework Outcomes.

NASA EDUCATION OUTCOME 1:

Fellowships and Scholarships

NCSG competitively awarded 56 fellowships and scholarships to students attending NCSG Affiliate institutions.

- Awarded 9 Graduate Research Fellowships and 21 Undergraduate Research Scholarships to students representing 7 university Affiliates. Nine of these research projects had significant partnerships with NASA centers that included a NASA research mentor and the students working on-site at the following centers: Ames (NASA Academy), Goddard (Internship), Johnson (Internship), Kennedy (Internship), and Langley (NASA LARSS).
- NC Space Grant continued its partnership with the LORD Corporation to offer a summer internship program for undergraduate and graduate students. NCSG leveraged funding from LORD to provide support for 13 students (counted in F/S student data) to participate in a 10-week internship at LORD. LORD is a worldwide leader in adhesives and coatings, vibration and motion control, and magnetically responsive technologies.

- Awarded 10 Undergraduate Scholarships and 3 Community College STEM Scholarships, enabling lower division students an opportunity to explore STEM-related research on their respective campuses.

NCSG Fellowship and Scholarship programs contributed to NCSG Goal 1. Objectives 1.1, 1.2, 1.5, and 1.6 were met in FY13. Objective 1.3 was below target due to a reduction in the number of applications received for the FY13 Community College Scholarship Program. Objective 1.4 was not implemented in FY13 due to a lack of funding beyond the base award.

Research Infrastructure

Four 'New Investigator' awards were competitively granted to early career university faculty who are conducting research that is directly aligned with NASA's research direction. All projects involved undergraduate and/or graduate students, which provided practical training to students as well as opportunities to present research at professional conferences (11 students engaged through New Investigator projects).

- *Ground Based Measurements of Volatile Organic Compounds (VOCs), Formaldehyde and Oxygenated Volatile Organic Compounds (OVOCs) in Houston, Texas during NASA's DISCOVER-AQ Aircraft Campaign,* Dr. Barkley Sive, Assistant Professor, Department of Chemistry, Appalachian State University.
  - Student Engagement: Six undergraduate students were engaged in Dr. Sive's research. The student team assisted Dr. Sive in carrying out ground-based measurements during NASA's DISCOVER-AQ aircraft campaign from August –September 2013. DISCOVER-AQ is a collaboration among scientists at NASA centers (Langley, Goddard, and Ames) and multiple universities (which includes ASU). Students utilized the comprehensive data set collected from the ground-based measurements for their Capstone Projects during the 2013-14 academic year. Multiple student presentations have been given to date including a student presentation at the Fall American Geophysical Union meeting in December 2013.

- *Novel Flexible Quantum Dot Solar Cell for Space Applications,* Dr. Nico Hotz, Assistant Professor, Department of Mechanical Engineering and Materials Science, Duke University.
  - Student Engagement: Two graduate students (Masters and PhD level) were engaged in Dr. Hotz's research. Both students assisted in the development and testing of a solar material design with long operating life and increased energy conversion efficiency to be used for space applications. This research directly contributed to the NASA Exploration Technology Development Program goal of developing technologies to provide low-cost, abundant power for deep-space missions, including solar power generation.

- *Fe isotope biosignatures and the redox state of the ocean recorded in 1.69 Ga late Paleoproterozoic BIFs with implications for space exploration,* Dr. Adriana Heimann, Assistant Professor, Department of Geological Sciences, East Carolina University.
  - Student Engagement: Two students (one graduate and one undergraduate) were engaged in Dr. Heimann's research. Students assisted Dr. Heimann in the preparation of samples for Fe isotope analysis (dissolution, ion exchange chromatography) and mass spectrometry. The graduate student traveled with Dr. Heimann to conduct Fe isotope analysis in collaboration

with Dr. Clark Johnson, PI of the Wisconsin NASA Astrobiology Institute at the University of Wisconsin at Madison.

- *Investigation of the Relationship between Convection and African Easterly Waves using NASA Satellite and Reanalysis Datasets,* Dr. Ademe Mekonnen, Assistant Professor, Department of Energy and Environmental Systems, NC A&T State University.
  - Student Engagement: One graduate (PhD) student was engaged in this project as part of her dissertation. She worked with Dr. Mekonnen to investigate the initiation mechanisms of Africans easterly waves (AEWs) that trigger major hurricanes that affect eastern and southern United States. Datasets from the NASA Goddard Institute for Space Studies Project (GISS) were used in the analysis; dynamics were investigated using Modern-Era Retrospective Analysis for Research and Applications (MERRA), a product of NASA's Global Modeling & Assimilation Office.

Ten NCSG Affiliate colleges/universities supported an additional 61 students to participate in STEM-related research through research assistantships under the supervision of a faculty /industry mentor. Research was either conducted on campus, at collaborating universities (Clemson University, Indiana University, and University of Kansas), or at other science facilities (Pisgah Astronomical Research Institute).

NCSG Research Infrastructure programs contributed to NCSG Goal 2. Objective 2.1 was partially met (the number of faculty seed grant awards were below target due to lack of additional funds beyond base funding; student target exceeded). Objectives 2.2 and 2.3 were met.

<u>Higher Education Programs</u>

Two 'Higher Education/Course Development' awards were competitively granted in FY13 resulting in the development of one new course (laboratory-based course in physical and earth sciences for K-6 pre-service teachers) and one enhanced course (senior capstone course in microgravity studies). The number of students engaged in these courses was not available at the time of this report (Higher Education Course Development activities will conclude June 30, 2014).

- Dr. Judith Beck, Lecturer in the Physics Department at UNC-Asheville, designed and implemented a college-level, interdisciplinary, laboratory-based course in physical and earth sciences for K-6 pre-service teachers. As an overarching theme for the course, Dr. Beck chose to focus on the Earth and Sun as a system. The Earth/Sun theme connects physical and earth science content areas in the NC Standard Course of Study Essential Standards and can be supported by NASA missions and resources. The course will be piloted in spring 2014 and will integrate laboratory exercises and hands-on investigations with discussion, presentations, use of web resources, and other content engagement, rather than designating class meetings as separate "lecture" and "lab" events. Results from the pilot-year experience will be shared with science faculty, education faculty, and administration at UNC-Asheville through on-campus meetings, as well as with teachers and administrators from surrounding school districts during USTEP (University-School Teacher Education Partnership) meetings. UNC-Asheville has expressed a commitment to offering interdisciplinary science courses targeted towards K-6

pre-service teachers, and—depending on pilot-year results—hopes to develop a complementary course in the future that focuses on K-6 life science standards.

- Dr. Tim Ritter, Professor of Physics at UNC-Pembroke, developed a two part special topics course sequence (1-2 credit hours) for microgravity studies for undergraduate students (science and non-science majors) utilizing NCSG Higher Education Course Development funds in FY11 and FY12. This course required student teams to develop a research plan and submit to the NASA Reduced Gravity Student Flight Opportunities Program. This sequence filled the need of providing some academic credit for student work. However, this special topics course had no formal course appearing in the UNC-Pembroke course catalog. Dr. Ritter received funds in FY13 to take this course sequence to the next step and offer a more robust, formalized capstone-type course (3 credit hours) for the senior level students participating in the program. The course, entitled *Microgravity Research*, will incorporate a significant writing component to align with UNC-Pembroke's recent Quality Enhancement Plan (2011) of enhancing undergraduate student skills in both general writing and professional writing in their disciplines.

In FY13, NCSG offered two additional competitive higher education grant programs: Senior Design and Team Competition. These programs provided support for student groups to participate in a variety of higher education activities that emphasize workforce development through the incorporation of interdisciplinary research collaboration. Ten competitive awards were granted in FY13 (5 Senior Design, 5 Team Competition) to teams at NC A&T State University, NC State University and UNC-Charlotte, reaching approximately 123 undergraduate students (FY13 team funded projects will conclude June 30, 214). Team competition activities will take place in the spring 2014 and include:

- Society of Automotive Engineering (SAE) Aero Design East Competition: NC A&T State University.
- IEEE SoutheastCon Hardware Competition: UNC-Charlotte.
- NASA Undergraduate Student Launch Initiative: NC State University (High Powered Rocketry Club) and UNC-Charlotte.
- NASA Robotics Mining Competition: UNC-Charlotte.
- Association for Unmanned Vehicle Systems International's Student Unmanned Air Systems Competition: NC State University (Aerial Robotics Club).

In FY13, NCSG and Connecticut Space Grant (CTSG) established a partnership to expand the Helicopter and Unmanned Aerial Vehicle Workshop, which was developed and has been sponsored by CTSG for several years. CTSG and NCSG joined forces to offer this workshop one year in CT and then the next year in NC. NCSG provided funds for Dr. Bill Fortney, Eastern Regional Director of Distance Education in the College of Engineering at NC State University, along with five Mechanical Engineering Systems undergraduate students, two Aircraft Technology community college students, and 1 employee from the In-Service Support Center at Marine Corps Air Station Cherry Point, to attend the workshop in the summer 2013 and begin planning for the NC workshop in summer 2014.

Additionally, NCSG Affiliates provided leveraged support to course development/team competitions on their respective campuses (student data not available at the time of this report; projects conclude June 30, 2014):

- Duke University: provided support for the team to participate in the Shell Eco-Marathon Challenge (April 2014). The 2013 Duke Eco-marathon team car more than doubled the efficiency of the 2012 competition car to 224 mi/kWh and earned a third place finish (out of a field of 43). Experience gained so far is being used by the student team in developing a competitive vehicle for 2014. Conceptual design for the full vehicle is complete, and the frame is presently under construction. Testing of motor characteristics is proceeding, with the goal of developing a generalizable driving strategy (throttle vs time and conditions) for maximum efficiency.
- East Carolina University: provided support for the development of an astrobiology course for the ECU Honors College.
- NC Community College System: provided funds to support Mitchell Community College's Rocket Club participation in the RockSAT C competition at NASA Wallops in May 2014. The Mitchell CC team will be using a full canister to demonstrate two technologies for a future CubeSAT launch, hopefully within the next 5 years. One of the students on the team is a NASA Community College Aerospace Scholar and most of the students this year are Engineering Technology majors. Profiles of Mitchell Community College's program can be found in the NASA article, "From Rockets to Careers: It's a STEM Thing."
- University of North Carolina at Chapel Hill: supported 18 undergraduate students to participate in the 22nd annual Educational Research in Radio Astronomy (ERIRA) program at the National Radio Astronomy Observatory in Green Bank, West Virginia (summer 2013). ERIRA is a unique experience that was developed by UNC-CH to encourage majors and potential majors to get excited about and get involved in research. To participate, students must complete a short application, after which we select them on the basis of enthusiasm first, and background in astronomy and science second.

NCSG Higher Education programs contributed to NCSG Goal 3. The Objective 3.1 was exceeded four fold. The number of courses supported fell short of the Objective 3.2 target due to lack of additional funds beyond base funding. Objective 3.3 was met.

Of the 248 students directly supported in FY13 through Fellowship/Scholarship, Research Infrastructure, and Higher Education programs, 57 (23%) went to students from historically underrepresented minority groups and 68 (27%) to females. It is important to note that the data reflected in this report may not represent all students engaged. Final student data reports will be provided by Affiliates after the conclusion of their FY13 performance period (June 30, 2014). *(NCSG Goal 4, Objective 4.1)*

- NCSG minority student participation does not meet the target of 28.3% set by the NCSG FY2010-14 Strategic Plan (and based on the enrollment percentage of minority students in NC as published in the National Center of Education Statistics Digest).
- The percentage of female participants fell short of the 55% target set by the NCSG FY2010-14 Strategic Plan (Outcome Indicator: 55% of awards will be made annually to female applicants. The 55% target was derived from the enrollment of female students in NC degree-granting institutions as published by the National Center for Education Statistics).

This strategic target, however, is not reflective of the number of female students enrolled in STEM degree programs.

NASA EDUCATION OUTCOME 2:

Three 'K-12 Professional Development' awards were competitively awarded in FY13. Funded projects involved collaboration with partners to achieve its strategic goals of equipping the future STEM workforce and enhancing precollege educator knowledge of STEM content.

- *Educator Training in Space Science for 6th Grade Teachers,* Dr. Judith Beck, Department of Physics, UNC-Asheville. This workshop was designed to address current NC educational needs in several ways. Firstly, the NC Essential Standards are new for the 2013 academic year and therefore both new and experienced teachers needed support in gaining content knowledge and in creating effective lessons addressing these topics. Secondly, 6th grade teacher have been targeted for participation because many are certified in teacher K-6 instead of Middle School Science. As a result, their science background and pedagogical training for teaching science is often weaker than that of the colleagues in 7th and 8th grade.

  Dr. Beck was one of 20 participants (selected from a pool of over 130 applicants) at the Galileo Educator Network Professional Development Institute (GEN PDI) held at the Adler Planetarium, Chicago, Illinois, in September, 2012, and sponsored by NASA and the Astronomical Society of the Pacific. The institute provided training in the design and delivery of professional development experiences that deepen teachers' content knowledge and emphasize the practices of science and engineering using NASA content and resources. As a NASA Galileo Educator Fellow, Dr. Beck developed a 2-day workshop in Summer 2013, for a total of 20 6th teachers that utilized tools obtained from the GEN PDI (*The Universe at your Fingertips 2.0* DVD-Rom and the *GEMS Space Science Sequence 6-8* kits). The workshop focused on helping teachers gain deep understanding of the concepts as well as training tem in using the resources to engage students in inquiry-based investigations. During the 2013-14 school year, the school system Science Curriculum Specialists visited the schools to support teachers as they implemented their new lessons.

- *NC STEM High School Externship Program,* Dr. Mark Jolly, Mechanical Research Manager, LORD Corporation. NCSG provided funds to LORD to leverage support in the development of a robust STEM workforce in North Carolina by enabling high school teachers to develop relevant and motivating curriculum based on real-world aerospace-related externships during the summer of 2013. Applications were solicited from two North Carolina STEM Schools - Wayne School of Engineering and NC State Early College High School – for the externship program. Applicants applied for the externship program as if they were applying for a job at LORD Corporation. Once completing the application and interview process, LORD Corporation chose two NC STEM high school teachers to spend four weeks as LORD externs. As LORD externs, the STEM teachers were treated as LORD engineers. They worked on projects that are relevant to current work at LORD. Furthermore, each extern was provided a LORD mentor and given time and resources to develop curriculum for modules and courses at their respective high schools during the 2013/14 school year. The LORD mentor provided

additional guidance on current projects and served as a supplemental resource for transitioning LORD programs and projects into teachable material.

- *Building STEM Linkages from Secondary Education to Higher Education: Integration of Earth and Environmental Science with Geographic Information Science,* Dr. Thomas Crawford, Department of Geology, East Carolina University. This project was designed to build linkages with secondary and higher education that enhance teacher professional development and encourages high school students to seek higher education STEM degrees in some combination of Earth/Environmental Science and/or Geographic Information Science. Along with Earth/Environmental Science, Geographic Information Science (GISc) is federally recognized as STEM designated degree program that deals with the theory and application of digital geographic data and information technologies using Geographic Information System (GIS) softwares. Integrating GIS into the K-12 curricula presents challenges due to the fact that very few K-12 teachers have been trained on fundamental GISc principles and GIS software applications. In March 2012, North Carolina signed a statewide license for unlimited use of the Environmental Systems Research Institute's (ESRI) ArcGIS software within K-12 education. The new statewide license provides a critical opportunity to engage teachers and students with the integration of multiple STEM disciplines; however, without professional development the opportunity afforded by the new statewide software license will be missed.

  In consultation with North Carolina's Department of Public Instruction and a local Earth Science high school teacher, Dr. Crawford produced a series of five laboratory GIS modules that will assist teachers in the delivery of NC Standard Course of Study Essential Standards in Earth/Environmental Science. Four of the five modules incorporate NASA observational data including: Landsat; Advanced Very High Resolution Radiometer (AVHRR); Tropical Rainfall Measuring Mission (TRMM); National Land Cover Dataset (NLCD); Shuttle Radar Topography Mission (SRTM); and Suomi (e.g. night time lights imagery).

  Dr. Crawford will demonstrate the modules during a one-day training workshop in Spring 2014 at East Carolina University's Center for Geographic Information Science. Digital versions of course modules will be established on a website hosted by the Center for Geographic Information Science at East Carolina University.

NCSG continued its partnership on a NASA K-12 Cooperative Agreement Notice awarded to the NC Science, Mathematics and Technology Education Center, that was initiated in FY2010 and was extended through a no-cost extension through the fall of 2013. *Flight Fellowships: STEM in Aerospace Science and Aeronautics* was an innovative professional development model brought together a coalition of high school teachers, research scientists and industry leaders in North Carolina. A total of 26 expert teachers (in three cohorts FY10-FY13) were competitively selected to learn about contemporary aerospace science and develop innovative, locally relevant curriculum using NASA educational resources to motivate students to pursue STEM study and careers in aerospace. Each Flight Fellowship included a mentored summer research externship, professional development institutes, and a mid-year professional development workshop. In the final FY13 cohort, four teachers were selected (representing 4 NC school districts) for Flight Fellowships at the following industries/organizations: CommScope, US Navy Fleet Readiness Center, Ingersoll Rand, and the Morehead Planetarium and Science Center at UNC-Chapel Hill.

NCSG precollege education program contributed to NCSG Goal 5. Objectives 5.1 and 5.2 were met.

NASA EDUCATION OUTCOME 3:

Five 'Informal Education and Public Outreach' awards were competitively awarded through partnerships with informal education venues and community groups. Participant data for these activities were not available at the time of this report (FY13 projects conclude June 30, 2014).

- *Introduction to Alternative Energy Sources to K-12 Students,* Dr. Althea Bluiett, Elizabeth City State University. NCSG provided support for the development of a series of physics demonstrations to deliver to local schools and informal science venues. In order to attract more students into STEM disciplines, educators must generate interest in the subject matter and discover ways to motivate students to learn. Teaching physics, in particular, is often challenging for instructors because it is a discipline that involves a connection between abstract mathematical concepts and real-life, concrete physical phenomena. Moreover, many students do not take physics in high school since it is not required, and as a result students are not prepared, nor motivated, to enroll in physics courses at colleges and universities.

  In an effort to garner interest and excitement in the physics discipline, Dr. Bluiett selected energy as a focal topic for outreach to elementary and middle schools, as well as two informal science venues, in Pasquotank County. Through a series of lectures, demonstrations, and hands-on activities, students gained a more concrete understanding of conventional energy (fossil fuels) and discovered more environmentally-friendly alternative sources of energy (solar, wind, water, as well as hydrogen fuel cell technologies).

- *A NASA Inspired Outreach Program for North Carolina American Indian Youth,* Dr. Tim Ritter, University of North Carolina at Pembroke (UNC-P). UNC-P is located in Robeson County, which is the second largest county in North Carolina, and home to almost 50,000 members of the Lumbee Indian tribe. According to findings of the State Advisory Council on Indian Education (2012), education leaders must "….inspire with purpose and passion". The report goes on to recommend that "Given the critical shortage of American Indians in STEM fields, students should receive early exposure to STEM disciplines…". For the past four years, NCSG has provided support for Dr. Ritter's microgravity research team, named the "Weightless Lumbees", to provide outreach to American Indian communities and economically challenged regions of North Carolina. The "Weightless Lumbees" team is comprised of undergraduate STEM and non-STEM majors from UNC-P, UNC-Charlotte and Robeson Community College who work to develop a research plan for the NASA Reduced Gravity Student Flight Opportunities Program. Students have shared their experiences and served as role models young people attending the same schools they themselves had attended at one time.

  NCSG funds were used in FY13 to expand outreach efforts of the "Weightless Lumbees" into other underserved areas of the state in order to inspire others to enter the scientific and engineering disciplines which have such a small American Indian representation.

- *Mobile Nanoscience Laboratory Outreach Program,* Dr. Tonya Coffey, Department of Physics and Astronomy, Appalachian State University. NCSG provided funds to establish (reported in FY12) and deliver (FY13) a mobile nanoscience laboratory outreach program in Western, North Carolina that puts state-of-the-art technologies such as scanning electron microscopy (SEM) directly in the hands of K-12 students and the general public. The overall goal of the nanoscience laboratory outreach is to integrate technologies into the existing curricula in order to: (1) improve students' understanding of core STEM concepts, (2) pursue new active, inquiry-based learning materials in order to increase fundamental understanding of science pedagogy, and (3) assess student learning with the new learning materials.

  Dr. Coffey, along with a team of four undergraduate students, traveled to middle and high schools in 14 counties; the majority of these counties are rather far from large population centers with easy access to advanced technologies, such as Charlotte or the Research Triangle Area. NCSG funds provided the initial seed funding (FY12 and FY13) to establish the outreach program. To make this program sustainable and more widespread, Dr. Coffey and her students have disseminated evaluation results nationally and internationally via the NanoEd Resource Portal and publication of the project in peer-reviewed journals. The published works will give the program credibility, and enable Dr. Coffey to pursue longer term funding options for the project.

- *Science Saturday Program on Space Biology, Materials, and Medicine,* Dr. Roger Narayan, Department of Biomedical Engineering, NC State University. Informal science education programs play an important role in disseminating information on scientific activities to students and teachers. These programs also stimulate young people to consider science, technology, engineering and math careers. NCSG provided support to continue the Science Saturday Program on Space Biology, Materials, and Medicine, a series of monthly lectures and scientific demonstrations that has been provided at the North Carolina Museum of Natural Sciences, and supported by NCSG since 2009. The goal of this program is to show young people and their families that people from a wide variety of backgrounds are active in space science research. All activities are hosted at the North Carolina Museum of Natural Sciences in the Nature Research Center (NRC). The NRC features research labs where resident or visiting scientists conduct their research while visitors observe science "in action" in an effort to increase the public's awareness of, and appreciation for, the importance and relevance of science and science research to daily life.

  The hands-on demonstrations and lectures present topics involving space science in an engaging and approachable manner to elementary school students, middle school students, high school students, and their families. Enthusiastic science communicators from NCSG Affiliate universities (North Carolina State University, North Carolina A&T State University, North Carolina Central University, University of North Carolina at Chapel Hill, and University of North Carolina at Pembroke) and others who are current or past recipients of NC Space Grant and/or NASA funding are invited to serve as presenters in the Science Saturday program. In particular, recipients of NCSG New Investigator grants are encouraged to discuss the results of their NC Space Grant-funded research activities. Students are provided with take-home kits that contain important information from the Science Saturday lectures and hands-on demonstrations. Other deliverables from the outreach program include (a) a dedicated website that contain recorded lectures as well as (b) teacher toolkits that contain

hands-on demonstration materials (Dr. Narayan engages a graduate student organizer to visit local schools and meet with teachers and disseminate materials).

- *NC Science Festival's Statewide Star Party,* Mr. Jonathan Frederick, Director, NC Science Festival, Morehead Planetarium and Science Center at UNC-Chapel Hill. Building upon the successes of the inaugural Statewide Star Party event in 2013 (FY12), NCSG continued its partnership with the NC Science Festival and provided support for the event scheduled for April 4-5, 2014. Funds will be used to support 35 star party events across North Carolina, looking at the real sky (solar or night-time observing) and open to the general public (i.e. no planetarium-only events). The second annual Statewide Star Party will have a new thematic focus: the Moon. Lunar observing and activities will greatly enhance the capacity of hosts to conduct astronomy programming. To support the Star Party hosts, each site will receive a star party kit that feature new and different materials compared to the 2013 kits, which focused on dark skies education. The Project Manager has identified online NASA content, including the Night SkyPlanner on the NASA Jet Propulsion Laboratory's Night Sky Network website, which will be especially helpful for hosts. Other useful NASA resources for the kits and webpage include information on when a spacecraft will be visible from a specific location; past, current and future NASA missions (specifically the LADEE lunar mission), as the Moon will be visible on the nights of the event; engaging astronomy activities for children of all ages; and NASA/STEM career advice for middle school students and older.

  In combination with the NASA resources, the major components of the kits will include a children's storybook that focuses on the Sun, the Moon and stars; a moon observing guidebook; a laminated moon map; activity materials and Morehead's customized star charts. The hosts will also receive tips on hosting successful skywatching sessions, and lists of suggested targets for naked-eye, binocular and telescope observing.

NCSG and its Affiliates provided funds to support local/regional events that engage students and the general public in STEM careers and NASA activities. Projects included:

- Support for two visually impaired high school students to participate in the National Federation of the Blind's 2013 Summer Youth Slam. This five-day academy engages and inspires the next generation of blind youth to consider careers in STEM. While staying on a college campus, students are mentored by blind role models during hands-on activities designed to build confidence and increase science literacy.
- Support for Guilford County School's participation in the Student Spaceflight Experiment Program Mission 5 to the International Space Station (fourth mission supported by NCSG funds). Thirteen middle schools participated in microgravity experimental design and proposal writing (approximately 300 students), and 60 flight experiment proposals were submitted from student teams. A student team proposal from Mendenhall Middle School was selected as the research project to fly onboard Orbital Sciences Orb-2 (Antares rocket, Cygnus spacecraft) scheduled for launch in May 2014.
- Support for a graduate student at UNC-Charlotte to develop hands-on activities for the summer UNC-Charlotte Summer Camps on Robotics program. The activities concentrated on robotics in space exploration and took place during 3 hours of each of the 30 hour summer camps. One exercise involved remote controlled underwater robotics, which was intended to mimic controlling a vehicle in space. Over the 7 weeks of the summer camps, she interacted with 168 elementary, middle school, and high school campers.

NCSG informal education and public outreach program contributed to NCSG Goal 6. Objectives 6.1 and 6.2 were met.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- Student Data and Longitudinal Tracking: Total awards = 248; Fellowship/Scholarship = 56, Higher Education/Research Infrastructure = 192; 57 of the total awards represents underrepresented minority F/S and HE/RI funding. During the FY13 program year 43 students are pursuing advanced degrees in STEM disciplines, 14 accepted STEM positions at NASA contractors, 57 accepted STEM positions in industry, 1 accepted a position at NASA, 1 accepted a STEM position in K-12 academia, 4 accepted STEM positions in academia, and 38 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while the received their Space Grant award.
- Diversity: NCSG Affiliates include: 6 four-year baccalaureate through doctorate institutions, 5 four-year baccalaureate through masters institutions, and 1 four-year baccalaureate institution. Of the 12 NCSG university Affiliates, 4 are Minority Serving Intuitions. Furthermore, the NC Community College System is an Affiliate and is comprised of 58 two-year associate degree granting institutions. All students and faculty attending a NCSG Affiliate institution were eligible to compete for NCSG support in FY13. Of all students receiving direct support, 23.3% were minority students and 27% were female.
- Minority-Serving Institution (MSI) Collaborations: NCSG has 4 MSIs that are active Affiliates of the consortium: Elizabeth City State University (ECSU), NC A&T State University (NCA&T), NC Central University (NCCU), and Winston-Salem State University (WSSU). Each of these universities received funding from NCSG in FY13 to implement programs on their campuses that contribute to NASA and NCSG.
  - ECSU: supported 4 student research scholarships (Outcome 1); hosted an in-service teacher professional development workshop on planetary geology (Outcome 2); provided funds for the ECSU Planetarium and Port Discover Science Museum to implement astronomy programs in the community (Outcome 3).
  - NCA&T: supported senior aerospace design activities and team participation in the Lockheed Martin/SAE Aero-Design competition (Outcome 1); provided support to Win-Win Resolutions BOTSO/LOTSO after school mentoring program (Brothers/Ladies Organized to Serve Others) to send a group of middle and high school students to NASA Langley (Outcome 3).
  - NCCU: supported 2 minority students in hands-on research activities mentored by faculty (Outcome 1).
  - WSSU: awarded one Undergraduate Scholarship through NCSG competition (Outcome 1); provided support for 21 students to present their research at national professional conferences (Outcome 1); student-led outreach in the local community (Outcome 3).
- NASA Education Priorities: NCSG accomplishments related to the "Current Areas of Emphasis" include:
  - Authentic, hands-on student experiences in science and engineering disciplines: project examples described in 'Program Accomplishments – Outcome 1.'

- Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise: 2 projects funded that support middle school professional development (described in 'Program Accomplishments – Outcome 2').
- Summer opportunities for secondary students on college campuses: NCSG did not perform any programs in this area of emphasis in FY13.
- Community Colleges: NCSG offers the competitive Community College Scholarship program to students attending any NC campus and are majoring in a STEM discipline. NCSG also supports student teams from Guilford Technical and Mitchell Community Colleges to participate in national competitions (described in 'Program Accomplishments – Outcome 1').
- Aeronautics research: Faculty at NC A&T State University (NCAT) are actively engaged in research related to NASA's Next Generation Air Transportation System and engage students in research activities (through collaborations at NASA Glenn Research Center and the Air Force Research Laboratory at Wright Patterson Air Force Base). NCAT's NASA funded Center for Aviation Safety (CAS) conducts engineering research and education in three major areas (Advancing Composites and Structures; Integrating Vehicle Health Management and Advancing Aeromechanics and Propulsion) to address the challenges of NASA's Aeronautics Research Mission Directorate's Fundamental Aeronautics and Aviation Safety Programs.
- Environmental Science and Global Climate Change: NCSG provided funds to support two 'New Investigators' faculty research projects and one 'K-12 Professional Development' project that are directly tied to environmental science and global climate change studies that utilize NASA data and resources (see 'Program Accomplishments – Outcome 1' and 'Program Accomplishments – Outcome 2').
- Diversity of institutions, faculty and student participants: as described in NCSG Goal 4, a common thread throughout all programming areas is to increase the participation of women, underrepresented minorities, and persons with disabilities. The composition of NCSG Affiliates (4 of which are Minority Serving Institutions) provides opportunities for minority populations to engage in NCSG programs. In FY13, 23.3% of student receiving direct support were from underrepresented minority groups and 27% were female. Furthermore, of the 24 faculty receiving direct NCSG support, 20% were females.
- Enhance the capacity of institutions to support innovative research infrastructure activities: the NCSG 'New Investigators' program is designed to strengthen North Carolina's aerospace-related research infrastructure by providing startup funding to early career university faculty who are conducting research that is directly aligned with NASA's Strategic Framework. Four 'New Investigators' projects were awarded in FY13 (described in 'Program Accomplishments – Outcome 1').

IMPROVEMENTS MADE IN THE PAST YEAR

- With approval of the NCSG Consortium Executive and Advisory Boards, NCSG hired an Assistant Director of Partnerships and Resource Development. This EPA time-limited, 0.75 FTE position is funded through state government funds. This position has responsibility for developing partnerships among universities, community colleges, and informal education centers; fund development via grant writing and proposal coordination in response to government entities and other organizations; and partnership development with individual

donors, corporations, and foundations. The Assistant Director of Partnerships and Resource Development began work in the fall of 2013 and reports to the Director of NCSG.
- In FY13, NCSG and Connecticut Space Grant (CTSG) formed a partnership to offer aviation-based workshops in in alternate years (see 'Program Accomplishments – Outcome 1, Higher Education' for full description). In the summer of 2014, NCSG, in collaboration with CTSG, NCSU, US Navy Fleet Readiness Center-East, and Craven Community College, will host the Aircraft Readiness Engineering Workshop in Havelock, NC.
- In FY13, NCSG leveraged $130,000 ($90,000 in FY12) beyond its core Fellowship and Scholarship funding to support student internships in aerospace industry at the LORD Corporation.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

NCSG has an organizational structure that enables each Affiliate member to play a significant role in project development and implementation of programs. Overall direction, policies, rules of governance, and budgetary priorities are established through consensus by the Consortium Executive Board, which consists of the NCSG Director and Campus Directors from each of the following thirteen Affiliate institutions:

Appalachian State University is a 4-year, Baccalaureate and Master's degree granting public university. ASU facilitates programs that contribute to NASA Education Outcomes 1-3.

East Carolina University is a 4-year, Baccalaureate, Master's and PhD degree granting public university. ECU facilitates programs that contribute to NASA Education Outcomes 1-3.

Elizabeth City State University is a 4-year, Baccalaureate degree granting public university and is classified as a HBCU. ECSU facilitates programs that contribute to NASA Education Outcomes 1-3.

Duke University is a 4-year, Baccalaureate, Master's and PhD degree granting private university. Duke facilitates programs that contribute to NASA Education Outcome 1.

North Carolina Agricultural and Technical State University is a 4-year, Baccalaureate, Master's and PhD degree granting public university and is classified as a HBCU. NCA&T facilitates programs that contribute to NASA Education Outcomes 1 and 3.

North Carolina Community College System is comprised of 58, 2-year Associate degree granting institutions across the state. The NCCCS facilitates programs that contribute to NASA Education Outcomes 1 and 3.

North Carolina Central University is a 4-year, Baccalaureate and Master's degree granting public university and is classified as a HBCU. NCCU facilitates programs that contribute to NASA Education Outcome 1.

North Carolina State University is a 4-year, Baccalaureate, Master's and PhD degree granting public university. NCSU facilitates programs that contribute to NASA Education Outcomes 1-3.

University of North Carolina at Asheville is a 4-year, Baccalaureate degree granting public university. UNCA facilitates programs that contribute to NASA Education Outcomes 1-3.

University of North Carolina at Chapel Hill is a 4-year, Baccalaureate, Master's and PhD degree granting public university. UNCCH facilitates programs that contribute to NASA Education Outcomes 1-3.

University of North Carolina at Charlotte is a 4-year, Baccalaureate, Master's and PhD degree granting public university. UNCC facilitates programs that contribute to NASA Education Outcomes 1-3.

University of North Carolina at Pembroke is a 4-year, Baccalaureate and Master's degree granting public university. UNCP facilitates programs that contribute to NASA Education Outcomes 1-3.

Winston-Salem State University is a 4-year, Baccalaureate degree granting public university and is classified as a HBCU. WSSU facilitates programs that contribute to NASA Education Outcomes 1 and 3.

In addition, partnerships with industry, government and nonprofit agencies help NCSG achieve its strategic goals and objectives. Consortium partners include:

Industry Partner:
LORD Corporation is a worldwide leader in adhesives and coatings, vibration and motion control, and magnetically responsive technologies. Operating from world headquarters in Cary, North Carolina, LORD Corporation has 17 manufacturing facilities in nine countries and 90 strategically located sales and support centers worldwide. NCSG partners with LORD to offer the NCSG/LORD Corporation Summer Internship program. Since 2008, 36 students have participated in the program, which is fully funded by LORD. LORD contributes to NASA Education Outcome 1.

Education Partners:
North Carolina Science, Mathematics and Technology Center (SMT) promotes innovation in science, mathematics, and technology learning in the state's elementary and secondary public schools. NCSG partners with the SMT Center to implement the NASA Flight Fellows program. SMT contributes to NASA Education Outcome 2.

Kenan Fellows Program for Curriculum and Leadership Development (Kenan Institute for Engineering, Technology & Science) promotes teacher leadership, addresses teacher retention and advances K-12 science, technology and mathematics education. NCSG partners with the KFP to implement the NASA Flight Fellows program. The KFP contributes to NASA Education Outcome 2.

Pisgah Astronomical Research Institute (PARI) is a not-for-profit foundation dedicated to providing hands-on educational and research opportunities for a broad cross-section of users in science, technology, engineering and math (STEM) disciplines. NCSG partners with PARI to

provide opportunities for students to conduct astronomical and/or engineering-based research projects. PARI activities contribute to NASA Education Outcome 1.

North Carolina Museum of Natural Sciences (NCMNS) is a state-funded museum that provides opportunities for visitors to explore the natural world through hands-on exhibits and programs. NCSG annually participates in the museum's Astronomy Days event. NCMNS activities contribute to NASA Education Outcome 3.

Student Spaceflight Experiments Program (SSEP) is an initiative by the National Center for Earth and Space Science Education, in partnership with NanoRacks, LLC, that provides opportunities for students to design, build and fly experiments in low Earth orbit. NCSG partners with SSEP to provide opportunities for NC middle school students to participate in the program. NCSG SSEP activities contribute to NASA Education Outcome 3.

Virginia Space Grant Consortium (VASGC) is part of the National Space Grant College and Fellowship Program. The Director of the VASG serves as a member of the NCSG Advisory Board.

Government Partners:
NASA Langley Research Center (LARC) provides opportunities for students and faculty to engage in aerospace research. NCSG activities at NASA LARC contribute to NASA Education Outcome 1.

University of North Carolina General Administration oversees the multi-campus university system composed of 16 public senior institutions of higher education and the NC School of Science and Mathematics. NCSG partners with UNCGA to ensure that strategic goals and programs align with North Carolina education priorities for higher education.

The National Space Grant Office requires two annual reports, the 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.