

The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) 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.

Arizona Space Grant Consortium
Lead Institution: The University of Arizona
Director: Timothy D. Swindle
Telephone Number: 520-621-4128
Consortium URL: Spacegrant.arizona.edu
Grant Number: NNX10AI41H

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 Arizona Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2014.

PROGRAM GOALS

The AZSGC mission is to expand opportunities for Americans to learn about and participate in NASA's aeronautics and space programs by supporting and enhancing science and engineering education, research, and outreach programs that integrate research with education to help build a diverse, scientifically literate citizenry and a well-prepared science, engineering and technology workforce. Our vision is to extend the arms of NASA--expanding our universities' capacity to conduct research and doing it in such a way that educates the next generation of scientists and engineers, all in direct partnership with industry and NASA demanding new talent and the latest innovations.

- AZSGC Management goals: Engage prominent and diverse partners to lead high quality education, research and outreach programs providing Arizonans opportunities to learn about and engage in NASA's mission and research, while benefitting our state's research enterprise and educating America's future STEM workforce.
- AZSGC Fellowship goals: Expand representation among active scientists and engineers, of our nation's diverse population. Design programs to be accessible to students from a variety

of backgrounds, including those in non-technical disciplines and to improve and inform graduate and undergraduate education by providing experiences for a substantial number of students which will contribute in a number of ways, including fostering some students toward professional careers in aerospace science and technology, while also fostering understanding, appreciation and sensitivity to space science and engineering as important national endeavors. To demonstrate success in meeting these goals, all fellowship/scholarship program awardees will be tracked to “next steps”.

- AZSGC Research Infrastructure goal: Sponsor innovative programs in space science/engineering focused research and design, with associated opportunities to apply classroom knowledge to real-world, NASA-focused problems.
- Higher Education goals: Recruit and support a diverse group of participants, promote initiatives to develop interdisciplinary courses/curriculum and teacher training, sponsor group educational activities for Interns, Fellows and others to complement and enhance student learning, to foster a sense of community by building linkages and promoting networking among students, faculty, researchers, industry professionals and the public, and to provide a diverse group of students opportunities for educational/professional growth and promotion.
- Precollege goals: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty with special focus on training STEM educators—not only to excite and inspire P-12 students—but to excite and inspire while instilling basic competencies to insure that AZ students are prepared and able to study science in college.
- Public Programs goals: Engage members of the public from traditionally underrepresented groups, bridge the gap between Earth systems science research, geospatial technology and societal needs in Arizona, leverage funding to extend the reach of Space Grant beyond direct investment, support science education needs in underserved areas of our state, engage our students in informal education initiatives and track impacts and evaluate programs success via quantitative and qualitative methods (plus longitudinal tracking of graduate fellow/undergraduate intern participants) to insure continuous process improvement.

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

For succinctness, throughout this report NASA Education Outcomes and Education Priorities are referred to by number: Employ and Educate as Outcome 1; Educate and Engage as Outcome 2; Engage and Inspire as Outcome 3; Hands on student experiences as **NEP1**; Middle school teachers as **NEP2**; Summer opportunities for secondary students as **NEP3**; Community colleges as **NEP4**; Aeronautics research as **NEP5**; Environmental Science and Global Climate Change as **NEP6**; Innovative research infrastructure as **NEP7**; and Diversity as **NEP8**.

AZSGC has become a catalyst for synergy between NASA, industry, and Arizona’s education/research efforts. Programs extend the arms of NASA—expanding our universities’ capacity to conduct research and doing it in a way that educates our next generation of scientists and engineers, directly contributing to Outcome 1 while also addressing each of NASA’s nine education priorities.

We use our presence at universities and partnerships with Arizona research organizations, federal research labs, and industry, to integrate smart, motivated students into current research programs and missions, which serve as ideal "classrooms" for training the next generation of aerospace

professionals, and then leveraging student research into outreach designed to promote the understanding of NASA-related research by engaging precollege audiences and the public (Outcomes 2 and 3). Simultaneously, researchers get student workers at an affordable cost, which in turn extends research program capabilities, learning and accomplishments. Integrating students into leading-edge research programs serves as a launchpad into our nation's STEM workforce and top graduate programs (Outcome 1). Select FY 2014 examples (representing many more) are:

Outcomes 1, and 3 (NEP1, 6, 7): In FY 2009, NAU undergraduate Eric Betz, a triple major in science journalism, astronomy, and physics, was awarded a mentored Space Grant Internship to work as a student science reporter at the *Arizona Daily Sun*, one of Arizona's largest daily newspapers. As an Intern, he wrote 11 articles published over a Space Grant byline--many of these on NASA-focused research. Upon graduation, he spent one year as a science writer for the American Institute of Physics, then returned to Flagstaff and was hired by the Daily Sun where he worked for three years as a senior reporter, responsible for covering science and the environment. During that time, he bylined over 1,300 stories and became the most-read name in local/regional news in and around Flagstaff, Arizona, an astronomy town and home to Lowell Observatory, the US Naval Observatory, USGS Astrogeology Science Center, NAU and others. He also mentored NAU Space Grant science writing interns at the Daily Sun until August 2014, when he was hired as an Associate Editor for *Astronomy Magazine*, the world's best-selling astronomy magazine. He now writes and edits news and science features, showcasing NASA research and discoveries to a world-wide readership.

Outcomes 1, 2, and 3 (NEP1, 5, 7, 8):

FY 2014 ASU/NASA Space Grant Graduate Fellow Michael Thompson is a Hispanic PhD student in Mechanical Engineering, and ASU's Academic Director for the Society of Hispanic Professional Engineers (SHPE). He is passionately interested in the development of biomimetically inspired micro air vehicles (MAVs). He is equally passionate about empowering other minority students to pursue STEM educational tracks/careers through experiencing the excitement and challenges of being an engineer. His Space Grant Fellowship provides an opportunity to marry his passions by leading project STEAM (Science, Technology, Engineering, Arts, and Mathematics) Enrichment Program activities. Working in partnership with Zell Fowler, President of the Arizona Alliance of Black School Educators, professionals from local industry, and ten graduate and undergraduate peers recruited through SHPE, Michael developed and delivers an aerospace engineering curriculum, "I believe I can fly", that provides hands on educational opportunities to 60 primarily Hispanic and African American elementary and middle students from three Phoenix area Title I schools. Students learn about the principles of flight first-hand through modeling, designing, building and testing mechanical flapping-wing bird MAVs. They find the STEAM program's hands-on approach to engineering that encourages creativity and innovation, to be fun and exciting. Pre- and post-program evaluations demonstrate they are building STEM competencies and interests, along with "if they can do it, then we can do it" attitudes inspired by working alongside inspiring minority role model engineers and engineers-in-training.

Outcomes 1, 2, and 3 (NEP1, 4, 6, 7, 8):

In FY 2012, Pima Community College (PCC) student Erica Hernandez was awarded a UA/NASA Space Grant Undergraduate Research Internship to work on the development of UA's NASA Steckler Lunar Greenhouse Prototype for Bioregenerative Life Support (LGH) program. As she gained experience and proficiencies, Erica assumed more and more responsibility for the day-to-day operations of the LGH system, contributing to structure development, fabrication, performance analysis, and a modified energy cascade model. She also participated in many public outreach activities, giving LGH facility tours to interested student, public, dignitary, and professional groups, and maintained healthy and attractive crops for public viewing and use in closure period experiments. In April 2013, Erica was selected to represent LGH at the 2013 Biotechnology Industry Organization (BIO 13) conference in Chicago. She did an impressive job of interacting with conference participants from around the world, and contributing to a live interview on the LGH bioregenerative life support system for a televised Chicago newscast. Dr. Gene Giacomelli, her Space Grant Mentor, facilitated Erica's participation in numerous "short courses" and professional conferences. In May 2014, Erica completed her PCC degree, and enrolled full-time at the UA. In July 2014, she co-authored and presented a paper at the International Conference on Environmental Systems (ICES), and in August, was competitively selected for a FY 2014 UA/NASA Space Grant Intern Advisor position, to mentor and serve as a role model for first-year Interns while continuing her LGH research and development efforts. She is currently setting up a LGH outreach and teaching module at the Biosphere 2 (B2), to educate school groups and about 100,000 B2 visitors each year, about the challenges of growing NASA priority food crops via a remotely controlled hydroponic greenhouse. Erica and her LGH Space Grant work is featured in an article, "How to Make a Meal on the Moon" in *Edible Baja Arizona* magazine's January-February 2015 issue (<http://issuu.com/edibleba>). Space Grant has been paramount in Erica's extraordinary undergraduate experience, providing many opportunities to learn from and interact with professionals in the important STEM workforce sector of controlled environment agriculture, she plans to enter. Erica reports, "Space Grant has given me the opportunity to not only be exposed to exciting and interesting research projects, but to participate in and contribute to research that I feel is important and life-changing."

PROGRAM ACCOMPLISHMENTS

Fellowships Programs: In FY 2014, AZSGC sponsored 6 Fellowship programs directed to Outcome 1, with select Internship and all Graduate Fellowship projects also contributing to Outcomes 2 and 3. Programs are designed to address Fellowships goals (above); 2014 accomplishments are measured against SMART objectives below:

1. **Support ≥ 87 students:** There were 144 Fellowships/Scholarships awarded to 130 undergraduates and 14 graduate students.
2. **Support a diverse group of students with at least 24% from underrepresented groups:** Of the total awards, 52 (36.1%) went to students from underrepresented minorities. In addition 5 undergraduate awardees have disabilities.
3. **Support 45% women:** Of 144 awardees, 70 (48.6%) are female.
4. **Support students from diverse academic backgrounds representing >30 majors:** 2014 students reported 45 distinct academic majors. 27 Interns and 2 fellows are considering pre-service teaching tracks.
5. **Promote quality outreach and community service programs with contributing partner organizations:** AZSGC supports 14 Graduate Fellows who designed and

implemented programs, and 44 ASU Interns contributed 20 or more hours to STEM outreach in local schools or other public venues delivered through precollege, higher education, and informal education components, which gave many others opportunities to participate in NASA's science, engineering and education (Outcomes 1, 2, 3).

6. **Support mentored (NASA-focused), Undergraduate Research Internships with Arizona, NASA and industry researchers:** 130 Undergraduate Research Interns from UA, ASU, NAU, ERAU, Pima Community College (PCC), and Coconino Community College (CCC), from a variety of backgrounds and technical and non-technical disciplines, are working with 101 researchers from Arizona's universities and research sector, on hands-on professional work experiences on university campuses, in local industry and at NASA Centers, focusing on science/engineering, education, journalism and science policy (Outcomes 1 and 2).
7. **Program participants and their research will generate >10 professional publications, presentations and proposals:** In FY 2014 to date, Science writing interns wrote 24 published articles with Arizona Space Grant bylines for two major AZ newspapers. 28 AZSGC authors published articles, 12 submitted papers not yet published, 4 presented invited papers, and 7 delivered self-submitted papers with a review process supported by Space Grant Fellowship efforts. In addition, 3 proposals were submitted to date, with one funded for \$150,000.
8. **Evaluate programs' success via quantitative and qualitative methods to ensure continuous process improvement:** Participants will complete written program evaluations, Graduate Fellows will make formal outreach program review presentations to steering committee members and interested members of the university community, and student tracking records were generated and will be updated for all program awardees.
9. **85% of program graduates will pursue advanced degrees in NASA-related STEM fields, and/or join the nation's STEM workforce:** Of (1079 total) AZSGC 2006-2014 Fellowship/Scholarship significant award recipients: 814 have completed degree programs, 35 seeking STEM employment are considered "still-to-be tracked". The remaining 779 have taken next steps, and of these, 735 (94%) are now employed in STEM fields or are pursuing additional STEM degrees.
10. **Leverage program funding:** AZ/NASA Space Grant Fellowships funds (\$263,752) are highly leveraged with Arizona dollars (\$214,882), and (\$61,303) of other federal cost sharing.

In total, AZ Fellowship programs directly addressed NASA Education Outcomes 1 with Outcomes 2 and 3 addressed through Intern community service, and through major Graduate Fellowship outreach programs conducted with a diverse group of cost-sharing stakeholders and educational partners. NASA priorities and current areas of emphasis (NP1, 2, 4, 5, 6, 7, and 8), and all goals and SMART objectives were met and exceeded.

Research: In FY 2014 to date, 133 students participated in 8 AZSGC sponsored Research programs directed to Education Outcome 1. In addition, two programs have Precollege and Informal Education components contributing to Education Outcomes 2 and 3 (ASU Robotics, Daedalus Astronautics). *It should be noted that data in this progress report, collected earlier than in recent years, reflects fall semester accomplishments; a balloon-sat program at Dine Tribal College scheduled for March 2015 will bolster participant diversity.* Programs are

designed to address the Research goals (above) and 2014 accomplishments are measured against the SMART objectives below.

1. **Support 30% diversity:** There are 133 participants (21%) from under-represented ethnic/racial groups; 54% of funded students are underrepresented.
2. **Support 45% women:** Of 133 students, 35 (26.3%) are women.
3. **Sponsor >6 multi-disciplinary, student led and directed team engineering programs:** AZSGC supported 7 team projects including 1) a statewide balloon satellite program, ASCEND! (UA, ASU, ERAU, PCC, SMCC, GCC; Diné); 2) Robotics Team Projects (ASU); 3) Daedalus Astronautics Rocketry Team (ASU); 4) HASP (ERAU); 5) EagleSat (CubeSat) development (ERAU); 6) Moonbuggy/NASA Human Exploration Rover (ERAU); and 7) HiBal (ERAU).
4. **Build relations with NASA and aerospace industry:** Research and design programs 1, 2, 3, 4, 5, 6, and 7 (Objective 3 above) were conducted in direct partnership with NASA centers and/or aerospace industry
5. **Grow ERAU and ASU R&D by at least 2 programs over 5 year grant cycle:** ASU and ERAU have supported 6 new team engineering programs since 2010.
6. **Support at least 5 teams in a statewide balloon-sat program:** 7 college and university teams (including 4 MSIs/HSIs) participated in “ASCEND!” our statewide balloon satellite program in 2014 with opportunities to experience the full design-build-fly-operate-analyze cycle of space missions; 49 undergraduate students participated during fall semester with some additional participants expected to join in the spring. All participants will present the results of their flight experiments in a dedicated “ASCEND!” session at our Statewide Symposium in April 2015 (see Higher Education).
7. **Promote NASA-focused astronomy learning, hands-on education and research through the 15 colleges/universities National Undergraduate Research Observatory consortium (NURO):** NAU SG provided small travel grant reimbursements for 15 students from NURO, competitively selected to travel to Arizona with mentors, and observe on a 31-inch telescope owned by Lowell Observatory/administered by NAU.
8. **Leverage program funding:** AZ/NASA Space Grant Research funds (\$37,000) are leveraged with Arizona dollars, bringing an additional \$7,750 to these workforce development programs in 2014 (funding for some student participants is reported in Fellowships above).

Cumulatively, programs help foster relations with NASA centers and aerospace industry, while directly contributing to Outcomes 1, 2, and NEP1, 4, 6, 7 and 8. All programs met the AZSGC Research goal of providing authentic, hands-on student (team engineering, research, and design) experiences rooted in NASA-related topics and incorporating real-life problem-solving and needs with a strong workforce development focus. All program area SMART objectives were met with the exception of objectives 1 and 2; we did not achieve the desired levels of ethnic/racial or gender diversity of overall participants. We far exceeded objectives for ethnic/racial diversity of direct funded students.

Higher Education: In FY 2014, AZSGC sponsored 14 higher education programs directed to Education Outcome 1, with 602 student participants to date. Programs are designed to address the Higher Education goals (above) and accomplishments are measured against the SMART objectives below:

1. **Support 30% diversity:** A total of 602 participants, 227 (38%) are from underrepresented groups.
2. **Support 45% women:** Of the 602 students 239 (40%) are female.
3. **Include at least 5 minority serving institutions/initiatives:** PCC Northwest, PCC West, SMCC, GCC, TOCC and Diné are AZSGC affiliate partners participating in FY 2014 programs. Four additional (MSI) community colleges (Signal Peak, Estrella Mountains, Phoenix College, and Superstition Mountain) were brought into a successful AZSGC proposal team that won a Space Grant augmentation community colleges grant.
4. **Support ≥ 5 multidisciplinary group activities:** Supported activities are: 1) SEDS research, promotion, precollege and community outreach (UA); 2) Statewide Symposium (UA, ASU, NAU, ERAU, SMCC, PCCC, GCC, CCC); 3) Multidisciplinary courses development (UA, ASU, SMCC, GCC, PCC); 3) Education/networking and promotion activities for Space Grant Community members: networking and team building activities, a private show at Flandrau Planetarium and planned for spring 2015 a brown-bag lunch series with guest speakers, a behind the scenes Earth sciences tour of Biosphere 2, and a workshop for underrepresented students on writing competitive applications to programs like Space Grant (UA). Orbital Space Systems engineer and ASU alum, Krzysztof Pennar, led workshops for ASU Interns on writing strong applications for aerospace sector jobs; 4) Scientific résumé, abstract and PowerPoint presentation development training workshops (UA, ASU, NAU, PCC, GCC); 5) Campus STEM outreach and program promotion events (ASU, NAU); 6) Women in Physics Conference (NAU); 7) STEM Courses Enhancement (ASU for Mesa CC, TOCC); 8) Starting a student Astronomy Club (Diné); and 9) Undergraduate Research and Design Day at NAU (spring 2015), will provide NAU Interns and others a venue to present research posters to peers, faculty and local industry.
5. **Host a statewide Undergraduate Research Internship Symposium:** In April 2014, the Twenty-Third Annual Arizona/NASA Statewide Undergraduate Research Internship Program Symposium was held, with 126 students (nine additional represented in-title-only, from across Arizona presenting on academic year-long research projects relevant to all NASA Mission Directorates.
6. **ASU outreach for recruiting:** February 11, 2015, Interns will showcase their research to the campus community via a professional poster session, along with providing hands-on demonstrations of navigating Mars terrain, water-bottle rockets, underwater robots, low-frequency cosmology demonstrations and more at the School of Earth and Space Exploration's Earth and Space Exploration Day. They will also act as docents in the Gallery of Scientific Exploration in ASU's new Interdisciplinary Science and Technology building (Objective 4 project 5).
7. **Support multidisciplinary course development:** Revised NASA science/engineering focused courses are offered at UA, ASU, PCC (HSI), SMCC (MSI), and GCC (HSI). The ASU course, co-developed by an ASU Graduate Fellow, will catalyze conceptualization, design and development of picosatellites (spacecraft < 1 kg) for an exciting mission concept called Asteroid IRIS (Asteroid Impact, Reconnaissance and Interior Sampling) Mission in the early stages of concept development by ASU faculty and JPL.
8. **Develop/support opportunities to network and promote linkages between Space Grant students, faculty, researchers, industry and NASA professionals to foster workforce development, educational/professional growth and promotion:** Higher

Education programs 1-9 (Objective 4 above) promote linkages, networking and enhanced student workforce development, educational/professional growth and promotion.

9. **Leverage program funding:** AZ/NASA Space Grant Higher Education funds (\$108,660) are highly leveraged with Arizona dollars, bringing an additional \$68,386 to these workforce development programs in 2014.

These activities and others, contribute directly to AZSGC Higher Education goals and objectives, and to Education Outcomes 1, 2, 3 and NEP1, 4, 5, 6, 7, and 8. All program area SMART objectives were met or exceeded except we fell short of our gender diversity target by 5%.

Precollege: To date in FY 2014, AZSGC sponsored 15 Precollege programs that have cumulatively served 381 formal and informal educators and 1447 Arizona precollege students. All activities are conducted in collaboration with partners to leverage funding and to extend reach; 10 programs were designed and delivered by UA and ASU Space Grant Graduate Fellows. Most programs address multiple AZSGC goals/objectives, and all contribute to NASA Education Outcome 2 (Educate and Engage). Programs are designed to address the Precollege goals (above) and accomplishments are measured against the SMART objectives below:

1. **Programs align with Arizona and National Standards:** All supported programs align with state and national standards.
2. **Direct programs to underrepresented/underserved groups and areas of greatest need:** Per the 2011 U.S. Census, Arizona's population includes 30.1% Hispanics and 5.2% American Indians. In 2010, Science Foundation Arizona reported that only 2% of Arizona's minority population pursued and graduated with STEM degrees. AZSGC is committed to addressing this serious shortcoming: 10 of 15 FY 2014 AZSGC precollege programs serve reservations or schools with high underrepresented enrollments. These include two NASA-focused programs serving reservation schools/teachers/communities including: 1) The "Navajo-Hopi Outreach program" with affiliate Lowell Observatory that is delivering hands-on NASA space science content, educational activities, field trips and guest presenters to 6 Navajo and Hopi reservation schools, 7 teachers, 6 informal educators/museum staff, and 91 students (NAU); 2) The "American Indian Mobile Education Resource (AIMER)" traveling science classroom and educators, delivered NASA Space Science educational resources, lessons, and activities to 2 middle school teachers and 100 of their students at rural reservation schools to date in 2014, with additional schools scheduled for participation in spring 2015 (NAU). Seven graduate-fellow led programs serve schools with large underrepresented populations including: 3) "Hurricanes, Societal Impacts, and the 1983 Tucson Flood", a curriculum development project about predicting extreme weather events, is carried out in partnership with the National Weather Service (UA); 4) "Racing the Sun" a solar go-cart development and race challenge that includes teams from 8 Arizona high schools, the majority with high percentages of underrepresented students (UA); 5) "Teaching and Learning through a School Reconciliation Ecology Program," conducted in partnership with Biosphere 2, serves a primarily Hispanic neighborhood school's students and teachers (UA); and 6) "Operation Soar" a 4th-6th graders student science club at Elvira elementary school (95% Hispanic) with hands-on computer science, electrical and biomedical engineering lessons and projects (UA); 7) Enriching Science Education at Cocopah Middle and Navajo Elementary Schools" provides lessons to reinforce key or difficult to understand concepts related to space sciences (ASU); 8) Development of an Applications-Based, Interactive

STEM Outreach Program at Coronado High School that includes units on aircraft engineering, swarm robotics and more (ASU); 9) I believe I can fly! STEAM program (see Michael Thompson success story above) (ASU); and 10) Interns' and ASU Manager led precollege outreach activities are largely directed to minority-serving, Title 1 schools (ASU).

3. **Programs support NASA Education:** All Native American and underserved-directed programs 1-10 (Outcome 2 above) focus on NASA research/skills-building topics, and incorporate NASA data, curricular materials and/or expertise. In addition, 11) "Are We Alone in the Universe?" (ASU); 12) Redefining a Science Curriculum for Grades 8-12 (ASU), 13) "Enhancing Statistical Fluency by Integrating Data Analysis into Biology Curriculum" (ASU); 14) "Middle School Science Clubs" (NAU); UA/AIAA Kids Club (UA); and the online educational videos development project, "Modern Geometry in Context" (UA), also integrate NASA material or aim to education and build skills to pursue NASA STEM fields in school.
4. **Programs engage middle school teachers in hands-on curriculum enhancement:** See programs 1, 2, 11 (objectives 2 and 3 above).
5. **NASA education and outreach provided to remote reservation schools via AIMER and Lowell Navajo-Hopi programs:** See programs 1, 2 above.
6. **Leverage program funding:** FY 2014 AZ/NASA Space Grant Precollege funds (\$39,500) are highly leveraged with Arizona (\$10,224) cost sharing dollars.

These and other Precollege activities contribute directly to AZSGC goals and objectives and to NASA Education Outcomes 1, 2, 3 and NEP1, 2, 3, 5, 6, 7 and 8. All program area SMART objectives were met.

Informal Education: In FY 2014, AZSGC sponsored 5 Informal Education programs, most in collaboration with partnering organizations to leverage resources and to extend reach. To date in FY 2014, these programs have served 15,403 participants. Our flagship effort, the Earth Grant Geospatial Extension Program led by UA Space Grant Associate Director Barron Orr, designed to bridge the gap between NASA Earth systems science and technology and its use by the general public through a strategic partnership between Land Grant (Cooperative Extension) and Space Grant in Arizona, is on hiatus for two years. We are extremely proud to report that in spring 2014 Barron was awarded the prestigious Marie Curie Actions International Incoming Fellowship by the European Union, to expand his Space Grant Geospatial Extension Program's model to Europe! For the next two years, he will help develop a model to promote collaborations between scientific researchers, stakeholders and citizens there. Also in 2014, Dr. Orr was the only US scientist selected to join the "Science Policy Interface" panel under the United Nation's Convention to Combat Desertification. This panel, composed of 20 scientists from around the world, is charged with translating the science of desertification into potential policy changes, to promote a "land-degradation-neutral world".

2014 Informal Education programs address multiple AZSGC goals/objectives and NASA Outcomes 2 and 3. Programs are designed to address the Informal Education goals (above) and accomplishments are measured against the SMART objectives below:

1. **30% diversity of participants:** Demographic data are only routinely collected for programs conducted under the Earth Grant Program, on hiatus in 2014.

2. **45% female participation:** Gender diversity data is only routinely collected for Earth Grant programs, on hiatus in 2014.
3. **Serve >12 communities with Earth Grant programs:** On hiatus in 2014.
4. **Train AZSGC students/informal educators to help deliver >4 NASA Earth science focused topical training sessions:** Earth Grant activities are on hiatus in 2014.
5. **Build strategic partnerships with formal and informal STEM education providers:** NAU Space Grant participates in the annual “Flagstaff Festival of Science”, a large, university-sponsored community event and longest running festival in the country, where participants enjoy and learn from hands-on activities, demonstrations, displays and presentations celebrating all things STEM. “ASU’s Space Grant Intern Informal Education Outreach” fosters participation in a variety of community STEM educational events—including Earth and Space Exploration Day, the Arizona SciTech Festival, and more—that help inform students, educators and community members about leading-edge research and development. Each event represents collaborations between many partners including ASU’s School of Earth and Space Exploration (SESE) and members of the greater Phoenix community. In addition, ASU Space Grant hosts “Alumni Night”, an opportunity for present and past Space Grant awardees to network, and for current students, aspiring to join the STEM aerospace workforce, to learn and to receive advice and coaching from past students who have successfully joined these workforce sectors. “Science Speakers” a program with 34 speakers offering presentations on 77 topics—from “How the brain works”, to “Rocks from Space”, to “Satellite remote sensing and the environment”—provides renowned expert speakers at no charge to schools and community organizations in and around Tucson (UA). Graduate Fellow led “Bringing Optics to Light” brings hands-on optical sciences learning to local Girl Scout troops (UA).
6. **Support NASA Applied Science:** All Earth Grant activities support NASA Applied Science but are on hiatus in 2014.
7. **Evaluate programs’ success via quantitative and qualitative methods (plus longitudinal tracking of graduate fellow/undergraduate intern participants) insure continuous process improvement:** Intern and Graduate Fellow-led programs are evaluated by Space Grant Managers and steering committee members, plus the students complete evaluation and tracking forms following their Space Grant experiences.
8. **Programs leverage NASA funding by >50%:** A NASA base budget investment of \$0 is highly leveraged with programs staffed by Space Grant Interns and Fellows with wages reported under Fellowships; ASU Interns contribute community service hours as part of their Fellowship award obligations, and Science Speaker bureau participants volunteer their time as a community service.

These and other Informal Education activities contribute directly to AZSGC goals and objectives, to NASA Education Outcomes 1, 2, 3 and NEP 1, 6, 7 and 8. All program area SMART objectives were met that are not Earth Grant Geospatial Extension Program related.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- Diversity:** AZSGC involves Arizona's four, four-year research universities as members, working with 29 affiliate partners including five MSI/HSI community colleges, federal research organizations, private industry, and for- and not-for-profit research enterprises. In 2014 we instigated collaborations with 5 additional MSI community colleges, to develop and write a successful Space Grant augmentation proposal to grow STEM opportunities for AZ community colleges. The state management team has ten members, (50% women, one from an underrepresented minority group) representing 9 diverse NASA and educational disciplines. There are 97 Arizona researchers from member and affiliate institutions, from 42 diverse disciplines, serving as FY 2014 research mentors to Space Grant Undergraduate Research Interns. To further grow our nation's STEM workforce, Space Grant Fellowship/Scholarship awards are not restricted to science/engineering students; non-STEM awardees frequently switch to STEM majors. We meet or exceed ethnic/racial and gender diversity goals for student participants in all program areas except research, where participant numbers reflect the composition of university/college classes, student clubs, etc., and in higher education where female participation (40%) fell 5% below our target. Space Grant *funded* students' diversity in Research significantly exceeds ethnic/racial diversity goals but lags below AZSGC gender diversity targets. A majority of Precollege and Informal Education programs are directed to schools/groups with large percentages of underserved populations across Arizona.
- Minority-Serving Institutions:** AZSGC includes five minority-serving/Hispanic-serving institutions, all community colleges: Pima Community College (PCC), South Mountain Community College (SMCC), Glendale Community College (GCC), Diné (Navajo Tribal) College and Tohono O'odham (Tribal) Community College (TOCC). In FY 2014 they are participating in the following programs (cumulatively addressing Outcomes 1, 2, 3 and NEP1, 4, 7 and 8): Fellowships (UA Undergraduate Research Internship Program)-PCC; Research (ASCEND)-PCC NW, PCC West, SMCC, GCC, and Diné; joining later this summer Signal Peak, Estrella Mountains, Phoenix College, and Superstition Mountain CCs; Higher Education (Statewide Symposium)-PCC, SMCC, GCC; (STEM Courses Enhancement)-TOCC; (Support for building student astronomy club)-Diné.

NASA Education Priorities:

- **Authentic, hands-on student experiences rooted in NASA related, STEM-focused questions and issues; incorporation of real life problem-solving and needs as the context for activities:** This priority is addressed through 1) all 130 mentored research internships (Fellowships); 2) NASA research-based outreach programs led by each of 10 Graduate Fellows (see Fellowships, Higher Education, Precollege and Informal Education); and 3) all Research programs.
- **Engage middle school teachers** in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. See Precollege programs 1, 2, and 11 (objectives 2 and 3), and build capabilities for teachers to provide authentic, hands-on middle school student experiences in science and engineering disciplines (see above).
- **Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM**

careers: In the summer of 2015, NAU Space Grant will co-sponsor the Nizhoni Academy, a program that gives about 35 Native American high school students opportunities to live and learn in a diverse and vibrant university community. Nizhoni provides an academically challenging environment filled with STEM learning and other opportunities for educational and personal growth.

- **Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges:** See Minority Serving Institutions above. In addition, NAU awarded Undergraduate Research Internships to two Coconino Community College students, and ASU Graduate Fellow Claire Antaya developed thematic active (engineering) learning modules for Mesa Community College faculty to use to incorporate grand challenges and experiential learning into their classes.
- **Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA's unique capabilities; directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen):** ERAU has its roots as an aeronautical university with an emphasis on aviation and aeronautical engineering. ERAU Space Grant supports basic and applied research in aeronautics. The projects range from basic low-speed aerodynamics studies up to applied research in unmanned aerial systems integration into the national air space. In 2014, 9 AZSGC Undergraduate Research Interns from UA, ASU, NAU and ERAU participated in mentored research on leading-edge aeronautics topics and one ASU Graduate Fellow's PhD research involves biomimetically inspired MAVs.
- **Environmental Science and Global Climate Change – research and activities to better understand Earth's environments:** In FY 2014, 15 Undergraduate Interns are working with Arizona researchers on Environmental Science/Global Climate Change projects and an entire topical session at the Statewide Symposium in April 2015 will be dedicated to these topics. Four outreach programs led by UA and ASU Graduate Fellows are focused on environmental science/global change subjects (see Higher Education and Precollege) In February and March 2015, UA Space Grant Intern Laura Kurtzberg and Mentor Nirav Merchant, will co-teach workshops on "spatial data carpentry" at Arizona's state universities (UA, ASU and NAU), for researchers working with spatial data but not well versed in its analysis and visualization. AZSGC is contributing internationally to research and activities to better understand Earth's environments and to combat negative impacts of global climate change through UA Associate Director Barron Orr's Marie Curie fellowship work in Europe, and his participation on the UN "Science Policy Interface" panel under the United Nation's Convention to Combat Desertification (see Informal Education above).
- **Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities:** When Internship project proposals are received from researchers starting to build research programs, split-funding requirements are waived (see Fellowships). Participation in our statewide balloon-sat program (see Research) has positively impacted the research infrastructures at five (MSI/HIS/Tribal) community college affiliates (by summer 2015, this number will grow to nine: According to Dr. Tim Frank at SMCC, "SMCC's initial involvement in the ASCEND Balloon Project has made a huge difference in our engineering program. It led us to create a special

projects course and change the focus of many of our other engineering courses to a more hands-on curriculum. It also allowed us to apply for and receive two \$25k grants from the Goodrich Foundation, which expanded the opportunities for our students to work on real-world engineering design projects. Furthermore, we were able to develop an internship program with Honeywell, which provided some of our students with paid internships working on the Orion Spacecraft, while also being a source of revenue for SMCC. This extra money has allowed us to promote and enhance our engineering program in ways that would never have been possible before our involvement with ASCEND.”

IMPROVEMENTS MADE IN THE PAST YEAR

1. **Management:** 2014 statewide meeting discussions resulted in three actions for program improvements, two of these now implemented. To facilitate Space-Grant related activity/event sharing between members and partners, a Google calendar system was created for group use. Now member and affiliate representatives can enter AZSGC partner- and NASA-sponsored opportunities/events into the calendars, which feed color-coded activity entries to <https://spacegrant.arizona.edu/about/calendar>, the AZSGC calendar. To facilitate and increase group member communication and relationships building, an AZSGC listserv was created with all managers partner representatives as subscribers. Subscribers have access to member names, affiliation information, and email addresses to also enable personal (not just full group) communications. In an attempt to grow statewide meeting attendance/participation, annual meetings will be rotated around Arizona, hosted by different members. When possible, meetings will be scheduled to coincide with Space Grant-related activities/events for group members to attend. In addition, ASU engaged a new affiliate, Tempe Union High School District, to work with AZSGC to motivate high school students into college STEM programs.
2. **Fellowships Diversity:** Always a goal and a challenge, in 2014 we began implementing findings from a FY 2013 UA peer STEM engagement study geared to enhance AZSGC capacity to identify, recruit, engage and insure the success of underrepresented students. We worked to better communicate the diversity of NASA research to potential applicants, educate academic advisors about Space Grant program breadth, enlist alumni/peers to promote opportunities, and develop smarter (group-focused) advertising. Associate Directors at UA, NAU and ASU participated in meetings/events for underrepresented student societies including the Society of Hispanic Professional Engineers (SHPE), National Society of Black Engineers (NSBE), and American Indian Science and Engineering Society (AISES). As a result, the 2014 Fellowship/Scholarship diversity is the greatest to date at 36%, up from 27% in 2013. ERAU achieved an outstanding diversity of Fellowship/Scholarship significant awardees at 25%; this is especially impressive at their university with an overall minority enrollment of only 10%.
3. **Precollege:** At ASU, all Undergraduate Research Interns are “educational ambassadors”, contributing at least 20 (unpaid) hours to community service as part of their award obligations. In 2014 they supported many large outreach events at ASU, including Homecoming, Night of the Open Door and Earth and Space Exploration Day. The goal is to instill an expectation to “pay it forward” for their Space Grant awards, by giving back to the community. The Interns demonstrated creativity, ingenuity and commitment in

finding new opportunities and ways to share NASA's science, programs and accomplishments with the public while helping to bring students—potentially America's next generation workforce, into the STEM pipeline..

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Members:

University of Arizona (Lead): State University
Arizona State University State: State University
Northern Arizona University: State University
Embry-Riddle Aeronautical: University

Affiliate Partners:

Higher Education Program Partner: Coconino CC
Higher Education Program Partner: Dine College (Tribal)
Higher Education Program Partner: Glendale CC (Hispanic)
Higher Education Program Partner: Nat'l Undergrad Research Observatory
Higher Education Program Partner: Pima CC (Hispanic)
Higher Education Program Partner: South Mountain CC (MSI)
Higher Education Program Partner: Tohono O'odham CC (Tribal)
Industry Affiliate: AZ Near Space Research
Industry Affiliate: Iridium Satellite LLC
Industry Affiliate: Orbital Sciences Corp
Industry Affiliate: Paragon Space Development Corp
Industry Affiliate: Raytheon Corp
Industry Affiliate: Rincon Research
Industry Affiliate: Vencore, Inc.
Outreach Affiliate: AZ Daily Star
Outreach Affiliate: AZ Daily Sun
Outreach Affiliate: Biosphere 2
Outreach Affiliate: Flandrau Planetarium and Science Center
Outreach Affiliate: Hungry Planets Systems & Services
Outreach Affiliate: International Dark-Sky (NPO)
Outreach Affiliate: Mt. Lemmon Sky Center
Outreach Affiliate: Prescott Astronomy Club
Outreach Affiliate: Tempe Union High School District
Research Partner: Jet Propulsion Laboratory
Research Partner: Lowell Observatory
Research Partner: National Optical Astronomy Observatories (Federal)
Research Partner: Planetary Science Institute (NPO)
Research Partner: USDA SWRC (Federal)
Research Partner: USGS, Flagstaff, Tucson (Federal)