

Arizona Space Grant Consortium
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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 Arizona Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2012.

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.

- 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)

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. 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 space related research to precollege audiences and the public (Outcomes 2 and 3). Simultaneously, researchers get student workers at a minimal 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 2012 examples (representing many more) are:

Outcomes 1, 2, and 3: 2012 Intern Ernest Peyketewa, Jr. (NAU Computer Science Junior), a Native American from Tuba City on the Navajo Nation, did not have access to many science and math courses in middle and high school. As a Space Grant Intern, he works on a project to increase Native secondary students' awareness of technological applications for Space Science, while educating them about exciting career opportunities

in science and engineering through Lego Robotics. His Internship took him back to Tuba City to work with middle school students, and while doing so, he discovered his passion and calling: he will return home as a middle school STEM teacher! How did he first become interested in STEM? He was inspired by a stellar Tuba City middle school teacher, Jackie Drewett, and participation in her 2001 Gifted and Talented after-school program. The hands-on aerospace activities highlighting this program were funded through an AZSGC Reservation Schools grant, and his Space Grant Internship brought his experience full-circle. We are proud that Space Grant made a huge difference in a young man's life--a young man enthusiastically poised to inspire many others.

Outcomes 1, 2, and 3: In 2012, AZSGC worked to grow and enhance our capabilities to educate and involve American students and citizens in NASA's important research and development in the area of bioregenerative life support systems through our Ralph C. Steckler Space Grant Phase 2 Lunar Greenhouse development program and associated Outreach and Teaching Module (LGH-OTM). In June 2012, well over a thousand preschool students and visitors to the San Diego County Fair experienced the LGH-OTM, and received talks, demonstrations and information. Next, the LGH-OTM was displayed at the Chicago Museum of Science and Industry--the largest science museum in the Western Hemisphere--from July 2012 through January 2013; the exhibit's gala opening event was shared with NASA's demonstration model of the Curiosity Rover. Several Space Grant Interns, two from HSI Pima Community College, work on Lunar Greenhouse development and remote crops monitoring with research mentors, including Lane Patterson, who first experienced controlled environment agriculture as a 2003 Space Grant Intern. In 2012 the AZSGC Ralph C. Steckler Space Grant Phase 2 Lunar Greenhouse development program and associated LGH-OTM received an Arizona Governor's Excellence in Economic Development Award.

Outcomes 1, 2, and 3: 2011 and 2012 Intern Pye Pye Zaw, (ASU Earth and Space Exploration senior), is an exceptional student with the intelligence, motivation and leadership qualities to take a superb opportunity, and use it as a launchpad for extraordinary personal and educational growth, and in Pye Pye's case, to benefit many others. She sought hands-on engineering opportunities at ASU, and was awarded a 2011 Internship to join their ASCEND (balloon sat) team and help develop stereographic camera systems. In 2012 she advanced to ASCEND team lead, simultaneously working with Mentor Mark Robinson, PI, on the Lunar Reconnaissance Orbiter Camera and participating on the ASU Space Grant Lunabotics team. Last summer she led an astrophysics/engineering team in the NASA Microgravity University Program. She is also a passionate and committed participant in outreach to inspire students to pursue STEM educations and careers. She teaches astronomy lessons at science camps, gives career talks at public outreach events, visits precollege classes, contributes to teacher workshops, mentors a FIRST Lego Robotics team, and mentors students from a Phoenix-area underrepresented-serving middle school in a summer Dust Devils Microgravity study sponsored by the NASA TRIAD Program. Her work and outreach have been featured in campus and local press, television, radio and public media. She graduates with a BS degree in May and will pursue a graduate degree in Engineering Management at ASU.

PROGRAM ACCOMPLISHMENTS

Fellowships Programs: In FY 2012, AZSGC sponsored 7 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); 2012 accomplishments are measured against SMART objectives below:

1. **Support ≥ 87 students:** 152 (Fellowships/Scholarships were awarded to 141 undergraduates and 11 graduate students).
2. **Support a diverse group of students with at least 24% from underrepresented groups:** 41 (27%) of the total awards went to students from underrepresented minorities.
3. **Support 45% women:** 77 (51%) of awardees were females.
4. **Support students from diverse academic backgrounds representing >30 majors:** 2012 students reported 43 distinct academic majors.
5. **Promote quality outreach and community service programs with contributing partner organizations:** 11 Graduate Fellows designed and implemented programs 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:** 141 Undergraduate Research Interns from UA, ASU, NAU, ERAU, and Pima Community College (PCC) from a variety of backgrounds and technical and non-technical disciplines, received mentored, 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:** Science writing interns wrote 35 articles for two major AZ newspapers. 58 AZSGC authors published research results, 25 authors submitted papers not yet published, 21 invited papers, and 26 self-submitted papers with a review process were supported by Space Grant Fellowship efforts. 30 proposals were submitted and to date, 9 have been funded with a value of \$766,150.
8. **Evaluate programs' success via quantitative and qualitative methods to insure continuous process improvement:** Participants completed written program evaluations, Graduate Fellows made formal outreach program review presentations to steering committee members and interested members of the university community, and student tracking records were generated and 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 854 (total) AZSGC 2006-2012 Fellowship/Scholarship significant award recipients: 595 have completed degree programs, 31 seeking STEM employment are considered "still-to-be tracked". The remaining 564 have taken next steps, and of these, 532

(89%) are now employed in STEM fields or are pursuing additional STEM degrees (see Tracking below).

10. **Leverage program funding:** AZ/NASA Space Grant Fellowships funds (\$263,752) are highly leveraged with Arizona dollars (\$214,882), and approximately (\$61,303) of other federal cost sharing.

In total, AZ Fellowship programs directly addressed NASA Education Outcomes 1, 2 and 3. Outcomes 2 and 3 are addressed through Intern community service, and through major Graduate Fellowship outreach programs conducted with a wide variety of cost-sharing stakeholders and educational partners. NASA priorities and current areas of emphasis, and all goals and SMART objectives were met.

Research: In FY 2012, 230 students participated in 16 AZSGC sponsored Research programs directed to Education Outcome 1. In addition, several programs have Precollege and Informal Education components contributing to Education Outcomes 2 and 3 (ASU Robotics, Daedalus Astronautics, ERAU Rocket Challenge, etc.). Programs are designed to address the Research goals (above) and 2012 accomplishments are measured against the SMART objectives below:

1. **Support 30% diversity:** 230 participants (13.5%) are from underrepresented groups and 37% of funded students are underrepresented.
2. **Support 50% women:** 230 students, 55 (24%) are women.
3. **Sponsor >6 multi-disciplinary, student led and directed team engineering programs:** AZSGC supported 14 team projects including 1) Lunabotics (ASU); 2) Robotics Team Projects (ASU); 3) Daedalus Astronautics Rocketry Team (ASU); 4) SunDevil Sat 1 development (ASU); 5) NASA Reduced Gravity (ASU); 6) HASP (ERAU, ASU); 7) Unmanned Vehicle Systems development (ERAU); 8) Cubesat development (ERAU); 9) NASA Centennial Challenge (ERAU); 10) HiBal (ERAU); 11) SWESat (ERAU); 12) Rocket Challenge Competitions (ERAU); 13) AZSGC statewide balloon satellite program ASCEND! (UA, ASU, ERAU, PCC, SMCC, and GCC).
4. **Build relations with NASA and aerospace industry:** Research and design programs 1, 2, 4, 5, 6, 8, and 9 (Objective 3 above) were conducted in direct partnership with NASA centers and aerospace industry
5. **Grow ERAU and ASU R&D programs by 2:** ASU and ERAU each supported one new team engineering program in 2012, programs 1 and 12 (Objective 3 above).
6. **Support at least 5 teams in a statewide balloon sat program:** 6 college/university teams (including 3 MSIs/HSIs) participated in “ASCEND!” our statewide balloon satellite program in 2012 with opportunities to experience the full design-build-fly-operate-analyze cycle of space missions. 27 participants presented the results of their flight experiments in a dedicated “ASCEND!” session at our statewide symposium (see Higher Education).
7. **Promote NASA-focused astronomy learning, hands-on education and research through the National Undergraduate Research Observatory consortium (NURO):** NAU SG supported 18 students from NURO to travel to Arizona with mentors, and observe on a 31-inch telescope owned by Lowell

Observatory/administered by NAU; as a result, 12 authors published scientific work, 12 authors have submitted papers awaiting publication, 8 papers have been presented with a review process and 4 proposals were submitted generating \$6,100 in funding.

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 2012 (funding for some student participants is reported in Fellowships above), directly contributing to NASA Education Outcomes 1, and 2.

Cumulatively, programs helped foster relations with NASA centers and aerospace industry, while addressing several NASA Education priorities directed at current areas of emphasis (see NASA Education Priorities below). 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 and gender diversity of participants.

Higher Education: In FY 2012, AZSGC sponsored 12 higher education programs directed to Education Outcome 1, with 1269 student participants. Programs are designed to address the Higher Education goals (above) and accomplishments are measured against the SMART objectives below:

1. **Support 30% diversity:** 569 participants (45%) are from underrepresented groups (71% of directly-funded students are underrepresented).
2. **Support 50% women:** 623 students (49%) are women.
3. **Include 5 minority serving institutions/initiatives:** PCC, SMCC, GCC, TOCC and Diné participated in programs.
4. **Support ≥ 5 multidisciplinary group activities:** Supported activities are: 1) SEDS research, promotion, preschool and community outreach (UA); 2) Statewide Symposium (UA, ASU, NAU, ERAU, SMCC, PCCC, GCC); 3) Multidisciplinary courses (UA, ASU, SMCC, GCC, PCC, TOCC); 4) Student travel to present research at professional meetings (UA, ERAU, ASU); 5) Four brown-bag lunch events with guest speakers, behind the scenes tours of Biosphere 2 and a private Space Grant Show at Flandrau Planetarium (UA); 6) Resumé, abstract and PowerPoint presentation development training workshops (UA, ASU, NAU, PCC); 7) Campus STEM outreach and program promotion events (ASU, NAU); 8) Space Grant Alumni Night (ASU); 9) Women in Physics Conference (NAU) and 10) Workforce Development via Geospatial Literacy activities (UA).
5. **Host a statewide Undergraduate Research Internship Symposium:** In April 2012, the Twenty-first Annual Arizona/NASA Statewide Undergraduate Research Internship Program Symposium featured 130 students presenting on year-long research projects relevant to all NASA Mission Directorates.
6. **ASU outreach for recruiting:** 30 Space Grant Interns showcased their research and design projects, providing hands-on demonstrations of Mars terrain, water-bottle rockets, underwater robots, low-frequency cosmology demonstrations and

- more at the School of Earth and Space Exploration (SESE) Earth and Space Exploration Day, and acted as docents in the Gallery of Scientific Exploration in ASU's new Interdisciplinary Science and Technology building (Objective 4 project 7).
7. **Support multidisciplinary course development:** 2 (new) and 5 (revised) courses were offered at UA, ASU, PCC (HSI), SMCC (MSI), GCC (HSI), and TOCC (Tribal College). The TOCC course, "Introduction to Weather and Climate", (Objective 4 project 3), was developed and delivered by a (Native) Graduate Fellow and contains associated higher education and reservation community outreach, that address NASA Education Outcomes 1, 2, and 3.
 8. **Develop/support opportunities to network and promote linkages between Space Grant students, faculty, researchers, industry and NASA professionals to foster workforce development, and educational/professional growth and promotion:** Higher Education programs 1-10 (Objective 4 above) promoted 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 2012.

These activities and others, contribute directly to AZSGC Higher Education goals and objectives, to several NASA Education current areas of emphasis (see NASA Education Priorities below), and to NASA Education Outcomes 1, 2 and 3. All program area SMART objectives were met.

Precollege: In FY 2012, AZSGC sponsored 13 Precollege programs, the majority conducted in collaboration with partners to leverage funding and to extend program reach; six programs were designed and delivered by 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:** Native Americans are markedly underrepresented in college STEM enrollment. Four NASA-focused precollege programs--two designed and led by Graduate Fellows--are directed to Native schools/communities in Northern California and Arizona including: 1) "Promoting Science, and Bridging Gaps in Native American Science Education" a summer GPS and GIS 6-12 grade training class delivered at the Klamath River Early College of the Redwoods in Northern California and (Tohono O'odham) Ha:san Preparatory and Leadership School (Ha:san) in Tucson that involved 20 students and 2 teachers (UA); 2) "Hands on astronomy research for Native Students" with Ha:san served 30 students and 4 educators (UA); 3) The "Navajo-Hopi Outreach program" with affiliate partner

- Lowell Observatory brought hands-on NASA space science content, educational activities, field trips and guest presenters to 4 Navajo and Hopi reservation middle schools and 112 students and 10 teachers (NAU); and 4) The “American Indian Mobile Education Resource (AIMER)” science classroom and traveling educators, delivered NASA Space Science educational resources, lessons, and activities to 558 students and 27 teachers at rural reservation schools (NAU). In addition 5) “Expanding the scope and accessibility of Mt. Lemmon Sky Center”, provided an immersive Earth and Space Science experience for 63 primarily underrepresented students (including a hearing impaired group with a sign interpreter), from economically challenged backgrounds and their teachers (UA).
3. **Programs support NASA Education:** All Native American and underserved-directed programs 1-5 (Outcome 2 above) focus on NASA research topics, and incorporate NASA curricular materials and expertise. In addition, 6) ASU Space Grant Interns and Fellows led a wide variety of NASA-focused precollege classes, activities and training sessions through the ASU Mars Education Center and at various local schools, including mentoring FIRST Lego League and FIRST Robotics teams that engaged 1965 precollege students, 25 inservice, 32 preservice and 3 informal educators, plus 944 administrators, parents/guardians, college students, faculty and members of the public at large (ASU); 7) “Changes in Altitudes” a statewide precollege balloon satellite program originally funded by NASA’s Phoenix Mars Lander Mission’s E/PO, provided real “space mission” experiences for five Arizona middle school teachers from four schools and their 24 students (NAU); and 8) “SciNews: Current Events in the 21st Century Classroom” provides educators short, timely, prepackaged, standards-based, scientific news/current events science curriculum. The project targets Arizona middle school classes, but now extends to educators from 40 states and 19 countries; 398 educators receive lessons by email with supplemental resources available via download (ASU). In addition, ASU and NAU support 9) Middle School Science Clubs, and ERAU sponsors 10) “Rocket Challenge”, a summer campus program for secondary students.
 4. **Programs engage middle school teachers in hands-on curriculum enhancement:** See programs 3, 4, 5, 7, and 8 (objectives 2 and 3 above).
 5. **NASA education and outreach provided to remote reservation schools via AIMER:** See program 4, objective 2 above.
 6. **Leverage program funding:** FY 2011 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 and 3. In addition programs address several NASA Education priorities directed at current areas of emphasis (see NASA Education Priorities below). All program area SMART objectives were met.

Informal Education: In FY 2012, AZSGC sponsored 7 Informal Education programs, most in collaboration with partnering organizations, to leverage resources and to extend reach. Our flagship effort, the Earth Grant Geospatial Extension Program, is 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. Led by the UA Space Grant Associate Director at no charge to our grant, leading a cadre of Graduate Fellows, Undergraduate Research Interns and representatives from partnering programs and agencies who collaborate to address shared program goals and sponsor a variety of activities, Earth Grant promotes STEM literacy and enhanced linkages between formal and informal education. The program focuses on capacity building, scientific literacy and STEM learning. FY 2012 projects land in three general categories: (1) technology transfer, (2) precollege afterschool programs that want to use NASA science and technology for STEM learning, youth empowerment, civic engagement and the promotion of healthy life styles, and (3) knowledge transfer associated with the science behind desertification and its control. Earth Grant and other 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 is only routinely collected for programs conducted under the Earth Grant Program. Overall Earth Grant activities directly engaged 1419 participants with 30.2% traditionally underrepresented in STEM (higher education student participants are reported in that reporting area).
2. **50% female participation:** Gender diversity data is only routinely collected for Earth Grant programs, which have directly engaged 48% female participation.
3. **Serve >20 communities with Earth Grant programs:** Programs and activities were conducted in 23 Arizona communities in 2012.
4. **Train AZSGC students to help deliver >4 NASA Earth science focused topical training sessions:** Overall Earth Grant activities directly engaged 296 informal educators in 15 professional development workshops, plus 1077 members of the public and 56 precollege students in Earth science educational activities. “Tohono O’odham Weather and Climate Community Education” activities were developed and delivered by a Graduate Fellow and four TOCC undergraduate interns including 14 workshops, 8 exhibits, and 16 student and 8 public at large hands-on activities, engaging 14 informal educators and 135 students and Tohono O’odham Nation residents.
5. **Build strategic partnerships with formal and informal STEM education providers:** Earth Grant activities are conducted in partnership with Cooperative Extension and numerous community organizations, schools, tribal groups, government agencies and businesses. NAU Space Grant participates in the annual “Flagstaff Festival of Science”, a large, university-sponsored community event: 11,673 students and others enjoyed hands-on activities, demonstrations, displays and presentations celebrating all things STEM. “ASU’s Space Grant Intern and Fellow Community Outreach Program” fosters participation in a variety of community educational events--including Earth and Space Exploration Day, the Arizona SciTech Festival, and more--that helped inform 6467 students, educators and community members in 2012. Each event represents collaborations between many partners including ASU’s School of Earth and Space Exploration (SESE)

and members of the greater Phoenix community. “Science Speakers” a program with 28 speakers offering presentations on 65 topics--from “How the brain works”, to “Rocks from Space”, to “Satellite remote sensing and the environment”--serves schools and community organizations (UA).

6. **Support NASA Applied Science:** All Earth Grant activities support NASA Applied Science. In FY 2012 1) The eXtension.org Map@Syst Syst (an online peer-reviewed system developed collaboratively by Geospatial Extension Specialists (GES) across the country) now has 88 COP members who have produced 1,718 pages, 152 peer-reviewed articles, 88 FAQs, 145 news reports, and 5 learning lessons. 2) Efforts to integrate Earth systems science into global land degradation policy resulted in the adoption by all 195 signatory nations of the UN Convention to Combat Desertification (UNCCD) of the monitoring & assessment recommendations compiled through an iterative, participatory scientific review process facilitated by Arizona’s GES. 3) The GES was also appointed as a Technical Evaluator for the Innovation Prize for Africa competition. The prize honors and encourages innovative achievements that contribute towards the development of new products, increased efficiency or cost savings in Africa. The prize also promotes the efforts of young African men and women pursuing science, technology and engineering careers as well as business opportunities that aim to contribute to sustainable development in Africa.
7. **Programs support NASA Education programs:** A Graduate Fellow provides “OSIRIS-REx Mission Education and Public Outreach (EPO) Program Support,” building survey database applications, collecting and compiling survey results, editing/reviewing all printed, posted and other material for content and accuracy, tracking presentations, public media, website, social media and YouTube coverage, building/maintaining sections of the program website, and more.
8. **Evaluate programs’ success via quantitative and qualitative methods (plus longitudinal tracking of graduate fellow/undergraduate intern participants) insure continuous process improvement:** All Earth Grant programs undergo quantitative and qualitative evaluation and review, and OSIRIS-REx EPO undergoes periodic and rigorous NASA reviews.
9. **Programs leverage NASA funding by >50%:** A NASA base budget investment of \$0 is highly leveraged with Geospatial Specialist Barron Orr committing 10% FTE (\$11,551) to programs at no charge to our grant. Earth Grant program non-federal partners contribute an additional (\$39,115) and other federal sources provide (\$348,228). Other efforts are 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.

These and other Informal Education activities contribute directly to AZSGC goals and objectives and to NASA Education Outcomes 1, 2 and 3. In addition programs address several NASA Education priorities directed at current areas of emphasis (see NASA Education Priorities below). All program area SMART objectives were met.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- Student Data and Longitudinal Tracking: Student Data and Longitudinal Tracking:** Of 854 AZSGC significant award recipients from 2006 to 2012: 595 have completed degree programs (31 seeking STEM employment are still-to-be tracked). The remaining 564 have taken next steps; of these, 532 (89%) are employed in STEM fields or are pursuing additional STEM degrees. 146 are employed by NASA, aerospace contractors, universities, and K-12 institutions, 148 are employed in STEM non-aerospace positions, 238 (see note below) are pursuing advanced STEM degree programs. 204 AZSGC 2006-2012 awardees are from underrepresented groups: 113 have completed degree programs (10 of these are seeking STEM employment and are still-to-be tracked). Of 103 students who have taken “next steps”, 98 (95%) of the underrepresented graduates are pursuing advanced STEM degrees or are employed in STEM fields. In addition, 42 graduate and undergrad awardees pursued advanced STEM degrees PLUS entered the STEM workforce. To avoid double counting, 40 undergrads and 2 grads, 8 from underrepresented groups, were not counted in the “pursuing advanced STEM degree” category.
- Diversity:** AZSGC involves Arizona’s four, four-year research universities as members, working with 27 affiliate partners: community colleges (including 5 MSIs/HSIs), federal research organizations, private industry, and for- and not-for-profit research enterprises. The state management team has ten members, (50% women, one from an underrepresented minority group) representing 9 diverse NASA and educational disciplines. 100 Arizona researchers from member and affiliate institutions, from 44 diverse disciplines, serve as FY 2012 research mentors to Space Grant Undergraduate Research Interns. To further grow our nation’s STEM workforce, Space Grant Fellowship awards are not restricted to science/engineering students; non-STEM awardees frequently switch to STEM majors. To help make STEM fields study more accessible to visually impaired students, two ASU Space Grant Interns (one blind) are significant contributors to “3D IMAGINE” (Image Arrays to Graphically Implement New Education), a program developing new tools to enable visually impaired students to tactilely “visualize” image data in STEM classes. In 2012 they made 15 oral and poster presentations, their work has been featured in 9 public media sources, and examples of their tactiles are traveling the world as part of an art and education exhibit. We meet or exceed ethnic 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. Space Grant *funded* students’ diversity meets or exceeds goals in Fellowships, Research and Higher Education areas, and meets gender diversity goals in Fellowships and Higher Education; the average percentage of awards to underrepresented minority students across all higher education program areas is 30.7%. Precollege and public programs are directed to underrepresented, underserved populations across Arizona.
- Minority-Serving Institutions:** AZSGC includes five minority-serving/Hispanic-serving institutions: Pima Community College (PCC), South Mountain Community College (SMCC), Glendale Community College (GCC), Diné (Tribal) College and Tohono O’odham (Tribal) College (TOCC). In FY 2012 they participated in the

following programs: Fellowships (UA Undergraduate Research Internship Program) PCC; Research (ASCEND) PCC, SMCC, GCC; Higher Education (Statewide Symposium) PCC, SMCC, GCC, TOCC; Weather and Climate Internships) TOCC; Informal Education (Tohono O’odham Weather and Climate Community Education) TOCC. New avenues for collaboration were established including: 1) funding GCC (HSI) as a stand-alone team participant in our statewide balloon sat program and inviting them to join AZSGC as an affiliate member, and 2) we met with Arizona Western College (HSI) administrators, and agreed to several avenues for future collaborations.

- **NASA Education Priorities:**

- **Authentic hands-on student experiences in science and engineering disciplines 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 141 mentored research internships (Fellowships); 2) All NASA research-based outreach programs led by each of 11 Graduate Fellows (see Fellowships, Higher Education, Precollege and Informal Education); and 3) all Research programs.
- **Diversity** of institutions, faculty, and student participants (gender, underrepresented, underserved). See Diversity (above).
- **Engage middle school teachers** in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. See Precollege programs 3-5 (Objective 2), programs 7-8 (Objective 3) and Objective 4 programs. 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:** ERAU Rocket Challenge Program (See Precollege program 10, Objective 3).
- **Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges:** See Minority Serving Institutions above.
- **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 2012, 10 AZSGC Undergraduate Research Interns from UA, ASU and ERAU participated in mentored research on leading-edge aeronautics topics.

- **Environmental Science and Global Climate Change – research and activities to better understand Earth's environments:** 32 Undergraduate Interns worked with Arizona researchers on Environmental Science/Global Climate Change projects in 2012; an entire topical session at the Statewide Symposium was dedicated to these topics. Four Graduate Fellows led outreach programs focused on environmental science/global change subjects (see Higher Education, Preschool and Informal Education), and many projects subsumed under the Earth Grant program are directed to these topics, especially to the effects of desertification and its control.
- **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, we waive split-funding requirements (see Fellowships). Participation in our statewide balloon sat program (see Research) has positively impacted the research infrastructures at three (MSI/HSI) community college affiliates: According to Dr. Tim Frank at SMCC, “Because of ASCEND!, I realized that I could get my students to work harder and learn more if I modified...courses to include more real-world projects. Consequently...modifying my introduction to engineering courses to include more “real-world” design projects [has helped grow] enrollment in our engineering courses by 46%, and most original ASCEND! class participants “...went on to transfer to ASU and major in engineering.” MSI PCC’s participation in the AZSGC balloon sat program, is showcased on PCC’s homepage and helped the college win funding for a new 47,000-square-foot sciences, technology, engineering and math building slated to open in 2013.

IMPROVEMENTS MADE IN THE PAST YEAR

1. A concerted statewide effort increased higher education program participant diversity from 21% in 2011 to 38% in 2012. To achieve this, managers at member universities met with members of student organizations such as Society of Hispanic Professional Engineers (SHPE), American Indian Science and Engineering Society (AISES), the Association for Women in Science (AWIS), and others, collaborated more closely with university minority serving program leaders, and used Earth Grant to rigorously pursue higher education workforce development via geospatial literacy.
2. We strengthened collaborations with new and existing affiliate partners Flandrau Planetarium, Mt. Lemmon Sky Center and Biosphere 2, by sponsoring educational events at their facilities and engaging Graduate Fellows in projects to grow their education and outreach capabilities.
3. We broadened the reach of ASU and UA Space Grant Facebook offerings to involve a growing group of followers in NASA’s mission and related science and technology development.
4. In 2011, an online web interface was developed and programmed at UA (lead) to help manage and run our largest statewide event, the Undergraduate Research Internship Program Symposium, hosted in alternate years by UA and ASU (see

Higher Ed Objective 4, program 2). The site collects student, mentor and guest RSVPs, plus over 130 scientific abstracts from student researchers. It saves event hosts time/labor by imposing consistent formatting, filters to correct encoding errors, and by allowing managers from all participating colleges and universities to review/approve their own students' abstracts. In 2012, the site was used successfully for a symposium hosted by ASU, while the website continued to be served and supported at UA. This is our first attempt to share web resources and support personnel in this way.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Members:

University of Arizona (Lead): State University
Arizona State University 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: Nat'l Undergrad Research Observatory
Higher Education Program Partner: South Mountain CC (MSI)
Higher Education Program Partner: Pima CC (Hispanic)
Higher Education Program Partner: Glendale CC (Hispanic)
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: PM & AM Research
Industry Affiliate: Raytheon Corp
Industry Affiliate: Rincon Research
Outreach Affiliate: AZ Daily Star
Outreach Affiliate: AZ Daily Sun
Outreach Affiliate: Biosphere 2
Outreach Affiliate: Flandrau Science Center
Outreach Affiliate: International Dark-Sky (NPO)
Outreach Affiliate: Mt. Lemmon Sky Center
Outreach Affiliate: Prescott Astronomy Club
Research Partner: Jet Propulsion Laboratory
Research Partner: Lowell Observatory
Research Partner: National Optical Astronomy Observatories (Federal)
Research Partner: Planetary Science Inst (NPO)
Research Partner: USDA SWRC (Federal)
Research Partner: USGS, Flagstaff, Tucson (Federal)

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