Arizona Space Grant Consortium
The University Arizona, Lead Institution
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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 $845,000 for fiscal year 2010. AZ/NASA Space Grant funds are highly leveraged with non-federal dollars, bringing an additional $733,938 to Arizona student-directed programs in 2010.

PROGRAM GOALS

Our 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. These programs integrate research with education to help build a diverse, scientifically literate citizenry and a well-prepared science, engineering and technology workforce.

AZSGC Fellowship programs are geared to expand representation among active scientists and engineers, of our nation's diverse population. Programs are designed to be accessible to students from a variety of backgrounds, including those in non-technical disciplines. Programs 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.

The goal of the AZSGC Research Infrastructure component is to sponsor innovative programs in space science/engineering focused research and design, with associated opportunities to apply classroom knowledge to real-world, NASA-focused problems. These programs "encourage cooperative programs among universities, aerospace industry and Federal, state and local governments" as articulated in the National SG Program objectives. Through team research, engineering and design programs, Space Grant students learn to work as team members, to be held to industry standards for deliverables, to complete tasks on schedule, to communicate about technical work to professionals, peers, and the public through oral and written presentations, and to work side-by-side with science and engineering faculty, researchers, NASA, and industry professionals. These challenging programs impact student education, future employability in industry, and contribute to science and technology development.

AZSGC Higher Education program goals are to 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.

AZSGC Precollege programs are geared to 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. All AZSGC precollege programs are aligned with AZ and National Standards, leverage funding, are directed to underrepresented/underserved populations, and support NASA Education programs.

Public Programs actively engage members of the public from traditionally underrepresented groups, bridge the gap between Earth systems science research and geospatial technology and societal needs in Arizona; leverage funding to extend the reach of SG beyond direct investment, support science education needs in underserved areas of our state, engage SG 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, OR 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.

That integrating students into leading-edge research serves as a springboard into our nation's STEM workforce and top graduate programs is documentable. Select FY 2010 examples (representing many more) are:

NAU Space Grant awardee Richard Nava completed a BS in Geographic Information Science from in December, 2010. Upon graduation he was hired to a full-time position at the USGS Astrogeology in Flagstaff, where he served as a Space Grant Intern.

Upon graduation in May, 2010, NAU Space Grant science writing intern Eric Betz was hired by *Inside Science News Service*. We were proud to see an article on the "NASA Desert Research and Technology Studies Team" http://azdailysun.com/news/local/article_ea67a2e6-6a50-5767-bbd0-6a946ff946c5.html picked-up by the *Arizona Daily Sun* where he worked as a Space Grant Intern.

Neither Martha Mosqueda nor Luis Huizar applied to the UA Undergraduate Research Internship Program with stellar gpas but inspired by glowing reviews of the program from other Space Grant Interns in the Hispanic Student center, decided to take a chance and to apply. Their applications showed strong motivation for research experiences and great potential for such experiences to be transformational--not just a resume fillers. Martha was awarded a UA Space Grant Internship in 2008, excelled, and was subsequently nominated by her mentor and selected competitively to receive a second year award as an Intern Advisor in 2009 where she again emerged as a group leader. Luis was awarded an Internship in 2009, exceeded his mentor's high expectations, and was nominated and selected to serve as an Intern Advisor in 2010. In FY 2010, Luis immersed himself in his Space Grant global change research and his program leadership position. Among other things, he set-up and helped lead evening workshops for Interns on how to write scientific abstracts in preparation for the upcoming April AZSGC statewide symposium by creating the workshops schedule, writing advertisements, creating and posting a Doodle scheduling poll for students to sign-up to participate and etc. Two years ago, he had never written an abstract, had no idea about the existence of Doodle polls, had little self-confidence, and certainly did not consider himself a smart and exceptional leader. Now Luis who prior to his internship never considered attending graduate school, has been accepted to the UA College of Science graduate program in chemistry and began work toward that advanced degree in January 2011. His Space Grant Mentor (Department Head in Civil Engineering/Engineering Mechanics and member of the SG steering committee) has been not only a great teacher, but also a role model and advocate for Luis' educational advancement. Martha was recently accepted to the UA's Master's program in Nutritional Sciences for Fall 2011. They plan to marry

early this summer--later in the same week that Luis makes his first presentation at a professional meeting based on the global-change related research he has conducted as a NASA Space Grant Undergraduate Research Intern! As their NASA Space Grant Internships have been their proudest college accomplishments, Martha and Luis proposed the idea of Arizona/NASA Space Grant graduation sashes—an idea now implemented at universities across our consortium.

In 2007, Christine Bradley, a student at Pima Community College (PCC) was awarded a UA/NASA Space Grant Internship. She will graduate from UA with a degree in Optical Engineering (OPTE) in May 2011, and has been awarded a first year scholarship and admission to the OPTE PhD program where she will work in the same lab where she worked as a Space Grant Intern.

Anthony Adame was an ASU Space Grant Intern in 2009 and has since entered graduate school at ASU studying alternative energy. As a NASA Space Science Student Ambassador, Anthony has been telling his story of how internship supported research changed his life.

Kyle Rine was a student set to transition from PCC into UA when he was awarded a Space Grant Internship in 2009. His mentor Dr. Eric Betterton, the Atmospheric Sciences Department Head and Space Grant steering committee member, was so impressed with Kyle's work he successfully nominated him for a second year Intern advisor position in 2010. When the long-time director of Betterton's research lab retired earlier this year, he did the unprecedented: he offered the prestigious staff position to Kyle as an undergraduate student online to graduate in May 2011.

PROGRAM ACCOMPLISHMENTS

Fellowships Programs: In FY 2010 AZSGC sponsored 7 programs that awarded 175 Fellowships/Scholarships to 162 undergraduates and 13 graduate students. 31 (18%) of the total awards went to students from underrepresented minorities, and 70 (40%) of awards were to females. All Graduate Fellows designed and implemented programs delivered through our 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). 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 a 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). 67 AZSGC authors published results supported by Space Grant Fellowship work in 2010. AZ/NASA Space Grant Fellowships funds ($415,730) are highly leveraged with Arizona dollars ($222,440), and approximately ($83,978) of other federal cost sharing, demonstrating a strong consortium commitment to providing leading-edge professional development opportunities to our nation's STEM workforce in training.

Research: In FY 2010, AZSGC Research programs directly served 138 students and 109 faculty and other participants. Highlights include ASCEND!, a statewide balloon satellite development/launch program, that provided teams of students from UA, ASU, ERAU, PCC, SMCC and their mentors, two successful launches/recoveries, and opportunities to experience the full design, build, fly, operate, analyze cycle of space missions. The fact that 2010 launches have been filmed by both SMCC and PCC district television crews is a testament to the importance and prestige associated with program participation within their two, large, AZ community districts. Student teams at ERAU flew an experiment in the NASA Reduced Gravity Student Flight Opportunities Program (RGSFO), and worked collaboratively with personnel from several ERAU departments and students and mentors from PCC (MSI) to develop NASA High Altitude Student Platform (HASP) payloads, systems and operations and integrate these for a scheduled September 2010 launch (delayed until September 2011). ERAU is also sponsoring student teams in the NASA University Student Launch Initiative (USLI), ESMD's Lunabotics competition, and a student team is working on the preliminary development of a CubeSat for launch into near-earth orbit. Students from ASU collaborated with mentors from Orbital Science Corporation (the lead industry mentor is an AZSGC program graduate and the AZSGC affiliate representative) to design and build robots to compete in national underwater robotics competitions to be held in the summer of 2011. Another ASU student team is designing and building UAVs (low-cost autonomous unmanned aerial vehicles) for aerial surveillance and other research-based tasks, while others participated in Daedalus Astronautics, a student run organization dedicated to the design, manufacture, and launching of large high powered rockets and associated rocket paraphernalia. Daedalus members undertake self-driven advanced astronautical engineering projects to enhance their educations and develop professional skills. Daedalus members compete in conferences and rocket competitions throughout the United States and have a very strong K-12 outreach component. In addition, NAU SG supported 43 students from the National Undergraduate Research Observatory Consortium (NURO) to travel to Arizona with mentors, and observe on a 31-inch telescope owned by Lowell Observatory/administered by NAU; 15 NURO participants published scientific articles as a result. AZ/NASA Space Grant Research funds ($61,800) are leveraged with Arizona dollars, bringing an additional $7,750 to these workforce development programs in 2010.

Higher Education: 654 AZSGC students have participated in 13 higher education programs in FY 2010, with others online to benefit from activities scheduled for summer 2011. Select program accomplishments, representing many more include: three (revised) courses at The University of Arizona, Tohono O'odham Tribal College (TOCC), and MSI South Mountain Community College (SMCC). According to Dr. Tim Frank, AZSGC Representative at SMCC, "Because of ASCEND! [see RI above], 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 project [has helped grow] enrollment in our engineering courses by 46%. While there are many factors that have contributed to this growth, I believe that the visibility and reputation of SMCC's engineering program has increased tremendously because of our participation in the ASCEND! program." Frank

further notes that most original ASCEND! class participants "…went on to transfer to ASU and major in engineering." At Dine (Tribal) college, SG funds are used to improve math education by enlisting and training peer tutors to help struggling students succeed in developmental math courses. Space Grant funds allow TOCC to offer remedial biology, mathematics and computer literacy summer courses, which, according to Tomas Sepulveda, AZSGC representative at that tribal college, help students "Make a smooth and successful transition to college life". In April, 2010, the Nineteenth Annual Arizona/NASA Statewide Undergraduate Research Internship Program Symposium featured presentations by over 119 students about their year-long research on topics relevant to all NASA Mission Directorates, and was attended by audiences of peers, mentors, dignitaries, family, friends and others. Jane Poynter, Co-Founder and President of AZ Space Grant Affiliate Paragon Space Development Corporation was the inspirational keynote speaker. AZ/NASA Space Grant Higher Education funds ($142,883) are highly leveraged with Arizona dollars, bringing an additional $64,387 to these workforce development programs in 2010. These and other Higher Education activities contribute directly to AZSGC goals and objectives and to NASA Education Outcomes 1, 2 and 3.

Precollege: AZSGC utilized innovative strategies to leverage program resources while providing opportunities for aerospace professionals-in-training to learn to mentor and share their enthusiasm for NASA subject matter with the younger generation. In FY 2010, four major NASA-topic-focused precollege programs were designed, implemented and led by UA and ASU Graduate Fellows; Undergraduate Research Interns also led NASA-focused precollege classes and training sessions. These student-led efforts benefitted 2,896 participants—many from groups traditionally underrepresented and underserved in Arizona Higher Education such as students from the San Carlos and Bylas Apache communities. NAU's Changes in Altitudes statewide precollege balloon satellite development/launch program, trained five new teachers, who joined seven previously trained teachers and 72 (primarily middle and high school) students from their 12 schools from across the state, to prepare for and participate in two balloon launches. Originally funded as part of NASA's Phoenix Mars Lander Mission's E/PO that ended in 2008, AZSGC secured grants from Science Foundation Arizona to continue this program that utilizes NASA-inspired content to teach and excite educators and their students through participation in the build, fly, operate, analyze cycle of real space missions. AZSGC supported two separate GEMS Space Science Teacher Training workshops in northern and central Arizona attended by 27 teachers. Designed to give grades 3-5 teachers opportunities to explore the Sun-Earth-Moon system while being trained in core science/math curriculum, workshop sponsorship helped AZSGC meet our goal of providing educational opportunities promoting NASA-focused STEM literacy and awareness. We are also supporting an Arizona team from Parkridge Elementary School in the Student Spaceflight Experiments Program (SSEP) on STS-135, the final flight of the U.S. Space Shuttle Program (Shuttle Atlantis.) Led by a middle school science teacher, Parkridge is using this historic opportunity to inspire and engage 525 grade 5-8 students in experiment design for flight on the Shuttle, while engaging all 1,063 K-8 students in the community-wide experience. Finally, FY 2010 AZ/NASA Space Grant Precollege funds ($75,501) are highly leveraged with Arizona ($40,946) and other federal

cost sharing dollars ($5,287). These and other Precollege activities contribute directly to AZSGC goals and objectives and to NASA Education Outcomes 1, 2 and 3.

Informal Education: Over the past year our Informal Education Programs, led by the Earth Grant Geospatial Extension Program, focused on bridging the gap between NASA Earth systems science and technology and the needs of the public. The program focuses on capacity building, scientific literacy and STEM learning. FY 2010 Projects in the program land in two general categories: (1) pre-college 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 (2) knowledge transfer associated with the science behind desertification and its control. The UA Space Grant Associate Director leads these efforts with a cadre of Graduate Fellows, Undergraduate Research Interns and representatives from partnering programs and agencies who work in partnership to meet shared program goals. Examples of FY 2010 Earth Grant accomplishments, representing many more are: Over the past two years we have developed 60 [public education/information] articles currently in review for publication on eXtension.org and an online peer-reviewed system called Map@Syst, a content-based management system created in collaboration with National Geospatial Extension Program (http://www.extension.org/pages/9608/mapsyst-community-page). Articles introduce informal educators to concepts and activities focused on STEM-based learning. Youth will learn basic knowledge and skills related to investigating satellite imagery, remote sensing opportunities and careers, and how earth observation solves real-world problems. As an example, one activity called Youth-Driven Community Asset Mapping, leads youth through a process similar to scientific investigation where they define an issue in their community and/or environment, collect the necessary geospatial and qualitative data, display their data in collaborative maps, and visually analyze the results before presenting their project to adults and/or community leaders. Other education support resources with topics on ecology, phenology, invasive species, and location-based services and games (mobile mapping) will be available through Map@Syst. These articles, FAQs and glossary terms will both provide information for viewers and link them to relevant NASA webpages and resources. In addition to online educational resource building efforts, this year Earth Grant activities have directly engaged 2514 participants in 72 professional development workshops for informal educators, produced and helped lead 101 student hands-on activities and supported 10 public educational events related to the use of NASA geospatial-related technologies and Earth system science. Audiences served were diverse and involved those traditionally underrepresented in science and technology. In addition, other UA Graduate Fellow led outreach promoted the use of solar energy/photovoltaics through tours at the Tucson Electric Power Company's Solar Test Yard, curriculum implementation in schools, teacher training and other public presentations. NAU Space Grant helps lead and support the 23-members Mt.Elden Middle School's science club for girls, the "Stem Sisters". Members meet twice per month to participate in activities that center around hands on science learning. The ASU Space Grant Program is integral to Earth and Space Exploration Day, an annual fall event hosted by the School of Earth and Space Exploration (SESE) on ASU's Tempe campus. The SESE community offers special science-related activities for students aged five and up, families, educators and anyone interested in exploring earth and space

alongside real scientists. Each year, the SESE community brings to life its research through innovative hands-on activities. This is a favorite event among Space Grant interns with 27 participating by showcasing their own projects or assisting with others. The interns provide informal education opportunities through an assortment of methods. The ASU Robotics team had robotic arms available for use and demonstrated their underwater robot in a kiddy wade pool. Members of Daedalus Astronautics instructed children on the steps necessary to build small water bottle rockets, provided videos of launches and tests, and handouts for children to color and take home. Activities aside, the members of Daedalus Astronautics also bring their own rocket projects to the event to give the children a hands-on experience of what they could do when they grow up. In addition, our table-top display provides excellent photo opportunities for those attending the event. Participating interns wear their Space Grant polos at IE events which help promote ASU/NASA Space Grant to the larger community. These Informal Education activities and others conducted outside the Earth Grant Program, served an additional 17,723 participants from across Arizona and directly contribute to NASA Education Outcomes 1, 2 and 3.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Longitudinal Tracking: Of 611 (total) AZSGC 2006-2010 awardees, 341 have completed (award) degree programs. Of these 313, nearly 92% are now employed in STEM fields or are pursuing additional STEM degrees. Of the 64 (total) AZSGC 2006-2010 awardees from underrepresented groups who have completed (award) degree programs, 56 (88%) are pursuing advanced STEM degrees or are employed in STEM fields. Some program grads not pursuing advanced STEM degrees are still seeking STEM employment.

- Course Development: AZSGC supported three (revised) courses in 2010 at South Mountain Community College (MSI), Tohono O'odham Tribal College and The University of Arizona).

- Matching Funds: Arizona/NASA Space Grant funds are highly leveraged with funds from state and other federal sources: NASA SG ($845,000-50%), Arizona ($754,661-45.5%) and Other Federal ($94,552-5.5%)

- Minority-Serving Institutions: Minority-Serving Institutions: AZSGC includes four minority-serving institutions: Pima Community College, South Mountain Community College, Dine Tribal College and Tohono O'odham (Tribal) Community College.

IMPROVEMENTS MADE IN THE PAST YEAR

Several improvements were implemented across AZSGC in 2010: (1) We improved our statewide and local UA and ASU websites by migrating them to Drupal; (2) AZSGC online reporting forms based on current NASA questions/format were developed and

utilized to collect APD and Annual Report data; (3) ERAU met a goal of keeping local steering committee members better informed on programs and progress by a generating (local) annual report; (4) ERAU created an internal "pipeline" for Space Grant Internships by enlisting more underclassmen as volunteers on team engineering projects. This helped them meet a Research goal of (5) adding several new student team engineering programs to their Research roster to involve more students and faculty with NASA Mission Directorates hands-on research and engineering; (6) UA enlisted past Interns who participated in NASA academy and other summer programs to coach current students about the world of opportunities within NASA and industry for those with serious interests in space and related technology/research and how to find and apply for these; (7) to further grow student leadership and feelings of program ownership, all UA brown bag lunch speakers are introduced by Undergraduate Research Interns and students are provided a forum at each event to make announcements, and to speak about current projects, issues and opportunities; and finally (8) We have designed and produced AZSGC graduation sashes to congratulate program graduates and to promote NASA Space Grant students and achievements to our greater university communities. To receive a graduation sash, past and present Space Grant awardees must complete online Award Degree Completion forms and provide required information for NASA tracking. For the first time, the upcoming Statewide Undergraduate Research Internship Program Symposium will feature a ceremony honoring graduating seniors and the first graduation sashes will be awarded!

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: Tohono O'odham CC (Tribal)
Industry Affiliate: AZ Near Space Research
Industry Affiliate: Iridium Satellite LLC
Industry Affiliate: Lowry Computer Products
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: International Dark-Sky (NPO)
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 Institute (NPO)
Research Partner: USDA SWRC (Federal)
Research Partner: USGS, Flagstaff, Tucson (Federal)