

**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.**

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

## PROGRAM GOALS

California Space Grant Consortium (CaSGC) Goals & SMART Objectives:

1. Promote diversity and inclusion in all programs and activities by encouraging participation by underrepresented minority and female students and faculty. *IA:* Each academic year, provide a percentage of awards to underrepresented minority and female students that is consistent with diversity targets<sup>1</sup> established by NASA. *IB:* Undertake at least three collaborative programs with a non-member Minority Serving Institution (MSI) each year. *IC:* Each academic year, conduct at least one outreach event in partnership with a non-member MSI to promote programs and opportunities to students and faculty.
2. Conduct quality internship, scholarship and fellowship programs including STEM (Science, Technology, Engineering, and Math) research awards for community college,

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<sup>1</sup> The diversity targets for FY14 are 42% for awards to minority students, based on National Center for Education Statistics data for California (2011), and 40% for awards to female students, based on NASA guidance.

undergraduate and graduate students to broaden and deepen students' knowledge and prepare them for advanced STEM degrees or STEM employment. *2A*: Each academic year, award undergraduate, graduate, and community college students with internships, scholarships and fellowships. Students will be competitively selected by a review panel. *2B*: Award at least the minimum funding amount required by NASA (currently \$150,000 from baseline and \$55,000 from augmentation funds) to at least 50 students each academic year. *2C*: Each academic year, provide a percentage of fellowship/ scholarship awards to underrepresented minority and female students that is consistent with diversity targets<sup>1</sup> established by NASA. *2D*: Longitudinally track 100% of all students receiving significant awards to identify their next step in academia or the workforce. Significant awards are those equal to or greater than \$5,000 or 160 contact hours, cumulatively, or a combination of both. *2E*: At least 90% of students completing their education and receiving significant awards will be employed by NASA, an aerospace contractor, higher education or other educational institutions. *2F*: At least 50% of undergraduate students receiving significant support from CaSGC will move on to advanced education in NASA-related disciplines.

3. Undertake programs that foster research capabilities at our affiliate institutions and serve as a catalyst for linking university researchers to NASA and other opportunities. *3A*: Each academic year, support at least three interdisciplinary student research infrastructure projects in partnership with CaSGC affiliate institutions. *3B*: Each academic year, involve at least 10 students in research infrastructure projects in partnership with CaSGC affiliate institutions. *3C*: Each academic year, provide a percentage of research infrastructure awards to underrepresented minority and female students that is consistent with diversity targets<sup>1</sup> established by NASA.

4. Offer quality interdisciplinary hands-on higher education programs in partnership with our affiliate institutions to prepare students for STEM employment. *4A*: Each academic year, provide paid internships for at least five students at California NASA Centers and at least one student at an industry partner. *4B*: Each academic year, conduct at least five hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions. *4C*: Each academic year, involve at least 50 students in hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions. *4D*: Each academic year, involve students from underrepresented backgrounds in hands-on higher education projects at a level consistent with diversity targets<sup>1</sup> established by NASA. *4E*: Each academic year, at least 70% of MSI affiliates will be involved in our higher education programs. Currently there are 8 MSI affiliates. *4F*: Each academic year, at least two new or revised courses targeted at the STEM skills needed by NASA will be developed with CaSGC support.

5. Provide quality precollege educational opportunities including professional development for pre-service and in-service educators and student-focused programs for students throughout the precollege pipeline. *5A*: Each year, provide professional development in STEM using NASA resources to at least 30 pre-service and/or in-service teachers. *5B*: Each year, reach over 150 precollege students by conducting student-focused programs and activities promoting participation in STEM and related careers. *5C*: At least 75% of precollege educators participating in two or more days of professional development will use NASA resources in their classroom following the

workshop. 5D: At least 60% of precollege educators receiving NASA resources or participating in CaSGC-led short duration activities will use NASA resources in their classroom. 5E: At least 50% of all precollege students participating in CaSGC-sponsored programs will express an interest in STEM careers.

6. Conduct Informal Science Education programs in partnership with formal and informal education members and partners. 6A: Each academic year, utilize material developed in CaSGC's other program elements to inspire and engage the general public in at least four science-related events and university open houses. 6B: Sponsor at least one program each year with the Reuben H. Fleet Science Center, the San Diego Air & Space Museum, and/or the California Science Center. 6C: Consider other appropriate informal science education opportunities as funding and partnerships permit with the goal of at least one other activity per year.

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

Higher Education (Outcome 1): The CaSGC worked closely with the Society of Women Engineers and Women in Computing to provide engineering opportunities for women. We ran a program involving Arduinos, Near Space Ballooning, and CubeSat Mission Control. At least eight of the ten women participating received NSF, NASA, Navy, or industry engineering internships for this current (2015) summer.

Research Infrastructure (Outcome 1): CaSGC student Benjamin Martins, a transfer student from community college, graduated from the University of California, San Diego, and is now pursuing a Ph.D. in Aerospace Engineering under Dr. John Kosmatka, the California Space Grant Director. With CaSGC research support, he was awarded a NASA Aeronautics Scholarship and is now conducting research on "Using Embedded Fiber Optic Sensors to Detect In-Flight Damage in Unmanned Aircraft", a joint project with NASA Armstrong Flight Research Center and the University of California, San Diego.

## PROGRAM ACCOMPLISHMENTS

**Outcome 1:** The CaSGC ran 37 Fellowship/Scholarship/Internship, Research Infrastructure, and Higher Education projects at 18 affiliate campuses providing students with the knowledge, skills, and interdisciplinary team experience for development of the STEM workforce in disciplines needed to achieve NASA strategic goals. We issued 176 awards, of which 74 (42.0%) were to underrepresented minority students and 65 (36.9%) were to females, meeting our NASA target for underrepresented minority students and within 4% of our target for females (SMART Objective 1A—diversity for all awards).

Fellowship/Scholarship/Internship awards were provided to 90 graduates & undergraduates. Students were selected based on academic achievement, letters of recommendation, leadership & personal statements. Of these, 30 (33.3%) were awarded to underrepresented minority students and 35 (38.9%) were awarded to women. Awards directly relate to SMART Objectives 2A, 2B, and 2C, where 2B (total Fellowship/Scholarship awards) was exceeded. Objective 2C (Fellowship/Scholarship diversity) for the F/S program nearly met our target for females. Projects include graduate research in Geophysics, Space Physics, and Aerospace Engineering and undergraduate research in Chemical Engineering, Nanotechnology, Materials Science, Mechanical

Engineering, Bioengineering, Biology, Remote Sensing, Environmental Science & Earth System Science. Included are five NASA Internships (SMART Objective 4A—NASA internships) and 5 Undergraduate Research Opportunity Program scholarships.

Research Infrastructure awards were provided to 15 graduates & undergraduates on 11 projects. Of the 15, 5 (33.3%) were underrepresented minority students and 5 (33.3%) were women. Objectives 3A (number of Research Infrastructure projects) and 3B (number of Research Infrastructure students) were met, and targets for Objective 3C (diversity in Research Infrastructure) were not met. In FY2015 we will take action to provide more Research Infrastructure opportunities to students traditionally underrepresented in STEM. Projects include undergraduate Astronomical research, Aerospace research in Embedded Fiber Optic Sensors in UAVs, Aerospace research in Control of Mixing in High-Speed Combustors, a Research Collaboration with the Washington Space Grant Consortium, the Reinventing Space Project to dramatically reduce space mission cost, and Research Collaborations between astrophysics, digital arts & computational sciences in sophisticated visualization tools.

Higher Education (HE) awards were given to 71 students in 24 projects at 12 of our affiliates. Of the 71 students, 39 (54.9%) are underrepresented minorities and 25 (35.2%) are female, surpassing targets for Objectives 4B (number of HE projects), 4C (number of HE students), and 4D (diversity in HE) in terms of underrepresented minorities. We improved this year with regard to our percentage of females in HE (FY2013: 23.9%), due to resuming connections with a local chapter of the Society of Women Engineers and working with Women in Computing to recruit women engineering students to a summer Arduino/Near Space Balloon/CubeSat Mission Control Operations project. In FY15 we will continue to develop this relationship. Interdisciplinary HE projects include classroom, laboratory & field operations for aerospace workforce development and student-led flight projects involving Near Space Balloons and rocket project support for teams on five affiliate campuses, of which two participated in the NASA Student Launch Initiative competition in April 2015. Our recent MESA Community College Laboratory Research program continues this year but students have not yet been selected at this time. Involves engaging HSI community college students in research in university laboratories working under university faculty and graduate students. Addresses Objective 1C for outreach to minority serving institutions. HE projects include student teams working on a morphable mirror telescope to observe Cosmic Microwave Background radiation, composite structures for deployable antenna & mirrors, asteroid mitigation design project using phased arrays of lasers to vaporize asteroids by the power of the sun for planetary defense, and CubeSat ideas for optical propagation and high redshift hydrogen detection.

**Outcome 2:** The CaSGC conducted five programs in a progression of educational opportunities involving precollege students, pre-service teachers, and in-service teachers to engage and educate in the STEM disciplines. A total of 540 precollege students, 84 pre-service educators, and 88 in-service educators were direct participants, surpassing Objectives 5A (number of teachers) and 5B (number of precollege students). Projects included sending a middle school experiment to the International Space Station (launches late June 2015). Involved the entire middle school (Lincoln Middle School) in preparation of student proposals and mission patch designs. In environmental sciences we supported year-round mentored high-school research projects. Also supported a week-

long program for middle school and high school students, exposing students to different fields in engineering encouraging them to consider STEM. We supported a conference for in-service and pre-service teachers on including engineering in their curriculum, addressing Next Generation Science Standards, a two day astronomical workshop, pre-service teacher training through classroom visits and workshops for students in science methods courses, and an evening session for high school teachers to learn about research from university and industry scientists and engineers—relating content back to high school classroom topics. We are tracking the use of NASA content in their classrooms (Objectives 5C and 5D). Pre and post project assessments of our precollege students show increased interest in pursuing STEM after participation (Objective 5E).

**Outcome 3:** The purpose of the CaSGC Informal Education program is to inspire and engage the general public in STEM, promote STEM literacy and awareness of the NASA mission, and expand the future STEM workforce. Projects include the UC Davis University Open House Geospatial Education Exhibition, presenting five interactive earth science-based activities focusing on remote sensing and geospatial technologies, and the UCLA Exploring Your Universe 2014 with interactive exhibits, focusing on the NASA Dawn mission. Our higher education students shared their research with the public at the San Diego Science Festival and the San Diego Air & Space Museum Space Day. We also supported the Jim Arnold public lecture on Geoengineering. Our higher education NASA Academy students conducted middle & high school student outreach to inspire students to aim for careers in STEM. Includes seven presentations in the cities of Carson, Carlsbad, Fillmore, and Davis to a total of 344 students. At Azusa Pacific University (APU) we sponsored informal education outreach by faculty and higher education students to elementary, middle & high school students for seven science & mathematics demonstrations & educational activities. We estimate having reached over 5000 people in these Informal Education activities strategically linking our higher education students to science & engineering informal education events where students prepare demonstrations and exhibits related to their higher education projects (Objective 6A). The Amazing Space Family Science Night opportunity was conducted at two middle schools in conjunction with Reuben H. Fleet Science Center (Objective 6B). We are considering additional informal science education opportunities as funding permits (Objective 6C).

## PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity:** Of the **176** awardees: **75** (42%) are minority students underrepresented in STEM, **65** (36.9%) are female, **79** (44.9%) attend 12 Hispanic Serving Institutions, **82** (46.6%) are the first in their family to graduate from college, and **61** (34.7%) qualified for a subsidized school lunch (low income).
- **Minority-Serving Institution Collaborations:** The CaSGC collaborated with eight affiliate Minority Serving Institutions:
  - California State Polytechnic University, Pomona (a. Aerospace Vehicle Laboratories Design, Build, and Fly: Classroom, Laboratory & Field Operations for Workforce Development; b. NASA Student Launch Initiative);

- California State University, Fresno (a. Summer Engineering Experience Camps, b. Aerospace Workforce Development in Unmanned Aerial Systems);
  - California State University, Long Beach (a. California Launch Vehicle Education Initiative Rocket projects, b. Student-Led Rocket Competition);
  - California State University, San Bernardino (Workforce Devel. in Astronomy);
  - San Diego City College, an affiliate through the San Diego Community College District (Research Academy—introduction to hands-on university research);
  - San Diego State University (a. Research Academy—introduction to hands-on university research, b. Aerospace research in High-Speed Combustors);
  - University of California, Riverside (a. Undergrad & Grad Student Research Fellowships, b. Regional Engineering Education Learning [REEL] Conference);
  - University of California, Santa Cruz (a. Undergrad & Grad Supercomputer Scholarships, b. OPENLAB: Visualization tools to the science community, c. Lamat Summer Research—community college intro to astrophysical research methods and tools through original research in computational astrophysics)
- **NASA Education Priorities:**
    - *Authentic hands-on STEM experiences:* We conducted numerous NASA-related authentic, hands-on science and engineering experiences including working with NASA Johnson Space Center on the design & test of the guidance & control systems of the Morpheus prototype planetary lander, astronomy & engineering at a university observatory and working with data from the HypIRI mission satellite to answer questions about biochemical diversity. Also included student-led flight projects in near space ballooning, autonomous unmanned aerial vehicles, CubeSats, high-powered rocketry, designing adaptive molds for deployable space applications, a directed energy system for asteroid mitigation, a backing structure for a morphable mirror telescope, and composite structures for deployable antenna & mirrors.
    - *Engaging middle school teachers with NASA expertise:* We provided several programs for middle school teachers with NASA science content and inquiry-based methods including in-service Next Generation Science Standards teacher training, astronomical workshops, a conference on including engineering in middle school curricula, the “My Daughter is An Engineer” project (to be run summer 2015) supporting participation of middle school teachers, and microgravity science & experiment design through the Student Spaceflight Experiment Program.
    - *Summer opportunities for secondary students:* The CaSGC runs week-long engineering summer enrichment programs on university campuses for middle school and high school students exposing them to engineering. We conducted a nine month-long university research program in environmental sciences where high school students from underserved backgrounds conducted research with graduate students.
    - *Community Colleges:* We engaged students in 7 community colleges through our rocket solicitation and projects conducted at our affiliate university campuses designed to expose students to university research. Includes Berkeley City College, Citrus College, Napa Valley College, San Diego City College, Santa Barbara City College, Santa Rosa Junior College & Southwestern College. In addition, we are working with twelve community colleges in our augmentation program: “Promoting

the California Community College STEM Experience Using Low-Cost Programmable Micro-Computers”, to be reported separately.

- *Aeronautics Research:* We conducted aeronautics research in High Endurance Green Aircraft Design, Variations in Interlaminar Tension Strength of Laminated Composites Reinforced with Carbon Nanotubes, and Active Flight Load Alleviation Using Segmented Trailing Edge Wings on a Small Unmanned Aerial Vehicle, all in partnership with NASA Armstrong Flight Research Center. We conducted the Control of Mixing in High-Speed Combustors with NASA Jet Propulsion Laboratory.
- *Environmental Science and Global Climate Change:* Through our UC Davis affiliate, we conducted research in the Hyperspectral Infrared Imager study, providing critical information on the state of the world’s ecosystems. We also supported graduate students at UC Irvine studying Earth System Science.
- *Research Infrastructure Capacity:* CaSGC Research Infrastructure projects have focused on graduate students in Aerospace Engineering, Structural Engineering, Electrical Engineering, Mechanical Engineering, Environmental Science, Earth System Science, Geography, Space Physics, and Planetary Geophysics.

## IMPROVEMENTS MADE IN THE PAST YEAR

**Management Improvements:** Strengthened ties with California Community Colleges & NASA Centers: This fiscal year we were awarded augmentation funds for the 2014 Community College & Technical Schools Program. While these results will be reported in OEPM later this year, our work on this project has had the effect of strengthening CaSGC management ties with community colleges in our state; 11 of the 12 community college partners in our program are Hispanic Serving Institutions. These partnerships will carry over into our base program as we continue to evolve to better meet the needs of the State of California. This has also given our management better ties with the three California NASA centers as we work together to produce regular webinars for our community college partners and students, and conduct faculty & student center tours.

**Programmatic Improvements:** Worked closely with the Society of Women Engineers and Women in Computing providing opportunities to women in engineering. The program involved Arduinos, Near Space Ballooning & CubeSat Mission Control. It was a big success with 10 women participating. At least eight of these ten women received NSF, NASA, Navy, or industry engineering internships for this current (2015) summer.

## PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

We are grateful for the participation of CaSGC affiliates & partners in our programs.

### AFFILIATES:

Four-Year Public Institutions within the University of California System: *UC San Diego* (Lead Institution for CaSGC; fellowships/scholarships in Engineering, Near Space Balloon Team), *UC Berkeley* (fellowship/scholarship programs in Space Sciences), *UC Davis* (higher ed and precollege programs in Environmental Sciences; serves on a CaSGC advisory board), *UC Irvine* (fellowships/scholarships in Earth System Science),

*UC Los Angeles* (fellowships/scholarships in Geophysics, Space Sciences, and Aerospace Engineering; hosted 2014 affiliate meeting), *UC Riverside*<sup>2</sup> (fellowships/scholarships in Engineering; precollege program with MESA), *UC Santa Barbara* (various experimental cosmology space-related instrumentation projects; works closely with Santa Barbara City College), *UC Santa Cruz*<sup>2</sup> (astrophysics programs with Hartnell and Cabrillo Colleges to develop students for careers in STEM research; serves on a CaSGC advisory board).

Four-Year Public Institutions within the California State University System: *Cal Poly Pomona*<sup>2</sup> (aerospace projects including partnership with Citrus College), *Cal Poly San Luis Obispo* (CubeSat and rocket projects), *CSU Sacramento* (Mechanical Engineering projects in conjunction with NASA Johnson Space Center), *CSU San Bernardino*<sup>2</sup> (Astronomy projects with Mt. San Antonio College), *CSU Long Beach*<sup>2</sup> (rocket projects; serves on a CaSGC advisory board), *CSU Los Angeles*<sup>2</sup>, *Fresno State*<sup>2</sup> (precollege program for middle and high school students and workforce development in UAVs; serves on a CaSGC advisory board), *San Diego State University*<sup>2</sup> (runs the San Diego MESA Alliance Research Academy for community college students in hands-on university research as well as graduate student Aerospace Research), *San Jose State University*, *Sonoma State University* (laboratory research experiences including Napa Valley College & Santa Rosa Junior College; serves on a CaSGC advisory board).

Four-Year Private Institutions: *Azusa Pacific University* (STEM outreach programs), *California Institute of Technology* (in a state of transition with CaSGC), *Pomona College*, *Santa Clara University* (robotics, CubeSats, and satellite operations in conjunction with NASA Ames Research Center), *Stanford University* (in a state of transition with CaSGC), *University of San Diego*, *University of Southern California* (Astronautical research).

Community College District: *San Diego Community College District*<sup>2</sup> (San Diego MESA Alliance Research Academy).

Other Educational Institutions: *San Diego Supercomputer Center* (conducts “TeacherTECH” in-service professional development in Space Sciences; serves on a CaSGC advisory board), *Astronomical Society of the Pacific* (conducts several precollege professional development programs for in-service and pre-service teachers).

## **PARTNERS:**

Education: Center for Excellence in Education, Citrus College, College of San Mateo, Hartnell College, Lincoln Middle School, Mathematics, Engineering, Science Achievement Program (MESA), Mt. San Antonio College, Napa Valley College, National Center for Earth and Space Science Education, San Diego MESA Alliance, Santa Barbara City College, Santa Rosa Junior College, Southwestern College, UCSD Division of Biological Sciences, UCSD Jacobs School of Engineering, Washington Space Grant Consortium.

Government: NASA Ames Research Center, NASA Armstrong Flight Research Center, NASA Dawn Project, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Johnson Space Center, NASA Marshall Space Flight Center, NASA Office of Education, National Renewable Energy Laboratory, National Science Foundation, United States Geological Survey.

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<sup>2</sup> Minority Serving Institution (MSI)

Industry: ATK Aerospace Systems, FLIR Systems, Inc., Intel Corporation, Microcosm, Inc., NanoRacks, Northrop Grumman, Pixar, Raytheon, SpaceX, Thermo Scientific, Zero Gravity Solutions.

Informal Education: Exploratorium, Reuben H. Fleet Science Center, San Diego Air & Space Museum, San Diego Science Festival, The Tech Museum of Innovation.

Societies & Organizations: American Institute of Aeronautics and Astronautics, AmericaView, Center for the Advancement of Science and Space, Keck Institute for Space Studies, National Council for Science and the Environment, Packard Foundation, Society of Hispanic Professional Engineers, Society of Women Engineers.