

California Space Grant Consortium
Lead Institution: University of California, San Diego
Director: Dr. John B. Kosmatka
Telephone Number: 858-822-1597
Consortium URL: <http://casgc.ucsd.edu>
Grant Number: NNX10AT93H

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 California Space Grant Consortium is a Designated Consortium funded at a level of \$575,000 for fiscal year 2013.

PROGRAM GOALS

California Space Grant Consortium (CaSGC) Goals and SMART Objectives are as follows:

1. Promote diversity and inclusion in all programs and activities by encouraging participation by underrepresented minority and female students and faculty.
 - *Objective 1A:* Each academic year, provide a percentage of awards to underrepresented minority and female students that is consistent with diversity targets¹ established by NASA.
 - *Objective 1B:* Undertake at least three collaborative programs with a non-member Minority Serving Institution (MSI) each year.
 - *Objective 1C:* 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 scholarship and fellowship programs including STEM (Science, Technology, Engineering, and Math) research awards for community college, undergraduate and graduate students to broaden and deepen students' knowledge and prepare them for advanced STEM degrees or STEM employment.

¹ The diversity targets are currently 41% 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.

- *Objective 2A:* Each academic year, award undergraduate, graduate, and community college students with scholarships and fellowships. Students will be competitively selected by a review panel.
 - *Objective 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 75 students each academic year.
 - *Objective 2C:* Each academic year, provide a percentage of fellowship/scholarship awards to underrepresented minority and female students that is consistent with diversity targets¹ established by NASA.
 - *Objective 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.
 - *Objective 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.
 - *Objective 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.
- *Objective 3A:* Each academic year, support at least three interdisciplinary student research infrastructure projects in partnership with CaSGC affiliate institutions.
 - *Objective 3B:* Each academic year, involve at least 15 students in research infrastructure projects in partnership with CaSGC affiliate institutions.
 - *Objective 3C:* Each academic year, provide a percentage of research infrastructure awards to underrepresented minority and female students that is consistent with diversity targets¹ established by NASA.
4. Offer quality interdisciplinary hands-on higher education programs in partnership with our affiliate institutions to prepare students for STEM employment.
- *Objective 4A:* Each academic year, provide paid internships for at least six students at California NASA Centers and at least one student at an industry partner.
 - *Objective 4B:* Each academic year, conduct at least five hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions.
 - *Objective 4C:* Each academic year, involve at least 75 students in hands-on interdisciplinary higher education projects in partnership with CaSGC affiliate institutions.
 - *Objective 4D:* Each academic year, involve students from underrepresented backgrounds in hands-on higher education projects at a level consistent with diversity targets¹ established by NASA.
 - *Objective 4E:* Each academic year, at least 70% of MSI affiliates will be involved in our higher education programs. Currently there are 9 MSI affiliates.

- *Objective 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.
 - *Objective 5A*: Each year, provide professional development in STEM using NASA resources to at least 40 teachers.
 - *Objective 5B*: Each year, reach over 200 precollege students by conducting student-focused programs and activities promoting participation in STEM and related careers.
 - *Objective 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.
 - *Objective 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.
 - *Objective 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.
 - *Objective 6A*: Each academic year, utilize material developed in CaSGC's other program elements to inspire and engage the general public at science-related events and university open houses.
 - *Objective 6B*: Sponsor at least one program each year with the Reuben H. Fleet Space Theater, the San Diego Air & Space Museum, and/or the California Science Center.
 - *Objective 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, & 3)

Outcome 1 Fellowship/Scholarship Highlight—Ms. Samira Motiwala:

Over the last four years the California Space Grant Consortium has supported Ms. Samira Motiwala, a student with dreams of becoming an astronaut, for several NASA opportunities from the time she was an undergraduate student at Cal Poly Pomona through her graduate degree at Stanford University, which she completed this month (June 2014).

While an undergraduate, Ms. Motiwala was supported for an Exploration Industry Internship at The Boeing Company at NASA Johnson Space Center as well as for her work on the Cal Poly Pomona Experimental Methods in Attitude Control (eXMAC)

CubeSat Team to test a low-cost high performance prototype attitude control system for CubeSat spacecraft and a backup stabilization system for emergency atmospheric entry. She and her team successfully tested these in-flight on the NASA Reduced Gravity Aircraft at NASA Johnson Space Center.

Ms. Motiwala was also the recipient of the California Space Grant Consortium Undergraduate Research Opportunity Program (UROP) award for a research project involving the estimation of angles of attack and sideslip for use on unmanned aerial vehicles (UAVs) to further the development of autopilots and stability augmentation systems, supporting research at NASA Armstrong Flight Research Center.

These past two summers Ms. Motiwala was sponsored by the California Space Grant Consortium for internships at NASA Glenn Research Center and at NASA Ames Research Center. At NASA Glenn she determined the feasibility of a wind-powered rover for Venus surface missions and at NASA Ames she assessed risk for conceptual launch vehicle and spacecraft designs, investigating critical design parameters and conducting sensitivity analyses for crew survivability.

This month (June 2014) Samira graduated with her Masters of Science degree in Aeronautics and Astronautics from Stanford University and has been selected by NASA Ames to continue her internship where she is modeling failure propagation for launch vehicle engine explosion scenarios and authoring several publications.

Samira believes that each opportunity at NASA brings a unique experience to the table that allows her to grow professionally, academically, and personally, and puts her one step closer toward her dream of becoming an astronaut. The California Space Grant Consortium is proud to have played an integral role in the growth and development of this dedicated and perseverant aerospace engineer.

Outcome 1 Research Infrastructure Highlight—Developing A Research Collaboration between UC San Diego and NASA Ames Research Center based on Tensegrity Robotics:

With the goal of developing ties between UC San Diego and NASA Ames Research Center, the California Space Grant Consortium initiated and advanced a research collaboration between the UC San Diego Mechanical & Aerospace Engineering Department (Professor Thomas Bewley) and the NASA Ames Intelligent Robotics Group (Researcher Vytas Sunspiral). We then sponsored two senior Mechanical Engineering students, Jeff Friesen and Alexandra Pogue, to work on the project at UC San Diego during the school year and at NASA Ames during the summer of 2013, working directly with Vytas Sunspiral. Both students graduated with their BS degrees in Mechanical Engineering. Alexandra Pogue is working in STEM non-Aerospace and will begin her MS in Mechanical Engineering at UC Los Angeles this fall. Jeff Friesen was accepted into a Ph.D. program at UC San Diego where he is continuing his work in the CaSGC-

sponsored collaborative research program and has applied for and won a NASA Space Technology Research Fellowship worth \$68,000 per year for four years on a closely-related tensesgrity robotics research project. We are very proud of Jeff's selection for this honor and for having played an instrumental role in this accomplishment. We are continuing support of this program in providing scholarships for two additional undergraduates to work with Vytas Sunspirial summer 2014 to advance the collaboration and Jeff Friesen's research.

Outcome 1 Higher Education Highlight—MESA Community College Laboratory Research Experience Program for Four California Community Colleges:

In an effort to promote diversity and inclusion in all our programs we have been working with the Mathematics, Engineering, Science Achievement (MESA) program for educationally disadvantaged students in the State of California. Within the MESA program is the MESA Community College Program (MCCP), established in 36 of California's 112 community colleges. To reach more community college students, the California Space Grant Consortium developed a program entitled "California Space Grant Consortium MESA Community College Laboratory Research Experience".

The program creates university laboratory research experiences for students attending MCCP community colleges to: (a) Encourage and prepare students in Associates degree programs for advanced STEM degrees and careers and (b) Increase participation of underrepresented minorities and females in STEM.

We selected two collaborations for this program: (a) Santa Ana College / Chapman University and (b) CSU Los Angeles / Pasadena City College / Rio Hondo College / East Los Angeles College.

The first collaboration, Santa Ana College / Chapman University, has already completed its project (May 2014). Ms. Cathie Shaffer of Santa Ana College partnered with Dr. Menas Kafatos, Director of the Center of Excellence in Earth Systems Modeling and Observations at Chapman University and his postdoctoral scholars to introduce Santa Ana College students to research in climate impact assessment using satellite observations. Twenty Santa Ana College students participated in the program, which was their first university laboratory research experience. They learned about scientific research processes & procedures, including experimental methods, data acquisition & analysis, documentation, and theoretical & governing equations, and learned how to conduct literature reviews. They then learned about vegetation activity and wildfire occurrence in Southern California using the FARSITE fire spreading model and the acquisition of satellite and ground based vegetation data. On the final day of the program they presented posters to CaSGC staff on their research. One student commented that he enjoyed the opportunity to learn something in-depth, going beyond the surface and being

able to ask questions and research the answers. This was echoed by all the students in reflections about the program. Several of these students work while taking classes and would not have otherwise had the opportunity to conduct research. Many of these students are planning to transfer to four-year universities in Southern California; having participated in a research project such as this will improve their transferability. Pre and post surveys have been administered to assess students' understanding of and interest in STEM careers. The results should be available shortly as the program just ended last month (May 2014).

PROGRAM ACCOMPLISHMENTS

Outcome 1: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals (Employ and Educate):*

The CaSGC ran 40 Fellowship/Scholarship, Research Infrastructure, and Higher Education projects at 16 of our affiliate campuses and 12 non-affiliate MSI community college campuses to provide mentored-research and hands-on interdisciplinary group projects preparing students for the needs and challenges of the STEM workforce. Through these projects the CaSGC issued 293 awards, of which 140 (47.8%) were to underrepresented minority students and 103 (35.2%) were to females, surpassing our NASA target for underrepresented minority students and within 5% of our target for female participants (SMART Objective 1A). SMART Objectives 1B and 1C were surpassed with 12 collaborative and outreach programs conducted with non-affiliate MSIs.

Fellowship/Scholarship awards across the Fellowship/Scholarship, Higher Education, and Research Infrastructure Program Elements, totaled \$174,000, over the \$150,000 requirement for our baseline funds. Within the Fellowship/Scholarship Program Element, awards were given to 159 students. These students were selected based upon academic achievement, letters of recommendation, leadership, and personal statements. Of these 159 students, 77 (48.4%) were awarded to underrepresented minority students and 68 (42.8%) were awarded to women. These awards directly relate to SMART Objectives 2A, 2B, and 2C, which were not only met, but exceeded. Projects include graduate student research in Geophysics, Space Physics, and Aerospace Engineering and undergraduate student research in Chemical Engineering, Nanotechnology, Materials Science, Bioengineering, Biology, Remote Sensing, and Earth System Science. Also included are scholarships for 6 students to attend NASA Academy or NASA Internships at a California NASA center (SMART Objective 4A) and 11 Undergraduate Research Opportunity Program scholarships for students to conduct mentored-research of their own choosing in an area that addresses priorities of one of the NASA Mission Directorates. All students receiving significant awards of greater than or equal to \$5,000 or 160 hours'

participation are longitudinally tracked to identify their next step in academia or the workforce (SMART Objective 2D).

Research Infrastructure awards this year were given to 21 graduate and undergraduate students on five projects. Of the students awarded, 8 (38.1%) were underrepresented minority students and 8 (38.1%) were women. Objectives 3A and 3B were met in terms of the numbers of supported projects, and the targets for Objective 3C were very close to being met. In FY2013 we made much improvement in increasing the diversity of students in our Research Infrastructure programs and will further increase this involvement in FY2014. This year's projects include graduate and undergraduate Aerospace research in Interlaminar Tension Strength of Laminated Composites in UAVs, Aerospace research in the Control of Mixing in High-Speed Combustors, Research Collaborations in Environmental Science (Hyperspectral Infrared Imager) to study ecosystems, Dynamic Tensegrity for robots performing space missions, the Reinventing Space Project to dramatically reduce space mission cost and schedule, and Research Collaborations between astrophysics, digital arts, and computational sciences bringing sophisticated visualization tools to the science community.

Higher Education awards were given to 113 students in 22 projects at 12 of our affiliates, including 7 MSI affiliates (addresses Objective 4E) and 11 non-affiliate MSI community colleges. Of the students receiving awards, 55 (48.7%) were underrepresented minority students and 27 (23.9%) are female. This meets Objectives 4B and 4C, and meets Objective 4D in terms of underrepresented minorities. With regard to increasing participation of our female students, in FY14 we are resuming connections with a local chapter of the Society of Women Engineers and engaging the local chapter of Women in Computing.

Interdisciplinary Higher Education projects in FY13 include classroom, laboratory & field operations for aerospace workforce development and student-led flight projects involving Near Space Balloons and our new rocket competition solicitation in which we supported rocket teams on six different California campuses. Two of these teams participated in the NASA Student Launch Initiative competition in May 2014. Other Higher Education projects include the brand new MESA Community College Laboratory Research program which ran in April-May 2014 with one community college/university partnership and will run in June-August 2014 with another community college/university partnership. The first project introduced Climate Impact Assessment Using Satellite Observations to students in one MSI community college and the second project will be providing a Solar Energy and Planetary Exploration lab research experience for students from three MSI community colleges. Both projects address Objective 1C for outreach to non-member MSIs. Higher Education projects also included support for a senior design project where students analyzed, designed, built, and tested a 1000 pound thrust liquid fueled rocket with Kerosene and LOX and an alternative fuel.

Additional Higher Education projects include CaSGC student teams working on the design and construction of a portion of the backing structure for a morphable mirror telescope to observe Cosmic Microwave Background radiation, composite structures for deployable antenna and mirrors, an 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. The CaSGC conducted the second year of our summer Research Academy for community college students giving them university laboratory experience in one of the following five projects: Near Space Balloon, Synthetic Jet Flow Control, Sensorimotor Neural Engineering, Dynamics of Flame Spread in Microgravity, and Arduino Computer Fabrication and Programming.

In the above-described Outcome 1 program elements (Fellowship/Scholarship, Research Infrastructure, and Higher Education), the CaSGC provided students with the knowledge, skills and interdisciplinary team experience for development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.

Outcome 2: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty (Educate and Engage):*

The CaSGC conducted seven programs involving Precollege students, pre-service teachers, and in-service teachers to educate and engage the students in STEM disciplines. A total of 1097 Precollege students, 94 pre-service educators, and 55 in-service educators participated in our programs this year (addressing Objectives 5A and 5B). The CaSGC provided week-long enrichment programs in engineering for middle school and high school students during the summer. During the school year we provided a middle school with an opportunity to send a project to the International Space Station where astronauts will carry out the student experiments through the National Center for Earth and Space Science Education Student Spaceflight Experiment Program (SSEP). As part of the experience the middle school students learned about microgravity science and experiment design and worked in teams to prepare proposals for microgravity projects. Through a downselection process a finalist was selected and will be launched to the ISS in July 2014 onboard the Orbital Sciences Orb-2 Cygnus. We also conducted a nine-month research program in environmental sciences where high school students conducted individual research projects under our graduate student mentors. This program prepares underserved youth for university degree programs and opportunities in Environmental Sciences, Resource Management and STEM.

With the Mathematics Engineering Science Achievement (MESA) Schools Program we sponsored the Student Engineering Mentoring Initiative (SEMI). This program provides mentoring opportunities between college engineering students and MESA precollege students through training and incentives for engineering student professional

organizations to mentor MESA precollege students. Additional CaSGC precollege projects were for teachers, including in-service teacher training based on the Next Generation Science Standards through a two day Astronomy 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. Our affiliates are in the process of tracking precollege educators to determine what percentage apply NASA content from our programs into their classrooms (Objectives 5C and 5D). Pre and post project assessments of our precollege students show an increased interest in pursuing STEM careers after participation in our programs (Objective 5E).

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission (Engage and Inspire):*

The purpose of the CaSGC Informal Education program is to engage and inspire the general public in STEM, promote STEM literacy and awareness of NASA's mission, and expand the nation's future STEM workforce. In this program element we strategically link our higher education students to science and engineering informal education events where students prepare demonstrations and exhibits related to their higher education projects (Objective 6A). This includes UC San Diego Triton Rocket Club introducing rocket science to almost 200 8th graders and the Citrus College Rocket Owl team conducting hands-on science lessons involving model rockets, catapults and projectiles to hundreds of elementary and middle school students. Our UC San Diego Near Space Balloon Team students demonstrated atmospheric science and aerospace engineering at both the San Diego Science Festival EXPO Day and San Diego Air & Space Museum Space Day. We also hosted the CaSGC annual Jim Arnold public lecture with world-renowned astronomer Jill Tarter of the Search for Extraterrestrial Intelligence (SETI) Institute as guest speaker. Later this year we will host an Amazing Space Family Science Night for disadvantaged schools in conjunction with the Reuben H. Fleet Science Center (Objective 6B). We are also considering other appropriate informal science education opportunities as funding permits (Objective 6C). We estimate having reached over 900 people this year through these activities.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Student Data and Longitudinal Tracking:**

Total CaSGC awards in FY2013 = 293 of which 159 awards are in the Fellowship/Scholarship program element and 134 are in the Higher Education/Research Infrastructure program elements. Of this year's awardees:

- 140 (47.8%) are minority students underrepresented in STEM fields
- 103 (35.2%) are female
- 144 received awards considered "significant" (includes one or more of the following: (a) has a value of greater than or equal to \$5,000, (b) participation of greater than or equal to 160 hours, or (c) through a cost-benefit analysis proves to have significant impact on the student's academic achievement and employment.

From FY2006 to FY2013 a total of 561 students are being longitudinally tracked. Of these students:

- 359 are still enrolled in the current degree program
- 60 have graduated and are pursuing advanced STEM degrees
- 14 have graduated and are seeking STEM employment
- 49 are employed in STEM Aerospace
- 39 are employed in STEM non-Aerospace
- 10 are employed by NASA/JPL
- 19 are employed in STEM academic fields
- 11 have graduated and are working in non-STEM fields

Reflecting on SMART Objectives 2E and 2F, 88% of our longitudinally tracked graduates are employed in STEM fields or are pursuing advanced STEM degrees.

- **Minority-Serving Institution Collaborations:**

This year the CaSGC collaborated with 21 Minority Serving Institutions, of which 9 are affiliates and 12 are non-affiliates:

Affiliates:

- California State Polytechnic University, Pomona:
 - Aerospace Vehicle Laboratories Design, Build, and Fly: Classroom, Laboratory & Field Operations for Workforce Development:
 - NASA Student Launch Initiative (SLI)
- California State University, Fresno:
 - 2013 and 2014 Summer Engineering Experience Camps: An enrichment program in engineering for middle and high school students.
 - Aerospace Workforce Development: Supporting research and development in Unmanned Aerial Systems (UAS)

- California State University, Long Beach:
 - In-service teacher training with NASA aerospace content at two summer residential programs:
 - My Daughter is an Engineer
 - Engineering Girls—It Takes A Village
 - Student-Led Rocket Competition
- California State University, Los Angeles:
 - MESA Community College Lab Research Experience Program: Solar Energy and Planetary Exploration
- California State University, San Bernardino:
 - STEM Workforce Development through Astronomy at an HSI
- San Diego City College (affiliate through the San Diego Community College District):
 - Research Academy introducing community college students to hands-on university research (with San Diego State University affiliate)
- San Diego State University:
 - Research Academy introducing community college students to hands-on university research
 - Aerospace research in the Control of Mixing in High-Speed Combustors
- University of California, Riverside:
 - Undergraduate and Graduate Student Research Fellowships
 - Student Engineering Mentoring Initiative (SEMI)—mentoring opportunities between college engineering students and MESA precollege students
- University of California, Santa Cruz:
 - Undergraduate and Graduate High-Performance Supercomputer Scholarships
 - OPENLAB: Art and Space Science Program bringing sophisticated visualization tools to the science community.
 - Lamat Summer Research Program introducing community college students to astrophysical research methods and tools through original research projects in computational astrophysics.

Non-Affiliates:

- Cabrillo College (teamed with affiliate UC Santa Cruz):
 - Lamat Summer Research Program introducing community college students to astrophysical research methods and tools through original research projects in computational astrophysics.
- Citrus College:
 - Student-Led Rocket Competition, including outreach to middle schools and high schools to speak with students about engineering
- Cuyamaca College:
 - Student-Led Rocket Competition

- East Los Angeles College (teamed with affiliate CSU Los Angeles):
 - MESA Community College Lab Research Experience Program: Solar Energy and Planetary Exploration
- Hartnell College (teamed with affiliate UC Santa Cruz):
 - OPENLAB: Art and Space Science Program bringing sophisticated visualization tools to the science community.
 - Lamat Summer Research Program introducing community college students to astrophysical research methods and tools through original research projects in computational astrophysics.
- Mt. San Antonio College (teamed with affiliate CSU San Bernardino):
 - STEM Workforce Development through Astronomy at an HSI.
- Napa Valley College (teamed with affiliate Sonoma State University):
 - Increasing the Flow through the STEM Pipeline at Sonoma State University (hands-on intensive summer research projects)
- Pasadena City College (teamed with affiliate CSU Los Angeles):
 - MESA Community College Lab Research Experience Program: Solar Energy and Planetary Exploration
- Rio Hondo College (teamed with affiliate CSU Los Angeles):
 - MESA Community College Lab Research Experience Program: Solar Energy and Planetary Exploration
- Santa Ana College:
 - MESA Community College Lab Research Experience Program: Climate Impact Assessment Using Satellite Observations
- Santa Barbara City College (teamed with affiliate UC Santa Barbara):
 - Morphable Mirror Telescope (design and construction of a portion of the backing structure for a morphable mirror telescope to observe Cosmic Microwave Background radiation)
- Southwestern College (teamed with affiliate San Diego State University):
 - Research Academy introducing community college students to hands-on university research.

- **NASA Education Priorities:**

- *Authentic, hands-on student experiences in science and engineering disciplines – the incorporation of active participation by students in hands-on learning or practice with experiences rooted in NASA-related, STEM-focused questions and issues; the incorporation of real-life problem-solving and needs as the context for activities*—The CaSGC conducted numerous NASA-related authentic, hands-on science and engineering experiences including working with NASA Johnson Space Center on the design and test of the guidance and control systems of the Morpheus prototype planetary lander, the development of creep-resistant ultra-high temperature carbide ceramics for heat-shield applications, and the synthesis of smart ceramics for sensor applications. Projects also included astronomy and engineering projects at a university observatory and working with data from the HypIRI mission satellite to answer questions about biochemical diversity at the canopy scale. Hands-on

experiences also included student-led flight projects in near space ballooning, quadrotors, autonomous unmanned aerial vehicles, CubeSats, and high-powered rocketry. Additional authentic hands-on Science and Engineering projects include the design of 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 and mirrors.

- *Diversity of institutions, faculty, and student participants (gender, underrepresented, underserved)*—The CaSGC has further increased its engagement with Minority Serving Institutions (MSIs) and students from underrepresented backgrounds. Through a partnership with the statewide Mathematics, Engineering, Science Achievement (MESA) program for the educationally disadvantaged we were able to reach out to several MESA Community College Programs (MCCP) this year for a new program entitled “California Space Grant Consortium MESA Community College Laboratory Research Experience”. Two proposals were selected involving engagement of four MSI community colleges with whom we had never before engaged and the program also allowed us to renew engagement with our MSI affiliate CSU Los Angeles. In addition, we continued our pilot program with MSI affiliate San Diego State University and two local MSI community colleges for the San Diego MESA Alliance Research Academy. Furthermore, we have encouraged all our affiliates to engage with their local MSI community colleges in applying for our annual Workforce Development and STEM Pipeline programs. Through these, we provided funding for projects that will give community college students from underrepresented and underserved backgrounds university research and team experience to bridge them to university STEM programs. This summer we are partnering with two STEM diversity organizations, the Society of Women Engineers and Women in Computing to include the students in hands-on team experiences and address gender diversity in Engineering. Results of this collaboration will be reported in next year’s report.
- *Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. Capabilities for teachers to provide authentic, hands-on middle school student experiences in science and engineering disciplines*—The CaSGC has provided several programs for middle school teachers including in-service teacher training based on the Next Generation Science Standards through astronomical workshops with NASA science content and inquiry-based methods. Through a Student Spaceflight Experiment Program with John B. Riebli and Mark West Charter School, middle school teachers were exposed to microgravity science and experiment design. We have also provided NASA aerospace-related content in workshops to middle school teachers through the “My Daughter Is An Engineer” and “Engineering Girls—It Takes A Village” programs.

- *Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers*—To increase enrollment in STEM the CaSGC runs week-long engineering summer enrichment programs on university campuses for middle school and high school students as well as a summer-long research intensive program for students to experience working in university laboratories. We also conducted a nine month-long university research program in environmental sciences where high school students from underserved backgrounds conducted research projects under graduate student mentors.
- *Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges*—This year we engaged 13 community colleges, including five new community colleges in an effort to introduce community college students to science and engineering projects and university experiences. These five community colleges are: Cuyamaca College, East Los Angeles College, Pasadena City College, Rio Hondo College, and Santa Ana College. These relationships were formed through the student-led rocket project and the “California Space Grant Consortium MESA Community College Laboratory Research Experience” described above. We have continued existing institutional relationships with the following community colleges: Cabrillo College, Citrus College, Hartnell College, Mt. San Antonio College, Napa Valley College, San Diego City College, Santa Barbara City College, and Southwestern College.
 In addition to the above projects conducted with community colleges, in Spring 2014 we engaged twelve community colleges (5 new relationships and 7 existing relationships) in preparing a proposal for the NASA Cooperative Agreement Notice: “Competitive Opportunity for Partnerships with Community Colleges and Technical Schools”. The proposal is entitled “Promoting the California Community College STEM Experience Using Low-Cost Programmable Micro-Computers”. Should we be awarded this project our community college engagement will be significantly enhanced.
- *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)*—The CaSGC has conducted aeronautics research in the following projects: High Endurance Green Aircraft Design using advances in solar cell efficiency, aircraft design, and lightweight composite materials to develop a solar-powered UAV that has a near infinite endurance and range. The UAV is being designed at UC San Diego (our CaSGC lead institution) and will be flight-tested at NASA Armstrong Flight Research Center. In addition we have supported aeronautics research in strengthening aircraft laminated composites through incorporation of carbon nanotubes. This project is being conducted at both UC San Diego and NASA Armstrong Flight Research Center. A third aerospace research project is the

Control of Mixing in High-Speed Combustors at our San Diego State University affiliate with NASA Jet Propulsion Laboratory.

- *Environmental Science and Global Climate Change – research and activities to better understand Earth's environments*—The CaSGC is conducting this research at our UC Davis affiliate in the Hyperspectral Infrared Imager study, providing critical information on the state of the world's ecosystems, including vegetation, pre-eruptive behavior of volcanoes, and gases released from wildfires. In addition, through the MESA Community College Program collaboration between Santa Ana College and Chapman University, students worked on various climate change projects involving precipitation, vegetation under different climates, extreme wildfire events, and fuel moisture using satellite observations of vegetation. This was conducted under the Director of the Center of Excellence in Earth Systems Modeling and Observations at Chapman University.
- *Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities*—This year's CaSGC Research Infrastructure projects have been focused on graduate students in Aerospace Engineering, Environmental Science, Space Physics, Planetary Geophysics, and Mechanical Engineering and we are strongly considering adding a program aimed at early career faculty.

IMPROVEMENTS MADE IN THE PAST YEAR

Management Improvements

This year we strengthened ties with a statewide program serving the educationally disadvantaged in Science and Engineering: the Mathematics, Engineering, Science Achievement (MESA) program. This program is run from the University of California Office of the President and is meant to address the need for more diversity and inclusion in the STEM fields. We reached out to this organization when drafting a new opportunity for MESA Community College Programs last year and have been working with them ever since. This collaboration has been instrumental in developing a program that addresses the state's and NASA's needs for a more diverse STEM workforce. We also strengthened ties with all three of the California NASA Centers. With NASA Armstrong Flight Research Center, our director has been working closely with the Education Office on developing ideas for a joint flight competition to involve nationwide campus and student participation with NASA Armstrong Flight Research Center. With NASA Ames we co-sponsored a CaSGC affiliate meeting (described below), and with NASA JPL we have begun discussions on developing a systems engineering fellowship program involving industry. We also involved all three centers in our community college proposal to NASA (submitted May 2014) to bring NASA content to community college faculty and student projects.

In spring 2014 we held two affiliate meetings in different parts of the state to allow affiliates, partners, students, and NASA representatives to attend. Both meetings were very well attended: 35 people attending our Bay Area Affiliate meeting at NASA Ames Research Center and 31 people attending our Southern California meeting at UC Los Angeles—at both meetings we had representatives from all three of the California NASA Centers and are grateful for their participation. In both meetings affiliates learned about our vision for the consortium, NASA Office of Education priorities, and discussed working within our baseline budget and responding to the new Cooperative Agreement Notice from NASA for Community Colleges. In conjunction with these affiliate meetings we held Arduino workshops for affiliates and students in using Arduinos (microcomputers) to collect sensor data, run experiments and control engineering projects.

Programmatic Improvements

This year we increased our engagement with Minority Serving Institutions by partnering community colleges with our four-year university affiliates to give community college students laboratory research experience and bridge them to STEM fields at four-year institutions. We took our San Diego Research Academy pilot project to Orange County (April/May 2014) and Los Angeles (June/August 2014) to bring about more community college-university interactions. This increased engagement resulted in an increase in awards going to underrepresented students (went from 37.6% of funded students in FY12 to 47.8% of funded students in FY13).

Another programmatic improvement is the establishment of a new opportunity for supporting student rocket teams participating in national rocket competitions. Through this program we encouraged students across the state to participate in several national high-power rocketry competitions. Six teams were supported this year, including two teams competing in the NASA Student Launch Initiative (SLI), two teams competing in the Students for the Exploration and Development of Space (SEDS) competition, one team competing in the Intercollegiate Rocket Engineering Competition (IREC), and one team competing in the First Nations Launch.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

CONSORTIUM AFFILIATES (28):

- Astronomical Society of the Pacific: A formal and informal education provider conducting several precollege programs for the consortium with professional development for in-service and pre-service teachers.

- Azusa Pacific University: Four-year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees. Executing higher education and fellowship/scholarship programs for the consortium.
- California State Polytechnic University – Pomona²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Directs several higher education programs for the consortium. Has partnered with non-affiliate Citrus College.
- California State Polytechnic University – San Luis Obispo: Four-year, public institution offering Bachelor's and Master's degrees.
- California Institute of Technology: Four-year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees. The relationship with this affiliate is in transition; we have identified candidates for a new CaSGC campus director and will soon resume CaSGC programs on that campus. Throughout this transition, however, we have continued to support Caltech students at NASA centers.
- CSU Sacramento: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Conducting CaSGC fellowship/scholarship and higher education workforce development projects in conjunction with NASA Johnson Space Center.
- CSU San Bernardino²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Performing CaSGC higher education workforce development projects in conjunction with NASA Armstrong Flight Research Center. Has partnered with non-affiliate community colleges Mt. San Antonio College and College of the Desert.
- CSU Long Beach²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Implementing CaSGC precollege programs for in-service teachers and middle school students as well as higher education workforce development rocket projects. Affiliate serves on a CaSGC advisory board.
- CSU Los Angeles²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Performing Unmanned Aerial Vehicle projects with NASA Armstrong Flight Research Center and running a CaSGC program for MESA community colleges with East Los Angeles College, Pasadena City College, and Rio Hondo College.
- Fresno State²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Executing CaSGC precollege program for middle and high school students as well as higher education workforce development Unmanned Aerial Vehicle projects. Affiliate serves on a CaSGC advisory board.
- Pomona College: Four-year, private, not-for-profit university offering Bachelor's degrees. Hosted the CaSGC Southern California meeting in 2010.
- San Diego Community College District²: A district of three community college campuses and one continuing education campus. The three community colleges offer certificates and Associates degrees. San Diego City College² in conjunction with San Diego State University and Southwestern College run the CaSGC San Diego MESA Research Academy for community college students to experience hands-on research in a university laboratory.

² Minority Serving Institution (MSI)

- San Diego State University²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Runs the CaSGC San Diego MESA Research Academy for community college students to experience hands-on research in a university laboratory. This affiliate also has a "mentoring chain" for aerospace research where graduate students being mentored by professors lead research teams of undergraduates, who in turn mentor community college students and perform outreach to precollege students as part of the MESA program.
- San Diego Supercomputer Center: An organized research unit of the University of California, San Diego leading in cyberinfrastructure innovation, development, and expertise. The CaSGC works with this organization's Education Group, which conducts "TeacherTECH" in-service professional development in Space Sciences for our consortium. This affiliate also serves on a CaSGC advisory board.
- San Jose State University: Four year, public institution offering Bachelor's and Master's degrees. Has carried out several CaSGC programs at NASA Ames Research Center.
- Santa Clara University: Four-year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees. Provides several higher education workforce development programs for students in robotics, CubeSats, and satellite operations in conjunction with NASA Ames Research Center.
- Sonoma State University: Four year, public institution offering Bachelor's and Master's degrees. Has provided laboratory research experiences for undergraduates and high school students. Works closely with Napa Valley College. This affiliate serves on a CaSGC advisory board.
- Stanford: Four-year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees. The relationship with this affiliate is in a state of transition; we have identified candidates for a new CaSGC campus director and will soon resume CaSGC programs on that campus. Throughout this transition, however, we have continued to support Stanford students in NASA internships.
- UC Berkeley: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Conducts Fellowship/Scholarship programs in Space Sciences.
- UC Davis: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Carries out Fellowship/Scholarship, Research Infrastructure, Higher Education, and Precollege programs for the CaSGC in Environmental Sciences. Affiliate serves on a CaSGC advisory board.
- UC Irvine: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Runs graduate Fellowship/Scholarship programs in Earth System Science.
- UC Los Angeles: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Provides graduate Fellowship/Scholarship programs in Geophysics, Space Sciences, and Aerospace Engineering. Hosted 2014 Southern California affiliate meeting. Campus director is the Principal Investigator of the NASA Dawn Mission.
- UC Riverside²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Provides graduate and undergraduate fellowships/scholarships in Engineering as well as Precollege projects associated with the MESA program.

- UC San Diego: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Serves as Lead Institution for the CaSGC. Provides graduate fellowships in Engineering and multidisciplinary undergraduate scholarships, conducts aerospace research, runs the Near Space Balloon Team higher education project and a new seminar series for undergraduate engineering students.
- UC Santa Barbara: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Various projects through the Experimental Cosmology Group providing undergraduate and graduate students with hands-on team experience designing and developing space-related instrumentation. Works closely with Santa Barbara City College.
- UC Santa Cruz²: Four year, public institution offering Bachelor's, Master's, and Doctoral degrees. Runs astrophysics programs with Hartnell and Cabrillo Colleges to develop students for careers in STEM research. Affiliate serves on an advisory board for the CaSGC.
- University of San Diego: Four year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees.
- University of Southern California: Four-year, private, not-for-profit university offering Bachelor's, Master's, and Doctoral degrees. Higher Education hands-on team research and development of CubeSats and a Lunar Lander in the Department of Astronautical Engineering. Also conducting the Reinventing Space Project with Microcosm, Inc.

We are grateful for the participation of the above affiliates in executing our statewide program and sincerely appreciate the support and guidance of the NASA Office of Education. We thank the following Education, Government, Industry, Informal Education, Society & Organization partners for their involvement and collaboration with the California Space Grant Consortium:

Education

- Cabrillo College
- California Community College Chancellor's Office
- California State University, East Bay
- Center for Excellence in Education
- Center for Human Factors in Advanced Aeronautics Technologies (a NASA University Research Center located at CSU Long Beach)
- Chapman University
- Citrus College
- College of San Mateo
- College of the Desert
- Cuyamaca College
- Hartnell College
- John B. Riebli School
- KidScience Adventures
- Mark West Union School District
- Massachusetts Space Grant Consortium

- Mathematics, Engineering, Science Achievement Program (MESA)
- Mt. San Antonio College
- Napa Valley College
- National Center for Earth and Space Science Education
- Riebli PTA
- San Diego MESA Alliance
- San Francisco State University
- Santa Ana College
- Santa Barbara City College
- Sonoma County Office of Education
- Southwestern College
- UCSD Jacobs School of Engineering
- UCSD School of Medicine
- University of San Francisco

Government

- Air Force Office of Scientific Research (AFOSR)
- Edwards Air Force Base
- NASA Ames Research Center
- NASA Armstrong Flight Research Center
- NASA Dawn Project
- NASA Jet Propulsion Laboratory
- NASA Johnson Space Center
- NASA Kennedy Space Center
- NASA Marshall Space Flight Center
- NASA Office of Education
- National Renewable Energy Laboratory
- National Science Foundation
- United States Geological Service
- US Forest Service

Industry

- Adobe Associates, Inc.
- Aerojet Rocketdyne
- Flometrics, Inc.
- General Atomics
- Intel Corporation
- JDS Uniphase
- Microcosm, Inc.
- NanoRacks
- Northrop Grumman
- Pixar
- SpaceX
- The Boeing Company

Informal Education

- Columbia Memorial Space Center
- 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
- Association for Unmanned Vehicle Systems International
- Center for the Advancement of Science and Space
- IEEE Control Systems Society
- James Irvine Foundation
- National Council for Science and the Environment
- Packard Foundation
- Society of Hispanic Professional Engineers
- Society of Women Engineers

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