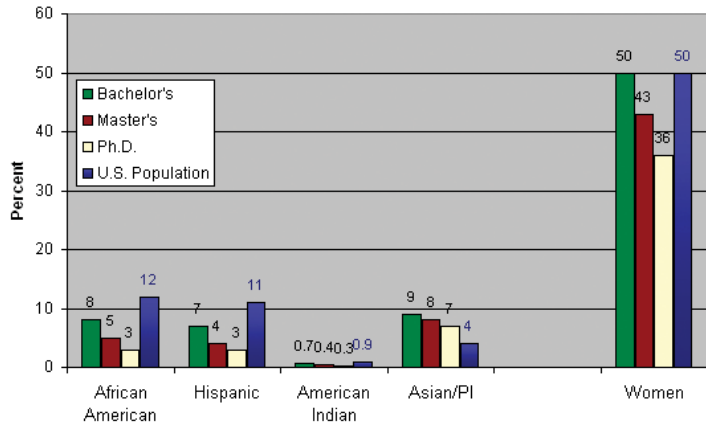


## An Overview of the Program and Its First 8 Years

BY THOMAS L. WINDHAM, AMY J. STEVERMER, AND RICHARD A. ANTHES

In 1996, a new program, Significant Opportunities in Atmospheric Research and Science (SOARS®), was established to help retain and eventually increase the number of participants from underrepresented minority groups in the atmospheric and related sciences. The need for such a program is demonstrated by various studies, which indicate that although the numbers of women and minorities pursuing bachelor's degrees in science and engineering have increased, the overall percentages of African American, Hispanic, and American Indian students in science and engineering remain low relative to their proportion of the U.S. population. The differences between science and engineering participation and percentage of U.S. population become even more pronounced at the graduate level (see Fig. 1).

Recent National Science Foundation studies (NSF 2000, 2002) indicate that minorities receive only a small percentage of master's and doctoral degrees awarded in science and engineering. African Americans accounted for 3% of all science and engineering doctorates in 2000—constant from 3% in 1997 and up from 2% in 1975—while receiving approximately 7% of the doctoral degrees awarded in other fields. Hispanics received 3% of the science and engineering doctorates awarded in 2000, compared to 4% in 1997 and 1% in 1975. American Indians received only 0.3%



**FIG. 1. Percentage of bachelor's, master's, and doctoral degrees in science and engineering received by minorities and women in 2000, contrasted with data on minority representation in the U.S. population (NSF 2002).**

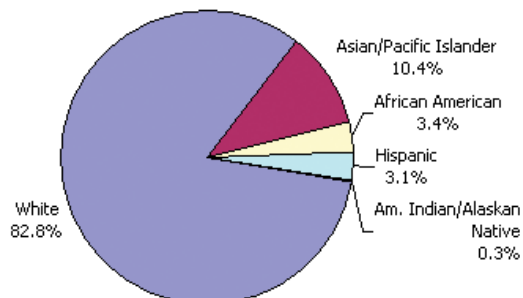
of the science and engineering doctorates awarded in 2000, compared to 0.4% in 1997 and 0.1% in 1975 (NSF 2000, 2002). These numbers are similar to the percentages of minorities currently participating in the scientific workforce (see Fig. 2).

The NSF (2000, 2002) studies also report that although women completed 47% of all bachelor's degrees in science and engineering in 1997, they accounted for only about 40% of science and engineering master's degrees and 33% of all science and engineering doctoral degrees. By contrast, women earned ap-

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**FIG. 2. Distribution of scientists and engineers in the labor force, by race/ethnicity (SESTAT 1997).**

proximately 54% of the doctoral degrees awarded in other fields. By 2000, the numbers had improved only slightly, with women receiving approximately 36% of the doctoral degrees in science and engineering fields. Women account for an even smaller percentage of the total science and engineering workforce. Data collected by the NSF, the U.S. Census Bureau, and other agencies suggest that women represented only 23% of the U.S. scientific and engineering labor force in 1997; about one-third of these women also identified themselves as belonging to a minority group (NSF 2000; CAWMSET 2000).

The discrepancy between minority representation in the U.S. population and the numbers of these students completing a degree and choosing to pursue a career in science or engineering suggests that recruitment and retention require further attention. Retention is a problem that must be addressed at the undergraduate level. Educators and diversity program managers often refer to a “pipeline” as a metaphor for building minority participation in science and engineering. The idea, that attracting and retaining more minority students in the sciences as undergraduate and graduate students will eventually increase the diversity of the scientific workforce, is simple in theory. Demonstrating the success of recruitment and retention programs is difficult, however, as earlier programs did not always document the career paths of their alumni. The small percentages of minorities in science and engineering professions indicate that much work remains. In a 2001 statement, NSF director Rita Colwell summarized the importance of a diverse workforce, saying: “All barriers must be removed because research is enriched when the broadest range of people participate. Especially in times of national crisis, we need all of our best minds working together to bring science and technology to bear on urgent issues.”

SOARS is one effort to promote racial and gender equality in the sciences. The multiyear mentoring program brings together students majoring in sciences, engineering, mathematics, and related social sciences for 10 weeks of intensive research each summer. The University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado, established SOARS with major support from the NSF. The program seeks to recruit and retain students from historically underrepresented communities, including the African American, American Indian/Alaska Native, Hispanic/Latino, and Pacific Islander communities.

SOARS began its eighth summer in 2003. The

program’s sponsors now include not only UCAR and NSF, but also the U.S. Department of Energy Global Change Education Program, the NASA Goddard Space Flight Center, NASA Living with a Star Program, the NOAA Office of Global Programs, and the University of Colorado’s Cooperative Institute for Research in Environmental Sciences. The following provides an overview of the program’s unique aspects, as well as some of the accumulated successes of the past 8 years.

### **INTRODUCING STUDENTS TO A SCIENCE CAREER.**

Many of the SOARS students (protégés) participate in research projects at the National Center for Atmospheric Research (NCAR), the UCAR Office of Programs, and other supporting laboratories in Boulder, Colorado. As the program has expanded, opportunities have also become available at other institutions. For example, in 2003, two SOARS protégés worked at NASA’s Goddard Space Flight Center in Greenbelt, Maryland, another worked at NOAA’s National Severe Storms Laboratory in Norman, Oklahoma, and a fourth was located at the Universidad Catololica del Norte in Antofagasta, Chile.

SOARS includes intensive personal interaction with a science research mentor. The protégés also participate in a series of workshops emphasizing effective ways to write and speak about scientific research. SOARS protégés are UCAR employees during their summer and, as such, are expected to produce results just as full-fledged researchers do. At the end of the summer, the protégés deliver both oral and written reports of their research methods and results. The end-of-summer colloquia, during which each protégé presents his or her work, are well attended by scientists, students, and staff, along with representatives from the sponsoring agencies.

The protégés’ experiences can lead to a presentation at a national conference and continued scientific experience. Each year, many SOARS protégés submit abstracts to various conferences, including those sponsored by the AMS, the American Geophysical Union, and the American Indian Science and Engineering Society. Many protégés present their summer research at the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference and have distinguished themselves well in that forum. In 2001, SOARS protégé Pauline Datulayta, although still an undergraduate, presented her research during the

graduate student oral session and won first place in the geoscience/atmospheric science section. Theresa Jo Johnson, who began her SOARS experience in 1999, won first place in the geoscience/atmospheric science section poster category. At the 2002 SACNAS conference, fourth-year SOARS protégé Sarah Tessororf received the first place award for graduate student oral presentation. This past fall, SACNAS awarded first place for graduate student oral presentation in the geoscience/atmospheric category to SOARS second-year protégé Rei Ueyama.

Attending professional meetings provides protégés with additional opportunities to participate in real-world science and to learn more about the issues facing the broad research community. In 2001, Tessororf was one of three protégés awarded a travel grant from AMS to attend the 81st Annual Meeting and credits the experience with helping influence her career goals. “One of the talks at the AMS meeting in Albuquerque recognized the need for better communication between scientists, media, and, though not specifically addressed in the talk, with policy makers. My interest in the AMS Policy Colloquium, which I attended in 2003, stems from this growing need to ‘bridge the gap’ between scientists and those who will use scientific output.”

The SOARS program encourages protégés to actively participate in presenting their research projects and results. Opportunities to share their work may be available at their home universities or at research symposia. Following his first SOARS summer in 2001, protégé Ernesto Muñoz Acevedo won a first-place award for his research presentation at the XII Undergraduate Research Symposium at the Universidad Metropolitana in San Juan, Puerto Rico. In 2002, SOARS turned out an exceptional showing at the Universidad Metropolitana’s XIII Undergraduate Research Symposium. Protégés Erik Noble, Casey

Thornbrugh, and Fabiola Navarro won first-, second-, and third-place awards, respectively, in the oral presentation category, and first-year protégé Olusegun Goyea placed third in the environmental sciences poster category. These experiences help build confidence and provide additional practice functioning in the scientific research community.

The protégés and alumni of the program best exemplify its success. From the program’s inception in 1996 through the summer of 2003, 85 protégés participated in SOARS, representing colleges and universities throughout the United States and Puerto Rico. A breakdown of the ethnicity and gender of the participants is shown in Table 1.

SOARS has maintained a high retention rate, with 80% of protégés returning for 2 or more years. Not one participant in the program has left college or university without completing an undergraduate degree in science, mathematics, engineering, or a related field. By summer 2003, 59 of all 85 participants had completed bachelor’s degrees,

and 48 had enrolled in graduate programs. As of fall 2003, the program has 17 alumni with graduate degrees (all master’s degree recipients). Six are enrolled in doctoral programs in the atmospheric or related sciences. The remaining 11 alumni, along with one protégé with a B.S. degree, are employed in the scientific workforce.

**TABLE 1. Ethnicity/gender representation of SOARS protégés, 1996–2003.**

| Ethnicity and gender     | Number of protégés | Percent of protégé population |
|--------------------------|--------------------|-------------------------------|
| African American         | 35                 | 41%                           |
| American Indian          | 11                 | 13%                           |
| Asian/Pacific Islander   | 4                  | 5%                            |
| European American        | 6                  | 7%                            |
| Hispanic/Latino American | 29                 | 34%                           |
| Female                   | 56                 | 66%                           |
| Male                     | 29                 | 34%                           |

**INCORPORATING UNIQUE INGREDIENTS.**

*A community-oriented, student-centered experience.* We attribute a portion of the program’s success to a unique set of ingredients that help SOARS create a positive learning community. The concept follows directly from the East African proverb, “It takes a whole village to raise a child.” The village is encompassed in the program’s team mentoring approach, providing each protégé with a great deal of personal attention and multiple learning perspectives. At the beginning of summer, each SOARS protégé is assigned a science research mentor and a sci-

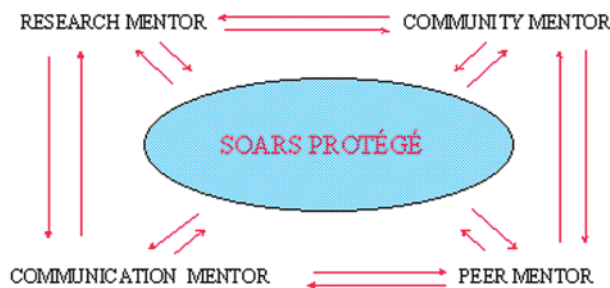
entific writing and communication mentor. First-year students are assigned two additional mentors: a community mentor, typically a UCAR staff person independent of the student's work who helps the protégé integrate into UCAR and the broader Boulder community, and a peer mentor, a fellow protégé who has been in the program for a year or more. This team approach, illustrated in Fig. 3, differs from the one-mentor-to-several-students model common in many internship programs. Protégés report that the multiple-mentor model works very well. Pauline Datulayta, who began SOARS in 2001, says: "The students have the luxury of having four individuals who serve as a resource. I considered my mentors [to be] supportive, generous, and guiding individuals who truly wanted me to succeed."

Jewel Prendeville, a recently retired program coordinator in NSF's Division of Atmospheric Sciences, says "[SOARS] has shown a great deal of flexibility in allowing the protégés to follow their own interests on their own schedules. The program flexes to fit the student rather than forcing the student to fit into a narrow mold, and I think that's been very productive." Incoming protégés are invited to choose a research project that will embody their needs and passions. At least five of the program's participants have completed summer research projects that later complemented or directly related to their graduate thesis work. Shirley Murillo, currently completing a master's degree in meteorology at the University of Hawaii, is one protégé who combined her SOARS experience and graduate research interests. Murillo entered the SOARS program as an undergraduate in 1997, after having interned with NOAA's Hurricane Research Division in Miami. Her SOARS experience exposed her to different areas within the field of meteorology, while allowing her to build on her interests in hurricanes. Murillo speaks highly of the opportunity: "Through SOARS, I met my advisor for my master's thesis and even got started on the research."

*Multiyear support.* SOARS helps ensure the success of its protégés by offering multiyear support. "It's not

a one-shot deal," says John Snow, dean of the College of Geosciences at the University of Oklahoma. Students can be involved for up to 4 years and are offered support for graduate study. Barbara Kraus, program manager for the University of Colorado at Boulder's Colorado Diversity Initiative in Science, Mathematics, and Engineering, views this multiyear support as "a strong incentive to go on, rather than drop out of the pipeline." SOARS protégés indicate that, indeed, the multiyear experiences provided by SOARS can be instrumental in encouraging them in a science career. Erik Noble, a third-year SOARS protégé in 2003, says the multiyear support—combined with the program's

appreciation of an individual's background and culture—helps make the participants feel valued. "It makes me feel like the program really wants to focus on me personally and how I can contribute to ongoing atmospheric research, instead of coming in, doing my part, and then going away, and not leaving a mark," says Noble.



**FIG. 3. The SOARS mentoring model. Every protégé is assigned a research mentor and a scientific writing and communication mentor. First-year protégés are assigned two additional mentors: a community mentor and a peer mentor, who help the newcomers to integrate into the broader community.**

*A framework for inspired performance and resiliency.* SOARS tries to inspire protégés to take on tasks that may require new skills. In many cases, growth can only occur outside an individual's comfort zone, and learning to work effectively outside one's comfort zone helps the protégé develop perseverance and skills, sometimes in the face of anxiety and overload. These same skills translate well to surviving graduate school and later life. Shaan Bliss, now a graduate student in Colorado State University's range management program, says: "I don't think my life would be the same if I wasn't in the program. Professionally, my career would have taken a different turn. It has sped up the process for me. I think I would have eventually gotten into graduate school, but it pushed me a lot further in my education, my experience, my confidence, my self-esteem. I see that I can do this now and I don't need to wait 5 years before doing research and feeling comfortable with it."

*An extended learning community.* Each summer, more than 70 scientists and other professionals at



Science research mentor **David Schimel** (center) discusses summer research projects with 2002 SOARS protégés **Atzel Drevón** (left) and **Christina Webb**. The research, performed at UCAR's Mesa Lab in Boulder, Colorado, focused on measuring global carbon fluxes.

NCAR and other SOARS-supporting institutions volunteer their time as mentors. The mentors share their enthusiasm and expertise during the summer program and throughout the year. SOARS's strong community aspect, designed to support the protégés, benefits the mentors as well. The team approach enables the individual mentors to specialize and share with their protégés the aspects of scientific life that they most enjoy. Having multiple mentors involved in a protégé's summer experience distributes the workload so that no one person alone is 100% responsible for the protégé's progress. It also gives mentors a chance to collaborate with others, often people outside their own work groups whom they may not otherwise meet. Working as part of a team provides mentors with the opportunity to recognize new

## SUMMER SOARS

**The SOARS summer program begins in June. Applications are due by 1 February of each year, and accepted candidates are notified in April. More information about the SOARS program is available online at [www.ucar.edu/soars](http://www.ucar.edu/soars).**

perspectives, in many cases offered by the protégés themselves, and the involvement is generally found to be highly rewarding. NCAR research scientist Sasha Madronich, who mentored SOARS protégé Stephanie Rivale during four summers, says the participation can definitely have an impact: "Stephanie has been

very helpful to me in better understanding some of the complications of urban-to-global transport, in connecting the small scale to the large scale. In subtle ways, she contributed to our group's evolution of thinking in these directions."

The SOARS learning community is further extended through complementary academic-year programs offered by many universities. These programs offer students an opportunity to extend their educational experiences and directly apply knowledge from their coursework. The Louis Stokes Alliance for Minority Participation (LSAMP) program is one such academic-year program, designed to help introduce and expose students to science and scientific research. To date, seven LSAMP students have been involved in SOARS: two are now in graduate school and the others plan to pursue graduate education after completing their undergraduate degrees.

*Continual feedback and adjustment.* Protégés play a role in SOARS's success by actively critiquing the program and providing suggestions for improvement. In Week 9 of each summer, the protégés gather in small groups for a half day to evaluate the program and make recommendations. Once the summer program has ended, each student completes a questionnaire evaluating the overall program and each of his or her mentors. The SOARS staff gathers additional suggestions for improvements or changes during meetings with the protégés at AMS, SACNAS, and other conferences.

The active role that protégés play in steering the program has led to many improvements. As one example, the protégé computer orientation that is now conducted in the first week of each summer was organized by the protégés themselves in response to their perception that an orientation to computing systems and programming languages would be useful. The protégés' active involvement in steering the program also provides valuable leadership training. Before the official start of the each summer's program, returning protégés arrive in Boulder for leadership and peer mentor training. During this time, they incorporate any appropriate program revisions. They also work with the SOARS staff to finalize the curriculum for the scientific writing and communication workshop, and to review and revise the job description for returning protégés who will serve as peer mentors for first-year participants. During Week 6, the peer mentors meet again to evaluate how well their peer mentoring is working.

**BUILDING ON SUCCESS.** SOARS protégés have performed exceptionally well on their educational and career paths. Tom Collett, professor of atmospheric sciences at Colorado State University, speaks highly of SOARS protégés and alumni: “The research experience gained by SOARS protégés, as a result of their participation in the SOARS summer program, makes them particularly strong candidates for appointment as graduate research assistants.” By fall 2003, more than 50 protégés had presented papers and posters at regional, national, and international conferences, and the summer work of at least 12 protégés had resulted in coauthored papers in refereed journals. Currently, SOARS boasts three AMS fellowship and two NSF fellowship recipients.

In 2001, SOARS was one of 10 institutions selected to receive the sixth annual Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. The awards, announced by President Bush on 4 December 2001, honor people and institutions promoting participation and achievement among women, minorities, and persons with disabilities in science and engineering careers. For SOARS, this recognition is viewed not only as an honor, but also as a responsibility for the program’s continued excellence.

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## FOR FURTHER READING

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**2003 protégé Amber Reynolds (left), with science research mentor David Dowell, at the Bow Echo and Mesoscale Convective Vortex Experiment (BAMEX) in St. Louis, Missouri.**