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NASA Graduate Fellowship Opportunities

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ABSTRACT. The US National Aeronautics and Space Administration (NASA) has a robust program in Earth observing and Earth science research, including oceanography. For decades, the agency has supported graduate students through research grants and a dedicated graduate fellowship program. The core and the longest-active graduate student program is the NASA Earth and Space Science Fellowship geared to students in basic and applied research in Earth and space science. This article provides some history and context for NASA's investment in oceanography graduate students, along with testimonials from some graduate fellowship recipients.

INTRODUCTION

One mission of the National Aeronautics and Space Administration (NASA) is understanding and protecting our home planet. Roughly 10% of NASA's budget is allocated to its Earth Science Division (ESD)—one part of NASA's Science Mission Directorate. ESD funds Earth observing satellites, Earth system science research, technology development, and application of remote-sensing data for societal benefit. People endeavoring to make Earth science their life work—graduate students—are at the core of ESD's support of modern research activities. This paper describes NASA's graduate fellowship programs as they apply to Earth science and the field of oceanography in particular.

SOME HISTORICAL BACKGROUND

NASA physical and biological oceanography programs were initiated effectively with the launch of the first satellite dedicated to ocean research, Seasat, on June 27, 1978. This satellite collected data for a mere 3.5 months, to October 10, 1978, when it ceased operating due to failure of its electric power system. Despite its short lifespan, Seasat demonstrated the feasibility of global satellite observations of oceanographic phenomena. With its first-of-a-kind satellite instruments, Seasat collected data on sea surface winds (scatterometer) and temperatures (scanning multichannel microwave radiometer), wave heights (synthetic aperture radar [SAR], altimeter), internal waves (SAR), atmospheric column water (microwave radiometer), sea ice features (SAR), and ocean surface topography (altimeter).

Prior to Seasat, there was the Electrically Scanning Microwave Radiometer (ESMR; operated 1972–1976) that measured surface brightness temperatures to derive sea ice concentrations. This technique evolved into the scanning multichannel microwave radiometer (SMMR; launched on Nimbus-7 October 24, 1978) and then a series of operational missions sponsored by the US Department of Defense. Another pioneering instrument used to observe the living ocean was the Coastal Zone Color Scanner (CZCS), which also flew on Nimbus-7. The busy year of 1978 also brought a new era of satellite sea surface temperature observations with the October 13 launch of the Advanced Very High Resolution Radiometer (AVHRR) onboard TIROS-N, a NASA-built satellite operated by the National Oceanic and Atmospheric Administration (NOAA). From these early efforts, the NASA physical oceanography and ocean biology/biogeochemistry programs have continued to expand with new ocean exploration missions. Presently, NASA Earth Science has ~20 operating missions, with the Earth Observing System platforms (Terra launched in December 1999 and Aqua in May 2002) carrying the largest instrument loads.

BUILDING A RESEARCH WORKFORCE

Since the beginning of Earth observing satellites, a key to further technological and scientific advances of ocean research has been sustaining workforce development. NASA has recognized the importance of workforce growth, particularly with respect to entraining and retaining new researchers in all fields of Earth remote sensing. Since its launch in 1979, the NASA Graduate Student Researchers Program (GSRP) has supported engineers and scientists in many sectors of science and technology. They, in turn, have made important contributions to NASA's mission from bases that range from universities and the federal government to nonprofit and for-profit organizations. GSRP spawned the NASA graduate research opportunities of today that we describe below. Investment in workforce development by NASA has been so successful that now more than 50% of NASA ocean research funding goes to non-NASA researchers at universities and other research organizations.

Colleen Mouw: NASA Fellow 2005–2007

The NASA Earth and Space Science Fellowship (NESSF) gave me the flexibility to pursue research topics and aspects I was most passionate about as a graduate student. The fellowship gave me a confidence boost in recognizing that my ideas were well grounded and worth supporting, provided early exposure to proposal writing and panel feedback, and allowed me to develop full ownership of the work and outcomes of the fellowship effort. These experiences have been invaluable in transitioning to an independent PI. Little did I know at the time that the development work I was doing during the fellowship would be so important in my ability to successfully fund independent work post graduation. I am now advising a student who is currently supported by the NESSF. This has allowed me to broaden the depth of my mentoring and the reach of my own research through more fully being able to encourage his creative and independent thinking.

Coleen Mouw is an assistant professor at Michigan Technological University and Great Lakes Research Center, Department of Geological and Mining Engineering and Sciences, Houghton, Michigan. She held a NASA fellowship from 2005 to 2008 at the University of Rhode Island.

Galen McKinley: NASA Fellow 1999–2002

I had the honor of being a NASA fellow during my PhD studies at MIT. This support allowed me to pursue my own questions about global ocean carbon cycling from the very beginning. I experienced independence of inquiry and gained confidence in my ability to formulate solid hypotheses and the work plan that would test them. This confidence was critical to my success as a postdoc and to being able to write successful proposals early in my career on the tenure track—including for a NASA New Investigator Program award for 2008 to 2011. I continue to find joy in asking the right questions and in seeing research develop toward answers. NASA has the ability not only to launch satellites, but also to launch careers. Thank you, NASA!

Currently a professor of atmospheric and oceanic sciences at the University of Wisconsin–Madison, Galen McKinley held a NASA Earth System Science Fellowship from 1999 to 2002 at the Massachusetts Institute of Technology.

NASA GRADUATE STUDENT OPPORTUNITIES

NASA currently offers several graduate education programs that are open to applicants from accredited US universities. Some of these programs are limited to applicants who are US citizens or permanent residents, and others are open to foreign students fully enrolled in US accredited universities. NASA also sponsors educational programs that are designed for students from underrepresented populations to broaden their participation in the remote-sensing community and to increase the talent pool by developing a more inclusive science and technology workforce. The selected students are located either at their home institutions or at NASA centers, depending on the program. Here, we review programs that are the most applicable to Earth science and oceanography.

The longest active graduate student program is the NASA Earth and Space Science Fellowship (NESSF), geared to students in basic and applied research in Earth and space science. The NESSF originated in the NASA Global Change Fellowship Program launched in 1991 to promote interdisciplinary and remote-sensing research and address the workforce needed for the Earth Observing System initiated in 1990s. The Global Change Fellowship Program was subsequently renamed the Earth System Science Fellowship (ESSF) in 1995, and it was expanded to include space sciences in 2007, when it became the NESSF. Prospective applicants conceive original research proposals, which are usually closely related to their PhD topics. The NASA Science Mission Directorate conducts the review and selection whereby these graduate student proposals are rated (via mail reviews and a panel review) by both NASA and non-NASA researchers in their respective disciplines. The fellowship provides up to three years of support. The program has been highly competitive, with the applicant pool showing some increase in recent years (Figure 1), and the award success rate decreasing from earlier years (Figure 2). Earth science fellowships are among the most competitive of all the NESSF applications.

Another nationally competed fellowship is the NASA Space Technology Research Fellowship (NSTRF), which is available only to US citizens or permanent residents. All NASA centers also provide

Julius Busecke: Current NASA Fellow

It goes without saying that I am unbelievably proud and thankful to be a recipient of a NASA Earth and Space Science Fellowship (NESSF). It has been the biggest stepping-stone in my career, in particular by providing the freedom to investigate and fine-tune the topic of my dissertation free from the constraints typically associated with scientific funding. This freedom has profoundly shaped my abilities and character as an aspiring scientist. The eligibility of non-American citizens is one of the features setting the NESSF apart from other graduate fellowships and, as a German citizen, receiving the NESSF has furthered my ambition to contribute to the advancement and excellence of Earth sciences in the United States.

A current recipient of a NASA Earth and Space Science Fellowship, Julius Busecke is working toward a graduate degree at Lamont-Doherty Earth Observatory of Columbia University in Palisades, New York.

Rashmi Shah: NASA Fellow 2011–2014

The NASA Earth and Space Science Fellowship (NESSF) gave me an opportunity to grow as a scientist during a critical period of my education. The fellowship played a significant role in my decision to continue my research on developing new remote sensing techniques for the ocean surface. As a fellow, I was able to focus on a topic of my own choosing and see it through over the course of my academic career. As part of that research, I traveled to an offshore oil platform (the NASA prime calibration site for the Jason series of reference altimeter missions), where I installed an experiment that was part of a multi-year investigation to measure ocean surface characteristics like wave height and sea surface height. The flexibility of the fellowship enabled me to build a number of fruitful collaborations with a variety of talented scientists and engineers. I accepted a permanent position at NASA JPL that started immediately after graduation.

Rashmi Shah, a native of Kathmandu, Nepal, works at NASA's Jet Propulsion Laboratory on the calibration/validation team for altimetry series satellites. While a graduate student at Purdue University, she was a summer intern at the Goddard Space Flight Center, Greenbelt, MD, and she held a NASA Earth and Space Science Fellowship from 2011 to 2014.

Sidharth Misra: NASA Fellow 2008–2011

My fellowship allowed me the opportunity develop necessary technical, logistical, and social skills to work with NASA missions. From the moment I submitted the NESSF proposal until my thesis defense, I went through most of the important stages in a systems life cycle—proposal, requirements, design, test, risk management, and implementation. I continue to use tools developed during my fellowship at my work.

Sidharth Misra, who holds an undergraduate degree from Gujarat University in India and MS and PhD degrees from the University of Michigan, is a science team member on the Soil Moisture Active Passive (SMAP) mission and is on the calibration team for the Aquarius and Juno radiometers at NASA's Jet Propulsion Laboratory. He held a NASA Earth Science and Space Fellowship from 2008 to 2011.

graduate research fellowships (depending on funding), where students work closely with researchers in a specific center.

In addition, NASA supports graduate education through the National Space Grant College and Fellowship Program. The goal of this program is to promote aerospace-related research, education, and public service to encourage a diverse workforce. These fellowships support both undergraduates and graduate students pursuing careers in science, mathematics, engineering, and technology (STEM) in universities belonging to the Space Grant Consortium.

The Jenkins Pre-doctoral Fellowship Project (JPFP) seeks to increase the number of graduate degrees awarded to underrepresented persons (women, minorities, and persons with disabilities) in the STEM disciplines. Another goal of this project is to increase the US talent pool by developing a more inclusive, multicultural, and sustainable STEM workforce. The JPFP provides up to three years of support and includes orientation, mentoring, a technical exchange symposium, and the competitive mini research award program. The latter project provides six weeks of hands-on research experience at NASA centers. Up to 20 fellows are selected annually.

Federal agencies involved in ocean research, including NASA, sponsor a program called Mentoring Physical Oceanography Women to Increase Retention (MPOWIR). This program, aimed at retaining women in this field, provides mentoring from late graduate school through early career stages. Limited funding is available through MPOWIR mainly for travel to give seminars, to meet NASA scientists, and to familiarize recipients with NASA research activities and work environments.

NASA also supports education fellowships for foreign students in some circumstances. As noted above, international students can apply for the NESSF fellowships if they are studying in US universities. Other limited opportunities are

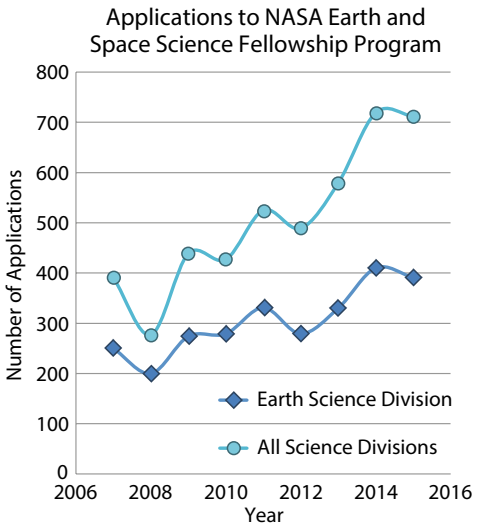

FIGURE 1. Applications to NASA Earth and space science fellowship programs, 2006–2016.

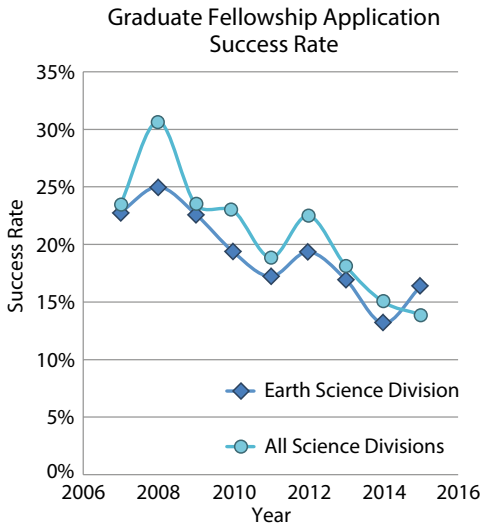

FIGURE 2. NASA graduate fellowship application success rate, 2006–2016.

available through the NASA International Internship (NASA I^2) Program, where non-US students participate either as interns (undergraduates) or fellows (graduate students). This program provides opportunities for interaction with NASA scientists both in the laboratory and in more informal settings. Three internship sessions are arranged during the calendar year (spring, summer, fall). Non-US interns or fellows must participate during the same session as their US counterparts in order to foster a truly collaborative and integrated environment. Currently, this program accepts applications from the following countries:

- Australia: Victorian Space Science Education Center (VSSEC)
- Brazil: Agância Espacial Brazileira (AEB)
- France: Centre national d'Études Spatiales (CNES)
- Ireland: Irish Research Council (IRC)
- Jordan: The Office of the Crown Prince of Jordan
- Lithuania: Agency for Science, Innovation and Technology (MITA)
- Mexico: Agencia Espacial Mexicana (AEM)
- South Korea: Korea Aerospace Research Institute (KARI)
- Sweden: Swedish National Space Board (SNSB)
- Trinidad & Tobago: National Institute of Higher Education, Research, Science & Technology (NIHERST)

SUMMARY

Since the beginning of NASA's remote-sensing programs for Earth observations, its graduate student fellowship programs have been at the forefront of expanding knowledge and expertise in the community at large and developing the new research workforce. It has also been important for NASA to sponsor fellowship programs geared toward minorities to create a more inclusive research community and workforce. As noted earlier, the success of NASA's graduate education endeavors can be seen in the growth of NASA research funding awarded to universities where NASA's programs have built a vibrant ocean workforce. NASA is committed to continue supporting education at the graduate level. The strong university research program that supports NASA oceanography is partly the result of this ongoing commitment.

RESOURCES

- **NASA Earth and Space Science Fellowship (NESSF) Solicitation Information**
  http://solicitation.nasaprs.com/open
- **NASA Space Technology Research Fellowship (NSTRF) Solicitation Information**
  http://solicitation.nasaprs.com/open
- **NASA Interns, Fellows, and Scholars Opportunities**
  https://intern.nasa.gov/ossi/web/public/main
- **National Space Grant College and Fellowship Program**
  http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={8193CA0B-2B1E-FF66-8103-DC63E0423162}&path=open
- **Jenkins Pre-doctoral Fellowship Project**
  http://intern.nasa.gov
- **Mentoring Physical Oceanography Women to Increase Retention (MPOWIR)**
  http://mpowir.org
- **NASA International Internship (NASA I2) Program**
  https://intern.nasa.gov/non-us-opportunities

AUTHORS

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