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Earth & Space Science PhDs, Class of 2003

This study documents employment patterns and demographic characteristics of recent PhDs. It summarizes the latest annual survey of recent Earth, Space, Atmospheric, and Ocean Science PhDs conducted by the American Geological Institute (AGI), the American Geophysical Union (AGU), and the Statistical Research Center of the American Institute of Physics (AIP). Highlights of the results include the following:

- Employment in the field of geoscience and salaries earned by the PhD class of 2003 remained stable, despite an economic downturn in recent years. The vast majority (87%) of graduates found work in the geosciences, and earned salaries commensurate with or slightly higher than in 2001 and 2002.
- Feedback about employment continued to be positive, with most graduates agreeing that their work was challenging, relevant and appropriate for someone with a PhD.
- The number of PhD recipients accepting postdoctoral positions (58%) increased slightly from 2002. In contrast, there were recent significant increases in postdoctoral employment in the fields of physics and chemistry.
- Perceptions of the job market remained stable compared to 2002, with about half of the respondents rating the job market neutrally and one-third rating it as bad or hopeless.
- Recipients of PhDs in the Earth, Atmospheric, and Ocean Sciences are slightly older than PhD recipients in other natural sciences because they are more likely to take time off between completing undergraduate studies and starting their graduate studies.
- Women in the Earth, Atmospheric, and Ocean Sciences earned 33 percent of PhDs in the class of 2003. This is slightly more than the representation of women in chemistry (32%) and far more than representation among PhDs in computer science (20%), physics (19%), and engineering (17%).

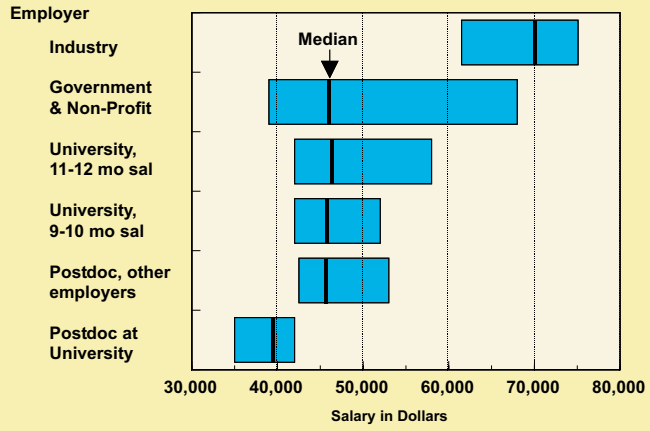
Introduction

The American Geological Institute (AGI) and the American Geophysical Union (AGU) have been collecting data on recent PhDs in the geosciences for the past eight years, from 1996 through 2003. Geoscience (or the Earth, Atmospheric and Ocean Sciences) covers a broad range of disciplines (See **Appendix Table A2**). In 1996 and 1997, a survey was conducted as part of a multidisciplinary effort coordinated by the Commission on Professionals in Science and Technology (CPST) and supported by the Alfred P. Sloan Foundation and the National Science Foundation (NSF). Since 1998, AGI and AGU have continued this effort with their own funds and included additional questions to provide a more complete picture of the graduates.

Each year, letters are sent to Earth, Atmospheric and Ocean Science departments requesting contact information for their recent PhD graduates. The graduates are then contacted directly and asked to answer questions about their education and employment (**Tables 1-5**), information on efforts to find their first job (**Tables 6-8**), experiences in graduate school (**Table 9**), as well as their demographic information.

Data collection and analysis were performed by the Statistical Research Center of the American Institute of Physics. This report draws on the results of the surveys of the past eight PhD classes (1996-2003) in the geosciences as well as data from the NSF. The NSF Survey of Earned Doctorates reported a total of 819 PhDs in the Earth, Atmospheric and Ocean sciences in 2003. We obtained valid U.S. mailing addresses for 289 doctorates. The report includes data from 180 PhDs, 30 of whom were space scientists who earned their PhDs from physics departments. This report does not include new PhDs who left the U.S. or those who earned their degrees from departments that do not have a geoscience term in their name.

Figure 1. Typical starting salaries for Earth & space science PhDs, classes of 2002 & 2003



Note: Typical salary range includes the middle half of reported salaries.

Figure 2. Percent of Earth & space science PhDs working in postdoctoral positions, classes of 1996 to 2003

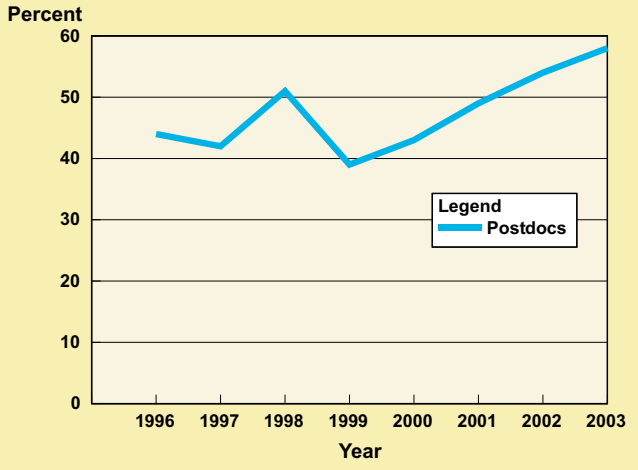


Table 1. Percentage of Earth and space science PhD graduates by employment field, class of 2003

Field of Employment	Postdocs %	Non-Postdocs %	Overall %
Earth and space sciences	94	80	87
Other sciences	6	16	11
Non-science	-	4	2
Number of Respondents	88	79	167

Initial Employment

New doctoral recipients in the Geosciences find a range of job opportunities in such areas as industry, academe, government, and non-profit organizations (see **Appendix Table A1**). A very high percentage (87%) of the PhD class of 2003 found employment within the geosciences (**Table 1**). Virtually all (94%) of those taking postdoctoral appointments were in the geosciences, and a large majority (80%) of those accepting potentially permanent positions reported that they were working in the geosciences.

Typical salaries have not changed significantly in 2003 from previous years, but there are still broad differences in salaries across sectors of the economy (**Figure 1**). Industrial employers still pay the highest salaries. There is a wide range of starting salaries of government and non-profit employees, because this group includes national labs, federal and local government agencies, as well as non-profit research institutes. Academic salaries range from the mid-thirties to the mid-fifties, and vary depending on salary base (9 to 10 months versus 11 to 12 months) and status (permanent versus postdoc).

There was a small increase in the proportion of graduates taking postdoctoral appointments (**Figure 2**), 58% this year compared to 54% in

Table 2. Employment sector by postdoc status and year of graduation, 1996 to 2003

Postdocs	2003 %	2002 %	2001 %	2000 %	1999 %	1998 %	1997 %	1996 %
Academe	39	35	33	23	25	32	31	36
Government	14	14	13	15	12	11	6	5
Industry	-	1	1	1	1	-	1	1
Non-Profit	5	4	2	4	1	8	4	2
Non-Postdocs								
Academe	25	28	24	23	27	20	27	30
Government	5	8	11	14	17	8	10	13
Industry	10	9	15	19	16	20	19	11
Non-Profit	2	1	1	1	1	1	2	2
Number of Respondents	145	204	211	150	157	144	327	123

Table 3. Percent of those working at least one year prior to earning PhD by employment sector, 1996 to 2003						
	Postdocs %	University, 9-mo salary %	University, 12-mo salary %	Govt. and non-profit %	Industry %	Overall %
Employed at least one year before earning PhD	1	8	14	18	33	10
Number of Respondents	698	208	145	231	199	1471

2002. By comparison, the proportion of both physics and chemistry PhDs taking postdoc positions increased significantly in the last two years, presumably in response to a softening in the job market for these scientists.

Most postdocs were academic appointments (**Table 2**), with almost one-quarter of all postdocs in government and about 9% in non-profit research institutes. Nearly 60% of all those who found permanent employment were working in an academic setting. Most of the others were employed in government and industry. These trends have not changed significantly since 2002.

Employment in Industry

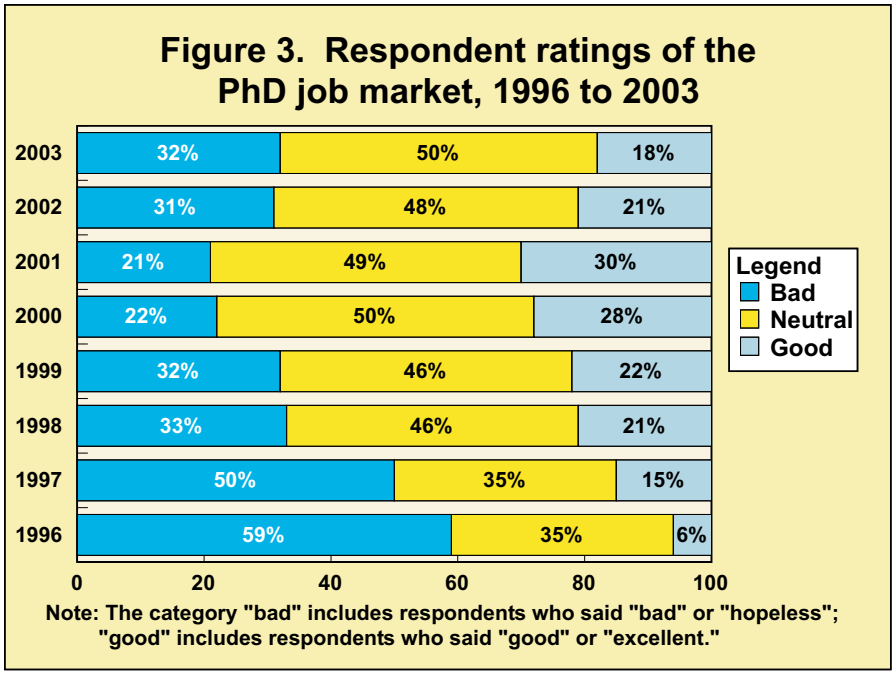
About 10% of the PhD class of 2003 found employment in industry and virtually all of them worked in the geosciences. Over half (60%) of the new PhDs who secured industrial employment were hired by petroleum companies. This is a significant increase over recent years. Most of the other PhDs were hired by environmental consulting firms and a couple were hired by high-tech companies.

Working before Degree Completion

A characteristic that is unique to geoscience PhDs is that a significant number have been working full-time prior to earning their PhDs (**Table 3**). Ten percent of geoscience PhDs over the past eight years started their first jobs more than one year before formally receiving their degrees. In contrast, new physics PhDs are less than half as likely as geoscience PhDs to have done so. Of the geoscience PhDs who had been working full-time before finishing their doctorates, over half had been employed for 3 years or more.

Table 4. Percent of PhDs agreeing with qualitative statements about their careers, by postdoc status, 2003			
	Postdocs %	Non-Postdocs %	Overall %
My current position is professionally challenging	96	91	94
My current position is commensurate with my education	95	93	94
My current position is related to my field	96	92	94
Number of Respondents	82	75	157

Respondents were asked to give their opinions on the extent to which they agreed with the above statements on a scale of 1 to 5 where 1=Strongly Agree, 3=Agree, and 5=Strongly Disagree. The above data reflect the percentage of respondents who chose 1, 2, or 3.



Perceptions of Initial Employment

Consistent with trends from previous years' surveys, an overwhelming majority of the PhD class of 2003 reported their new jobs to be challenging, related to their field of study, and suitable for a holder of a PhD (**Table 4**).

Similarly, the percentage of new PhDs using skills learned in graduate school was stable (**Table 5**). Cognitive and technical skills were most broadly used, as well as broad Earth science concepts, whether the graduate worked in academe, government, or industry. The most significant changes in these data both occurred in industry. The vast majority (85%) reported using management skills in their new jobs, up from just 57% of 2002 grads. Nearly half (46 %) of the new PhDs working in industry reported that they used knowledge of their dissertation field, compared with 27% of 2002 graduates. New PhDs employed in academe or government are still far more likely to use knowledge of their dissertation field on the job than their counterparts in industry.

Finding Employment

As with previous PhD classes surveyed, there was no correlation between the amount of time spent seeking employment and the graduates' perceptions of the job market (**Table 6**). The average time the new PhDs of 2003 spent

Table 5. Degree to which new PhDs use the following skills on the job, 2003

	PhDs who often use these skills			
	Academe %	Industry %	Govt. %	All %
Cognitive skills (analytical thinking, problem solving)	89	85	88	88
Technical skills (computer skills, modeling & simulation)	83	85	84	84
Knowledge of broad concepts in Earth & space science	80	92	80	81
Knowledge of dissertation field	81	46	72	75
Management skills	61	85	56	62

Respondents were asked to rate the degree to which they use the above skills and knowledge on a scale of 1 to 5, where 1=Extensively, 2=Often, 3=Regularly, 4=Occasionally, and 5=Not at all. Those who chose 1 or 2 are represented above.

Table 6. PhD rating of job market by time spent looking for employment, 2003

	Months spent looking for employment				Overall
	Zero months	1 to 3 months	4 to 6 months	More than 6 months	
Bad	26%	24%	27%	64%	32%
Neutral	67	53	38	32	50
Good	7	24	35	4	18
Number of Respondents	46	38	26	22	132

looking for employment saw little change from previous years, and their view of the job market was virtually unchanged from the previous year's grads as well. Of the class of 2003, 32% felt the job market was bad or hopeless, 50% said it was neither good nor bad (neutral), and just 18% felt it was good or excellent (**Figure 3**). Those PhDs who entered permanent positions in academe seemed to have the most favorable perception of the job market, while university postdocs had one of the worst.

The time it took new PhDs to find employment in postdoctoral positions was slightly less than the time it took to find a permanent position. The average search time for postdocs was just over three months, and the mean for non-postdocs was just over four months. As with previous surveys, the relatively shorter time it takes for PhDs to enter into postdoc employment suggests that this may be a planned step, perhaps a stepping stone for entering academe, and not the end result of a failed job search.

Their employment goals greatly affected the way in which the new graduates looked for jobs. While graduates entering all employment sectors used informal channels such as friends or colleagues to land their jobs, postdocs also rely heavily on their academic advisors for placement (**Table 7**). Nearly three-fifths of the postdocs from the class of 2003 cited either informal channels or advisors as their most effective job search method.

Table 7. Most effective job search method by type of initial employment, PhD classes of 1998 to 2003

	Non-Postdocs			Postdocs %	Overall %
	Academic %	Government %	Industry %		
Informal Channel	25	40	31	23	25
Advisor	11	-	-	34	23
Journal	20	-	15	9	12
Electronic Source	20	40	-	14	15
Former Job	8	-	8	7	7
Other	16	20	46	13	18
Number of Respondents	36	5	13	70	125

Table 8. PhDs who said that the following were helpful in their career planning, PhD classes of 1998 to 2003

	Non-Postdocs %	Postdocs %	Overall %
Advisor	80	76	78
Scientific society	55	55	55
Department	43	37	40
University	35	30	32
Number of Respondents	60	74	134

Note: Respondents were asked to indicate how helpful the above were using a 5 point scale where 1=Extremely Helpful; 3=Helpful; and 5=Not at all Helpful. The above represent the percentage who answered 1, 2, or 3.

Newsletter, magazine, and journal listings continued to decline in importance for those PhDs entering academe, as just 20% named this media as the most effective job search method. Informal channels were the most named method, as was the case for both government and industry. This further emphasizes the hypothesis set out in the report on 2002 PhD recipients that graduate school connections could be a very important part of the initial job search.

Unlike the data of previous surveys, there was no clear schism between the postdocs and non-postdocs in effective job search strategies. For the class of 2003, 80% of non-postdocs and 76% of postdocs named their advisor as being helpful in career planning (**Table 8**). This reversed a trend of several years when PhDs who did not take postdocs had listed advisors much less frequently. The gap seen previously in the role of scientific societies also evaporated, with 55% of both postdocs and non-postdocs saying that the societies were helpful in career planning.

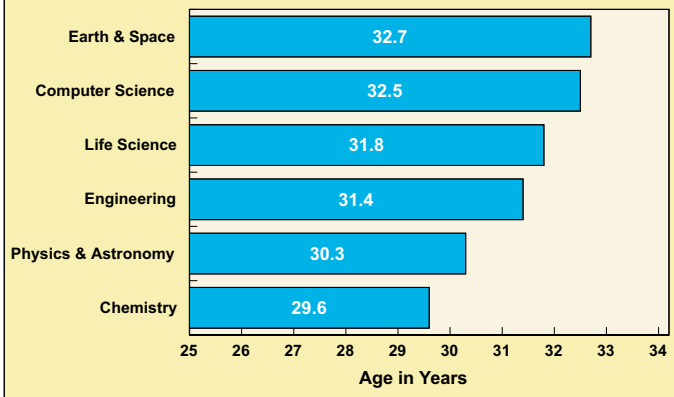
The percentage of postdocs and non-postdocs naming their academic department as helpful dropped precipitously from the average of the previous five years. Only 37% of postdocs listed departments as helpful, down from 52% for the span from 1998 to 2002. The percentage of graduates who felt their university in general was helpful also fell, but by a smaller margin. These data suggest a weakening role for academic institutions in career planning, and a stronger role for individuals through networking. As suggested in the 2002 survey report, universities may not be providing appropriate career resources for PhD level students.

Table 9. Top reasons for considering dropping out of PhD program, PhD classes of 1998 to 2003

	Female %	Male %	Overall %
Financial concerns	26	43	37
Didn't feel intellectually capable	35	22	27
Poor job market	23	28	26
Poor relationship with advisor	35	20	26
Family concerns and responsibilities	19	22	21
Loneliness	32	18	24
Number of Respondents	31	54	85

Note: This table is based on the 47% of respondents who indicated that they had considered dropping out of graduate school at some point. Respondents were asked to choose all reasons that applied. The above list represents the five reasons cited most often.

Figure 4. Median age of PhD recipients by discipline, 2003

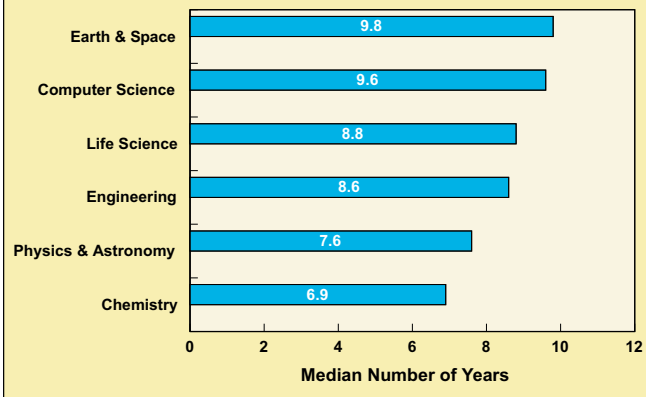


Source: National Science Foundatioin Survey of Earned Doctorates 2002

The Graduate School Experience

Earth and space science PhDs have a median age of 32.7 at graduation, on a par with computer science, but older than other natural science PhDs (**Figure 4**). Of 180 survey respondents, 85 (47%) reported that they had considered dropping out of graduate school at some point. The reasons they considered doing so can be arranged into six main categories (see **Table 9**). Consistent with survey data from 1998 through 2002, the primary reason that the class of 2003 considered dropping out of school was financial concerns; 43% of males but only 26% of the females who thought about dropping out reported this reason. Geoscientists have the longest time lapse between the baccalaureate and doctorate degrees (**Figure 5**) and postpone graduate school (**Figure 6**). It is presumed that a significant number of these students have family obligations or desire a higher standard of living.

Figure 5. Total time lapsed from baccalaureate to doctorate degree, 2003



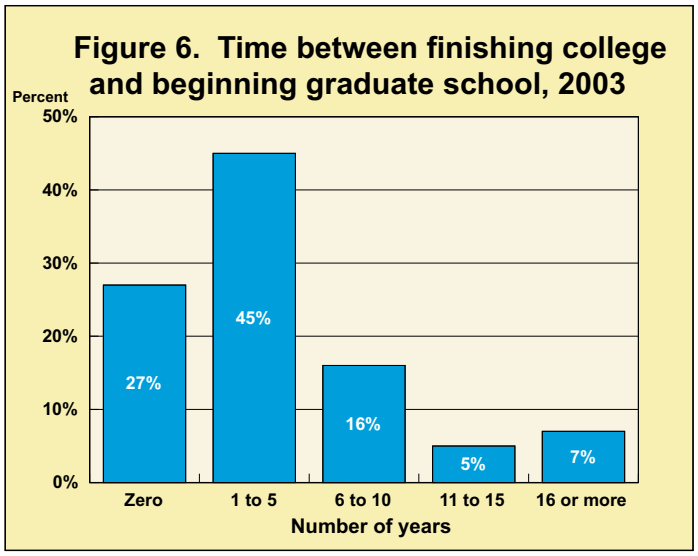
Source: National Science Foundation Survey of Earned Doctorates 2002

Other major concerns of graduate students were whether they felt intellectually capable of completing their PhD studies, perceptions of a poor job market, and a poor relationship with an academic advisor. There was a notable gender difference in the responses to this question. Of the 2003 PhD recipients, 35% of females but only 22% of males cited the self-perception of intellectual ability as a reason for thinking about dropping out of graduate school.

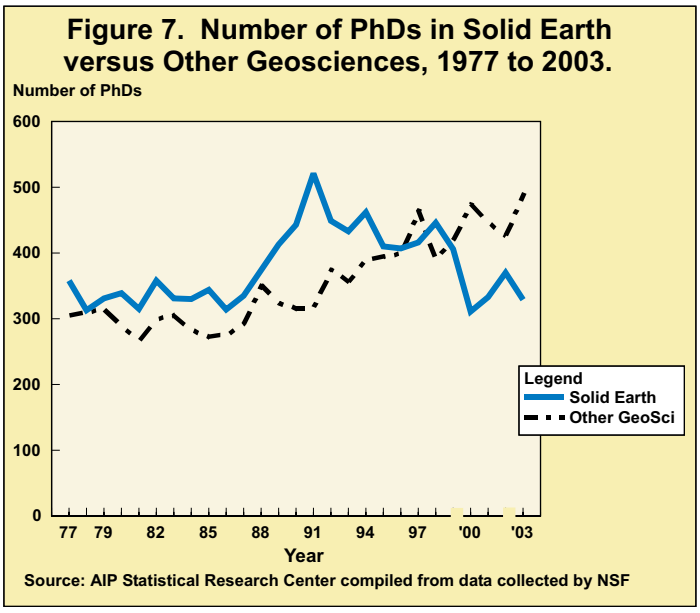
In the 2003 data, women were also more likely to name a poor relationship with their advisor as a reason to contemplate dropping out. The same was true of loneliness. Men were slightly more apt to consider leaving school due to family concerns and a poor job market. The major differences of the class of 2003 from the 1998-2002 classes were wider gender gaps in those citing financial concerns, poor advisor relationships, and loneliness.

Demographics

The NSF reported that a total of 819 PhDs were awarded in the geosciences in 2003, which has been stable over the last several years (**Figure 7**). Over the past dozen years, the numbers of PhD recipients in the sub-disciplines of geosciences that are "Solid Earth" fields (**Appendix Table A2**) has declined gradually (**Figure 7**). In 2003, about 330 PhDs specialized in the subfields of Geology, Chemical Earth



Science and Solid Earth Geophysics. Concurrently, there has been an increase in the number of PhDs earned in the fields of geoscience that include non-Solid Earth fields, such as Atmospheric Science, Environmental Science, and Oceanography.



Gender and Ethnicity

Women are increasing their representation among geoscience PhDs, with 33 percent of PhDs in the class of 2003 earned by women (**Figure 8**). This continues the upward trend in the representation of women in the field. For example, in 1990 fewer than 20 percent of PhDs awarded in geosciences went to women. However, the representation of women varies by subfield within the geosciences. In 2003, women earned 44% of the Oceanography PhDs, 41% of Environmental Science PhDs, but only 28% of both Solid Earth and Atmospheric Science PhDs (**Figure 9**).

Compared to other natural science disciplines, the geosciences have high representation of women among their PhDs (**Figure 8**). In 2003, only life science had a higher proportion of female science PhDs (48%) than did the geosciences. The geosciences recently passed chemistry (32%) and are well ahead of computer science (20%), physics (19%), and engineering (17%).

Participation in the geosciences by minorities continues to be very low. According to NSF data, less than 4 percent of PhDs in the geosciences were earned by ethnic minorities over the last 5 years. In the past thirty-one years combined (1973 through 2003), only 313 Hispanic Americans, 135 African Americans and 49 Native Americans earned PhDs in any of the geosciences.

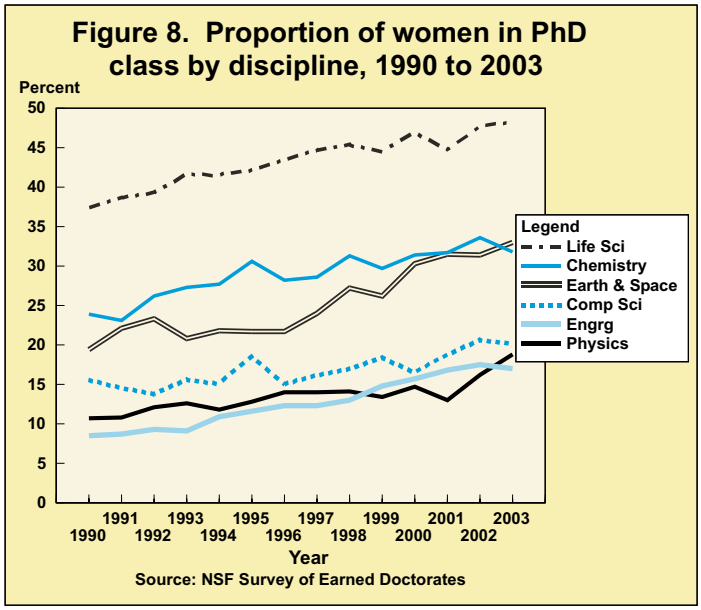


Figure 8. Proportion of women in PhD class by discipline, 1990 to 2003
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Legend
Life Sci
Chemistry
Earth & Space
Comp Sci
Engrg
Physics
Source: NSF Survey of Earned Doctorates

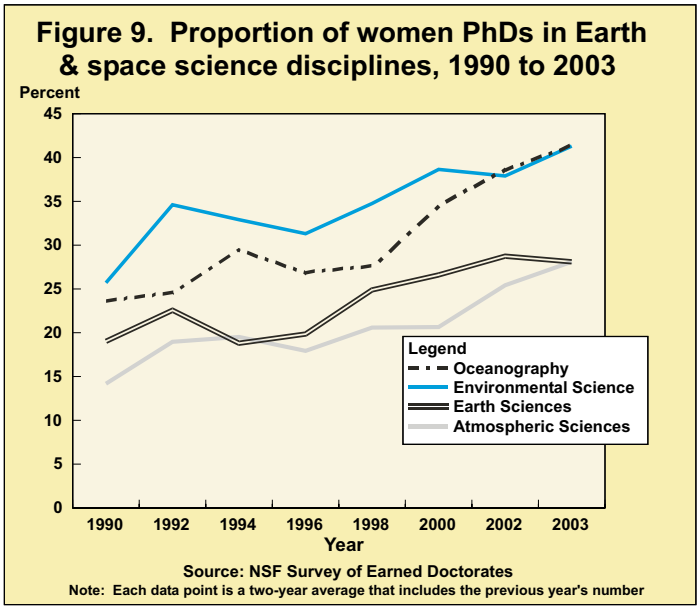
Figure 9. Proportion of women PhDs in Earth & space science disciplines, 1990 to 2003
Percent
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1994
1996
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2002
2003
Year
Legend
Oceanography
Environmental Science
Earth Sciences
Atmospheric Sciences
Source: NSF Survey of Earned Doctorates
Note: Each data point is a two-year average that includes the previous year's number

APPENDIX

Methodology

In March 2004, 195 PhD-granting Earth and space science departments received a request for the names and addresses of students who earned a PhD between July 1, 2002 and June 30, 2003. Those who did not respond received a second request in April 2004 and a third in May. By July, 126 departments replied, yielding a 65% response rate.

Questionnaires were sent to 289 recent PhDs between April and September. PhDs who did not respond received a second request four to seven weeks after the first mailing. Of the 289 PhDs with valid addresses, 140 responded, for a response rate of 48%.

As PhDs in the space sciences are not all granted by departments in geology and similar fields, we appended our data with that collected by the American Institute of Physics (AIP) in their study of recent PhDs from physics departments. Thirty space science PhDs from physics departments were included in our analyses. The questionnaire used for AIP's study omitted several questions included on ours. Of the data taken from the AIP survey of physics departments, the questions used in ours were worded identically.

The date some students indicated as their degree date differed from that which their institutions stated, leading to some discrepancies between school reports and self-reports. We relied upon the student's statement, but expanded our window to include degrees completed between May 2002 and September 2003. Eighteen students were excluded from the analysis because they received their degrees outside of this range. Twenty-eight respondents from last year's study have been included in the current analysis because they received their PhD after October 2002. They were not included in the analysis of the previous report, Earth & Space Science PhDs, Class of 2002 (Claudy, et al.) published November 2003.

A total of 179 PhD recipients for 2003 are included in the analysis of this report. Data are excluded only as a last resort when the information provided by the respondent either is not comparable to the aspect under study or does not make sense given other factors. Twenty-one who have been working at their current job for more than one year were excluded from all salary analyses to restrict such results to starting salaries. Our focus is on initial employment in the US only.

Table A1. Types of employment included in each of the employment sectors

Category	Employment areas included
Industry	Multinational corporations
	Large companies
	Small consulting firms
	Self-employed workers
Academe	Four-year colleges or universities
	Two-year colleges
	Elementary or secondary schools
Government	Federal agencies
	National laboratories
	State and local governments

Note: People working at non-profit agencies are included with government employees unless otherwise specified.

Table A2. Breakdown of subfields by category	
Category	Subfields included
Atmospheric Sciences	Atmospheric Sciences
	Meteorology
	Climate Studies
	Global Earth System Science
Hydrology and Environmental Science	Hydrology
	Water Resources
	Soil Science
	Geomorphology
Oceanography	Physical, Chemical, & Biological Oceanography
	Geophysics
	Sea Floor Processes
	Marine Geology
	Ocean Engineering
	Coastal Science
	Fisheries
Solid Earth Geology	Paleontology
	Sedimentology
	Stratigraphy
	Structural Geology
	Tectonics
	Rock Mechanics
	Paleoscience
	Glaciology
Chemical Earth Science	Volcanology
	Petrology
	Mineralogy
	Geochemistry
Solid Earth Geophysics	Seismology
	Economic Geology
	Exploration Geophysics
	Other Solid Earth Geophysics
Space Science	Planetary Science
	Space Physics
	Aeronomy
	Astronomy
Other Science and Engineering	Engineering
	Computer Science
	Science Education
	Other Science
	Public Policy