BAMS
Essay

Atmospheric Sciences Bachelor's Degree Recipients

Trends, Early Career Earnings, and Student Debt, 2015–19

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ABSTRACT: Data on the number and economic status of bachelor's degree recipients are harder to access for the atmospheric sciences than for other similar fields. The U.S. Department of Education's College Scorecard provides a new, comprehensive, and annually updated way to obtain these data. Five years of College Scorecard data are analyzed, revealing that from 2015 to 2019 the number of bachelor's recipients in the United States was at least 700 annually, with a downward trend of about 13% over the period. Institution-specific data allow for a ranking of undergraduate programs by number of bachelor's recipients that has been impossible to compile since the demise of the American Meteorological Society (AMS)–University Corporation for Atmospheric Research (UCAR) *Curricula* publication in the mid-2000s. Early career earnings data for federally aided students from larger programs compiled in the College Scorecard indicate that median first-year annual salaries by the end of the 2010s averaged about $35,000, with an increase to $45,000 by the third year. Median debt at graduation during the same period averaged slightly less than $25,000. In the future, College Scorecard data could be used to provide regular updates on atmospheric sciences students, graduates, and early career professionals at all degree levels. The AMS should partner with the American Institute of Physics' Statistical Research Center to create and disseminate such reports.

KEYWORDS: Community; Education; History

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Up-to-date data on the number and economic status of bachelor's degree recipients in the atmospheric sciences are surprisingly hard to obtain, compared to other physical and Earth sciences. For example, the Statistical Research Center of the American Institute of Physics (AIP) provides multiple annual (or regular) updates for physics and astronomy on enrollment numbers, the number of B.S. degree recipients by institution and nationally, the postgraduation career/educational choices of these degree recipients, their starting salaries, and a state-by-state listing of employers who hired them (AIP 2022). The American Geosciences Institute (AGI) periodically releases their survey-based *Status of Recent Geoscience Graduates* publication that provides overviews of the demographics, curricular and extracurricular experiences, and outcomes of degree recipients (including employment trends by sector and starting salaries) in a particular academic year. Although the atmospheric sciences (which include meteorology, climate science, and other related sciences) are part of the geosciences, the much larger field of geology/Earth science completely dominates these AGI statistics, representing nearly 70% of all bachelor's recipients in the AGI's 2020/21 report. Only 0.7% of B.S. respondents to the survey used for the latest AGI status report were from meteorology (AGI 2022, p. 7). The AGI also publishes the *Directory of Geoscience Departments*, in its 56th edition as of 2021.

In contrast, for over 15 years there has been no comparable source of regularly updated information for the atmospheric sciences. Our discipline's analog to the AGI *Directory*, the *Curricula in the Atmospheric, Oceanic, Hydrologic, and Related Sciences*, was published biannually by AMS and partner organizations beginning in 1964, but died a quiet death online in the mid- to late 2000s as fewer and fewer atmospheric sciences programs provided updated information. The *Curricula* was then reduced to a set of links to individual programs' websites, and eventually vanished completely. A search of the AMS website for a listing of colleges and universities with degree programs in meteorology/atmospheric sciences today leads to a listing hosted by the National Weather Association, which provides links but none of the types of information compiled by AIP and AGI for physics, astronomy, and geology.

Instead of yearly or periodic updates from a disciplinary organization, data relating to atmospheric sciences bachelor's degree recipients have been published piecemeal and irregularly, in peer-reviewed contributions in *BAMS*. For example, there have been reports on job opportunities for B.S. recipients in Horn et al. (1974), Orville (1978), and Hanson (1993); and a combination of enrollment/degree production and job opportunities in both Mass (1996) and Knox (2008). The two earliest publications were reports from, or inspired by, AMS committee efforts; the last three were individual efforts.

With the demise of the *Curricula* and other sources of data used in Knox (2008), for the past 14 years I have been unable to update those results beyond the mid-2000s. However, the Obama Administration's College Scorecard Initiative, unveiled in 2015 as a source of information on American higher education for consumers, has unexpectedly provided an opportunity both to update and extend the analysis in Knox (2008). The annually updated College Scorecard website (U.S. Department of Education 2022) provides surprisingly granular information on atmospheric sciences degree recipients, their early career earnings, and—for the first time from any data source—statistics on students' cumulative debt loads at graduation.

The College Scorecard data are over 2 years old by the time they are posted, as are other, similar federal sources of information. This delay is arguably an advantage at this moment in history because the most recent data end in 2019, prior to the impact of COVID on higher education and personal finances.

Below I present data from the College Scorecard site, including national and program-level numbers of B.S. recipients, institution-averaged earnings data, and institution-averaged student debt data. The data should be of great interest to the atmospheric sciences community, as they provide recent information on the state of undergraduate students and recent graduates in our discipline. College Scorecard data should be especially valuable to current and prospective undergraduates in the atmospheric sciences, and their families as well, in order to have recent, reliable quantitative answers to such basic questions as "How many people study this subject in college?" "How many students does a particular program graduate in a year?" "What is a typical starting salary for a B.S. recipient in this field?" and "How much debt am I likely to incur?" I conclude this essay with a summary and discussion of results, and an explanation of how and why future work on this subject should be conducted under the auspices of the AMS and should not be the responsibility of individual investigators.

Bachelor's degree recipients

National data. Knox (2008) relied in part on U.S. Department of Education's National Center for Education Statistics (NCES) for estimates of the total number of bachelor's degree recipients annually in the atmospheric sciences in the United States. Similarly, the College Scorecard provides bachelor's (and other) degree recipient data for each college or university, in keeping with its consumer, college-comparison orientation.

The first check on the accuracy, utility, and apples-to-apples relationship of College Scorecard versus NCES data are to 1) sum the number of bachelor's degree recipients for the Classification of Instructional Programs (CIP) code 40.04, "Atmospheric Sciences and Meteorology," for all U.S. educational institutions; and then 2) compare the sum to NCES data (NCES 2022) for all CIP codes related to meteorology for the same years.

This comparison is shown in Fig. 1, which reveals that the data from the two sources are nearly identical. Each year the College Scorecard has a few more recipients than NCES, but the differences are small; over 5 years of overlapping data, the College Scorecard averages 1.4% more B.S. recipients than NCES. This result supports the inference that the College Scorecard is at least as comprehensive a source of information on atmospheric sciences bachelor's degree recipients as the NCES data used in Knox (2008).

However, the College Scorecard is not a *complete* census of atmospheric sciences programs and their graduates. The large program at Mississippi State University (MSU) is not included, nor are there graduates listed for the Ohio University and California University of Pennsylvania (now PennWest California) programs. In all three cases, the CIP codes for the degrees obtained by students in these programs are not being captured by the College Scorecard analysis. For example, students in the MSU program receive geosciences degrees (CIP code 40.06) with emphases in broadcast meteorology and professional meteorology. Undercounts are a known weakness of national statistics of graduates in the physical and Earth sciences (R. Czujko 2006, personal communication), a point I return to in the discussion.

These imperfections notwithstanding, we can now revisit a question of much importance in Knox (2008): What is the national trend in the number of bachelor's degree recipients in our field? From the 1990s through the 2000s, the number of bachelor's degree recipients increased rapidly, ultimately peaking at all-time highs around 750 in 2007, and again in 2013 and 2014. These numbers are approximately double the number of B.S. recipients in the early 1990s in the NCES dataset. However, from 2015 to 2019 the number of degree recipients actually

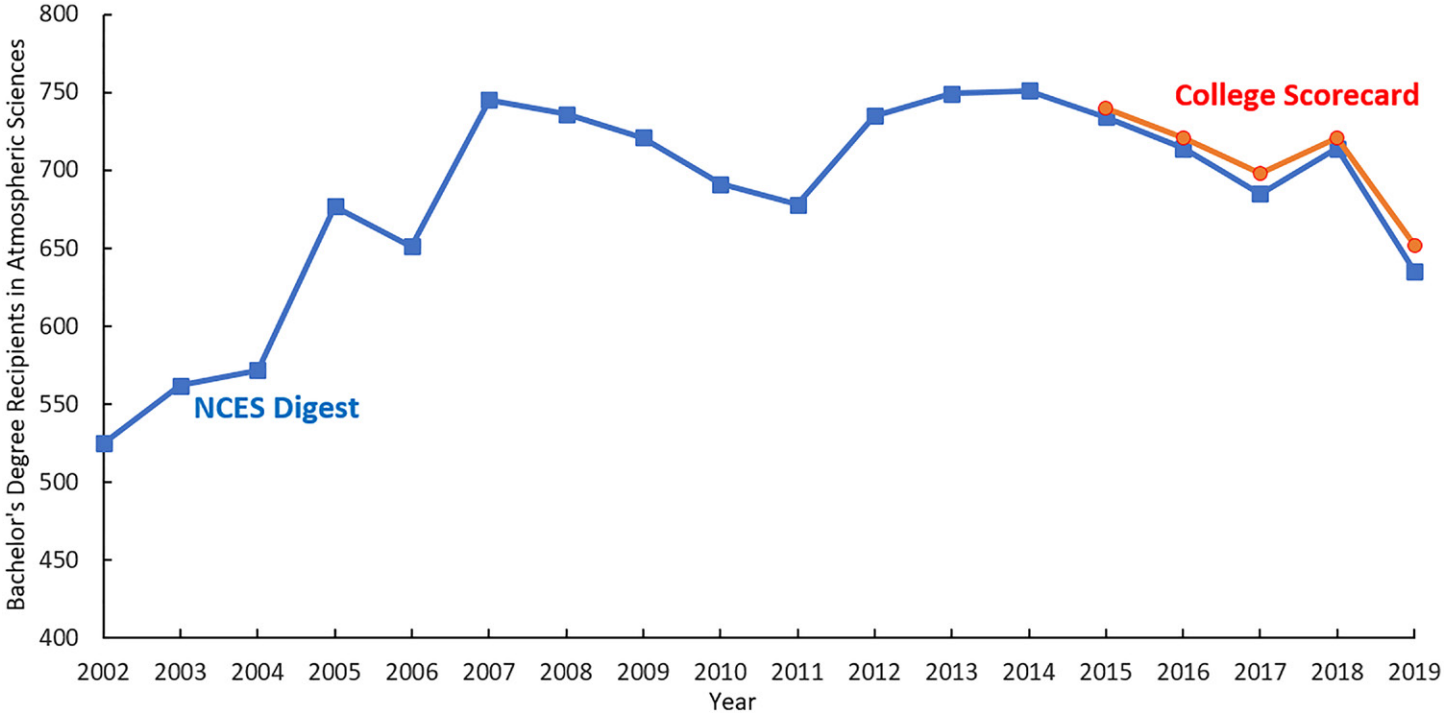

Fig. 1. Annual number of B.S. recipients in meteorology and the atmospheric sciences from two datasets: the National Center for Education Statistics (NCES) Digest (2002–19) and the College Scorecard (2015–19).

declined 12%–13% from the record highs in both the NCES and College Scorecard datasets, down to levels last observed in the early to mid-2000s in NCES data.

Program-specific data. The College Scorecard dataset provides the annual number of bachelor's degree recipients for colleges and universities around the nation. From the 2014/15 academic year through the 2018/19 academic year, 71 different institutions graduated at least one student at the bachelor's level in our field, as defined by CIP code 40.04. This level of detail allows us to compile a list of the largest (i.e., an average at least 10 graduates annually) atmospheric sciences undergraduate programs in the nation based on standardized multiyear data; see Table 1.

Only two out of the 29 largest programs are private universities; the rest are public colleges and universities. While many of the names near the top of Table 1 are familiar, the growth of programs at Virginia Tech during the past decade, and at Valparaiso University during the past 25 years, have placed both in the top six, ahead of other, older programs. It should be stressed that Table 1, as a 5-yr average of annual bachelor's degree recipients ending in 2019, does not capture bachelor's degree programs that have grown rapidly during the late 2010s and early 2020s, such as my own program at the University of Georgia. As noted earlier, Table 1 does *not* include several programs around the nation, such as Mississippi State, whose students receive non-CIP-code-40.04 degrees.

Early career earnings

Using U.S. Treasury data, the College Scorecard compiles medians of 2-yr-averaged earnings for working degree recipients for 1, 2, and 3 years after completing their highest academic credential. This information is gathered from deidentified tax records of cohorts of federally aided students. Salaries are adjusted for inflation to the year after the last year of reporting.

Most atmospheric sciences programs have so few graduates that these data could be linked to specific individuals; therefore, earnings data are "privacy suppressed" in the College Scorecard dataset for most programs. Data are listed only for some institutions, most of which are

Table 1. Undergraduate atmospheric sciences programs in the United States averaging at least 10 B.S. recipients annually during the academic years 2014/15 through 2018/19, based on College Scorecard data.

Rank	College or university	Average number of B.S. recipients in atmospheric sciences, 2015–19
1	Pennsylvania State University—Main Campus	41.2
2	University of Oklahoma—Norman Campus	37
3	University of Missouri—Columbia	30.6
4	Virginia Polytechnic Institute and State University	27.4
5	Texas A&M University—College Station	26.2
6	Valparaiso University	23.4
7	Florida State University	20.4
8	University of Washington—Seattle Campus	20.4
9	University of Illinois at Urbana–Champaign	19.6
10	Millersville University of Pennsylvania	19.2
11	North Carolina State University at Raleigh	17
12	Lyndon State College/Northern Vermont University	15.6
13	Iowa State University	15.4
14	Northern Illinois University	15
15 (tie)	Embry–Riddle Aeronautical University—Daytona Beach	14.4
(tie)	University of Wisconsin–Madison	14.4
17	SUNY Maritime College	14
18	University of California, Los Angeles	13.8
19	Ohio State University—Main Campus	13
20	State University of New York at Oswego	12.4
21 (tie)	Rutgers, The State University of New Jersey—New Brunswick	12.2
(tie)	University of North Dakota	12.2
23	University at Albany, State University of New York	11
24	Stony Brook University, State University of New York	10.6
25 (tie)	Saint Cloud State University	10.4
(tie)	University of North Carolina at Charlotte	10.4
27 (tie)	Central Michigan University	10.2
(tie)	Purdue University—Main Campus	10.2
29	University of South Alabama	10

listed in Table 1. For this reason, in Table 2 I aggregate data from all programs and provide national averages of median earnings only, with the averaging performed over the number of institutions. This aggregation means that the earnings statistics are based on hundreds of individuals from many different programs, making them more representative and robust than a program-by-program analysis would be. Also, no data on earnings were gathered during the first year of the College Scorecard's existence. Between the 2-yr averaging and the absence of data in the first year, only 3 years' data exist as of the writing of this essay.

These data suggest that median starting annual salaries in atmospheric sciences jobs for federally aided students at the end of the 2010s were close to $35,000. This is nearly identical to the 2006 average salary determined from National Association of Colleges and Employers data and included in Knox (2008, Table 5). However, at that time it was hypothesized that the NACE average was artificially inflated due to employment outside of the meteorology/atmospheric sciences sector. A starting salary of $35,000 is also identical to the findings for meteorology/atmospheric sciences for the early 2010s in the extensive

Table 2. Individual earnings data for atmospheric sciences bachelor's recipients in the first 3 years' postgraduation, from College Scorecard data. Numbers in parentheses indicate the number of individuals and the number of institutions represented in each average of the median data.

Average over institutions of	CY 2016 + CY 2017 (2018 dollars)	CY 2017 + CY 2018 (2019 dollars)	CY 2018 + CY 2019 (2020 dollars)
Median earnings 1 year out	$31,050.00 (172, 6)	$35,829.62 (406, 21)	$36,115.00 (333, 14)
Median earnings 2 years out	—	$34,495.43 (416, 23)	—
Median earnings 3 years out	—	—	$45,286.10 (273, 10)

data analysis performed by Casselman (2014) using U.S. Census data. Finally, the College Scorecard data indicate that median salaries rise 25% from the first to the third year, into the mid-40s.

Student debt levels

College Scorecard data make available, for the first time to my knowledge, data on the cumulative debt loads at graduation carried by undergraduate atmospheric sciences students. Only graduates with debt are included, just as only employed graduates are included in the earnings statistics. As in the case of earnings, these data are averaged over two years and reported annually; unlike earnings data, debt data were included in the first College Scorecard report, so there are 4 years of data available. In Table 3 I summarize one debt statistic in the College Scorecard, the 2-yr median debt from Stafford loans. (Virtually no data exist for Parent Plus loans for the parents of undergraduate students, nor are private education loans, so this statistic is an underestimate of total debt associated with college, for those who have debt.) As with earnings data, I have averaged over all institutions for which this data category is not privacy suppressed in order to provide a more robust result. The 4-yr average of the medians is just shy of $25,000, with a suggestion of a downward trend of roughly 10% over the period.

Discussion and future work

The results of this preliminary study of the new College Scorecard data can be summarized in easy-to-remember, round numbers: during the 2010s, there have been at least 700 B.S. recipients in the atmospheric sciences each year at about 70 different colleges or universities in the United States. During the latter half of this period, however, from 2015 to 2019 the number of bachelor's degree recipients at these institutions has declined almost 15%. For students who have received federal financial aid and were employed upon graduation, graduates' median first-year earnings in 2018 and 2019 were a little more than $35,000. These salaries are comparable to the median first-year earnings of bachelor's recipients in similar fields such as environmental science, geology and Earth science, and geography, but are about $10,000 or more below that of B.S. recipients in mathematics and physics (Hamilton Project 2022).

Table 3. Median student debt (Stafford loans) for atmospheric sciences bachelor's recipients from College Scorecard data. Numbers in parentheses indicate the number of individuals and the number of institutions represented in the averages of the median data.

Average over institutions of	AY 2014/15 + AY 2015/16	AY 2015/16 + AY 2016/17	AY 2016/17 + AY 2017/18	AY 2017/18 + AY 2018/19
Median debt at all institutions	$25,891.38 (355, 13)	$25,683.93 (385, 14)	$24,490.16 (470, 19)	$23,346.87 (356, 15)

The results of this study show that median student debt of atmospheric sciences undergraduates at graduation was a little less than $25,000. Very limited data from the most recent College Scorecard report indicate that the average across institutions of the individual's median monthly loan payment for a 10-yr repayment is about $230, yielding a debt-to-income (DTI) ratio of approximately 8%, which is below the recommended DTI of 10% (or less) for student debt (Kantrowitz 2021). It should be noted that parental debt and nongovernment private student debt are not included in this statistic.

The key to having manageable student debt is, of course, being employed (not underemployed or unemployed) after graduation. In Knox (2008) it was stated that, if then-current trends of rising atmospheric sciences enrollments and graduates continued, there would be an oversupply of atmospheric sciences bachelor's recipients in the near future. This oversupply came to pass in the early 2010s, with a large assist from the Great Recession and the very slow economic recovery that followed. For example, reports of several hundred applications for a single National Weather Service job opening were circulated throughout the atmospheric sciences community during the mid-2010s (Landsea 2014).

By 2019 the opposite situation apparently existed: there had been a half-decade-long downward trend in the number of graduates. Subsequent anecdotal evidence of increased public-sector and private-sector hiring, including at the B.S. level, has been prevalent from 2019 to the writing of this essay in 2022. The data and the anecdotal evidence are good news for B.S.-level job seekers in 2022. However, the volatility of the early 2020s—from the swings of the national and world economies, to political decisions affecting the weather and climate community, to the effects of the COVID pandemic on personal career decisions, to the increasing automation of our field—makes any attempt at forecasting the job market for B.S.-degreed meteorologists very difficult at this time.

The number of bachelor's recipients in our field is confirmed to be an undercount, with several programs of note not being captured in the College Scorecard (and presumably also NCES) data. A more fine-grained, manual analysis to include these programs may be required to obtain a truly complete count of bachelor's recipients in our field.

Furthermore, it is also possible that some fraction of the apparent downturn in bachelor's recipients could be because students are pursuing climate-related bachelor's degrees that are not captured in either the NCES or College Scorecard datasets under CIP code 40.04. There seems to have been growth in the number of climate science majors nationally since the late 2010s, and so future studies will need to account for the broadening of our discipline at the undergraduate level.

The College Scorecard provides much additional data not analyzed here, including information on M.S. and Ph.D. recipients, and (where the numbers are large enough not to be privacy suppressed) additional financial data for B.S., M.S., and Ph.D. recipients. As the period of record of the College Scorecard lengthens, there will be enough reports and a long-enough time series to perform additional analyses on the degree recipient data and financial data at all levels.

However, this future work should be performed by an impartial national organization, not by individual researchers. I recommend that the AMS partner with the AIP Statistical Research Center to gather and collect data on student enrollments, degree recipients, and their financial status on a regular basis, just as is done for other physical and Earth sciences. When the task falls to an individual professor, or to a group of graduate students as in the case of Card et al. (2020) on the subject of standardized graduate student stipend calculations, the temptation to impugn the motivation or methods of the study can be strong among those who, for whatever reasons, dispute the findings. An annual or biannual report published under the banner of the AMS in conjunction with the expertise of the AIP SRC would reduce or eliminate such criticisms and focus attention on the results. For this effort to be effective, atmospheric sciences

programs would have to cooperate with and be responsive to requests for data, and provide accurate information. The recent Card et al. (2020) effort with regard to graduate student stipends was hindered by a lack of responsiveness on the part of some programs and, in one instance, by inaccurately reported data from a program (Card et al. 2021).

A regular annual or biannual reporting cycle coordinated at the AMS level would also close the unjustifiably long gap between published reports on undergraduate degree recipients (i.e., Horn et al. 1974; Mass 1996; Knox 2008; and this essay). I urge the AMS Council to fill this current, and chronic, data void with regard to our discipline's undergraduate programs, their students, and the students' outcomes.

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Data availability statement. Data used in this study were obtained and culled from multiple Excel files stored at and downloaded from https://collegescorecard.ed.gov/data, and then analyzed by the author.

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