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AMS Best Practice Statement on Preparing Students for Employment in the Private Sector

A Best Practice Statement of the American Meteorological
Society

(Adopted by the AMS Council *12 January, 2025*)

The AMS reviewed and updated its Information Statement on the Bachelor's Degree in Atmospheric Science; the new statement was approved and adopted by AMS Council in November 2023. During the review process, the Board on Best Practices was tasked with developing a Best Practice Statement for Preparing Students for the Private Sector to make recommendations for academic programs to ensure that students develop the necessary hard and soft skills for employment in the private sector. This statement is the result of that work and is referenced in the Bachelor's Degree Information Statement (Sec. 5b).

Key Recommendations:

Private sector organizations and academic institutions must partner to focus on the skills needed in the workplace. The AMS Board on Higher Education, the AMS Mind the Gap Committee, and the AMS Board on Private Sector Meteorology focus on building and supporting initiatives that inspire the following outcomes:

1. Academic sector instructors/professors partner with members of the private sector to develop course content that includes specific areas of private-sector expertise and leverages outside experts to help evaluate student work and present content about career paths in the private sector.
2. Private sector employees join academic advisory boards for curriculum development, career services, and departmental engagement.
3. Academic institutions invite private sector employees to become adjunct professors in order to supplement curriculum.

Specific Recommendations for Private Sector Entities, AMS, Educators and Students:

Practical implementation of the best practices outlined in this document for (academically) preparing students for private sector careers will look different across a range of different institution types, program sizes, and students served. As employment opportunities increasingly diversify in the private sector and the pace of technological development continues to rapidly evolve, modernizing curriculum and providing resources to help students develop skills that employers seek, *while maintaining academic rigor*, can be daunting. This is especially true when faculty themselves lack domain-specific knowledge, skills, or connections to the private sector. It is advantageous for the private sector to engage with academia to provide educators with insights into changing expectations in the workplace and help students, as potential future employees, develop skills essential to their success. Therefore, the recommendations presented require development of relationships on several fronts. These best practice recommendations are provided with the intent that they will be interpreted and adapted in various ways according to interest, motivations, needs of students, funding, and time commitments.

The AMS Board on Higher Education, the AMS Mind the Gap Committee, and the AMS Board on Private Sector Meteorology can focus on building and supporting initiatives that inspire the following best practices:

Best Practices for the Private Sector

- **Volunteer to be a contact** for educators as part of the AMS Board of Private Sector Meteorologists (BPSM), Mind the Gap Committee (MtG), or any of several boards and committees under the [Commission on the Weather, Water, and Climate Enterprise](#). You do not have to join the board or committee to get involved.
- **Form an active connection with institutions seeking your input.** Private sector employees are recommended to engage in activities that help institutions keep up-to-date on current skills needed in the workplace.

Below are a few suggestions of activities:

- Act as a member of an advisory board for an institution or a program.
- Work directly with an instructor to develop course content in your area of expertise.
- Help evaluate student work.
- Give presentations on your work and/or your career path.
- Become an Adjunct Professor to supplement a program's curriculum.

- Connect with a Student Chapter of the AMS.
- Host visits of student groups from a course, or Student Chapter of the AMS at your workplace.
- **Facilitate mentorships and internships, and announce them in well known discipline-specific outlets.** Often, mentorships and internships are difficult for students and faculty to find, are unadvertised, and may or may not pay students ([Pandya et al. 2012](#)). Specific recommendations:
 - **Participate in pre-existing mentorship programs** such as the BPSM Private Sector Mentorship program, which has successfully run since 2001 and connects undergraduate and graduate students directly with those working in the private sector.
 - **Develop formal or informal mentoring opportunities for students.** The best approach is through a trusted moderator, such as faculty, an AMS Chapter, or a Student AMS Chapter.
 - **Develop structured or unstructured internship programs** that help students learn specific skills, as well as help them establish what they may want to do for their career. Motivated students typically perform well and can be an efficient hire as they have already been trained. Internships can be either paid, for-credit, or unpaid. We recommend that students be paid for their efforts or offered the opportunity through their institution to earn credit that can be applied toward graduation.
- **In job advertisements, clearly outline skills that are required for entry-level positions** separately from desired skills, and **ensure that required skills are realistic.**

Best Practices for AMS Committees and Boards

- **Take an active role in acting as a conduit** for private sector employees who are motivated to share their skills and knowledge with current students and faculty. A prime example of this is the [BPSM Private Sector Mentorship program](#).
- **Establish a student member position** on each board or committee where practical and **actively advertise** this opportunity to students through social media or AMS media outlets.
- **Continue to host free, publicly visible resources for internships, mentorships, and jobs.**
- **Continue to foster collaboration/integration between various boards and committees** to ensure that the separate entities are working in a unified manner without duplicating efforts. This can be accomplished through several pathways including informal, but regular, communications between board and committee chairs. For

example, the work of the drafting committee responsible for this statement maintained close contact with and included members who were on: the Board of Higher Education, the Mind the Gap committee, and the Board of Private Sector Meteorologists.

Best Practices for Educators (e.g., Faculty, Instructors)

- **Seek connections with private sector employees** through your network and/or local connections, or communicate with AMS Boards or Committees to help guide you to interested individuals or groups. **Work with these individuals or groups to invent novel experiences** for students to develop specific skills (e.g., those in the Important Skills for Private Sector Employment section below), use (sanitized) datasets and/or perform data analysis, and/or communicate outcomes to clients, among other potential applications.
- **Include recommended skills (from the Important Skills section below) in the syllabus** as course objectives and alter existing student assignments, or create new assignments, with opportunities to develop skills in these areas. This is not a new idea, as studies such as ([Galen et al. 2022](#)) have mapped specific student tasks like “plot and interpret NWP output” and “prepare and present communication strategy for customer group” directly to course learning outcomes. Appendix A provides two sets of anecdotes provided by two professors that developed new strategies, during the Mind the Gap 2 workshop, to incorporate private sector skills into their classrooms in innovative ways.
- **Stay in contact with alumni and invite them to get involved.** Former students employed in the private sector are often willing to return to engage with current students, which can be highly informative and influential.
- **Seek out resources from partner institutions** such as UCAR. The UCAR COMET program is developing (as of 2024) educational modules on different private sector careers and skillsets, intended to be integrated into nearly any level course, from introductory/freshman courses to senior undergraduate and graduate courses.
- **A final recommendation for faculty:** Educators endeavor to teach according to their students’ needs, through use of modern and evidence-based pedagogical techniques. As new approaches are applied in the classroom, it is important to monitor the impact on students and/or student outcomes, document experiences, and *publish, or otherwise share your approach through academic outlets*. (See Appendix B for more specific information.) By publishing your innovative teaching approaches, you are not only contributing to the body of knowledge on education in our discipline, you also may be inspiring other educators to adopt similar methods, learn from your mistakes, or experiment with different strategies.

Best Practices for Students

There are many recommendations for action by the private sector and academia within this document, but sometimes it takes a well-intentioned and inquisitive student to spark this action. If students identify what they need, and ask for it, educators and administrators as well as private sector employees may be motivated to meet these needs.

- **Build your knowledge about private sector opportunities.** The [AMS BPSM has developed online resources](#) and the AMS has an online [Career Center](#), but many other resources exist through partner institutions such as UCAR, current job postings, and web searches.
- **Pursue real-world work experiences through internships, mentorships, job shadowing and similar opportunities.** Contact private sector businesses and ask about what opportunities are available.
- **Be persistent and polite in your requests and interactions.** Consider your request from the perspective of the person you contact.
- **Find opportunities to engage and interact with the private sector.** For example, invite people from the private sector to meet with or present to academic departments, community groups, or your local AMS chapter, either in-person or remotely.
- **Ask your instructors for opportunities to practice the skills outlined in this document** (The Important Skills for Private Sector Employment section below).
- **Consider pursuing a graduate degree** in a field that aligns with a branch of the private sector after obtaining your undergraduate meteorology degree.
- **Realize that you are an active agent in your future success.** Actions you take in your formative stages as a student will help you develop skills and connections that will make you a better candidate as you pursue your career.

Motivation and Background

Job opportunities for newly minted meteorologists span America's Weather, Water and Climate Enterprise. Many of these jobs are found in the private sector, which is comprised of a diverse group of organizations that specialize in providing products and services that fill a specific need for customers. A [2017 National Weather Service Enterprise Report](#) estimated the private sector to have a market capitalization of seven billion dollars. Over the next 10 years (2022-2032), the [Bureau of Labor Statistics](#) expects the meteorology field to grow by four percent, with many of these jobs in the private sector.

While a 1995 AMS Private Sector Survey found that students leave universities with a solid education, knowledge gaps valued by employers remain. This finding was established in recent initiatives such as "Mind the Gap: Educating the Next Generation of Atmospheric

Scientists for Industry Needs” and a 2023 AMS Hiring Manager Survey. Students and faculty from multiple atmospheric science programs have leveraged AMS forums to express the view that there remains a clear lack of awareness about existing private sector career opportunities and requisite skill sets to pursue those careers among both students and faculty. To address this widespread lack of awareness concerning pathways to private sector employment, the AMS created the Mind the Gap Committee. The best practices outlined in this document draw from available survey results, curriculum review, and Mind the Gap workshop outcomes to provide updated guidance for universities, individuals working in the private sector, and students in preparation for private sector work.

The Weather Enterprise private sector has grown significantly over the last decade with expected growth of meteorology career opportunities of 4% between 2022 and 2032.

In addition to overall growth, the private sector has evolved from providing third-party weather and climate services to actively partnering with the public sector to provide expanded services that complement National Oceanic and Atmospheric Administration (NOAA) and National Weather Service (NWS) data and services. The private sector has also engaged with academia to prepare students and early career professionals (recent students with some private sector experience) for emerging and expanding private sector roles and opportunities. The broader market for weather and climate services has evolved rapidly over the last five years, creating new roles and functions that span from traditional roles to new unique and novel career opportunities. This expanding range of products and services creates new opportunities along with new skills requirements. This in turn creates additional gaps for students and early career professionals. Skill gaps include hard skills (e.g., IT, programming, data analytics, machine learning) and non-scientific skills (e.g., oral and written communications).

Several AMS boards and committees over the past five years have addressed private sector skills requirements and gaps including the Board for Private Sector Meteorologists (BPSM), the Board on Higher Education (BHE), and the Mind the Gap committee (MtG). Findings of prior investigations into [private sector skills requirements](#) (Houghton et al. 1996) align with recent results which indicate the continuing need for strong science and technical skills, communication skills in traditional areas (oral, written, presentation), and more contemporary communication modalities such as email and instant/direct messaging.

A recent survey conducted by the Mind the Gap committee, directed towards early-career meteorologists, identified private sector skill gaps that would help refine preparation of students and early career professionals for successful careers and employment. The survey revealed knowledge gaps in interviewing, professional communication, leadership/teamwork, statistical analysis, spreadsheet/database analysis, and programming.

Over 70% of respondents indicated ‘moderate’ to ‘high’ importance of the following non-technical skills: interviewing, communicating professionally, leadership, and teamwork. Only 20% of respondents indicated that these skills were emphasized in their undergraduate programs. A more detailed breakdown indicated a significant majority consider oral skills (69%), written skills (51%), teamwork and networking (60%) as ‘very important’. Approximately 84% rated professional behavior (e.g., email, interpersonal communication) as ‘very important’. Science and technical skills were also rated as ‘important’, with half of survey respondents indicating that coding, programming and database skills are ‘very important’. Modeling, GIS and

general IT skills were ranked as ‘moderately’ to ‘very important’ in between 30% and 40% of the responses. These findings mirrored a corresponding survey of hiring managers.

These recent survey results identify skills essential to professional success for individuals pursuing a career in the private sector. Additional surveys focused on early-career professionals, as well as academia, should be conducted to broaden the perspective from the standpoint of not only gaps but needs and opportunities. Surveying later career private sector professionals as well as those that have moved between sectors (public, private, academic) during their careers would help to understand how the private sector has evolved and how that relates to current and future skills, needs and opportunities.

Important skills for private sector employment

Two surveys conducted by AMS committees and boards in 2022 and 2023 focused on assessing student preparedness for private sector employment. These surveys conclude that early career graduates pursuing jobs in the private sector are well prepared with meteorological skill sets (89% of respondents completely or moderately agree). These findings also highlight a significant gap between the skills meteorology students acquire during their scholastic programs and other skills that are highly valued by private sector employers who hire from these programs. Additionally, a broad survey of 160 members of the AMS (conducted in 2022) found that only 7% of respondents indicated they “completely agree” that “current U.S. undergraduate programs in meteorology/atmospheric science are adequately preparing students for entry into the private sector workforce.”

A narrower, independent, survey (conducted in 2023) of 99 AMS members who identified themselves as hiring managers in the private sector of meteorology emphasized the need for meteorologists to develop skills outside the domain of meteorology.

Communication ranked as the most important non-meteorological skill in the private sector. The ability to present scientific information orally to non-meteorologists was one of the most frequently cited examples. The survey also highlighted the need for basic professional communication skills such as writing reports, memos, agendas, and e-mails along with basic professional behavior in conversation about ongoing projects. Only 12% of hiring managers indicated complete agreement that “meteorologists are prepared” with these skills upon graduation while 77% of hiring managers indicated these skills are strongly sought-after in the hiring process.

Approximately 69% of the broader survey group indicated that effective oral presentation skills were ‘very important’ for early career professionals (i.e., less than 15 years of experience). 84% believed that communicating professionally (e.g., email etiquette, behavior) was ‘very important’. **Less than 25% of these respondents indicated that they developed these skills “during their undergraduate program.” Over 50% of respondents indicated that professional communication skills were “self-taught.”**

While communication skills represent the most significant gap between education and early-career practice, only 54% of respondents to the broader AMS survey indicated that they completely or moderately agree that meteorologists are prepared with other necessary scientific but non-meteorological skill sets. The following skills were rated either ‘completely’ or

‘moderately’ agreed as to the “level of importance to the positions for which [hiring managers] hire meteorologists”:

Skill	% of Respondents who Rated the Skill as ‘Completely’ or ‘Moderately’ Important
Programming	78%
Scripting	75%
Spreadsheets	77%
Modeling and Computing Packages	70%
Data Science	66%
GIS/Mapping	60%
Database Management	59%

Respondents indicated that the following curricular requirements in most meteorology programs are ‘most important’ in the private sector. While forecasting and synoptic meteorology are well aligned from curriculum to career, the survey also highlights a gap between curricular focus and needed career skills.

Skill	% Respondents who Rated the Skill as ‘Most Important’
Forecasting and Synoptic Meteorology	76%
Dynamic and Physical Meteorology	26%
Advanced Math (incl. Calculus and Differential Equations)	11%

The AMS Mind the Gap Committee reports that the large majority of job openings in today’s market do not include the term ‘meteorology’ or ‘atmospheric’ in their title. Instead, today’s example private sector opportunities have titles such as:

- Catastrophe Analyst
- Insurance Claims Analyst
- Climate Data Analyst

- Data Scientist
- Earth Science Data Specialist
- Environmental Analyst
- Environmental Consultant
- Programmer Analyst
- Risk Communicator
- Scientist, Climate Technology
- Technical Project Manager
- Trading Analyst

Three main findings emerge from survey results and work of the AMS Mind the Gap committee:

1. Significant curriculum shifts can be guided by collaborative feedback between private-academic sector discussions;
2. Private-academic consortia and relationships can help prepare students for career paths in the private sector; and
3. A system for tracking students beyond their education to gather career stories and data from alumni can be leveraged to advise students moving into their early careers.

References

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Appendix A: Development of Career Skills in the Classroom: Recent Faculty Success Stories

While there are some outstanding published examples of private sector simulation or involvement, such as restyling an instrumentation course as a consulting company term project ([Croft & Ha 2014](#)), and operating a forecast service staffed by paid undergraduates ([Roebber et al. 2010](#)), it is essential to modernize teaching approaches as desired private sector skillsets change. The examples that follow are from the 2022-2023 academic year and illustrate how recommended skills (from the Important Skills for Private Sector Employment section) can be developed alongside content knowledge and skills.

Dr. Gary Lackmann incorporates development of communication skills alongside development of meteorological knowledge in several different ways for his upper-level undergraduate students at North Carolina State University (NCSSU).

- On quizzes and tests, he "changes the audience," asking students to explain some meteorological phenomenon in language that would be understandable to an audience with no background knowledge in meteorology. Examples of different audiences are: a college-student friend who is a non-STEM major, an elementary school classroom, and a group of public stakeholders. He states that students generally adapt their explanations appropriately for the audience, but that several attempts are required for students to realize that they cannot use meteorological jargon or equations in their responses. A sample question he provided is, "Explain why there is a narrow, westerly jet stream in midlatitudes to a public audience of non-meteorologists."
- An assignment was created where students acted as "meteorological consultants" and were required to provide expert testimony in a legal case involving coastal beach erosion. To answer specific questions, they carried through calculations using a Python notebook and provided analysis that was written in a way that was understandable in a court of law, explaining what they found and the methods used. Dr. Lackmann reported that the students did well but found the communication aspect to be challenging; "it is very difficult to explain highly technical methods to non-practitioners!"

Dr. Ross Lazear offered examples from two courses, aimed at different student groups, at the University at Albany - State University of New York (UAlbany).

- In a junior-level course for atmospheric science majors, "Severe and Hazardous Weather and Forecasting," Dr. Lazear geared weekly weather discussion sessions toward different private sector applications. Students were paired and made forecasts for "stakeholders" such as: a public event students had interest in, like a football game, farmers' market, outdoor movie night; forecasts for FedEx pilots and aviation interests,

shipping routes, and overland transportation. Students were assigned background reading and work centered around the applications and external contacts were invited to present material or help students understand the end-user needs for the specific application. Students were enabled to consider the client's needs and how their forecasts would impact their client. They also had practice honing their written and oral communication skills through a one-page slide they presented to the class, in an environment similar to what they will encounter in the private sector. Dr. Lazear reported that after the marine forecasting exercise, one student asked for more information and plans to apply for marine forecasting jobs after graduation.

- In a freshman seminar on major topics in atmospheric and environmental science, Dr. Lazear piloted a communication exercise for a section on emergency/hazard preparedness. Students were asked to interpret hazard maps for Hurricane Ian, which featured many different types of hazards as well as timing and intensity of winds and flooding during the hurricane. Students were separated randomly into groups, and asked to distill the overwhelming amount of information into just two sentences. The class evaluated all responses and identified which they believed was most succinct, clear, and easily digestible for emergency managers, and for the public. Through the exercise, students got hands-on experience succinctly communicating important information to the public, or decision makers.

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Appendix B: Development of Career Skills in the Classroom: Publishing Teaching Approaches

There have been relatively few articles on (undergraduate) education published within meteorology ([McNeal et al. 2022](#)), so any contributions are valuable: from simple classroom experiments to course-long or curricular adjustments. An article describing an innovative educational approach that references informal student feedback or anecdotal evidence can be published in the [National Association of Geoscience Teachers \(NAGT\) “In the Trenches,”](#) a teaching-focused periodical, or as an InBox Article in the Bulletin of the American Meteorological Society (BAMS). It could also be presented in the Conference on Education at the AMS Annual Meeting or other educational gatherings such as the [NAGT Earth Educators’ Rendezvous](#). Consider taking implementation of new techniques a step further and approach as a Scholarship of Teaching and Learning (SoTL) project, or an Atmospheric Science Education Research (ASER) project (see definitions in [Kopacz et al. 2021](#)). Partnering with a cognitive psychologist or an education expert from your institution’s Center for Enhancement of Teaching and Learning (or similar) would lead to a more scientifically constructed experiment involving your teaching method. The nature of this work involves human research subjects and an Institutional Review Board (IRB) approval or exemption should be sought, especially if you intend to publish or professionally share your results. Depending on the level of rigor included in the study of the teaching method, it may be possible to publish the results as a research article in BAMS.

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