BAMS In Box

# The National Weather Service–North Carolina State University Internship Course

## Impacts and Success over a Generation

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**ABSTRACT:** Nearly 100 North Carolina State University (NCSU) students have participated in a unique, highly structured internship course conducted by the National Weather Service (NWS) Weather Forecast Office (WFO) in Raleigh, North Carolina. Here, we explore the impact that this course has had on their professional development and career trajectories. As of this writing, the course has been running for 17 years; this paper provides an update on how the course has changed over time, and information concerning participant outcomes. Changes include a reduction in class size to allow for more individualized mentoring, and the addition of experiences outside of the WFO. The course serves as a compelling selling point in student recruiting for the Department of Marine, Earth, and Atmospheric Sciences (MEAS), and participation also helps to ensure that the curriculum is adequately preparing students for positions in the NWS. The NWS benefits from a pool of potential employees that will require less spin-up time if hired; additionally, some NCSU graduates have participated in similar student volunteer programs at their respective offices once hired.

**KEYWORDS:** Operational forecasting; Education

https://doi.org/10.1175/BAMS-D-20-0260.1
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In final form 17 April 2021

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There is a long-standing collaboration between the National Weather Service (NWS) Weather Forecast Office (WFO) in Raleigh, North Carolina (RAH), and the Department of Marine, Earth, and Atmospheric Sciences (MEAS) at North Carolina State University (NCSU). An informal relationship dates back to the 1970s when the NWS office was located at Raleigh–Durham International Airport (RDU), approximately 10 miles from the NCSU campus. This relationship strengthened when the NWS office moved from RDU to NCSU's Centennial Campus in 1994, eliminating the geographical gap between the two groups. Such proximity helped to facilitate student and faculty interactions with NWS staff, fostering interest in the continuous growth of aspiring operational forecasters while also providing a prime staging ground to promote research to operations (R2O) and operations to research (O2R) initiatives.

Another important element in the successful NCSU–RAH collaboration has been the Collaborative Science Technology, and Applied Research (CSTAR) program. While NCSU has partnered with the NWS through several National Oceanic and Atmospheric Administration (NOAA)-funded projects, the CSTAR projects promote direct interactions between NWS personnel, students, and faculty in ways that provide operational input directly into the research, and allow NWS staff to learn of research innovations at an early stage. The earliest CSTAR grant was awarded to NCSU in 1999, and CSTAR-funded research collaborations have continued ever since. The CSTAR grants are beneficial to both NCSU and the NWS; NCSU students and professors have the opportunity to conduct operationally relevant research projects, while the NWS benefits from involvement in the projects such that they align with local/regional forecast issues.

While NCSU CSTAR students have had the opportunity to complete research projects that are directly relevant to operational NWS forecasting, these research activities rarely provide opportunities for students to gain experience in an operational forecast setting. Initially, some students volunteered to assist with projects at the NWS office, but this arrangement was loosely structured and the experience was inconsistent from student to student. To add structure and consistency, an experimental internship course was established in 2004 at NCSU as a two-credit-hour elective (Brennan et al. 2005). Five undergraduate and five graduate students enrolled in the inaugural course (Fig. 1), where they attended NWS training sessions, "shadowed" NWS staff, performed routine NWS duties, and assisted NWS staff during high-impact weather events. The course has been available every year since then, with a cumulative enrollment of nearly 100 students. The course is offered each spring semester, with experiences often extending into the summer sessions.

The course has evolved over the years, and the purpose of this article is to share information about the symbiotic advantages of the NCSU–RAH collaboration, with emphasis on the internship course. Our goals include soliciting additional feedback, documenting course outcomes, and hopefully inspiring other such collaborations. We also share some lessons learned which have led to a natural evolution of the course, and we present direct correspondence with former course participants, documenting benefits, challenges, and some valuable suggestions. We seek to provide a balance of NWS staff, student, and NCSU faculty perspectives within this article.

## Course structure and activities

***Workload, enrollment, and selection.*** After 17 years, it is to be expected that the course has evolved from the description provided by Brennan et al. (2005). However, some

aspects of the course remain as originally conceived: the course remains open to senior undergraduate and graduate students, and the basic concept of exposing students to the myriad NWS forecast office activities from multiple perspectives continues to this day. The course format has been codified more in recent years, with a concerted effort to pair each student with a different NWS employee each week to maximize perspectives and networking, while distributing the workload among the NWS staff. Many staff members benefited from their own volunteer experiences [13 of 19 (68%) current WFO Raleigh meteorologists had experience either volunteering or participating in a course before being hired by the NWS] and wish to "pay it forward"; however, conducting the intern course places added workload above and beyond their regularly assigned tasks. Training, mentoring, and supervising all require staff time and effort, even when the students' main role is "shadowing" their mentor. Proven time and time again, the retention of such a consistent program and experience took buy-in and partnership from multiple levels, including NCSU professors, NWS managers, and the NWS staff members. In essence, it is a true exemplar of public–academic partnership, and of whole office concept ideals where the entire office is involved in making the program successful.

**Fig. 1. NCSU students from the 2004 spring semester (along with a student who did not volunteer but facilitated the scheduling of the other students). All 11 students were working in the meteorology field as of December 2020, 7 of whom are employed by NOAA and 2 of whom are employed by WFO Raleigh. From left to right, front row: David Hamrick, Kelly Mahoney, Meredith Bell, Joshua Palmer, Matthew Miller, David Levin; back row: Pete Childs, Tom Green, Mike Brennan, Blair Holloway, Mike Strickler.**

The additional workload imposed on RAH staff has also necessitated changes in course structure. During the early years of the course, at least 6, and as many as 10 students participated. Beginning in 2014, intern course enrollment was limited to roughly four students, as it became necessary to cap enrollment at a level that would not place an undue burden on the staff. From the outset, students were required to "apply" to the intern course; application materials include a resume and a cover letter that explains their interest in the course and what they hope to gain from it. Once the office staff completes the review of the student application materials, they conduct in-person interviews. This provides the students with invaluable experience in a professional interview setting, regardless of whether they are selected for course participation. Students, both selected and not, are provided with constructive criticism regarding their application and interview. The selected students are notified in the fall, allowing time for them to enroll in a two-credit pass–fail internship course that is represented on their official university transcript.

***Course content.*** One goal of the course is for students to observe and gain experience with the many different activities undertaken by a typical NWS office. These include examining surface, upper-air, and remote sensing observations, interacting with the public, decision-makers, and emergency managers, and ultimately issuing forecasts, watches, and warnings. For those students who ultimately go on to gain NWS employment, many will eventually participate in all of these activities, and this broad exposure provided participants with a complete perspective of what an NWS forecast office job involves, including exposure to shift work. Prior to taking

the course, students are often unaware of the various types of forecasts produced, and this experience helps students recognize that the NWS does much more than just issue warnings and public forecasts.

While an NWS forecast office employee will spend much of their time in the office, there are important responsibilities that take place outside of the office as well; thus, another important aspect of the program is providing students with experiences *outside* of the office. Intern course students have opportunities to visit with NWS Deep Core Partners (partners who make decisions most critical to public safety), including the North Carolina Department of Emergency Management (NCEM). This opportunity allows the students to interact with emergency managers and gain a sense of how meteorology and NWS forecasts can impact critical decisions at the state and local levels. The NWS has many core partners that rely on their impact-based decision support services (IDSS), and a visit to NCEM allows students to gain appreciation for the application of meteorology and for the increasing need for effective forecast communication in IDSS processes (Fig. 2). Other off-site activities include a visit led by NWS electronic technicians to the local WSR-88D site, KRAX. KRAX is approximately 10 miles away from RAH, and some planning is required to coordinate schedules, transportation, and identify a day with favorable weather conditions. Students are given a tour of the radar property, are shown critical processing components, and are even allowed into the dome itself to see the antenna once it has been placed in standby mode. Students also take a trip to the upper-air sounding site in Greensboro, North Carolina (KGSO), where they have the opportunity to witness a complete upper-air observation (Fig. 3a).

**Fig. 2. NCSU students from the 2020 school year (in addition to two coauthors and an NWS Pathways student) visiting the NCEM. Left to right: Dan Leins, Mike Rehnberg, Cassie Mora, Jamie Morrow, Ronak Patel, Nick Goldacker, Chase Graham.**

Finally, while one of the primary functions of the course has always been to demystify the NWS hiring process, an even greater emphasis is now placed on what it takes to gain NWS employment. At the end of the semester, each student completes a "hypothetical" application for an entry-level meteorologist position in the NWS. Materials necessary for this process include a cover letter, resume, unofficial transcripts, copy of course descriptions, and references. Once collected, individual interviews are scheduled between the students and three NWS employees. Immediately following the interview, real-time feedback and tips are provided to the students. There may be no better way to gain experience for the application process than to actually go through the process itself!

## Benefits

***For students.*** A high percentage of course participants have gone on to successful careers in the NWS and elsewhere in the field of meteorology; as of December 2020, 99 students had completed the course in 17 offerings. At the time of this writing, more than 40% of former course participants are working somewhere within NOAA, including two course alumni working as forecasters at NWS-RAH. Five former participants are currently enrolled in graduate school, 9 are not currently working in the meteorology field, and 16 others are either still completing undergraduate degrees or were unreachable.[1] Thus, 41 out of 69 remaining participants, nearly 60%, are

[1] We recognize possible bias in our survey, given that we were easily able to contact all course participants who are now working for NOAA.

now employed by NOAA, with the majority of those in the NWS (Fig. 4). This demonstrates a tremendous benefit to NOAA, to the students, and to the university. Students learn about NWS careers, gain real-life experience in an NWS office, and then the NWS has the opportunity to hire these students who already have working knowledge of NWS operations. Of the remaining participants who are not working in NOAA, the employers are diverse, including the private sector, local, state, or federal government jobs outside of NOAA, and academia.

In a survey of prior course participants, the majority of responses came from NWS meteorologists, most likely because that they are more reachable and are more likely to have had positive experiences with the course. We asked, "Do you feel that the NWS Intern Course motivated you to become more (or less) interested in pursuing a career in the NWS?" Thirty-seven responses (all but four) indicated increased interest, with many also stating that they already had a high interest in the NWS even before taking the course. There was nearly universal praise for how the internship course impacted their career progression, a sampling of which is included in Fig. 5. The only topic that elicited some negative feedback was a topic that also received positive feedback: a discussion about the NWS hiring process and suggestions for gaining employment within NOAA.

**Fig. 3. (a) Four 2018 NCSU students (Shae McLamb, Levi Lovell, Andy Wade, and Alex Mitchell) and GSO upper-air observer Maher Haddad (center) preparing to launch an upper-air balloon. (b) NCSU students from (a), as well as NWS electronics technician Blake Ellis and NWS meteorologist Jimmy Danco viewing equipment at the (now closed) Horace Williams Airport (IGX) in Chapel Hill. (c) NWS meteorologist Chrissy Anderson and 2019 NCSU student Lindsay Hochstatter examining an archived severe weather event on the Weather Event Simulator (WES).**

***For NC State, NOAA, and the NWS.*** In the aforementioned survey, multiple respondents indicated that the collaboration between NCSU and the NWS was one of the positive factors in their decision to attend NCSU. The unique collaboration that exists between NCSU and the NWS is a compelling selling point for the MEAS department and NCSU when it comes to recruiting high-quality students. While the field of meteorology is certainly more than just operational forecasting, this is often where individuals receive their initial exposure. Although many meteorology students will eventually transition to some aspect of the field outside of operational forecasting, aspirations of an operational career will likely guide many students at the beginning of their academic trajectory. Only a subset of meteorology departments are collocated with an NWS WFO. To realize the potential benefit

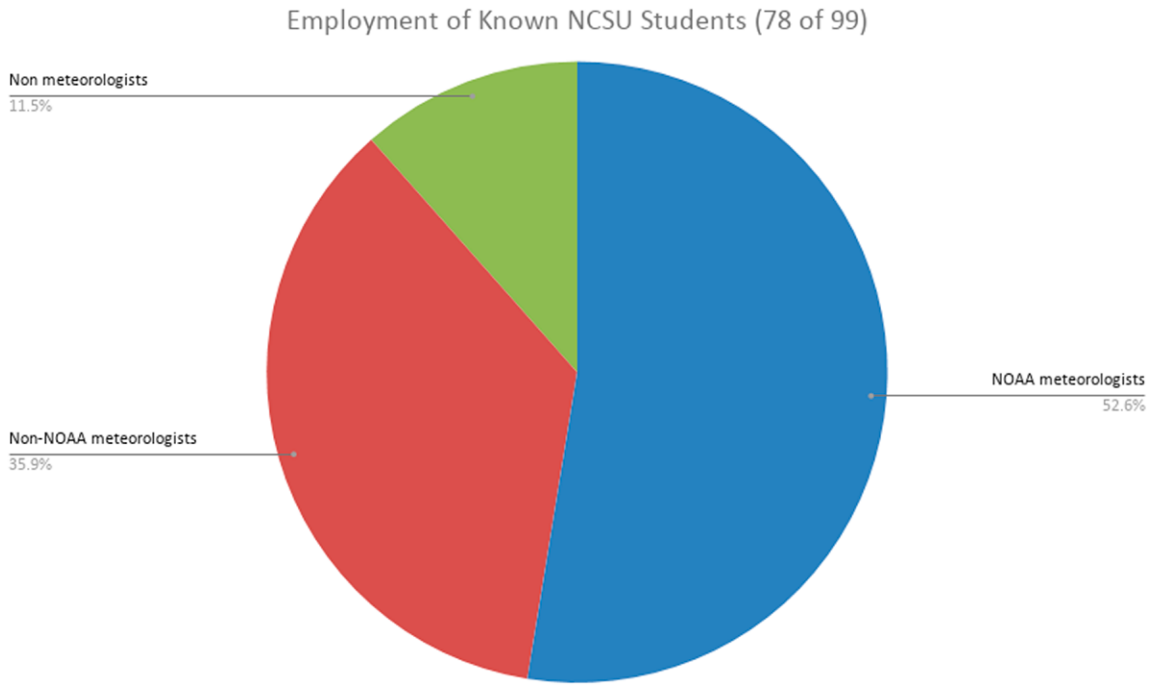


**Fig. 4. Employment status for former student volunteers as of May 2020. Those students whose status is unknown or who are still in school (undergraduate or graduate) are not included in this chart.**

of collocation, however, we believe that a structured program such as that described here is critically important.

Another benefit from the university perspective is an opportunity to ensure that the curriculum is adequately preparing students for the job market. While a relatively small fraction of NCSU meteorology graduates go on to work for NOAA, it is important for them to recognize the need to build nonmeteorological skills, in addition to the traditional scientific ones. Observing the need for effective communication between forecasters and nonmeteorologists in decision support activities, such as at the NCEM, helps them to appreciate and embrace adjustments made in courses or curricula that emphasize communication.

While there are some benefits for NOAA as the parent agency of the NWS, most of the benefits are directly realized by the NWS. Hiring a former intern course participant is advantageous because they already have gained experience in an NWS office and will therefore require less spinup time before becoming operationally proficient. In addition, not only is the collaboration advantageous to NCSU in recruiting, it can also be a convincing aspect for the Raleigh office in recruiting staff. Finally, an unintended benefit of the RAH intern course was that many survey respondents indicated they were now in charge of or involved with student volunteer programs at their respective offices.

## Challenges and difficulties

The intern course takes time to plan, coordinate, and execute on top of routine operational duties. Additionally, this internship may be the first exposure to a professional work environment

NWS meteorologist: "I walked away from those experiences with a huge smile on my face thinking to myself "THIS! This is what I'd love to do every day.""

NWS meteorologist: "Overall, it was an extremely well-rounded experience that hit on the importance of the forecasting aspect of the NWS while also highlighting how important the communication side is (which is often forgotten and will become more important as time progresses)."

Non-NWS NOAA meteorologist: "The NWS/NC State Internship program confirmed for me that I wanted to anchor my career in civil service."

Doctoral student in meteorology: "Ultimately, I found the experience interesting and a great opportunity to connect with scientists in my field but it made me realize that a career in forecasting wasn't for me."

Broadcast meteorologist: "Everyone was so welcoming and I met many people who I consider my mentors still in this industry."

**Fig. 5. Quotes from previous participants of the internship course.**

for many students and there can be challenges associated with participants' lack of experience in professional conduct, and other formalisms and courtesies that are often taken for granted in office environments. Not all students recognize and appreciate the generous gift that they are receiving from the NWS staff, who are working hard to make the course a meaningful experience. But in sum, the benefits discussed above far outweigh the drawbacks.

Demographically, 33 of the 99 participants have been female students, which is on the low side. In terms of ethnic diversity, there has been a significant underrepresentation of people of color in the intern course. These challenges reflect a broader issue in geosciences, one which is being actively addressed in the MEAS department and at NCSU. We recognize that we need to do a better job of increasing the diversity of course participants, and we are actively exploring ways to address this challenge.

## Looking ahead

Feedback for the course remains positive, both from students and NWS employees. It is telling that more than one out of every three students who have participated in the program are currently NOAA employees. Not only are high-caliber students being chosen to participate in the program, but those students complete the volunteer program ready and eager to join NOAA, typically the NWS. The NWS continues to evolve just like any other agency, and as the agency changes, the course will adapt to reflect this evolution. One of the biggest changes to the NWS over the last 10–15 years is the emphasis on IDSS and communicating directly with partners. The addition of the field trip to the NCEM is one example of course adaptation. Perhaps in the future, we will expand opportunities which allow students to participate in outreach activities and meet directly with NWS constituents. Also, restrictions related to the COVID-19 pandemic required the program to move into a virtual setting during the 2020 and 2021 offerings. While the course is still best offered in-person, several lessons learned during the pandemic resulted in new, more innovative ways of delivering experiences to the students.

The collaboration between the NC State MEAS department and RAH is vital for both institutions, having persisted for more than two decades in an official capacity. We are optimistic that it will continue for many years to come.

## Reference

Brennan, M. J., K. Keeter, A. J. Riordan, and G. M. Lackmann, 2005: Expanding horizons with an NWS internship course. *Bull. Amer. Meteor. Soc.*, **86**, 1407–1409, https://doi.org/10.1175/1520-0477-86.10.1401.