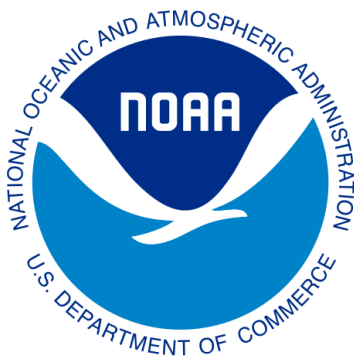# Updates and Recommendations for the UFS Student Engagement Plan

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Introduction

There is a greater need for collaboration amongst the weather enterprise regarding numerical weather prediction (NWP) and analysis. Numerical models are important for forecasting from short-term weather to seasonal predictions, including severe weather events. To facilitate collaboration amongst sectors, the [Earth Prediction Innovation Center (EPIC)](#) in the [Weather Program Office (WPO)](#) has supported the development of the [Unified Forecast System (UFS)](#). The UFS is a community-based Earth System modeling framework, is NOAA's first community-based system, and serves as the unified approach to simplify the National Center for Environmental Prediction's (NCEP) modeling suite. The UFS allows stakeholders from across the weather enterprise to contribute innovations back into the model code, potentially improving the operational forecast system that the National Weather Service uses to make life saving decisions that the public rely on.

Neil Jacobs, the UFS Chief Science Advisor of the UFS wrote, "Devising a community modeling program that results in a successful public–private–academic partnership, where all stakeholders are contributing and benefitting, is the ultimate goal." Student engagement is increasingly imperative when building a community based system, because students are the next generation of professionals. Students should be familiar with the modeling framework that operational meteorologists use for forecasts. They can also contribute newer perspectives from the current meteorology curriculum.

This year's project goal is to expand upon the UFS Student Engagement Plan written by the UFS Student Ambassador, Aleyka Srinivasan, in 2023 with updates and recommendations. The goal is to diversify stakeholder engagement and continue to increase student participation. The UFS Student Ambassador continues to provide an undergraduate perspective on the accessibility of the UFS, as well as a student perspective on UFS training and tutorials.

Personal Experiences and Perspective from the UFS Student Ambassador

The role of the UFS Student Ambassador is to find ways to ease the entry pathway for students with the UFS. The UFS Student Engagement Plan was written by the previous ambassador with recommendations on increasing engagement between the UFS and academia, from the perspective of an undergraduate student. The current student ambassador, Samantha Lang, has programming experience that is similar to that of the previous ambassador's. The current UFS student ambassador's exposure to programming includes:

1. Introduction to MATLAB in Introductory Atmospheric Sciences course
2. MATLAB focused Computing in the Geosciences course
3. Use of MATLAB in further coursework and labs

Unlike the previous UFS Student Ambassador's experience, the current UFS Student Ambassador has only learned one language in her meteorology curriculum at North Carolina State University. This varies across institutions, as some students learn multiple programming languages, and some only are required to learn one. For the current UFS Student Ambassador, a small introduction to MATLAB and the basics of how to use it was integrated into the first year meteorology course curriculum. Students get familiar with MATLAB and possibly programming for the first time in this course. This still leaves students with a bit of uncertainty, as only a small portion of the semester is spent on introducing MATLAB. There is also a course dedicated to computing in the geosciences. This mainly self-led course taught students the basics of MATLAB, with the expectation that students could use MATLAB confidently in later courses and labs. MATLAB continued to be the primary language used, with utility in the Thermodynamics and Atmospheric Physics labs. With only having exposure to one programming language in a lab setting, there is a common theme that most students are not comfortable with their programming skills entering their professional careers. Exposure to applications like the UFS during undergraduate classes could be crucial to bridging the gap between student engagement with the UFS, as well as increase students' confidence with numerical modeling and operational forecasting in the NWS.

Greater focus on numerical weather prediction and forecasting can make the transition into using models such as the UFS more streamlined. It is recommended that the UFS be incorporated into early atmospheric science and computing courses in an undergraduate science (i.e., meteorology) curriculum. Neil Jacobs also highlighted the importance of

incorporating a UFS lesson plan in classrooms: " Further, the UFS can be used for teaching in the classroom, as well as a tool for basic research and NWP experiments, where subsequent improvements and gained knowledge would result in scientific journal publications." After watching the Github tutorials offered on the EPIC community portal (ECP), as well as the Short-Range Weather Application user guide, it is clear that a general background in programming terminology would benefit new users and set them up for success.

Project Inspiration

The UFS Student Engagement Plan (2023) was inspired by the Unifying Innovations and Forecasting Capabilities Workshop (UIFCW) 2022 post workshop survey. The post workshop survey revealed attendees representing academia were in the minority. This year's student engagement project (2024) will utilize the UIFCW 2023 post-workshop survey as well as student and university outreach.

The main goal of the project is to expand upon the recommendations made in the inaugural 2023 UFS Student Engagement Plan. With new perspectives and improvements, new recommendations can be given to increase student engagement with the UFS. This project directs outreach towards students attending UIFCW 2024 with a survey of questions sent at the end of the workshop. The timing of this allows more relevant feedback about student engagement at UIFCW and respondents' opinions about discussions during UIFCW. Students will also provide feedback on their use of UFS in their academic setting.

The post workshop UIFCW 2023 survey also gave valuable feedback when it comes to students and academia and their involvement in the UFS. UIFCW 2023 included facilitated discussions between various stakeholders regarding communication and collaboration in numerical weather prediction. Even though a lot of these discussions took place informally during breaks and lunches, there were also roundtable discussions that provided key takeaways used in this project.

A question and topic at the center of one of the roundtable discussions during the workshop was, "How to diversify and incentivize participation across sectors, disciplines, and demographics in the UFS". One answer to this was to reach out to students in non-meteorology

fields. This emphasizes the point made previously, where increasing interdisciplinarity is critical. Another answer to diversifying participation across sectors in the UFS is the potential to not only connect with undergraduate and graduate students, but students in K-12 as well. Introducing students to NWP before college courses increases comfortability with programming and leads to more participation with applications like the UFS. Participants also contributed points like aligning operational needs with academic goals and expanding the UFS Student Ambassador program. This does not have to be limited to just students, but students acting as ambassadors can be more efficient and successful at sharing their knowledge with their peers. This is the targeted audience.

Another question posed in the roundtable discussion at UIFCW 2023 was "how we can enhance knowledge transfer and collaboration across UFS contributors." Participants highlighted the need for centralized resources like webinars and newsletters as well as a single point of entry for the UFS. Navigating the UFS website and repositories on Github can prove difficult, especially for new users who are trying to get familiar with the various UFS applications and projects. Participants in the discussion also mentioned establishing lesson plans for universities could enhance collaboration across UFS contributors. This is vital for student and academic engagement. Incorporating UFS into lesson plans could prove to increase participation throughout the weather enterprise and make students and early career professionals more comfortable with NWP as well as applications such as the UFS. These recommendations from participants directly correlate to recommendations given by not only the 2023 UFS Student Ambassador but also the current UFS Student Ambassador, as well as initial goals from UFS stakeholders and innovators.

Lastly, another topic of discussion was, what are the biggest science challenges we should be working on as a UFS community? The largest challenges were ensuring the UFS was easy to run for all experience levels, integrating social science, and relating real world issues to the UFS. Addressing these challenges would give the research a purpose and help us understand why students and other users would want to get involved with the UFS. Additionally, UFS training materials are integral to the usability of the applications and increasing participation across the weather enterprise. Increasing the interdisciplinary work of the UFS would increase overall engagement. It is important to extend outreach past known users of the UFS and university atmospheric science programs. Incorporating social scientists to give their

feedback on the modeling system as well as relating social issues to UFS applications will also improve engagement.

Participants in the round table discussions at UIFCW 2023 agreed that future discussions are needed. There was also an agreement that visualization tools are needed, as well as defining UFS culture and fostering a community. Implementing and expanding the UFS Student Ambassador program throughout the community could promote and support the UFS. Student ambassador projects such as this one contribute a new perspective. With increasing social media usage, there is a market for prominent social media users to get familiar with the UFS and promote it across their platforms. "Influencers" in the STEM field could reach younger audiences, and there may be better engagement with social media outreach. People with this wider network on social media may increase engagement outside of government and those in the industry, especially with students and early career professionals. The current UFS Student Ambassador has personal experience with learning about key projects and opportunities from social media personalities, proving that social media outreach is important.

The UIFCW 2023 report stated that there was a fifteen percent increase in registered academic attendance compared to the 2022 workshop. This does not take into account the virtual viewers of the workshop, who did not have to register. This data shows that academic and student involvement in the UFS is slowly growing, highlighting the importance of continuing student engagement and outreach to increase participation, not only in workshops such as UIFCW, but other UFS related events.

Academic Outreach

In regards to university outreach and building upon previous UFS student engagement plans, there should be adjustments made to get new insights. The previous UFS student ambassador sent surveys to universities via email, selecting schools with atmospheric science and computer science programs. Survey questions asked for information regarding: the accessibility of programming and NWP courses to students at their respective institutions, what software students are using in programming courses, do they have issues with their current software, and would they be willing to participate in a UFS roadshow. Some responses from universities showed an interest in live UFS demonstrations, with a willingness to participate in

outreach activities. Universities mentioned their programs having programming and NWP courses, mostly in the form of optional electives, or classes that are not offered every semester. Python was the most common language used by respondents. It is clear that the common theme amongst universities is that there is a lack of emphasis towards learning NWP and other programming languages in a typical atmospheric science curriculum. Continuing this outreach should include working with universities that have incorporated the UFS into their curriculum or professors at universities that are familiar with the UFS and may use it. This, instead of just targeting universities based on their atmospheric or computer sciences programs, will gather more relevant data on UFS usage in academia and outreach with students. Focusing this research on current users of the UFS can give critical feedback on use of it in the classroom and in academic settings.

Student Outreach

It is important to get insight and feedback from students in programs outside of atmospheric and computer science. One of the goals of student outreach is to understand how students are currently using the UFS, as well as get their opinions on student engagement and how involved they are in the UFS community.

Expanding upon qualitative research and data from previous projects and workshops includes outreach at UIFCW 2024 at Jackson State University in Jackson, Mississippi. Survey questions will gather important opinions and perspectives from students involved in UFS from across the weather enterprise. This survey will be sent to all attendees from academia towards the end of UIFCW 2024. Last year's survey was released prior to the workshop. This update will allow for feedback about not only the UFS community, but also UIFCW. New survey questions include:

- In an academic environment, how do you currently use UFS?
- How would the development of lesson plans increase your understanding of the UFS from an academic perspective?
- How well was student and academic engagement facilitated at UIFCW 2024? What recommendations for improvement would you give?

- Would you be interested in participating in academic outreach planning for the UFS?
- What were you most looking forward to at UIFCW 2024 prior to attending? Do you feel it improved your understanding of the UFS, and if so, how?
- What, if any, is your experience with Numerical Weather Prediction (NWP)?
- Are you interested in becoming a UFS Student Ambassador at your university?
  - A description of the role includes serving as a liaison between the UFS and academia. This includes fostering relationships between their university and the UFS community, promoting the UFS and its initiatives through social media , and gathering feedback from the academic community about the UFS. Ambassadors would be encouraged to share their knowledge and experience with their peers.

This qualitative data we receive can provide key updates to previous outreach, with feedback on how to improve engagement with students and academia. These updates and new survey questions will likely provide information for new recommendations for not only the UFS Student Ambassador but for the EPIC and UFS teams. Results from this survey are detailed on .

EPIC and UFS teams currently perform community outreach in the form of Application trainings and CodeFests, where participants can sign up for and learn how to run the different UFS applications with an expert from the EPIC team. In addition to UFS application training and CodeFests, there is also a quarterly newsletter, titled UFS Insights, available for the public to read. UFS Insights highlight upcoming events, code releases, as well as new insights and updates from the UFS community. Innovators are also highlighted, acquainting the community with those involved with UFS and their success stories. Readers can find resources to get code, as well as links to webinar series and training. In addition to GitHub forums and FAQ pages that are managed by the EPIC team, there are also UFS Steering Committee open meetings every month. Past events include UFS application training and presentations at conferences such as the American Geophysical Union (AGU) and the American Meteorological Society (AMS) annual meetings. The outreach and presentation at meetings are great for those attending, but it is important to connect with those not attending large conferences. UIFCW is the largest

community event to bring together the UFS community and have open discussions, present research, and increase community engagement.

Social media engagement is increasing. According to the metrics retrieved from the EPIC website, EPIC's presence on "X", a platform formally known as "Twitter", increased from 765 followers on February 13th 2022, to 1,207 followers on June 28th 2024. This shows the importance of a growing social media presence. As engagement increases from followers, there should be an increase of engagement from the EPIC side. For the UFS community, increasing social media engagement will increase student participation, especially for those who may not have exposure to large conferences. Current social media users with wide networks on different platforms can promote the UFS and its outreach activities, such as UIFCW and UFS Insights releases. Social media outreach is not restricted to individuals, but extends to organizations as well. For example, The American Meteorological Society Board of Student Affairs (AMS BOSA) has an active social media presence, including interactions with student chapters at universities. Collaborating with well established groups will reach students easier rather than solely posting on EPIC social media accounts. The organizational accounts reach an audience of over 1,000 accounts on average.

The implementation of the UFS Student ambassador program, will lead to increased student engagement. With an ambassador program, students at various universities will be able to share their knowledge and experience with the UFS. University ambassadors, such as researchers or professors, may be more successful recruiting other students to join the UFS community. Like mentioned in the student survey, ambassadors are not required to commit to a lot. Their main goal is to be a personal connection and facilitator for UFS engagement with their peers and universities. The creation of a widespread ambassador program expands the network of students involved. Students would be able to connect their university with the program, promoting the UFS modeling system to professors that may be interested in using it in their research and classrooms.

Another recommendation from the Student Ambassador is the implementation of a UFS lesson plan. Even though changing university requirements and courses is difficult, a UFS lesson plan can be created. One program that some universities and K-12 programs utilize is the [Cooperative Program for Operational Meteorology, Education and Training (COMET) MetEd](#)

program, which is populated and maintained by the University Corporation for Atmospheric Research's (UCAR's) Community Programs. Professors have utilized this resource to supplement their lessons in the classroom and laboratories. This is just one example of a program that would support lesson plans that can be used in the classroom. Creation of a lesson plan that can be universally utilized in classrooms, not only limited to undergraduate students but K-12 as well, would increase students' knowledge of the UFS and the community-based modeling system.

A UFS lesson plan should include background information about Earth System Sciences so that students can understand how the technical knowledge fits with broader environmental issues. This ensures that students are not only learning how to code, but learning how to apply that code as well. For example, a lesson plan would greatly benefit from using real world case studies in a tutorial. Those in academia have expressed interest in the UFS and introducing it to their students, but want a way to do that. Having a UFS lesson plan would complement already existing training materials offered on the ECP. A lesson plan would be beneficial for those in K-12 as well, introducing students to numerical weather prediction and meteorology before they begin courses at a university. This would not only expand the UFS community, but also get feedback on the UFS usability at all experience levels. Targeting these students increases their presence in the community, focusing on one of the main goals of outreach.

Survey Data - UIFCW 2024 Academia Survey

In the 2024 Academia survey, student and academic experience was gathered. The survey was sent to registered academic UIFCW participants at the end of the workshop getting new feedback about their experience at the workshop, as well as with the UFS community. A common theme throughout respondents was their background. Those responding came from either a data assimilation, meteorology, or earth sciences background. The majority of respondents attended the workshop in person. The following information was taken from the previously mentioned UIFCW 2024 Academia Survey:
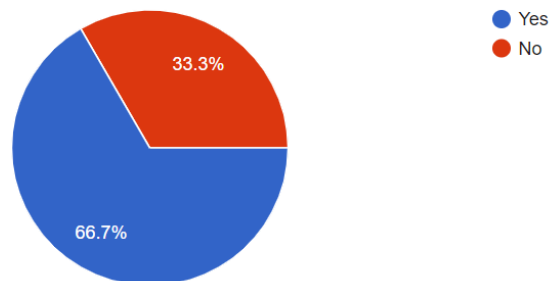
How did you attend UIFCW24?

25 responses

- In-Person
- Virtual
- Hybrid

52%

44%
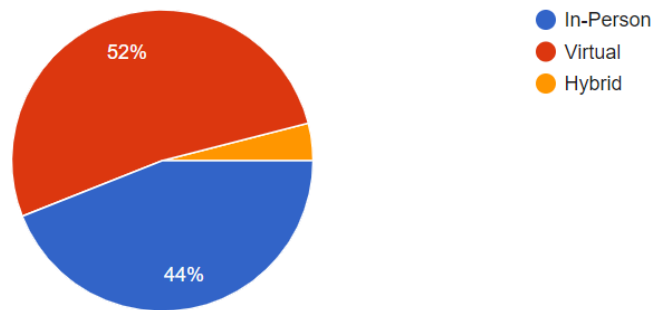
Would you be interested in participating in the planning process for future Academic Planning for UFS Outreach and Education?
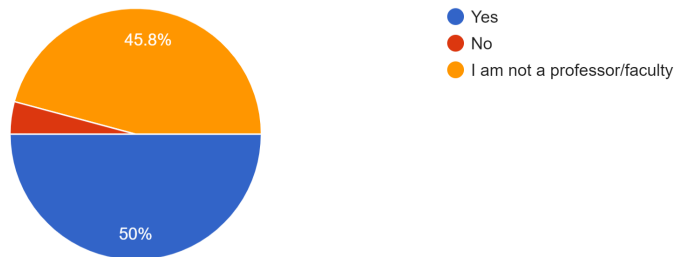
24 responses

- Yes
- No

33.3%

66.7%

Are you interested in becoming a UFS Student Ambassador?   Description: UFS Student
Ambassador   As a student ambassador for the Unifi...out with more information if you are interested.
24 responses

- Yes
- No
- I am not a student

62.5%
25%
12.5%
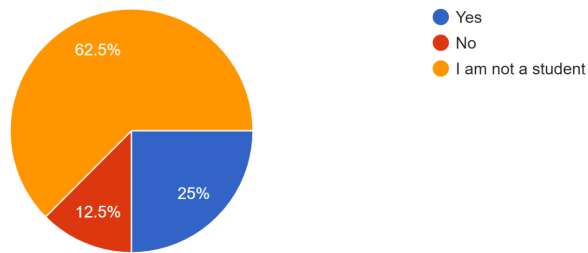
If you are not a student, would you be interested in being a UFS Supporting Faculty Member?   We
will reach out with more information if you are interested.
24 responses

- Yes
- No
- I am not a professor/faculty

45.8%
50%

In response to how surveyors currently use the UFS in their academic setting, there was a common theme that some do not currently use the UFS but wanted to learn more for future use or research. Some responses included that they attended the workshop to just be exposed to the field. Other responses included that they were presenting work they have done to help improve the model. These anonymous responses include:

"To get updated about the latest developments in this area…" -Anonymous

"I attended to present the work our group has done in helping to improve the model and also to discuss how better to facilitate use of the model by the academic community." -Anonymous

"... get a clearer sense of what is needed for me to transition to UFS from WRF" - Anonymous

13

"I work on a NOAA project with UFS and JEDI." - Anonymous

When asked about recommendations for increased academic engagement at UIFCW each year, surveyors had recommendations including increasing interactive engagements, more representatives from academia in panel discussions, as well as a student tutorial session for running a UFS application. Example of these anonymous responses are included below:

"One idea could be having a student tutorial session where students get a walk through on how to run a specific model. This would be super helpful because, in my experience, when I have attended tutorials they are a bit over my head, and I'm hesitant to ask questions I may have."
-Anonymous

"A hands-on training for installing and building the model on laptops/linux clusters would be very interesting and useful. It would also be a good test of the ease-of-use of the system, a "usability test" in place of the now-deprecated 'graduate student test'." - Anonymous

Most of the uses of the UFS from academia included those using the UFS in their research or for validation. This further solidifies the importance of including students and academia in UFS engagement, as their work using the application in different research topics and projects will expand the UFS development and innovation.

When asked about their interest in a "roadshow", which would potentially include live demos, a background, and a history of the UFS, those responding expressed great interest in a live demonstration with trouble-shooting guidance. Some different ideas included:

"I think a university roadshow should focus on answering the "Why?" and "How?". Why should I switch from my current tool and use the UFS instead? How do I get the code and set up an experiment?" - Anonymous

"It would be great if we had a python package like thing that can be introduced to undergraduates to try out UFS!" - Anonymous

There is interest in in-person lab training with case studies, as well as online modules to supplement them. One response showed interest in hybrid engagement.

"I think initially it will require some in-person training sessions until there is a sufficient critical mass of professors and students who can use the model to make use of the UFS self-supporting and self-propagating" - Anonymous

"I like to teach it in my classroom." - Anonymous

Two thirds of participants indicated interest in being involved in the planning process for future academic planning for UFS Outreach and Education. This is not restricted to just students, but all those who identify as academia. Of the students' responses, two-thirds of the students indicated they were interested in becoming a UFS Student Ambassador, serving as a liaison between the UFS community and academia. Out of the non-student responses, 92% showed interest in being a UFS Supporting Faculty Member. These results show the great interest from academia in immersing themselves into the UFS community, improving their knowledge of the UFS, and how they can incorporate it into their research and universities.

Student Ambassador Recommendations

After research, focus groups, and analyzing survey data from UIFCW participants, there are some main recommendations from the UFS student ambassador. These include:
- Establishment of a UFS Lesson Plan
- More interactive engagements, including a Student-Specific Tutorial
- Trainings paired with online modules
- Updating and improving a Frequently Asked Questions page on the EPIC Community Portal, as well as Github
- Increased social media engagement to promote online modules, community events, and trainings

Summary

With extensive research and qualitative data received from student and academic outreach, new recommendations, as well as updates to existing recommendations from the inaugural Student Ambassador, provide new perspectives for increasing student and academic engagement. These updates and recommendations were provided through collaboration efforts between the UFS Student Ambassador and the EPIC team. These recommendations will assist continued efforts towards establishing the UFS community and increasing student and academic engagement.

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