The vision of AI2ES is to create trustworthy Artificial Intelligence (AI) methods for diverse environmental science (ES) users that will revolutionize our understanding and prediction of high-impact atmospheric and ocean science phenomena and create new educational pathways to develop a more diverse AI and environmental science workforce.

AI2ES News

Edited by Jayne-Marie Linguist, Raven Reese, Dr. Amy McGovern, and Mel Wilson Reyes

June 2024 Edition
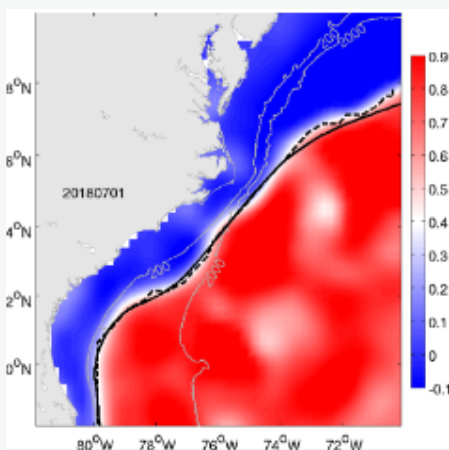
Gulf Stream Position Tracking model

North Carolina State University

North Carolina State University (NCSU) is located in Raleigh, North Carolina and is home to approximately 25,000 undergraduate students. NCSU was founded in 1887 under the 1862 Morrill Land-Grant Act. Their colors are red and white and their mascot is a wolf. According to their website, NCSU "...offers more than 100 undergraduate majors and more than 200 master's and doctoral programs" (ncsu.edu). The university is a leader in many research endeavors with an annual research expenditure of over $583 million.

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NCSU has been an integral part of AI2ES as one of our core academic partners since the institute's inception. Dr. Ruoying He, a co-PI of AI2ES, is the Director of the Ocean Observing and Modeling Group at NCSU, managing multiple postdoctoral researchers who conduct oceanographic research for the AI2ES "OceanNet" project. Dr. He is a Goodnight Innovation Distinguished Professor in the Department of Marine, Earth, and Atmospheric Sciences; his research interests include (but are not limited to) satellite oceanography, coastal ocean observations, remote sensing data analyses, and the development of ocean circulation prediction models. In addition to his roles at NCSU, Dr. He is an editor for the American Meteorological Society's Journal of Artificial Intelligence for the Earth Systems (AIES).

For the OceanNet project, Dr. He and his group focus on numerical modeling, coastal circulation dynamics, marine physical-biogeochemical interactions, air-sea interactions, satellite oceanography, data assimilation, coastal ocean observing systems, and finally, AI and machine learning systems. Their extensive research in these areas allows the team to create products that track and monitor current issues in the field of oceanography. For example, one product of the OceanNet project is the Gulf Stream Position Tracking model (seen in the figure on page 1). According to their website, the Gulf Stream Position Tracking shows "the position of the Gulf Stream off the U.S. east coast varies according to large-scale oceanic conditions." The Oceanet team also provides weekly forecasts of harmful algae blooms tailored to the Gulf of Maine.
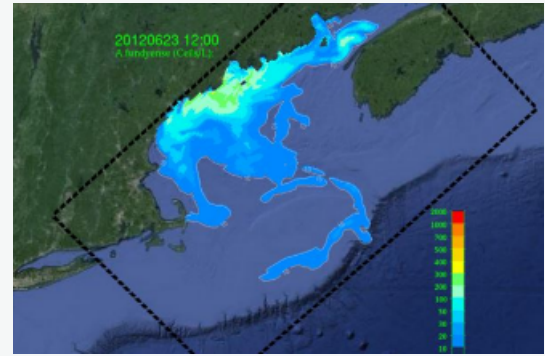
Harmful Algae Bloom (HABs) model

Dr. He also works with several students and postdoctoral researchers at the Ocean Observing and Modeling Group (OOMG), the predecessor to NCSU's OceanNet project. Two of Dr. He's team members, Tianning Wu and Anna Lowe, serve individual roles in the OOMG project and have contributed their prior research to the development of the OceaNet model. As a successive model from the OOMG team, Lowe explains "the OOMG team has built a machine learning model called OceanNet that predicts the ocean sea surface height (SSH) field into the future. One of the advantages of this model is its simplicity and flexible framework with lots of room for continued development. The CNAPS ocean reanalysis encompasses the western half of the Atlantic Ocean and has 30 years of model output of several oceanographic variables that could potentially be used for input eventually."

The Coupled Northwest Atlantic Prediction System (CNAPS) is a three-dimensional marine environment nowcast and forecast model. CNAPS includes ocean circulation, wave, and atmosphere modeling system predictions from Nova Scotia down to the Caribbean Sea. CNAPS creates maps of these predictions, separated into three sections:
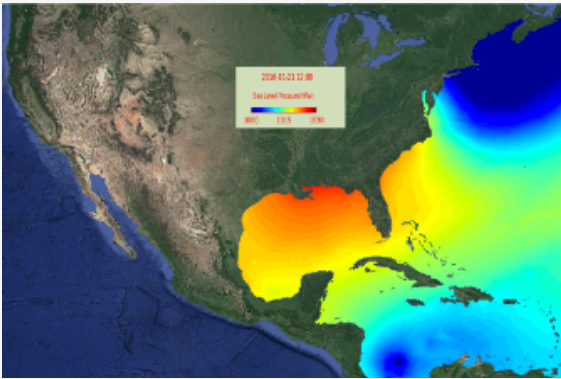
Coupled Northwest Atlantic Prediction System (CNAPS)

marine weather, ocean waves, and ocean circulation. User-friendly research products like CNAPS allow for a wide-array of consumers to understand the predictions, apply them to their own work, and effectively "take on the role of oceanographer, by collecting model-generated data" (oomg.us). Lowe emphasizes that this machine learning model of OceanNet and its variant products have been created collaboratively throughout the OOMG team. Wu and Lowe highlight this collaboration through their own work on the project; in development of OceaNert, for example, Lowe will use reanalysis created by Wu to then create the machine learning model. Then, Lowe and other OOMG team members analyze the output of the machine learning model from five days and use the analysis to generate another five-day output as far out as 120 days in the future.

OceanNet Team

Dr. Ruoying He - Principle Investigator, oceanography and numerical modeling expert with insight on how to improve the model, analyses, identifying where it is performing poorly

Ashesh Chattopadhyay - Assistant Professor UCSC, collaborative machine learning expert, built the FNO model and testing the model

Michael Gray - just finished his Masters degree, he has written most of the code to tweak and improve the model architecture, hyperparameter training, etc.

Tianning Wu - PhD Student, he has run the CNAPS ocean reanalysis, which is used as input to the OceanNet machine learning model.

Nazanin Chaichitehrani - Researcher, she has built a machine learning model for waves, separate from OceanNet

Anna Lowe - Post Doctoral Student, she tested the OceanNet models to determine the best rendition, and performed most of the analyses of how the model performs from an oceanography perspective.

OOMG and AI2ES

he team at OOMG works closely with the Risk Communication team at AI2ES. Lowe explained that she, Wu, Gray, and others researchers collaborate with the Risk Communication team to develop "interview protocol for forecasters working in the oil and gas industry to identify parts of the model, statistics, and display methods that are most beneficial to their usage, and those that are not. The results from these interviews will provide feedback as we continue building the next version of the model and building useful tools that forecasters may use in the future." Additionally, the team collaborates and networks with other

AI2ES members at seminars and presentations to receive feedback on their machine learning models. Lowe notes that "it is helpful to have a built in network of machine learning experts, environmental science domain experts, computer scientists, and industry professionals that are willing to help one another and interested in different types of research applications.""

Post-Doc Journey

Tianning Wu began working on his numerical model at the beginning of his PhD studies and was invited by Dr. He to apply his experience to the AI2ES research. The research Wu conducts is on the cutting edge of AI sciences, which interested him to continue his work on OceanNet. For post-doctoral researcher Anna Lowe, she met Dr. He at a conference while finishing her PhD. At the time, Lowe was also working with numerical models and took a similar interest as Wu in Dr. He's lab. Like Wu, Lowe was fascinated with the new, up-and-coming research offered by machine learning and was excited to branch into new research endeavors.

When asked about advice that they would give to undergraduate and graduate students as well as fellow doctoral and postdoctoral researchers, Lowe and Wu both emphasized the importance of collaboration and making connections in the field. Lowe said it was important to "keep those connections warm and reach out to people." Wu

added that networking can also help people to find projects that they are interested in pursuing further in their career. Additionally, the two highlighted how important it is to expand your skill set as a scientist and researcher, never shying away from a pivot into new territories with their research. Lastly, Wu and Lowe shared their favorite memories while working with AI2ES. They shared fond memories in traveling to Belgium as presenters at the first international machine learning conference for oceanography. This opportunity gave Wu, Lowe, Gray, and Chaichitehrani a valuable opportunity to share their research across the globe, as well as the opportunity to hear what others in the field are doing and creating international network connections.

Dr. He's team attending the International conference on Machine Learning and Data Analysis in Oceanography at University in Liège, Belgium (from left to right): Dr. Roy He, Tianning Wu, Nazanin Chaichitehrani, Anna Lowe, and Michael Gray

Florida International AI/ML, Monitoring, and Modeling Workshop

On June 19th and 20th, our ExpandAI partners at Florida International University (FIU) held an AI/ML, Monitoring, and Modeling Workshop. The workshop was organized by ExpandAI Co-PI Jayantha Obeysekera, Director of the FIU's Sea Level Solutions Center, and his colleagues; the event was sponsored by the Institute of Environment (https://environment.fiu.edu/) Knight Foundation School of Computing and Information Sciences. TAMU-CC AI2ES Co-PI Dr. Philippe Tissot joined the FIU team alongside officials and scientists from the South Florida Water Management District (SFWMD), the Everglades Foundation, and NOVA Consulting. The first day of the workshop took place at the FIU International Center for Tropical Botany at The Kampong in Miami, a modern and beautiful facility with direct access to Biscayne Bay. The Kampong is also a historical estate of plant explorer Dr. David Fairchild. Talks included a welcome and overview from FIU's Director of the Institute of Environment, Todd Crowl, talks on AI/ML theory,

FIU workshop group The Kampong, home of the International Center for Tropical Botany and the historical estate of plant explorer Dr. David Fairchild. (Photo courtesy of Mike Sukop)

XAI, time series, and hurricane intensity modeling. Other talks included modeling of sea level variability, climate models downscaling, and a presentation of FIU's Institute of Environment saltwater intrusion monitoring network by Mike Sukop. One of the foci of the workshop was coastal inundation and the potential of AI/ML to predict and gain insights into the growing problem of compound flooding events. Miami's broad urban expense, the dynamic of its karst aquifer, intense precipitation events, and proximity to the ocean, all make it a perfect and impactful location to study compound flooding. It was also great to see again several members of the FIU team who had participated in our AI2ES day at AMS in January and it was a pleasure to meet many new partners.

The second day of the event was focused on visiting coastal and compound flooding sites, including locations that had seen over a foot and a half of flooding just a week before the event. Locations included a canal and salt water barrier near FIU, a pump station and a groundwater monitoring station in Hallandale Beach, and ocean/bay locations on Miami Beach. This visit highlighted the importance of pump station networks to help mitigate the impact of compound flooding events at all the visited locations, including the highly-frequented Miami Beach. The availability of data from the pumps and canal gates will be important to set up the models, and interactions and discussions with onsite experts from the different agencies were both valuable and enjoyable. Thank you FIU and ExpandAI partners for a great workshop!

Del Mar College Summer CODE IT Camp

During the weeks of June 17 and June 24, our AI2ES colleagues at Del Mar College organized their summer CODE IT camps. The first camp is directed towards beginners at coding and robotics while the second week is for more advanced middle schoolers including participants in the first week's camp. Korinne Caruso, Dara Betz and the Del Mar team have been organizing these high impact events for several years. For the third consecutive year, the Wednesday session of the advanced camp invited AI2ES student researchers and included presenting and participating in the AI2ES site-wide meeting.

Campers and AI2ES undergraduate researchers spent most of the day together working on solving problems and interacting with the young, aspiring computer scientists. Sandwiches from an excellent local restaurant put a smile on everyone's face and made sure the audience was ready for the following presentations:

- **Anointiyae Beasley** - Semaphore: a software to operationalize AI models

- **Brian Colburn** - Update on VAE coastal fog prediction models for R2O

- **Felix Fuentes** - Plans for a compound flooding model for Corpus Christi, Texas

- And selected robotics/coding demonstrations from campers

The campers asked several questions to the AI2ES researchers, along with online questions from AI2ES researchers. Students were impressed that the presentations garnered an audience from all over the country: Seattle to Norman, Boulder, Fort Collins, Albany, Massachusetts, and even an international attendee from Spain.

The site-wide meeting was followed by a discussion between the campers and undergraduate researchers, animated by Professor Caruso. Campers asked about how and when the AI2ES student researchers choose their majors and their career directions. Other parts of the discussions focused on programming languages and how to best prepare oneself for a college career. A word of wisdom offered to the campers: "undecided" majors are typically not the recipient of scholarship, so committing to the direction you like the most and seeking financial aid is a great first step. In the end, students can always change their major if their initial choice was not the right fit. The day finished with a discussion between DMC organizers, TAMUCC faculty, students, and their camp mentors. Several are interested in doing research with AI2ES and a visit to TAMU-CC is already in the works. Anointiaye Beasley, one of the presenters, was in a great position to share her experience as she was a prior camp mentor, a former DMC student, and now a TAMU-CC undergraduate researcher. Everyone is looking forward to what next year brings to both DMC and AI2ES as a collaborative force for the youth of Corpus Christi.

More Photos from This Month...

Miami Beach viewed from South Pointe Park Pier, visited as part of the field trip. (photo courtesy of Philippe Tissot)

Storm Water Pump Station 3 which was heavily used during the week of June 10 floods in Hallandale Beach, FL (Photo courtesy of Mike Sukop).

Post FIU workshop relaxation on the water (left to right): Drs. Leonardo Bodadilla, two enthusiastic PhD students, Todd Crowl, and Wenquian Dong

CODE IT campers and AI2ES undergraduate researchers attending the AI2ES sitewide meeting at Del Mar College.

Camper Evelyn Nanez-James is demonstrating and explaining how she coded for her robot to go through a small obstacle course.

Anointiyae Beasley presents the recently released Semaphore software to speed up the deployment of AI live predictions.

To view recordings for past Site-Wide meetings, please visit:
https://www.ai2es.org/publications/ai2es-talks/