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 Raven Reese, Dr. Amy McGovern, Mel Wilson Reyes, and Dr. Philippe Tissot

October 2024 Edition

Mel with Dr. Andrew Fagg, Dr. Dimitris Diochnos, Dr. Chris Thorncroft, Dr. Scott King, and Dr. Nate Snook at a proposal meeting in Norman Oklahoma, May 2024

Introduction

This month, AI2ES is excited to introduce two members to our team through individual spotlight articles! One familiar face, Mel Wilson Reyes, rejoins the institute as Project Manager after graduating with her M.S. in Computer Science from OU and venturing out into a federal position. As well, long-time collaborator and associate professor at Central Michigan University, Dr. John Allen, brings his climate expertise and his management experience to AI2ES as Associate Director.

To celebrate the finalization of this year's annual review, PIs from across the institute have provided a list of "AI2ES

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Nuggets" to help summarize our work throughout the first four years of AI2ES. Thank you again to Mel, Dr. Allen, Dr. McGovern, and Dr. Tissot for all of your contributions to this newsletter edition.

Mel Wilson Reyes, Project Manager

Introductions are never an easy social maneuver; this is why AI2ES is excited to welcome back a close acquaintance that we already know well, Mel Wilson Reyes, to the newly-created Project Manager role! Many of our members have either collaborated with Mel during her time as a Graduate Research Assistant at the University of Oklahoma (OU), or learned about her research at events such as AMS. While completing her M.S. in computer sciences, Mel was recommended to join AI2ES under Dr. Andrew Fagg. She used her time as a GRA to develop a deep-learning model that measures atmospheric visibility based on camera images taken from Mesonet and New York Department of Transportation data. This project soon became the focus of Mel's thesis, and even after her graduation, she is excited to see that the torch of her work is carried by REUs and Undergraduate Research Assistants at OU's lab. However, the end of her academic career offered many prospects outside of AI2ES, and Mel wanted to try her skills in a federal research atmosphere. She advanced to the position of Data Scientist at the National Security Division of the Pacific Northwest National Library (PNNL), building models for national security applications covering topics such as authorship attribution, object recognition, and image/audio geolocation. . In her time at PNNL, Mel found that her colleagues were "really impressed" with her intimate understanding of "all levels of the project pipeline", a dedication to the machine-learning construction process that she credits AI2ES for providing to her during her master's experience. Though Mel was slated for a promotion in her short time at PNNL, there were certain needs or aspirations that left her looking for a change of direction.

"I was working in a highly-technical role; I really enjoyed aspects of my technical work, but I wanted something a little bit more broad, where I can be a part of a long-term vision, planning and supporting our mission from an organizational standpoint." While looking for new jobs, Mel found our opening for Project Manager at AI2ES; though she initially felt under qualified for the position, it was once again Dr. Fagg who encouraged her to rejoin AI2ES. After the standard hiring process, Mel returned to the institute at the end of January, 2024! Nine months in, Mel is glad to say that this

role allowed her to "grow in areas that (she) didn't have the opportunity to grow" in during her independent post-graduate work. As Project Manager, Mel is responsible for bringing in new projects, sponsorships, writing proposals, and applying for external funding. "I support all of the PIs, but I interact mostly with Amy (McGovern). Anything that needs to be done that I can do, I work on." Recently, Mel focused her efforts on delegating sections of the Annual Review to different labs and developing the next renewal proposal alongside Dr. McGovern and another new member of the team, Associate Director Dr. John Allen. The nature of this new position "provided (Mel) with freedom in investigating what (she) want(s) to do going forward," so even though she is beholden to the PIs and Dr. McGovern, Mel too has a say in the direction of AI2ES after working to bolster the institute's research throughout her educational journey. In the future, she may even be able to return to her research with the visibility team as a mentor during their continuation of the project. She is also enthusiastic about AI2ES's "broadening participation in workforce development" as a former GRA and now adjunct professor at Oklahoma City Community College. As she takes on new skills back at AI2ES, Mel is thankful for leaders like Dr. McGovern, who has encouraged her to explore every avenue that she may pursue next in her Project Manager role.

For students soon to graduate and enter the workforce like Mel, a great piece of advice that she offers is to never "be afraid to reach out to new collaborators within AI2ES; if you have an idea,

please share it!" This is not simply another aphorism to take lightly, as it is based on her own academic experience while working as a GRA: "As a grad student, I worked primarily with OU and UAlbany because we were collaborating on the winter weather project. Something that I wish I did more was to reach out to other research groups to understand what they were doing, and see if we could collaborate." She now has plenty of opportunity to do so as Project Manager, however, these connections could have only better prepared Mel for every research opportunity inside and outside AI2ES. It is never a waste of time to learn about your colleague's research, and can only work to expand a student's web of connections in preparation for the workforce. Once graduated, "pull on your network! If you're looking for a new job, reach out" to the people that you've spent the majority of your academic research career with at AI2ES. It's one of the endless benefits of a student's time at the institute, and can only serve to elevate them to roles unimaginable, with Mel's story as real-world example. Thank you so much, Mel Wilson Reyes, for reintroducing yourself to the team; we look forward to working with you again!

Click here to visit Mel's bio on the Team page

Dr. John Allen, Associate Director

Along with the reunion of Mel to the AI2ES team, we are excited to welcome a new face to the "Team" page at www.ai2es.org, Dr. John Allen of Central Michigan University (CMU)! Dr. Allen joins AI2ES as Associate Director, after years of collaboration with OU students and faculty on individual research pursuits and as an AI2ES partner. Dr. Allen began his fascination with meteorology as a child in Sydney, Australia: "I've always been a diehard weather nut." While attending the University of Melbourne, Dr. Allen discovered that his interest in severe weather events, such as Sydney's frequent hail storms, is shared amongst the researchers in the university's meteorology department. He graduated with a double major in meteorology and statistics/applied mathematics, earning a qualifying GPA for the university's straight-to-PhD track. In this program,

Dr. Allen found a home in the meteorology field, studying severe thunderstorms and climate change across Australia as a whole. This led him to work with "big data sets, statistical modeling, linear discriminant analysis," and other variables that would now be considered foundational elements of machine learning. After completing his academic ventures, Dr. Allen moved to the U.S. to pursue his postdoctoral period at Columbia University under Dr. Michael Tippett, Associate Professor in the Department of Applied Physics and Applied Mathematics. Finally, after establishing himself as a well-studied and knowledgeable researcher in the field, Dr. John Allen landed at Central Michigan as a faculty member, and is now an Associate Professor of Meteorology, and a former Director of the Earth and Ecosystem Science Ph.D. Program. Projects that Dr. Allen leads at CMU focus on research applications to severe weather prediction, the relationship of severe weather to the climate systems, and engineering resilience in disseminating climate information through design codes and other means to increase stakeholder engagement.

In his own work, Dr. Allen sees the value of AI to both simplify some of these efforts, and allow researchers to look deeper into the data sets that they use to design their research. "I very much think that a lot of what we can do with AI is going to change the face of what we think about in terms of atmospheric science and climate science." Before joining the team, Dr. Allen collaborated with other members and was funded through NOAA JTTI, a research grant with AI2ES's Dr. Amy McGovern, to study the prediction of fronts using AI. His background with the institute, including co-advisory

roles with OU students Andrew Justin and Tobias Schmidt, prompted Dr. Allen to join as soon as the time was opportune; as of September 1st, 2024, that time has lined up well for him to come aboard! As Associate Director, Dr. Allen is tasked to "support the director and leadership team in thinking about things across the institute." One potential use of AI that Dr. Allen brings to the table at AI2ES is how researchers can use the tool to better understand their "mean" value of weather predictions. "I'm interested in how we use AI to break that apart and start asking questions of what are the nuances, or what are the things that we are missing? Are there things that we are limiting ourselves with by trying to do it all at once?" Though he offers many new applications of AI to the institute, Dr. Allen also recognizes the important endeavors already in the works here at AI2ES, such as the potential to infuse AI into educational pedagogy. "How we prepare people to handle what the world looks like is a great challenge, and it's one of the things that really impresses me about AI2ES." At his home institute, CMU also values the applicability of technical skills outside of the classroom, so collaborations with different institutions (such as the partnership of Del Mar College and Texas A&M University - Corpus Christi) is "something that really excites (Dr. Allen) about AI2ES: finding ways to bridge those divides and to bring a more diverse scientific group to achieve different perspectives."

The Associate Director role, much like the newly-established Project Manager role, affords Dr. Allen many privileges outside of an enclosed academic setting. For one, the wide reach of AI2ES allows

for connections to researchers across the country. "I am looking forward to building collaborations across this space. AI2ES is not just what is funded under the institute, but it's thinking about what the future of AI within the environmental sciences and earth sciences is; there is a lot of opportunity to learn as a leader through experience and watching others." Though he flatters us with his praise, Dr. Allen is well-equipped to bring new directions to AI2ES as Associate Director. During the first phase of his role, Dr. Allen will lend his expertise to the convective research team and focus on assisting both Dr. McGovern and Mel on drafting the next renewal proposal. However, he "would very much value hearing different people's opinions. One other part of the Associate Director role is being another point of contact: another person where we can have those conversations about what people view as a way forward." Dr. Allen encourages you to reach out to him through email, as his "door is always open!" Thank you again, Dr. John Allen, for introducing yourself to our team. AI2ES is excited to learn from and alongside you as you settle into the role of Associate Director!


Click here to visit Dr. Allen's bio
on the Team page

AI2ES Nuggets

In honor of the many AI2ES achievements during our first four years, we started collecting descriptions of our institute's achievements in the form of "nuggets." If any AI2ES members would like to share their accomplishments over these past four years, please submit them to the Google Form below with a brief "nugget" or description; no nugget is too small!

During its first four years AI2ES:
- created a convergent team across AI, RC, and ES that include end users and demonstrate the power of convergent science to tackle complex environmental problems and for making fundamental new contributions
- Convergent Science: new ways of thinking about trustworthy AI, best practices for creating convergent AI teams, best practices in ethical and responsible AI for weather
- helped to create a new research area of ethical and responsible AI for weather and climate
- created new approaches to understanding trust in AI for weather and climate
- deepened understanding of how to best apply XAI methods to ES phenomena and developed new XAI methods tailored to ES
- developed a data-driven model for ocean waves and circulation
- developed novel approaches to quantifying and communicating uncertainty
- demonstrated how physics-based knowledge can be used to create more trustworthy AI
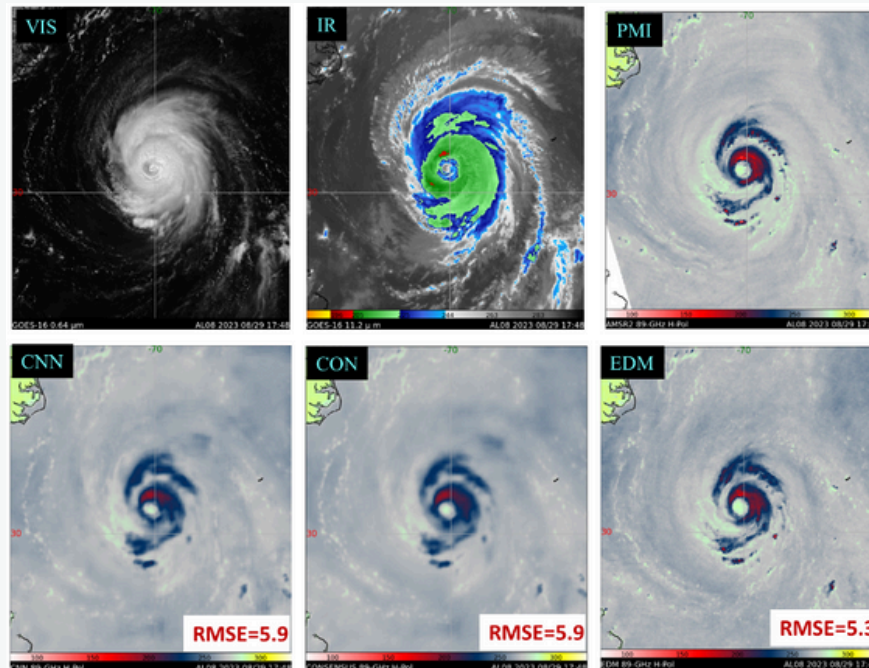
Comparison of visible, infrared, AMSR2 89 GHz, CNN, CON, and EDM for Hurricane Franklin (AL082023) on August 29, 2023.
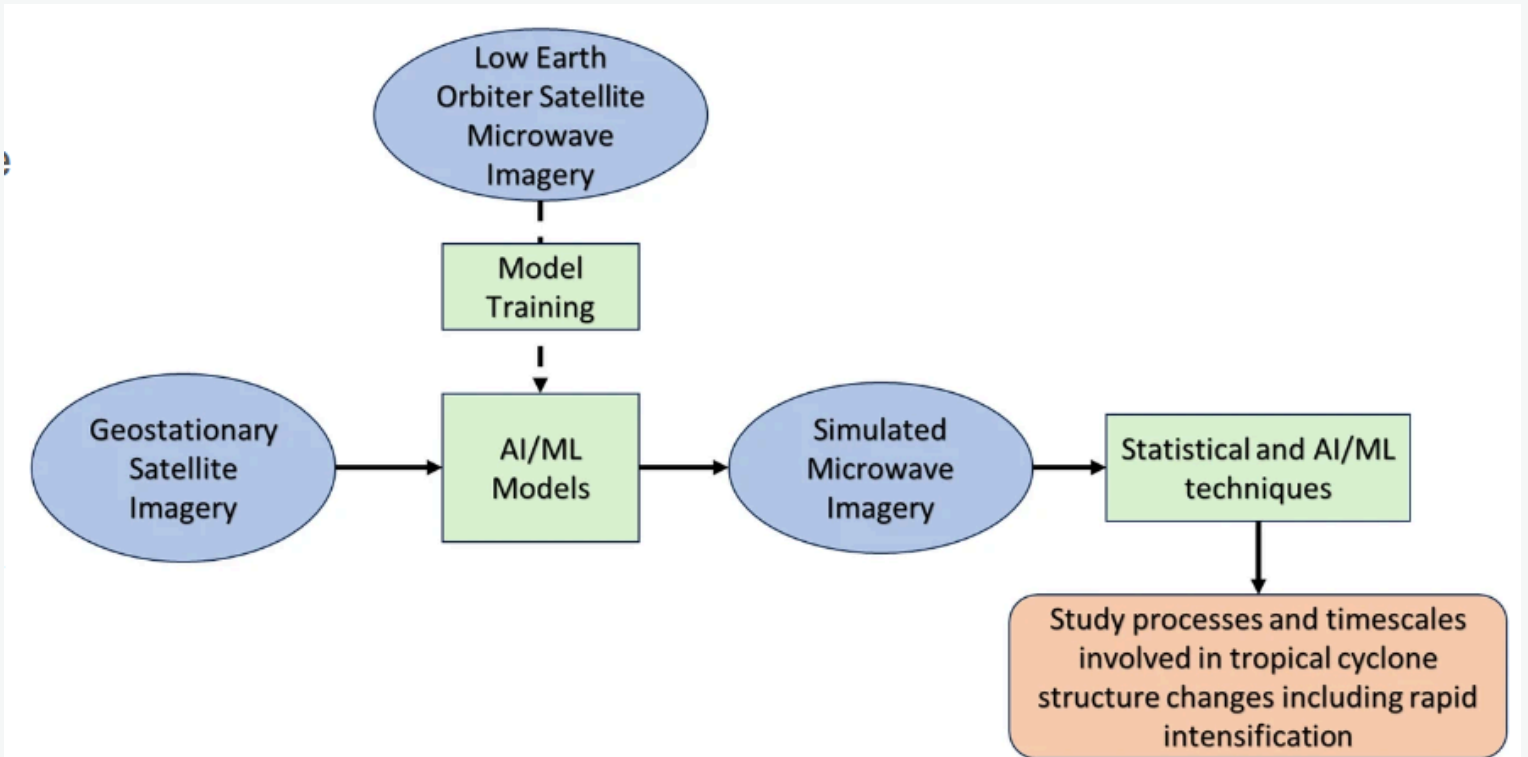
Process for creating new data to improve the study of tropical cyclone intensification

AI2ES's impacts as a Nexus:
- researchers from around the globe seek AI2ES out to improve their research
- over 70 highly cited papers across AI, ES, and RC
- several hundred talks, including many invited talks
- strong partnerships across agencies and sectors
- creation of a highly impactful journal for researchers working at the intersection of AI and geosciences

AI2ES fundamental contributions in
- Foundational AI: new XAI and IAI models, integration of physics into ML methods, development of best practices for AI for ES, uncertainty quantification methods
- Foundational RC: new understanding of trust in AI, new approaches to understanding trustworthiness
- Foundational ES: new approaches to understanding— convective weather including tornadoes, winter weather including road weather and visibility, tropical cyclones including rapid intensification, and coastal oceanography including ocean eddies, ocean waves, fog, coastal inundation

AI2ES established Partnerships:
- 8 academic institutions including 2 R2 and ERI, 2 HSI/MSI, and 1 community college
- 10 private industry partners
- 1 FFRDC partner (NCAR), and 2 government collaborators (NOAA, NIST)
- 2 ExpandAI partners (FIU, SDSU)

AI2ES contributions to education, broadening participation, and workforce development:
- created one of the nation's first community college AI certificate and graduated several cohorts of students from the program
- created an original integrated pipeline from community colleague to research universities and internships for improving diversity in AI for ES
- , tutorials and work-shops on AI for ES
- developed an integrated pipeline from community college to university and the workplace to improve diversity in AI and ES
- published multiple high-impact tutorials and held two large summer schools in AI for ES
- Researchers and educators supported: 24 faculty partially supported, 12 research scientists, 18 postdoctoral research associates, 36 graduate students, 68 undergraduate researchers and REU students

Knowledge transfer outcomes:
- published over 70 papers in high-impact journals and conferences
- developed tutorials and work-shops on AI for ES
- transferred several models to operation to industry partners including a model to delineate frontal systems developed at OU and finalized at The Weather. Also transferred models to operation within AI2ES universities (several coastal inundation models and cold stunning model).
- developed a software, Semaphore, to streamline and speed up the transition from AI academic models to real-time prototypes for stakeholders and to facilitate convergent efforts
- operated live AI models used by stakeholders such as the TAMUCC model predicting the onset and duration of cold stunning events and
- over 27 students at TAMUCC alone participated in internships at other universities, in the US and overseas, government laboratories, and industry partners providing two way knowledge transfer
- active GitHub repository to share code to others

We are particularly interested in additional nuggets you may think of for:
- potential new science understanding,
- did we transfer other models into operations at industry collaborators, NOAA or universities?

We look forward to hearing more from AI2ES members across each partnered organization! To submit your own "Nuggets" to the next edition of our newsletter, please fill out the Google Form linked here

AI2ES Graduations

Finally, we would like to congratulate many AI2ES students for their completion of a degree program in the last year:

Andrew Justin graduated with a M.S. in Meteorology (chair Amy McGovern), and continues to research with AI2ES as he pursues his PhD in Meteorology.

Dr. Stuart Edris graduated with a PhD in Atmospheric Sciences and Meteorology, and is working under Dr. Amy McGovern as a postdoctoral researcher.

Dr. Amanda Burke graduated with a PhD in Atmospheric Sciences and Meteorology (chair Amy McGovern).

Dr. Bethany Earnest graduated with a PhD in Computer Science (chair Amy McGovern) and is working at Atmospheric G2.

Dr. Marina Vicens-Miquel graduated in the spring with a PhD in Geospatial Computing Science from Texas A&M University-Corpus Christi (chair Antonio Medrano, Co-Chair Philippe Tissot) and is now working under Dr. Amy McGovern as a postdoctoral researcher at OU.

Dr. Jason Stock successfully defended his PhD in Computer Science (chair Chuck Anderson) from Colorado State University just a few days ago.

We had several undergraduate researchers graduate as well; congratulations to all! We are happy to still work alongside you as your journey through academia continues past this recent graduation.

AI2ES is searching for an awesome postdoc to work with us on AI and ethics issues related to weather and climate. We are looking for someone with a background in AI and weather/climate and a strong interest in ethics and risk management. Please apply here! https://apply.interfolio.com/151506

Don't forget to prepare for January 12th, 2025 for the next AI2ES @ AMS gathering in New Orleans, Louisiana!

We are planning to hold AI2ES@AMS 2025 on Sunday, January 12th at the National World War II Museum in New Orleans (approval pending). Details to follow!

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