

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, Dr. Amy McGovern, Dr. Philippe Tissot, Dr. Samuel Shen, Dr. Efi Foufoula-Georgiou and Jennifer Warrillow

## November 2023 Edition

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## National Science Foundation ExpandAI

Recently, AI2ES grew thanks to two new close partners' recipients of Expand AI grants from the National Science Foundation (NSF). The "PARTNER: Expand AI2ES for 4D Space-time Organization of Precipitation Processes and Extremes, Visualization Tools, and Workforce Development" and "PARTNER: An AI/ML Collaborative for Southeast Florida Coastal Environmental Data and Modeling Center" grants bring new collaborations with San Diego State University (SDSU), the University of California Irvine (UCI) and Florida International University (FIU), to increase AI and Machine Learning capacity at Minority-Serving Institutions (MSIs) and Hispanic-Serving Institutions (HSIs), enhance education in AI, and broaden the workforce.

This month, we focus on PARTNER: Expand AI2ES for 4D Space-time Organization of Precipitation Processes and Extremes, Visualization Tools, and Workforce Development which brings San Diego State University (SDSU) and the University of California, Irvine (UCI) to AI2ES. This partnership leverages pre-existing research at SDSU and UCI, expands the scope and scale of mentorship of underrepresented minority students, and creates new approaches to AI and environmental science research through collaboration.

### **San Diego State University**

SDSU is based in San Diego, California and was established in 1897. The university is a federally recognized HSI and has a student body of over 36,000. SDSU serves a diverse population of students of color, military members, and veterans and was ranked as a top college for LGBTQ+ students.

According to their website, "SDSU formally recognizes Native and Indigenous peoples as traditional stewards of the land on which our university resides, and respects the enduring relationship that exists between Indigenous peoples and their ancestral territories. At San Diego State University, we recognize the land as Kumeyaay." SDSU's colors are black and red. While the university does not currently have an official mascot, SDSU retains an Aztec identity and states that "The university continues to chart the path forward for SDSU's relationship and educational efforts with the historical and contemporary descendants of the Aztec people and the Aztec Empire."

### **University of California, Irvine**

UCI is located in Irvine, California, about 70 miles from SDSU. The university is both an HSI and an Asian American and Native American Pacific Islander-serving institution (AANAPISI). The university was founded in 1965 and today has more than 36,000 enrolled students and over 224 degree programs, including a joint computational sciences program with SDSU. More than 46% of its undergraduate students receiving bachelor's degrees are first generation students. UCI's colors are blue and gold and their mascot is Peter the Anteater.



# National Science Foundation ExpandAI

## **Florida International University**

FIU is based in Miami, Florida and is home to more than 56,000 students. FIU's student body serves a diverse community of students and is an officially recognized MSI. FIU was established in 1965 under Senate Bill 711 to construct a public research university in Miami using an abandoned airfield as its new location. Today, FIU has grown to be an R1 institution and is among the 10 largest universities in the nation, offering associate, bachelors, masters, and doctoral degrees on campus and online. Their colors are blue and gold and their mascot is Roary the Panther.



San Diego State University



University of California, Irvine



Florida International University



### **PI Samuel Shen**

SDSU Distinguished Professor, Co-Director of Center for Climate and Sustainability Studies



### **Co-PI Efi Foufoula-Georgiou**

Distinguished Professor & Henry Samueli Endowed Chair in Engineering

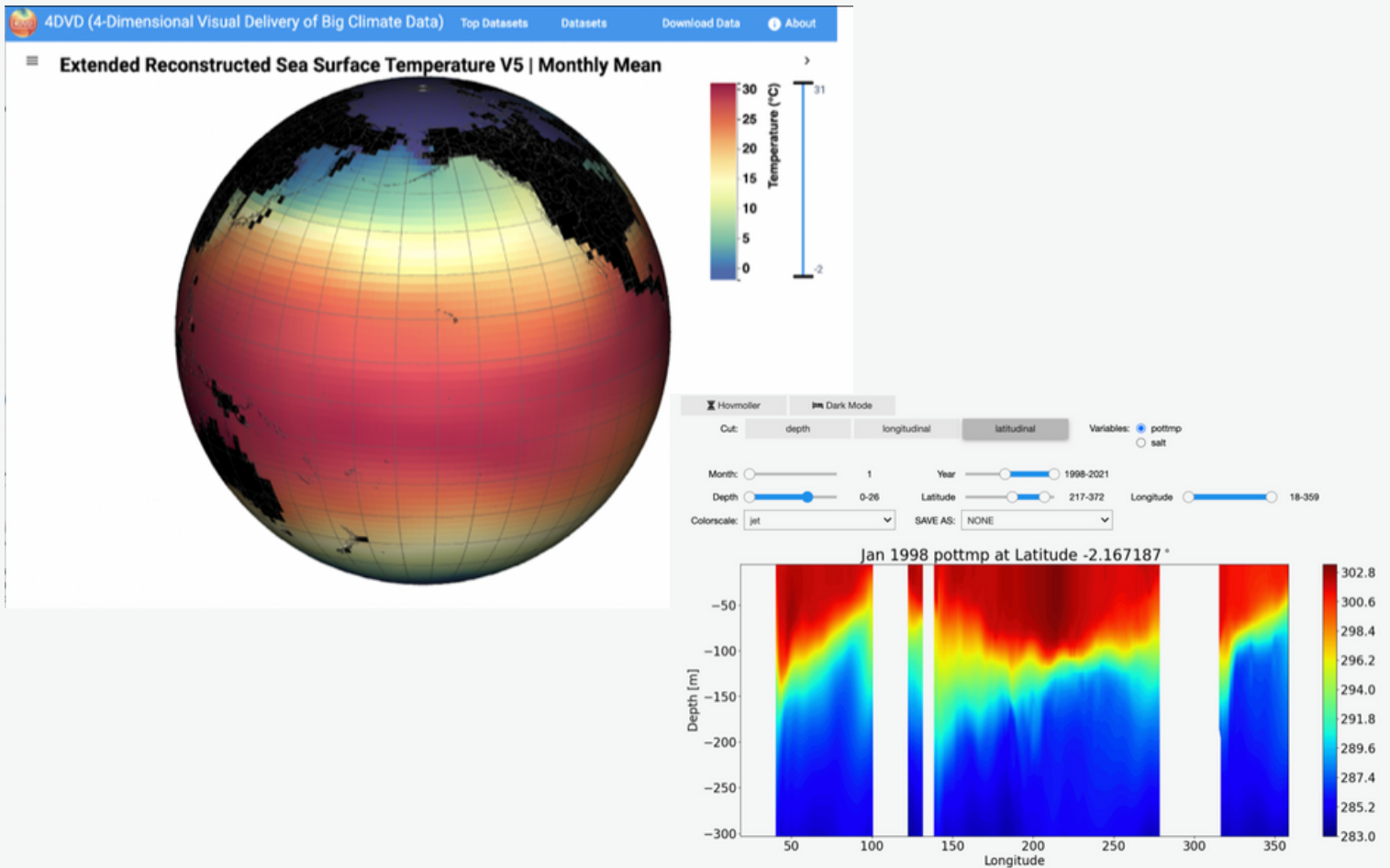


### **Co-PI Amy McGovern**

OU Lloyd G. and Joyce Austin Presidential Professor, Director and PI of AI2ES

## **PARTNER: Expand AI2ES for 4D Space-time Organization of Precipitation Processes and Extremes, Visualization Tools, and Workforce Development**

Called ExpAI2ES for short, this grant, led by PI Samuel Shen of SDSU and co-PI Efi Foufoula-Georgiou of UCI, will bring together SDSU and UCI in collaboration with AI2ES to enhance climate and precipitation research, support underrepresented minority and first-generation college students, and diversify the AI workforce. SDSU and UCI will be using several products from their labs and their joint computational sciences graduate program to support this project, including the 4-dimensional visual delivery (4DVD) software that allows users to view big climate datasets from 1851 to 2014 across the globe. PI Shen noted that 4DVD takes inspiration from the psychology behind video games and online shopping to attract users and keep them interested in using the software. ExpAI2ES will focus its research on exploring space-time organization of precipitation and other climate variables using AI and Machine Learning methods with an emphasis on weather extremes. ExpAI2ES will also collaborate with AI2ES, specifically the University of Oklahoma to research deep neural networks (DNN) for precipitation and extreme weather. The UCI team has extensive experience with multi-scale analysis of space-time precipitation fields and the development of advanced metrics for evaluating the performance of climate model predictions and satellite global precipitation products, as well as using these metrics for training AI algorithms. Other institutions at AI2ES will also collaborate with SDSU and UCI on explainable AI (XAI) techniques for their extreme precipitation research.





In addition to collaborative research with AI2ES, SDSU and UCI will continue supporting and mentoring underrepresented minority (URM) and first-generation students. SDSU and UCI have co-supervised multiple URM students who have developed research methods and products in PI Shen's lab. A student with whom Dr. Shen worked had attended an AI2ES Research Experience for Undergraduates (REU) program and used what they learned there to influence Shen's lab's research on ML for extreme precipitation and weather. With ExpAI2ES, SDSU and UCI will be able to expand their cohort of students to support nine additional URM students in their labs along with co-supervision by personnel from AI2ES. ExpAI2ES will also enhance existing products 4DVD and the Progressive Education for Atmospheric Sciences (PEAS) education program. 4DVD will be customized to AI2ES's needs and will produce more functions and data sets. The PEAS program, an existing collaboration between SDSU and UCAR, will add an AI component to the program, including an AI workshop. According to Dr. Shen, a large part of the PEAS program is its approach to education pedagogy. For example, Dr. Shen has written *Climate Mathematics: Theory and Applications* to introduce students to new approaches to mathematics that are tailored to their majors and the most useful applications for their desired skills. One other enhancement of ExpAI2ES involves the joint computational science degree between SDSU and UCI. ExpAI2ES will provide funding and assistance to support enrolled students.

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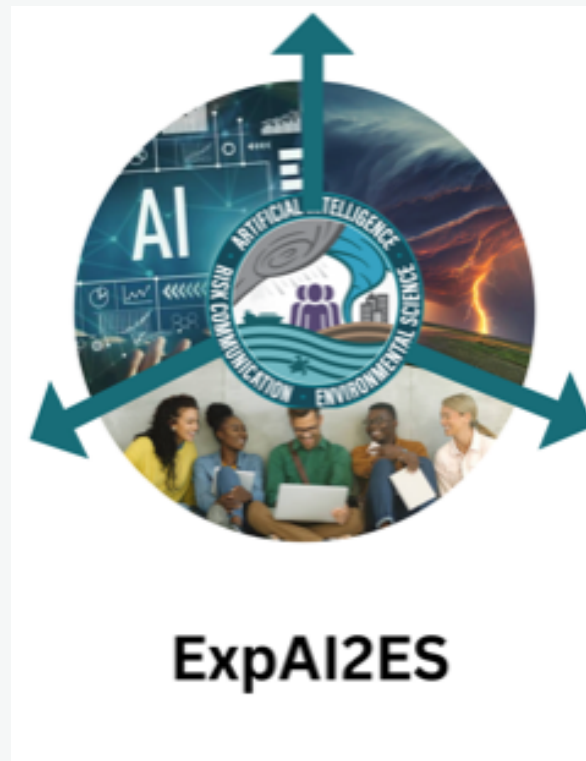
CLIMATE  
MATHEMATICS  
Theory and Applications

SAMUEL S. P. SHEN  
RICHARD C. J. SOMERVILLE

"Climate Mathematics is an engaging work that provides students of climate science with the most essential mathematical and computational tools of the trade. This may well prove the most useful text they will encounter on the road to becoming climate scientists."  
- KERRY A. EMANUEL, Massachusetts Institute of Technology



ExpAI2ES will allow Dr. Shen and his team to develop new course materials focusing on AI and the environmental sciences to train URM students at all levels of higher education. The course materials will use interdisciplinary and collaborative approaches to efficiently train students across multiple disciplines, including environmental science, mathematics, and AI. AI education practices will also introduce "learning-by-doing" methods to teach students applied techniques of AI early on in their degree plan. Finally, ExpAI2ES will bring new directions to use-inspired AI research. This includes the customization of 4DVD along with machine learning models and remote sensing to answer questions of uncertainty quantifications and precipitation extremes.



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To experience 4DVD for yourself, visit <https://4dvd.sdsu.edu/>

To learn more about AI2ES, visit <https://www.ai2es.org/>