NATIONAL ACADEMIES Sciences Engineering Medicine

NATIONAL ACADEMIES ROUNDTABLE ON ARTIFICIAL INTELLIGENCE & CLIMATE CHANGE

AI for Emulation: Weather & Earth Systems Modeling

AI for Weather & Climate Forecasting Webinar Series

Artificial intelligence (AI) is rapidly advancing frontiers in weather and climate forecasting, transforming how information is modeled, interpreted, and used to inform decision-making. Model emulators, which are simplified versions of larger, more complex models, are used to simulate future weather and climate events, providing valuable information for both short-term forecasting and long-term climate predictions. Through technical presentations, subject matter experts will identify how AI can be utilized to enhance weather and climate simulations and models, highlight the overarching technical challenges associated with integrating AI, and explore the most promising applications. A moderated discussion will follow about the technical challenges that exist and potential solutions.

Join the livestream at this link and submit your questions and comments using this link. Speaker materials and a recording of the webinar will be made publicly available on this page.

This is the first of a 4-part educational webinar series, which is an activity of the National Academies Roundtable on Artificial Intelligence & Climate Change. The Roundtable seeks to foster ongoing discussions, shared learning, and nimble coordination around emerging issues related to AI and climate change, including: how AI can combat climate change; the environmental impact of AI itself; and strategies for mitigating the impacts of AI energy consumption and climate effects. See the Roundtable's Statement of Task here.

TUESDAY, SEPTEMBER 23, 2025

10:00 AM (ET)[1] **Welcome**
April Melvin, National Academies Polar Research Board

10:05 AM **Technical Presentation: AI-Guided Climate Model Ensembles for Refining Future Projections**
Greg Elsaesser, National Aeronautics and Space Administration Goddard Institute for Space Studies & Columbia University

10:20 AM **Technical Presentation: AI/ML for Climate Model Emulation**
Claudia Tebaldi, Pacific Northwest National Laboratory

[1] All time in Eastern

10:35 AM **Discussion**
Moderated discussion about technical challenges in this space, and potential solutions.

Moderator: Stephan Sain, Jupiter Intelligence

11:00 AM **Audience Q&A**

11:15 AM **ADJOURN**

Speaker Biographies

Stephan Sain, Jupiter Intelligence, National Academies AI & Climate Roundtable
Stephan Sain is a Senior Principal Data Scientist and Senior Director at Jupiter Intelligence, where he heads the data sciences and is responsible for operational aspects of the broader Jupiter science organization. Jupiter provides data and analytics services to better predict and manage risks from weather and sea level rise, storm intensification and changing temperatures caused by medium- to long-term climate change. Steve is an experienced data science leader and applied statistician who has long worked at the intersection of climate research, applied statistics, and machine learning, including a focus on spatial methods for large datasets, extremes, uncertainty quantification, and climate risk analytics. From 2006 to 2014, he was the head of the Geophysical Statistics Project and a scientist in the Institute for Mathematics Applied to Geosciences at the National Center for Atmospheric Research in Boulder, Co. Steve is a Fellow of the American Statistical Association (ASA). He is a past recipient of the Distinguished Achievement Award from the American Statistical Association's Section on Statistics and the Environment. Steve also serves as chair for the ASA's newly formed Caucus of Industry Representatives, is a past member of the ASA's committee on climate change policy, is an affiliate faculty in the University of Colorado's Department of Applied Mathematics, and is a member of the advisory board for the Institute for Mathematical and Statistical innovation (IMSI) at the University of Chicago.

Greg Elsaesser, National Aeronautics and Space Administration (NASA)
Dr. Greg Elsaesser has been a research scientist at the Goddard Institute for Space Studies (GISS, Columbia University and NASA) since 2014. His research focuses on the use of observations of clouds and atmospheric environments to inform development in (and evaluation of) the NASA GISS Earth System Model (ESM, known as ModelE). He maintains a close connection with the satellite observational product development community, currently serving as a co-chair for WCRP-ESMO's Obs4MIPs. He has been a principal investigator for several NASA, National Science Foundation (NSF), and Department of Energy (DOE) projects, and is a member of the senior personnel for Learning the Earth with Artificial Intelligence and Physics (LEAP), an NSF Science and Technology Center (STC) aiming to improve near-term ESM climate projections. Dr. Elsaesser recently led the development of an 'automated-calibration' framework in the NASA GISS ESM, where AI is used to optimize physics in the ESM and create variants of the ESM that all agree with observational benchmarks but have different projections. This effort resulted in the first collection of AI-calibrated ESM configurations submitted to the Coupled Model Intercomparison Project Phase 6 (CMIP6) from a U.S. climate modeling institution (NASA GISS).

This AI-calibration effort was highlighted in EOS (https://eos.org/editor-highlights/calibrating-climate-models-with-machine-learning), with specific details on how an emulator was developed and used as a surrogate for the NASA GISS atmosphere discussed in the following reference: Elsaesser, G. S., M. van Lier-Walqui, Q. Yang, M. Kelley, A. S. Ackerman, A. M. Fridlind, G. V. Cesana, G. A. Schmidt, J. Wu, A. Behrangi, S. J. Camargo, B. De, K. Inoue, N. M. Leitmann-Niimi, and J. D. O. Strong. (2025). Using machine learning to generate a GISS ModelE calibrated physics ensemble (CPE). Journal of Advances in Modeling Earth Systems, 17, e2024MS004713. https://doi.org/10.1029/2024MS004713.

Claudia Tebaldi, Pacific Northwest National Laboratory (PNNL)
Dr. Claudia Tebaldi is a statistician by training and her work has centered around uncertainty characterization in future projections of anthropogenic climate change, with a focus on changes at the regional scale, particularly in the extremes. In the last decade, her work has increasingly shifted towards connecting physical changes in the climate system to impacts and risk assessment. In service of this focus, she has been working on climate model output emulation, publishing technical and review papers on the subject in collaboration with colleagues at PNNL, Western Washington University and Massachusetts Institute of Technology. Dr. Tabaldi was a staff scientist at the National Center for Atmospheric Research, and Climate Central Inc. and joined the Joint Global Change Research Institute, a division of the Pacific Northwest National Laboratory also affiliated to University of Maryland in 2019. Dr. Tebaldi has worked as an author on several Assessments of the Intergovernmental Panel on Climate Change (IPCC), as part of Working Group I, and on the 5th US National Climate Assessment (NCA5). She co-chairs ScenarioMIP, which organizes the coordinated scenario simulations by the world's climate modeling centers. She maintains an affiliation with Climate Central, a non-profit, non-advocacy science communication organization dedicated to educating the US public about the impacts of climate change and its solutions. Dr. Tebaldi is an elected fellow of the American Geophysical Union.

A recent review paper on climate model emulators: C. Tebaldi, N.E. Selin, R. Ferrari and G. Flierl (2025) Emulators of Climate Model Output. ANNUAL REVIEW OF ENVIRONMENT AND RESOURCES. Vol. 50. https://doi.org/10.1146/annurev-environ-012125-085838.