

Climate Change Science Institute

Climate change is a tangible reality that affects our daily lives. The past decade was the hottest on record, and extreme events such as wildfires, hurricanes, and flooding are becoming more frequent and intense. The Climate Change Science Institute (CCSI) at Oak Ridge National Laboratory (ORNL) is addressing these challenges by advancing our understanding of climate change and its impacts on human and natural systems. CCSI brings together the multidisciplinary expertise and big science capabilities—including worldclass supercomputers—required to predict the future of our changing planet and to evaluate potential solutions at the intersection of climate, clean energy, national security, and environmental justice.

Informing Solutions

Formed in 2009, CCSI is unique within the national laboratory system and across the nation. The institute fosters innovation and interdisciplinary approaches to climate science, focusing on the areas below.

Earth system modeling—Uses high-performance computing (HPC) to advance modeling techniques, enabling Earth system models to operate at higher resolutions. Translates new knowledge of environmental processes into the existing Energy, Exascale, Earth System Model (E3SM) for greater predictive accuracy on finer geographic scales.

Data integration, dissemination, and informatics—Merges data from diverse sources and distributes them through single portals to a broad range of scientists and stakeholders interested in climate change information. Creates data management tools to facilitate science.

Integrative ecosystem science—Captures model-inspired measurements and observations from a range of biomes and biogeochemical processes, leveraging unique ecosystem-scale climate change experiments managed by ORNL. Uses these data to inform predictive models from local to global scales.

Impacts, adaptation, and urban dynamics—Develops analytical tools and methods for assessing adaptation strategies at the intersection of climate science, energy use, and environmental justice. Provides data to stakeholders who must prepare community members and infrastructure for risks associated with climate change.

Pathways to net-zero carbon emissions—Uses artificial intelligence and HPC to integrate data from diverse sources into regional climate models to determine decarbonization pathways and to inform mitigation strategies and technology development.

 ADVANCING understanding of climate change
ASSESSING clean energy solutions
COMMUNICATING science to diverse stakeholders
LEVERAGING expertise and big science capabilities
INTEGRATING climate, clean energy, national security, and environmental justice

"We're examining the ways global and regional climate models can inform local decision-making to equip our cities and communities with equitable solutions that address climate change and its impacts."

Melissa Allen-Dumas, *Research Scientist, Computational Urban Sciences Group*





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CCSI encompasses two major data centers that curate more than 12,500 diverse environmental and climate datasets and many tools for their management, navigation, and analysis. These datasets are available to the worldwide research community.

Key Projects



Atmospheric Radiation Measurement (ARM) Data Center—Sharing computing resources and data on atmospheric radiation balance to inform models of global climate change



ORNL Distributed Active Archive Center (ORNL DAAC) for Biogeochemical Dynamics— Providing scientists and stakeholders with access to biogeochemical and ecological data and models



Fine-Root Ecology Database (FRED)—A freely available global root trait database advancing understanding and model representation of belowground trait variation within and among species and across environmental gradients



Next-Generation Ecosystem Experiments (NGEE Arctic, Tropics)— Advancing predictive understanding of the structure and function of the Arctic and tropical terrestrial ecosystems in response to climate change



Spruce and Peatland Responses **Under Changing Environments** (SPRUCE)—Assessing the response of northern peatland ecosystems to increases in temperature and exposures to elevated atmospheric CO₂ concentrations



Free Air CO₂ Enrichment (FACE) Model Data Synthesis— Analyzing data from long-term CO₂ enrichment experiments in ecosystems spanning the world



Energy Exascale Earth System Model (E3SM)— Model development and simulation investigating energyrelevant science via HPC

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Reducing Uncertainty in Biogeochemical Interactions through Synthesis and Computation (RUBISCO)— Facilitating comparisons between ensembles of earth system models

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