The NCAR Earth System Laboratory. NESL’s mission is to advance understanding of weather, climate, atmospheric composition, and processes; to provide facility support for such advancements to the wider community; and to produce research results that can be applied to the benefit of society.

OPPORTUNITIES

NESL science strategy, opportunities for collaboration, and community support are delivered through its three science divisions:

The Atmospheric Chemistry Division (ACD) advances understanding and predictive capability for atmospheric composition and related processes through both observational and modeling activities. Research is organized around two major themes: air quality prediction and weather-chemistry-climate interactions. www2.acd.ucar.edu

The Climate and Global Dynamics Division (CGD) focuses on investigation and modeling of the Earth system across a range of spatial and time scales. This research has expanded beyond atmospheric dynamics to encompass how the atmosphere interacts with and is influenced by other components of the Earth system, including the underlying ocean, land, and cryosphere, in addition to human systems. www2.cgd.ucar.edu

The Mesoscale and Microscale Meteorology Division (MMM) conducts the fundamental research essential to both the improvement of current weather and climate models and the development of the next generation of models. The success of the enterprise stands on the tripod of numerical modeling (including physics parameterizations), data assimilation, and model verification. www.mmm.ucar.edu

Substantial cross-divisional interactions, robust visitor programs, and collaborations with other NCAR entities and the broader research community are all essential to meet the three overarching interdisciplinary science challenges currently at the core of the NESL program. These are: to identify and model the processes responsible for hazards related to weather and air pollution and project the influences of climate change; to determine the inherent predictability of the Earth system with respect to weather, climate and air quality; and to identify and model the processes and interactions that govern climate variability.
COMMUNITY RESOURCES

NESL scientists and collaborators conduct advanced research aided by the development, maintenance, and support of major modeling and observational facilities. Enabling world-class community science is a NESL priority, a goal pursued in the three major focus areas below. Details of specific activities can be found in the ACD, MMM, and CGD brochures.

Development and support of NCAR community models: Models are essential for integrating the myriad physical, chemical, and biological processes that determine the evolution of the atmosphere as well as past and future climates, and for making predictions of use to policy makers and society. NESL community models have been adopted across the international scientific and user community, with more than 20,000 registered users worldwide of the Weather Research and Forecasting (WRF) model (www.mmm.ucar.edu/wrf/users) and the Community Earth System Model (CESM) (www2.cesm.ucar.edu). User support for the models has grown to become one of NESL’s major outreach activities, including highly popular tutorials to train the next generation of scientists in their use. NESL also pursues community-model development, with regular model updates and releases to enable world-class community science.

A more unified strategy of model and data assimilation system development for weather-chemistry-climate prediction: The Earth system contains features and processes that operate on a wide range of time and spatial scales, all contributing in varying degrees to observed weather, chemistry, and climate phenomena. NESL scientists engage with the broader community to develop global models that run efficiently and accurately at a variety of uniform global horizontal resolutions, as well as with variable-mesh grids for both regional downscaling and upscaling research, such as the Model for Prediction Across Scales (MPAS) (mpas-dev.github.io). These developments closely integrate data assimilation with model development and verification to determine the best use of available observations for generating initial conditions, to facilitate analysis of model parameter sensitivity and uncertainty quantification, and to assess the incremental benefit of new observations.

Expanding community use of and access to instruments, models, and data sets: The provision of data, models, and instruments and related expertise to the broader research community remains a central feature of the NESL mission. Data sets encompass output from climate model experiments, post-processed model data, observations from satellites, field programs and laboratory experiments, and value-added observationally based datasets. NESL scientists also evaluate data sets and examine their suitability for model evaluation and other studies, and they transform data sets into user-friendly formats. Community model codes, as well as information on model configurations, experimental designs, and online diagnostics are made available through frequently updated websites. NESL also provides expertise and instrumentation needed to conduct community field campaigns through the Atmospheric Chemistry Center for Observational Research and Data (www2.acd.ucar.edu/accord). In collaboration with the NCAR Earth Observing Laboratory and the wider atmospheric chemistry research community, ACCORD provides focus and consolidation of in situ measurement capabilities and a forum for community prioritization of research issues.

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