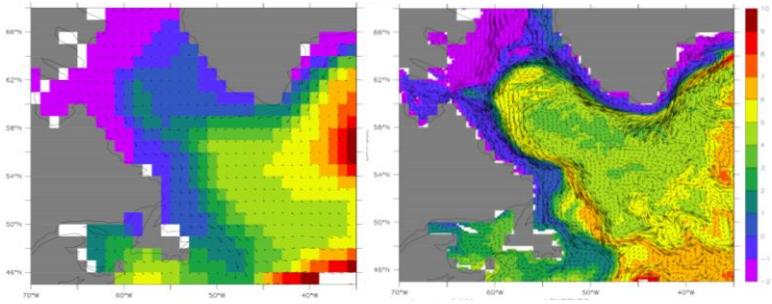
Geophysical Fluid Dynamics Laboratory

Modeling the Earth's climate

What Does the Geophysical Fluid Dynamics Laboratory Do for the Nation?



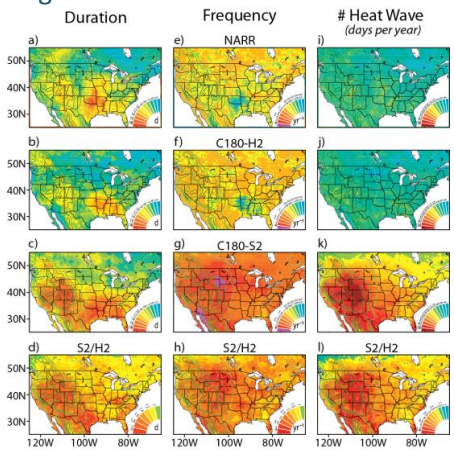
Higher resolution models produce more realistic results. Left: sea surface temperature from previous generation model, Climate Model 2.1 (IPCC, 2007); Right: from our new generation of models, Climate Model 2.4. *Image credit: NOAA*

NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) develops and uses mathematical models and computer simulations to improve our understanding and prediction of the behavior of the atmosphere, ocean, and climate. GFDL builds models that benefit society, such as hurricane research and prediction, seasonal forecasting, and understanding and projecting climate change. Since 1955, GFDL has set the tone for much of the world's research on modeling global climate change, and has played a significant role in the World Meteorological Organization, the World Climate Research Program, the Intergovernmental Panel on Climate Change (IPCC) assessments, and the U.S. Global Change Research Program.

Research Highlights

Projecting Heat Waves: Understanding the processes that contribute to North American heat waves and projecting changes in the 21st century is an integral part of NOAA's mission.

Heat waves are responsible for significant human casualties and economic losses. Researchers at GFDL evaluated the fidelity of GFDL climate models in reproducing the characteristics of summertime heat waves in different parts of North America, and produced model-projected changes of these characteristics in the 21st century. Published in July 2012, these model projections indicate considerable lengthening of heat wave duration, as well as notable increases in the frequency of heat wave episodes during the 21st century, compared to the 20th century. The upward trends in heat wave duration and frequency are projected to be discernible in the early decades of the 21st century.



Top row: Observational data. Second row: Simulation from the C180 HiRAM model for 1971-2000. Third row: Projection for 2041-2070. Fourth row: Ratios of heat wave measures in the 2041-2070 period versus the 1971-2000 period. *Image credit: NOAA*

Ozone Pollution Observations: GFDL scientists analyzed transport of Asian ozone pollution into surface air over the western United States during springtime pollution episodes.

As Asian countries develop, they emit more ozone precursors that pollute surface level air. Many studies have documented this pollution being carried by air currents to the western United States. GFDL scientists quantify this pollution using a new global high-resolution chemistry climate model. Model results were analyzed alongside measurements from balloon soundings, aircraft, surface, and satellites, from spring of 2010. Their peer-reviewed findings indicate that pollution from Asia contributes as much as 20% of total ozone during springtime pollution episodes in western U.S. surface air. Although local pollution plays a large role on days when ozone exceeds the EPA standard in Southern California, the authors estimate that 53% of the instances where that limit was exceeded would not have occurred without the pollution contribution from Asia. This research also showed that an index based on satellite observations of pollution plumes from Asia could serve as an early warning indicator of pollution influence on air quality in the western United States.

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More Research Highlights

Climate Change Research: Assessing the effects of climate change on marine life is essential to protecting ecosystems and biodiversity.

Marine turtles must lay eggs on sandy beaches, so climate change can affect both their land and sea habitats. GFDL scientists and colleagues studied a population of critically endangered eastern Pacific leatherback turtles, to assess its sensitivity to climate change in the nesting beach and ocean. Mature females' success in finding food in the ocean, and the success of nests on the beach, varies with the El Niño Southern Oscillation. This peer-reviewed study combined an Earth system model, climate projections, and a population dynamics model to estimate a seven percent per decade decline in the nesting population at Playa Grande, Costa Rica over the 21st century. This is primarily due to the negative effects of increased air temperature on hatchling survival within the nests. This suggests that climate change could drive eastern Pacific leatherbacks to disappear in Costa Rica, even in the absence of fisheries interactions, such as by-catch mortality.

Research fishery biologist with a mature female Leatherback turtle. The satellite tags allow researchers to understand how the turtles interact with the ocean, and how climate change may affect them. *Photo credit: NOAA*

What's Next for GFDL?

- Using high-resolution coupled climate models, GFDL is developing prediction systems for climate extremes on time scales of seasons to decades. High resolution systems will better represent important small-scale processes, leading to skillful seasonal-to-decadal predictions of regional changes and climate extremes, such as tropical storm activity, heat waves, and droughts.
- GFDL will enhance its ocean model development efforts by merging the best capabilities of two ocean models. Innovative and robust global marine ecosystem models developed at GFDL will be integrated with the long-standing Modular Ocean Model (MOM), to capture interactions between climate and living marine resources.
- GFDL is developing a more comprehensive coupled climate model to improve our understanding of air quality and climate on regional scales. This effort synthesizes a number of current activities, including advanced representations of atmospheric chemistry, aerosols, clouds, terrestrial and oceanic biogeochemistry, to better capture the interactions involving the carbon cycle.

Did You Know?

GFDL's collaborative graduate program with Princeton University's Program in Atmospheric and Oceanic Sciences has awarded nearly 100 doctorates since 1972. Many graduates continue their research using GFDL climate models throughout their careers. Alumni can be found at five federal agencies, more than 27 different universities in the U.S., institutions in at least 15 foreign countries, and numerous sectors of private industry.

Research Partners

GFDL has research partnerships with many national and international organizations, totaling several hundred active collaborations. GFDL also works with other NOAA research programs and laboratories, the National Science Foundation, the University Corporation for Atmospheric Research, NASA, Department of Energy, and numerous academic institutions. GFDL is a partner with Princeton University in the Cooperative Institute for Climate Science.

Budget

The Fiscal Year (FY) 2014 President's budget request for GFDL through NOAA's Office of Oceanic and Atmospheric Research (OAR) is $23.2M. The OAR GFDL FY 2013 actual budget is $17.8M and the FY 2012 actual budget was $18.8M. GFDL is located in Princeton, New Jersey.

www.gfdl.noaa.gov

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