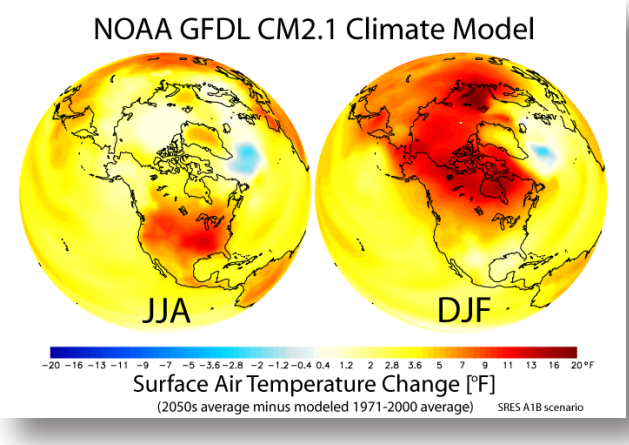
Geophysical Fluid Dynamics Laboratory

Modeling the Earth's climate and weather

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



Global projection of change in seasonal (June-July-Aug / Dec-Jan.-Feb) mean surface air temperature by the end of the 21st century. Image: 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 are aimed at benefiting society, such as hurricane research and prediction, seasonal forecasting, and understanding and projecting climate change. Since 1955, GFDL has set the agenda for much of the world's research on modeling of 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.

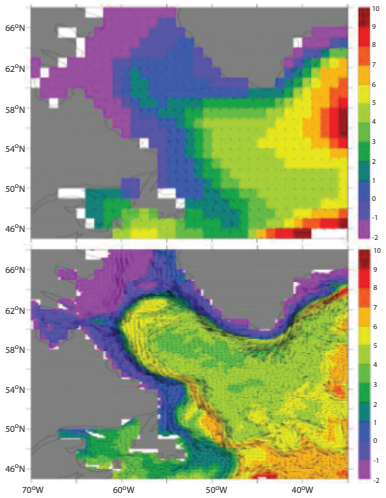
Recent Accomplishments

Benefit: More reliable attribution of climate change to human induced and natural forcings. This will lead to improved projection capabilities for ecosystems, climate, atmospheric composition, air quality, and coastal pollution.

GFDL recently completed a multi-year effort to develop a new generation of climate models, producing an improved understanding of historical climate evolution, climate forcing, feedback, sensitivity, and global and regional responses, and a range of projections about future climate. New capabilities include representations of the complexity of atmospheric chemistry, as well as aerosol and cloud physics and optics, terrestrial ecosystems, and biogeochemical cycles. The greatly enhanced resolution in the ocean model creates an ocean circulation that is extremely energetic and realistic, accounting for the effects of ocean eddies, with grid sizes varying from 25 km in the tropics to 5 km at high latitudes. (The ocean component of climate models used in the 2007 IPCC assessment report had grid sizes of 100-200 km.)

Benefit: Advances in our understanding of factors controlling global hurricane activity and our ability to predict changes in future activity.

Scientists at GFDL have developed a global atmospheric model at a very high resolution (5 km, experimentally). This model realistically simulates tropical meteorology and tropical cyclone activity, and has the potential to revolutionize both climate research and operational forecasting. A highly innovative and adaptive technology is under development, allowing this model to be used at varying resolutions, instead of one fixed resolution.



Higher resolution models produce more realistic results. Top: sea surface temperature from CM2.1 (IPCC, 2007); Bottom: from our new generation of models, CM2.4. Image: NOAA

Did You Know?

GFDL's joint graduate program in Atmospheric and Oceanic Sciences (AOS) with Princeton University has granted more than 85 PhDs since it was founded in 1972. These graduates work at leading academic institutions, research laboratories, and private companies throughout the world.

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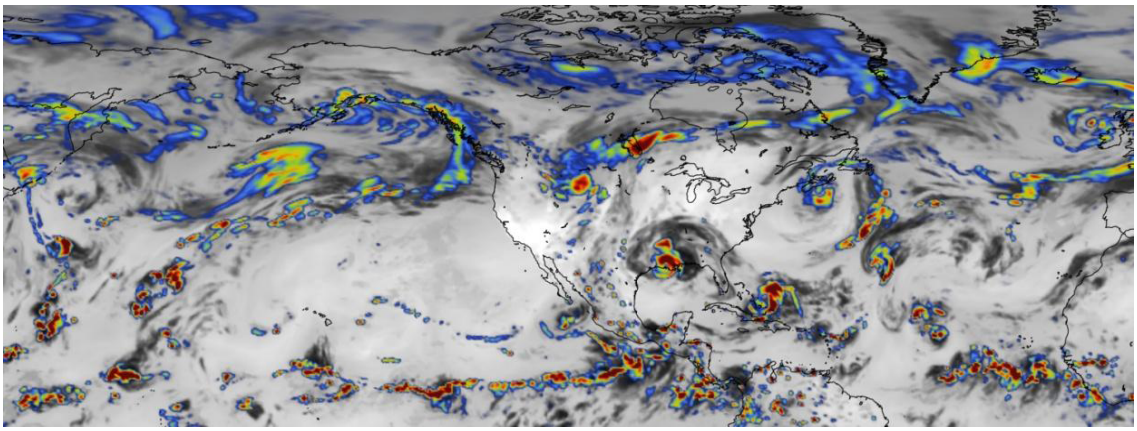

Atlantic hurricane activity simulated by GFDL's experimental high resolution global atmospheric model, including Hurricanes Gustav and Hanna in 2008. Image: NOAA

What's Next for GFDL?

- In 2010, GFDL will devote approximately half of the capacity of the lab's supercomputer to conduct simulations of past climate and projections of future climate to contribute to the 2013 IPCC Assessment Report. New models will offer improved realism of the interactions between atmospheric concentrations of carbon dioxide, ozone and aerosols, and climate change. The development of a state-of-the-art model will allow inclusion of predictions of decadal-scale climate fluctuations, such as large-scale changes in Atlantic ocean temperature, arising from both natural variations and changing radiative forcing.
- Predicting hurricane genesis, frequency, intensity and geographical distribution is inherently difficult. GFDL is developing a comprehensive global high-resolution atmospheric model (HiRAM) as a tool to explicitly simulate hurricane climatology and variability and to understand what controls hurricane variability to predict storm activity. HiRAM, at roughly 25-50 km resolution, has provided high quality simulations of global hurricane climatology, capturing inter-annual variability and decadal trends of hurricane frequency over the North Atlantic, the East and West Pacific.
- Under a three-year agreement with the U.S. Department of Energy, GFDL is using more than 10 million hours of computing time on two of the world's most powerful computers (at Argonne and Oak Ridge National Laboratories) to improve the quality of, and quantify the uncertainty in global and regional climate projections. Advanced, high-resolution climate models from GFDL will be prototyped to improve the prediction of climate extremes and high-impact weather events and provide the best science-based climate information for management and policy decisions.

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, and with Columbia University in the Cooperative Institute for Climate Applications and Research.

Budget and Staff

The fiscal year (FY) 2010 President's budget request for GFDL was $19.6M and the FY 2010 enacted budget for GFDL was $20.1M. The FY 2011 President's budget request is $19.6M. GFDL supports 81 permanent full time federal employees. GFDL is located in Princeton, New Jersey.

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