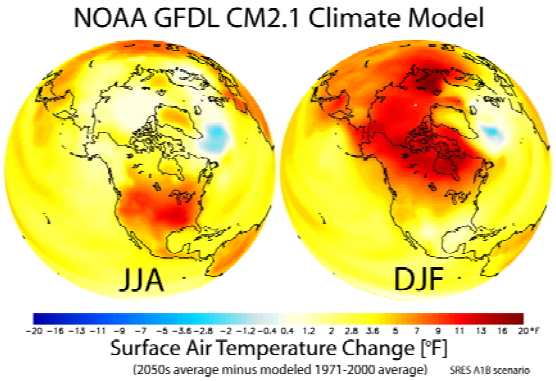
Geophysical Fluid Dynamics Laboratory

Modeling the Earth's climate and weather

What does the Geophysical Fluid Dynamics Laboratory do for the Nation?

The 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.

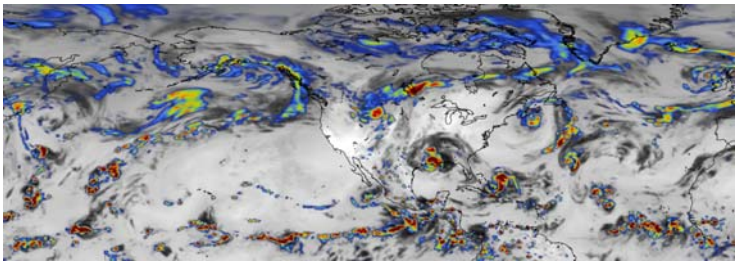
Over its 53-year history, GFDL has set the agenda for much of the world's research on the modeling of global climate change and has played a significant role in the World Meteorological Organization, the Intergovernmental Panel on Climate Change (IPCC) assessments, and the U.S. Climate Change Science Program. GFDL scientists create and operate complex computer applications using state-of-the-art supercomputer and data storage resources.
The lab focuses on model-building relevant for society, such as hurricane research, prediction, and seasonal forecasting, and understanding global and regional climate change.



GFDL 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)

Recent Accomplishments:

- GFDL's new climate model (CM2.4) represents a quantum leap in simulating the ocean component of the climate system. This new model has greatly enhanced resolution in the ocean, with grid sizes varying from 25 Km in the tropics to 10 Km at high latitudes. (For comparison, the ocean component of climate models used in the 2007 IPCC assessment report had grid sizes of 100-200 Km.) The new model creates an ocean circulation that is extremely energetic and realistic, including the effects of ocean eddies. **Payoff: This model enables crucial, pioneering studies on the importance of ocean eddies to climate variability and change, including marine ecosystems.**
- Scientists at the lab have developed a global atmospheric model at very high resolutions (5Km, 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 low, medium, or high resolutions, instead of one fixed resolution. **Payoff: Advances in our understanding of factors controlling global hurricane activity and our ability to predict changes in future activity.**



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

- GFDL has been working to resolve uncertainties governing critical aspects of climate-air quality connections, by developing and applying a suite of models that elucidate the complex physics and chemistry of the atmosphere. Along with observations, these model simulations help us explain relationships such as the effects of short-lived gases and particle pollutants, which are generated locally and tend to be concentrated close to their source, but exert a global influence on climate.

Payoff: Improved understanding is leading to advances in quantifying the influences of atmospheric composition on the 20th century climate and projected climate changes in the 21st century.

What's next for GFDL?

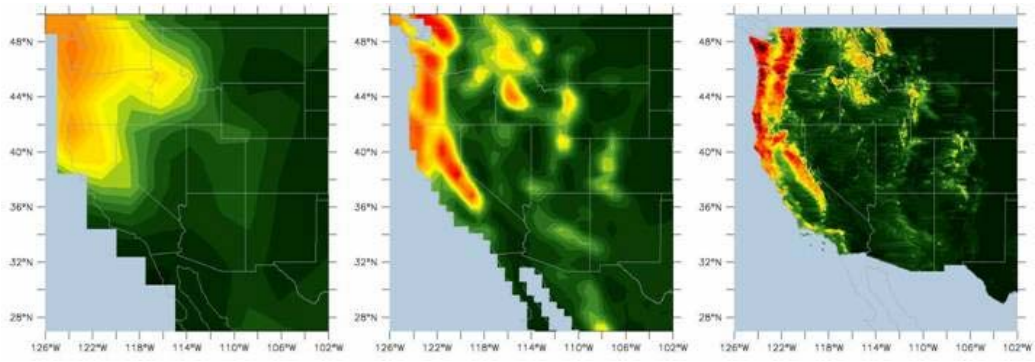
- GFDL is implementing an Earth system modeling capability, which includes interactive oceanic and terrestrial ecosystems (carbon cycle), biogeochemical cycles, and atmospheric chemistry cycles. This Earth system model will provide new forecasting and analyses capabilities for ecosystems, climate and air quality, and coastal pollution. The next IPCC Assessment Report will use Earth System Models, including GFDL's, for long-term projections of climate change.

Did You Know?

GFDL was founded in 1955 and in 1969 the results of the first-ever coupled ocean-atmosphere general circulation model were published by two GFDL scientists. General circulation models emerged as a central tool for climate research in the next decade.

- GFDL's hurricane forecast model has distinguished itself by showing particular skill in predicting hurricane intensity, among the models used by the National Hurricane Center. GFDL is currently using this forecast model to further downscale storms from a regional climate model (ZETAC), already proven as a research tool for simulating hurricane activity in the Atlantic. A growing body of evidence is raising concern that future greenhouse-gas induced warming could lead to more intense hurricanes in the future. This new effort is expected to improve our understanding of storm intensification and our ability to predict future changes in intensity.

- GFDL is building the modeling systems necessary to develop a prototype decadal prediction system. All previous climate projections used for the IPCC have predicted the response of the climate system to changing radiative forcing, but did not predict the evolution of potentially important natural variability in the system on decadal time scales. The development of this state-of-the-art model will allow us to predict decadal-scale climate fluctuations, such as large-scale changes in Atlantic ocean temperature, arising from both natural variations and changing radiative forcing.



Current model resolution (200km) compared to high-resolution model (50km) and satellite image (observed). High-resolution model provides much greater detail. (image: NOAA)

Research Partnerships

GFDL has research partnerships with many 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 (CICS).

Budget and Staff

The fiscal year 2008 enacted budget for GFDL is $18.7M and the fiscal year 2009 President's budget request is $19.3M. GFDL currently supports 110 permanent full time Federal employees.

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www.gfdl.noaa.gov

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