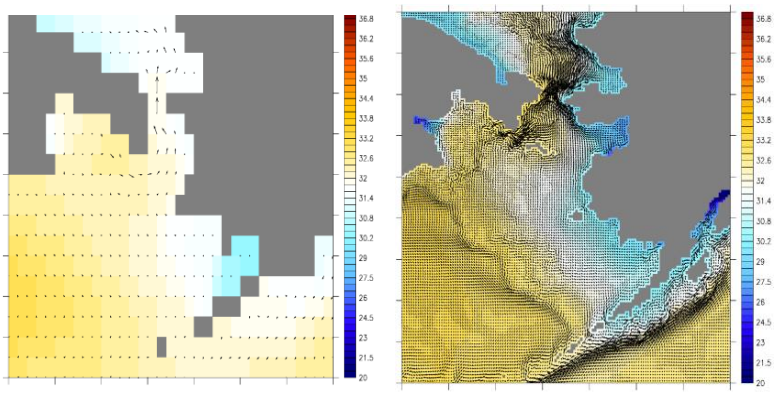
Geophysical Fluid Dynamics Laboratory

Modeling the Earth's Climate

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

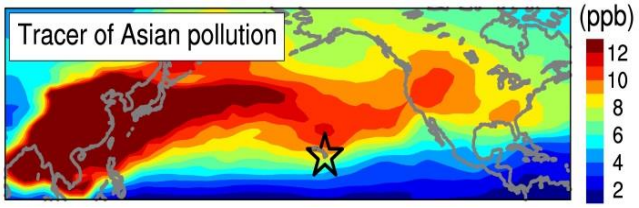
Researchers at the Geophysical Fluid Dynamics Laboratory (GFDL) advance scientific understanding of climate, its natural and anthropogenic variations, and impacts, improving NOAA's predictive capabilities through the development and use of world-leading computer models of the Earth system. Since 1955, 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.



Higher resolution models produce more realistic results.
Left: Surface currents and surface salinity from previous generation model, Climate Model 2.1 (IPCC, 2007); Right: from our new generation of models, Climate Model 2.5. *Image credit: NOAA*

Research Highlights

Tropospheric Ozone Trends at Mauna Loa Observatory Tied to Decadal Climate Variability



Asian ozone pollution over Hawaii varies according to climate. *Image credit: NOAA*

Climate shifts have caused Asian ozone pollution reaching Hawaii to rise unexpectedly in autumn since the mid-1990s. Ozone levels in the lower atmosphere would be expected to increase in the spring, due to powerful springtime winds and tripling emissions from Asia since the 1980s. The 40-year Hawaiian record, however, has shown little change in ozone pollution in spring but an increase in autumn. Changing wind patterns mask the increase in pollution from Asia in the spring, but amplify the change in the autumn. These findings imply that climate variability must be considered when detecting and attributing trends in ozone levels in the lower atmosphere, and are the result of a multi-institutional research collaboration.

Role of Global Climate Change in the Extreme Low Summer Arctic Sea Ice Extent in 2012

GFDL researchers used model simulations to determine if the observed 2012 summer Arctic sea ice decline could be explained by both natural and human activity, and evaluated the relationship between the sea ice decline and the observed global warming trend. Comparisons between observations and 19 models reveal that the observed rapid decline of summer Arctic sea ice in the early 21st century is much stronger than the average decline in the models when both anthropogenic and natural forcings are used. In addition, the decline is an extremely rare event in the context of modeled internal climate variability alone (without anthropogenic or natural forcing). In contrast, September global mean temperatures over the same period (2001-2012) warmed less than in the previous two decades, although this slower warming was consistent with the models. This suggests that model response to anthropogenic forcing is too weak, implying that future model-projected ice loss rates may be overly conservative, or perhaps natural climate variability in the Arctic sea ice is underestimated in models.

Geophysical Fluid Dynamics Laboratory

More Research Highlights

Seasonal Predictions of Tropical Cyclones

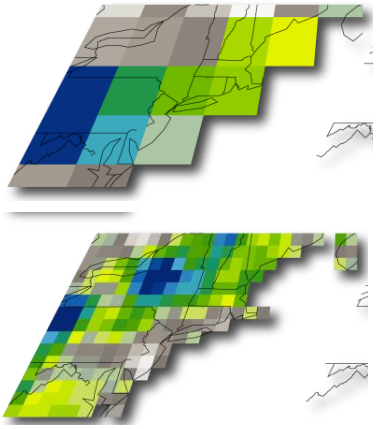
GFDL scientists demonstrated the feasibility of using a high-resolution climate model designed for long-term climate simulations (HiRAM), to study the impacts of climate change on the intensity of tropical cyclones. Retrospective seasonal predictions of tropical cyclones were performed with this model for the period 1990 to 2010. Results showed that storm counts of both tropical storm and hurricane categories are remarkably predictable in the North Atlantic basin during the 21-year period. The relative skill in the prediction of storm counts is shown to be consistent with the quality of the predicted large-scale environment in the Atlantic, Pacific, and Indian Ocean basins. This is an important step towards an integrated environmental modeling system for predictions and projections on time scales from days to decades.

Did You Know?

GFDL scientists collaborate closely with scientists from the National Marine Fisheries Service to understand the diverse effects of climate on fisheries resources. Work is presently underway to integrate GFDL's pioneering seasonal to decadal prediction system with fisheries management to improve the management of the nation's commercial fisheries, which support 1 million jobs.

What's Next for GFDL?

- GFDL provides predictions of the state of climate at global and regional scales, such as the statistics of weather extremes, hurricanes, heat-waves and drought, to the operational forecasting and research community, including monthly predictions sent to the National Weather Service. GFDL's new Forecast-oriented Low Ocean Resolution (FLOR) model has an atmospheric resolution of approximately 50km, greatly enhancing our ability to predict regional climate conditions and extremes.
- GFDL supports an ocean model (MOM) used by hundreds of researchers around the world and has begun work on the next version. New features include coupled dynamic ice-shelf cavities and multiple vertical coordinates. Future development will include improving the representation of physical and bio-geochemical processes.
- GFDL scientists are developing the next-generation global climate model (CM4), incorporating the carbon cycle, clouds, aerosols, and chemistry. The horizontal resolution in the atmosphere will be roughly 50 km, with a ¼ degree ocean resolution. The model will be suitable for projections of future climate change up to several hundred years into the future, as well as seasonal-to-decadal predictions. Regional-scale information and assessments of diverse climate impacts will also be improved.



Precipitation maps, with deep blue and green indicating stronger rainfall, from two GFDL seasonal-to-decadal prediction models: current generation (above), next generation GFDL-FLOR (below). *Image credit: NOAA*

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) 2015 President's budget request for GFDL through NOAA's Office of Oceanic and Atmospheric Research is $23M. The FY 2014 Omnibus funding for GFDL is $21.1M and the FY 2013 actual budget was $17.9M. GFDL is located in Princeton, New Jersey.

www.gfdl.noaa.gov

For more information, contact: **Mackenzie Tepel**
National Oceanic and Atmospheric Administration, Office of Legislative and Intergovernmental Affairs
14th Street & Constitution Avenue, NW, Room A100, Washington, DC 20230
Phone: 202.482.2497 Email: Mackenzie.Tepel@noaa.gov

March 2014