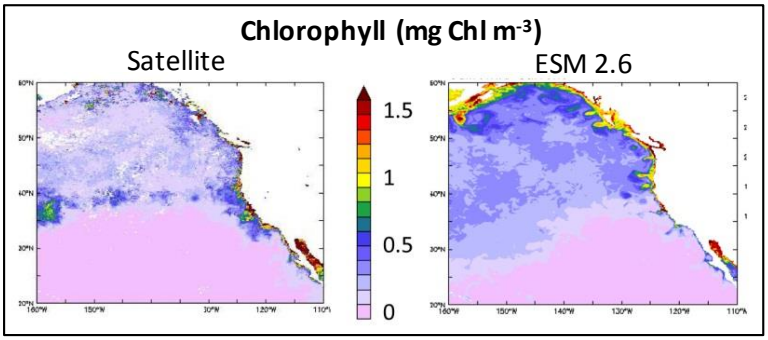
Geophysical Fluid Dynamics Laboratory

www.gfdl.noaa.gov

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, natural and anthropogenic climate 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. In addition, GFDL 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.

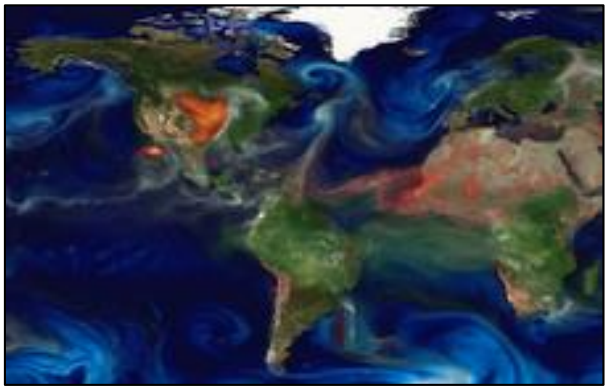


Simulated chlorophyll distributions from ESM2.6, a prototype high-resolution Earth system model (ESM). The ocean resolution of ESM2.6 is 1/10 degree of latitude/longitude, or approximately 10 km. This is nearly 10 times the resolution of past generation ESMs, greatly enhancing the resolution of U.S. coastal ecosystems in models. Source: NOAA

Research Highlights:

Determining Natural and Land-Use Sources of Dust

Dust is one of the most abundant aerosols in the atmosphere, with important implications for climate, ocean biogeochemistry, air quality, and visibility. GFDL scientists have developed high-resolution modeling capabilities to detect, attribute sources of, and simulate dust from natural and land-use sources. Results indicate that land use contributes 50% of U.S. dust emission, with most sources located along the High Plains from Texas to Canada. Comparison with observations for the last 50 years shows remarkable agreement in reproducing daily, seasonal, inter-annual, and even decadal variations. Preliminary analysis of surface winds and soil moisture simulated by GFDL models indicates the largest potential increase of wind erosion is predicted for the southern High Plains, through reduced soil moisture.



GFDL model showing continental-scale dust plume extending from agricultural land in Nebraska to the U.S. east coast in October 2012. Also shown, natural dust plume from the Saharan desert dispersing over the Atlantic. Source: NOAA

Understanding and Predicting Regional Marine Ecosystem Changes

Marine ecosystems experience large fluctuations due to climate variability, and may experience pronounced shifts due to climate change. Changes in temperature, salinity, stratification, and acidity may drive ecosystem shifts in the ocean. While reductions in global ocean primary productivity on the order of 1% - 10% are expected under high emissions climate change scenarios, recent studies with GFDL's Earth System Models (ESMs) suggest the potential for much larger regional changes (10-50%) in large zooplankton, such as krill, under high emissions climate change scenarios. The possible regional reductions of large zooplankton, which are a food resource to fish, raises significant economic, conservation and food security concerns. GFDL's investment in a new generation of high-resolution ESMs will improve understanding of regional marine resource changes and help anticipate and manage for potentially abrupt changes.

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More Research Highlights:

Seasonal Forecasting of Regional Tropical Cyclone Activity

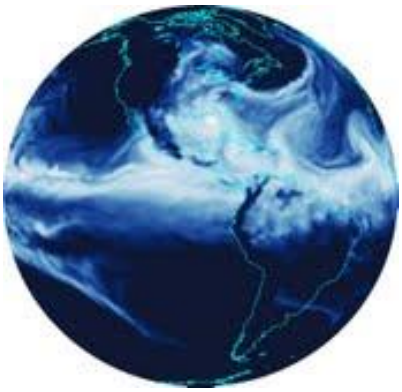
Predicting seasonal hurricane activity on regional scales (e.g., smaller than the entire Atlantic basin) would significantly aid planning and preparations in vulnerable areas. A new high-resolution coupled climate model developed at GFDL, known as FLOR, has a demonstrated ability to simulate regional tropical cyclone activity, as well as predict basin-wide hurricane frequency in the Atlantic. Long-lead forecasts of seasonal hurricane frequency in the Atlantic with the new system outperform all other published methods. Routine experimental predictions made with FLOR are provided to the National Weather Service.

Did You Know?

GFDL scientists collaborate closely with scientists from NOAA's 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 management of the nation's commercial fisheries, which support 1 million jobs.

What's Next for GFDL?

- GFDL supports the National Weather Service's efforts to produce a state-of-the- art weather prediction system. GFDL's Finite Volume dynamical core (FV3) is among contenders from across several Federal agencies to upgrade the dynamical core used in current operational weather forecasts. FV3 provides superior representation of rotating flows that characterize significant weather events, such as strong winter storms, tropical cyclones, super-cell thunderstorms, and tornadoes.
- GFDL develops and supports the Modular Ocean Model (MOM) that is used for operational ocean predictions and research by NOAA and hundreds of other scientists around the world. The latest version (MOM6) has new capabilities, which will improve our ability to understand and predict processes important for sea-level rise, ecosystems, and heat and carbon uptake by the ocean.
- GFDL scientists are developing the next-generation global Earth System Model (ESM4), incorporating the carbon cycle, clouds, aerosols, and chemistry. The horizontal resolution is four times greater than current tools, allowing us to study climate at smaller scales. Unprecedented advances in land and ocean physics and ecosystems, and comprehensive atmospheric physics and chemistry interactions, will allow us to meet a new suite of challenges regarding both extremes and long-term feedbacks in air quality, water quality and living marine resource applications.



A model-generated tropical cyclone and variations in atmospheric moisture shown making landfall on the U.S. Gulf Coast. This snapshot of column water vapor is from an experimental seasonal prediction with GFDL-FLOR.
Source: 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) 2016 President's budget request for GFDL through NOAA Oceanic and Atmospheric Research (OAR) is $23.4M. The FY 2015 enacted funding for GFDL is $21.3M and the FY 2014 enacted funding was $21.1M. GFDL is located in Princeton, NJ.

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

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