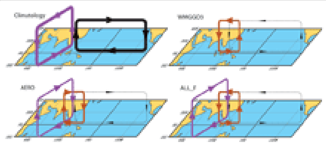
GFDL Accomplishments (July 2011-December 2011)

Since the last major scientific assessments (Intergovernmental Panel on Climate Change, 2007; Global Change Research Program, 2009), GFDL has advanced the state of the art in numerical climate modeling by developing global climate models with greater comprehensiveness to capture realism and finer spatial resolution to capture regional climate aspects. Progressively higher-resolution atmospheric models (atmospheric grids of 50, 25 and 12.5 km) have been applied to investigate the frequency of the Atlantic hurricanes, with remarkable simulations of observed frequencies over the past two decades. Studies conducted with a new coupled climate model (atmospheric grid 50 km and ocean grid varying between 10-27 km) are yielding sharper and more realistic regional features over both land and oceanic regions. Fully interactive modeling of atmospheric chemistry and aerosol processes with climate has highlighted the roles of greenhouse gases and aerosols in the evolution of past and future climate changes. Earth system modeling (ESM) activities extend the scientific methods and applications beyond the physical climate to represent the marine and terrestrial biosphere, and are being used to study the interaction of climate impacts with ecosystems and human activities. These research thrusts are advancing the scientific understanding of climate variations and change, including climate detection and attribution and projections of future climate.

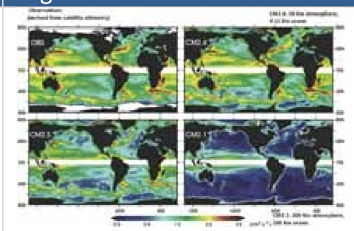
Anthropogenic Aerosols and the Weakening of the South Asian Summer Monsoon



An important part of the global water cycle, the South Asian summer monsoon provides about 80% of the region's annual precipitation, and touches the lives of more than 20% of the world's population. In the first detection and attribution study facilitated by the latest GFDL global climate model "CM3", GFDL scientists investigated what caused the observed decrease in the South Asian summer monsoon rainfall over the second half of the 20th century.

The observed drying trend of the South Asian summer monsoon is shown to be of anthropogenic origin, and attributed to increased aerosols rather than human-influenced greenhouse gas emissions. This work also demonstrated that the decrease in the monsoon rainfall can be explained as an outcome of a slowdown of the tropical meridional circulation, driven by the need to counteract the aerosol-forced energy imbalance between the northern and southern hemispheres. This study provides compelling evidence of the prominent role of aerosols in shaping regional climate change over South Asia. Read more... (http://www.gfdl.noaa.gov/news-app/story.30/title.anthropogenic-aerosols-and-the-weakening-of-the-south-asian-summer-monsoon/menu./sec./home./)

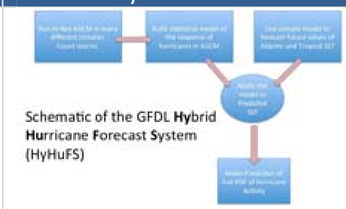
Simulated Climate and Climate Change in the GFDL CM2.5 High-Resolution Climate Model



GFDL scientists have completed a multicentury control simulation and an idealized climate change simulation using a new high-resolution coupled climate model, CM2.5. High-resolution models, ultimately, will allow us to simulate aspects of climate variability and change on regional spatial scales -- of great interest to the public and to policy makers. They will also enable us to improve the representation of small-scale processes in the climate system, such as regional circulations and ocean mesoscale eddies. CM2.5 has grid spacing of 50Km in the atmosphere; it ranges from 28Km (at the equator) to 8Km (high latitudes) in the ocean.

CM2.5 simulates many aspects of climate notably better than previous lower resolution models (CM2.0, CM2.1), especially regional-scale precipitation. Simulation of tropical climate is especially realistic, including Indian monsoon rainfall and variability in the tropical Pacific. This new model was used to perform experimental decadal prediction simulations for IPCC AR5. Read more... (http://www.gfdl.noaa.gov/one_pager_for_cm25_j_clim_paper)

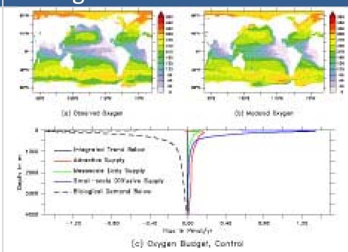
GFDL Experimental Long Lead Seasonal Hybrid Hurricane Forecast System



GFDL has developed an experimental system to make forecasts of seasonal hurricane frequency in the North Atlantic, building on our understanding of the influence of forced and internal climate changes on hurricane activity. We have applied that understanding, gained from researching the century-scale response of hurricanes to climate change, to produce an improved method for forecasting year-to-year variations in seasonal hurricane activity.

The seasonal forecasts are generated using a hybrid statistical-dynamical North Atlantic hurricane frequency prediction scheme, which employs dynamical climate models to predict the future state of the climate system and a statistical model to estimate the frequency of North Atlantic hurricanes given the predicted future climate. The frequency forecasts of Atlantic hurricanes over a broad range of climates is based on a simple statistical model with two predictors: Atlantic and tropical-mean sea surface temperature. Read more... (http://www.gfdl.noaa.gov/hyhufs)

Will Open Ocean Oxygen Stress Intensify under Climate Change?



Global warming is expected to reduce oxygen solubility and vertical exchange in the ocean, changes which would be expected to result in an increase in the volume of hypoxic waters. A simulation made with a full earth system model with dynamical atmosphere, ocean, sea ice and biogeochemical cycling shows that this holds true if the condition for hypoxia is set relatively high. However, the volume of the most hypoxic waters does not increase under global warming, as these waters actually become more oxygenated. We show that the rise in oxygen is associated with a drop in ventilation time.

A term-by-term analysis within the least oxygenated waters shows an increased supply of oxygen due to lateral diffusion. compensating an increase in remineralization within these highly hypoxic waters. This lateral diffusive flux is the result of an increase of ventilation along the Chilean coast, as a drying of the region under global warming opens up a region of wintertime convection in our model. Read more... (http://www.gfdl.noaa.gov/news-app/story.51/title.will-open-ocean-oxygen-stress-intensify-under-climate-change-/menu.no/sec./home./)