# Global Climate Model

During the past decade, Los Alamos has developed a strong program in numerical modeling of the oceans and sea ice using high-performance parallel computing. Sponsored by DOE's Climate Change Prediction Program, Los Alamos' current focus is development and validation of ocean and sea ice models and their application within such fully coupled models as the National Science Foundation's Community Climate System Model.

The global ocean is a crucial part of the earth's climate system. With a density a thousand-fold greater than the atmosphere, the ocean acts as a thermal and compositional flywheel for the system, exchanging with the atmosphere heat, fresh water, and dozens of chemical species that play a role in ocean biogeochemistry. The ponderous ocean circulation is driven at the surface by wind-stress and in the interior by density differences.

Because the internal velocities are much smaller than in the atmosphere, it may take many centuries before the deep ocean responds to surface changes. For similar reasons, the ocean plays a central role in all climate variations of a year or longer. Computer models that accurately simulate the behavior of the oceans and atmosphere are the only way to project future climate and humanity's impact on it. Los Alamos' model simulates at high resolution the incredibly complex ways that ocean currents and temperature evolve over time, along with distributions of temperature, pressure, and salinity. It depicts the three-dimensional global ocean, including realistic bottom topography and coastal boundaries of continents and islands.

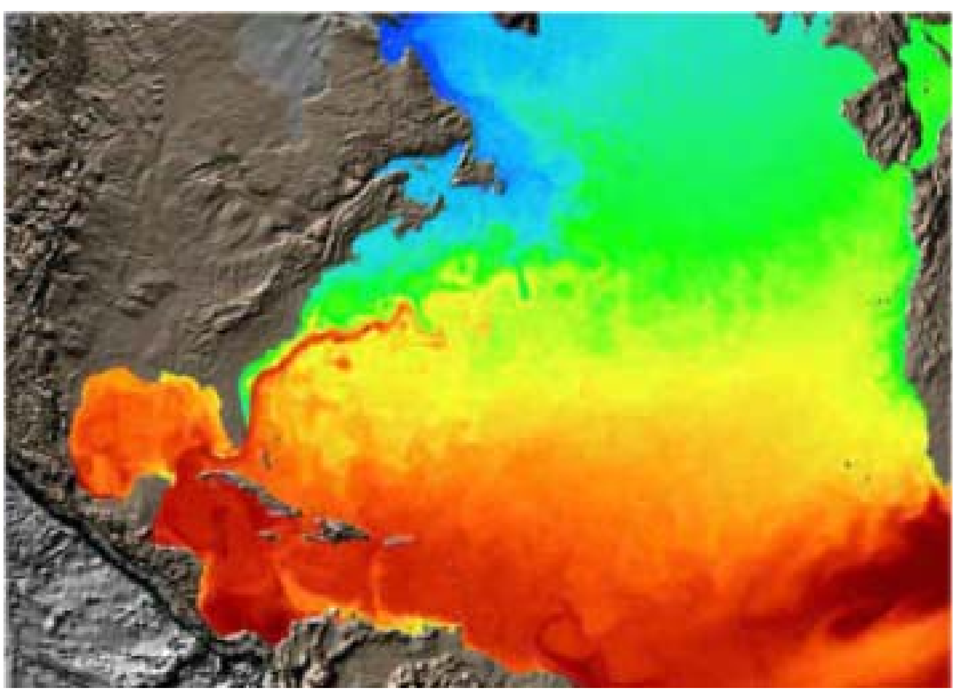
Los Alamos scientists initially used massively parallel computers to build the first models to show eddies realistically. Eddies are present throughout the atmosphere and ocean, but their characteristic sizes in the ocean are one-tenth of those in the atmosphere and initial models missed much of the energy spectrum that drives ocean eddies. Los Alamos' Parallel Ocean Program cut the resolution nearly in half, but this required twice the number of gridpoints in latitude and in longitude, four times as much computer memory and eight times the overall computational burden.

Resolution still was not fine enough. By restricting the model to the Atlantic Ocean, the team obtained spectacular results that agreed closely with satellite measurements of variations in sea-surface height and reproduced many circulation features correctly for the first time. In collaboration with the Naval Postgraduate School, Los Alamos now is running a global simulation at one-tenth of a degree resolution (six miles at the equator) with twice the number of vertical levels (40) as earlier models.

Another major accomplishment was a more responsive, computationally efficient, and physically accurate model of sea ice dynamics. The model now resolves multiple ice categories of different thicknesses, including thin first-year ice and thick pressure ridges, and provides better estimates of ice strength, growth and melt rates, and surface fluxes. Thinner ice grows much faster than older, thicker pack ice floes. Recent upgrades improve resolution of vertical temperature and salinity profiles and simulate the atmosphere-ice-ocean energy budget more accurately.

In addition to DOE and NSF, collaborating institutions include the National Center for Atmospheric Research, UCLA, Colorado State University, Naval Postgraduate School, the University of Miami, and NASA Goddard Institute for Space Studies.

Applications include use as a source for regional climate modeling done by the Laboratory's Earth and Environmental Sciences Division. The Parallel Ocean Program was named the best use of information technology in the science category of the 1994 Computerworld/Smithsonian Awards program.



**North Atlantic temperatures**

Los Alamos National Laboratory is operated by the University of California for the U.S. Department of Energy's National Nuclear Security Administration

Publis Affairs Office 505-667-7000
www.lanl.gov