

## **National Center for Computational Sciences Snapshot The Week of March 5, 2007**

### **Scientists Shed Light on Climate Change**

*NCCS simulations are improving our understanding of carbon dioxide's role in global warming*

Scientists have established beyond serious dispute that the earth's climate is getting warmer.

While the change may seem modest—with the average temperature at the planet's surface rising about 0.75°C (or more than 1°F) over the last century—the potential consequences could be dramatic.

A project headed by Warren Washington of the National Center for Atmospheric Research is using the formidable computing resources of the National Center for Computational Sciences (NCCS) to increase the confidence of global climate analysis. In doing so, the project will provide information needed by residents and policy makers alike to address their changing climate.

The team contributed simulations for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), sponsored by the United Nations. The report concluded that there is more than a 90-percent chance that climate warming over the last 50 years has been the result of human activity.

The primary culprits are chemicals known as greenhouse gases because they cause the atmosphere to trap more of the sun's heat than it otherwise would. The most important greenhouse gas is carbon dioxide, which is primarily released through the burning of fossil fuels by power plants, industry, and vehicles.

Washington's team has already made substantial contributions to the field. It is responsible for the prominent Community Climate System Model (CCSM), which effectively simulates the effect of carbon dioxide on temperature across the planet. Future versions will simulate the entire carbon cycle, calculating emissions where they occur—at factories, power plants, and the urban settings where vehicles are concentrated—and modeling the journey of carbon dioxide in the atmosphere, forests, and the ocean.

The team goes into 2007 with an allocation of 4 million processor hours on the NCCS's Cray XT4 Jaguar supercomputer and 1.5 million processor hours on the center's Cray X1E Phoenix system.

The outcome will be of benefit not only to the dozens of leading scientists working on the project, but also to the scientific community in general.

“We think of the code that we’re developing as an instrument,” explained John Drake of the Oak Ridge National Laboratory (ORNL), chief computational scientist for the project. “No one can develop a climate model on their own anymore; it’s just way too complicated.”

Collaborations between researchers of the National Science Foundation and Department of Energy to develop version 3 of the CCSM are now extended through new partnerships with the National Aeronautics and Space Administration (NASA) and university researchers. The aim is achieving unprecedented simulations and concerted model development. The resulting next-generation climate model—CCSM4—will be used in the next IPCC assessment, scheduled in 5 years, which will explore the dynamics of the atmosphere, land, and ocean and their impact on the physical climate system.

### **Researchers Take Advantage of Increasing Number of Processor Cores**

*Applications are successfully scaling to exploit system upgrades*

Statistics from the fourth quarter of calendar year 2006 indicate that nearly a quarter of the Cray XT3 system’s run time—23 percent—saw usage of more than 8,000 computer cores. In contrast, only 5 percent of usage in the previous quarter was at more than 8,000 cores.

The numbers indicate that users are successfully scaling their applications to take advantage of system upgrades. In August all of Jaguar’s 5,000-plus processors were replaced with dual-core processors, which doubled both the system’s overall speed and the number of processing cores.

Jaguar is the nation’s most powerful supercomputer for open scientific applications. The August upgrade brought the system to a peak performance of 54 trillion calculations per second (54 teraflops).

Users will have access to even more computing power in the coming months as system upgrades continue. The NCCS received 68 new cabinets for Jaguar in November, and users have been moved to the new system, which has a peak performance of 65 teraflops. The two systems will be connected by the end of March, creating a combined system with a peak performance of 119 teraflops.

Eventually Jaguar will be upgraded to a peak performance of 250 teraflops as the dual-core processors are replaced with quad-core processors in the XT4 cabinets.

The NCCS will offer a summer workshop for one-on-one training in scaling of a panoply of scientific applications, ensuring that as the system size grows, researchers are marching step-by-step with it.

## **Cray Users Pool Experience at Workshop**

*Nashville event highlights applications that scale to thousands of cores*

Researchers and computer specialists from the United States and Europe gathered in Nashville, Tennessee, last month to share their expertise and experiences with the Cray XT series and hear news of future lineups.

The first Cray Technical Workshop—USA, sponsored by the NCCS and the Cray User Group, featured both current and prospective users of Cray XT3 and XT4 systems. Attendees from the United States and Europe came from universities, national laboratories, and industry.

Speakers included Cray Chief Technology Officer Steve Scott, who discussed the company's roadmap for future products, as well as Luiz DeRose of Cray, on Cray performance tools, and Brian Waldecker of Advanced Micro Devices (AMD), on upcoming AMD products.

Cray users also gave a number of talks. Topics included benchmarking and performance analysis of the XT3 and XT4 systems, performance analyses of applications in a wide range of scientific and engineering areas, and strategies for optimizing input and output on the XT3 and XT4.

The workshop was modeled on a series of successful workshops that have been held in Europe, and sponsors expect it to become an annual event. Additional support for the workshop came from AMD, Cluster Resources, Blue Arc, and Q-Logic.

Video and slides from the workshop will be available on the NCCS Web site at <http://nccs.gov/news/workshops/cray/index.html>.