NASA expands high-end computing system for climate simulation

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Goddard Space Flight Center recently added 4,128 processors to its Discover high-end computing system, with another 4,128 processors to follow this fall. The expanded Discover will host NASA's climate simulations for the Intergovernmental Panel on Climate Change. Credit: NASA/Pat Izzo

NASA's Goddard Space Flight Center in Greenbelt, Md., made available to scientists in August the first unit of an expanded high-end computing system that will serve as the centerpiece of a new climate simulation capability. The larger computer, part of NASA's High-End Computing Program, will be hosting the agency's modeling contributions to the Intergovernmental Panel on Climate Change (IPCC) and other national and international climate initiatives.

The expansion added 4,128 computer processors to Goddard's Discover high-end computing system. The IBM iDataPlex "scalable unit" uses Intel's newest Xeon 5500 series processors, which are based on the Nehalem architecture introduced in spring 2009.

Discover will be hosting climate simulations for the IPCC's Fifth Assessment Report by the Goddard Institute for Space Studies (GISS) in New York City and Goddard's Global Modeling and Assimilation Office (GMAO). Stimulus funds from the American Recovery and Reinvestment Act of 2009 will enable installation of another 4,128 Nehalem processors this fall, bringing Discover to 15,160 processors.

"We are the first high-end computing site in the United States to install Nehalem processors dedicated to climate research," said Phil Webster, chief of the Computational and Information Sciences and Technology Office (CISTO) at Goddard. "This new computing system represents a dramatic step forward in performance for climate simulations."

In preliminary testing of Discover's Nehalem processors, NASA climate simulations performed up to twice as fast per processor compared to other nationally recognized high-end computing systems. Moreover, the new computational capabilities allow NASA climate scientists to run high-resolution simulations that reproduce atmospheric features not previously seen in their models.

"Nehalem architecture is especially well-suited to climate studies," said Dan Duffy, CISTO lead architect. "Speed is an inherent advantage for solving complex problems, but climate models need large memory and fast access. We configured our Nehalem system to have 3 gigabytes of memory per processor, among the highest available today, and memory access is three to four times faster than Discover's previous-generation processors."

In daily forecasts for NASA satellite missions and field campaigns, the GMAO typically runs its flagship Goddard Earth Observing System Model, Version 5 (GEOS-5) at 27-kilometer resolution. Using Discover's new processors, the GMAO has been testing a special "cubed-sphere" version of GEOS-5 at resolutions as high as 3.5 kilometers.

"Once the model goes below 10-kilometer resolution, features such as well-defined hurricane eyewalls and convective cloud clusters appear for the first time," said William Putman, acting lead of the Advanced Software Technology Group in Goddard's Software Integration and Visualization Office. "At these cloud-permitting resolutions, the differences are stunning." Putman has been collaborating with GMAO modeling lead Max Suarez and others on the cubed-sphere configuration of GEOS-5.

NASA's IPCC simulations will include both longer-and-shorter-term climate projections using the latest versions of the GISS and GMAO models. GISS ModelE will perform simulations going back a full millennium and forward to 2100. Making its first IPCC contributions, the GMAO will focus on the next 30 years and perform decadal prediction simulations using GEOS-5 and atmospheric chemistry-climate simulations using the GEOS Chemistry Climate Model. With the performance of GEOS-5 on the Nehalem processors, investigations of societal relevance, such as climate impacts on weather extremes, now reach a new level of realism. The IPCC's Fifth Assessment Report is due to be published in 2014.

NASA climate simulation efforts also contribute to the U.S. Global Change Research Program, the U.S. Integrated Earth Observation System, and the U.S. Weather Research Program. Supported international programs include UNESCO's Intergovernmental Oceanographic Commission, the United Nations Environment Programme, the World Climate Research Programme, the World

Meteorological Organization, and the World Weather Research Programme.

Source: NASA/Goddard Space Flight Center