UCSD's Supercomputers Cast Light on Cloudy Puzzle of Global Weather

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Record heat waves, exceptionally powerful hurricanes, destructive tsunamis, and melting icecaps have many discussing the weather, but can anybody do anything about it?

The first step towards any solution is understanding the problem, and that's where the San Diego Supercomputer Center (SDSC) – in separate collaborations with the Lawrence Livermore National Laboratory and Colorado State University – applies its heavy-duty number-crunching expertise.

With both Livermore Lab and Colorado State – recent recipient of a $19 million National Science Foundation (NSF) grant to establish a Science and Technology Center – SDSC is working to thoroughly describe and model the role of clouds and other atmospheric phenomena, with the eventual goal of accurate worldwide forecasts.

SDSC, an organized research unit of the University of California, San Diego, has partnered with Livermore since 2005 on an advanced scientific data-management project dedicated to both global climate modeling and cosmology simulations of the early universe. Tim Barnett, of UC San Diego's Scripps Institution of Oceanography, leads the climate-modeling effort; Michael Norman leads the cosmological research at UC San Diego.

"Our work with the Livermore Lab uses global climate modeling to determine the impact of climate changes on water supply," said Barnett.

“We’ll answer the question: Can we detect a global warming signal in main hydrological features of the Western United States? This will involve making runs of global climate and downscaling models that will be unprecedented in scope.”

The collaboration with Colorado State was announced in July, with UC San Diego’s John Helly, laboratory director for earth and environmental sciences at SDSC, named co-principal investigator. That work will also be, in many ways, unprecedented.

“The characterization of clouds is a major limitation in current climate models,” Helly said, discussing the urgency of such research. “With this award, the Center for Meso-scale-modeling of Atmospheric Processes is provided the opportunity to advance the accuracy and precision of atmospheric models. SDSC will play a key role in making this problem computationally tractable, as well as in disseminating the voluminous, high-resolution model results to the research and education community.”

SDSC brings powerful tools to both partnerships. Available resources include production data-management systems as well as development environments for creating and testing next-generation software. The production-data environment includes supercomputers, archival storage systems, high-performance disk arrays, commodity-based disk systems, data-management platforms, database platforms and advanced visualization systems. SDSC capabilities include peak 15-teraflops-capable systems, a 18-petabyte tape archive, and 1.5 petabyte on-line high-performance data-handling systems that can move data at rates from 1 to 7 gigabytes a second.

The center is a node on the Teragrid, and its hardware and software systems support the Scripps Institution of Oceanography’s SIOExplorer digital library, the Real-Time Observatories Network data grid, the NSF’s National Science Digital Library persistent archive, the Joint

Center for Structural Genomics data grid, the Alliance for Cell Signaling digital library, the UC San Diego Libraries' ArtStor image collection, and the Southern California Earthquake Center digital library, among other institutions and resources.

Can those massive computing abilities make enough sense of the unpredictable atmosphere to enable timely, and life-saving, forecasts? Scientists admit that even with today's leading-edge resources, simulations still cannot capture the full complexity of the global-scale patterns of the weather.

But Colorado State's David Randall, professor of atmospheric science and director of the newly funded NSF Science and Technology Center, believes his institution and the SDSC have developed a prototype model with significant promise.

"Our model allows scientists to take a two-dimensional model of a collection of clouds and apply the behavior of those clouds to each of the thousands of 'grid columns' of a global atmospheric model," he said. "The project will make it possible to produce more robust simulations of both next week's weather and future climate change."

Fran Berman, director of the SDSC, sees great benefits to the partnerships with Livermore and Colorado State. "To understand a force as dynamic and complex as the Earth's atmosphere -- or something as ephemeral as a cloud -- today involves simulations with massive computing resources and data collections. SDSC is delighted to participate in the new Science and Technology Center with our partners, and we look forward to the new discoveries that will ensue from this collaboration."

Source: By Paul Mueller, University of California, San Diego