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Courtesy of Pittsburgh Supercomputing Center—07/02/2008

Pittsburgh Supercomputing Center Again Supports Major NOAA and University of Oklahoma Forecasting Effort

By: Michael Schneider / PSC

PITTSBURGH - Once again this year during spring storm season, NOAA (the National Oceanic and Atmospheric Administration) mounted a major experiment in storm forecasting. As has been the case many times over the past 15 years, computational support came from the Pittsburgh Supercomputing Center (PSC).

A goal of the experiment was to test and refine "ensemble" forecasting - which involves running a forecast model multiple times to assess the degree of uncertainty inherent in the forecast. Since it requires running a model many times within a short time period, ensemble forecasts demand large amounts of computational power. Answering that need, providing more than a hundred times more computing each day than the most sophisticated National Weather Service operational forecasts, was PSC's Cray XT3, a 21-teraflop system of the National Science Foundation TeraGrid.

The annual experiment, called the Spring Experiment, is the cornerstone of the NOAA Hazardous Weather Testbed (HWT) located in the National Weather Center at the University of Oklahoma, Norman (OU). Operated jointly by NOAA's Storm Prediction Center (SPC) and the National Severe Storms Laboratory (NSSL), both at OU, the HWT provides a one-of-a-kind environment where researchers and forecasters collaborate while they evaluate the most advanced technologies available for forecasting severe weather. This year's experiment ran for seven weeks (April 21 to June 6) and brought to the HWT more than 60 research and student meteorologists and forecasters from around the world, in groups of about a dozen each week.

Every day during the seven weeks, forecasters at the Center for Analysis and Prediction of Storms (CAPS) at OU transmitted weather data to the XT3 at PSC. Running a 10-member ensemble, 10 slightly different configurations of the forecast model, for nearly the entire continental U.S. at four-kilometer resolution, the XT3 produced forecasts for the next day and transmitted them to OU as they were produced. In addition to the 10-member ensemble runs, CAPS also ran at PSC each day a single higher-resolution forecast (two-kilometer resolution) for the same domain.

"The finer resolution of this run better captures the structure of thunderstorms," says Ming Xue, director of CAPS. "Another significant achievement of this year's spring experiment," he adds, "is the use of observational data from over 120 weather radars to initialize thunderstorms in the prediction model. This has never been done before anywhere."

Back at the HWT, the forecast results were translated into visual display of various forecast products, and that week's group of researchers and forecasters scrutinized a series of computer screens, large and small, arrayed around the room as if it were a sports bar with about a dozen weather reports happening at the same time. Split into two small groups, they talk out loud in turns, with running commentary like radio sportscasters as they interpret the screen displays of vividly colored swirling patterns overlaid on a U.S. map.

"The two-kilometer forecast is the first to go to a more linear mode - with that embedded bow structure." "Most of the initiation is approximately right." "There's a moist tongue extending up the central plains toward Davenport." "The trough axis is slowly progressing eastward."

After awhile they grade the forecasts, assigning a quality score on a 1 to 10 scale. "We're evaluating not just how well the forecast corresponds to reality," says Steven Weiss, Science and Operations Officer of SPC, "but also we're looking at what indicators they give about storm characteristics and severe weather likelihood. These attributes are important and a key reason for testing high-resolution models."

Weiss and Jack Kain, a research meteorologist at NSSL, coordinate the group discussions. NOAA has found, they say, that this interaction between research meteorologists and operational forecasters is unique in the opportunity it provides for the two communities to learn from each other. Forecasters see the latest research concepts and forecast products and researchers experience the constraints and challenges of front-line forecasting.

This year's experiment is only the second time that ensemble forecasts have been carried out in a simulated operational forecasting environment and with a spatial resolution that can directly present the storms. "CAPS and PSC are at the cutting-edge of what we can do technologically," says Kain, "and this is where the rubber meets the road - where the practical value of the latest technologies can be assessed."

Since 1993 PSC has collaborated with CAPS in spring experiments and since 2004 with NOAA. Steady advances in computational technology have led to corresponding advances in the ability to predict storm-scale weather. "The directors and staff of PSC have been scientific collaborators in the deepest sense," says Kelvin Droegemeier, co-founder and director emeritus of CAPS and associate vice-president for research at OU. "They work hand-in-hand, not just to get our codes to run, but with networking and data-transfer, how the code is structured on the machine."

In 2005, using PSC's LeMieux, the first terascale system available via the TeraGrid, CAPS and NOAA learned that with sufficient high-resolution it's possible, in some cases, to predict the details of thunderstorms 24-hours in advance, a milestone in storm forecasting, suggesting that weather at this scale is inherently more predictable than previously thought.

More information: <http://www.psc.edu/science/2007/storms/>

About PSC:

The Pittsburgh Supercomputing Center is a joint effort of Carnegie Mellon University and the University of Pittsburgh together with Westinghouse Electric Company. Established in 1986, PSC is supported by several federal agencies, the Commonwealth of Pennsylvania and private industry, and is a leading partner in the TeraGrid, the National Science Foundation's cyberinfrastructure program.

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