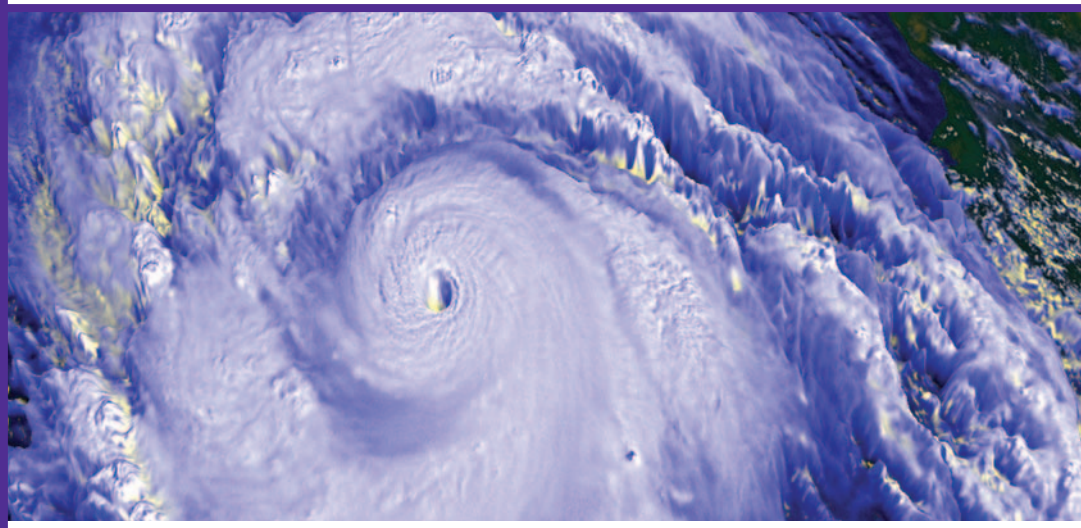
Success Story

Delivering Vital Forecasts for TV Broadcasts



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BAMS Improves Weather Forecasting WITH SGI TECHNOLOGY

As Congress prepares to increase funding for the National Weather Service to fly more hurricane hunter planes in 2006, one commercial weather forecasting company is attracting increased attention for their accuracy during the 2004 and 2005 hurricane seasons. Co-located at the National Climate Data Center in Ashville, North Carolina, Baron Advanced Meteorological Systems (BAMS, *www.baronams.com*) provides broadcast television customers and emergency management officials across the U.S. with 4X daily real-time, site-specific forecast data, 365 days a year. A division of Baron Services, Inc., BAMS processes hurricane weather information multiple times daily, employing SGI® Altix® systems and SGI® InfiniteStorage solutions to run high-performance atmospheric modeling programs.

After customizing the NCAR mesoscale model systems (known as MM5) for more than a decade, specifically targeting boundary layer, land-surface, convective, and cloud microphysics schemes and their interactions, BAMS forecasts have proved increasingly reliable in predicting potential storm paths and changes. Employing 15km resolution across the entire conterminous U.S. and 45km resolution for coastal waters, BAMS runs enhanced, proprietary MM5 codes using a technique called "ensembling" in which different model formulations running on SGI Altix systems analyze many possible atmospheric variations simultaneously.

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"The major benefit of the SGI Altix system is that it has allowed us to expand our numerical weather prediction domains to much larger sizes than before, at much higher resolutions," says John McHenry, chief scientist, Baron Advanced Meteorological Systems. "We can also run forecasts much more frequently, at greater speed, with a larger number of model variants. That's important, because different model formulations allow us to produce ensemble forecasts that account for forecast uncertainty. Faster storage allows us to get models into system memory faster, eliminating bottlenecks. Additionally, with the Altix, our turnaround time has improved by a factor of 4-8X, and that allows us to disseminate weather data to clients much more quickly."

Data From SGI Altix Feeds VIPIR Broadcast Weather Graphics

The public receives BAMS' vital forecasting data through a PC-based product called VIPIR®, developed by Baron Services (*www.baronservices.com*). As the parent company of BAMS, Baron Services, based in Huntsville, Alabama, with satellite offices in Oklahoma, North Carolina and Florida, develops localized weather analysis products for on-air use by broadcast meteorologists, as well as foreign and domestic governments. Its products include real-time radar display and storm tracking, advanced Doppler radar, instant alert systems, weather sensors, weather vans and Internet radar displays. The VIPIR weather system is the first to combine photorealistic mapping, powerful 3D graphics and BAMS forecasting data into a single, real-time environment. Its timeliness and accuracy help television viewers get a clear understanding of the location, path and intensity of approaching storms, so they can make informed decisions about seeking shelter and protecting life and property.

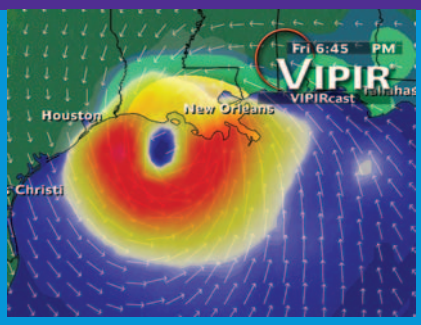
When a new forecast is completed on the SGI Altix system, data post-processing produces a file compatible with the graphics and visualization hardware and software inside the VIPIR which, in turn, produces the animated images viewers see at home. Output files are disseminated to each individual VIPIR system through a centralized data repository at BAMS. The information is not changed in content but it is transformed in terms of its expected input format, and the VIPIR-ready content is then sent out via the Internet from the data center to the individual VIPIR systems in the various geographies. BAMS currently provides weather data to over 200 television broadcasters and emergency management offices across the U.S.

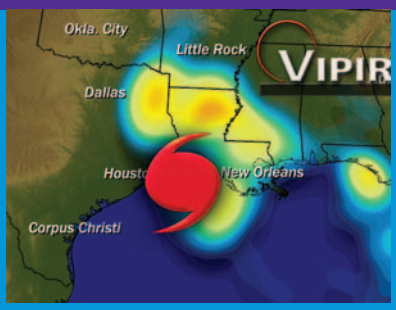
While BAMS is a rising force in the broadcast industry, the Baron subsidiary also provides year-round weather and air quality forecasting to government, scientific and academic entities. For the last two years, BAMS has relied on an SGI® Altix® 3700 high-performance compute system powered by Intel® Itanium® 2 processors and running the Linux® OS and SGI® Advanced Linux Environment and ProPack™. Because its data requires fast access, BAMS employs two SGI® InfiniteStorage TP9100 systems. In addition, the company uses SGI® Altix® 350 systems for research, and runs weather and atmospheric modeling programs on an SGI® Origin® 3800 that has been in use for four years.

Customizing MM5 in IRIX and Linux

The SGI Origin system, which runs the SGI® IRIX® operating environment, has been the main computational backbone used to customize MM5, a weather community model available on the NCAR website (*www.mmm.ucar.edu/mm5*). Customizations were added based on BAMS own expert analysis of the forecast strengths and weakness of the community model. Most of BAMS scientists have had 10 to 15 years experience collaborating with the NCAR people and understand, at a very in-depth level, how that model works and what its strengths and weaknesses are.

One of the primary modeling areas BAMS focuses on strengthening is called the





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atmospheric boundary layer (ABL). The ABL is the layer of air that touches the earth's surface and extends upwards to about where puffy clouds often float along. The ABL is influenced by the frictional forces of the earth's surface mountains, hills, buildings, trees, and even water waves - that essentially slow down the wind. These land-surface features influence not only the surface winds but also the temperature and moisture structure, including the daytime warming and nighttime cooling familiar to our everyday experience of the weather. BAMS invested significant scientific resources toward improving the representation of the ABL within the various mesoscale models they use—especially the way the ABL is to the representation of the land surface and clouds.

Areas having to do with cloud "microphysics" in the schemes BAMS uses have also been improved. The new numerical representation of the microphysics is part of the code that simulates the processes that occur in clouds. Especially with interactions of water vapor and condensed water including particles such as sleet or ice crystals, as well as rainfall amounts and its feedback to atmospheric heating and cooling due to condensation and evaporation.

"All of the work that's been done in making the improvements to MM5 has been performed on SGI platforms, whether it's the Origin or the Altix, and we think that we've made a big difference in the ability of the model to produce good weather forecasts," adds McHenry. "A lot of this work was done on the Origin but it translates over to the Altix very well: it's IRIX into Linux. But you can't make those kinds of improvements without making a lot of model runs, you can't do it in a few days, a few weeks, a few months. You really need a few years, so you can get a grasp on how the model is treating weather in all four seasons, because you want to make improvements that will affect the performance of the model year-round. We've worked toward that and we've been able to statistically validate that the improvements we've put in actually do improve the model in all four seasons. We believe that this is the primary reason for our success in hurricane track forecasting the last few years."

Hurricane Forecast Ensembling on SGI Altix

Early in this decade, the National Oceanic & Atmospheric Association (NOAA) and other tropical weather experts began warning that we were entering a multi-decade cycle of increased hurricane activity in the Gulf of Mexico and along the U.S. Eastern seaboard. In 2004, the Atlantic Basin saw 15 tropical storms and nine hurricanes, including six major (Category 3 or higher) hurricanes. The records were shattered by the 2005 hurricane season: 26 named storms, 13 hurricanes, including seven major hurricanes, and the first time four major hurricanes hit the U.S. in a single season. Broadcast meteorologists began noticing that BAMS' forecast tracks were increasingly accurate, which McHenry credits to both the model physics improvements and ensembling methods developed at BAMS.

"There are different ways to set the model up in terms of its domain, its resolution, and its vertical layer structure, and we use all of these techniques to produce different ensemble members," explains McHenry. "We use different schemes to

represent different physical processes within each member; and in some cases, we use schemes that we haven't worked on. When we construct an ensemble, we construct it with a view towards such a variety in order to approximate the actual physical sensitivity of the weather to subtle influences that cannot be accurately measured or fully represented. That gives us a nice broad spectrum of model results and, as a season evolves or as events evolve, we can make expert judgments about what's doing what, allowing us to send out the best performing product for each unique tropical event."

To ensure continued broadcasting to the areas hardest hit by the 2005 Hurricane season, Baron Services responded two days before Katrina made landfall in the Gulf, providing technology, equipment and technicians to eight television stations in Louisiana, Mississippi and Alabama. The company also supplied a VIPIR system to CNN to aid in its continuous weather coverage. During the outbreak of hurricanes in Fall 2004, Baron sent 40 systems and representatives to assist clients in the path of storms such as Hurricane Charley.

While almost all numerical forecasts agreed where Hurricane Katrina would make landfall, the uncertainty in the track and land-fall intensity of Hurricane Rita was high. Five days out, the BAMS ensemble focused on southwestern Louisiana as a highly probable landfall location. In the ensuing days, the BAMS ensemble consistently continued this trend despite its being 300 to 400 miles to the right of the official forecasts used to guide coastal evacuations along the Texas Gulf Coast from Houston to Galveston and farther south. Approximately six to 12 hours before landfall, the official forecast was changed to correctly predict landfall in extreme southwestern Louisiana.

"When it comes to comparing models against models and forecast methods against other forecast methods, where the rubber really meets the road is a true mathematical analysis of the track forecasts, the intensity forecasts, the landfall forecast and how those forecasts played out against what actually happened," says McHenry. "I think that qualitatively, with quite good confidence, that for many of the major storms that occurred this summer we provided alternative information of high value. Because our models have some different kinds of features in them, it really boils down to how well those novel features perform. We believe that there is compelling evidence that our models provide an improved accuracy in information. We would welcome the opportunity to share this information with official government forecasters to provide the optimum environment for public forewarning."

The BAMS forecast model also received nationwide recognition in 2004 when it was the only model to correctly forecast the path of Hurricane Charley, the strongest and costliest storm (until Katrina) to hit the U.S. since Hurricane Andrew in 1992. Making landfall as a Category 4 hurricane, Charley ravaged Florida's southern Gulf Coast—notably the town of Punta Gorda –causing approximately $14 billion in damage. Other forecasts had the hurricane's eye making landfall up to 150 miles north.

The compute power, speed and reliability of the SGI Altix system is of paramount importance to BAMS forecasts. "The Altix combines a powerful Intel processor with SGI technology that allows for computing and scalability with both shared and distributed memory," concludes McHenry. "You cannot be dealing with systems that constantly need to be watched and fixed in a 24/7 operational environment, so we appreciate the stability and robustness of SGI products. Our company slogan is 'technology and people dedicated to saving lives.' That's why we're here. And we need the best equipment to give our customers the information they need to properly inform the public."

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