Earth System Research Laboratory
Global Systems Division
High Performance/Fine Grain Computing and GPUs

Meeting NOAA's Computing Needs

What does ESRL's Global Systems Division High Performance/ Fine Grain Computing and GPUs Research Provide to the Nation?

NOAA's Global Systems Division's (GSD) goal is to provide revolutionary technology that meets the needs of NOAA environmental modeling programs including the High Impact Weather Prediction Project (HIWPP), Hurricane Forecast Improvement Program, Warn-on-Forecast, and the National Weather Service's Next Generation Aviation Weather Program.

www.esrl.noaa.gov/gsd/

High Performance/Massively Parallel Fine Grain Computing and GPUs Research Highlights

High Performance Computing: GSD supports top-level scientific research with continuous high-performance computing in a state-of-the-art center

High performance computing is required to manage and process the increasing amounts of complex data and equations necessary to improve the accuracy and timeliness of predictions. A high performance computer (supercomputer) produces complex weather predictions by breaking the mathematics into hundreds of thousands of smaller, more manageable, and reliable calculations that are solved simultaneously.

GSD is one of NOAA's three sites that host research and development high performance computing systems shared by the entire NOAA user community and connected by NOAA's NWAVE multi-10Gb network. GSD's 2,060-square foot computing facility is housed at the NOAA campus in Boulder, Colorado and managed by GSD.

The room's award-winning design can handle the system's rigorous environmental and electrical demands. State-of-the-art ambient air cooling, a fire protection system, and many sophisticated facility environment monitoring and control safeguards, are features that add up to a highly reliable and resilient center. The facility enhances NOAA's efficient and timely delivery of products and services.
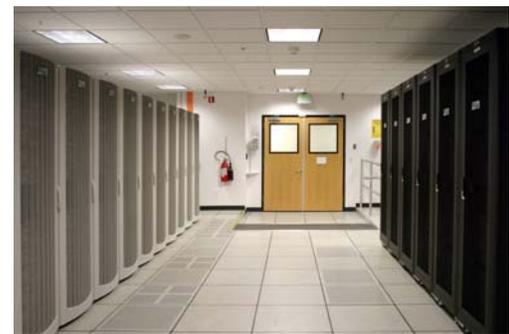
Massively Parallel Fine Grain Computing: A faster and more efficient high performance computing architecture

GSD is at the forefront of a new generation of high-performance computing architecture called "Massively Parallel Fine Grain" (MPFG). Up to 24 powerful cores are found in a typical Computer Processing Unit (CPU), but MPFG relies on hundreds to thousands of computer cores to subdivide large problems into smaller ones, and solve them at the same time.

Using MPFG is a cost effective, reliable, and energy efficient way to run the best available weather and climate prediction models. High Impact Weather Prediction Project (HIWPP) activities build on successful GSD research and development on MPFG.

GSD's state-of-the-art high-performance super-computer and award-winning facility at NOAA's Earth System Research Laboratory in Boulder, CO. *NOAA photos by Will von Dauster*

High Performance/Fine Grained Computing and GPUs Research Highlights - Continued

Graphics Processing Units (GPUs): Affordable, powerful processors originally designed for life-like video games adapted by GSD for science

GSD began exploring GPUs for next-generation supercomputers in 2008 as a means to lower the cost of computing, while speeding up the calculations. Today GSD rigorously develops and tests Graphical Processing Units (GPUs) to use in high-performance supercomputing platforms that support NOAA and the nation's scientific and modeling needs.

A GPU is a special computer chip used to create images for visual displays used in mobile phones, personal computers, workstations, and game consoles. Modern GPUs manipulate computer graphics efficiently, and their highly parallel structure makes them more effective than general-purpose CPUs for algorithms that require large blocks of data to be processed at the same time.

GSD studies show GPUs are much more reliable, 10-20 times cheaper, and provide equivalent processing power when compared with larger CPU systems that are more complex and sensitive to individual components. GPUs consume less power and space, and execute work in small batches using memory more effectively so computations are never waiting in line. GSD has also demonstrated that weather models can run three to five times faster on GPUs than on traditional multi-core CPUs.

NVIDIA Tesla (top) and Intel MIC (bottom) Graphics Processing Unit - GPU-accelerated computing is the use of GPUs together with CPUs to accelerate scientific and engineering applications. Research and development is ongoing at GSD to explore and use these powerful processors for the needs of NOAA and the nation.

Bronze Medal Recognition

In 2014, a GSD senior manager was awarded the Department of Commerce Bronze Medal for "dedication in acquiring supercomputing services to sustain production of the Nation's operational numerical weather and climate forecast systems."

Up Next for GSD

GSDs research and development supercomputers support a wide variety of applications, serving NOAA research labs and university collaborators. The calculating power and volume-handling storage allow scientists to produce more accurate ocean, air quality, and environmental models that lead to a better understanding of our complicated Earth system.
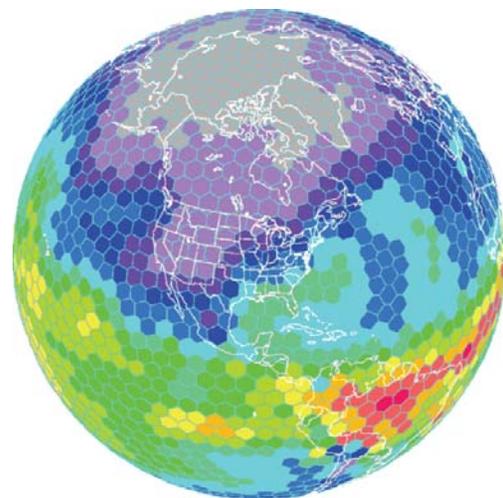
An example of the grid of a GSD high-resolution weather model, the Non-hydrostatic Icosahedral Model (NIM) that runs faster and uses less power on MPFG-based super-computers than traditional CPU-based processors.

For more information on the Global Systems Division, visit http://esrl.noaa.gov/gsd/