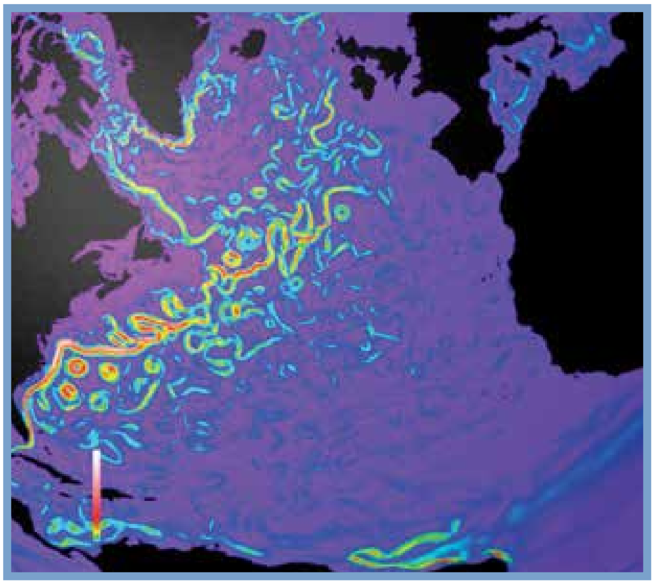
STRATEGIES FOR LEADERSHIP CLASS COMPUTING AND CLIMATE MODELING AT THE DEPARTMENT OF ENERGY

AGU TH32B December 5, 2012, 12:30 – 1:30

This town hall is devoted to the grand challenges in climate science and the potential for addressing these challenges using advances in Earth system models and leadership computing. This issue is especially timely with the release of petabytes of climate simulation through the latest Coupled Model Intercomparison Project (CMIP5) through a truly global federation of climate modeling centers and data providers. The town hall will feature several of the scientific leaders in the Department of Energy (DOE) climate community, including William Collins (LBL/UCB), Jim Hack (ORNL), Phil Jones (LANL), and David Randall (CSU). The speakers will cover a range of topics of interest to anyone who uses climate projections for studies in climate science, impacts and adaptation, or mitigation. The recent NRC report and its implications for climate simulation and its computational support will be discussed. The town hall will conclude with an open discussion of computational challenges and opportunities.



DOE researchers are developing high and variable resolution models, such as this variable resolution ocean Model Prediction Across Scales (MPAS), which is capable of resolving eddies in high-resolution regions.

TOPICS COVERED INCLUDE:

- How has science evolved with computational capability and architecture, and how might these evolve during the coming decade?
- What are the trade-offs between complexity, resolution, and ensembles, and how are these affected by hardware architectures?
- How will partnerships with the mathematical and computational Institutes under the Energy Department's Scientific Discovery through Advanced Computing (SciDAC) program help to advance our climate science?
- What are the emerging techniques to maximize the utility of leadership computing and how are these evolving?
- How could modern workflow designs rationalize and streamline the design, implementation, and rigorous testing of climate models?
- What are the major new challenges in big climate data and what new approaches are required to address the exponential growth in climate simulation?
- What new machine capabilities will DOE be offering soon and how does one obtain access to these machines?

GRAND CHALLENGES

Advancing new grand challenge climate model simulations requires that model deployment keep stride with the continuous evolution of high-performance computers. Current leadership-class machines have enabled DOE researchers to perform ultra-high resolution climate simulations (25km atmosphere, 10km ocean) that explicitly resolve features like tropical cyclones and ocean mesoscale eddies while also reducing biases and enabling analysis of climate extremes. Other DOE projects have used computational capability to add new processes to address outstanding questions, such as ice sheet models for projecting the rate of future sea level rise. New computing architectures will improve the ability to perform routine ensembles of simulations, while continuing the push toward cloud-resolving scales and other new capabilities.

EXPLOITING NEXT-GENERATION ARCHITECTURES

Next-generation computing architectures rely on increased parallelism (many cores) and alternative chip technologies (GPUs as accelerators) for improved performance.
As DOE Leadership Computing Facilities deploy these new architectures, new opportunities are available to advance climate science. Early results from porting current models to these new machines indicate factors of up to 2-3x improvement in throughput. However, taking full advantage of new architectures will require revisiting current approaches and designing new algorithms in collaboration with applied mathematicians and computer scientists. The DOE Scientific Discovery through Advanced Computing (SciDAC; http://www.scidac.gov) program is an example of such collaboration that funds climate science projects with specific links to partners in dedicated math and computational science Institutes. These partnerships enable climate scientists to take advantage of the latest algorithmic advances and computational expertise to map new algorithms to advanced architectures.

DOE is deploying advanced architectures, like Titan, at their Leadership Computing Facilities that will enable further improvements in climate science and continue the drive toward cloud-resolving climate models and beyond. Access to these machines for DOE researchers, their collaborators, and the broader climate science community is available through proposal-based processes, see http://science.energy.gov/ascr/facilities/.

DATA MANAGEMENT

Data archiving, management, and analysis have not kept pace with the grand challenge simulations being performed. DOE provides frameworks for remote data access and is developing the needed parallel analysis tools. Integrated workflows are also being developed to manage climate simulation ensembles, analysis of results, and new statistical tools for uncertainty quantification and parameter calibration.

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DOE CLIMATE PROJECT EXAMPLES

SciDAC Projects
https://outreach.scidac.gov/multiscale/
http://www.scidac.gov/PISCEES/
http://www.aces4bgc.org/

Climate Science for a Sustainable Energy Future (CSSEF)
http://climate.llnl.gov/cssef/index.html