Summary of the Information Technology Infrastructure Plan to Advance Ocean Sciences

Urgent Issues

The scientific case for enhanced Ocean Information Technology Infrastructure (OITI) resources is founded on the experience derived from a decade of global ocean programs and the scientific challenges and opportunities identified by two recent reports, *NSF Geosciences Beyond 2000* and *Ocean Sciences at the New Millennium*. These reports, combined with community input gleaned from a comprehensive survey of current and projected information technology (IT) needs, identified several urgent IT infrastructure issues.

Scientific Opportunities in Ocean Sciences

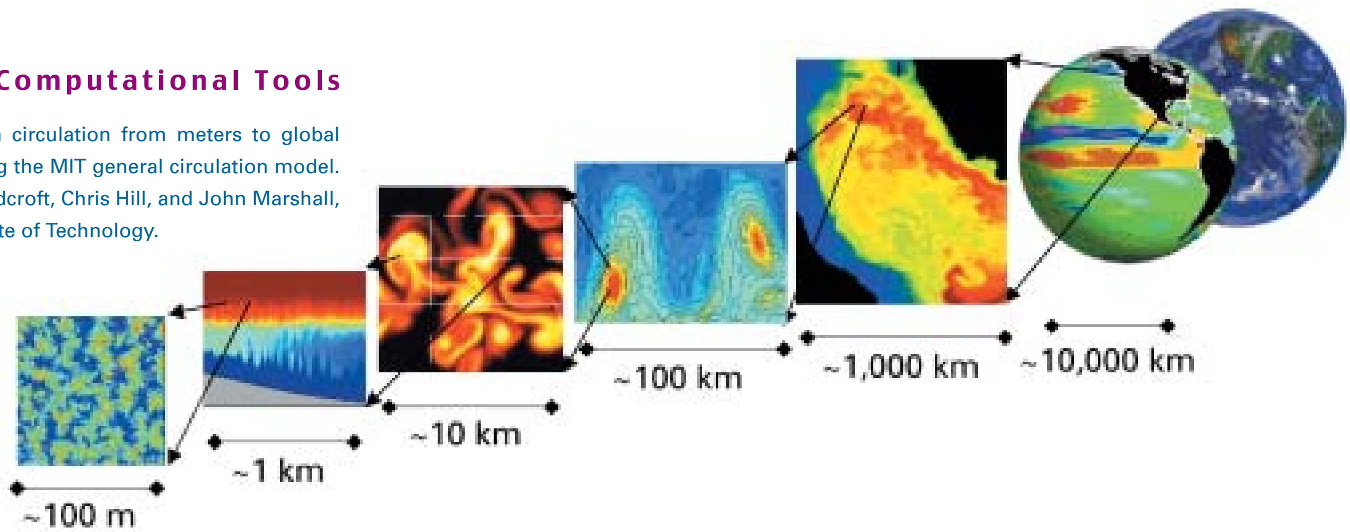
- Ocean Turbulence
- The Complex Coastal Ocean
- Non-Equilibrium Ecosystem Dynamics
- Long-Term Ocean Observations and Prediction
- The Ocean's Role in Global Climate
- The Ocean Below the Seafloor
- Dynamics of Oceanic Lithosphere and Margins

from *Ocean Sciences at the New Millennium*

- Hardware capacity. A multi-fold increase in hardware capacity is required to meet ocean sciences research goals in the next ten years. The most critical bottlenecks are in the availability of compute cycles, memory and mass-storage capacity, and network bandwidth.
- Software systems. There are significant challenges in the area of software systems for efficient use on massively parallel computers. Significant advances must be made in visualization techniques to deal effectively with increasing volumes of observations and model output, and well-designed, documented, and tested community models of all types are urgently needed.
- IT personnel. There is an extreme shortage of skilled IT infrastructure personnel accessible to the ocean sciences community. Steps must be taken to train and retain new IT specialists.
- Data systems. Novel IT approaches are needed to handle and exploit the present and future data streams from experiments, observing systems, and model runs. The challenge extends beyond just the computational resources of handling the data streams and requires advances in the way data streams are documented, shared, and saved.

Computational Tools

Simulations of ocean circulation from meters to global scale carried out using the MIT general circulation model. Courtesy of Alistair Adcroft, Chris Hill, and John Marshall, Massachusetts Institute of Technology.

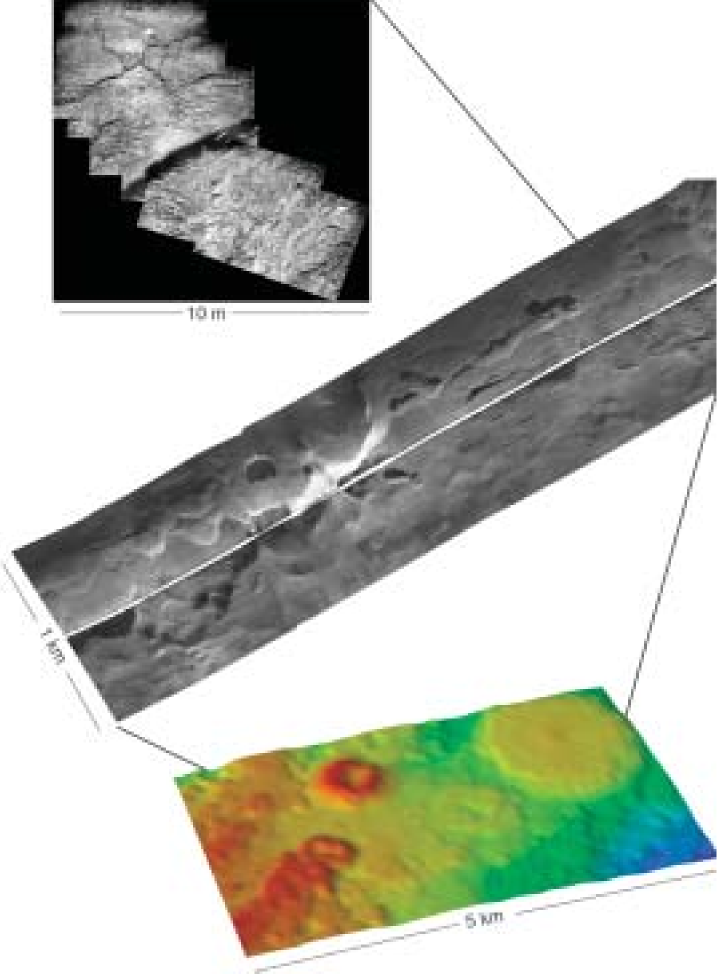


Long-Term Recommendations

To address the issues and roadblocks identified by the ocean sciences community, the OITI Steering Committee* recommends a substantial long-term investment in IT Infrastructure for ocean sciences. This infrastructure would deployed in flexible ways and managed by a new entity called Ocean.IT (pronounced ocean I T). Ocean.IT will serve four main functions.

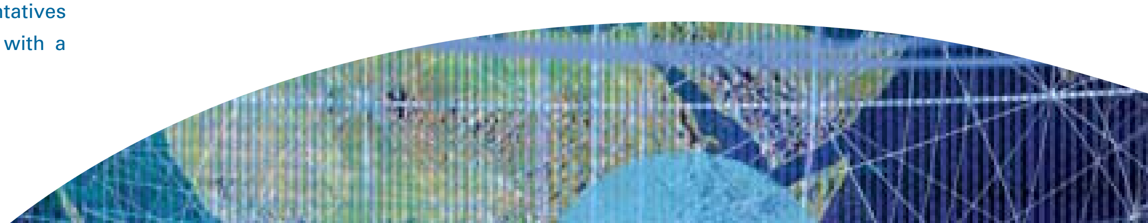
1. Improve access to high-performance computational resources across the ocean sciences. This will be accomplished by both streamlining the current allocation procedure for shared resources, and by the acquisition of new hardware for dedicated use by the ocean sciences community.
2. Provide technical support for maintenance and upgrade of local IT Infrastructure resources. Ocean.IT will provide consulting services to facilitate efficient deployment of IT infrastructure within institutions involved in oceanographic research. Staff will be responsible for continuous technical evaluation of computing and networking hardware options, will make recommendations on computer software acquisition, and will provide guidance on hardware and software installation.
3. Provide model, data, and software curatorship. Community models will be distributed through a central repository, with ongoing documentation of algorithm development and improvement. Archives of key data sets and model output will be served to facilitate their use in research by the wider community. A library of diagnostic and visualization tools will be maintained.
4. Facilitate advanced applications programming. Technical support and training will be provided to allow ocean scientists to take maximum advantage of IT infrastructure resources, including parallelization tools and advanced software interfaces.

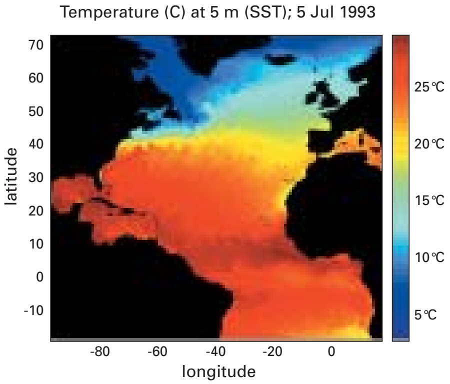
* The OITI Steering Committee includes representatives from academic and governmental institutions with a range of information technology expertise.

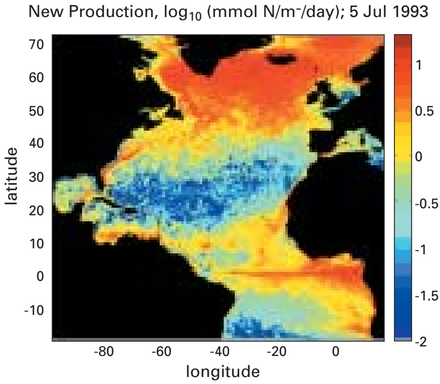


Ocean.IT Will...

- function like a scientific program office and provide leadership and advocacy for the infrastructure needs in ocean sciences research areas that use and need information technology.
- function as a resource center for hardware, software, archiving, data serving, technical training and consulting.
- provide both central and distributed human and technical resources.

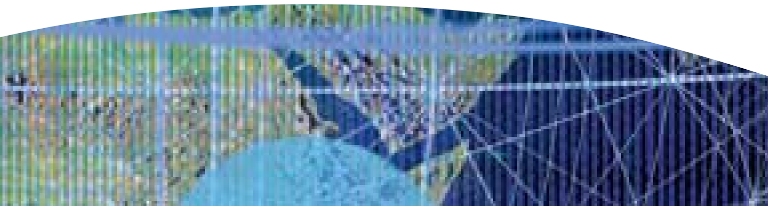






Basin-Scale Eddy-Resolving Biogeochemical Simulations

Mesoscale (100s of km) eddies in the ocean are an important vehicle for transporting nutrients to the surface where they are consumed by plankton. Recent increases in computational capability, together with progress in ocean modeling, have facilitated some of the first truly eddy-resolving, basin-scale simulations. Such calculations provide a framework in which the impact of mesoscale processes on biogeochemical cycling can be studied (above). A significant enhancement in computational infrastructure is required to study the productivity of ocean ecosystems with a more appropriate degree of biogeochemical realism. Courtesy of Dennis McGillicuddy, Woods Hole Oceanographic Institution.

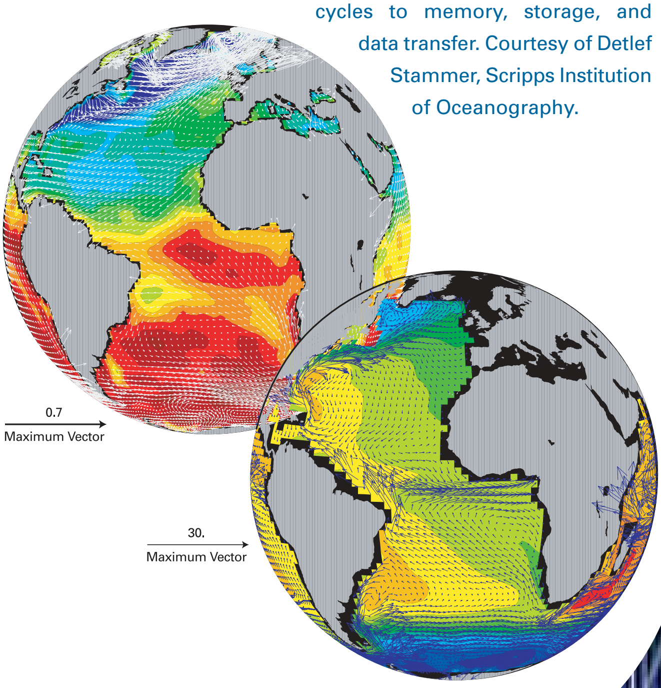


High-Resolution, Multi-Sensor Data Sets of the Seafloor

"Nested surveys" are now a common strategy for mapping the seafloor at increasing resolution using different instruments (left). With these surveys come vastly increased data volumes that must be archived and made easily accessible to users. Tools for analysis and visualization of these data are also critical needs. Courtesy of Deborah K. Smith, Woods Hole Oceanographic Institution and Suzanne Carbotte, Lamont-Doherty Earth Observatory.

Global Ocean State Estimation

Ocean state estimation combines information from data and models to obtain the best possible description of the changing ocean (below). This technique will provide insights into the nature of climate-related ocean variability, major ocean transport pathways, heat and freshwater flux divergences, the location and rate of ventilation, and the ocean's response to atmospheric variability. State estimation places very heavy demands on IT resources, from computational cycles to memory, storage, and data transfer. Courtesy of Detlef Stammer, Scripps Institution of Oceanography.



To view the full plan visit:
www.geo-prose.com/oiti/report.html

To request a single copy of this report, "Ocean Sciences at the New Millennium," or "NSF Geosciences Beyond 2000," write to:
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