www.calit2.net   ceoa.ucsd.edu

Calit2 & CEOA

Transforming Scientific Discovery Through Telecom and IT

Calit2 & CEOA
Transforming Scientific Discovery Through Telecom and IT

Earth system science requires detailed investigation of a complex, dynamic, multi-scale, multidisciplinary environment. Advances in wireless and optical telecommunications and information technology are radically transforming previous methods of investigation serving a broad range of Earth system science, and vastly broadening their scope. This is especially true for Earth observation science; technologies recently being brought to bear include sensornets with in-line pattern recognition, remote high-definition video, and scalable visualization walls.

Integrating these technologies with state-of-the-art computing and telecommunications infrastructure makes it possible to build, for example, comprehensive data collection, archiving, and analysis systems. Such innovative systems are collecting real-time data continuously from large areas—on land, in the atmosphere, and from the seafloor—that can be studied, assimilated with predictive computational models, visualized in the highest possible resolution, and stored in publicly accessible data grids for colleagues around the world to access.

Imagine being able to view—from your office—live, continuous, high-definition video of a thermal sea vent a few kilometers below the seafloor. Or imagine the signal from the site of an earthquake racing over the Internet faster than the seismic wave, and shutting down gas lines in cities before the shaking begins. Prototypes of both of these applications have already been developed by university researchers, who are exploring how these capabilities might fundamentally change scientific expectations and the educational opportunities that emerge from them.

As new technological capabilities are made available to Earth system scientists, they, in turn, will develop new research ideas to pursue, which will then push development of technological capabilities. It is this opportunity for "leapfrogging" between Earth observations and applications, and telecommunications and information technology that has drawn CEOA and Calit2 together to share ideas, technologies, software/middleware, personnel, and space.

Background image: The flooded condition of a small section of the Amazon River (Western Para Province, Brazil), including the jungle towns of Obidos and Oriximina. Courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center.

SIO researchers Atul Nayak and Debi Kilb study hurricane Katrina transposed over global topography and bathymetry data on the high-resolution "iCluster" Mac tiled display (4 panels wide by 3 tall array of 30-inch Apple Cinema HD Displays).

About Calit2

Calit2, a partnership between UC San Diego and UC Irvine, conducts research on the future of telecommunications and information technology and how these technologies will transform a range of applications important to the economy and quality of life. (www.calit2.net)

Larry Smarr
Calit2 Director

About CEOA

Established in the Spring of 2005 at UC San Diego, and led by Scripps Institution of Oceanography, the Center for Earth Observations and Applications (CEOA) is bringing together scientists from across the spectrum of natural, physical, and social sciences, engineering, and information technology to provide an integrating vision for work related to Earth observations. (ceoa.ucsd.edu)

John Orcutt
CEOA Director

USArray Network Facility

A continent-scale seismic observatory (a component of the NSF-funded Earthscope experiment), this network supports integrated studies of the continental lithosphere and deep Earth structure. The Array Facility, located at the Cecil H. and Ida M. Green Institute for Geophysics and Planetary Physics at SIO, is collecting real-time data from flexible sensor arrays that are moving incrementally across the US, performing quality control, archiving the data, and making it available to the public through innovative applications. The facility was set up to house the

Image from EarthScope's USArray, a continental-scale seismic observatory.

computer equipment and personnel to support this undertaking. The data collected, which amounts to more than a Gigabyte a day from 100 stations, is viewed on a tiled, 50-megapixel display, consisting of 30-inch Apple Cinema HD Displays (4 panels wide by 3 tall). (anf.ucsd.edu)
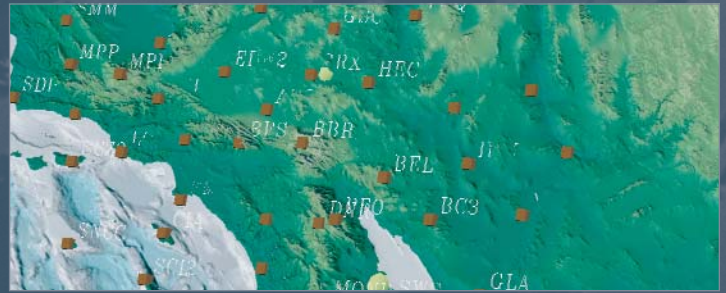
Real-time Observatories, Applications, and Data Management Network (ROADNet)

ROADNet develops sensor networks, autonomous field sensors to monitor fire and seismic hazards, environmental pollutants, water availability and quality, weather, ocean conditions, soil properties, and the distribution and movement of wildlife, and the hardware, middleware and software tools to make this data available in real time to a variety of end users. ROADnet tools allow visitors, for example, to see real-time images from University-National Oceanographic Laboratory System (UNOLS) vessels, San Diego beaches and piers, and the

ROADNet webcam captures lightning striking the Imperial Beach Pier, September 2005.

Santa Margarita Ecological Reserve north of San Diego. (roadnet.ucsd.edu)

HiSeasNet, a related satellite communications network, provides continuous Internet connectivity for oceanographic research ships and platforms. It transmits data in real time to shore-side collaborators, supports e-mail, voice, and videoteleconferencing for scientists, engineers, and crew at sea, and provides tools for real-time educational interactions between shipboard scientists and teachers and their classrooms. (hiseasnet.net)

## Laboratory for the Ocean Observatory Knowledge Integration Grid (LOOKING)

LOOKING seeks to integrate existing and emerging technologies into a coherent cyberinfrastructure to create an ocean observatory-based knowledge grid. It will support dynamic harnessing of resources, including physical assets (e.g., instruments, network segments, power, compute/storage/visualization grids), retrospective informatics and analytic services, real-time sensing networks, and predictive modeling services. The goal is to create an autonomous sensor network that responds to changes in user requirements, technologies/software/middleware, and ocean observatory life cycle needs. (lookingtosea.ucsd.edu)

Screen capture from a video of a black smoker chimney. The video—taken 200 miles off the Washington coast and 7,000 feet below the surface of the ocean by the University of Washington—was transmitted in real time to Calit2 during iGrid 2005.

OptIPuter

The OptIPuter, named for its use of **Opt**ical networking, **I**nternet **P**rotocol, and comp**uter** storage, processing, and visualization technologies, is an emerging infrastructure that tightly couples computational resources over parallel optical networks using the IP communication mechanism. The OptIPuter exploits a new world in which the central architectural element is optical networking, not computers, creating "supernetworks." This paradigm shift requires large-scale, applications-driven, system experiments and a broad multidisciplinary team to develop innovative solutions for the emerging "LambdaGrid" world. The goal is to enable scientists generating terabytes and petabytes of data to interactively visualize, analyze, and correlate their data from multiple storage sites connected to optical networks. One of the drivers for OptIPuter development is EarthScope. (www.optiputer.net)
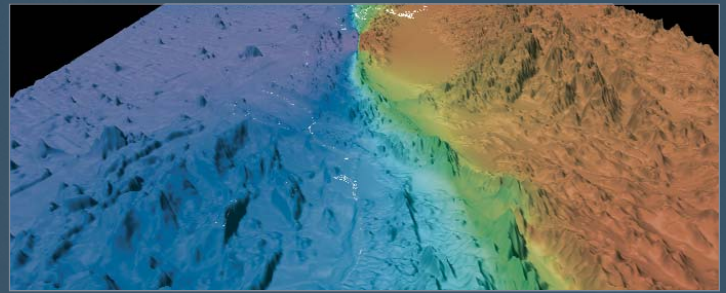
Theoretical model of tectonic plate motion along the San Andreas fault in California. Courtesy of the Scripps Visualization Center.

# Southern California Coastal Ocean Observing System (SCCOOS)

SCCOOS integrates coastal observations along the southern California bight to address issues in coastal water quality, marine life resources, and coastal hazards. Working interactively with local, state, and federal agencies, resource managers, policy makers, educators, scientists, and the public, SCCOOS is improving delivery of coastal observations to enable better management of the coastal ocean environment. The SCCOOS website serves: automated and manual shore station data dating back to the early 20th century; near-real-time surface current, wave height, and surface winds data; and bathymetric data for the southern California bight. (www.sccoos.org)
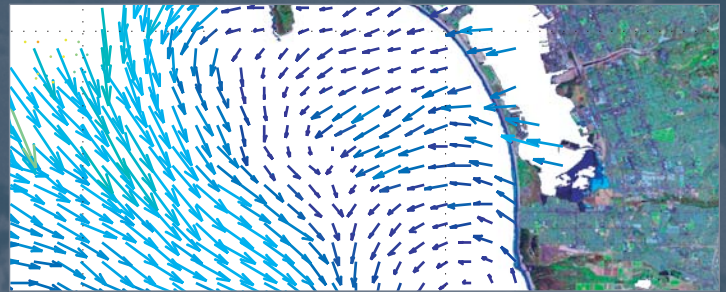
HR radar vector field, offshore San Diego, California

Visualization Center at Scripps

The Visualization Center at Scripps provides a diverse array of research tools supporting real-time videoteleconferencing and lectures, webcasts, data sharing among distributed locations, live field reports, and real-time data acquisition and presentation. Its resources are also being applied to wider community needs, heightened response to natural and human induced disasters, and education and outreach. The center comprises high-resolution projection and tiled display systems supporting Earth system science visualizations that are driven by multiprocessor SGI machines and Linux and MacOS X clusters. It is a node on the OptIPuter grid. (siovizcenter.ucsd.edu)
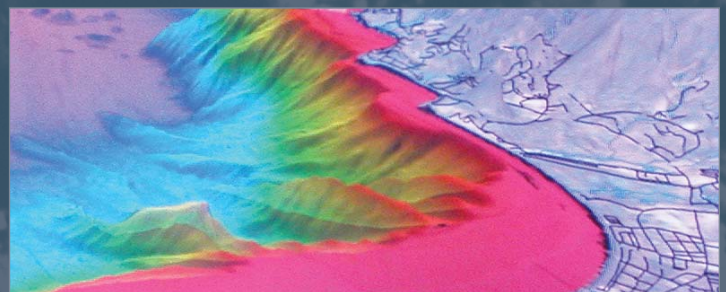
3-D visualization of the bathymetry and topography of Lake Tahoe and surrounding region as viewed on the Scripps Visualization Center HIVE.

for more information

Calit2

Stephanie Sides *Director of Communications*

ssides@ucsd.edu
858.534.5131 (p)
858.822.3912 (f)

Calit2
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0436

CEOA

Carolyn Keen *Program Manager*

cskeen@ucsd.edu
858.822.3700 (p)
858.822.3372 (f)

Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0225

This brochure outlines some early collaborative projects, many of which are supported by the National Science Foundation. These projects are being demonstrated at a variety of multidisciplinary and technology conferences, including the Supercomputing and American Geophysical Union meetings.

www.calit2.net   ceoa.ucsd.edu

The Drake Passage. Courtesy of the Scripps Visualization Center.