Scientific Perspective of Earth Observation Systems

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Establishing an integrated Earth observation system is crucial to sustaining the healthy functioning of our planet's ecosystems and to the social and economic well being of our global society. This system will be key to our comprehensive understanding, careful monitoring, and accurate prediction of changes on our planet. It will undoubtedly enhance our ability to improve weather forecasts, assess disaster situations, prevent loss of life, modify resource use and reuse, and of course, track large-scale Earth changes. We stand at the threshold of forming a new and deeper understanding of our planet, across the scales of space and time.

Clearly, understanding the Earth systems requires studying many interrelated processes across the globe. We know that we cannot completely comprehend its complexity by examining elements in isolation. We also know that we must share key observations to be able to benefit from each nation's observing capacity.

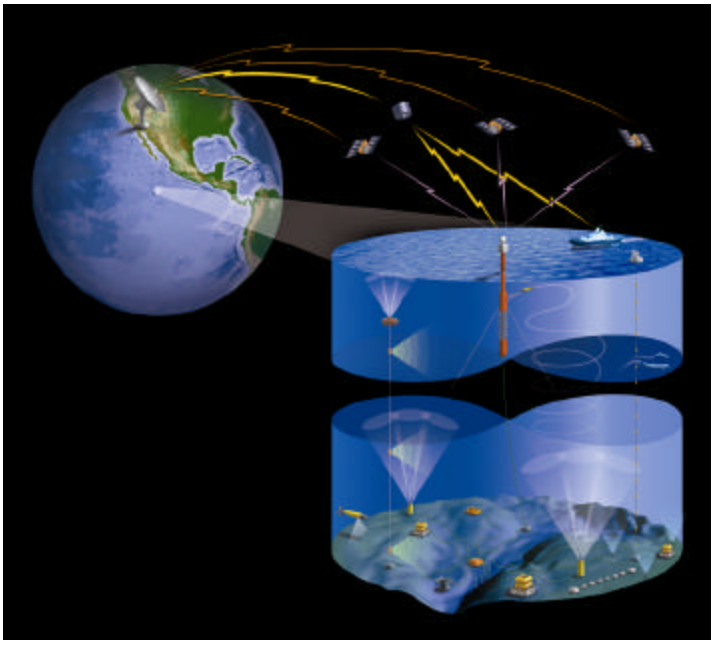
We are fortunate that science and technology offer new tools not only to observe but also to synthesize, not only to probe our planet's past, but also to model future outcomes.

The National Science Foundation supports a very broad range of science and engineering activities. It invests in creative people, innovative ideas, and evolving technology. Of the many possible examples of NSF contributions to the Earth observations, I have selected a few that offer exciting prospects for enlarging our understanding of the Earth and its processes.

The Ocean Observatories Initiative (OOI) is one of a number of innovative concepts that will employ new technical capabilities to obtain observations from remote areas of the ocean, and for sufficient duration to provide the basis of new understanding of ocean phenomena.

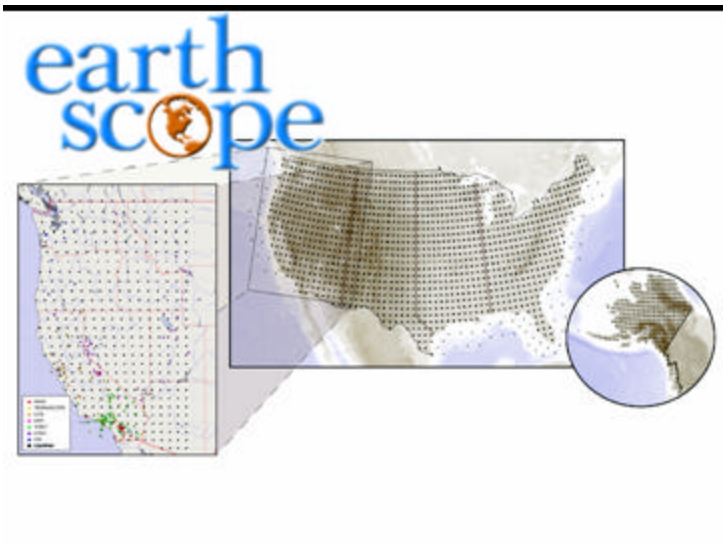
The Ocean Observatories Initiative will enable the ocean sciences community to probe the depths of oceans and will provide us access to a broad range of long-term measurements in the oceans and seafloor below. The OOI will be an integrated observatory network linked to the Internet via seafloor cables and/or satellites and will allow near real-time access to global data. The OOI concept is comprised of three principal elements: a regional observatory consisting of interconnected sites on the seafloor that span several geological and oceanographic features and processes; several deep-sea observatories based

around a system of buoys that can be situated to observe key phenomena; and an expanded network of interdisciplinary coastal observatories.



Schematic illustration of the Ocean Observatories Initiative

EarthScope is another innovative tool with exciting possibilities. The EarthScope facility is a multi-purpose array of instruments and observatories that will greatly expand the observational capabilities of the earth sciences. It will permit us to advance our understanding of the structure, evolution, and dynamics of the North American continent. Scientists will be able to conduct studies on fault properties and the earthquake process, crustal strain transfer, magmatic and hydrous fluids in the crust and mantle, plate boundary processes, large scale continental deformation, continental structure and evolution, and the composition and structure of deep-Earth.



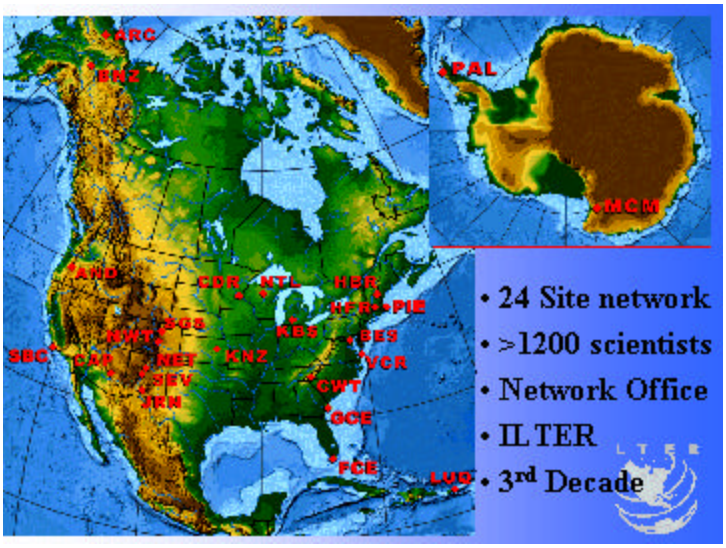
U.S. illustrating proposed Earthscope instrumentation.

The National Ecological Observatory Network (NEON) program is a major initiative being developed to establish a national platform for integrated studies and monitoring of natural processes at all spatial scales, time scales, and levels of biological organization. NEON will link a large number of field observation sites via high-capacity communication systems. It will provide the resources and infrastructure for fundamental biological research that will enhance our understanding of the natural world, improve our ability to predict the consequences of natural and anthropogenic events, and inform our environmental decisionmakers.

In contrast with these two emerging programs, the Long-Term Ecological Research (LTER) program was established in 1980 to enhance our understanding of long-term patterns and processes of ecological systems at

multiple spatial scales. There are currently 24 field sites from northern Alaska to the Antarctic.

The LTER program supports analysis of ecological phenomena -- both natural and human influenced. LTER also facilitates the comparison of ecological observations across diverse ecosystems, and the integration of information from multiple sites. In addition, extensive computer networking allows regional, national and international efforts to be synthesized. It is important to note that LTER is an element of a broader worldwide ecological research network, which links LTER sites with others in Europe, Latin America, and the Asia/Pacific region. The international network consists of over 100 sites in 25 countries.

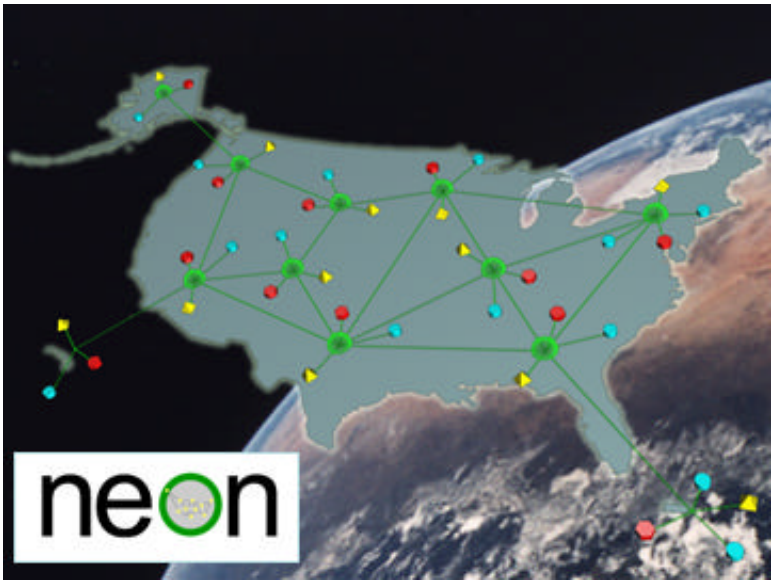


NSF LTER sites in the U.S. and the Antarctic

These are examples of the wide range of platforms, instrumentation, telemetry and other tools needed to observe, analyze, and model environmental processes

at multiple scales. Although a particular observing system may focus on a single feature, such as atmosphere, land, fresh water, ocean, or ecosystems, it must be developed in such a way as to maximize interactivity and coordinate with other types of systems. A major challenge is to improve the ability to correlate heterogeneous environmental data in order to understand complex processes and to enhance the value of observing systems for understanding and predicting long- and short-term behaviors.

Fundamental to observing systems is the development of effective sensing devices that are robust, non-polluting, self-calibrating, and yielding consistent information. Fixed and mobile sensor systems that can provide sustained time-series observations are essential for projects like EarthScope, Ocean Observatories, and NEON.



U.S. and the NEON locations
(National Ecological Observatory Network)

The development of cyberinfrastructure also contributes to our capacity to carry out environmental observations. The explosion of data, particularly real-time data, will require near real-time analysis and distribution if it is to be useful in saving lives during earthquakes, floods, or hurricanes. Data confederation and collaboration are essential to the effectiveness of environmental observatories.

And finally, environmental observatories offer a centralized forum for environmental education at all levels and an excellent venue for the cyberinfrastructure needed to integrate, distribute, and analyze diverse data sets.

Through these and similar activities, the National Science Foundation enables the scientific community to obtain critical observations so they may address the complex interdisciplinary issues that face society today and in the future.

This paper was prepared in conjunction to remarks delivered at the Earth Observation Summit.

Earthscope
Source: Earthscope Magazine
Website: http://www.earthscope.org

Illustration of a uniform grid of 2000 sites that researchers will sample over the next decade using portable seismic stations. An observatory four kilometers deep will directly monitor processes in the active San Andreas Fault zone, while a distributed observatory will gather data on plate movements from Alaska to Mexico. Combined with new satellite and GPS systems, the entire EarthScope array will provide a dynamic picture of the forces that continue to shape Earth.

LTER
The LTER Network sites marked along the map of North America within the U.S.
Source: Stuart Perlmeter
Website: http://www.lternet.edu

NEON
Source: National Science Foundation, Archibald Biological Station and San Diego Supercomputer Center
Website: http://www.sdsc.edu/NEON

NEON will be a network of networks, a system of environmental research facilities and state of the art instrumentation for studying the environment. Each node in NEON will be a regional observatory, comprised of a core site and associated sites that are linked via cyber-infrastructure. These observatories will be geographically distributed based on the US Forest Service defined ecoregions of the US.