opinion

A 21st-century vision for geophysical data management

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Five decades ago scientists and policymakers embarked on a remarkable experiment in international cooperation: the International Geophysical Year of 1957–58. That successful effort gave birth to the space age, launched the World Data Center system, made a commitment to free exchange of geophysical data, and put in place an observatory structure that serves the scientific community to this day. The anniversary years of 2007–08 are widely known as the "IGY + 50" period.

Demographers tell us that there were 2.9 billion people on Earth in 1957. Today there are more than 6.8 billion people. The world of 50 years ago was dangerously divided into two major political blocs that competed militarily, socially, and ideologically. In many ways, only science provided a common ground for communication and a forum for cooperation. The IGY recognized that all people live in one world. It made clear that we have to study the Earth, the oceans, the atmosphere, and surrounding space as one coupled system. The data gathered about Earth and space systems during the IGY were—at least ideally—to be shared widely, openly, and freely. (See the article by Fae L. Korsmo, PHYSICS TODAY, July 2007, page 38.)

The IGY saw the birth of many things. Besides the launching of the space age, the IGY gave everyone more than ever before a sense of the smallness, the unity, and the fragility of the world we inhabit. Today we live in a much different world. Not only has the human population more than doubled, but the political and social climate has been altered dramatically. Old enemies are new friends, and challenges of the cold war have been supplanted by very different issues. But even with all the political and social changes that have occurred in the past five decades, many things have stayed the same. We still have only one world to live in. We must still be good stewards of the land, the oceans, the air we breathe, and outer space. We certainly must still share widely and freely what we learn from science in order to try to make the world a better place.

Modern international programs

Several "international years" currently are commemorating the IGY and building on its legacy. They include the International Polar Year and the International Year of Planet Earth. However, the one international year that cuts across all disciplinary boundaries and reinforces the spirit of data sharing that the IGY envisioned is the Electronic Geophysical Year (see http://egy.org). The eGY program builds on some of the most powerful trends of 21st-century science. Among those are the growth of so-called virtual observatories, the prevalence and use of the internet, and the singular importance of interdisciplinary science.

Currently we are firmly embedded in the information revolution, and our information society is growing ever more tightly coupled and interactive.

The eGY—the clear heir to the legacy of the IGY—is an internationally recognized effort by the science community to make past, present, and future Earth and space science data rapidly, conveniently, and openly available. The program provides the international framework for stimulating and coordinating activities to facilitate access. It focuses on electronic data location; permission to use data freely; conversion of data into digital form; data preservation; capacity building, particularly in developing countries; and outreach.

Philosophy

In the geosciences, as in other disciplines, providing widespread access to the vast and growing collections of cross-disciplinary digital information is the key to understanding and responding to complex Earth-system phenomena that influence human survival. To that end we have a shared responsibility to create and implement strategies to realize the full potential of digital information for present and future generations.

Two developments have brought us to the threshold of a modern revolution in advancing our understanding of Earth and near-Earth space. First, the ability to collect data has increased dramatically, with pervasive networks of observational stations on the ground and in the oceans, the atmosphere, and space. Second, modern digital communications and methodologies for information management provide an unprecedented ability to access, process, and share information.

Those developments coincide with a heightened awareness by governments of the need to sustainably manage the finite natural resources of our planet, the importance of understanding Earth as a complex system, and the central role that ready access to comprehensive information and knowledge plays. That awareness translates into a growing readiness to support so-called e-science and grid infrastructures of computing resources. Such data management and computation concerns lead us to identify key eGY drivers:

- Growth of data volumes, with higher space and time resolution
- Demand for real-time response
- Need for a multidisciplinary and multi-institutional approach to understanding the Earth–space system
- Data assimilation and integration requirements for modeling and knowledge development
- Demonstrable benefits of universal equal access to data.

The benefits of cooperation and data sharing have led the eGY to begin globally coordinating geoscience efforts. The international coordination will help maximize the value of free and open exchange of data and of sharing

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the benefits equally among nations.

Data exchange is evolving so that most of the information transfer is done between machines using state-of-the-art virtual observatory software. One example of virtual observatories is the National Virtual Observatory (http://www.virtualobservatory.org).

Many discipline areas now have large-scale systems based on virtual observatory technology. In geophysics, one of the best examples is EarthScope (http://www.earthscope.org). That ambitious and interdisciplinary project involves a community of scientists who conduct research across the Earth sciences utilizing all of the freely accessible data from the participating observatories. EarthScope provides data and data products from thousands of geophysical instruments that measure motions of Earth's surface and record seismic waves. Many of EarthScope's observatories and ground facilities also acquire meteorological, magnetometer, and global positioning data used by atmospheric and ionospheric researchers.

A vivid example of the power of virtual observatory technology can be seen on the seismic monitor webpage of the Incorporated Research Institutions for Seismology (http://www.iris.edu/seismon/bigmap/index.phtml). Data from worldwide, near real-time seismic sensors and from an archival database are combined to provide a global image that can be used by scientists, teachers, and policymakers.

Objectives

The mission of the eGY is to foster an international commitment, secure a mandate, and provide an international coordination framework to facilitate, inform, stimulate, encourage, and promote the following concepts:

- Cooperation among scientific agencies, institutions, and programs to reduce duplication and encourage standards
- Data discovery to determine who holds what, where, and how to promote standards for metadata (information about the data's content, quality, condition, and other characteristics)
- Data release to secure access permission and to ensure active rather than passive release
- Preservation of data and accessibility to existing data
- Data integration and knowledge to support information sharing needs and to develop information systems that enable the identification and understanding of relationships between various data sets and measurements
- Capacity building to boost the scope and output of scientific endeavors and to help develop opportunities for growth of science and reduction of the digital divide in countries in need
- Outreach to raise awareness and inform students, scientists, decision makers, and the public; and to promote environmental literacy.

Through the establishment of virtual observatories, the eGY will complement in cyberspace the contribution from physical observatories.

Participants and support

The eGY is an ICSU (International Council for Science)-endorsed initiative of the International Union of Geodesy and Geophysics (IUGG), under the leadership of the International Association of Geomagnetism and Aeronomy. The eGY is supported by in-kind contributions from participating agencies and by grants from NASA and NSF.

Signatories and participants in the eGY are drawn from the following:

- National academies of science from around the world
- International Year initiatives linked to the 50-year anniversary of the IGY: the International Polar Year, the International Year of Planet Earth, the International Heliophysical Year, and the International Living with a Star program
- Geoscience societies such as the European Geosciences Union and the American Geophysical Union
- E-science and digital network and digital library initiatives
- The World Data Center system, with 52 centers in 12 countries and a wide range of solar, geophysical, environmental, and human dimensions data that are especially useful for monitoring changes in the geosphere and biosphere
- Global observing agencies and programs (for example, the Integrated Global Ocean Services System and the Global Earth Observation System of Systems)
- Science organizations, including ICSU's Scientific Committee on Solar–Terrestrial Physics and Committee on Data for Science and Technology.

The GeoUnions is a new consortium for the Earth sciences that includes IUGG, the International Union of Geological Sciences, the International Union of Soil Sciences, the International Geographical Union, and the International Society for Photogrammetry and Remote Sensing.

On 7 July 2007 at a special convocation at the IUGG meeting in Perugia, Italy, the eGY was officially launched. It was the expressed hope there that all of us in the eGY and the broad geophysical community would work together to ensure that the remaining months of the eGY would raise awareness of people throughout the world about the availability and importance of geophysical data. In so doing eGY would provide an impetus to Earth and space science research for the next 50 years as great as the springboard provided by the IGY. If the Electronic Geophysical Year can strive for such a vision and such an outcome, we will, indeed, have had a remarkably successful enterprise. ■

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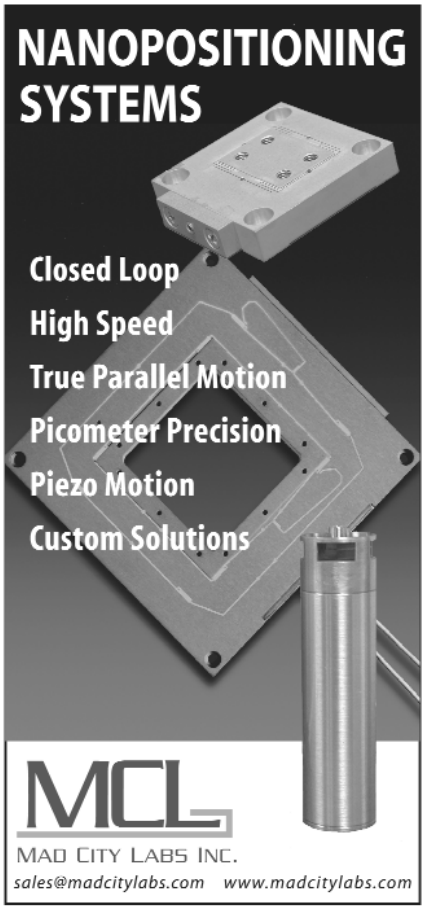

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