NASA Perspective on a Comprehensive Coordinated Earth Observation System

NASA's vision is "To improve life here, To extend life to there, To find life beyond…"

Building upon 45 years of advancing leadership in aeronautics and space activities, NASA pursues its vision by taking on and accomplishing our bold mission objectives: to understand and protect our home planet, to explore the Universe and search for life, and to inspire the next generation of explorers…. as only NASA can. NASA plays a leading role in efforts to 1) Understand Earth's system and apply Earth system-science to improve the prediction of climate, weather, and natural hazards; 2) Enable a safer, more secure, efficient, and environmentally friendly air transportation system; and 3) Create a safer world and improve the quality of life by investing in technologies and collaborating with other agencies, industry, academia and international partners. We recognize common goals and objectives for a Comprehensive Coordinated Earth Observing system.

NASA's science program is focused on study and understanding of planets, most importantly our home planet. Over the last two decades, NASA has led a revolution in Earth science, emphasizing understanding the Earth as an integrated system. Naturally occurring and human-induced change in the Earth system have profound consequences for our nation and the world. Severe weather events caused nearly $12 billion in damages to the United States in 2001 alone. The 1997-98 El Nino phenomena had on the order of $25 billion economic impact in the U.S. In the summer of 2000, wildfires burned 8.4 million acres in the western US. If an Earthquake the magnitude of the 1906 San Francisco Earthquake were to hit the Bay area today, it is estimated it would cause damage on the order of $500 billion. Of course, such natural hazards are not exclusive to the U.S. they have socio-economic impacts to countries around the world.

Earth observation (from local to global) and the understanding such observations yield about Earth system processes are key to predicting future weather, climate and natural hazards, and to making sound, science based economic and policy decisions. The Earth Observation Summit marks the start of an international effort to build an international, comprehensive, cooperative Earth observation system. Socio-economic forces of global development and change present serious challenges to world leaders, decision makers, and institutions. In calling for the Earth Observation Summit, G-8 nations recognize that humanity has entered a new era where human ingenuity must now be applied to developing a deeper understanding of the Earth's complex systems—an understanding that should begin with this international Comprehensive Coordinated Earth Observing System.

NASA's Contribution to the Comprehensive Coordinated Earth Observing System

Our partners and stakeholders use the scientific knowledge, information, and technology generated by NASA. There is on-going dialog to optimize the process of ranking scientific questions to be address by future research and enabled by Earth observations. Currently, NASA has a constellation of 18 active research satellites carrying 80 sensors that deliver observations of key geophysical parameters that characterize the Earth system. Along with surface and suborbital systems, these satellites produce research-quality data records to monitor trends and establish models for prediction of weather, climate and natural hazards. In the coming decade, additional missions and new initiatives are planned to continue key long-term measurements of geophysical parameters identified as critical for advancing our ability to characterize, understand, and predict the Earth System. Beyond measurements, NASA is advancing capabilities to model the Earth system and is a leading partner in the U.S. Earth System Modeling Framework. Over 23 numerical models are included in the NASA partnership network of academic institutions and federal research labs. These models serve as important platforms for simulating Earth system processes and providing key predictive outputs. NASA's Earth Science Applications program develops partnerships and capacity that enables the Agency's science results, modeling output, and technology to serve society. NASA's Earth Observing Data Information System provides global access to the measurements and climate data records representative of a Comprehensive Coordinated Earth Observation System.

The importance of Earth system science to society has led NASA to adopt a planning and implementation framework that is science-driven and results-oriented. We recognize a continuum from Earth system science research to Earth science applications, which is to be traversed via a systematic approach that integrates observations, research and data analysis, modeling, scientific assessments, and decision support tools. It is a framework defined by making contributions to integrated solutions tailored to address societal needs. The framework seeks to:

- Identify and rank by priority frontier science questions with the global Earth science community.
- Sponsor and conduct research that defines the requirements for the observing systems required, analyzes the resulting observations, and develops the understanding needed to model the processes involved.
- Design and implement an integrated observing strategy with partners that encompasses satellite, sub-orbital, surface and sub-surface based platforms needed to collect the types and qualities of observations required, and the information systems needed for stewardship of the data.
- Employ measurement, monitoring, and verification observations to produce information products and initialize and improve and apply Earth system models.
- Record new scientific discoveries and conduct assessments useful for decision-making by governments, businesses, and citizens.
- Work with partner agencies to benchmark the improvement in their decision support tools.
- Interact with international partners on key science, societal application, or technology issues.
- Make available the knowledge we generate to the education community, and assist them in creating tools to teach Earth science.
- Ensure that we invest in the educational tools needed to guarantee the intellectual capital necessary in generations to come for responsible stewardship of these laudatory goals.

NASA's Potential Contributions to a Comprehensive Coordinated Earth Observation System

Several features of NASA's approach to Earth system science research are are directly in line with the Comprehensive Coordinated Earth Observation System. The first is the concept of studying the Earth as a system. The view from space provides deep insight of the interconnections among continents, oceans, atmosphere, ice and life. It is these interconnections that motivate the study of planet Earth as an integrated physical and biological system.

This leads to the second feature —that of designing and implementing an end-to-end, systematic approach to posing and answering Earth science questions. With the help of the Earth science community at large, NASA selects research questions on the leading edge of science, which are important to society, and for which remote sensing can make a defining contribution. We then bring to bear the basic research, observing capability, advanced technology, and computational modeling needed to answer the questions, and the partnerships with operational organizations that can deliver results to society.

The third feature of NASA's approach is partnership. While we pursue answers to science questions in an end-to-end way, we do so in partnerships with others in every step of the process. We have international partnerships in nearly all our observing system programs; with other nations' space agencies in satellite missions and with non-space fairing nations in *in situ* observing systems. We are active participants in many international research programs, including the World Climate Research Program, the International Geosphere/Biosphere Programme, the World Meteorological Organization, and we engage the academic community through open, peer-reviewed solicitations comprising one-fourth of our annual budget. We have extensive relationships with the U.S. industrial and commercial communities to bring private sector expertise to bear on public sector challenges.

A fourth feature of our approach is innovation. As a research and technology agency, NASA continually creates new technologies and techniques to make new measurements possible. To the extensive array of passive remote sensing capabilities now in orbit, we are working to add active remote sensors, radars and lidars that enable three-dimensional profiles of the structure of the atmosphere, land surface, oceans, and ice caps. And we are working to leverage ongoing revolutions in computing and communications technologies to enable the vast quantity of new observation data to be exploited effectively for research and applications.

Expectations and Challenges

As we look ahead together with our partners, we have high expectations for the future. Through participation in the Committee on Earth Observing Satellites and its partnerships with the World Meteorological Organization and others, we pioneered the concept of an integrated global observing strategy almost a decade ago. The dialog and pilot projects conducted under this rubric by NASA and others laid the groundwork for the Comprehensive Coordinated Earth Observation System envisioned by this Summit.

Several challenges lay ahead. One is assuring effective transitions of new capabilities from research to operational systems. The next generation polar-orbiting operational environmental satellites in the U.S. and Europe are one example of the progress. Another is the plan to transition NASA/CNES ocean altimetry to NOAA and EUMETSAT towards the establishment of a sustained climate observing system. The world's space research agencies are developing many innovative capabilities, and we must partner effectively with our operational agency counterparts to assure the new understanding derived from them can be exploited to improve the essential services these operational agencies provide.

A second challenge is to maintain and extend the policy of full and open data access at minimal cost to all users, especially for scientific exploration and humanitarian needs. The progress of science and the improvement of public services both require a data policy that promotes the broad, ready use of environmental information in our economies and societies.

A third challenge is to facilitate the broadest participation in Earth system science and environmental research. The integrated, comprehensive observing system we design must be based on a architecture, standards, and protocols that easily accept new observing and data management components, be they satellites, ground or ocean-based sensors, along with computational resources, or scientific research and assessments. Potential partners must find ready entrance at both the organizational and technical levels.

Keeping the ultimate goal in mind, a fourth challenge is to assure that the results of our observation and research programs improve essential public services and quality of life by facilitating their use in the decision support systems as an integral component of global information infrastructure. This requires focused efforts to select high-payoff applications that can benefit from Earth observations, to identify specific decision support systems, such as weather prediction models, agricultural yield forecasts, and energy generation and distribution management systems, that can be upgraded to incorporate Earth observation and model results, and then to benchmark (measure) the potential improvement to these systems possible from use of this information.

NASA believes the GEO framework has enormous potential to create new scientific understanding, to fuel economic vitality, and to improve the quality of life for all of planet Earth's inhabitants. We look forward to working with partner agencies, nations, and organizations to make this vision a reality for our generation and those to follow.