



INTERNATIONAL RESEARCH AND COOPERATION

The United States is continuing and augmenting, through the CCSP, its international leadership in climate change science research and assessments, especially regarding planning for development of a new global Earth observing system. The United States involves and supports a variety of governmental, intergovernmental, and nongovernmental organizations, and academic activities in advancing climate and global change research. The United States has elevated international attention to Earth observing system issues by convening the first Earth Observation Summit (see Figure 25), and through establishment of the Group on Earth Observations (GEO).

GOALS OF INTERNATIONAL CLIMATE CHANGE SCIENCE AND ITS SUPPORT

It has long been recognized in the United States and other countries that it is essential to study climate change and variability on both global and regional scales. To do so effectively—in terms of both scientific and financial

resources—requires international cooperation among scientists, among research institutions, among governmental agencies, and among governments themselves. The United States and its scientists, institutions, and agencies are at the forefront of such international cooperation, reflecting U.S. leadership in climate science.

The United States seeks to develop and maintain an intergovernmental framework within which climate change science, including research and observational programs, can be planned and implemented. The overarching goals of U.S. efforts to promote international cooperation in support of the CCSP are to:

- Actively promote and encourage cooperation between U.S. scientists and scientific institutions and agencies and their counterparts around the globe so that they can aggregate the scientific and financial resources necessary to undertake research on change at all relevant scales, including both the regional and global
- Expand observing systems in order to provide global observational coverage of change in the atmosphere, in the oceans, and on land, especially as needed to underpin the research effort



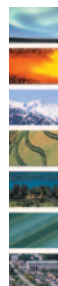
Figure 25:
Earth Observation Summit (EOS)
participants, U.S. Department of
State, 31 July 2003.
Credit: NASA.

- Assure that the data collected are of the highest quality possible and suitable for both research and forecasting, and that these data are exchanged and archived on a timely and effective basis among all interested scientists and end users
- Support development of scientific capabilities and the application of results in developing countries in order to promote the fullest possible participation by scientists and scientific institutions in these countries in research, observational, and data management efforts.

THE INTERNATIONAL FRAMEWORK

U.S. scientists and institutions work with their counterparts in other countries to identify climate change research issues of global and regional importance and to plan and implement cooperative programs and projects to address these issues. To assist in this process the United States supports a continually evolving framework through which the United States invites and encourages other countries to work to address climate change research and observations. The CCSP works with global-scale research programs and with both nongovernmental and intergovernmental international organizations in order to meet these global- and regional-scale needs.

As a leader in climate change science, the United States plays an important role in international assessments such as ozone, biodiversity, and ecosystems, as well as those concerned with regional climate. This includes financial and logistical support, support for U.S. scientists' participation in assessment activities, and the acquisition and exchange of data to support assessments. The CCSP intends to continue its support for and participation in activities of the Intergovernmental Panel on Climate Change (IPCC), international ozone assessments, the Millennium Ecosystem Assessment (MA), and the Arctic Climate Impact Assessment (ACIA).



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EARTH OBSERVATION SUMMIT AND GROUP ON EARTH OBSERVATIONS

The Earth Observation Summit—held in Washington, DC, in July 2003, hosted by three U.S. Cabinet members (the Secretaries of State, Commerce, and Energy)—marked an extraordinary milestone in the development of a comprehensive, coordinated, and sustained Earth observation system. Thirty-three nations and the European Commission adopted a Declaration that signifies a political commitment to move toward development of a comprehensive system that will enable researchers and decisionmakers to monitor continuously the state of the Earth, increase understanding of dynamic Earth processes, enhance prediction of the Earth system, and further implement international environmental treaty obligations. Ministers from developed and developing countries seek through their agreement to increase timely, high-quality, long-term, global information, which can serve as a basis for sound decisionmaking for the benefit of society. More than 20 international organizations also participated in the initiative.

Other high-level U.S. officials participating in the Summit included Interior Secretary Norton; Science Advisor to the President Marburger; Council on Environmental Quality Chairman Connaughton; Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator Lautenbacher; NASA Administrator O’Keefe; National Science Foundation Director Colwell; Under Secretary of State for Global Affairs Dobriansky; Under Secretary of Agriculture for Agricultural Research, Education and Economics Jen; Under Secretary of Transportation for Transportation Policy Shane; Undersecretary of Energy for Energy, Science, and Environment Card, and Acting Environmental Protection Agency Administrator Horinko.

The Earth Observation Summit also established the *ad hoc* Group on Earth Observations (GEO) to prepare a 10-year Implementation Plan for a comprehensive, coordinated, and sustained Earth observation system. NOAA Administrator Lautenbacher was named by the White House as the lead U.S. representative to the GEO and USGS Director Groat as his alternate. At the inaugural GEO meeting on 1-2 August 2003, the U.S. representative was elected co-chair along with representatives from the European Commission, Japan, and South Africa.

Historically, observation systems have been effective at providing critical data for a variety of regions and countries across the globe. But most of the global observational capabilities are not coordinated, and data collected are not of the same format or quality. Additionally, many countries in the developing world lack the resources to fund adequate observation systems and as a result do not benefit from these powerful tools. This lack of adequate observations in developing regions of the world also results in substantial observational gaps that impede the ability to understand climate and other systems.

An Earth observing system as described in the Declaration will produce a number of benefits, in both the near and long-term. In the near term, all of the countries participating in this system can expect that—through improved observations of weather, climate, the oceans, seismic activity, and fires, among others—loss of life and damage to property can be reduced. Additional benefits will include improved water management, health assessments, agricultural efficiencies, aviation safety, coastal management, and disaster management. In the long term, an Earth observing system will offer greater understanding of the Earth system that will underpin decisionmaking in many areas, including the reduction of disaster loss and supporting sustainable global development.

The Declaration supports the need for improved coordination of strategies and systems for observations and identification of measures to identify gaps; a coordinated effort to involve and assist developing countries in improving and sustaining their contributions to observing systems, as well as access to and utilization of observations; the exchange of observations recorded from *in situ*, aircraft, and satellite networks in a full and open manner, with minimum time delay and minimum cost; and the preparation of a 10-year Implementation Plan, building on existing systems and initiatives.

The inaugural meeting of the GEO established five subgroups: international cooperation; architecture; capacity building; data utilization; and user requirements and outreach. These groups, with the support of the GEO Secretariat, generated a draft Implementation Plan, the framework of which was accepted at the second Earth Observation Summit, held in Japan during the spring of 2004. The Implementation Plan is expected to be completed by late 2004, directly preceding the third Earth Observation Summit in Europe. International organizations will play a key role in the work of the subgroups, since those organizations have been instrumental in the development and maintenance of existing systems that will serve as the backbone for a future global network.

SUPPORTING CLIMATE CHANGE SCIENCE AND TECHNOLOGY BY IMPROVING THE INTERNATIONAL FRAMEWORK

Implementation of Presidential Initiatives

The President's climate change policy announcements on 11 June 2001, and 14 February 2002, highlighted the importance of international cooperation to develop an effective and efficient global response to the complex and long-term challenge of climate change. Under the leadership of the Department of State, the United States adopted a Bilateral Climate Change Strategy, focusing on countries or regional entities that are responsible for nearly 75% of the world's greenhouse gas emissions. Through this important network of bilateral and regional partnerships, the United States is advancing the science of climate change, enhancing the technology to monitor and reduce greenhouse gases, and assisting developing countries through capacity building and technology transfer.

Bilateral Cooperation in Climate Change Science and Technology

Working with a mix of developed and developing countries, the Department of State is leading a major effort to advance international cooperation in climate change science and technology, building on key elements of the CCSP and the CCTP: research, observations, data management and distribution, and capacity building.

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- *U.S.-Italy Cooperation in Climate Change Science and Technology.* The United States and Italy have developed a bilateral partnership encompassing a wide range of cooperative science and technology projects and activities, including climate change modeling, atmospheric processes, the carbon cycle, remote sensing, human and ecosystem health, and ocean observations and the ocean ecosystem. On the technology side,



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the partnership is advancing cooperative efforts on the hydrogen infrastructure and energy technologies, including fuel cells, renewable energy, advanced power systems, and advanced energy technologies including carbon capture and sequestration. The two countries have announced their intention to promote the exchange of graduate students, young scientists, and senior scientists in the area of climate change science and technology.

- *U.S.-Japan Cooperation in Climate Change Science and Technology.* The two countries have established U.S.–Japan High Level Consultations (HLC) on climate change, through which they maintain active partnership in climate change science and technology. The HLC Working Group on Science and Technology has selected ten projects for priority implementation in seven areas: improvements of climate models; impacts and adaptation/mitigation policy assessment employing emission-climate impact integrated models; observation and international data exchange and quality control; research on greenhouse gas sinks including land-use, land-use change, and forestry; research on polar regions; and development of mitigation and prevention technologies. Experts are also collaborating on issues relating to developing countries and market-based approaches. The United States and Japan have also conducted a series of climate change science workshops on such important issues as “Water and Climate,” “Health and the Environment,” and “Carbon Cycle Management in Terrestrial Ecosystems.”

U.S. Reentry to UNESCO

The United States rejoined UNESCO and participated in the UNESCO General Conference in the last quarter of 2003. At the General Conference, the United States was elected to the UNESCO Executive Board. U.S. participation in UNESCO is expected to afford a wide range of opportunities for international cooperation in climate change science and technology and international science in general. A particular focus of the UNESCO science agenda has to do with preservation of the world’s freshwater resources. This focus is supported through a number of projects in the International Hydrology Program, including the Hydrology for the Environment Life and Policy (HELP) program, supported in part by the CCSP.

Inter-American Institute for Global Change Research (IAI)

U.S. scientists play an important role in the research programs carried out by the IAI, and in bringing together the over 200 research universities and government institutions in the Western Hemisphere that make up its research network. Research programs sponsored by the IAI have aided in development of new decision and management tools in diverse areas, ranging from the incorporation of long-range forecasts into dam

management for hydropower and irrigation, to the establishment of a tri-national sardine fishery forum that regularly brings together regulatory agencies, resource managers, fishermen, and researchers from Canada, Mexico, and the United States. In addition, IAI research enabled the first rigorous scientific ranking of drivers of global change, based on scenarios of changes in global biodiversity.



ENGAGING THE INTERNATIONAL CLIMATE CHANGE RESEARCH COMMUNITY

International cooperation plays an important role in focusing the world's scientific resources on the highest priority climate and global change research issues, in helping to reduce scientific redundancy in a world of limited financial resources, and in improving exchange of data and information internationally. By developing both conceptual and research frameworks, international research programs provide models that aid U.S. program managers in planning and coordinating their efforts. Much of the research conducted and sponsored through the CCSP benefits from and contributes to projects sponsored by the four major international research programs—the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), the International Human Dimensions Programme (IHDP), and the Diversitas program—and the newly launched interdisciplinary collaboration between all of the programs, the Earth System Science Partnership (ESSP).

The IGBP is transitioning into its second phase with new emphases in biogeochemical sciences with relevance to issues of societal concern, interdisciplinarity, Earth system science, and regional-scale integrated research. Many of the IGBP phase-one projects are coming to a close or, as in the case of International Global Atmospheric Chemistry (IGAC), being reoriented. New projects such as Land-Atmosphere, Land, Land-Ocean, and Ocean are in the development stage or beginning work.

The WCRP is focusing its efforts on its major projects, including Climate and Cryosphere (CliC), Climate Variability and Predictability (CLIVAR), Global Energy and Water Cycle Experiment (GEWEX), Stratospheric Processes And their Role in Climate (SPARC), and the World Ocean Circulation Experiment (WOCE), which continues to provide satellite, *in situ* observations, and models. CLIVAR is hosting its 2004 international meeting in June 2004 in Baltimore, Maryland. Development of the first global integrated data set of the water cycle (GEWEX, CliC, CLIVAR), which is the first element of the Coordinated Enhanced Observing Period (CEOP), is currently underway.

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IHDP is focusing on a number of core project efforts, including the Global Environmental Change and Human Security (GECHS) project, the Institutional Dimensions of Global Environmental Change (IDGEC) project, the Industrial Transformation (IT) project, and Land-Use Land-Cover Change (LUCC) project. In addition to the core projects, the IHDP is also addressing cross-cutting questions, such as thresholds/transitions, vulnerability/resilience, adaptation/learning, and governance in the face of global environmental change. Additional questions include study of human drivers of change, as well as its relevance for sustainable development. Through investigation of these issues, IHDP will develop perspectives on key questions in global environmental change research.

Diversitas, the newest of the international programs, is focusing on development of three core projects—bioDISCOVERY, ecoSERVICES, and bioSUSTAINABILITY—as well as cross-cutting networks and projects. The Biodiscovery project is focused on discovery and understanding of changes in global biodiversity. The Ecoservices project will assess the impacts of biodiversity changes, while the Biosustainability project will develop the science of conservation and sustainable use of biodiversity. The three core projects are completing their planning and beginning implementation.

The ESSP—a partnership for the integrated study of the Earth system, changes, and the implications of those changes—is currently developing its core projects: the Global Carbon Project (GCP), Global Environmental Change and Food Systems (GECAFS), the Global Water System Project (GWSP), and Global Environmental Change and Human Health (GECHH). These projects are designed to address issues critical to the understanding of global change and to build upon the existing core programs and, to the greatest extent possible, their existing infrastructure.



The SysTem for Analysis, Research, and Training (START)

START is the outreach arm of the WRCP, IGBP, and IHDP, and is hosted by the United States. START's primary purpose is to assist developing countries to better enable scientists and institutions in these countries to conduct research on global environmental change and the challenges these changes pose for human health, agriculture, water, and food security and to apply the results of such research in decisionmaking. START has ongoing activities in Africa, Asia, Central America, and South America and collaborates with a number of multilateral international organizations such as the IPCC, the IAI, and the Asia Pacific Network for Global Change Research.

International Research Institute for Climate Prediction (IRI)

IRI conducts strategic and applied research on climate information and prediction, decision systems, impacts, institutions and policy, with a focus on education and capacity building in developing countries. NOAA, under direction of the CCSP, has led in development of IRI in cooperation with Columbia University and the Central Weather Bureau of Taiwan. IRI works in partnership with experts and institutions in project regions to advance understanding of climate in the context of decision strategies in sectors including agriculture, health, and water resource management.

In northeastern Brazil, IRI collaboration has resulted in the demonstration of decision opportunities to maximize water usage in a drought-prone region by introducing climate-informed strategies to minimize annual spill of reservoirs. In the Greater Horn of Africa, it has resulted in development of forecast tools for Rift Valley Fever in cattle, a disease that creates huge economic and trade impacts for the region. In South Asia, it has yielded a process by which agricultural systems analysis and climate information can be combined with direct linkages to smallholder farmers to positively influence agricultural decisions.

Many of the inhabitants of the vast, semi-arid region of the state of Ceará in Northeast Brazil live by small-scale, rain-fed agriculture and ranching. They face



Figure 26: Irrigation of beans in Morada Nova, Ceará, Brazil. In northeastern Brazil, a collaboration between the state of Ceará and the International Research Institute for Climate Prediction is working to improve the state's water management systems in this vast, semi-arid region. *Photo credit: Kenneth Broad, IRI.*

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hunger, unemployment, and dislocation during recurrent water shortages in the region. Two million rural people were affected by the last severe drought in 1998, and received \$360 million in aid from the United States. In April 2002, Ceará became an IRI member and committed to a collaboration to improve the state's water management systems. The IRI Ceará program concentrates on 1) seasonal and interannual water management and allocation, 2) drought relief and mitigation, and 3) long-term water management and development. Improvements in these areas will come from advances in forecasting and analyses of climate, water supply and demand, agriculture, and socioeconomics. Those advances will be incorporated into a new decisionmaking framework consisting of existing institutional channels, the people most affected by water and drought management, and a new procedure for them to use in comparing policies.



North Greenland Ice Core Project (NorthGRIP)

U.S. researchers from several universities and USGS are contributing to an international collaboration to retrieve the deepest ice core in Greenland. The Danish-led NorthGRIP project involves scientists from Denmark, Germany, Japan, Sweden, the United States, Switzerland, France, Belgium, and Iceland. Bedrock was finally reached at a depth of almost 3100 meters in mid-July 2003, after 7 years of effort. The NorthGRIP ice core is expected to provide important new information about the climate system during its transition from the last warm interglacial (the Eemian, 130-115 thousand years ago) into the Wisconsin Ice Age (10,000-60,000 years ago).

Global Terrestrial Network for Permafrost

U.S. scientists from various universities and Federal agencies are cooperating with their counterparts from 12 other nations to establish the Global Terrestrial Network for Permafrost (GTN-P), one of the new terrestrial sub-networks of the Global Climate Observing System (GCOS). Analysis of data from the GTN-P 16 network will be used to better define the current state of the Earth's cryosphere, for climate change detection (particularly in the Arctic), and to provide critical input to climate models used for impact assessments.

The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project

The primary goal of IMBER is to understand the sensitivity of the ocean to global change within the context of the broader Earth system, focusing on biogeochemical cycles, marine food webs, and their interactions. IMBER is directed at development of

a comprehensive understanding of the impacts of climate and anthropogenic forcing on food web dynamics and elemental cycling (including the impacts of underlying physical dynamics of the ocean) and how these linked systems respond to global change resulting from natural climate variability and anthropogenic perturbations, and their feedbacks to climate, ocean physics, and marine resources. A draft science and implementation strategy for IMBER has recently been prepared under the aegis of IGBP's Global Oceans Ecosystems Dynamics Program and the International Council for Science (ICSU) Scientific Committee on Oceanic Research (SCOR). U.S. scientists, with support from CCSP participating agencies, played a major role in preparation of this plan and the United States currently hosts the secretariat for this project. A Scientific Steering Committee for IMBER was formed in 2004.

Climate Information Access Program Project (CIP)

The Climate Information Access Program is in its fourth year of a cooperative effort to develop the Radio and Internet for the Communication of Hydro-Meteorological and Climate Information for Rural Development (RANET) project. The U.S. leads this effort with partners such as the World Meteorological Organisation and the African Center of Meteorological Applications for Development. Activities of RANET strengthen institutional capacities in developing country meteorological and related services, broaden the availability and application of forecasts and observations, and contribute to hazard preparedness and mitigation through provision of information. Currently RANET has developed throughout Africa, begun pilot activities in the Pacific, and is planning activities for much of Asia in FY 2004.

Famine Early Warning System Network (FEWS NET)

The United States supports FEWS NET to provide decisionmakers with information to respond effectively to drought and food insecurity in Africa. FEWS NET analyzes remote-sensing data and ground-based meteorological, crop, and rangeland observations to track progress of rainy seasons in semi-arid regions of Africa to identify early indications of potential famine. In addition to using data produced by host governments for its analyses, FEWS NET uses data from satellite imagery (NDVI or "greenness" images, and Meteosat rainfall estimation images) that it receives every 10 days throughout the year.

The Northern Eurasia Earth Science Partnership Initiative (NEESPI)

NEESPI is aimed at developing an enhanced understanding of interactions between the ecosystem, atmosphere, and human dynamics in northern Eurasia, especially to

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understand how land ecosystems and continental water dynamics in that region of the world interact with and alter the climatic system, biosphere, atmosphere, and hydrosphere. NASA, the Russian Academy of Sciences, and possibly other partners in the United States, Europe, and Asia, are becoming involved in NEESPI activities. The NEESPI Science Plan will be published in 2004. Data capacity building workshops will be held in 2004 on boreal zone and on non-boreal zone of northern Eurasia to develop a comprehensive inventory of available space-borne and ground-based data sets for the region. This will facilitate preparation of a NEESPI Implementation Plan. NEESPI is organizing an interagency briefing in 2004, for major sponsors and stakeholders in the United States. The first NEESPI Open Science Conference will be held in 2004-2005.



Global Observations of Forest Cover and Land Cover Dynamics (GOFC-GOLD)

GOFC-GOLD is a coordinated international effort under the aegis of the Global Terrestrial Observing System to provide ongoing space-based and *in situ* observations of forests and other vegetation cover for sustainable management of terrestrial resources and to obtain an accurate, reliable, quantitative understanding of the terrestrial carbon budget. GOFC-GOLD is implemented through regional networks of data providers and users to address a combination of global change and natural resource management questions, and engages local scientists with local and regional expertise and knowledge. GOFC-GOLD seeks to develop methods and implement systems that provide both research and operational information on a regular sustained basis. Key activities in 2004 are expected to include two regional data capacity building workshops in northern Eurasia and meetings of the GOFC-GOLD Land Cover Implementation and Fire Implementation Teams.

The Climate and Societal Interactions Program

The Environment, Science, and Development (ESD) program of NOAA's Climate and Societal Interactions (CSI) effort seeks to catalyze and accelerate the use of climate science and technology in the resolution of key resource management challenges, such as adaptation, water management, and natural hazard mitigation. ESD fosters decision support-oriented research and applications activities that link science and technology to economic development, sustainable management needs, and policymaking processes. The program builds upon a 10-year global-scale pilot effort in climate research applications, and recent scholarship on research, assessment, and decision support systems for climate and global change. The program supports Regional Climate Outlook Forums, pilot applications projects, workshops, training sessions, capacity building, and technical assistance in Africa, Southeast Asia, Latin America and the

Caribbean, and the Pacific. This initiative is a collaborative effort that involves partners such as the World Bank, the World Meteorological Organisation, USAID, IRI, and regional institutions in Africa, Latin America and the Caribbean, Southeast Asia, and the South Pacific. In 2003, CSI convened a workshop on 'Insights and Tools for Adaptation: Learning from Climate Variability.' The report from this workshop, available in 2004, will offer recommendations for linking adaptation to today's climate to research and applications on longer time scales.

Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)

LBA is intended to improve understanding of the climatological, ecological, biogeochemical, and hydrological functioning of Amazonia; the impact of land-use change on these functions; and interactions between Amazonia and the Earth system. LBA is led by Brazil and involves substantial participation by U.S. scientists, institutions, and agencies. Recent results include the release of two LBA data sets for the study area (i.e., longitude 85° to 30°W, latitude 25°S to 10°N). The first data set consists of LBA regional historical climatology (precipitation, temperature, and pressure data) for the period 1832-1990, and is a subset of the Global Historical Climatology Network (GHCN) Version 1 database for sites in the LBA study area. The second data set on LBA Regional Derived Soil Properties includes measurements for several variables, including soil organic carbon density, soil carbonate carbon density, soil pH, and soil water capacity. Under the aegis of LBA, substantial progress has been made in training and educating students (73 PhD and 46 Masters degrees underway or completed). In addition, almost 300 students and 35 Amazonian institutions have been and are involved in U.S.-Brazil collaboration in LBA research.