GEOSS: Maximizing the Value of Satellite Remote Sensing for Societal Benefits

Each year weather and climate related natural hazards cause thousands of fatalities and tens of billions of dollars in economic losses worldwide. Hurricanes, typhoons, and mid-latitude storms are highly visible to the public. Frequently these severe storms cause significant loss of life and property. In 2005, the Gulf coast of the United States suffered through two devastating Category 5 hurricanes, Katrina and Rita, which killed nearly 2,000 people and caused property losses of between $70 and $130 billion. In May 2008, another devastating tropical cyclone in the Indian Ocean killed over 78,000 people in Myanmar. At the other extreme, extended periods of drought can also inflict tremendous losses. In 1988, dry conditions in the Midwest caused an estimated $40 billion in crop damage. Continuing drought conditions in the southwest United States have seriously depleted water resources in the Colorado and Rio Grande River basins, impacting agriculture as well as interstate and international relations. Recent drought has also contributed to massive wildfires in southern California. Statistics compiled by insurance companies for the past 50 years show that major natural disasters around the world have caused economic losses of nearly $1 trillion. Global environmental observing systems that support better warnings and preparedness can reduce this loss of life and property due to natural disasters.

Today many thousands of individual instruments, data collection systems, and data distribution systems are in constant use for diverse purposes around the world, but these systems usually are operated independently without even local or regional connectivity. Users at many levels – farmers making crop choices, emergency managers planning evacuation routes, nations battling drought and disease, the public checking daily weather reports – all take advantage of available data from satellite remote sensing, aerial surveys, land or ocean-based *in situ* monitoring systems, and a vast array of socio-economic information to make important decisions. However, the Earth observation data being collected are just a fraction of what could be put to use in every region of the world, if the data collection and distribution systems were interconnected globally to provide easy access and user friendly information.

Since 2003, the Group on Earth Observations (or GEO), that now includes 74 governments and the European Commission, has been coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). This emerging global, public infrastructure is beginning to interconnect a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. GEOSS will link together existing and planned observing systems around the world and support the development of new systems where gaps currently exist. Common technical standards are being adopted so that data from the thousands of different instruments and systems can be combined into coherent data sets and accessed in near real-time for use by decision makers.

GEOSS is simultaneously addressing nine areas of critical importance to society. The goal of GEOSS is to empower the international community to: improve weather forecasts, protect itself against natural and human-induced disasters, respond to climate

change and its impacts, safeguard water resources, understand the environmental sources of health hazards, manage energy resources, manage ecosystems, promote sustainable agriculture, and conserve biodiversity. GEOSS is using a cross-cutting approach to address interrelated issues, thereby avoiding unnecessary duplication, encouraging synergies between systems, and ensuring substantial economic, societal, and environmental benefits.

Satellite remote sensing systems are an important component of the emerging GEOSS. Since the mid-1980's, the Committee on Earth Observation Satellites (CEOS), which is one of 51 Participating Organizations in GEOSS, has fostered cooperation among international satellite operators and programs. CEOS has helped lay the groundwork for the satellite remote sensing component of GEOSS by identifying gaps in remote sensing coverage and providing high-resolution satellite data free of charge to nations in the midst of national disasters. Operational and research polar-orbiting satellites along with operational geostationary satellites provide cost-effective, continuous global coverage of critical environmental information, such as storms, pollutants, ocean surface temperatures, precipitation, soil moisture, snow and ice cover, and vegetation health. Within the U.S., NOAA's Polar-orbiting Operational Environmental Satellites (POES) and Geostationary Operational Environmental Satellites (GOES) are already contributing data to the emerging GEOSS. By the time that the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and GOES-R are launched in the next decade, the GEOSS infrastructure will be well poised to accept and use the improved global environmental data from these new systems.

As part of the "backbone" of the U.S. contribution to GEOSS, NPOESS and GOES-R will provide an unprecedented ability to accurately monitor Earth and its processes across a broad range of temporal, spatial, and spectral scales. Certainly members of the National Weather Association should be aware of the expected contributions of measurements from NPOESS and GOES-R to improvements in numerical weather prediction and weather nowcasting and forecasting. Moreover, these new systems will allow us to address all nine GEOSS societal areas with fidelity equal to that for weather forecasting. For example, improvements in visible, infrared, and microwave imaging will allow us to better map and monitor spatial patterns and seasonal and inter-annual variability in global vegetation and monitor crop stress, deforestation, and desertification globally. The information provided will play a crucial role in decisions affecting agriculture, trade policy, and international food aid.

GEOSS appears to have already affected international satellite remote sensing programs. China, India, Japan, Russia, and the Europeans, through their Global Monitoring for Environment and Security (GMES) initiative, are planning or preparing to launch their next generation geostationary and polar-orbiting environmental satellite systems. GEOSS will help promote the inter-calibration of current and future U.S. satellite measurements with other international environmental satellite systems to allow the combined capabilities of these systems to benefit a greater portion of the world's population. For many of the GEOSS nine societal areas, these systems will become part of a "global early warning system." GEOSS is also having a marked impact on the "free

and open exchange" of data among the international community. Notably the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) have recently relaxed their restrictions on the release of satellite data to non-member state organizations. Indeed access to and the exchange of environmental data is fundamental to GEOSS.

GEOSS will be a global network of content providers, similar to the Internet that will provide decision-support tools to a wide variety of users who will be able to access and extraordinary range of environmental information. Users will be able to access data through the "GEOPortal" or via "GEONETCast." The GEOPortal is a single Internet access point that connects users seeking data, imagery and analytical software packages relevant to all parts of the globe to existing data bases and portals. The GEO has initiated a year-long test and evaluation phase for GEOPortal and is soliciting users to test and provide feedback on three candidate GEOPortal systems. Users who want to participate in this test phase may access the portals at: http://www.earthobservations.org/gci_gp.shtml.

For users with limited or no access to the Internet, similar GEOSS information is available via the GEONETCast network of telecommunication satellites. GEONETCast is a near real-time, global network of satellite-based data dissemination systems designed to distribute space-based, air-borne and *in situ* data, metadata and products. GEONETCast is led by EUMETSAT, the U.S., China, and the World Meteorological Organization (WMO). The European (EUMETCast) and Chinese (FengYunCast) components of GEONETCast are currently operating. NOAA is planning a future broadcast service called "GEONETCast-Americas" that will cover the Americas. The following products and services are being made available to the GEONETCast user community:

Meteosat image data
GOES East and West image data
Land and Ocean Sea Ice Satellite Application Facility (SAF) products
EUMETSAT meteorological products
NOAA-NESDIS meteorological products
NOAA-NESDIS Ocean color and sea surface temperature products
VEGETATION products from VITO Belgium
MODIS Ocean color products
China Meteorological Administration (CMA) FY2C satellite images
CMA FY2C meteorological products

Additional information on GEONETCast is available at: http://www.eumetsat.int/home/Main/What_We_Do/Technical_Cooperations/GEONETCast/index.htm?l=en.

From land to sea, to wind, rain and drought, improved global monitoring of the Earth will benefit the world's people and provide valuable information about our dynamic and changing environment. Sustained measurements of the Earth system that will be

available through GEOSS will assist in essential tasks such as improving weather forecasts, assessing disasters, monitoring crops and climate, managing marine resources, and determining environmental change.

For additional information on GEOSS see the following web sites:

http://www.earthobservations.org/index.html
http://www.noaa.gov/eos.html
http://usgeo.gov/
http://www.epa.gov/geoss/

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