TESTIMONY OF JIM GERINGER

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WYOMING GOVERNOR (1995-2003)

REPRESENTATIVE OF THE ALLIANCE FOR EARTH OBSERVATIONS

SUBMITTED ON FEBRUARY 13, 2007, TO THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE & TECHNOLOGY

THE HONORABLE BART GORDON, CHAIR

Chairman Gordon, Ranking Member Hall, members of the Committee, special guests, ladies and gentlemen. I am Jim Geringer, currently Director of Policy and Public Sector Strategy for Environmental Systems Research Institute (ESRI), the industry leader for geospatial information systems. I served as Governor of Wyoming from 1995 to 2003. I am also a representative of the Alliance for Earth Observations, a nonprofit initiative to unite the private sector in the mission to promote the understanding and use of Earth observations for societal and economic benefit. My past includes time spent as an agricultural producer and user of earth observation information and several years with the unmanned space program configuring remote sensing satellites. I will relate some of my perspective from each of these roles.

We each benefit from earth science, remote sensing and location-based information every day. Through TV, newspapers, PDA's and online information, we check the weather, the latest headlines and map out where to meet someone for dinner. On a broader scale, we can track indicators of change across our planet. The National Oceanic and Atmospheric Administration (NOAA) reported that last year was the warmest on record for the United States. My part of the Rocky Mountain West continues to suffer extreme drought. Last week's report from the Intergovernmental Panel on Climate Change (IPCC) confirms what we already knew anecdotally—that human activity is adversely affecting our climate.

Today's discussion centers on Earth science and applications from space and the requisite analytical tools that are necessary to make use of the data. As a former governor, agricultural producer and now involved with geospatial technology, I support the programs dealing with Earth science, applications, and observational technologies for public use, business decisions, and everyday personal choices.

I thank Drs. Berrien Moore and Rick Anthes for their leadership as co-chairs of the National Research Council (NRC) study, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, which is the focus of this hearing. I congratulate them and the other members of the Committee for an exceptional report. I serve on a related committee under the NRC, the Mapping Science Committee, so I know that the quality and breadth of reports such as this don't just happen; they require a very dedicated and concerted effort.

Response to the Report

Quoting from the report, "the United States' extraordinary foundation of global observations is at great risk. Between 2006 and the end of the decade, the number of operating missions will decrease dramatically and the number of operating sensors and instruments on NASA spacecraft, most of which are well past their lifetimes, will decrease by 50 percent." A fifty percent reduction in today's space-based information systems is in sharp contrast to ever increasing demand.

Quoting further, the Committee was "challenged by the rapidly changing budgetary environment of NASA and NOAA environmental-satellite programs. By definition, decadal surveys are forward-looking documents that build on a stable foundation of existing and approved programs. In the present survey, the foundation eroded rapidly over the course of the study." It is difficult maintain your vision from a crumbling vantage point.

I offer three recommendations to the Committee for your consideration and deliberation:

- Enable the best possible **personal and policy decisions** by providing our citizens with information, technology and tools to monitor and respond to our changing world, thereby protecting lives and property;
- Provide an integrated earth observation system to assure U.S. **competitiveness**;
- Designate clear **leadership** responsibilities to resolve the issues and attain the goals identified in the Decadal Study;

Enable the Best Decisions

The American people need and deserve the most comprehensive and timely information possible about our world. The value of objective, timely, and accurate information has never been higher. We all would like to have predictable certainty and security, in our lives. The value of information is high when uncertainty is high. Today nearly every issue we face has increasing uncertainty which drives the necessity for better information. We devote funding and resources to modern medicine to keep our bodies healthy using the best information; likewise, we should have quality information about our nation's food supply, water supply, energy, climate change and national security or face more and more uncertainty. In today's world of RSS feeds, 24-hour news channels and emails that propagate rumor far faster than truth, information that is dangerously incomplete is being used to influence decision makers. Today's media and Internet capabilities can and should provide more and better information. Remote sensing with the right analytical technology can provide an objective and accurate assessment of the situation before decisions are made with information that has not yet been validated.

We should develop a culture among agencies and levels of government to share data, applications and predictions, then serve the results to the public so that we individually and collectively are more self-reliant, less vulnerable and can assure long-term sustainability for our world.

A policy maker in Washington, a water resource manager in the West, a farmer in Indiana each must have good information upon which to base decisions. We must have access to the most accurate and comprehensive science information to develop a policy of sustainability for ourselves and for future generations.

Earth Observations are Vital to American Competitiveness

Integrated Earth observation capabilities are vital to American competitiveness. The Decadal Survey helps us realize that the U.S. Earth observation capability is not keeping up with expectations and our competitiveness is at risk. We must have the global information infrastructure that is critical to our interconnected society. Comprehensive science information ensures that decisions will be made based on evidence rather than anecdotes. Long-term, sustained data is needed to identify trends. Without U.S. long-term climate data, the IPCC assessment would not have been possible.

Small satellites such as the Disaster Monitoring Constellation (DMC) from the United Kingdom, Algeria, China, Nigeria and Turkey, provide information for disaster prediction and mitigation. But one of the most effective applications has been the monitoring of opium production in Afghanistan. A constellation of low-cost satellites showed that the area under opium cultivation grew to a record 165,000 hectares in 2006 compared to 104,000 hectares in 2005. The U.S. is not alone in innovative approaches.

On June 21, 2004, the Western Governors unanimously adopted a report entitled, *Creating a Drought Early Warning System for the 21st Century: The National Integrated Drought Information System.* I encourage the members to download a copy from http://www.westgov.org/wga/publicat/nidis.pdf. I was pleased to provide testimony on their behalf before the Senate Committee on Commerce, Science & Transportation, Subcommittee on Disaster Prevention & Prediction last April that helped with the passage of H.R. 5136 authorizing NIDIS. Last week the President proposed $4.4 million in the FY2008 budget to fund it.

The strongest case for NIDIS is to enable risk management by individuals, businesses and governments, dramatically shifting from our practice of reaction and response to one of prediction and mitigation. Our competitive capability will increase with better risk management. We cannot do this without accurate and regular satellite observations.

With better sensors, data, applications, tools and ever-improving technology we should reward risk management over resignation to the elements.

Of all the commodities sought in our marketplaces today, none will affect our competitiveness in the future more than water. Not oil or gold or pork bellies, but water. Our municipalities must have timely information that enables water policies that minimize or eliminate water shortages, farmers to plant alternative crops, ranchers to locate alternatives for grazing, river barges to anticipate low flows in navigable waterways, and health agencies to control disease.

Space sensors and satellite observations improve our understanding and response to climate change to sustain international competitiveness. In today's global economy, innovation is the key to competitiveness. The United States must stay at the forefront of Earth observation and geospatial technologies to better forecast and mitigate the impact of climate change, natural disasters and not only lead the competition but leave a more sustainable world for our children. The motivations and aspirations of the next-generation workforce are being shaped today. We should be setting a long-range vision in place to encourage today's youth to pursue science, math, technology and engineering professions to assure future innovation and competitiveness.

Our commitment today to technology and greater knowledge of the Earth would allow us to better protect life and property and create unprecedented opportunities to promote economic vitality. The right instruments and information systems enable our ability to make forecasts that help anticipate outbreaks of infectious disease, ensure adequate water availability and quality, or increase agricultural productivity.

The recommendations by the NRC report would enable a global view of issues and activities. But a global view alone is not sufficient to make policy or decisions. We need researchers, geospatial modeling and analysis that integrate pertinent sources of data. We should promote the use of established standards and protocols to assimilate data from multiple sensors and sources—including commercial providers, state and local governments, academia and international partners—and provide the data through user-friendly web portals.

The U.S. private sector capabilities lead other nations. Google, Microsoft, Yahoo and MapQuest provide online mapping sites with remotely sensed imagery that we take for granted. In the private sector, companies such as GeoEye and DigitalGlobe provide high-resolution satellite imagery. Tourism, real estate and insurance companies routinely use remote sensing information available online. High-resolution imagery has enabled corrections to legal descriptions and settled ownership disputes of land parcels. Light Detection and Ranging, or LiDAR sensors are used extensively to map terrain and elevation allowing state and local governments to aid in planning and development decisions.

Dr. Glenn Hill of Texas Tech University used 3-D imaging to catalog and preserve the archaeological heritage in Mesa Verde National Park. If space-based technology were developed to produce images of the quality created by Hill's team, high-definition 3-D images of entire national parks would enhance our ability to manage our national parks. These and many other examples point out how public expectations continue to increase for good science and timely assessment.

I affirm the comment in the NRC report that "Satellite observations have spatial and temporal resolution limitations and hence do not alone provide a picture of the Earth system that is sufficient for understanding all of the key physical, chemical, and biological processes." We need a system of space, ground, airborne and ocean-based sensors, both public and private, that can gather complementary information and can be integrated with a minimum of duplication. In addition we need a national network information integration that can be provided by collective efforts such as a Geographic Information System for the Nation described in the paper attached to my written testimony as *Appendix A.*

Clear Leadership is Essential

Clear leadership is essential to resolve the issues and attain the goals identified in the Decadal Study. The report before you calls for increased funding to improve our current national earth monitoring capability. Yes, funding is important but the essential missing element is leadership. Scientific assessment, increased budgets, improved technical capabilities, and coordinated public-private engagement must be accompanied by designated, consolidated leadership. Critical elements including satellite and aircraft sensors, in situ instruments such as stream gauges, and geospatial information systems, have been fragmented among our Federal agencies, always a secondary mission, never the priority responsibility.

Earth observation is not a priority mission for any designated agency at the cabinet level. Not within NASA, the Department of Commerce, the Department of Interior nor any other Federal agency. The important technologies that enable us to measure climate change and identify and monitor the impacts to our environment, our lives and our livelihood are the sole responsibility of no one agency or person. Our federal policy and programs are fragmented, even duplicative, and fall short of national goals. Our Earth observation systems that might help mitigate such things as drought or major disasters are neither efficient nor integrated. Consequently our current laws and practices foster dependency rather than enabling risk management, creating expectations that the federal government will bail us out of any and all misfortunes.

Who should be the lead agency or position for U.S. Earth observation capabilities? What is our national vision for Earth observations? How are requirements from the Federal operational sector such as NOAA, USGS, USDA and EPA reflected in our research and development programs within NASA and NSF? Are requirements from the private sector being addressed?

Leadership is essential to:

- Protect these critical assets;
- Develop a national Earth observation strategy to appropriately addresses climate change and other environmental challenges based on evidence over anecdote;
- Assure economy and efficiency in agency plans and budgets;
- Allow a smooth transition from research to operations;
- Improve U.S. land-observing capabilities to an equal priority with atmospheric and ocean observations;
- Improve capability and cooperation among government, private sector, academia, and non-governmental organizations;
- Assure the much needed integration of our national and international Earth observation systems;
- Develop the products needed to make the best decisions for our country and future generations.

I support the report recommendation that:

> The Office of Science and Technology Policy, in collaboration with the relevant agencies, and in consultation with the scientific community, should develop and implement a plan for achieving and sustaining global Earth observations. Then a single point of contact or program office at the Cabinet level should be established to assure complementary rather than duplicative or fragmented effort for all operational aspects of earth observation and analysis.

I urge that the private sector—industry, academia, and non-governmental organizations—be consulted regarding an integrated plan for Earth observations through a high-level Commission (e.g., Congressional or White House). Good ideas and best practices abound outside of government.

The U.S. Integrated Earth Observation System (IEOS) would also advance our national capabilities. IEOS would be the U.S. component of the Global Earth Observation System of Systems (GEOSS), which is now supported by more than 66 countries and 46 international organizations. This U.S.-initiated effort is intended to allow Federal interagency and multi-national coordination to assure that disparate environmental-related data systems here at home and abroad are interoperable and compatible. A strong IEOS effort should be characterized by clear designation of responsibilities, enabled by a web-based system of rapid communication, and funded across agency boundaries with a clear purpose. IEOS/GEOSS would improve the capabilities for today's decision makers by providing new information products. That is not the case today. IEOS has neither been funded nor has program leadership been designated.

We take for granted our capability to use credit or ATM cards almost anywhere in the world. The financial and banking systems throughout the world are interoperable—they exchange, transfer, translate, and deliver data that is used in decision support tools. If insufficient funds exist, both the bank and the account holder know. Decision support tools used by banks flag and even stop transactions. We should do the same with today's Earth observations systems. Unfortunately, they are not integrated. Our current systems do not allow users to easily access, integrate or deliver data, nor do they include adequate decision support tools. We need a common integrated information architecture that IEOS/GEOSS would require.

Space-based assets made possible the discovery of the Antarctic ozone hole, enabled forecasting more than 40 hours beforehand as to where and when Hurricane Katrina was likely to make landfall, and now help us to understand the evidence and impacts of climate change. These same technologies are used by farmers, energy executives, and coastal managers for their daily operational decisions.

Satellite Measurements for Agriculture and Other Areas

Mr. Chairman, I have generally covered all of the questions in your letter of invitation for me to testify. I submit these additional comments:

1. *Describe the capabilities and applications made possible by data derived from remote sensing satellites. What kinds of measurements are of chief interest to each of the following communities:*
    - *Agriculture*
    - *Natural resource managers*
    - *Municipal water supply managers*
    - *Tourism and recreation officials*

Each of these communities is heavily dependent on accurate weather and climate forecasts provided by NOAA and private sector weather information companies.

Earth observations are widely used for assessments of production and resource conditions at a point in time. We need to move beyond the emphasis of a single snapshot to the incorporation of observations made over time, analyzed by models that can be used to predict yield or resources status as a consequence of future climate, management, biological or societal changes.

According to our U.S. Department of Agriculture, remote sensing associated with sustainable agriculture, forestry, and responsible natural resource stewardship would include:

- Monitoring domestic and foreign yearly yields and harvests of food, and fiber production at field, local, regional and global scales.
- Measuring soil erosion from wind and water.
- Evaluating impacts of global change, especially climate.
- Detecting the presence of, and then monitoring the spread of invasive species including plants, animals, insects and diseases affecting agriculture, forestry, and natural resources.

- Detecting and measuring contamination of soil, water, and air resources, including dispersion of pollutants.
- Detecting indicators of landscape health such as the impacts of resource degradation on agri-ecosystems and natural ecosystems.
- Measuring resources involved in the development and production of biofuels
- Evaluating the effect on food supplies of agriculture's shift from food production to biofuels.
- Detecting and measuring the impact of, and the progress of recovery from, episodic catastrophic events such as drought, flood, hurricanes, tornadoes, volcanic eruptions, earthquakes and wildfires.
- Detecting the effects of bioterrorism such as plant diseases, water-born pathogens and monitoring progress of remediation.
- Establish metrics for maintenance of soil quality, especially organic matter, and chemistry.
- Detecting and measuring landscape factors indicating compliance with agreements between landowners/operators and federal and state agencies such as the Conservation Reserve Program (CRP), easements, timber sales, rangeland management and public lands.
- Detecting and measuring landscape factors indicating compliance with international treaties and agreements.
- Identifying pathways that transport hazardous waste, and measuring the amounts and ultimate fates of waste.
- Measuring the status and changes of habitat and effects on plant and animal biological diversity.
- Understand the effect of energy development activities on or near critical habitat for threatened and endangered species.
- Measurements to identify and quantify factors influencing water quantity, water quality and air quality.
- Measuring carbon sequestration strategies to determine beneficial climate change.
- Measuring the long-term effects of the increasing removal of ground water from underground aquifers.
- Calculate the near-term and long-term effects of urban sprawl on agricultural production, critical habitat and recreation opportunities.

Agricultural users require direct measurements from hyperspectral imagery to identify ground cover or to the type and health of vegetation and soils, such as too much or too little water, fertilizer or ripeness, on a short time scale of days to weeks. Archived, these same parameters provide climatologists with longer-trend information, from seasonal to yearly variations such as El Niño, for capacity planning such as transportation and silo storage. The Drought Monitor is consulted by farmers, ranchers, and land managers especially in the West, and internationally by those who seek competitive advantage in export markets or where they may gain temporary advantage in their own country or region when drought would decrease our exports into their countries.

Natural resource managers use direct measurement by hyperspectral imagery from aircraft or from space to provide signatures of water resource conditions such as algae and contaminants. These same measurements can provide forestry with tree type and conditions of their health. Measurement of atmospheric temperature and moisture provide input to atmospheric forecast models that predict future temperature, precipitation, and severe weather, which could place healthy resources at risk.

Municipal water supply managers also use atmospheric temperature and moisture measurements to provide input to atmospheric forecast models that predict temperature and precipitation for planning in usage and supply.

Tourism and recreation officials assess atmospheric temperature and moisture measurements to provide input to atmospheric forecast models that predict weather and severe hazards for travel and tourist site conditions.

The World Meteorological Organization (WMO) has recognized 26 Essential Climate Variables (ECVs) documented by the science community—26 measurements that are critical to the models that forecast weather and climate.

NASA, the U.S. Geological Survey, the Environmental Protection Agency, the Department of Energy, the Department of Agriculture, the Department of Commerce and others are developing, deploying, and maintaining Earth observation data sets used in key models and decision support tools.

2. *How do these groups gain access to remote sensing data? Is special training required to understand remote sensing data, and if so, how is it derived? Do private companies provide value-added products for these groups?*

Groups access remotely sensed data several ways. The NOAA weather and climate forecasting services (National Weather Service, National Hurricane Center) provide data and information through NOAA maintained portals and servers that provide access to over 250 individual information products, including forecasts. Private sector companies (Accuweather, ZedX Incorporated, The Weather Channel) access and exploit this information for individual clients. Commercial companies such as Google and ESRI provide online portals, and consulting and software solutions used by many of the companies to visualize information for several of these markets and to enable modeling and workflow analysis.

Raw remote sensing data by itself is not entirely useful. Training and education vary by the level and sophistication of the end user. Ordinary citizens use data provided through many types of media. Capabilities range from basic literacy skills up to doctoral research, certified professionals and technology aware managers. Special expertise is required to turn data into actionable information. Public domain and general information is provided through government agencies while tailored information for special and commercial users is provided by value-added companies.

User communities throughout the U.S. are generally fairly sophisticated, benefiting from training and information provided by NOAA, NASA, and NSF, the Air Force, and professional societies such as the American Meteorological Society, the National

Association of Broadcasters. Individual companies such as ESRI also provide specialized training programs. There are thousands of registered meteorologists and GIS professionals throughout the United States that are trained in the use of the observations and the Earth science models that use them to create trends and forecasts.

The number and diversity of players in the satellite observation field is growing.   New and emerging capabilities offered by GoogleEarth, Microsoft Virtual Earth 3-D, ESRI's Explorer and others deliver all types of data and information products to a wide variety of users particularly through internet-based web services and data portals that allow many users to discover and extract information.

As a cautionary note – we risk becoming too complacent about having imagery and maps right at our fingertips. Visualization is interesting but can be so shallow as to be misleading. Development of good policy alternatives and decisions depend on the quality and configuration of remotely sensed data. Data must be described in terms of metadata, or its appropriateness for use. Compatibility of diverse date sources is essential. The casual user of online free imagery may not realize how much useful spatial and spectral information can come from satellite sensors and used for analysis. The full value of remotely sensed data comes from computer programs and analytical models that extract and transform information from validated and verified sources.

Academia plays a very important role in delivering information products and training. Our universities not only provide vital research, but they are also developing the next generation of scientists, engineers and end users.

We don't just need more data. We need more data that becomes information to enable decisions. The Data was there that said that the nursing home in New Orleans was putting the residents at risk. But the data wasn't available in the right form and wasn't used to make decisions, a tragic outcome for those who needed it.
You as members of Congress are enabled through a wide variety of information through the Library of Congress that helps suggest a range of policy options that you may use in legislative deliberations.

3. *Based on your experience, how broadly are government and industry using remote sensing data to plan and manage crop production and other natural resources?*

The most positive potential for government and industry alike is to leverage and integrate information in a complementary way. The most negative potential is for agencies to be fragmented in approach, duplicative in some efforts and void in others.

Both government and industry use remote sensing data to plan and manage many activities including crop production and natural resources. The U.S. Department of Agriculture, for example, benefits greatly from access to a robust set of observations and forecasts that are provided by a wide range of Earth observation systems (public and private). These are used by the Foreign Agriculture Service (FAS) to provide the monthly global crop assessment products. These products are key to policy and management decisions on agriculture worldwide. Business entities that advise the agriculture community are critically dependent on NOAA and other sources of near-term weather forecasts and seasonal to inter-annual forecasts of climate conditions that are used in decisions of what to plant, when to plant, and when to harvest.

NASA's MODIS satellite has been an invaluable source of information to detect and fight wildfires in the West. Knowing where the active fire lines are helps protect the safety of our firefighters. The sensors help scientists monitor the extent of irrigated agriculture and deforestation worldwide and provide data that private analysts use to predict the global agricultural production including which crops will be in short or over supply.

As industries become more dependent on managing on small margins or managing against disaster risk, information from remote sensing will become even more important. Weather risk managers seek to identify the economic consequences of adverse weather on enterprises and organizations by relating their revenues, margins and costs to critical weather variables. A professional market exists that makes its business in assuming this weather risk. In exchange for a premium or other benefits, these businesses take on this risk based on indices of pertinent weather variables, such as average temperature or rainfall.

A couple of years ago, the Metropolitan Area Planning Agency representing sixty-four member organizations from five counties in Nebraska and Iowa contracted to provide aerial data acquisition, digital orthophotography, and production services for over 2,200 square miles in Nebraska and Iowa. It was a multi-sensor program involving a large consortium of government user communities. It included a combination of Lidar mapping, floodplain mapping, data for master planning, design and construction projects, floodplain analyses, web services, highway and road design, 3D visualizations, GIS municipal requirements, and various engineering and public works functions.

There is similar interest in managing the economic impact of extreme events—earthquakes, hurricanes, monsoon and typhoons—by utilizing indices based on windstorms, seismic magnitude and seismic intensity in ways that are very similar to the way the weather risk market uses weather data. The risk-management business has strong interest in serious, systematic attempts to improve, expand and intensify the capture of data relating to our planet. We also see growing interest in the risk management and insurance industries for understanding shorter-term weather risk in terms of climate change. In sum, better, fuller data mitigates data risk and model risk for the providers of risk capital.

Moving Forward

As noted earlier, the American people deserve the best and most comprehensive information about our changing planet. Recent revelations about climate change, particularly as affected by human activity, elevate the importance of ensuring national climate observing systems. We must approach our environmental security with as much rigor and commitment as we approach homeland security.

We should build upon the Decadal Study results by:

- Ensuring that the U.S. long-term climate monitoring capability is maintained;
- Addressing the void in Earth observation leadership and vision;
- Establishing a single point of contact or program office within the Office of Science and Technology Policy;
- Improving our research-to-operations efforts across all relevant agencies;
- Establishing a common integrated information infrastructure;
- Implementing the U.S. Integrated Earth Observation System (IEOS) of the Global Earth Observation System of Systems (GEOSS);
- Immediately beginning a dialogue with the private sector--industry, Academia, and non-governmental organizations—to ensure our satellite observation assets respond to the needs of various sectors as well as to consider new technology solutions, such as the Geographic Information System for the Nation described in *Appendix A.*
- Establish a high-level Commission composed of private sector (industry, Academia, and non-governmental organizations) representatives to further examine and develop an integrated plan for earth observations.