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# The Forum On Earth Observations™ V

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Creating a National Strategy for  
Environmental Intelligence

***FINAL REPORT***



June 14, 2011 • Washington, DC

[www.ForumOnEO5.com](http://www.ForumOnEO5.com)



### TO THE READER

*Last year we witnessed ocean observations that were too sparse to quickly and accurately estimate the amount of oil escaping into the Gulf of Mexico as a result of the Deep Water Horizon disaster. This year, tornadoes, extreme weather, drought, and heat waves highlight the importance of weather and climate observations. With these events freshly imprinted in the psyche of most Americans, the fifth Forum on Earth Observations was organized to examine why the United States needs a comprehensive, long-term strategy for environmental intelligence and just how we might go about creating one.*

*As the need for actionable environmental intelligence grows, the Alliance for Earth Observations continues to stress the importance of bringing together public and private sector leaders in an active dialogue. This allows us to cooperatively address our national capabilities and ensure that the nation's environmental information supply chain delivers the broad array of ocean, land, and atmospheric information needed for decision making.*

*The highlights of the Forum are summarized in the following pages.*

*We hope its key message will resonate with you: environmental intelligence impacts every sector of the U.S. economy, the supply chain that provides this information is fragile, and a national strategy is of the utmost importance. It has never been more evident that U.S. environmental information capabilities will be crucial in meeting global challenges such as climate change, food security, and natural disasters.*

*Because we were not able to include every thought leader or expert in this one-day event, we also invited written statements from numerous leaders in the field. These valuable statements are also included in this report.*

*We are extremely grateful to the Forum sponsors, cooperating partners, organizing committee, our esteemed speakers and panelists, and attendees for the significant contributions they made to this successful event.*



**Nancy Colleton, President**  
Institute for Global  
Environmental Strategies

**Executive Director**  
Alliance for Earth Observations

INSTITUTE  
for  
GLOBAL  
ENVIRONMENTAL  
STRATEGIES



ALLIANCE  
FOR EARTH  
OBSERVATIONS



### EXECUTIVE SUMMARY

**Against the backdrop of one of the most devastating tornado seasons ever experienced in the United States**, a continual rise in natural catastrophes on a global scale, unprecedented famine in the Horn of Africa, and one of the most contentious and uncertain U.S. budget environments, leaders in the U.S. Earth observations community met on June 14th to assess the nation's environmental information capabilities and examine the need for a national strategy to ensure the capture and delivery of this critical information.

The signature event of the Alliance for Earth Observations, the Forum on Earth Observations V: Creating a National Strategy for Environmental Intelligence, brought together those that develop the technologies that monitor the Earth with those that need the information to better manage it. Government, business and academic leaders—in the areas of agriculture and forestry, intelligence, insurance, civilian and military operations, weather and climate, observation technologies (satellites, ocean buoys and aircraft), information systems, energy, Earth science, data management, communications, and emerging technologies—took part in this event. All agreed that a pressing need exists for a national strategy that ensures the long-term and timely delivery of environmental intelligence—actionable information that enables individuals, governments and businesses to make critical decisions.

Included below are the findings and recommendations that resonated throughout the Forum. Regardless of whether the discussion centered on insurance, international development, food security, or public-private partnerships, these issues represent key points of consensus about current Earth observation needs and the way forward.

#### ■ ENVIRONMENTAL INTELLIGENCE AND CLIMATE CHANGE

- Environmental information is indispensable for individuals, governments and businesses to adapt to the growing costs imposed by natural disasters.
- Climate change is considered a critical national security issue. Meeting the challenges it poses requires a long-term planning perspective.
- Earth observations are fundamental to the activities of U.S. agencies and other institutions engaged internationally.

- Unbalanced quality and availability of data hamper the delivery of global assessments of the changes and growing demand on the world's resources.
- Climate change and the need for improved environmental information present an economic opportunity.
- Research must expand to be more multidisciplinary to incorporate the human component of a changing climate.
- Education and public outreach are key to addressing climate change and fostering better use of limited resources.

#### ■ MEETING USER DEMAND

- A national strategy is needed that ensures long-term measurements and the widespread availability of Earth observations data.
- Meeting user needs can be improved. Better communicating what information is collected is a necessary step in this direction.
- Landsat is one of the most important U.S. contributions to the world.
- The U.S. open data access model is revolutionary and key to facilitating the use of important environmental information around the world.

#### ■ A CHANGING LANDSCAPE

- A paradigm shift for business intelligence is underway, with more industries realizing the role of environmental information in the short and long term.
- Opportunities exist for improved international cooperation.
- Fiscal constraints create opportunities to innovate.
- The data flow model is shifting. Assets include academic, international and commercial platforms, greatly augmenting government capabilities.
- Public-private partnerships are essential and must be improved.
- U.S. leadership in Earth observations should be leveraged to present greater economic opportunity for the nation.
- Given the difficult budget environment, the private sector is expected to play a greater role in the future.

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## INTRODUCTION

**The Forum on Earth Observations™** brings together public and private sector leaders to discuss the nation's growing demand for improved environmental intelligence—the most accurate and timely information available about our planet that enables governments, communities, companies and individuals to make sound decisions. Environmental intelligence is vital to local, national and global decision making, and will be critical in enabling our civil, defense and commercial programs to meet the nation's priorities.

Environmental intelligence is the result of a critical supply chain that begins with science and observations—ground sensors, ocean buoys, stream gauges, satellites, etc.—and ends with actionable information that allows decision makers to better respond and adapt to a changing planet. But

such decisions are made difficult, sometimes impossible, when the U.S. environmental information supply chain is weak or threatened, and essential environmental intelligence is not available or easily accessed. Given that the environment impacts every sector of the U.S. economy, a national strategy for environmental intelligence that ensures the continued availability of this critical information is of the utmost importance.

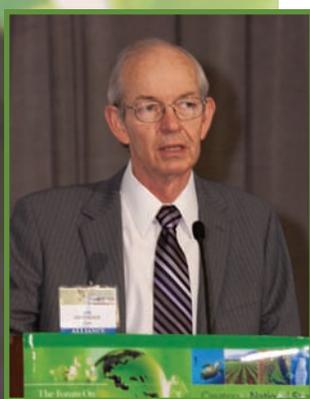
The fifth in the series and the Alliance for Earth Observations' signature event, the 2011 Forum brought together a diverse community of leaders and stakeholders of the environmental information supply chain who shared their ideas, priorities and potential contributions for creating a cohesive and comprehensive national strategy for environmental information.



Participants at the Forum.



From left: Scott Hausman of NOAA, Stephen Ambrose of NASA, and Helen Wood of NOAA exchange views during a networking break.



Geringer.

## OPENING REMARKS

### Jim Geringer

*Wyoming Governor 1995-2003; Member, Board of Directors, Institute for Global Environmental Strategies (IGES); Director of Policy and Public Sector Strategies, Environmental Systems Research Institute (ESRI)*

IGES Board member Jim Geringer introduced the theme of this year's Forum and the concept of environmental intelligence, crucial to decision making. "Decision making, after all" said Mr. Geringer, "is the ability to take action." Concerned about recent events such as abnormal precipitation trends, droughts and sea level changes, he suggested that Forum organizers sought to examine those issues that

may be impairing individuals, business and governments from taking action. Referencing the National Research Council's 2007 *Decadal Survey for Earth Science* that highlighted the need for synthesis in Earth observations, Mr. Geringer reiterated that the lack of synthesis—between the raw data and decision making—makes taking action nearly impossible. The day's discussions would take a careful look at the different aspects that would enable the development of a synthesis tool—a national strategy. "That's what we want to do with intelligence—that is, to say: what do we have, what should we have, and how do we make up the difference," said Mr. Geringer in closing.



**THE NEED FOR IMPROVED ENVIRONMENTAL INTELLIGENCE**

■ **Carl G. Hedde**

*Senior Vice President and Head of Risk Accumulation, Munich Reinsurance America, Inc.*

*“I work for an organization that has done an awful lot of work on the climate change arena, [that] believes we are seeing a change in climate and, as a result, we need to do things differently.”*

—Mr. Hedde

This year has been a very active one from an insured and reinsured perspective, began Mr. Hedde, who highlighted the role of information in decision making, particularly in terms of the costs imposed by natural disasters.

Using MunichRe data, Mr. Hedde provided a detailed overview of the most recent and costliest disasters in the United States and abroad, what he described as “game-changing events.” These included, for example, the earthquakes in New Zealand and Japan, as well as the record-breaking spring storms in the United States.

The game-changing events in Japan result in “contingent business interruptions” or “business income loss,” he explained, where companies around the world—not necessarily in the same continent where the event occurred—have their business chain disrupted as a result of a natural disaster. The costs borne by society are striking: the 255 events that took place

up to May 2011 around the world produced 18 thousand fatalities and \$253 billion in losses, of which \$48.3 billion were insured losses.

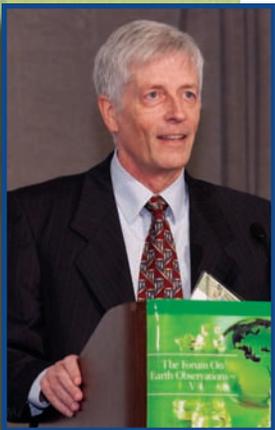
The positive aspect is that businesses are integrating this information to better adapt. The Insurance Institute for Business and Home Safety, for example, in 2010 opened a large-scale wind research facility where it performs research on the appropriate building guidelines for homes to sustain extreme winds. This is by no means unwarranted, as many of these extreme weather events are taking place within the United States, including eight of the top 11 costliest natural disasters since 1950. In fact, insured losses through May 2011, in what he said could be classified as “the year of the tornado,” amounted to a record \$11 billion in the United States.

Taking stock of this information forces the question: “What can we do better to get people out of harm’s way so that they are not killed and injured as a result of these types of events?” Mr. Hedde asked rhetorically whether issues such as climate change, increase in value, urban concentration or even bad luck were factors in the location of these events.

Earth observations are helping answer these and other key questions that could avoid future casualties and losses. Such information is the basis of what he described as “risk adequate insurance pricing” which could balance costs to help people make better decisions. Environmental information, he concluded, is “the basis of how we make decisions down the road.”



Hedde.



Nelson.

**THE ROLE OF OBSERVATION AND FOOD SECURITY**

■ **Gerald “Jerry” Nelson, Ph.D.**

*Senior Research Fellow, Environment and Production Technology, International Food Policy Research Institute (IFPRI)*

*“We need regular observations...that means observations made using standard methods that occur year after year, after year, everywhere on the planet. And these observations need to be made freely available to all.”*

—Dr. Nelson

“The food security challenges facing us as a species are really unprecedented,” said Dr. Nelson. For the experts that study the future of food security, information about the Earth’s

environment, climate and resources is vital.

To the mounting pressures of an increasing world population, estimated to reach 9 billion by 2050, climate change is a “threat multiplier.” While the long-term effects of climate change are uncertain, Dr. Nelson said, “I can guarantee you that climate change will reduce productivity of existing systems everywhere,” and that, in most places, the costs to adapt to those changes will be very expensive. In a monograph published last December, IFPRI researchers considered the impact of income and population growth in future scenarios of food security through 2050. When the effects of climate change were included, the price increase of maize, a staple crop, was estimated to double from about 50% to 100% in



the same period.<sup>1</sup> Dr. Nelson explained that this reflected a largely “uncertain world” and a very different one from the previous century.

In this context of costly and dangerous uncertainty, Dr. Nelson asked: “How much do we really know about what the state of our planet is and how it is changing?” To demonstrate the relevance of accurate data, he compared Earth observation data of country resources, such as irrigated land in India, with government statistics. The discrepancies were quite stark: the International Water Management Institute relied on remotely-sensed data to estimate about 115 million hectares of irrigated land, while the Indian government estimated there was about half as much.

As this and other examples illustrated, what is needed is not just more information on the state of these resources but also on how these change over time, in order to un-

derstand the drivers of those changes, Dr. Nelson said. This is key, he added, to developing policies and programs that “increase the likelihood of sustainable food security even in a world with climate change.”

Dr. Nelson reiterated the need for truly reliable sources of data that match needs. Landsat, which he described as “the workhorse for the world in addressing these problems,” is an example of the difference in coverage motivated by operational and research needs, the latter resulting in “spotty” coverage. Dr. Nelson concluded that to answer the critical questions posed by food security in a world with climate change, experts depend on the comparatively “boring” operational observations that produce full coverage of the globe—“that’s exactly what we need going forward.”

## MEASURING TO MANAGE

### ■ David J. Hayes

Deputy Secretary, U.S. Department of the Interior

*“Our need for relevant, timely, understandable, collected data has never been more acute.”*

—Deputy Secretary Hayes

Despite being the largest landowner in the United States, the Department of Interior (DOI) has traditionally not been active in measurement of the country’s resources, explained Deputy Secretary Hayes. At the root of this is an assumption of limitless resources and taking a “light hand” as the best management strategy. With climate change “clearly impacting our resources,” and creating a pressing need to understand and adapt to these changes, the deputy secretary said that this approach has begun to change.

DOI must measure more to learn about risks such as rising sea levels, which threaten the 35 thousand miles of coastland it oversees, or the pine beetles “chewing up forests” across the country. Deputy Secretary Hayes went on to say that greater understanding will allow DOI to better adapt to these changes and make more effective strategies for using and protecting the nation’s resources.

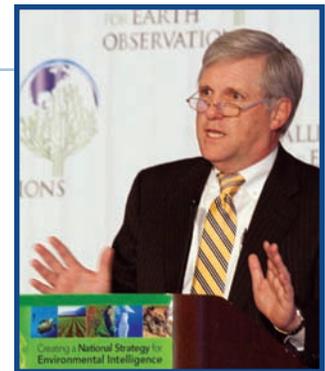
Speaking about the role of information to enhance decision making, the deputy secretary mentioned examples of the kind of “landscape-level planning” in which DOI is increasingly engaged. For example, there is increasing pressure to use public lands for domestic energy production, such as the world’s largest solar plant, 1000 megawatts, being built in the desert of southern Arizona. DOI is using mapping and numerous data sources to better manage U.S. resources. This is very important when determining where to place offshore wind farms or make better land use decisions based on biological sequestration information.

Yet such environmental information is valuable only to the extent it can be accessed and used. Deputy Secretary Hayes highlighted the importance of the Landsat program, which he described as “revolutionary,” as a model for open access to data

and how to facilitate use of this important data throughout the world. He made special mention of the USGS and ESRI-developed *Change Matters* website,<sup>2</sup> providing easy access to Landsat data. The value of this approach, he said, is not just to share data for the sake of having it, but so that policymakers can have access and use it to make better decisions. “We are, at the Department of the Interior, all in on Landsat,” stated Deputy Secretary Hayes.

This approach reflects an understanding of the need to think of resource use in a more calibrated and open way, he said, engaging with more stakeholders. “With climate change we see how interconnected our ecosystems are,” revealing that risks need to be addressed by a community of resource stewards. DOI is helping to provide the infrastructure for this new kind of engagement through the Landscape Conservation Cooperatives (LCC).<sup>3</sup> The LCCs enable the federal government to provide the forum for these discussions, as well as offer data through DOI’s climate science centers.<sup>4</sup>

Deputy Secretary Hayes concluded by expressing support for this changed management model that relies on more data and “a more participatory society” working together to make informed decisions about the use of its resources.



Hayes.

<sup>1</sup> “Food Security, Farming, and Climate Change through 2050,” (2010) <http://www.ifpri.org/publication/food-security-farming-and-climate-change-2050>

<sup>2</sup> It can be accessed at: <http://changematters.esri.com/compare>

<sup>3</sup> LCCs constitute “a network of public-private partnerships that provide shared science

to ensure the sustainability of America’s land, water, wildlife and cultural resources.” For more information, visit: <http://www.doi.gov/lcc/index.cfm>

<sup>4</sup> For more information, visit: <http://www.doi.gov/whatwedo/climate/strategy/CSC-Map.cfm>



**ENVIRONMENTAL INTELLIGENCE  
ROUNDTABLE: THREE PERSPECTIVES  
ON U. S. NEEDS**

Setting the stage for the discussions that focused on specific user communities, this roundtable discussed U.S. growing need for critical environment information from the perspective of the science, national security and business communities.

Moderated by Nancy Colleton, president of IGES and executive director and co-founder of the Alliance for Earth Observations, the roundtable featured:

- Richard L. Engel (Major General USAF, Ret.), Director, Environment and Natural Resources Program, Strategic Futures Group, National Intelligence Council



Engel.

- Thomas R. Karl, L.H.D., Chair, Subcommittee on Global Change Research, U.S. Global Change Research Program; Director, National Climatic Data Center, NOAA
- Charles F. Wald (General USAF, Ret.), Director and Senior Advisor, Aerospace and Defense Industry, Deloitte Services LP

**Observations and Recommendations**

■ **Climate change is considered a critical national security issue, and decisions to meet the challenges it poses must be made with a long-term planning perspective in mind.** Among the aspects characterizing a new security reality is climate change. Its potential impact on the world’s resources, particularly water, and the instability it could cause at home and abroad is an important issue of concern to the national security community. The U.S. intelligence community,

in particular, is looking at climate change to understand the human sustainability question.

■ **Unbalanced quality and availability of data make it difficult to provide a truly global assessment.** The ability to monitor developments on a global scale is hampered



From left: Engel, Karl and Wald.

by a lack of data, particularly as the availability and quality of measurements are unbalanced across the world. The Intergovernmental Panel on Climate Change (IPCC), which attempts to provide this service, is solely dependent on the availability of data on a given region to draw its conclusions and is therefore able to provide only a mixed story. It was recommended that a new national institution tasked with providing global and regional assessments be created. This institution should also be in charge of studying climate change as a driver of long-term change in crosscutting areas such as food, water and energy.

■ **A strategy is needed that ensures the long-term availability of Earth observations.** “One-off” research efforts are not sustainable and decision makers need the reliability of information that comes from sustained observations. A national strategy is needed that integrates the measurement, validation and prediction activities, but also ensures the long-term ability to maintain Earth observations capabilities and information.

■ **Research must expand to be more multidisciplinary to incorporate the human component.** A national strategy must also include a plan to prepare and maintain a trained workforce, able to work across disciplines, to understand the issue of human sustainability in a world with climate change. Specialists must be able to bring together information from across the physical and social sciences and contribute to better social and human modeling to address these complex issues.

“What’s really missing is a methodology and a process owner to assure that physical models are developed and validated (for water, food and energy), and that we have ways to do social modeling to understand the impact on human sustainability and political stability.”

—Major General Engel

“...There’s a lot more that can be done in terms of trying to garner the capability to do assessments and understand the impacts on the regional scales, but it all hinges on being able to maintain those observations...”

—Dr. Karl

“There’s enough evidence across the board in our security apparatus that people understand [climate change] is an issue.”

—General Wald



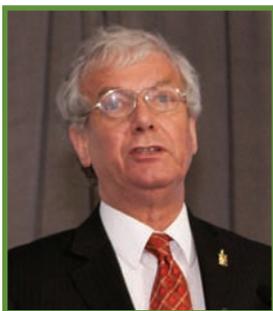
## PANEL 1

### LINKING ENVIRONMENTAL AND BUSINESS INTELLIGENCE

Environmental information has become indispensable to the bottom line of businesses across the country, but the transition from scientific information to actionable business intelligence can be difficult. This panel was convened to examine how to further strengthen the delivery of actionable environmental information to the business sector.



From left: Freilich, Hayes, Miglarese and Walsh.



Townshend.

Moderated by Dr. John Townshend, dean of the College of Behavioral and Social Sciences and professor at the Department of Geography of the University of Maryland, the panel included:

- Michael Freilich, Ph.D., Director, EarthScience Division, Science Mission Directorate, NASA
- John L. “Jack” Hayes, Ph.D., Assistant Administrator, Weather Services, and Director, National Weather Service, NOAA
- Anne H. Miglarese, Principal, Booz Allen Hamilton
- Paul E. Walsh, Senior



Freilich.

Vice President, Business Solutions, Atmospheric and Environmental Research, Inc.

### Observations and Recommendations

■ **A paradigm shift for business intelligence is underway.** Recent extreme weather events have created a sense of uncertainty in U.S. companies, leading many to realize the importance of environmental and weather information in the short and long term. Weather data is key to understanding the impact of weather on business

and is increasingly being used as a “profit multiplier.” Nevertheless, some industries, such as the retail sector, need greater understanding of how weather impacts their business, their suppliers, their energy and transportation requirements, and their ability to meet user demand. This need provides an opportunity for the private sector firms to offer detailed, actionable weather information that complements that provided by the National Weather Service.

■ **Assurance of long-term measurement is critical.**

Without sustained social and political commitment to measurement programs, advances in technology or data-acquisition tools are insufficient to secure the best environmental information possible. Technology investments are limited if they are not matched with a long-term commitment to maintain ongoing observations. This sustained commitment is necessary to enhance the accuracy of predictions, produce mid-term and long-term climate studies, and avoid national security risks. Lack of funding threatens the continuing data flow and the ability of the National Weather Service to issue long-term forecasts, critical for individuals, businesses and governments to plan ahead.

■ **The data flow model has changed.**

Data is no longer moving solely in one direction, from the federal government to the users, but is now moving across and between actors. Private actors are increasingly satisfying data needs, and non-traditional sources, such as crowd-sourced data, could become more important in the future. In the meantime, the federal government can exercise more leverage, coordinating among agencies to approach the private sector as a single consumer.

“Without some assurance of long-term measurement...we’re not going to get full-fledged investment from all sectors, and we’re not going to be able to redeem the investments we are making now to deliver the societal benefit we need.”

—Dr. Freilich

“I am a big believer in that there’s nothing but positive effects for the public sector in improving the relationship with the private sector.”

—Ms. Miglarese

“Our view here is: Use science, use the observations we can get to better prepare America to take actions to prepare for something we can’t avoid.”

— Dr. Hayes



■ **Public-private partnerships must be improved.** Private-sector weather business contributes greatly to the U.S. economy, and public and private actors share common objectives, which serve as the foundation of good partnerships. Yet avenues of cooperation can be improved. This includes greater communication and dialogue about the value derived from this data in order to better articulate its importance to policymakers and the public.

■ **Challenges are multidisciplinary.** Social and human science experts must be integrated into the environmental intelligence communities. Challenges ranging from how to measure and com-

municate the societal benefit and return on investment of Earth observations, to understanding why forecasts and weather warnings sometimes have limited effect in mobilizing the population, can be addressed by engaging experts in these fields.

■ **Meeting user needs can be improved.** Determining priorities by considering user needs and perspectives can help ensure the United States gets the most out of its existing investments. Learning more about how users take advantage of this information can also help identify affordable priorities for U.S. Earth observation capabilities.

“...The private sector, sitting between the [National] Weather Service and the data collectors and the science, provides an invaluable resource to industry and the economy to support the ability to optimize the way that goods and services are served up...”

—Mr. Walsh

## PANEL 2

### U.S. EARTH OBSERVATIONS: CONTRIBUTING BEYOND OUR BORDERS



From left: Batten, Biasi, Echavarria and Spitzer.



Gourlay.

From natural crises to the management of Earth's resources, U.S. Earth observations capabilities have become an increasingly important tool to understand and address global environmental issues. It is becoming even clearer that our investments in Earth obser-

vations go well beyond our national borders. This panel considered the current and future use of U.S. Earth observation assets abroad and how these can help us better address some of the global challenges we face today.

Moderated by Peter R. Gourlay, president and founder of the Maryland-Asia Environmental Partnership (MD-AEP), the panel included:

- Kit Batten, Ph.D., *Global Climate Change Coordinator, U.S. Agency for International Development (USAID)*

- Frank Biasi, *Director, Digital Maps and Atlases, National Geographic Maps*
- Fernando R. Echavarria, Ph.D., *Foreign Affairs Officer, Office of Space and Advanced Technology, Bureau of Oceans, Environment and Science, U.S. Department of State*
- Marty Spitzer, *Director, U.S. Climate Policy, World Wildlife Fund*

### Observations and Recommendations

■ **Earth observations are critical to the activities of U.S. agencies and institutions engaged internationally.** Environmental information is fundamental to the missions of U.S. agencies engaged in a variety of activities, from economic development and scientific capacity building in developing countries to conservation work in the United States and abroad. Climate change has highlighted the need to integrate such information in the work of specific agencies, such as USAID, which has closely aligned this phenomenon with its development activities.

“The Landsat archive is certainly one of the most important assets that this country has given the world.”

—Mr. Biasi

“You need to maintain the medium- and long-term funding stream to make sure that our Earth observation infrastructure is able to... persevere, be sustained... and not relegate this very important international function to other countries.”

—Dr. Echavarria



■ **Lack of global availability of data is of concern.**

Some areas of the world have not been adequately or consistently covered in the past, presenting a challenge to the user communities.

■ **Landsat is one of the most important U.S. contributions to the world.** Landsat data, now more widely available, is helping close the gap in some parts of the world where the lack of basic data has proven to be an obstacle to decision making. This open data policy, captured in the 2010 National Space Policy, has permeated internationally and in the private sector, which is now providing imagery to organizations unable to purchase it.

■ **Communicating the information collected is necessary to meet user needs.** Simply collecting the best data is not sufficient, and challenges remain in communicating environmental information to the specific users in a way that can support decision making. USAID and other agencies, including NASA, are partnering to meet this need, combining their special expertise to aid in data collection and dissemination in developing countries. An example of such an effort is the SERVIR program that provides a regional monitoring tool to enhance environmental change monitoring and improve disaster response in three regional hubs: Panama, Nepal and Kenya.

■ **There are opportunities for improved international cooperation.** No agency or government can collect all

the necessary information to understand and address global challenges. Partnerships are important for leveraging resources and expertise, as well as for providing necessary redundancy.

■ **Value proposition must be better articulated.** Despite U.S. and international reliance on Earth observations, investments in this area are sometimes hard to justify, particularly because domestic benefits are often not well articulated. The economic analysis of the value of this data, as well as the mobilization of stakeholders at the local level, could go a long way in bolstering arguments for continued investment. Simultaneously, there must be better communication of how U.S. investments fit into a larger picture and support a broad range of activities abroad.

*“...Unless we’re communicating this information, we can collect the best, most spatially explicit, downscaled information possible, but if it’s not being used, then we’re missing the boat.”*

—Dr. Batten

*“Making sure that we continue to fund the U.S. Global Change Research Program should remain a high priority.”*

—Dr. Spitzer

## PANEL 3

### INNOVATIVE SOLUTIONS FOR ENVIRONMENTAL INTELLIGENCE



From left: Hays, Hieb, Lane, Ali, Sullivan and Vass.

The topics discussed in the previous sessions highlighted a number of issues facing the environmental intelligence community. At a time of heightened budgetary constraints, meeting growing user needs will require innovative advances in the technologies used, and in the collection, acquisition and sharing practices implemented to produce and utilize environmental information. This

panel was convened to consider innovations taking place today and what may be needed in the future.

Moderated by John M. Broder, reporter for *The New York Times*, the panel featured:

- Sharon L. Hays, Ph.D., Vice President, Office of Science and Engineering, CSC
- Richard J. Hieb, Vice President, Exploration and Science Solutions, Lockheed Martin Information Systems and Global Services-Civil
- Carol Lane, Vice President and Lead Executive, Corporate Strategy and Federal Relations, Ball Aerospace & Technologies Corp.
- Amena Ali, Chief Marketing Officer, Earth Networks
- Kathryn D. Sullivan, Ph.D., Assistant Secretary of Commerce for Environmental Observation and Prediction; Deputy Administrator, NOAA
- William Vass, President and CEO, Liquid Robotics

### Observations and Recommendations

■ **Public-private partnerships are indispensable and must be improved.** Public-private partnerships have greatly advanced the Earth observations field, allowing government to take advantage of the private





Sullivan and Vass.



Lane and Ali.

sector’s innovative capacity as well as its role in garnering support. Many deployed sensors have been funded by government contracts, while the private sector contributes by purchasing patents or data. A similar, sustained partnership model can have the federal government bearing 100% of the cost and making up for it through industry purchases of the data gathered, simultaneously allowing free data to be provided to communities such as academia.

■ **Fiscal constraints create opportunities to innovate.**

The current constrained fiscal environment may offer opportunities for government to assume the risks of engaging industry’s innovative capacities. Opportunities arise in data collection, for example, by obtaining data from new sources, such as delivery trucks and taxi drivers. To support these innovations, government can define standards and ensure that the data collected from these different sources can be integrated into traditional datasets.

■ **Climate change and the need for improved environmental information present an economic opportunity.** The

climate change discussion has focused on questions of verifiability and culpability, taking attention away from important debates about how to address and adapt to these changes. The approach has been mainly to see it

as a policy and political issue rather than as an operational issue. In order to shift the dialogue, a value proposition must be made, thus demonstrating the concrete benefits of investments in this area. A potential solution is to create a climate services function, a single source of information about the climate that supports decision making, and to stimulate a climate services industry.

■ **The data flow model is shifting.** Changes in the direction of traditional data flows, particularly as assets expand to include academic, international and commercial platforms, greatly augment government capabilities. Free and open data access has enabled the federal government to fulfill its mission of protecting life and property, while spurring the private sector to offer a range of specialized services. At the same time, while this data model is beneficial to furthering a return on investment, it must be balanced with an approach that accounts for the costs of launching and maintaining Earth observation systems. There is a need to connect the dots between taxpayer investment and the free access to data to ensure its continued availability.

■ **Making the case for more and improved measurements.** Obtaining more data faces challenges such as weighing the long term vs. a short-term tradeoff. This forces the need to change the way stakeholders communicate on a range of issues: transmitting the difference between sensors and speaking in support of constellations as opposed to individual systems, better articulating the benefits of sustained and long-term measurements and the economic value derived from this, and clearly communicating priorities.

*“We’re [public-private partners] going to be evolving together through some interesting times in the next few years, so there’ll be lots of puts and takes to adjust the specifics of that partnership; but that is the only way this enterprise goes forward.”*

— Dr. Sullivan

*“I think that we need some sort of climate services function within the government... some single point of information about the climate that decision makers can then take and use in all kinds of different ways...”*

—Dr. Hays

*“...There’s a single thing I wish we could fix: it’s this...lack of understanding on the part of the government [of] how best to take advantage of what industry can bring...”*

—Mr. Hieb

*“The fiscal environment lends itself to the government applying industry innovation to procurement, acquisition or hardware solutions.”*

—Ms. Lane

*“...Our ability to innovate, our technological prowess, those should be key national skills that we deploy to get our way out of this situation while we get more environmental intelligence—while not necessarily paying the commensurate amount more in budget.”*

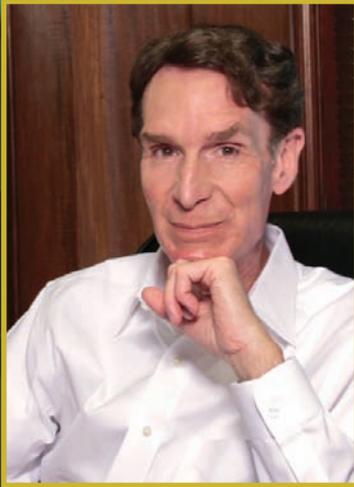
—Ms. Ali

*“Before, the only way we could envision looking at the oceans was pretty much satellites and a few buoys; now we can look at the oceans in a whole different way.”*

— Mr. Vass



## LUNCHEON PROGRAM



Nye.

*"In the early days of the environmental movement, we all wanted everyone to do less. Drive your car less. Use less clean water, and wear dirty clothes. And really if you can, just don't eat. But just doing less turns out to be very unpopular, especially in the developing world. All of us, people everywhere, mostly end up just doing more with more: more energy, more clean water, more coal and gas. But suppose we find ways to do more with less? That's the key. New efficient ways to get more for everyone using less of what we already have. We can change the world..."*

*—Mr. Nye*

### ■ LUNCHEON SPEAKER

**Bill Nye, "Bill Nye the Science Guy"**  
*Executive Director, The Planetary Society*

"For me, Earth observations is intimately connected to climate change, which is intimately connected to the weather that we've been having," began Bill Nye "the Science Guy" in his luncheon address.

Intermingling his remarks with light humor, Mr. Nye, who recently became the executive director of the Planetary Society, spoke about the importance of educating children about climate change to, as he put it to the audience, "dare I say it: change the world."



Speaking about the climate skeptics that may find the possibility that humans could change the climate unimaginable, Mr. Nye argued that Earth observations could help in this process of education. "It's not rocket surgery," joked Mr. Nye, "when you have an atmosphere that thin and 7 billion humans all trying to drive to work, you are going to be able to change the climate." Earth observations, he explained, produce a "blink quality" of "quick understanding" of the magnitude of changes taking place.

Using the Apollo program as an example, which cost about \$151 billion

in 2010 dollars, Mr. Nye went on to describe today's challenge and opportunity as not finding ways to just do less but to do more with less. "New efficient ways to get more for everyone using less of what we already have," he said, adding that economic opportunities abound in this effort. One such opportunity is to focus on education and public outreach,



targeting those generations that will have to deal with the implications of climate change in the coming decades. Mr. Nye suggested using examples of extreme weather events, such as the Katrina disaster or the recent floods, to communicate the importance of the issue. "It's that once in a while that we can exploit right now," he said.

Reaching out to young people, concluded Mr. Nye, is an effective use of limited resources and may prove to be the best strategy to enable real change. "This is it, this is our time," urged Mr. Nye, "if we don't get it in the next decade or two [then] things are going to change a little too much."



## 2011 ALLIANCE AWARDS

The inaugural annual Alliance Awards recognized leaders who have made a significant contribution to the field of Earth observations, as judged by their peers. Alliance for Earth Observations members voted on outstanding individuals or organizations nominated in the categories of Leadership, Stewardship and Innovation.

### LEADERSHIP AWARD



Because of a scheduling conflict, Senator Mikulski was unable to receive her award during the luncheon. Bill Nye and IGES president Nancy Colleton presented her with the award during a visit to her office.

The Leadership Award honors individuals or organizations that have demonstrated exceptional leadership and service with respect to the country's environmental information needs through vision, expertise,

commitment, integrity, communication skills, innovation, accomplishments and diplomacy.

#### **Senator Barbara Mikulski (D-MD)**

*For her leadership as chairwoman of the Senate Appropriations Committee Subcommittee on Commerce, Justice and Science—and support of the science and innovation within NASA, NOAA and other agencies—that will continue to help our country prepare for the impacts of a changing climate.*

### STEWARDSHIP AWARD



Karl and Nye.

#### **Thomas R. Karl, L.H.D.**

*Chair, Subcommittee on Global Change Research, U.S. Global Change Research Program; Director, National Climatic Data Center, NOAA*

The Stewardship Award honors an individual who has, over the period of his/her career, significantly impacted the progress of Earth monitoring or the delivery of environmental information.

*For his leadership in communicating the importance of accurate, timely and sustained climate and weather data for long-term modeling, planning and forecasting—and for his contribution to U.S. climate efforts, including the NOAA Climate Service, the National Assessment, U.S. Global Change Research Program (USGCRP), and working with his counterparts in DoD to improve U.S. climate models.*

### INNOVATION AWARD

The Innovation Award honors an individual, group or organization for their groundbreaking technological research or applications innovation in Earth observations.



Hans Graber and Ret Turner from CSTARS with Nye.

#### **CSTARS**

*(Center for Southeastern Tropical Advanced Remote Sensing)*

*For its innovative action during the Deepwater Horizon disaster. CSTARS provided unprecedented, daily coverage of an expanse from Texas to Florida—never before has the government used such extensive, sustained unclassified remote sensing data to cover a disaster like this. CSTARS' proactive approach to changing licensing rights allowed greater data coverage, which was instrumental for federal, state and local responders to have rapid access to the data.*





Malay.

### Jonathan T. "Jon" Malay

President, American Meteorological Society (AMS); Director, Civil Space & Environment Programs, Lockheed Martin Corporation

### Gregory M. Vaughn

Chief Systems Engineer, Maritime Systems Operation, Science Applications International Corp. (SAIC)



Vaughn.

**To wrap up the event, two Alliance for Earth Observations members talked to the audience about the Alliance's mission and its recent accomplishments.**

Mr. Malay introduced the new logo, which he said represents a "better metaphor for what we're all about: all these sources of observations of the planet coming together to provide...environmental intelligence."

He offered a brief historical perspective, describing the birth of the Alliance as the desire of the private sector to take part in the environmental dialogue. This alliance of organizations in the private sector affords a unique opportunity to counterbalance government discussions, while advocating, educating and communicating the needs of the environmental intelligence community.

Mr. Vaughn, speaking of this year's Forum as "the keystone event for the Alliance throughout the year," lauded the depth of the day's discussions. He directed audience members to the

Alliance website to find the 2010 Alliance report, where the organization's activities for the year are highlighted.

Mr. Vaughn went on to describe what to him are some of the key takeaways of the Forum, which included the imperative to

communicate the data that is collected and its value—as well as engaging the diversity of disciplines that not only benefit from this information, but may also be critical in creating the solutions needed to meet the environmental challenges. He went on to explain that communicating with the younger generations will help set the values by which budgetary priorities will be made in the near future, hopefully sustaining the activities and programs discussed during the event. Mr. Vaughn concluded his remarks with a hopeful note saying that we still "don't understand what we don't understand," and that as we begin to scratch the surface of understanding the Earth, "it's an exciting time."



From left: Congressional staffer Ana Unruh-Cohen, consultant Dixon Butler and WWF's Marty Spitzer talk between sessions.



Freelance media Katelynn Bell and IGES' Adrian Ash with Bill Nye.



Engel and Karl.

*"The Alliance has become exactly that: a private-sector side partner with the government... That [public-private dialogue] is what the Alliance was formed to do."*

—Mr. Malay

*"I found more insights per minute in this particular Forum and more sound bites per speaker than I was able to keep up with."*

—Mr. Vaughn



# The Forum On Earth Observations™ V

## Q&A STATEMENTS

In an effort to reflect more views in this year's Forum on Earth Observations and to engage more experts in the dialogue, the Alliance for Earth Observations solicited input from various thought leaders in the community.

*The responses to this question are provided below and on the next five pages.*

### ■ For the price of a cup of coffee— please give us weather satellites!

The spring of 2011 has brought a string of disastrous weather-related events, including

A GREAT COUNTRY  
and a world leader  
must have accurate and  
timely weather and  
climate intelligence.  
— *Anthes*

drought and wildfires in Texas that burned 2.5 million acres; the April 27 super-tornado outbreak in Alabama and other southeastern states that killed at least 350 people and caused more than \$3 billion of insured property losses (the deadliest tornado outbreak in 80 years and the costliest in history); the May 22 Joplin, Missouri tornado that occurred less than a month later and killed more than 100 people; and the greatest floods of the Mississippi Valley since 1927. The human and economic costs of these disasters would have been even greater without the satellite and radar observations and weather forecast models run by NOAA. Since the 1960s, U.S. satellites have allowed forecasters to track critical weather details that cannot be seen from the ground. Satellite data are also fed into forecast models and are by far the most important observations that contribute to forecast accuracy, giving us “heads up” on severe winter snowstorms, hurricanes, and tornado outbreaks days in advance.

Each was asked to respond to this question:

***What are critical steps the United States should take over the next five years to improve the nation's environmental intelligence capability?***

The nation's investment in weather satellites is a bargain. Not only do these data save lives and reduce injuries, but satellite-based observations and predictions provide economic savings and spur productivity at an annual rate many times their cost. Yet Congress passed an FY11 NOAA satellite budget that was short by almost \$700 million, funds needed to keep NOAA's polar-orbiting satellite program on schedule. This shortfall, which represents about the cost of one cup of coffee per person in the U.S., will result in a significant gap in meteorological satellite data coverage over the U.S. and the world. This gap is likely to slow or reverse the steady upward trend in forecast accuracy and severe weather warnings that has been occurring over the past several decades.

We cannot afford to move backward. With society's ever-increasing complexity and vulnerability to floods, tornadoes, hurricanes and other high-impact weather, such an increase in environmental ignorance is unacceptable. Demand for accurate weather and climate information is increasing in all sectors of the U.S. economy—agriculture, water and energy management, transportation, health, and the military. Adequate funding of Earth observations from space is a life-saving and cost-effective investment. A great country and a world leader must have accurate and timely weather and climate intelligence.

— ***Richard A. Anthes, Ph.D.***

*President, University Corporation for  
Atmospheric Research*



■ **[The U.S. needs to] continue to develop system-based approaches to environmental observations and modeling.**

Integrating the complex physical, chemical, biological and radiation relationships that exist with respect to the state of the sun, air, water and land across multiple ecosystems will significantly enhance the growth of environmental intelligence.

— **Raymond J. Ban**

*Consultant, Weather Industry and Government Partnerships, The Weather Channel, Inc.*

■ **Sectors within the traditional green plant industry represent a broad array of familiar enterprises.**

They include landscape architecture, landscape contracting, nurseries, garden centers, golf, outdoor recreation, botanical supplements, gardening and others. Bringing land management

organizations, botanic gardens, nature centers, natural resource agencies, and related media into the mix swells substantially the national fiscal impact of these and allied sectors.

In spite of their economic mass, these plant-based sectors represent only the “ornamental” aspects of our national landscape. Plants also form the

basis, directly and indirectly, for our agricultural economy and our supply of food and fiber, building materials, medicines, and a great many other commodities. Consequently, plants represent a national genetic repository that sustains us and fuels scientific advancement. They, in turn, require stability in weather and climate conditions.

No issue is more important to these sectors than reliable, objective weather and climate information, scaled to local and regional levels. Effective business strategies and risk management policies regarding adaptation to environmental change must be based on unimpeachable data, information and modeling.

Thus, a consistent and sustained national commitment to resourcing earth observation, environmental data interpretation, and adaptation strategies is of particular concern to the plant-based sectors.

— **George Briggs, Ph.D., FASLA**

*Executive Director, The North Carolina Arboretum*

■ **There remain today structural problems associated with the provision of climate-quality measurements from space-based systems** designed to meet national objectives more closely associated with the needs of the operational weather forecast community. As stated in the *NRC Decadal Survey for Earth Science (2007)*, “There is a lack of clear agency responsibility for sustained research programs and the transitioning of proof-of-concept measurements into sustained measurement systems.” Much of climate science depends on long-term, sustained measurement records. Yet, as has been noted in many previous NRC and agency reports, the nation lacks a clear policy to address these known national and international needs.

Current NASA-NOAA transition pathways include successful examples that represent strong models for other transition activities. However, transitions have been ad hoc and often complex and unstructured. No organizational mechanism exists to ensure efficient and effective transitions. A long-term climate-monitoring strategy is needed to provide for the essential characterization, calibration, stability, continuity and data systems required to support climate applications. Such a national policy for provision of long-term climate measurements should have clear agency roles and responsibilities, identify the role of international cooperation, and provide for the insertion of new technology, design of a sustained system architecture, and community involvement in the development of climate data records.

— **Antonio J. Busalacchi, Ph.D.**

*Director and Professor, Earth System Science Interdisciplinary Center, University of Maryland*

■ **Weather is dangerous and costly.** When the full spectrum of weather-related events and accidents are taken into account, an average of 10,000 people are killed annually from the effects of adverse weather in the United States, while economic losses approach \$100 billion. Is our nation’s weather enterprise doing all it can to reduce these effects? Simply stated: No, it is not! Can it do much better? Yes, it can! Does it know how? Yes, it does! Does it have the resources? No, not today!

Our nation’s weather measurement capabilities are inadequate for the task. Without significantly improved weather observations and models, the country cannot provide the improved forecasts, warnings, and decision-support products and services necessary to reduce weather-caused deaths and injuries, effectively mitigate economic losses and societal disruptions, and enhance the operation of weather-impacted industries. Two recent studies by the National Academies address the problem and make cogent recommendations.

A CONSISTENT AND SUSTAINED national commitment to resourcing Earth observation, environmental data interpretation, and adaptation strategies is of particular concern to the plant-based sectors.

— Briggs



Over the next five years, the National Weather Service, together with the active participation of its weather enterprise partners (public, private and academic alike), must take concrete steps to remedy today's deficiencies. A critical first step is establishing a prototype regional-scale next-generation weather measurement, modeling, impacts-prediction and decision-support capability. (The concept has analogies to designing and constructing a new, state-of-the-art building. Measurements are the foundation on which the upper floors—the models, forecasts, warnings and decision-support tools—are built to serve multiple users). In the regional prototype, new measurement technologies would be deployed and tested together with advanced models, with the ultimate endpoint being a next-generation operational weather enterprise that provides greatly improved societal and economic benefits.

— **Walter F. Dabberdt, Ph.D.**

*Chief Science Officer, Vaisala Group*

■ **There is in progress a grand convergence of the Earth, ecological, environmental and social sciences**, which, enabled by Earth observations and cyber-infrastructure, will lead to continuous awareness of Earth's systems and their interactions with human activities. Continuous awareness will enable adaptive management of natural and urban environments. We will use continuous awareness to manage our resources and environment, and speed our responses to disasters. Continuous awareness will enable prompt responses to global climate challenges as they emerge.

— **Charles F. Kennel, Ph.D.**

*Chair, Space Studies Board, National Research Council; Director and Distinguished Professor Emeritus, Scripps Institution of Oceanography; Senior Advisor, Sustainability Solutions Institute, University of California, San Diego*

■ **How much are Earth observations worth? We have little clue.** Certainly Earth observations help us measure and monitor much of what we value about our quality of life, whether it is clean air, a weather forecast, containing a spill from the Deepwater Horizon explosion, or deploying humanitarian aid in the aftermath of an earthquake. In the absence of environmental intelligence, we fly blind.

And yet how much should we invest in this intelligence? It hasn't been enough to report, for instance, that MODIS data products provide a true-color image of a Sahel dust storm, deforestation in the Amazon rainforest, or the number of fires in Madagascar. People ask "so what?" Regrettably we have not answered that question. Even worse, we haven't systematically documented improve-

ments in the fundamental science of Earth processes, which to many is the primary reason for Earth science missions. When was the last effort to collect and report—beyond press releases—our science achievements? We struggle to justify budgets and argue for money for Earth observations but we have done a poor job of showing Congress and the taxpayer "why and how much." We measure what we value and we value what we measure. In the fiscally constrained situation for the U.S. over the coming years, we need to do better.

— **Molly K. Macauley, Ph.D.**

*Research Director and Senior Fellow, Resources for the Future*

IN THE ABSENCE  
of environmental  
intelligence,  
we fly blind.  
— Macauley

■ **Over the next five years and beyond, the nation must assure continuity, absolutely without gaps in coverage, of our civil and defense environmental satellite programs.** These geostationary, polar-orbiting and Earth-sun libration point spacecraft are the sentinels which provide life-saving warnings of natural disasters and the essential observations of atmosphere, ocean, ice, land and the sun, which enable scientific research and operational predictions needed for our national defense, our economy, and most of all, the safety of our citizens.

While this huge step is absolutely necessary, a full stride is always two steps. The second is to ensure that all United States observations (from space or sensors in air, land, or on or beneath the sea) are readily available to achieve their full utilization and effectiveness. This requires a strategic process of data management, modeling and prediction, and communications, using state-of-the-art information technology and computational capabilities. This observations-plus-data-management enterprise is no less important than any of our other national security programs. Our technologically sophisticated and globally linked society lives and works within the Earth's all-too-often dangerous, fragile and ever-changing environment comprised of interdependent physical and information-based critical infrastructures.

We need environmental intelligence, and our government (with its private sector partners) needs to strategically plan, wisely invest in, and effectively manage this critical enterprise.

— **Jonathan T. "Jon" Malay**

*President, American Meteorological Society; Director, Civil Space & Environment Programs, Lockheed Martin Corporation*



■ **The Earth's climate is experiencing changes that will undoubtedly have profound impacts on our society for decades and centuries to come.** The public sector can, and should, be a leader in understanding the science of climate change and developing mitigation and adaptation measures. However, the magnitude of the problem and the complexity of the required solutions will require focus, skills and resources that are well beyond those of any single public or private entity.

Answers to some of the biggest challenges of our time will result from public-private partnerships that bring together private-sector technologies with governmental leadership. Looking ahead, I envision public-private partnerships around the world in which private companies provide technological innovation and operational expertise to measure and network thousands of data sources—including weather, lightning and greenhouse-gas observations—from monitoring stations deployed worldwide. A future “network of networks” will observe the planet and integrate vast amounts of data from a variety of public and private sources to tell a far more detailed story regarding the overall health of the planet. Such a network will enable greater scientific understanding of the Earth and provide society with invaluable environmental intelligence.

— **Robert S. Marshall**

*President and CEO, Earth Networks*

■ **What steps? Stop stepping backward. We need to at least maintain our operational capabilities.** Yes, there is a real necessity to reduce government spending. There

DRIVING ON WORN-OUT tires is risky; relying on worn-out weather satellites could be deadly.

— B. Moore

is also a critical need to replace the aging fleet of weather satellites. Satellites, like tires, wear out and must be replaced.

There is, however, a significant difference between

tires and satellites. There is no off-the-shelf satellite store. Weather satellites are complex systems requiring nearly a decade to design, build, test and launch. NOAA is faced with the task of replacing both its geostationary satellites and its low-Earth orbiting systems. Both are needed and both are in need of replacement.

Tough choices must and will be made. Earth observations, like all other costs, must be justified on merit. Weather forecasts do not appear magically on television. The National Research Council has stated it clearly, “the

dramatic and documented improvements in our ability to predict weather have come from the linkage of satellite-based observations and computer-based weather models; both are essential.” Driving on worn-out tires is risky; relying on worn-out weather satellites could be deadly.

— **Berrien Moore III, Ph.D.**

*Director, National Weather Center; Vice President, Weather and Climate Programs; Dean, College of Atmospheric and Geographic Sciences, University of Oklahoma*

■ **As we face future natural and human-generated hazards and disasters, the geosciences have a critical role in the public awareness, safety and national security of our nation.** This past year, we have experienced volcanoes, earthquakes, tsunamis, hurricanes, tornadoes and severe flooding, yet it is becoming increasingly more difficult to find opportunities in K-12 education for students to engage in relevant related studies. What implications will this have on the 21st century workforce?

Teachers are using satellite and remote sensing technologies to incorporate imagery, data and real-time observations in the classroom. Geographic information systems content is being taught as a technical skill, and is used to develop “geospatial thinking” in problem solving. Today, pre-college students and teachers are collaborating with the commercial aerospace industry and NASA to build “CubeSats” (small cube-shaped satellites) ready for spaceflight, creating authentic science experiences. Students are engaged in observing the Earth and visualizing their future.

Our community has an opportunity to inform policy makers in the development of emerging national STEM (Science, Technology, Science and Math) education initiatives. The interdisciplinary nature of our discipline lends itself to providing the required leadership. Therefore, it is imperative that any plan for “Creating a National Strategy for Environmental Intelligence” highlights education as a fundamental component.

— **John D. Moore**

*Albert Einstein Distinguished Educator Fellow 2009–2011*

■ **From the point of view of a community of users (e.g., insurers), the practical challenge for the U.S. and for the users is to integrate predictive modeling used in climate studies with statistical models used by business and local, national and regional government officials.** Climate models are based on long-time horizons and are spatial; catastrophe models used by insurers (and probably others, such as community planners and emergency responders) are short term and geographically narrow.



The following steps would constructively address the overlapping value of both approaches and seek to reconcile their different basis:

BRING CLIMATE  
models to a  
regional scale.  
— Nutter

- Increase funding for observational data at both remote and Earth levels.
- Standardize measurements.
- Characterize the level of uncertainty in data quality.
- Bring climate models to a regional scale.

- Engage in more multi-disciplinary research.
- Develop means to integrate data from diverse sources.
- Tailor data solutions.

— **Franklin Nutter**

*President, Reinsurance Association of America*

■ **One of the most critical steps that the United States needs to take in order to improve the nation's environmental intelligence capability** is to lead in the development of an international legal and policy framework for the collection, use and transfer of data, particularly spatially enabled data. Currently, issues such as intellectual property rights, national security, data quality and privacy are proving to be obstacles due to uncertainty in how the law should apply and the variances between national legal and policy regimes. These issues are going to become both more critical and prove to be even more of an obstacle in the future because informed decision making will require more and different types of sensors and an increase in the amount of data contributed by citizens, corporations and NGOs. Unfortunately, a legal and policy framework with respect to such data does not exist today. The United States should bring legal/policy professionals and relevant technology experts from around the world together to address these matters. Otherwise, it is very likely that future technology will not be fully utilized.

— **Kevin D. Pomfret**

*Executive Director, Center for Spatial Law and Policy*

■ **Although the first Landsat was placed in operation more than 30 years ago, land remote sensing is now coming into its own**, with mature methods and technologies to address critical global environmental issues. Today, we are challenged by several converging land-based issues, from climate change and carbon management to desertification. We need to begin to

operationalize the land-based Earth observation assets. In the domain of carbon management this will require a suite of satellites across a range of spatial and temporal scales, from moderate imaging for process-level analysis, such as the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), to extremely fine-resolution imaging for detecting individual trees. What is becoming clear is that the amount of carbon sequestered in trees outside of forests is potentially immense, and the need to begin to account for trees in whole landscapes is demanding increased use of high spatial resolution object detection on a global scale. Land remote sensing will change how we measure biomass on land—if there is the will and effort to do so.

— **David Skole, Ph.D.**

*Professor of Forestry and Director, Global Observatory for Ecosystem Services, Michigan State University*

■ **The U.S. Navy's Arctic and Climate Change Roadmaps state the Navy must understand the timing, severity and impact of current and projected changes in the global environment.** The Roadmaps direct the Navy to conduct assessments that identify science and technology needs and required capabilities for assessing and predicting global environmental change, and leveraging the Earth System Prediction Capability interagency partnership. The Navy's ability to respond to uncertainties related to changing environmental conditions would benefit from improvement of the current suite of atmospheric, ocean and ice forecasting prediction systems in collaboration with our interagency partners. Initial FY12 investments from the Office of Naval Research will advance monitoring and prediction of critical Arctic environmental changes as well as global climate change more broadly.

— **Rear Admiral David W. Titley**

*Oceanographer and Navigator of the Navy and Director, Maritime Domain Awareness and Space, U.S. Navy*

■ **Effective and Integrated Ocean Information Foundation: Gaining and Harnessing Ocean and Environmental Knowledge**

Given the many changes taking place in our oceans and their importance to the U.S. and global economies, future energy outlook, food security, and national (and international) security, the United States must demonstrate even greater leadership in environmental information by encouraging and facilitating the investments necessary to support and sustain integrated ocean data



collection efforts. President Obama's Ocean Policy Task Force recognized and recommended such a strengthened ocean observing emphasis and framework as part of a comprehensive ocean strategy. Such a commitment, which includes data management, data integration, robust modeling and verification, and resultant products and services, is key to translating a scientific understanding in isolated areas and over short periods into a fully realized knowledge of the ocean and all of its interfaces.

Accurate, timely and dependable *in situ* and remotely sensed ocean observations are critical to understanding the key attributes of our oceans. Robust mapping of these attributes and correlation with past, present and future events will feed, expand, improve and deliver models with critical predictive capabilities, which will continue to be refined over time by real-time measurement-based feedback.

Understanding (and predicting) the contributions of our oceans to weather, climate, ecology and biology will pay huge dividends to society at all levels. The resulting improvement in intelligent "tactical" decision making will ensure that far-reaching strategies for the preservation of our ocean and coastal areas will not be compromised. These strategies will ensure the appropriate balance of societal, ocean and planet-oriented needs are met while avoiding many of the potentially disastrous and tragic effects of unforeseen events.

A robust understanding is required to underpin the data-driven principles of the president's Coastal and Marine Spatial Planning efforts and regional planning boards that hope to provide both strategic and tactical guidance to both decision makers and users. Without the integrated data and the information and predictions that an integrated environmental information pipeline can deliver, bureaucracies charged with managing competing interests will be sailing into dangerous waters without a chart or means to safely navigate through policy options.

It should be clear, however, that a focus on the oceans alone is only a partial answer. Ocean observation has sadly been neglected because of the difficulty in adequately observing the ocean depths and maintaining continuous streams of information with sensors exposed to harsh ocean environments. Departures from the stovepiped views of our planet as a set of separate and well-defined air, water and climate issues, however, will go a long way in realizing the benefits of integrating data and information models. Oceanography, meteorology and climate sciences still exist as separate and distinct communities that do not collaborate and coordinate often enough—even though that is improving. Data streams from many unique data sources are not integrated to optimally support today's societal needs. The

benefits derived from integrated ocean observing can be leveraged by integrating with other disciplines to deliver the information needed to meet these needs.

Since 2001, the national framework necessary for the integration of ocean environmental data and information has been called out as a priority, even codified in law, but never sufficiently resourced to realize its potential. The nation has an opportunity once again to translate policy discussions into effective action as President Obama's National Ocean Policy comes to grips with its strategic vision and execution plans. In the very near future, these priorities and strategies will be woven into a series of plans that will dictate how we seize or miss the opportunity to harness the knowledge of the ocean and our planet's environment.

Finally, recognizing that we live in a world of scarce resources, all of our allocation decisions must result in the return of real value to our citizenry. In the final analysis, having predictive models of how the ocean and its inhabitants function—and the ability to refine sophisticated computer simulations using high-quality observations from remote and *in situ* distributed sensor networks collected over extensive periods of time—will be a national treasure and security issue in which our nation not only should, but must, invest.

— **Gregory M. Vaughn**

*Chief Systems Engineer, Maritime Systems Operation,  
Science Applications International Corporation (SAIC)*

— **Ray Toll**

*NOAA Account Manager, Science Applications  
International Corporation (SAIC)*



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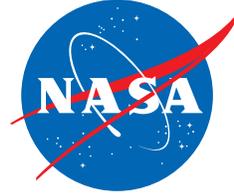
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