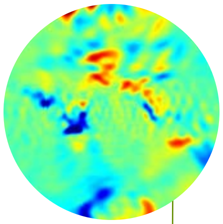
Earth Observation Priorities 2014





A Report by ALLIANCE FOR EARTH OBSERVATIONS

INTRODUCTION

Within the borders of the world's third largest country resides the most dynamic and technologically advanced economy on the globe. From smartphones and cars to supercomputers and nanotechnology, the United States is a global leader in innovation.

As a vast country with a diverse landscape of mountains, deserts, plains, coasts, wetlands, lakes, and forests, and an equally diverse populace, the United States must rely on its technological innovation to guide a secure future for the more than 318 million people that make this nation their home.

Nowhere is reliance on technology and innovation more apparent than in the area of understanding and predicting weather and climate on time scales that range from hourly to decadal. The U.S. has invested billions of dollars annually into understanding how the planet is changing by the hour, day, month, season, and decade, and how Americans will respond to change. No state, community, or American is untouched by natural events whether floods, storms, drought, earthquakes, or wildfires.

Just as natural events can disrupt the supply of goods and services across the country and the globe, numerous factors can impact the fragile environmental information supply chain that Americans have come to rely upon for personal, economic, and national security decisions. Technical challenges, inadequate funding, insufficient planning, and ineffective governance all have the potential to disrupt the flow of vital information that enables the world's most technologically advanced nation to protect its citizens and grow the economy.

From the submersibles deep in the ocean, to ground-based instruments, to satellites in space, today's U.S. civil Earth observation capabilities may seem robust. However, despite monitoring the planet with an estimated $5 billion annually spread across 17 federal agencies, the United States still faces many challenges. Satellites are operating well past their designed life span, there is a lack of integration across programs, no comprehensive strategy exists to ensure future systems are adequately robust to meet new needs, and approaches to engage and grow the private sector have yet to be defined.

Progress has been made. For example, the White House and Congress have recognized the value of our nation's weather satellites and have improved development with stable and consistent funding and oversight. The Office of Science and Technology Policy has developed the *National Strategy for U.S. Civil Earth Observations*. The *Implementation Plan for the National Strategy for the Arctic Region* and the *National Ocean Policy Implementation Plan* have recognized the key role of observations and outlined necessary actions for the federal government to pursue. The U.S. House of Representatives passed the Weather Forecasting Improvement Act and Congress recently reauthorized the National Integrated Drought Information System program. The recent release of the *National Climate Assessment* also drives home the important message regarding the need for improved environmental information, which results from space-based, airborne, and in situ ocean, land, and atmospheric observations, research, and modeling.

This report, *Earth Observation Priorities 2014,* seeks to further identify key priorities and recommend actionable steps that decision makers can pursue immediately. Developed by member representatives of the Alliance for Earth Observations, this report provides a unique non-federal perspective on key priorities and programs for consideration by the administration, Congress, and private sector leaders.

Members of the Alliance for Earth Observations include representatives from industry, academia, and non-governmental organizations with varied expertise in aerospace, Earth science, international programs, big data and analytics, commercial systems and solutions, systems architecture, media, and geospatial technologies. In addition, these experts also have considerable experience engaging the public, non-governmental, and non-traditional stakeholders.

Many of the recommendations outlined in this report do not cost extra money, but rather require a commitment to maintain programs already approved through stable and consistent funding; encourage cost-effective alternatives for sustaining critical data and accelerating innovation in a constrained budget environment; and recognize the importance of Earth observations to the health and security of the United States.

These recommendations were also informed by numerous reports such as the Government Accountability Office's *2013 High Risk List* and the *Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey.*

PRIORITIES

Earth Observation Priorities 2014 focuses on five critical topics:

- **Priority 1: Weather and Climate;**
- **Priority 2: Drought;**
- **Priority 3: Water Resources;**
- **Priority 4: The Arctic; and**
- **Priority 5: Economic Competitiveness.**

Related to these priority areas, the Alliance recommends that Congress provide stable funding for Earth observation programs across the federal government, recognizing the interconnectedness of these programs, the importance of mitigating and reducing the risk of data gaps, the goal of restoring superiority in weather forecasting, and the economic benefit of long-term investment to the nation.

Specifically, Congress should:

- **Better protect American lives, property, and the economy** by supporting the FY2015 budget request for weather and climate satellites and surface-based observation programs (JPSS, GOES-R, NASA's Earth Science Research missions, the Defense Weather System Follow-on, and the National Mesonet Program).
- **Equip Americans to better understand and respond to drought** by providing:
  - Funding as authorized to maintain and improve the National Integrated Drought Information System (NIDIS) and;
  - Consistent funding and oversight for a continuous medium-resolution governmental land imaging program.
- **Advance U.S. freshwater monitoring and forecasting** by continuing to fund the National Streamflow Information Program at an appropriate level.
- **Protect U.S. interests and implement expanded Earth monitoring capabilities in the Arctic** to better understand and predict changes in the most rapidly changing region in the world and how those changes affect not only the Arctic, but the entire globe.
- **Drive U.S. innovation, create jobs, and grow the economy** by adopting public-private partnership business models where feasible:

• To augment national systems with commercial data sources, hosted payloads for dedicated sensors, and new innovative measurement capabilities, and;

• To provide the private sector with greater access to existing government data sources.

The President should direct federal agencies to continue to work toward an integrated Earth observation system of systems that leverages the unique capabilities of each participating agency. In addition:

- **The Office of Science and Technology Policy should complete** the *National Plan for Civil Earth Observations* and ensure individual agencies immediately begin implementation.
- **Pursue innovative commercial space-based solutions** to augment the core government Landsat program and seek innovative acquisition strategies from commercial providers to ensure affordability and access to higher-resolution imagery than can be obtained from government civil Earth imaging satellites.
- **Enable access to older data** from the government's National Technical Means imaging systems.
- **Support and actively facilitate the** *Implementation Plan for the National Strategy for the Arctic Region* and the *National Ocean Policy Implementation Plan.*
- **Support a U.S./Canadian agreement** regarding Arctic communications and weather satellite capability.
- **Optimize U.S. policy and Category XV of the *U.S. Munitions List*** so that commercial-class U.S. remote sensing hardware is able to successfully compete against foreign suppliers.
- **Establish a centralized mechanism** by which commercial solutions can be considered within the federal Earth observing enterprise, thus spurring innovation and reducing costs.

The Alliance for Earth Observation's unified commitment towards developing a second-to-none world-class Earth observation enterprise means non-federal action as well.

Therefore, in 2014, the Alliance will:

- **Continue to reach out to stakeholder groups** across sectors to bring together data collectors with data users to facilitate improved engagement and dissemination;
- **Continue to work across various sectors and disciplines** to support U.S. programs, leverage U.S. investment in Earth observations, and provide the highest quality research and development capabilities;
- **Utilize the breadth of expertise and experience of the Alliance members** to continue to inform the public and policy makers about the key components of an Earth observation system and to demonstrate support for these components;
- **Support the President and Congress** in their efforts to sustain necessary programs and to promote innovative new policies; and
- **Participate as an active member of the Earth observations enterprise** to provide innovative strategies and ideas for future systems and capabilities.

THE BOTTOM LINE *is that data collection and dissemination is the common denominator across* Earth Observation Priorities 2014.

The widespread reliance on this data and information is critically important. Working together, stakeholders have an opportunity to see an improved, more robust system emerge.

Each of the individual priorities is discussed in the following pages.

To better protect American lives, property, and the economy by reducing the risk of data gaps, restoring superiority in weather forecasting, and increasing understanding of climate change.

One only needs to view the evening news to understand the correlation and impact of severe weather on social and geopolitical events worldwide. With the availability of weather data across multiple channels, including on-air, online, and via mobile devices, many Americans take accurate weather forecasts for granted. It is not difficult then to understand how investment in Earth science and observations is leveraged for economic, environmental, and national security purposes.

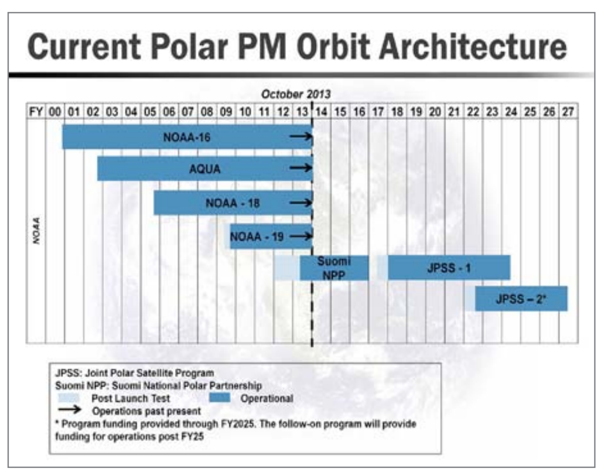
Federal investment in satellites, ground-based sensors, supercomputers, and modeling and analysis has enabled the United States to provide its citizens with some of the most advanced forecasting and predictive capabilities in the world—thus enabling a multi-billion dollar weather enterprise. The impact of weather on our daily activities, as well as broad sectors of the U.S. economy, is astounding. Major storms can cause billions of dollars in damage and wreak havoc on the economic viability of a community. In 2012, Superstorm Sandy was responsible for approximately $65 billion worth of damage and 159 deaths. Nearly as destructive, but not as widely reported, was the impact of the heat wave and accompanying drought that affected a large portion of the U.S. during 2012. It is estimated that the heat wave and drought were responsible for $30 billion worth in crop damage and 123 deaths.[1]

Maintaining crucial weather and climate information, however, is not necessarily a given—particularly considering the delicate state of the nation's space-based operational and Earth science constellations, and the overall decline in the federal spending for Earth observations.

U.S. Weather Satellite Systems. Despite the importance weather forecasting has on the lives, property, and economy of U.S. citizens, the U.S. currently faces a weather satellite data gap potentially lasting 15–40 months beginning as early as 2017. Major satellite acquisition programs to replace aging satellite systems are currently in development. The Joint Polar Satellite System (JPSS) is being developed to provide global environmental data critical to weather forecasting. The data and imagery to be collected by JPSS aid NOAA and the U.S. government in developing timely and accurate public warnings and forecasts. JPSS will host the same next-generation weather instruments that are currently in operation on the precursor satellite, the Suomi National Polar-orbiting Partnership (NPP). JPSS-1 is not expected to launch until 2017. The Government Accountability Office has noted that the potential gap in weather satellite data constituted one of the high risk government programs in 2013.

Figure 1 (below) depicts the current and planned civil weather system as detailed by the NOAA NESDIS Independent Review Team's *One Year Assessment*. The report indicates that current NASA and NOAA satellites are operating beyond their designed life span and the on-orbit architecture becomes very sparse in the forthcoming years. In addition, the Defense Meteorological Satellite Program (DMSP), designed to cover the nation's needs for the AM orbit, recently launched the second-to-last in its series. The final DMSP satellite (F-20) is ready for launch; yet the DoD has only recently requested funding to implement the follow-on program. Even as such, the Weather Satellite Follow-on (WSF) program is being designed to meet only the highest priority DoD weather requirements but will not have the same capability as DMSP. Urgency is increased by imminent gaps (i.e., ocean surface vector winds and tropical cyclone intensity, and some space weather gaps) that will not be met by DMSP capabilities, or other US capabilities.

Figure 1: Nation's current and planned civil weather satellite system. [2]



[1] "Billion Dollar Weather/Climate Disasters," NOAA National Climatic Data Center, accessed February 2014 • http://www.ncdc.noaa.gov/billions/events

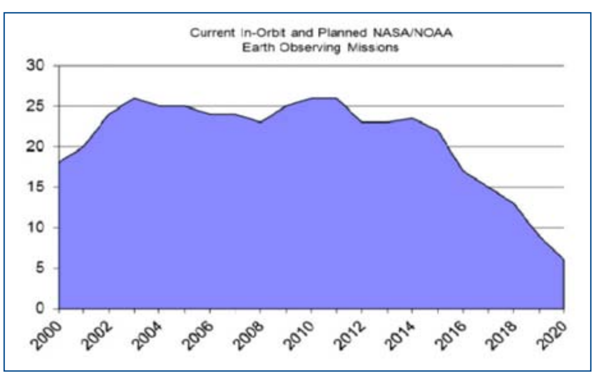
[2] *NOAA NESDIS Independent Review Team Report Assessment Update,* November 2013, pg. 14.

In addition, the Geostationary Operational Environmental Satellite-R series (GOES-R) is a geostationary satellite system that will provide atmospheric and surface measurements of the Earth's Western Hemisphere for weather forecasting, severe storm tracking, space weather monitoring, and meteorological research. GOES-R is the next generation of the current GOES system that NOAA already relies on for monitoring, forecasting, and researching interactions between land, ocean, atmosphere, and climate. Despite initial program challenges and funding shortfalls, recent commitment to keep GOES-R on track will result in a scheduled launch of early 2016.

NASA Earth Observation System. NASA also operates a fleet of Earth science research satellites that contribute to our weather and climate prediction capabilities, all of which are operating well beyond their designed lifetime. The fleet of both satellite and airborne platforms provides integrated and long-term global observations meant to provide a coordinated and improved understanding of Earth's environment as one system.

A 2012 review of NASA's Earth Science program, *Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey,* found that within the next 6 years the number of NASA and NOAA Earth observing instruments in space will be only 25 percent of the current fleet *(See Figures 2a and 2b).* As the report states, "rapid decline in capability is now beginning" and "the needs for both investment and careful stewardship of the U.S. Earth observations enterprise are more certain and more urgent now than they were 5 years ago." As a result, the loss of key Earth system observations will exacerbate our ability to understand and forecast changes and have "significant adverse consequences for science and society." [3]

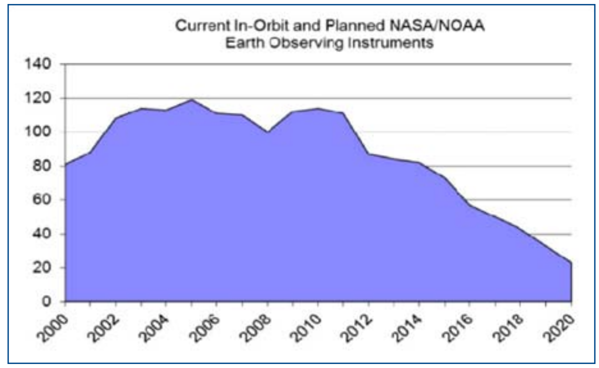
Figure 2a: Current in-orbit and planned NASA/NOAA Earth observing missions through 2020. [4]



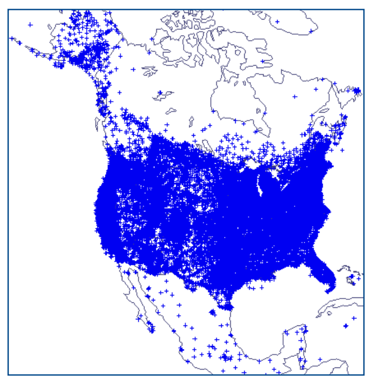
[3] *Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey,* 2012, pg. 2.

[4] Ibid., pg. 3.

Figure 2b: Current in-orbit and planned NASA/NOAA Earth observing instruments through 2020. [4]



National Mesonet Program. An observational network of networks that facilitates access to existing non-federal observational assets, these "mesonets" are located throughout the United States (locations of all North American stations shown in map below). The data gathered are critical to meeting the needs of ever increasing high-resolution weather prediction models and are thus required for driving the accuracy, precision, and lead times of impending severe weather.



This program is a prime example of how the federal government can augment traditional data gathering assets via non-federal sources. The U.S. government should continue to consider commercial data sources (for both ground-based and other types of data), hosted payloads for dedicated sensors, and other new and innovative measurement capabilities where appropriate and feasible.

Planetary Boundary Layer (PBL) Measurements. Other opportunities exist to obtain vital ground-based data throughout the planetary boundary layer for improved forecasts. For example, although there are approximately 1500 lidar-ceilometers around the country that can (but presently do not) provide profile information on the structure of the planetary boundary level, the need exists to extract and provide these profiles to the NWS, OAR, and other users within and external to NOAA. In addition, water vapor structure is largely unsampled in the PBL, yet it is a critical parameter to improved forecasting of convection. And temperature profiles are, similarly, largely undersampled.

National Strategy for Civil Earth Observations. The same 2012 National Academies report suggested that an interagency framework for sustained global Earth observation systems should be developed. [5] The Office of Science and Technology Policy released a *National Strategy for Civil Earth Observations* in April 2013. While such a framework was an essential first step, the White House needs to complete the process by finalizing the *National Plan for Civil Earth Observations* that will fill in the necessary details for a coordinated federal Earth observation program that allocates roles, responsibilities, and resources needed to maintain a national Earth observation system. The comprehensive national plan should also consider areas of future investment and innovation, which would enable the private sector to better position its capabilities and investments. As our nation requires more detailed and diverse information, policies that promote and reward a culture of active collaboration between the U.S. public, private, and academic sectors will be essential. In addition, national policies should incorporate alternative data sources and operational constructs to acquire or augment key measurements for improved forecasting operations and research — thereby building resiliency and redundancy within the weather enterprise and other areas.

Reliable and accurate weather forecasting and prediction capabilities cannot be compromised and actions need to be taken to:

- **Ensure long-term U.S. capabilities in weather and climate data continuity** by guaranteeing critical satellite systems remain on track with appropriate funding and continued oversight. This includes fully funding the FY2015 NOAA requests for both JPSS and the GOES-R satellite systems, accelerating acquisition of JPSS-2, and fully funding the FY2015 request for both the critical NASA Earth Science Division missions and the Defense Weather Satellite Follow-on Program.

NASA's first new Earth science mission of 2014 — the launch of the Global Precipitation Measurement (GPM) Core Observatory.

- **Embrace cost-effective alternatives for sustaining and enhancing** the long-term supply of critical weather and climate data by considering commercial acquisition strategies, commercial data sources (for both ground-based and other types of data), hosted payloads for dedicated sensors, and new innovative measurement capabilities and public-private partnership business models, where feasible and appropriate. This includes continued budgetary support for the National Mesonet Program and expanded ground-based observation capabilities.
- **Complete the *National Plan for Civil Earth Observations*** and ensure individual agencies immediately begin implementation.

[5] *Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey*, 2012, pg. 5.

To equip Americans to better understand and respond to drought by optimizing drought data and information for improved forecasting capabilities.

The ability to monitor and forecast drought conditions in the United States impacts every American. The cost of everyday goods such as dairy and produce are directly linked to drought conditions. Yet drought has become the new normal for much of the country. In California, for example, more than 98 percent of the land is considered at least abnormally dry and almost 9 percent is in "exceptional" drought as of January 2014. California produces about 50 percent of the country's fruits and vegetables. The lack of adequate water has forced many farmers and ranchers in California to cut production dramatically, thus impacting the supplies of the food most consumers take for granted. According to the Consumer Price Index from the U.S. Bureau of Labor and Statistics in March 2014, the prices of food — notably meat, fish, eggs, and fruits — have seen sharp increases since the start of 2014, and food prices are expected to continue to rise, all due largely to drought.[6] Additionally, drought impacts on American consumers do not stop at our own borders. For example, an ongoing drought in Brazil is impacting the prices of coffee, sugar and soybeans.

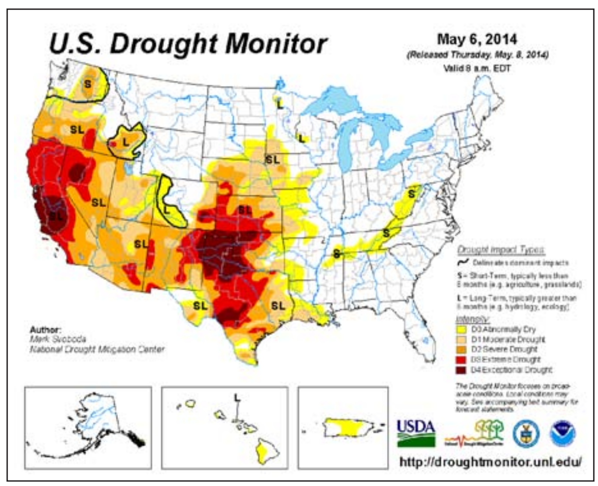
Video: *Why California's Drought Impacts Every American Who Buys Food*[7]

The importance, therefore, of long-term forecasting for drought cannot be overstated. In order to better predict and mitigate the impacts of prolonged drought, farmers and ranchers and researchers alike rely on forecasting capabilities provided by our national atmospheric and land-imaging infrastructure. The National Integrated Drought Information System (NIDIS) and Landsat satellite programs both support long-term forecasting capabilities that are crucial for managing impacts of drought and for developing mitigation strategies. Furthermore, data from our nation's intelligence satellites exists and could be adapted for civil use.

National Integrated Drought Information System (NIDIS). In 2006, Congress established NIDIS at NOAA "to better inform and provide for more timely decision making to reduce drought related impacts and costs."[8] NIDIS's role is to provide forecasts, research, and data dissemination for individual localities to use. According to Jim Ogsbury, executive director of the Western Governors Association, "NIDIS provides the kind of authoritative, objective, and timely drought information that farmers, water managers, decision-makers, and local governments require to prepare for and respond to drought."[9]

The U.S. Drought Monitor complements NIDIS by providing real-time updates on the status of drought in the United States. Figure 3 below clearly demonstrates the magnitude and reach of current drought conditions in the U.S. Forecasts provided by the U.S. Drought Monitor indicate continued drought well into summer 2014, therefore exacerbating the impacts to the American agriculture sector and the pocketbooks of Americans across the country.

Figure 3: U.S. Drought Monitor Map[10]



Adequate funding for NIDIS, therefore, is essential for decision makers to get real-time data available for use in land planning, wildfire mitigation strategies, and more. Since its inception, NIDIS has not been funded at the levels as originally authorized in FY2007. Figure 4 (on the next page) details the authorized versus actual spending for NIDIS for FY2007–FY2012.

[6] Consumer Price Index release on April 15, 2014 retrieved from • http://www.bls.gov/news.release/cpi.nr0.htm

[7] *Why California's Drought Impacts Every American Who Buys Food,* April 14, 2014, retrieved from • http://www.weather.com/news/science/environment/drought-boosts-food-prices-set-biggest-rise-years-report-20140319 • in May 2014.

[8] National Integrated Drought Information System Reauthorization Act of 2014 retrieved from • https://beta.congress.gov/bill/113th-congress/house-bill/2431 • in June 2014.

[9] "Western Governors salute House, Senate reauthorization of NIDIS to battle drought," published on February 10, 2014 as retrieved from • http://westgov.org/news/298-news-2014/580-western-governors-salute-reauthorization-of-nidis-by-house-to-help-battle-drought • on May 13, 2014.

[10] U.S. Drought Monitor Home Page as retrieved from • http://droughtmonitor.unl.edu • on May 13, 2014.

Figure 4: Authorized vs. appropriated funding for NIDIS FY2007–FY2012 [11]

Fiscal Year	Authorized Amount ($US)	Amount in NOAA Spending Plan ($US)
2007	11.0 million	4.0 million
2008	12.0 million	8.4 million
2009	13.0 million	10.4 million
2010	14.0 million	12.9 million
2011	15.0 million	13.7 million
2012	16.0 million	12.2 million
Total: 2007–2012	**$81.0 million**	**$61.5 million**

Landsat Satellite Program. An important component of monitoring and measuring drought in the U.S. is improved forecasting and understanding of land cover and terrain changes. For over 40 years, the Landsat program has continuously provided an objective, efficient, and accurate source of highly calibrated data to catalog natural and man-made changes on the Earth's surface. The latest satellite of the series, Landsat 8, was launched in February 2013 and is estimated to provide continued coverage until at least 2018.

According to a National Academies review, *Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program,* the space-based land imaging provided by Landsat is "essential to U.S. national security as it is a critical resource for ensuring our food, energy, health, environmental, and economic interests." Furthermore, the report committee stated that the "economic and scientific benefits to the United States of Landsat imagery far exceed the investment in the system." [12]

Video: *Landsat Tracks Urban Change and Flood Risk*

The future of Landsat, however, is uncertain. Historically, the program development and acquisition has been managed by NASA. Once a satellite is on-orbit and becomes operational, the United States Geological Survey has operated the satellite and maintained the database of information. The President's FY2014 budget request recognized that Landsat is a critical piece of our nation's infrastructure by establishing, for the first time, an operational land imaging budget line. Additionally, the 2014 Budget Act provides resources to begin acquisition of Landsat 9 and requires NASA to provide a plan to acquire a Landsat 9. However, the current funding set-aside is not sufficient to meet program needs. It is imperative that NASA begin acquisition of Landsat 9 as quickly as possible, while also producing an acquisition plan for a long-term, continuous governmental land imaging program.

Utilize Existing U.S. Government Data Sources. Consideration should also be given to declassifying and re-sampling imagery and data from U.S. Government intelligence gathering satellites. This historical data may be of great use in better understanding changes over time on the ground.

The U.S. government does not fully take advantage of valuable imagery from commercial remote sensing satellites. Most of this data is sold to the National Geospatial-Intelligence Agency (NGA), an intelligence arm of the Department of Defense, and it largely remains there for use in DoD and intelligence missions and mapping. For example, one such commercial provider has acquired more than 30 times the landmass of the Earth in high-resolution imagery at less than 1-meter ground resolution, and that archive is not being exploited by agencies outside of the DoD and intelligence communities.

Under these circumstances, it is imperative that the United States evaluate the needs for this data against the costs and potential opportunities that might exist. In addition to continuing historical data-gathering programs, the U.S. government should evaluate the possibility of new and innovative acquisition models in an attempt to get the same and/or similar data at a lower cost threshold.

Recognizing the impact that drought, wildfire, and floods can have on the lives of everyday Americans, decision makers must continue to protect life and property by:

- **Providing funding** as authorized to maintain and improve the National Integrated Drought Information System.
- **Providing consistent funding** for a continuous medium-resolution governmental land imaging program. Establishment of a long-term budget and acquisition strategy, to enable an uninterrupted set of critical Landsat measurements, is not optional; there must be a commitment to replace Landsat satellites as they age or fail.
- **Pursuing innovative commercial space-based solutions** to augment the core government Landsat program. The criticality of land imaging data to the U.S. requires a robust operational architecture. The private sector is more than capable of filling this augmenting role.
- **Seeking innovative acquisition strategies** from commercial providers to ensure affordability and access to higher-resolution imagery than can be obtained from government civil Earth imaging satellites.
- **Enabling access to older data** from U.S. government National Technical Means imaging systems.

[11] H.R. 2431–113th Congress: National Integrated Drought Information System Reauthorization Act of 2014. (2013) as retrieved from • http://www.govtrack/uscongress/bills/113 • on February 22, 2014.

[12] *Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program,* National Academies Press, August 2013, pg. 2.

To advance U.S. freshwater monitoring and forecasting as a critical component of managing scarce water resources.

The ubiquitous nature of water runs deep. Water truly is the lifeblood that keeps society and individuals alive and well. From day-to-day household usage, to sustaining a vibrant agricultural sector, to using water as a means of transporting goods, understanding and managing the nation's vital surface and ground water resources has a direct impact on the economy. Too little water results in droughts and water rationing. Too much water can wipe out a community in the blink of an eye.

Proper resource management begins with reliable, consistent, and comparable data in order for localities to develop plans for both mitigation and adaptation. The quality of data is of the utmost importance. Traditional data sources and cutting-edge technologies are needed to maintain the continuous record of data and to improve insight into the global water system. By advancing U.S. freshwater monitoring and forecasting, decision makers can provide peace of mind to millions of Americans while ensuring proper management of our water resources.

National Streamflow Information Program. The National Streamflow Information Program (NSIP) within the U.S. Geological Survey (USGS) and in coordination with more than 800 other federal, state, local, and tribal agencies, operates over 7,400 streamgages nationwide. The use of this data is widespread. The National Weather Service, for example, uses the information in the prediction of floods, and new models are being developed (Article: "Computer model helps Iowa cities, public prepare for flood").

Water resource managers analyze the data to determine how to allocate scarce resources for disparate interests—anywhere from power production, crop irrigation, fisheries, and habitat assessments, to recreational uses such as kayaking and fly fishing. Even civil infrastructure projects such as designing bridges, roads, culverts, and water treatment facilities all need the historical streamflow information that this network provides.

The NSIP was instituted in 2000 to provide an overall coordinating mechanism of streamgages across the country. The USGS began measuring streamflow in the U.S. in 1889. Since then, the number of streamgages across the United States has grown to over 7,400. However, streamgages are often subject to local needs and budgets. NSIP is intended to provide stability to the network and constant funding to the most critical of streamgages nationwide, to ensure at least 30 years of continuous data is maintained.

The streamgage program, however, operates at levels much lower than optimal for data collection and analytics. Total funding for the USGS streamgage network in FY2013 was $161.5 million—half of which is funded by state and local partners. The FY2014 budget for NSIP is $33.7 million; however a fully funded program would require approximately $122 million annually in order to put in place and operate a "backbone network." Full funding would also allow for 1,000 needed streamgages to be reactivated.

Data Infrastructure. The information the streamgages provide are only as good as the availability of the data they generate. The streamgages nationwide rely on an infrastructure that transmits the data in "real time" to users. The Geostationary Operational Environmental Satellites (GOES), local ground stations, and data acquisition systems are all needed to get the data onto the Internet quickly and seamlessly. Data users are then able to update the information they need via the National Weather Information System.

NASA Research Programs. While the streamgage system provides much-needed real-time data of the state of our freshwater, NASA research programs are paving the way for advancing monitoring and forecasting capabilities. The NASA Gravity Recovery and Climate Experiment (GRACE), launched in March 2002, was designed to map variations of Earth's gravity field and has provided scientists with information such as changes to ocean currents, groundwater storage, and ice sheet variations. The mission is currently in extended operating status and the agency is developing a GRACE Follow-0n (GRACE FO) mission.

More recently in February 2014, NASA and Japan launched the Global Precipitation Measurement (GPM) mission, designed to improve our understanding of Earth's water and energy cycle and aid in the forecasting of extreme events. The information is collated with an international network of partner satellites and stands to provide an unprecedented detail of data. Continuing research programs such as GRACE and GPM will advance the science behind monitoring and forecasting our vital groundwater and surface water resources.

Congress should support the advancement of state-of-the-art water resources analysis and prediction capabilities by:

- **Gradually increasing funding to the National Streamflow Information Program** from $33.7 million in FY2014, to a goal of fully funding the program at $122 million annually by FY2020.
- **Ensuring that the infrastructure to transmit and analyze the streamflow data** is maintained. This includes keeping the GOES-R satellite development on track.
- **Supporting new data collection techniques,** such as NASA's GRACE or GPM satellites, that measure groundwater and the water cycle from a global perspective.

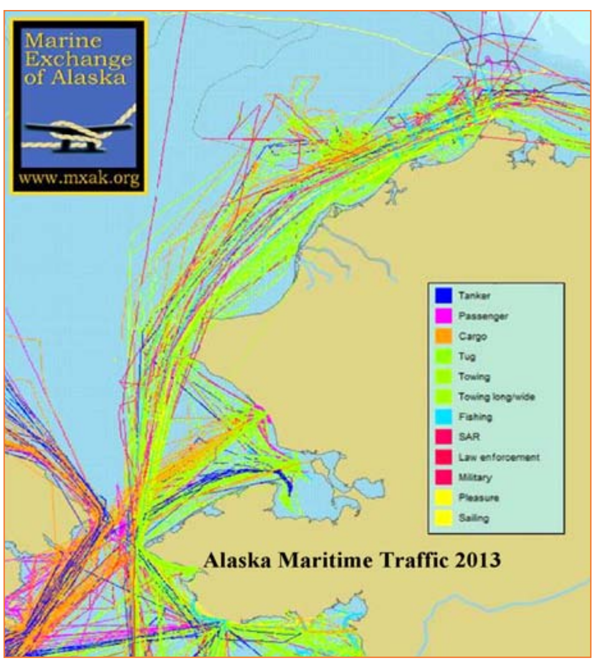
PRIORITY 4 ◗ The Arctic

To protect U.S. environmental, economic and national security interests in the Arctic by expanding Earth monitoring and communications capabilities in the region.

The Arctic is often used as the poster child for the environmental protection movement, yet many in the United States may not recognize how changes in the Arctic impact their everyday lives. Leading research indicates that even slight changes to sea and glacial ice have far-reaching consequences that affect U.S. citizens daily. Increases in extreme weather events or rising sea levels impact how we prepare for future calamities. And increased economic activity in the region bears importance to U.S. strategic interests.

Over the past ten years, the Arctic has warmed at a rate twice that of the rest of the world. The melting sea and glacial ice has a large number of consequences ranging from increasing levels of fresh water going into the oceans, changing temperatures of ocean currents, altering jet stream patterns, and causing an increase of methane gases into the atmosphere. Changes in the Arctic can be predictive to the rest of the globe and provide researchers with a "time capsule" of information—both from the past and into the future.

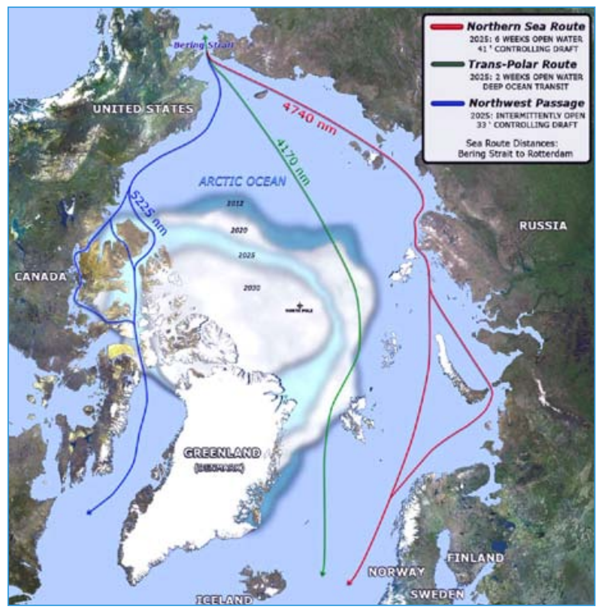
Figure 5. Alaska maritime traffic continues to increase.



Maritime traffic in the Arctic and Alaska, already significant as of 2013, is only expected to continue to increase as melting sea ice opens up passageways for shipping and new regions for resource extraction (e.g. oil). (*See Figure 5, above, and Figure 6, next column).*

The region is economically attractive and geopolitically desirable for countries that have a vested interest in the region. As stated in a September 2013 editorial by Robert Gagosian and Sherri Goodman, two members of the Joint Ocean Commission Initiative, the Arctic is the most rapidly changing region in the world today where "economic, social, and national security issues collide."

Figure 6. Decreasing Arctic ice opens shipping and travel routes. **US Navy Arctic Roadmap.**



Sea Ice Measurements and Modeling. Investing in technologies that can provide enhanced observational data and improving agency coordination will be necessary to understand the interactions of land, ocean, atmosphere, and ice on a global scale. A U.S. all-weather capability to monitor sea ice extent and concentration — in order to support safety of navigation due to increased shipping, tourism, fishing, and U.S. companies extracting natural resources from the Arctic region — is of the utmost importance.

The 2013 *National Ocean Policy Implementation Plan* calls on federal agencies to "evaluate how to most effectively integrate observational data, test and develop ocean sensors and communication standards, and implement data and modeling techniques to support a global observational capability." [13]

[13] *National Ocean Policy Implementation Plan,* pg. 25.

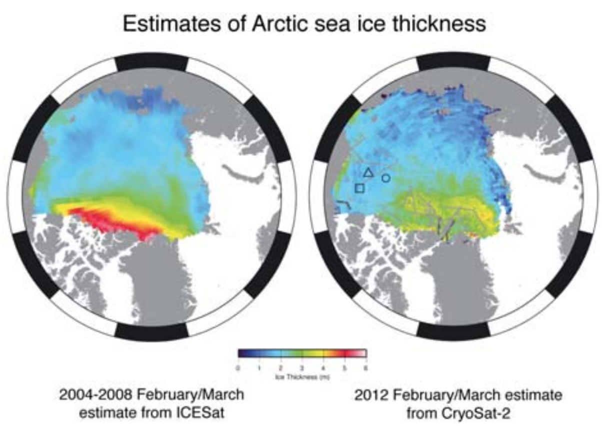
More specifically, in January 2014 the White House issued an *Implementation Plan for the National Strategy for the Arctic Region* that provides for developing a framework for observations and modeling to support forecasting and prediction of sea ice. This framework supports the *Arctic Research Plan: FY2013–2017,* which aims to improve observations that can reduce uncertainty in forecasts by the end of 2014.

Critical to enhancing these observations will be the successful launch of NASA's Ice, Cloud, and land Elevation Satellite 2 (ICESat-2) and the follow-on to the Gravity Recovery and Climate Experiment (GRACE FO) by the end of 2017. The mapping gravity data from GRACE FO, for example, will support U.S. Navy and U.S. Coast Guard operations and help ensure safety and security in the Arctic. [14]

Arctic Communications System. According to the *National Ocean Policy Implementation Plan,* increased maritime activity in the Arctic also demands an improved communications system to "prevent and respond to maritime incidents and environmental impacts." The implementation plan explicitly calls for U.S. government agencies to:

> ***Strengthen existing communication systems to allow vessels, aircraft, and shore stations to effectively communicate with each other, and to receive information such as real- time weather and sea ice forecasts that will significantly decrease the risk of loss of life at sea or damage to property or the marine environment.*** [15]

Improved communication systems in the Arctic are also viewed as critical to U.S. national security. In November 2013, the U.S. Department of Defense released a new *Arctic Strategy* that explicitly emphasizes the near-term challenges of ice and weather reporting and forecasting, as well as limitations in communications and surveillance in the region. More recently in February 2014, the U.S. Navy released its *Arctic Roadmap* stating strong support for a potential U.S. and Canadian partnership on a communications and weather satellite to improve monitoring and communications capability in the Arctic.



To protect U.S. environmental, economic, and national security interests in the Arctic, Congress should:

- **Maintain launch dates for NASA's ICESat-2 and GRACE Follow-on missions** to ensure expanded and new Arctic sea ice observations, with requested funding and continued program oversight.
- **Support a U.S./Canadian agreement** regarding Arctic communications and weather satellite capability, to provide for safe operations and improved information within the region.

[14] *Implementation Plan for the National Strategy for the Arctic Region,* pg. 15-16; retrieved from • http://www.whitehouse.gov/sites/default/files/docs/implementation_plan_for_the_national_strategy_for_the_arctic_region_-_fi....pdf • on April 2, 2014.

[15] *National Ocean Policy Implementation Plan,* pg. 12; retrieved from • http://www.whitehouse.gov//sites/default/files/national_ocean_policy_implementation_plan.pdf • on April 2, 2014.

PRIORITY 5 Economic Competitiveness

To drive innovation, create jobs, and grow the economy by enhancing the economic competitiveness of U.S. businesses.

Understanding the planet and how changes can affect the livelihood of American citizens and our global economic competitiveness is vitally important. This report has detailed a variety of ways in which specific sectors are dependent on the information provided by our current Earth observation system. Driving innovation and economic growth in this sector starts with adopting public-private partnership business models, where feasible, to augment national systems with commercial sources, utilize hosted payloads for dedicated sensors, field new innovative measurement capabilities, and provide the private sector with greater access to existing government data sources.

A straightforward assessment of the economic competitiveness of the U.S. Earth observation sector begins with a deliberate review of the current U.S. regulatory regime. The imperative for U.S. manufacturers to compete on a level playing field internationally has only increased in recent years. After the 2012 release of the much anticipated *Section 1248: Report to Congress,* many within the U.S. satellite industry were hopeful that the potential changes to U.S. trade regulations would enable access to a competitive global commercial satellite marketplace. However, cuts to U.S. government commercial imagery purchases instead resulted in the further consolidation of the U.S. commercial remote sensing industry.

In January 2013, Colorado-based DigitalGlobe acquired Virginia-based GeoEye when the National Geospatial-Intelligence Agency (NGA) cancelled GeoEye's ten-year $3.7 billion contract for Earth imagery and other services. In the acquisition, DigitalGlobe acquired the yet-to-be-launched GeoEye-2 satellite and has mothballed the satellite until there is additional demand for high-resolution imagery. Even though DigitalGlobe plans to launch WorldView-3 in August 2014 from Vandenberg AFB, California, there is real interest for satellite and payload operators to look to international markets to sustain production capabilities over the long haul.

Changes to the export control law ushered in by the U.S. Congress was only the first step in ensuring a modernized approach toward international trade in commercial remote sensing capabilities. The U.S. government is currently reviewing Category XV of the *United States Munitions List.*

Updated Commercial Aperture and Resolution Limits. The first commercial Earth observation (EO) satellite system, IKONOS, was developed in the U.S. in the 1990s with a telescope aperture of 0.70 meters. Today's U.S. commercial EO satellites are allowed a much greater aperture size of 1.1 meters and foreign competitors are not far behind.

Foreign EO satellite systems with apertures of 0.65 meters or greater are available commercially and sold internationally. Though it's dependent on the altitude flown, the larger the aperture the higher the resolution of the images.

On June 11, 2014, DigitalGlobe announced the company received permission to sell its best quality imagery. Prior to this date, all commercial imaging providers had to resample or degrade the quality of the imagery to half-meter ground resolution. This new modification to its operating license means that DigitalGlobe can sell imagery better than that, and when WorldView-3 is launched this summer, the company will be able to capture images with a remarkable ground resolution of .31-meter, or about 12 inches. And when future commercial systems are launched, providers will be able to sell imagery at .25-meter ground resolution, or about 9-inch ground resolution. This decision was made at the highest levels of government and was more than a year in the making. But it was the right decision and positions U.S. commercial imagery providers as leaders in the growing international market for Earth imagery. The bottom line is that these recent changes will help U.S. industry stay competitive internationally in the midst of aggressive foreign competition.

Satellite images: IKONOS (top), Skybox (bottom).

Commercial solutions to spur innovation and reduce costs. The National Mesonet Program, as discussed earlier, is a great example of how the U.S. government can leverage private innovation. Similar constructs for other types of data (e.g., satellite) should also be encouraged. Innovative uses of hosted payloads, for example, could leverage commercial satellite constellations to launch critical Earth observation sensors faster and at a lower cost than via typical government satellite programs. Likewise, purchasing commercial data from U.S. companies could be a cost-effective solution to increase the quantity and quality of data available, and to mitigate expected gaps in key weather monitoring capabilities, while also creating U.S. jobs. The U.S. government should establish a centralized mechanism to consider commercial solutions within the federal Earth observing enterprise.

Recognizing the economic impacts of promoting the global competitiveness of U.S. businesses, the U.S. government should:

- **Optimize U.S. policy and Category XV of the *United States Munitions List*** so that commercial-class U.S. remote sensing hardware is able to successfully compete against foreign suppliers.
- **Enable greater access to existing data** via continued support for efforts such as the Open Environmental Information Services and the National Mesonet Program, which are designed to leverage existing and future capabilities from non-federal partners, resulting in the acquisition of high temporal and spatial resolution data in a cost-effective manner.
- **Establish a centralized mechanism** by which commercial solutions can be considered within the federal Earth observing enterprise, thus spurring innovation and reducing costs.

CONCLUSION

The United States has in place a network of effective and necessary observational tools that aid in the prediction of weather and changes to our climate. This network, however, is fragile and not guaranteed. In the short term, it is critical that we do not take these systems for granted and instead understand how they all fit together into a global puzzle of information that is important for the protection of U.S. lives, property, and economic competitiveness.

It is imperative that the White House and Congress continue their support for these programs. Likewise, policies should enable U.S. businesses to partner with the federal government to continue to innovate cost-effective and state-of-the-art solutions. More information—not less—will ensure that the United States remains on the forefront of changes affecting our day-to-day lives. The recommendations outlined in this report represent a first but necessary step in order to ensure these capabilities are maintained and to set a foundation for future improvement.

ALLIANCE FOR EARTH OBSERVATIONS

This report was prepared by members of the Alliance for Earth Observations.

The Alliance is a publicly- and privately-funded initiative to promote the understanding and use of land, air, and sea observations for societal and economic benefit. Through active stakeholder engagement, the Alliance brings together those that develop the tools to monitor the planet with those that need the information to manage it, and serves as a link between the private sector, the government, and the general public.

The Alliance's mission is to ensure the rapid and broad delivery of the most timely, comprehensive, and accurate environmental information for improved decision making. With members from the private sector, academia, and non-governmental organizations, the Alliance advances the sustainability of U.S. Earth observation capabilities to ensure that this vital intelligence continues to protect citizens and property, grow the economy, and ensure national security—now and in the future.

The Alliance is facilitated by the Institute for Global Environmental Strategies.

For more information, please visit:
http://strategies.org/environmental-information/alliance-for-earth-observations