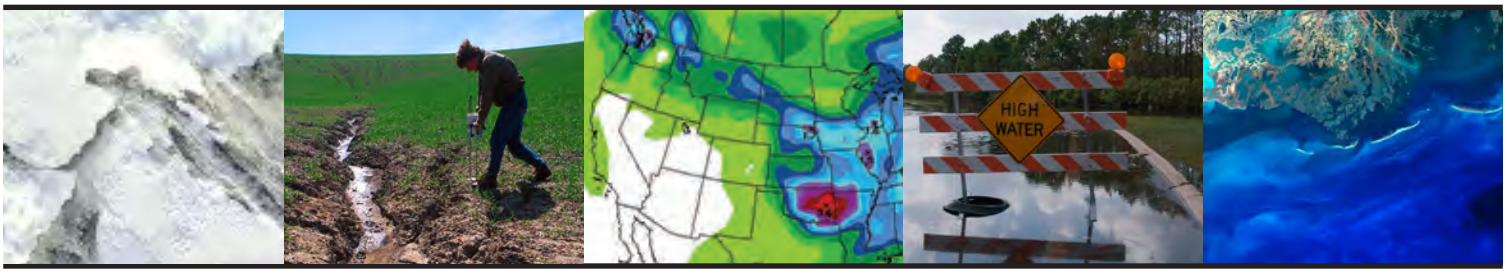
Climate Services and Approaches for Public-Private Engagement



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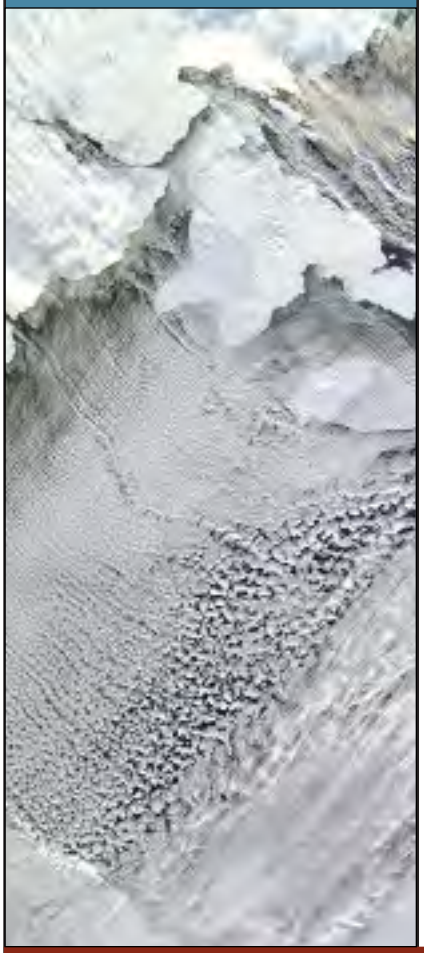


EXECUTIVE SUMMARY

Record-breaking extreme weather events in 2011, sustained drought throughout the continental U.S. in the summer of 2012 and the regional destruction that resulted from Superstorm Sandy, have become the latest wake-up calls for the need to better understand long-term environmental trends and how these are changing. In a context of tightening budgets increasing the challenges of the National Oceanic and Atmospheric Administration (NOAA) to capture and deliver this critical information, it is clear that our nation's ability to meet growing demand – from governments, businesses and individuals – will depend on the success of integrating both public and private capabilities in the provision of climate services.

With this in mind, NOAA and private sector stakeholders have taken meaningful steps to initiate discussions about how to structure a Climate Services Enterprise (CSE). Of particular interest is the debate over how the public and private sector will interact in the provision of these services. Building upon previous work in this area, the Institute for Global Environmental Strategies (IGES), analyzed recent developments in this area – specifically, the Climate Partnership Task Force (CPTF) report, the Open Weather and Climate Services (OWCS) white paper, recent statements and meetings organized by the American Meteorological Society (AMS)and steps to review the NOAA Partnership Policy – and conducted a series of interviews with key NOAA/National Climatic Data Center (NCDC) officials and private sector representatives to gain additional insights on how NOAA might move forward with the CSE.

This assessment agrees with the basic assumption of recent reports and statements that have considered the issue: that the existing model of cooperation in the provision of weather services should be expanded and adapted to advance climate services. If NOAA is to assume a leadership role in bringing together lessons-learned from these separate efforts, the following conclusions will be critical moving forward:

- Consider the similarities and differences of climate and weather services.

- Derive specific lessons that can be applied from the Weather Enterprise experience and recognize that some aspects of the CSE may evolve in a different direction.

- Identify how the Enterprise can address critical education and communication issues, specifically:

  - Lack of public understanding about climate – Climate may require

a different strategy when it comes to communicating needs and benefits. The private sector, academia (including social scientists) can play a larger role in fostering awareness.

- Lack of user education about climate services – User education requires particular emphasis, both from public and private sector providers of data and services.

◆ Advance OWCS concept to improve private sector access to NOAA data.

◆ Develop attribution guidelines that help communicate NOAA's critical role as a foundation of the overall Enterprise. Continue to engage the private sector. Open participation between the partners will be key moving forward.

This research was conducted by Nancy Colleton and Laura Delgado López as part of IGES' project on Stakeholder Engagement to Better Understand Climate Information Needs funded by NOAA via the Cooperative Institute for Climate & Satellites – North Carolina (CICS-NC) under North Carolina State University *Sub-award 2009-1380-08*.

INTRODUCTION

Above: This Landsat 7 image taken on 8 August 2012, shows the Mississippi reduced river flow as a result of record-setting high temperatures and dry weather. Reduced river flow in 2012 led to millions of dollars in increased shipping costs in this major transit route. In contrast, every day that traffic on the river is stopped, the national economy loses $300 million. Credit: NASA Earth Observatory

In June 2011, the National Center for Atmospheric Research (NCAR) released a report [1] that concluded that the annual impact of routine weather on the economy is as much as 3.4% of U.S. gross domestic product (GDP), about $485 billion annually. The study also found that no sector of the economy is immune to the effects of weather, which impact every state. Although it did not consider the impacts of fluctuations in climate, what it suggests for the economic impact of climate change is considerable.

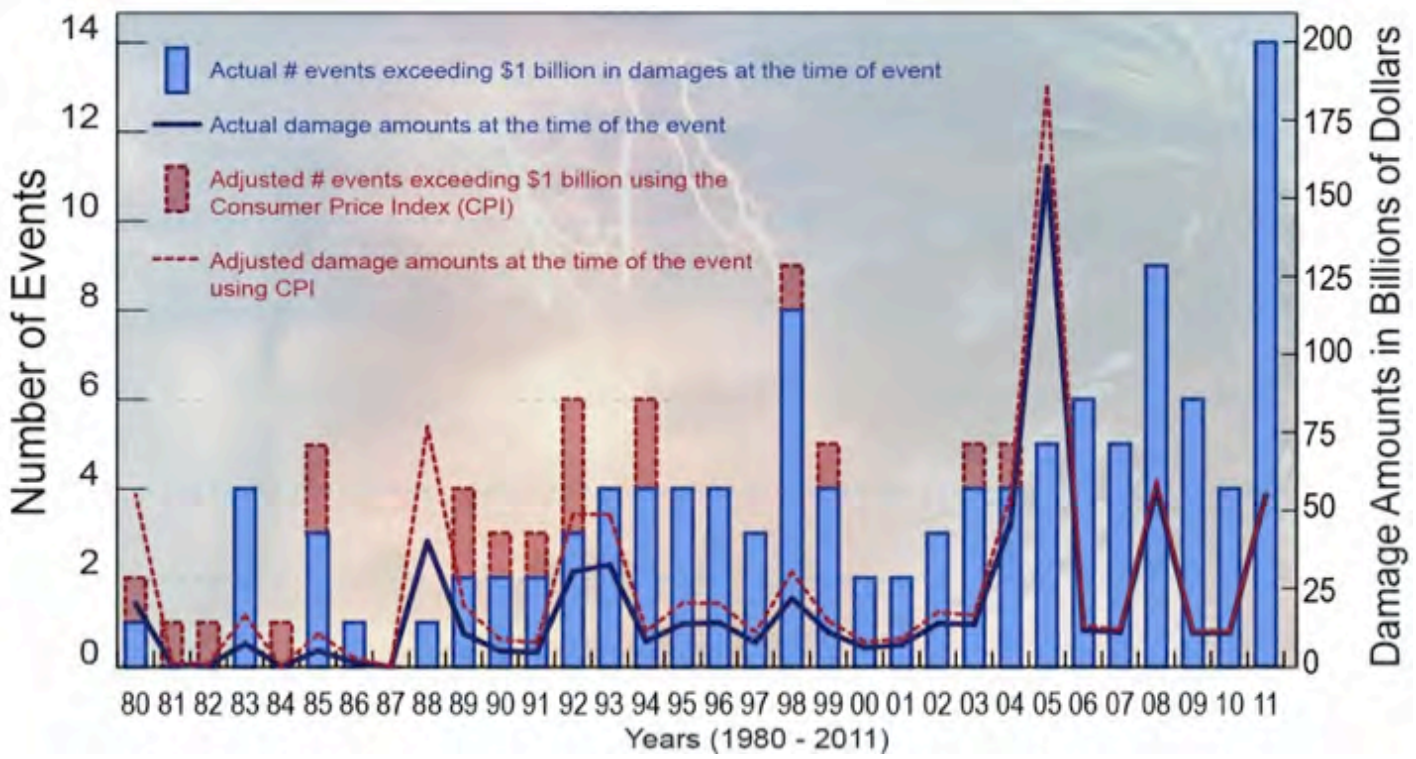


Figure 1: In 2011, the United States experienced a record 14 weather and climate disasters exceeding $1 billion in losses. Total losses since 1980 of billion-dollar disasters exceed $800 billion. Credit: NCDC

In this context of increasing record-breaking extreme weather events in the United States, not the least of which was Hurricane Sandy, "the Storm of the Century," the impact of environmental changes has been put in the forefront. From extreme temperature, drought and floods to an unusually active hurricane season, the costs of these disasters for individuals, businesses and governments across the nation continue rising. According to the National Oceanic and Atmospheric Administration (NOAA), 2011 was a record-breaking year with 12 billion dollar weather and climate disasters amounting to aggregate losses of $52 billion. [2] [Figure 1] Historic droughts causing over $25 billion in insured losses last summer and initil estimates of $50 billion in damages caused by Hurricane Sandy in the Northeast are just two indications that 2012 will likely set new records too.

These developments have highlighted the growing need to monitor and understand the environmental changes taking place and the need to address the challenges faced by NOAA in capturing and delivering this critical information. [3] [Figure 2] At a recent meeting, NOAA Administrator Jane Lubchenko linked recent disasters with climate change. "What we are seeing this year is not just an anomalous year, but a harbinger of things to come for at least a subset of those extreme events that we are tallying," she was quoted as saying. [4] She added that "demand for services provided by agencies like NOAA is at an all-time high and rising."

"Demand for services provided by agencies like NOAA is at an all-time high and rising."

- Jane Lubchenco, NOAA Administrator

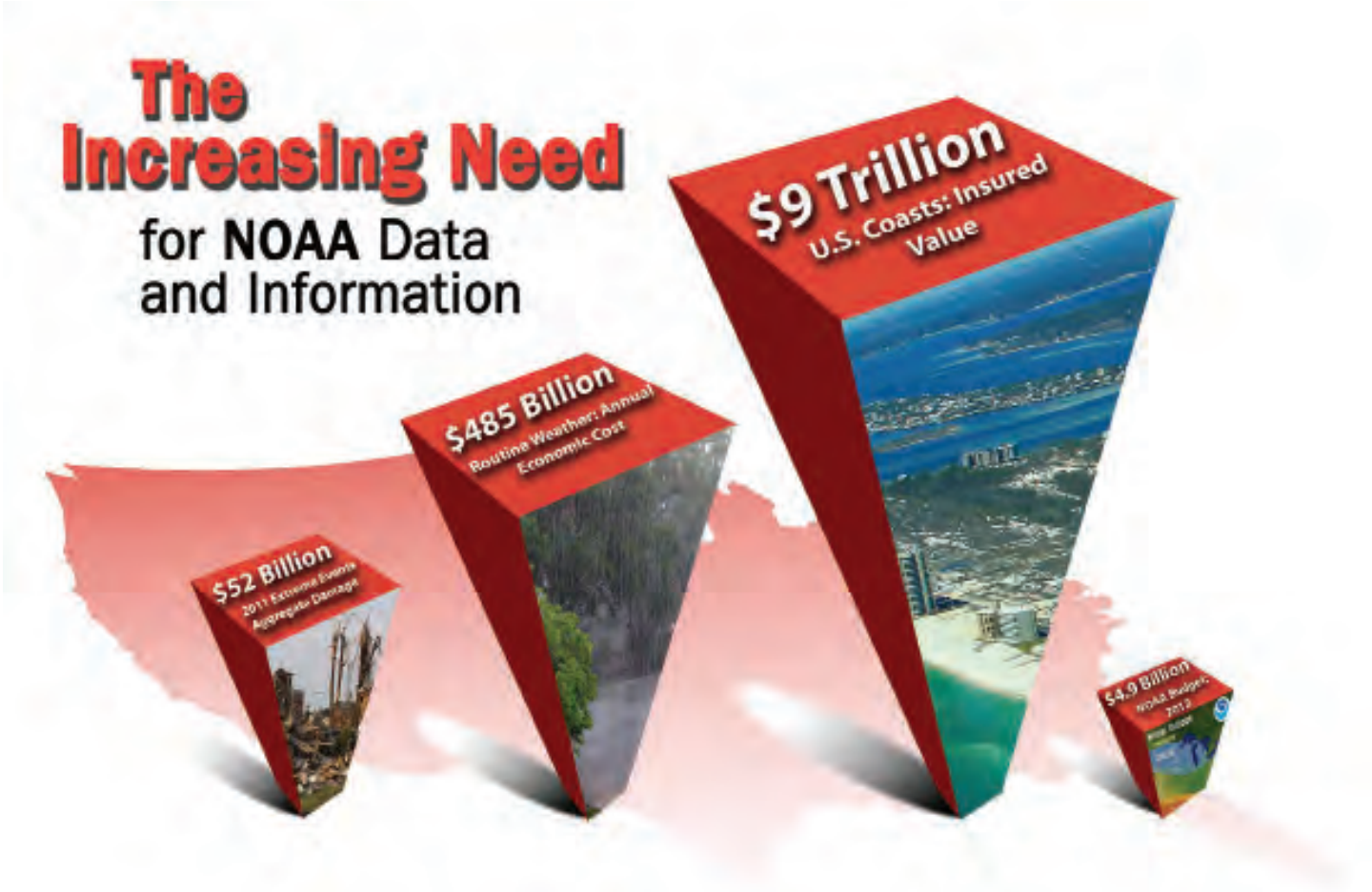


Figure 2. This graphic compares the NOAA budget – at $4.9 billion in 2012 – with the rising costs of extreme weather and climate events (at $52 billion in 2011), the routine cost of weather and the insured value of U.S. coasts. It forces the question: are we truly investing to avoid risk? Source: IGES.

Statements like these have resurfaced even more forcefully in the aftermath of Hurricane Sandy with a recurring question: Are storms like these only going to increase in the future? And inevitably, are we prepared for that?

With this in mind, stakeholders have begun to look to the private sector as a fundamental component of a successful Climate Services [5] Enterprise (CSE) that supports NOAA's mission while meeting growing demand and fostering new economic opportunities. Almost two years ago, discussions about how to structure this partnership and ensure that the private sector has the ability to take advantage of NOAA data and technologies led to calls for the establishment of a NOAA Climate Service. Included in the President's FY2012 budget request for NOAA, the proposal would lead to an internal reorganization and the creation of a new office to centralize widely dispersed climate capabilities within the agency. [6] It also relied on collaboration with other parts of the enterprise, based on the assumption that: "NOAA alone cannot meet all of the nation's needs for climate information and services; partnerships from federal to local levels, including other agencies, the academic community and private sector will be essential to fully meet the nation's needs." [7] The proposal received support from broad sectors of industry and the scientific community, but was eventually defeated by Congress in the agency's FY2012 budget, signed into law November 2011. [8]

Despite this setback, NOAA's commitment to continue providing climate services and do so in partnership with the private sector remains. The question of how best to engage with an increasingly capable enterprise (involved in weather, water and climate), was identified by the National Research Council as a key challenge in its recent *Weather Services for the Nation: Second to None* report. [9] In this context, stakeholders have engaged in discussions about how to advance

the Climate Services Enterprise. Recent developments include the release of the Climate Partnership Task Force (CPTF) report and the Open Weather and Climate services (Open WCS) white paper as well as recent statements and meetings organized by the American Meterological Society (AMS). Additionally, in 2012 the Environmental Information Services Working Group (EISWG) of NOAA's Science Advisory Board (SAB) has undertaken a study to examine the effectiveness of the NOAA Policy on Partnerships in the Provision of Environmental Services.

Although a lot of work has been done thus far in examining these issues, the task of structuring the climate enterprise is still ahead. To propose a way forward, this study will examine models for public-private sector collaboration by considering areas of commonality between these recent developments and through interviews with key stakeholders and by identifying outstanding issues yet to be addressed.

This study will also build upon the Institute for Global Environmental Strategies (IGES) previous work in leading public-private engagement in this area. On October 20, 2010, IGES hosted the Executive Roundtable on Environmental Information: Meeting the Climate Needs of U.S. Business with Secretary of Commerce Gary Locke, Administrator Lubchenko, and a variety of business sector leaders. The discussion highlighted industry's need for improved environmental services not only to manage risk effectively in its response to climate change, but also to take advantage of government's investment in environmental services.
Although the discussion centered on the creation of the Climate Service, key take-aways will be instrumental in crafting a model of engagement between the public and private sector. These include:

- Both Fortune 500 companies and smaller businesses will benefit from credible, accurate and accessible climate information. This information will help corporations calculate the benefits of embracing clean and renewable energies, and will enable improved private-sector planning, research and decision-making that will minimize risk, create jobs and build wealth.
- There must be easy and efficient interaction between government and the users and providers of climate information, especially the business leaders and entrepreneurs who stand ready to invest in climate-related services and utilize them for economic and environmental gain.
- Climate change is a tremendous threat to America's military operations. NOAA climate data is increasingly used by the Department of Defense (DoD) to improve its energy efficiency and to anticipate the destabilizing effects of climate change on developing countries. As a major user of NOAA climate information, the DoD must be engaged in the discussion.
- NOAA has the opportunity to spur a multi-million dollar climate services industry that generates thousands of jobs, aids in climate change response; and supports informed decision-making by a multitude of business sectors, governments and individuals across the nation and around the world.
- An effective public-private partnership is essential to meet the needs of NOAA climate services users, while strengthening America's competitiveness.

This research was conducted by Nancy Colleton and Laura Delgado López as part of IGES' project on *Stakeholder Engagement to Better Understand Climate Information Needs* [10] funded by NOAA via the Cooperative Institute for Climate & Satellites – North Carolina (CICS-NC) under North Carolina State University *Sub-award 2009-1380-08.*

PUBLIC-PRIVATE MODELS

Public-private engagement in the provision of climate services could take many forms. Delving into the literature on the subject, one finds that different models have been applied in different contexts, with the actors assuming varying kinds of risk and responsibility. As in other fields, such as in land remote sensing, these arrangements reflect the cultural and legal views of each country toward what constitutes "public" and "private."[11] The following table, adapted from Rogers and Tsirkunov (2011)[12] captures the broad strokes of existing models of collaboration in the provision of meteorological services.

PUBLIC-PRIVATE MODELS IN THE PROVISION OF HYDROLOGICAL SERVICES

Gov't Supported Public Service	Core & Discretionary Funded	
• Agency relies solely on public funding • Agency aims to advance public good • Private sector takes basic information, enables value-added industry • Ex. U.S. NOAA/NWS	• Goverment provides core funding for agency • Additional funds are competed through short-term contracts • Alternative: state-owned enterprise • Ex. U.K. MetOffice	
Commercially Funded	**Public Private Partnerhip (PPP) or Build-Operate-Transfer (BOT)**	
• Agency competes directly in commercial, competitive markets • Ex. New Zealand Met Service	PPP • Institutional cooperation betwen partners to jointly manage project • Exchange of risks, know-how	BOT • Private sector builds, operates, and maintains facilitaties • Facilities are then transferred to public sector

As noted by Rogers and Tsirkunov (2011), the government supported public service, exemplified by the U.S. National Weather Service "might be considered the ideal model if public sector financing is sufficient." While increasingly limited government funding has caused numerous challenges, considering the pros and cons of each suggests that it will remain the appropriate model for structuring the CSE. Two elements that must be considered are:

- *Existing policies* –NOAA's mission statement, the U.S. open access data policy and NOAA's partnership policy set the foundation (and the culture) for this kind of engagement where public, private and mixed goods are defined.

- *The success of the Weather Enterprise* – The last 30 years have shown the growth of an increasingly capable private sector that takes part in an active Weather Enterprise where public, private and academic actors interact. Thanks to this maturation, it is clear that this model works for NOAA and the private sector. The lessons learned from this effort could be very beneficial in designing a parallel effort that considers the specificities of expanding to the climate arena.

Adopting the other models is not impossible and it may be useful to gauge the opinion of key stakeholders within and outside of NOAA in exploring them. Nevertheless, it is clear that each would require considerable institutional, legal and policy changes, such as new procedures that would allow NOAA/NCDC to compete with the private sector, the creation of a new institutional body that would be jointly funded to act as broker, or a new data sharing policy. The failure to establish a Climate Service within NOAA despite stakeholder support suggests that there currently may not be the political clout to push for such reforms. At this point, the most fruitful approach is for stakeholders to adopt the Weather Enterprise model (e.g. the NOAA Partnership Policy) as the foundation of the CSE for public-private engagement.

The developments considered in the following section all begin with the assumption that improving the existing model is the best bet to structure public-private engagement in the provision of climate services. This exercise is useful to understand that ongoing – and sometimes heated – debates revolve around the details of such engagement – including key questions such as the definition of appropriate roles or guidelines for attribution – and not in the foundational understandings of the interactions between these actors.

SUMMARY OF KEY DEVELOPMENTS

Above: This image, taken on Milford, Conn. on November 8, 2012, shows the dramatic contrast of a house that was elevated and thus sustained minimal damage due to storm surge, with the house on the right that was not elevated and was destroyed during the storm. Credit: Marilee Caliendo/FEMA

This section summarizes relevant documents that have paved the way in addressing the question of how to structure public-private partnerships in the provision of climate services. These are: NOAA's Partnership Policy, the CPTF report, the OCWS white paper and the AMS Policy Statement on Climate Services. [See Appendix B]

Policy on Partnerships in the Provision of Environmental Information

The 2006 NOAA Policy On Partnerships in the Provision of Environmental Information, [13] hereafter referred to as the Partnership Policy, was developed in response to the recommendations of the NRC's *Fair Weather: Effective Partnerships in Weather and Climate Services* report, [14] which called for replacing NOAA's 1991 Partnership Policy with one that "defines processes for making decisions on products, technologies, and services, rather than rigidly defining the roles of the NWS and the private sector."

The resulting policy applies to the provision of environmental information throughout the agency. It acknowledges the changing landscape of the environmental information services enterprise, particularly the growing involvement of private and academic institutions in the provision of weather and climate information. It describes the interaction of these three sectors as a service to the nation: "The nation benefits from government information disseminated both by Federal agencies and by diverse nonfederal parties, including commercial and not-for-profit entities."

At the same time, the policy recognizes the challenges to successfully navigate between the complementing but often overlapping roles of these actors. Recognizing that "some level of friction is inevitable," the policy aims to balance the need of advancing NOAA's role while growing the involvement of these different stakeholders. It states that NOAA is committed to "foster the growth of this complex and diverse enterprise as a whole to serve the public interest and the nation's economy."

The principles of the policy are: mission connection, consultation, open information dissemination, equity, and recognition of theroles of others. In broad terms it commits NOAA to the following:

- Promoting the open access of information to all entities. "NOAA will provide information in forms accessible to the public as well as underlying data in forms convenient to additional processing, to the extent practicable and within resource constraints." This involves the use of dissemination technologies and standards to encourage the broadest use of data;

- Avoiding duplication of effort. As this cooperation benefits public and economic interest, NOAA will take advantage of existing capabilities and services and competition in areas not related to the NOAA mission;

- Engaging in open consultation. NOAA will engage in open consultation with all interested parties on decisions affecting the enterprise. These can involve the creation, modification or discontinuation of products and services, actions to advance the environmental information enterprise, and advice on matters of concern; and

- Improving the global environmental information services enterprise. NOAA is committed to the "open and unrestricted exchange of environmental information worldwide, and [will] seek to improve global opportunities for developing the enterprise."

The partnership policy came into effect in January 2006. Because NOAA is committed to review the effectiveness of the policy every five years, in 2012 the NWS issued a call for comments to the community via the Federal Register in order to gauge the effectiveness of the policy. As of November 2012, it seems that no comments were submitted, which suggests that the community does not consider the partnership policy controversial.

The EISWG will review the NWS's request for comments at their December 2012 meeting.

"The nation benefits from government information disseminated both by Federal agencies and by diverse nonfederal parties, including commercial and not-for-profit entities."

A Vision and Model for NOAA and Private Sector Collaboration in a National Climate Services Enterprise: A Report to the NOAA Science Advisory Board

The NOAA SAB tasked its Climate Working Group and the EISWG to establish the Climate Partnership Task Force (CPTF). The CPTF was charged with developing a model for public-private sector [15] collaboration in the provision of climate services. Specifically, they were asked to:

- Propose a vision and a model for NOAA-industry interaction;
- Identify potential private sector contributions to create effective partnerships in the provision of climate services;
- Identify possible mechanisms for private sector engagement in NOAA's development of new approaches to provide these services;
- Compile a preliminary list of U.S. companies offering climate services and products; and
- Identify applicable lessons-learned from private sector involvement in the weather enterprise.

"NOAA will engage and empower the private sector as a partner in creating climate products and services and delivering them to the nation."

The findings and recommendations of the report[16] capture the following theme: "NOAA will engage and empower the private sector as a partner in creating climate products and services and delivering them to the nation." This is based on an understanding that private sector climate services and products are indispensable to meet growing demand: "NOAA cannot meet the accelerating demand for climate information alone—it must involve the private sector." Further, it argues that a strengthened partnership between the public and private sectors in this area delivers the most benefit to the nation.

The following are some of the Task Force's key observations, relevant to the discussion of structuring the public-private climate enterprise.

- More than 70 U.S. companies are involved in the provision of climate products and services. Their offerings include tailored monthly and seasonal forecasts, analysis of revenue/expense fluctuations owing to weather or climate variability, basic and applied research in climate variability and climate change, and instruments and observing systems for climate monitoring. The companies listed are located throughout the nation, with a large concentration in California, Virginia and Maryland.
- A successful partnership is key for improving the return on investment (ROI), particularly in light of continued fiscal constrains; "private sector success is NOAA success."
- At the root of this effort is enabling open-access to publicly-funded data and developing a system for sustained collaboration – from the development of new products and services, and the integration of private sector observations to augment publicly-funded data, to the transition of private-sector research into the economy.
- The Weather Enterprise serves as a background of success. Despite some tensions, "the private component of the weather enterprise generates some $5 billion in revenue compared to an annual budget of approximately $1 billion for the National Weather Service.

Based on these observations, the recommendations outlined address the following key actions:

- Establishing clear processes. Several recommendations touched upon the need to define a process: for structuring the climate enterprise; for the effective management of data; for public and private sector engagement in addressing specific questions, such as defining roles, priorities, services, products, and clients; for users to identify appropriate sources of products and services; and for educating users about how to understand forecasts, products and

data sets.

- Defining roles without stifling innovation. This is one of the most challenging tasks ahead. A mission statement must be developed "that distinguishes between services delivered by NOAA for the public good and those that are the responsibility of the private sector and the other components of the national climate partnership."

- Effectively managing data. This includes identifying climate datasets and forecasts (including datasets from other agencies), archiving and ensuring the integrity of the data, making it readily available on reliable operational servers. It should also consider how best to balance the need to make publicly-funded data available without compromising its value.

- Attracting private sector collaboration. NOAA should create funding mechanisms to engage the private partners in managing and analyzing climate data sets, developing computer models for predicting climate variability and long-term trends, and designing/ implementing new observational capabilities.

- Incorporating data sets from various sources. This includes surface observations and networks. The goal is to develop a business model that allows partners to share data, as well as the costs of creating, processing and disseminating it.

- Balancing risk. New climate products and services should be undertaken by the private sector, a course that could have positive economic spill-over effects and that would transfer risk away from government.

The final report was released in October 2011. An initial version was presented to the SAB in July 2011. On 15 November 2012, the NOAA response to the CPTF report [see page 15 for a summary] was presented to the SAB. The SAB accepted the response and the EISWG will further discuss at their December meeting.

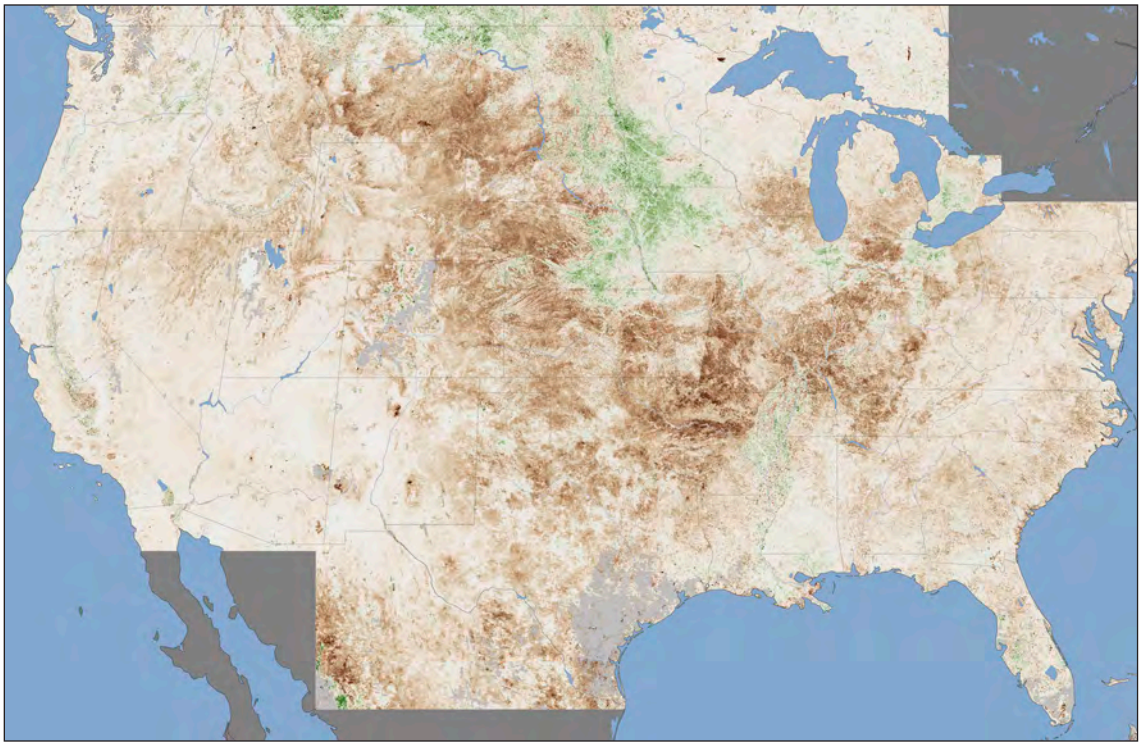


Figure 3. In 2012, 62% of the contiguous U.S. was covered by drought. In this vegetation anomaly map, brown indicates areas with reduced plant growth and cream depitcs normal growth when compared with average conditions between 2002 and 2012. It is based on data from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. Credit: NASA Earth Observatory

Towards an Open Weather and Climate Services

In June 2011, the SAB's EISWG produced a white paper[17] that examines the issues resulting from the broader Weather and Climate Enterprises' (the Enterprise) limited access to NWS weather data. [18] The document proposes a new concept and policy for broader access to NOAA's vast resources of data, with a goal of improving the benefits derived from its exploitation.

The white paper identifies limited access to NWS data as a main obstacle to fully realizing the value of the investment on the NWS and on its ability to fully carry out its mission of protecting life and property and growing the national economy. This is based on the assumption that the value of its information is realized outside of the NWS, within the Enterprise. To address this issue, the document proposes: 1) a data access policy that provides open access to all NWS information; 2) aprivate sector involvement in the design and development of new algorithms and technologies. This approach, captured in the concept of Open Weather and Climate Services (OWCS), engages the private sector much earlier in the data development and delivery supply process than is currently the case.

As fiscal constraints rise and NWS and other NOAA offices are forced to determine what its core capabilities and services ought to be, the white paper argues that the OWCS concept is the key to improving ROI and societal benefits and helping justify further investment in NWS and NOAA; "There may be alternative ways for the NWS and the Enterprise to interact during technology development that will lead to improved solutions for society, without significantly impacting the time or cost to develop the technology."

Two key points summarize the issue of limited access to NWS data:

- The NWS collects and creates valuable information more rapidly than can be practically communicated outside of its domain.

- Limitations in the availability of NWS data are not due to a censoring policy but to practical constraints: NWS lacks the resources to process, store and communicate the copious amounts of data it collects.

NWS is forced to decide on what information to publish by a filtering process of factors like time, parameter and resolution of satellite imagery.

This filtering process is informed by input from the Enterprise on what is deemed to be of the greatest use to the largest percentage of users. Although usually reasonable, it limits the value- adding purposes that can be accommodated, eliminating the possibility that other creative and innovative uses of this data could be explored.

Exchanges between the NWS and the Enterprise during the development and deployment of new information technologies are not optimized to realize maximum value of that new technology.

Because the NWS develops new technologies in semi-isolation before releasing them into service – in what is called a "block change process" – the Enterprise also has limited access and input into the development of new technology.

Without more substantial advanced visibility and hands-on insight into the details and working of new technology, the Enterprise is not able to fully prepare to accommodate and exploit it, limiting its value and the nation's return on this new investment.

A conceptual barrier to more open access results from the idea of being "outside" and "inside" of the NWS. OWCS proposes a different paradigm that implies the idea of side-by-side development. "In this idealized paradigm, the need to filter information transmitted by the NWS is eliminated because there is no longer a need to transmit the information." Although the OWCS will never be fully achievable, the white paper argues that "NOAA should adopt the OWCS paradigm as part of its core philosophy and work to implement it whenever and wherever possible."

A more open development paradigm not only permits full access to NWS data, but also supports improved communication during the development and deployment process of new technologies. This translates into a higher ROI and greater societal benefits as a result of the immediate incorporation of new technologies and their outputs in research and education, as well as their full exploitation once operational.

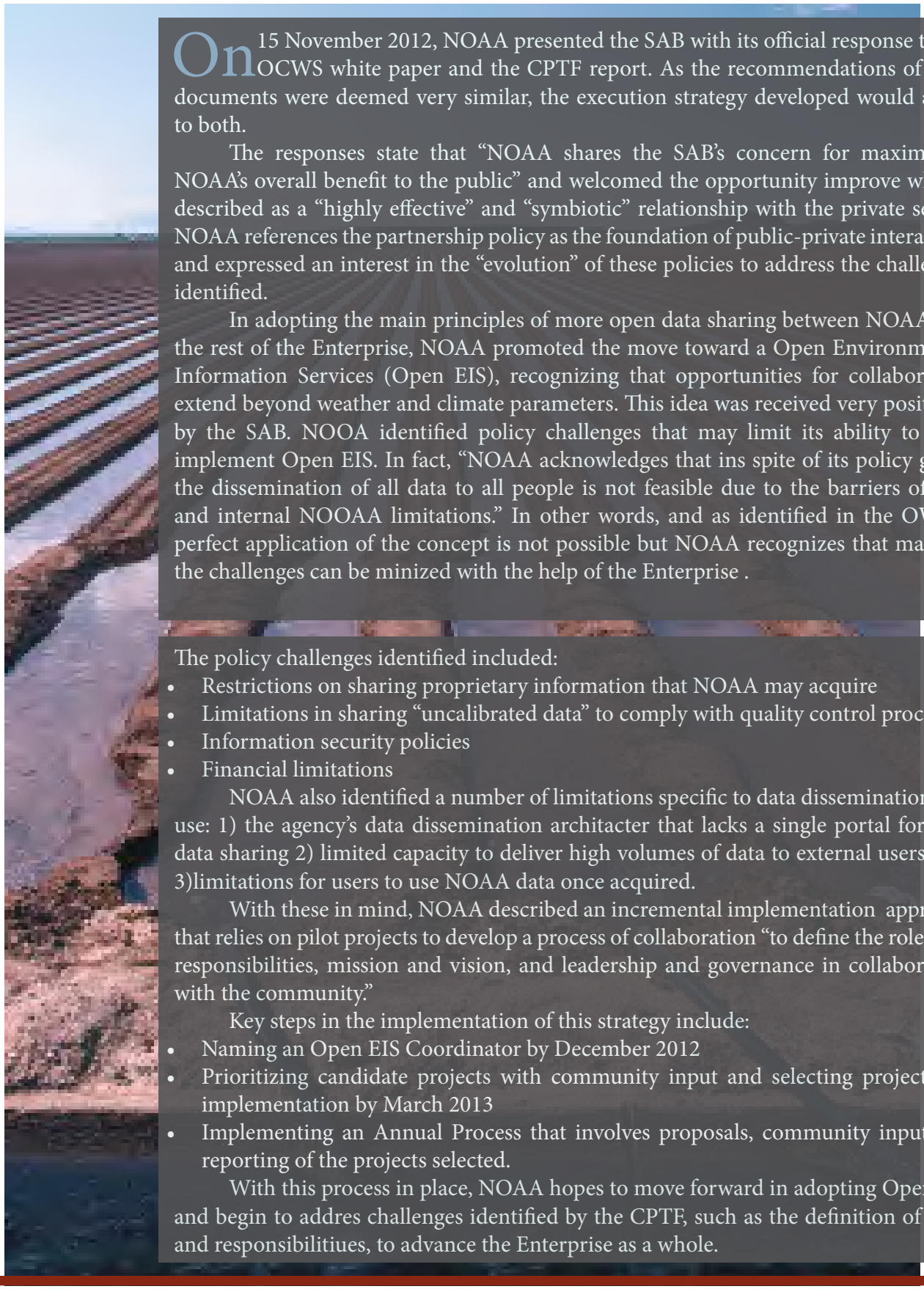
The white paper includes suggestions of different approaches that would enable the implementation of this paradigm, as well as some challenges – such as cyber security, cost, development burden, and fair access – that would need to be addressed. Next steps proposed include a NWS 90-day study of how the concept might be implemented and an action plan with specific recommendations and follow-on actions. This action plan would be adopted within 6-9 months of the release of the paper, or in the December 2011 – February 2012 timeframe.

During its November 2011 meeting, the SAB received the white paper and deliberated on its merits. Board members were strongly aligned with the intentions and concepts of the report and felt that it is appropriate to move forward on its recommendations. The Board has formally voted to accept the report and transmit it to NOAA for review and response. However, the Board echoed many of the challenges identified in the report that NOAA must address in implementing the OCWS paradigm. It therefore requests NOAA to examine the cost, technical, legal, and architectural challenges associated with implementation. This could be done on a case-by-case basis or through pilot projects. The Board also felt strongly that the academic research community along with the U.S. private sector be considered and engaged in this process.

The NOAA response to the OWCS paper was presented to the SAB on November 15th along with the Agency's response to the CPTF. It included changing the name of the initiative the Open Environmental Information Services, issuing a call for pilot projects, and convening an annual conference to better engage the private sector in strategies for realizing OEIS. The SAB accepted the response and the EISWG will further discuss at their December meeting.

"There may be alternative ways for the NWS and the Enterprise to interact during technology development that will lead to improved solutions for society, without significantly impacting the time or cost to develop the technology."

NOAA RESPONSE TO SAB REPORTS



On 15 November 2012, NOAA presented the SAB with its official response to the OCWS white paper and the CPTF report. As the recommendations of both documents were deemed very similar, the execution strategy developed would apply to both.

The responses state that "NOAA shares the SAB's concern for maximizing NOAA's overall benefit to the public" and welcomed the opportunity improve what it described as a "highly effective" and "symbiotic" relationship with the private sector. NOAA references the partnership policy as the foundation of public-private interaction and expressed an interest in the "evolution" of these policies to address the challenges identified.

In adopting the main principles of more open data sharing between NOAA and the rest of the Enterprise, NOAA promoted the move toward a Open Environmental Information Services (Open EIS), recognizing that opportunities for collaboration extend beyond weather and climate parameters. This idea was received very positively by the SAB. NOOA identified policy challenges that may limit its ability to fully implement Open EIS. In fact, "NOAA acknowledges that ins spite of its policy goals, the dissemination of all data to all people is not feasible due to the barriers of cost and internal NOOAA limitations." In other words, and as identified in the OWCS, perfect application of the concept is not possible but NOAA recognizes that many of the challenges can be minized with the help of the Enterprise .

The policy challenges identified included:

- Restrictions on sharing proprietary information that NOAA may acquire
- Limitations in sharing "uncalibrated data" to comply with quality control process
- Information security policies
- Financial limitations

NOAA also identified a number of limitations specific to data dissemination and use: 1) the agency's data dissemination architacter that lacks a single portal for easy data sharing 2) limited capacity to deliver high volumes of data to external users, and 3)limitations for users to use NOAA data once acquired.

With these in mind, NOAA described an incremental implementation approach that relies on pilot projects to develop a process of collaboration "to define the roles and responsibilities, mission and vision, and leadership and governance in collaboration with the community."

Key steps in the implementation of this strategy include:

- Naming an Open EIS Coordinator by December 2012
- Prioritizing candidate projects with community input and selecting projects for implementation by March 2013
- Implementing an Annual Process that involves proposals, community input and reporting of the projects selected.

With this process in place, NOAA hopes to move forward in adopting Open EIS and begin to addres challenges identified by the CPTF, such as the definition of roles and responsibilitiues, to advance the Enterprise as a whole.

American Meteorological Society's (AMS) Climate Services Statement; AMS Commission on the Weather and Climate Enterprise (CWCE)

On 10 August 2012, the AMS Council adopted a new policy statement on climate services, which aimed to characterize the benefits of these services both to the United States and to the world as well as identify ways to foster and improve their delivery. The statement recognized that the CSE "comprises a wide variety of entities," where NOAA provides the core capabilities, and other entities, including other federal agencies, universities, NGOs and private businesses, play different roles in development and delivery.

With respect to the roles of the different actors, it states that:

> *The roles of the public, private, and academic sectors in [climate services] are sometimes difficult to distinguish. Strong relationships and frequent communication among sectors are essential to ensure that responsibilities are coordinated, unnecessary redundancies are minimized, and issues among members of the enterprise are resolved effectively.*

In its recommendations, the statement discusses general guidelines for appropriate public-private sector roles, where federal and state governments continue to assume responsibility for maintaining basic systems, universal access to information, providing information for the benefit of society, etc., and where the private sector is in charge of developing new products and responding to specific requests for services. The recommendations point to a collaborative process between them where the private sector makes recommendations as to government research agendas and funding priorities. Universities and other entities play a key role in education, while all members engage with users, identify needs and opportunities and collaborate with each other. The final recommendation describes an AMS commitment to maintain a list of climate service providers and to develop initiatives that foster closer ties among providers and users.

Other relevant developments within the AMS in this area are linked with its Commission on the Weather and Climate Enterprise (CWCE), established in 2007. The CWCE engages a broad community of private, public and academic stakeholders in a discussion on the most pressing needs facing the enterprise and how these may be addressed in unison.

"The enterprise is working - based on NOAA's foundational forecasts and private sector development."

OBSERVATIONS OF CSE THOUGHT LEADERS

Above: Captured by the MODIS instrument on NASA's Aqua satellite on 9 November 2012, this satellite image shows the snow cover left by a wintery nor'easter storm that landed on the region just days after Hurricane Sandy. For many of the millions only beginning to recover from the storm, the snow brought a whole new set of complications. Credit: NASA Earth Observatory

In adition to the developments discussed in the previous section, IGES conducted a series of interviews with key NOAA/NCDC officials and private sector representatives to gain addiitonal insights on how NOAA might forward with the CSE. [The list of questions developed for these interviews is included in Appendix A.] The following section describes observations derived from this work.

1. The NOAA partnership policy is sufficient to guide the public-private partnership in the provision of climate services.

The community representatives interviewed agree that the NOAA partnership policy will continue serving as the foundation for NOAA-private sector interaction in the provision of climate services. Speaking about the context that led to the inception of the 2006 policy, one NOAA official described it as "forward-looking" in its ability to acknowledge that the agency is an important information provider beyond weather.

When asked whether the policy, which counts both weather and climate under the umbrella of environmental information, is appropriate to address questions arising from the climate angle, private sector representatives said that it is "the foundation," and "robust enough" to guide this relationship. A NOAA official intimately involved in the implementation of the policy said that this stems from the fact that the policy is based on "thoughtful decisions" made on a case-by-case basis, a dynamic that offers a more "pragmatic and "adaptive strategy" than drawing lines in the sand between the actors.

The literature on this subject and the statements of other groups suggest that pending issues regarding public-private collaboration will be addressed in practice through open dialogue and participation between NOAA and the private sector and need not be captured in the partnership policy. The seeming lack of interest to comment on the policy during the NOAA review process in 2012, suggests that substantive changes may not be considered until the policy is actually tested by the partners in the provision of climate services. For the time being, the policy is deemed to be flexible enough to withstand scientific and technological advancements that may cause responsibilities to shift while setting the core principles guiding the public-private relationship.

2. Though coupled in practice and policy, similarities and differences between weather and climate services may be critical to navigating a successful climate services partnership

The NOAA partnership policy, the NRC Fair Weather Report and other key documents and statements rarely draw a distinction between weather and climate information and instead refer to environmental information. Although obviously linked, differences between these phenomena may prove directly relevant to debates over how to structure the CSE and specifically over how the public and private sector interact to deliver these critical services.

A contrast in products and product development

For many in the community, this distinction begins with the products themselves. [19] One private sector representative put it in terms of scale: the sheer volume of data necessary to produce the analytics of climate products is in sharp contrast with those required to develop weather products. The focus on data quality, data preservation and access to historical data as fundamental to the development of useful products is also another distinction.

A clearer delineation is possible by considering the timelines of interest to the user of climate information. A weather information user is interested in information and predictions ranging from the immediate present and out to two weeks. The timeline of interest for a climate information user, on the other hand, is a lot broader, covering anything from past climate and present climate to future climate. When defined as anything beyond the two-week window, therefore, it becomes clear that climate services will appear in an incredibly more complex variety than already exhibited in weather. [Figure 4]

Figure 4. This figure captures the inextricable link between weather and climate while showing the stark difference in scope between their products.

This discussion of how to define weather and climate is not just semantic; it may prove to be directly relevant to how the partners interact. It forces the question: How are weather and climate similar or different in terms of he practices and policies used to develop and deliver services to the users? For example, products focused on analysis of the historical record, such as 30-year climate normals or analysis of the climate of the previous ice age, will not be developed in as routine a fashion as the products focused on shorter time spans. In contrast, NOAA and its partners could successfully draw from the parallel development of routine products of shorter time spans, such as daily or weekly for weather forecasts and monthly or seasonally for climate projections. The point here is to highlight the importance of considering that differences in scope – of both data and period of interest – may lead to different expectations between the public-private partners.

How are weather and climate similar or different in terms of the practices and policies used to develop and deliver services to users?

Different levels of maturity

The comparison between weather and climate services usually leads to comments about the stark differences in the maturity of these markets. Private sector representatives described the climate sector as "substantially immature" and "not robust" when compared to the state of the weather sector. One participant suggested that the best evidence of this immaturity was his inability to name the top companies providing climate services, whereas he could easily name the top weather information providers.

This is not a permanent state of course, but one that comes to bear when it comes to the ability of private companies to take advantage of business opportunities. In particular, it highlights the difficulties in convincing outside stakeholders and customers of their need of climate services. According to one

participant "[weather] enterprise-wide thinking is in a real state of maturity" and stakeholders readily understand the benefit of weather information. Climate, in contrast, "is a tougher sell," since there is less understanding of what it means and there is not a clear and coherent message from the community.

This infancy also leads to the existence of blurred lines of responsibility between actors. As one participant phrased it "[these] roles are not understood in climate because applications are still trying to be figured out." The question of who should do what is not evident because it is unclear who can do what. Beyond the initial CPTF survey of climate services/product providers mentioned before, there has not been a comprehensive survey of the existing players in this developing market and what their offerings are. Will there be competing sources of climate information as there are in weather? Or will considerably larger computing requirements prove a disincentive and the private sector continue to rely almost exclusively on government and academic sources of data? At this point, answers to questions like these are simple speculation.

"[Weather] enterprise-wide thinking is in a real state of maturity."

"Roles are not understood in climate becaue applications are still trying to be figured out."

For some, this question of capability suggests that the frictions arising from the public-private partnership may, in fact, turn out to be different from those experienced before: "I'm not convinced that aggregate capacity is enough to meet the country's needs," said one NOAA official. Competition, he explained, may result from different actors assuming duplicate roles but "if the country's needs are bigger than all of us combined, [then] there's a problem."
The following table captures some of the distinctions denoting different levels of maturity between the sectors. As the CSE matures, some of these may prove to be persisting differences between weather and climate.

Additional distinctions between weather & climate services market		
	WEATHER	**CLIMATE**
BUSINESS REQUIREMENTS	Well-defined	Varies by sector
USER EDUCATION	Advanced	Varies by sector
SCOPE OF DATA	Short-term (0 hours - 2 weeks)	Historical, Trend analysis, Short term (2 weeks-1 year), Long term (intraseasonal - 1year+)
OBSERING SYSTEM/ OPERATORS	Government, Growing business market	Government, Academia
DISTRIBUTION MECHANISM	Government, Established business market	Government, Academia, Research, Emerging business market
PUBLIC-PRIVATE ROLES	Well defined, Continually tested	Not well communicated, Untested
ENTRY POINTS	Well defined	Undefined, Untested

3. Climate service providers face a unique challenge in communicating the benefit of their products to potential users.

It is no surprise that for many, discussions involving the provision of climate services inevitably bring to mind contentious issues related to climate change. This has prompted new ways to talk about climate – such as long-term forecasting information, inter-seasonal projections – and to frame the issue in terms of the kind of decisions that can be supported by these products and services. One NOAA official said that the agency is learning to have different conversations with different communities, ones that begin with the question: What does this community value? In this evolving conversation, which needs to be informed by more input from the social sciences, meaningful subjects such as seasonal variability, disaster preparedness and economic development take center stage.

For the time being, this challenge to make climate more relatable also impacts the business opportunities for private actors moving into this sector. There is a lack of user education in many user communities both in the kind of services and information they need to make improved decisions, but also on what is already available. For example, despite indications that the financial services sector is already a large business area for climate services, there are still challenges in reaching users within this community, "usually because institutions are unaware of its availability or are unfamiliar with how to use it." [20] This lack of understanding goes both ways, where the providers are also unaware of the needs of some of their users. Again drawing attention to the financial services sector, Altalo et. al (2004) expand on this point: "Institutions supplying weather, climate and other environmental data are not always conversant with the needs of the financial services sector, so there is in many cases a disconnection between the suppliers and the end-users of this information." However, NOAA, through stakeholder dialogues, has devoted much time and effort to reaching the financial services sector to better understand such needs.

This is one area where the merging of weather and climate seems to act as a disincentive. According to several of those interviewed, users already purchasing weather products often question why they would need climate products at all as they expect weather and climate products to provide very similar kids of information. One private sector representative described it as having the customers say "just give me the number," expecting the same level of accuracy of prediction and not understanding key differences in levels of uncertainty.

This condition presents a challenge both for emerging private sector providers and for NOAA as both address the gap between real and perceived benefits of these services. To address this need and improve the development of user-oriented information products and services, NCDC reaches out to 12 different user communities – ranging from agriculture and forestry to tourism and litigation – as part of its User Engagement Activities. [21] The goal is to establish a two-way communication between NOAA and different user communities to communicate the services already available to users and inform the user-oriented development of products. While NCDC views it as a way to focus limited resources and ensure it is carrying out its mission, some private sector representatives believe that this is not an appropriate role for the agency and that this kind of targeted outreach should be in the sole purvey of the private sector. Although the answer to this debate is beyond the scope of this report, the point is to draw attention to an issue that must be addressed by the partners.

Of particular relevance to the Enterprise is therefore the important question of how to educate user communities about climate, their climate needs and the availability and appropriate use of services and products and, perhaps more importantly, who should be tasked with doing so.

4. An impediment to providing climate information services is gaining access to and using NOAA data and models.

Several private sector representatives expressed frustration in their ability to find and use NOAA climate data and models for the development of products and services. They said that "keeping track of new data is difficult," described it as a "discovery process" and that it was akin to stumbling across new sources. This element of ignorance was called out as one the biggest impediments to taking advantage of NOAA data and information: as one phrased it, "how can we use it if we don't know it exists?"

Fortunately, the OWCS concept described before is deemed to be a large part of the solution. Its adoption could serve different functions, including drawing the full benefit of investment in NOAA as the private sector finds new innovative uses of this information. As noted in the NRC Weather Services for the Nation report, "In the face of government budget pressures, it is conceivable that the non-NWS elements will provide most of the overall enterprise growth over the next decade." This open access to information could ease the road toward a successful CSE. As a private sector representative involved in the development of the concept said, this issue of accessibility of data is a "foundational building block for the establishment of the enterprise."

5. Public-private partner roles are largely undefined.

While this point has been alluded to before, it is important to highlight that there is ongoing debate about what the appropriate roles should be in the provision of climate services. The issue of who should provide the tailored products to specific users or industries and whether that results in unintended competition is probably the most contested issue.

For some within the private sector, applications that benefit specific vertical markets should not be within the purview of the agency, in part because the government is not equipped to address the nuances of those markets: "that's where the private sector excels," said one private sector representative. Yet some within NOAA believe that some of these applications are just a result of improvements in how the agency carries out its mission. "If we can improve it, we can't stop," said one participant, adding that "it's not as simple as 'take the observations, run the models and get out of our way.'" To the extent that this uncertainty exists, the agency may incur in well-intentioned action that can be misinterpreted to be competition. [22]

Even if those lines were clearly drawn, it has not yet been defined how NOAA should refer potential users to private sector providers when serving those needs went beyond its mandate. One participant described a scenario in which the government tells a potential customer to seek out the service they require in the private sector before wondering, how do they refer somebody? Is it appropriate for NOAA to maintain a database of commercial providers? "There are no easy answers," he concluded.

One clear lesson from the development of the Weather Enterprise is that the public-private roles must not be strictly drawn but should instead be defined in a way that permits their evolution. The benefit is that instead of fighting it out first, the CSE could benefit from the opportunity to engage in a meaningful discussion about appropriate roles early on.

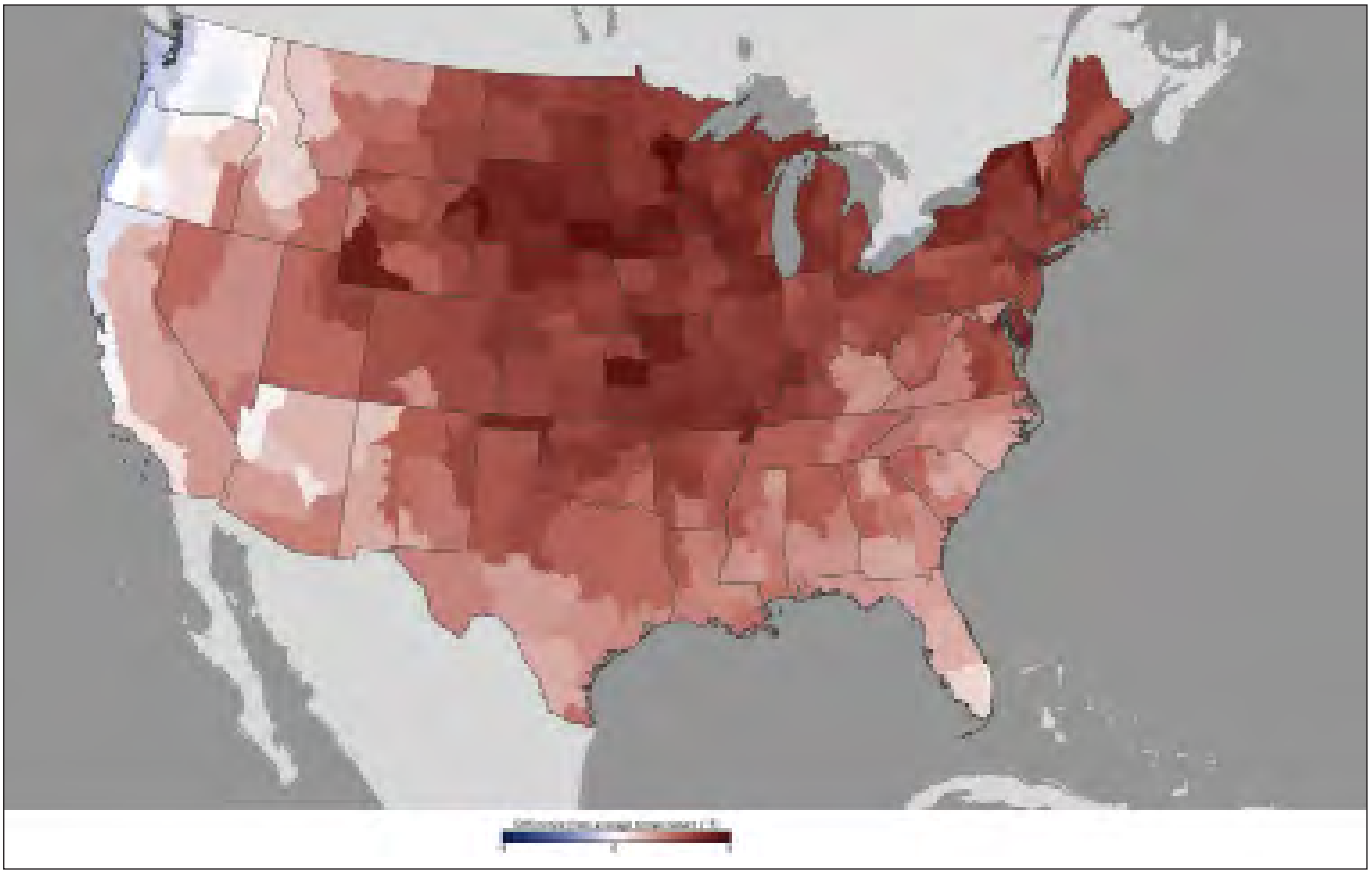
6. Attribution guidelines for data could reduce tensions.

Even as the as details continue to be fleshed out over appropriate roles, the community agrees that one of NOAA's fundamental responsibilities lies in serving as a foundational data source. One NOAA official described it as tied to the agency's core missions and said that, at a minimum, providing observations and models, data stewardship and interpretation will continue being a government role. According to a private sector representative, this role of providing "good, sound data," which stems from the agency's stewardship responsibilities is a key step in making climate services better for everybody.

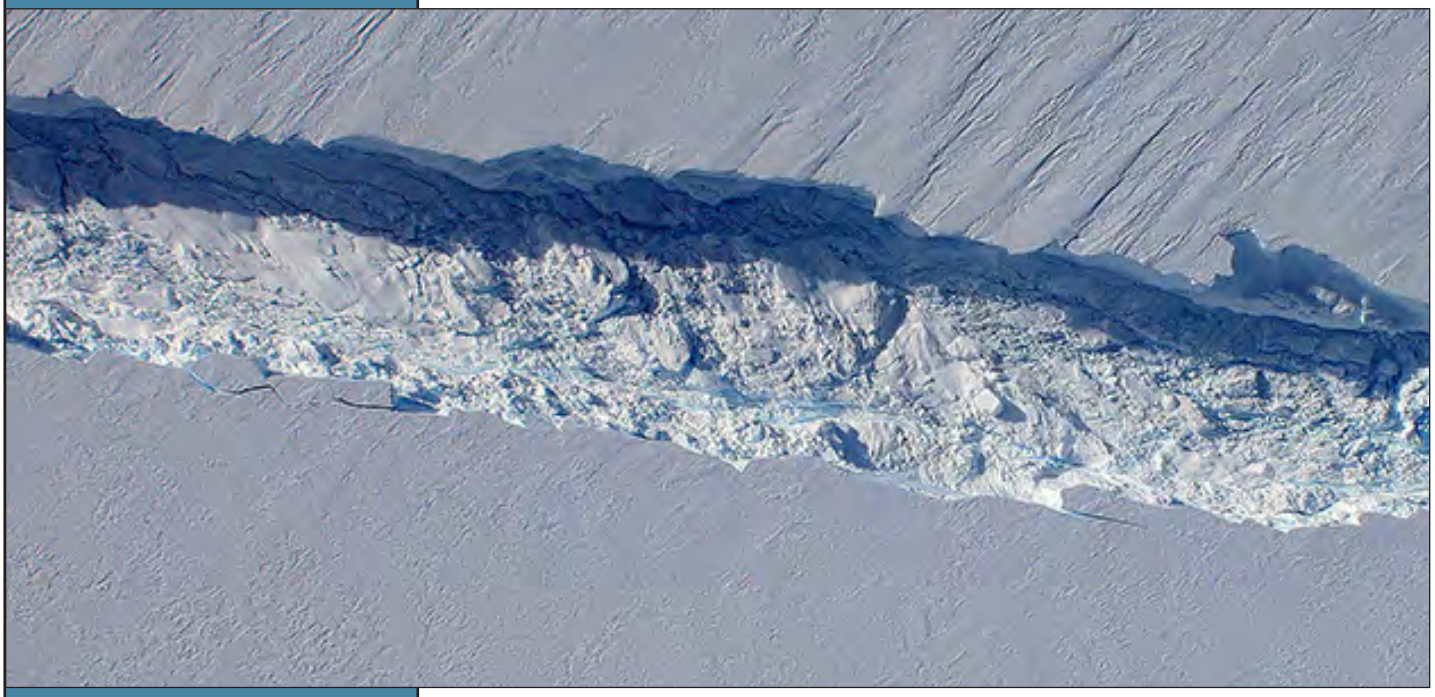
In order for the agency to do that and to facilitate the development of applications in the private sector, private companies must be more vocal about whythey need NOAA, a sentiment that was expressed by several participants. One interviewee said that the private sector must make it clear that the "private sector does not exist without NOAA" and that the agency is the "backbone of the weather and climate enterprise." As described in the NRC Weather Services for the Nation report: "…while the NWS is only one part of the overall weather, water, and climate enterprise, the enterprise as a whole would crumble without the core infrastructure and capabilities the NWS provides." This should be clearly communicated to outside stakeholders if the CSE is to grow and prosper.

"The private sector does not exist without NOAA."

Below: October 2012 ended a 16-month streak of above-average monthly temperatures. In this map, shades of red indicate temperatures up to 5° Fahrenheit warmer than average, when compared to 1981-2012 averages. Source: NOAA/ Climate.gov



MOVING FORWARD



Above: This is a close-up of a crack spreading across the ice shelf of Pine Island Glacier in Antarctica. Scientists expect the crack to continue propagating and the ice shelf to calve, creating an iceberg roughly the size of New York City. This image was taken on 26 October 2011 by the Digital Mapping System (DMS) as part of NASA's Operation Ice Bridge mission. Credit: NASA/DMS

In its Weather Services to the Nation report, the NRC stated: "the greatest national good is achieved when all parts of the enterprise function optimally to serve the public and businesses." This statement applies not just to weather but also to a burgeoning CSE. As the need to better understand long-term trends and how these are changing continues to grow, it is clear that managing risks and taking advantage of opportunities will depend on the success of integrating both public and private capabilities in the provision of climate services.

As this assessment demonstrates, NOAA and private sector stakeholders have taken meaningful steps to initiate discussions about how to structure the CSE. Of particular interest is the debate over how the public and private sector will interact in the provision of these services. After taking a step back to consider other models that have been applied around the world, this study agrees with the basic assumption of recent reports and statements that have considered the issue: *that the existing model of cooperation in the provision of weather services should be expanded and adapted to advance climate services.* By considering common assumptions and concerns in these developments, as well as incorporating input from interviews with key stakeholders, this study has drawn a number of relevant observations, described in detail in the previous pages.

If NOAA is to assume a leadership role in bringing together lessons-learned from these separate efforts, the following conclusions will be critical moving forward:

- Consider the similarities and differences of climate and weather services.

- Derive specific lessons that can be applied from the Weather Enterprise experience and recognize that some aspects of the CSE may evolve in a different direction.

- Identify how the Enterprise can address critical education and communication issues, specifically:

  - Lack of public understanding about climate – Climate may require a different strategy when it comes to communicating needs and benefits. The private sector, academia (including social scientists) can play a larger role in fostering awareness.

  - Lack of user education about climate services – User education requires particular emphasis, both from public and private sector providers of data and services.

- Advance OWCS concept to improve private sector access to NOAA data.

- Develop attribution guidelines that help communicate NOAA's critical role as a foundation of the overall Enterprise.

- Continue to engage the private sector. Open participation between the partners will be key moving forward.

Tied into all of these conclusions is an understanding that many of the most relevant questions are still unknown because of the immaturity of the market. NOAA should take concrete steps to assess the capabilities and challenges of private sector providers to better understand how to facilitate the CSE. Greater understanding of what the private sector can offer and ongoing engagement between the partners will not only allow that issues of contention be resolved without impairing the growth of the Enterprise but will also be fundamental in ensuring the Enterprise's ability to meet the climate information needs of the nation.

NOTES

1. "Economic cost of weather may total $485 billion in U.S.," (21 June 2011) AtmosNews: http://www2.ucar.edu/news/4810/economic-cost-weather-may-total-485-billion-us
2. "Billion Dollar Weather/Climate Disasters" NOAA/NCDC: http://www.ncdc.noaa.gov/oa/reports/billionz.html
3. A discussion that prompted several editorials and articles in the aftermath of the storm involved assertions that the U.S. has fallen behind in storm forecasting, noting that a model from the European Center for Medium-Range Weather Forecasts was more accurate and days ahead of any U.S.-produced hurricane model.
4. L. Morello (8 December 2011) "NOAA Chief: 2011 Weather Was 'Harbinger of Things to Come,'" Scientific American: http://www.scientificamerican.com/article.cfm?id=noaa-chief-2011-was-harbi
5. According to the AMS, climate services are defined as "scientifically based information and products that enhance user's knowledge and understanding about the impacts of climate on their decisions and actions." See "Climate Services: A Statement of the American Meteorological Society" (10 August 2012) https://www.ametsoc.org/policy/2012statement_climate_services.html
6. See "A Climate Service in NOAA" NOAA: http://www.noaa.gov/climate.html
7. *A Vision for Climate Services in NOAA* (2010) p.16: http://www.climate.noaa.gov/pdf/GandPdocumentOct21.pdf
8. Page 218 of the H.R. 2112 conference report states that "The conference agreement does not establish a NOAA Climate Service as proposed by the Senate." Available at: http://www.gpo.gov/fdsys/pkg/CRPT-112hrpt284/pdf/CRPT-112hrpt284.pdf
9. Committee on the Assessment of the National Weather Service's Modernization Program; Board on Atmospheric Sciences and Climate; Division on Earth and Life Studies; National Research Council, *Weather Services for the Nation: Second to None* (The National Academis Press: 2012): http://www.nap.edu/catalog.php?record_id=13429
10. Learn more at: http://www.cicsnc.org/projects/nancy-colleton.html and http://strategies.org/environmental-information/stakeholder-engagement-climate-information/
11. In her study of international land remote sensing laws and policies, Grabynowicz notes that: "In Europe, for example, the term "commercial" means to generate revenue, and it applies to any entity that does so, regardless of by whom.69 In the U.S., the term "commercial" means a private sector activity, and in general, is not applied to government activities." J.D. Grabynowicz, *The Land Remote Sensing Laws and Policies of National Governments: A Global Survey.* U.S. Department of Commerce/ NOAA's Satellite and Information Service Commercial Remote Sensing Licensing Program: 2007) page 15: http://www.spacelaw.olemiss.edu/resources/pdfs/noaa.pdf
12. Adapted from D. Rogers and V. Tsirkunov, "Managing and Delivering National Meteorological and Hydro-meteorological Services" (Global Facility for Disaster Reduction and Recovery: 2011): http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/Managing_Delivering_National_Meteorological_Hydro-meteorological%20Services.pdf
13. "Policy on Partnerships in the Provision of Environmental Information" NOAA:

http://www.noaa.gov/partnershippolicy/

14. Committee on Partnerships in Weather and Climate Services, Committee on Geophysical and Environmental Data, National Research Council, *Fair Weather: Effective Partnerships in Weather and Climate Services* (The National Academies Press: 2003): http://www.nap.edu/catalog/10610.html
15. In this report, "private sector" stands exclusively for industry and does not academia because NOAA climate research already enjoys strong ties with academia in the development of products and services.
16. Available online: http://www.sab.noaa.gov/Reports/CPTF_RPT_FINAL.pdf
17. Available online in the reports section of the NOAA SAB website: http://www.sab.noaa.gov/Reports/Reports.html
18. Though the focus is on the NWS, the concept and policies proposed are directed to the whole of NOAA activities.
19. For some, this distinction is not appropriate because products use both kinds of information. One participant said that "weather and climate need to be merged" and that "trying to take them apart is inadequate" because the decision-support tools his company develops require both a short-term and long-term outlook.
20. M.G. Altalo, C. Summerhayes, N. Flemming and P. Bernal, (2003) "Demand side 'pull' for EuroGOOS products: identifying market and policy decisions impacted by new environmental information," In, Dahlin, H., Flemming, N.C., Nittis, K. and Petersson, S.E. (eds.) Building the European capacity in operational oceanography. Proceedings of the Third International Conference on EuroGOOS, 3-6 December 2002, Athens, Greece. 3rd International Conference on EuroGOOS Amsterdam, The Netherlands, Elsevier, 409-421.
21. See "User Engagement Activities at the National Climatic Data Center," NOAA/NCDC: http://www.ncdc.noaa.gov/oa/userengagement/userengagement.html
22. Others within the private sector do not see "competition" from NOAA as a negative thing at all. "Competition is good, healthy" said one participant.

APPENDIX A

Below is a list of sample of questions that were discussed during the interviews with stakeholders.

1. How are climate and weather different from a services perspective and from the standpoint of the customer?

2. Is it counterproductive that weather and climate have been treated jointly in the past?

3. In your experience, what, if anything, can be learned from the weather services model that would apply to the Climate Services Enterprise?

4. Do you think NOAA's current practices are sufficient for you to gain access to the base data to develop your products and services?

5. What do you think should be NOAA's next step to facilitate your company's use of climate information and involvement in this process?

6. How mature is the distinction between public and private-appropriate roles in the provision of climate services? Will it come up against the same challenges that weather did in the past?

7. The issue of visibility also arises in climate as it does in weather. How clear is it to the public and the policymakers what roles the actors all play?

8. In the set of activities that begins with the development of systems for data collection and ends with the delivery of actionable information, where do you see your company playing a role?

9. What are the current obstacles you see in realizing a successful climate service model?

10. What are the main challenges in engaging the user communities?

APPENDIX B

SOURCES INFORMING THIS ASSESSMENT