Options for Developing a National Climate Service

A Report from the Climate Working Group of the NOAA Science Advisory Board

(as developed by the Climate Services Coordinating Committee

With option assessments provided by four Tiger Teams)

April 22, 2009

Preface

The role of government agencies in the provision of climate services has been recognized since Congress passed the National Climate Program Act of 1978, which established a network of regional climate centers (RCCs) and resulted in the creation of the Climate Analysis Center (the center's name was subsequently changed to the Climate Prediction Center). In 2000, the Office of the Federal Committee for Meteorological Services and Supporting Research asked the Board on Atmospheric Sciences of the National Research Council to address the next steps in creating a more formal climate service (*A Climate Services Vision*, NRC, 2001). This request recognized that "the provision of climate services was evolving rapidly in response to the combination of a growing knowledge base, a growing appreciation of the importance of climate in human endeavors, and a greater demand for climate information." In 2008, NOAA developed a *Draft Strategic Plan for a Climate Service*. NOAA's Science Advisory Board (SAB) and its subordinate Climate Working Group (CWG) sought advice on NOAA's plan during a June 2008 workshop, consisting of over 80 participants largely external to NOAA and representing a wide range of sectors and backgrounds.

The review team commended NOAA on its efforts to a develop climate service but also concluded that the draft plan did not appreciate the breadth and depth of users, partnerships, and applications of a climate service. The study group report recommended the establishment of external Tiger Teams to evaluate four different options for developing a National Climate Service and the SAB endorsed this recommendation. In response, the CWG established two types of committees, a Coordinating Committee and four "Tiger Teams," that would work together to examine each option and develop an integrated report. This effort was designed to provide a new report entitled *Options for Developing a National Climate Service.* This effort was placed on a fast track, to enable a new administration to make well-reasoned choices on the development of a National Climate Service. The Coordinating Committee and the Tiger Teams were charged with identifying the pros and cons of <u>four specific options</u> for developing a National Climate Service:

1. Create a national climate service federation that would determine how to deliver climate services to the nation
2. Create a non-profit corporation with federal sponsorship
3. Create a national climate service with NOAA as the lead agency with specifically defined partners, and
4. Expand and improve weather services into weather and climate services within NOAA

The charge to the Coordinating Committee consisted of four tasks:

1. Provide 6 to 10 compelling examples that will communicate the potential scope of climate services and demonstrate actionable outcomes from climate information. The objective of this task was to communicate why a climate service is needed and to indicate the breath of potential societal benefits. The Committee produced a series of short examples based on presentations at the June 2008 workshop in order to demonstrate the breadth of potential users of a climate service and to indicate that information will be actionable by a wide variety of decision makers. Designed as an introduction as to why a climate service is needed, this section barely scratches the surface in communicating the compelling need for a national climate service.

2. Provide a definition of climate service. The Coordinating Committee answered this call by articulating the vision, mission, and key attributes of a climate service.

3. Provide an analysis of each of the four specific options stated in the charge to the Coordinating Committee, with a Tiger Team assigned to address each option. The Coordinating Committee was explicitly asked not to select an option, but rather to weigh the pros and cons of each option against 12 guiding principles developed in the June 2008 workshop. The analysis of the pros and cons was not intended to be exhaustive, but rather sufficient to elucidate the ability of each option to address the listed set of objectives and goals of the service. To a large extent, the Coordinating Committee and Tiger Teams fulfilled this charge, but there are distinct weaknesses in the report that stem from (a) the urgency of the effort to assess alternate models (options) for the provision of the services prior to initiating efforts to "design" components of a National Climate Service and (b) the fact that small Tiger Teams cannot sufficiently represent the breadth and needs of user groups. To be more specific: First, this report fails to define the roles of different federal agencies in a National Climate Service. Despite diverse agency representation at the June 2008 workshop and on the Coordinating Committee and Tiger Teams, there was great reluctance to explicitly define the interactions between agencies and the contributions of each relevant agency. Second, the committees were charged with defining an evolution (implementation) from targeted user groups, as a mechanism of evaluating the strengths of the four different options. However, the small Tiger Teams included a few representatives from different user groups. Because each Tiger Team couldn't include representatives from the same sectors or same user groups, as well as a range of sectors, it was not possible to provide a consistent end-to-end analysis of the same sectors by each Tiger Team. Therefore, the committee was unable to compare the implementation of each of the options from this perspective. This is a clear short-coming of the report.

4. Define performance and success criteria for each option, including input and output, and outcome and impact metrics. The Coordinating Committee developed its recommendations from guidance in the NRC (2005) report *Thinking Strategically: The Appropriate Use of Metrics for the Climate Change Science Program.*

Although imperfect, this report fulfills an important purpose. It stresses the importance of a set of principles and guidelines in developing an effective climate services and it demonstrates that each of the four options has weaknesses and strengths in its ability to address the guidelines. Most importantly, the evaluation was designed to assist the administration in its selection of a model for the provision of climate services to the Nation, without being proscriptive. However, much additional work will be required to develop a comprehensive implementation plan once a model for the National Climate Service is established. In particular, the selection of a specific model will enable a careful analysis of its implementation, and consideration of a host of additional important characteristics including the role of a climate service in an international arena, the specific roles and needs of diverse federal agencies, and specific mechanisms that ensure active engagement of stakeholders.

Eric J. Barron, Chair Coordinating Committee

Executive Summary

At the present, our nation lacks the capability to provide the diverse range of climate information that could beneficially serve society. While many elements of the information needs could be met by combining the products of many agencies and organizations, there is currently no single source of authoritative, credible and useful information that will allow society to span such important topics as the physical aspects of sea level rise, temperature and precipitation, the resource implications of failed crops, anticipating adverse human health outcomes, robust water resource supply, managing changes in ecosystems, or the social implications of migrations and resource competitions. A National Climate Service will dramatically increase our ability to respond to the challenges that are currently limited by the difficulty in obtaining data, predictions, and syntheses across such a broad span of sectors and regions. The Climate Service will be utilized by decision-makers to promote economic vitality, promote environmental stewardship and sustainability, and protect life and property. It has the potential to enable us to avoid many costly mistakes in both adaptation and mitigation policies. It has even greater potential to promote a broad set of societal benefits, many of which are not yet recognized. In summary, the potential benefits of a robust National Climate Service are enormous.

The objective of this report is to provide a framework for the development of a successful National Climate Service by assessing options or models for climate services in the United States. This report follows the recommendations of the *Climate Services External Review Report* (July 15, 2008) which suggested that NOAA lead an effort, with its partners, to compare and contrast specific options for the development of climate services based on an assessment of how these options satisfied twelve guiding principles for a robust and successful service.

In fulfilling this request, NOAA established four Tiger Teams (one per option) and a Coordinating Committee to examine the pros and cons of four options:

1. a national climate service federation that would determine how to deliver climate services to the nation
2. a non-profit corporation with federal sponsorship
3. a national climate service with NOAA as the lead agency with specifically defined partners, and
4. a weather and climate services within NOAA developed from an expanded and improved weather services

This report is the product of the work of these teams of individuals. The Coordinating Committee, supported by four Tiger Teams, each assigned to a specific option, was charged with addressing:

Part 1. Why a climate service is needed, by providing 6 to 10 compelling examples that would show how climate services will produce actionable outcomes and serve a breadth of users.

Part 2. The definition of a climate service.

Part 3. How a climate service should be implemented, based on an analysis of the pros and cons of each option compared with 12 guiding principles and objectives.

Part 4. How success will be judged.

The Coordinating Committee developed a vision, mission and set of key characteristics, that when combined with the 12 guiding principles, should guide the development of a Climate Service.

> **Vision:** The National Climate Service will provide information to the nation and the world to assist in understanding, anticipating, and responding to climate, climate change, and climate variability and their impacts and implications.
>
> **Mission:** The Service will inform the public through the sustained production and delivery of authoritative, timely, and useful information to enable management of climate-related risks, opportunities and local, state, regional, tribal, national, and global impacts.
>
> **Key Attributes:** The Service will achieve its mission by promoting active interaction among users, researchers, and information providers. The Service will be user-centric, by ensuring that scientifically-based information is accessible and commensurate with users' needs and limitations. The Service will provide such usable information and enable development of decision support tools through a sustained network of observations, modeling, research activities, and user outreach and assistance.

Findings and Recommendations

The *Climate Services External Review Committee* listed a series of principles and objectives that are characteristics of a successful climate service. The Tiger Teams completed an analysis of the pros and cons for each Option based on this set of guiding principles as a way of informing decisions in the development of a National Climate Service. The Coordinating Committee utilized this information to compare each option and form the conclusions of this report.

Finding 1. Each of the four options has significant strengths and weaknesses. None of the options analyzed was viewed as an ideal description of a National Climate Service.

Finding 2. The greatest strengths of the federated options are their flexibility and nimbleness (especially the non-profit option), ability to connect and actively engage a broader range of users and members of the research community, and potential to have a single focus (no competing agenda).

Finding 3. The greatest weaknesses of the federated options are the potential that the "voice" will be less authoritative, the lack of existing examples of successful federations to learn from, and a structure will take time to set up and may require new legislation.

Finding 4. The greatest strengths of a lead agency or NOAA-led service (combined weather and climate service) are an ability to speak with an authoritative voice, build quickly from existing components of a climate service, ensure support of inherently governmental functions (observing systems, operational systems), and an ability to ensure "one-stop shopping" if weather and climate functions are integrated.

Finding 5. The greatest weaknesses of a lead agency or NOAA-led service are the competing agendas within agencies, potential problems in ensuring that NOAA is responsive to the needs of other agencies and/or ensuring other agencies provide needed contributions, and the lack of experience in dealing with the enormous breadth of potential users (and lack of internal expertise to work with this community).

Finding 6. The current NOAA organization is not well-suited to the development of a unified climate services function. Greater connectivity between weather and climate functions, and between research, operations and users is required.

Finding 7. The level of commitment and the nature of collaboration and interaction among federal agencies that would participate in a National Climate Service are not well-defined. This is a distinct weakness in formulating a national strategy.

The Coordinating Committee was unanimous in stating that a successful strategy for developing a National Climate Service relies on five recommendations:

Recommendation 1. Internal reorganization of NOAA that enables greater connectivity of weather and climate functions is a necessary step for success.

Recommendation 2. Each federal agency needs to collaboratively define its role and level of commitment in an NCS and there needs to be a lead federal entity.

Recommendation 3. Success of an NCS requires recognized, clear, authoritative, responsible leadership within the Federal System at the highest level possible.

Recommendation 4. An NCS requires a defined, independent budget large enough to influence the direction of the Service and achieve its mission.

Recommendation 5. An NCS requires an interface best described by a federated structure (i.e., non-profit or federation) because it has a stronger connection to users and the research community.

In addition, the Coordinating Committee encourages NOAA and its partners to maintain a community advisory function as the steps are taken to develop a National Climate Service that is of real value to the Nation.

Introduction

An organized and directed set of climate services has the potential to greatly enhance the value of climate information for the greater benefit of society. Our nation is clearly ready to utilize a climate service to create these benefits, as demonstrated by several key attributes:

(1) Significant linkages exist between climate and human endeavors and human interests
(2) Knowledge of these linkages, combined with climate information, can be utilized by decision-makers to promote environmental stewardship and sustainability, protect life and property, and promote economic vitality
(3) Access to authoritative, credible and useful information will enable effective decisions
(4) A significant number of decision-makers are already capable of useful application of climate-related information
(5) Deliberate efforts to promote an active community of researchers, users and climate information providers has the potential to ensure substantially larger, broader, and more significant benefits to society, many of which may be unexpected.

The objective of this report is to provide a framework for the development of a successful National Climate Service by assessing options or models for climate services in the United States. This report follows the recommendations of the *Climate Services External Review Report* (July 15, 2008) which suggested that NOAA lead an effort, with its partners, to compare and contrast specific options for the development of climate services based on an assessment of how these options satisfied twelve guiding principles for a robust and successful service.

In fulfilling this request, NOAA established four Tiger Teams (one per option) and a Coordinating Committee to write the report which follows. This report is the product of the work of these teams of individuals. The report is divided into four sections that focus on the development of a National Climate Service: (1) its importance, (2) a definition, (3) implementation and (4) assessing success.

I. The Importance of Creating a National Climate Service

At the present, there is no single source for the diverse range of climate information that could beneficially serve society. While many elements of the information needs could be met by combining the products of many agencies and organizations, there is currently no single source of authoritative, credible and useful information that will allow society to span such important topics as the physical aspects of sea level rise, temperature and precipitation, the resource implications of failed crops, managing changes in ecosystems, or the social implications of migrations and resource competitions. A National Climate Service will dramatically increase our ability to respond to the challenges that are currently limited by the difficulty in obtaining data, predictions, and syntheses across such a broad span of sectors and regions. The Climate Service will be utilized by decision-makers to promote economic vitality, promote environmental stewardship and sustainability, and protect life and property. It has the potential to enable us to avoid many costly mistakes in both adaptation and mitigation policies. It has even greater potential to promote a broad set of societal benefits, many of which are not yet recognized.

The potential benefits of a robust National Climate Service are enormous. No single set of examples can do justice to this potential. The examples offered below are far from comprehensive and are intended only to illustrate the breadth of societal objectives, decision support needs and information requirements associated with climate and climate change. Some of the examples that follow demonstrate cases where climate information is currently being utilized, but the potential is not fully realized. Other cases describe only the potential. In both cases, they are only suggestive of the range of benefits that can be achieved with the creation of a National Climate Service.

A. Economic Vitality

Promoting a Green Economy.

Societal objectives: Lowering carbon concentrations in the atmosphere; decreasing energy dependence on fossil fuels; promoting sustainable energy sources.

Decisions needed: Optimization of site selection, infrastructure design and operations for solar, hydro and wind energy systems.

Decision-makers: Private industry, state and regional planners, public utilities.

Climate service information needs: Regional assessments of historical climate variability and ranges; accurate and properly scaled weather and climate information on times scales of days to decades; authoritative analysis of the potential for climate change to impact high cost infrastructure.

Greenhouse Gas Management.

Societal objectives: Mitigate future impacts of greenhouse gases; cost-effective strategies to solve a well-characterized problem (the climate problem) while simultaneously ensuring a robust economy.

Decisions needed: Carbon policy and management; specifically how rapidly and deeply to cut or mitigate greenhouse gas emissions.

Decision-makers: National and international policy-makers.

Climate service information needs: Authoritative and robust regional climate projections, data about past climate trends, impact analyses, and valuations designed to support assessment of the magnitude, timing and costs of climate change damages that could be avoided through emissions reductions; regular assessment updates; carbon and climate monitoring data to support decision making and to verify the success of policy changes.

Managing Harmful Invasive Agricultural Diseases.

Societal objectives: Food security; ability to respond and contain invasive species and harmful agents that have the potential to cause damages in the tens of millions of dollars. Example: Hurricane Ivan introduced harmful Asian Soybean Rust spores into the Gulf Coast creating an epidemic.

Decisions needed: Optimization of response strategies that enables growers to respond to existing invasive species (e.g. Soybean Rust) or to prepare for and prevent new harmful invasions.

Decision-makers: U.S. Department of Agriculture; agriculture and farming industry.

Climate service information needs: Authoritative source for past, current, and future climate and weather information and an ability to rapidly combine surface data and reports and fine-scale numerical models (including trajectory models) when needed.

Enhancing Capabilities to Manage Drought.

Societal objectives: Mitigation of severe drought impacts.

Decisions needed: Optimization of management in drought/climate sensitive sectors, such as water resources, energy, agriculture, tourism and recreation, and coastal resources.

Decision-makers: States, regions and municipalities, resource management federal agencies, and private industry.

Climate service information needs: A coordinated, integrated drought monitoring, forecasting, and early warning information system based on the consolidation of physical/hydrological and socio-economic impacts data, integration of observing networks, development of a suite of drought decision support and simulation tools focused on critical management indicators and triggers, and the interactive delivery of standardized products and authoritative information with an early warning framework; authoritative assessments and predictions of the impact of climate change and variability on drought ranging from seasons to decades and longer. NDIS (the National Integrated Drought Information System) provides a case study of a climate service function designed to serve these specific needs.

B. Environmental Stewardship and Sustainability

Mitigating Ecosystem Impacts.

Societal objectives: Limit impact of climate change on natural ecosystems; address expectations that there will be increasing impacts on species and ecosystems as the magnitude of climate change increases. Example: the pine beetle population and the resultant tree damage are regulated in part by cycles of cold, sustained weather. The past few warmer winters in Colorado have not produced enough sufficiently cold days to control the beetle population. In addition, drought has weakened the natural defenses of the trees. Thus, climate change appears to be playing a key role in this widespread pine destruction.

Decisions needed: Actions to limit the geographic expansion of infestations; actions to recover from climate-related events - should a region be reforested; reforested with different species, reforested with pine beetle resistant trees; or be subject to no action?

Decision-makers: U.S. Forestry Service, forest industry, individual land owners

Climate service information needs: Authoritative information on regional climate change and variability; historical records of past climate variations; authoritative assessments and predictions of the impact of climate change and variability on drought and temperature ranging from seasons to decades.

Balancing Competing Societal Needs.

Societal objectives: An ability to balance between competing societal needs such as food production, energy, and sustainable ecosystems. Example: the salmon fishery in the Pacific Northwest experiences significant variability in landings from year to year, often independent of management efforts. A large fraction of this variability is associated with climate, and in particular the large-scale pattern of climate variability known as the Pacific Decadal Oscillation (PDO). Both hydropower management and variations in annual salmon catch in the U.S. are associated with changes in annual stream flow associated with the PDO, suggesting substantial vulnerability to climate variability). Management of these resources has a significant impact on ecosystem sustainability.

Decisions needed: Optimization of hydropower management; improved management of fisheries; improved decisions in highly managed river systems such as in the Pacific Northwest.

Decision-makers: fisheries industry, hydropower producers, state governments

Climate service information needs: Authoritative downscaled (fine spatial resolution) climate information on time scales of seasons to decades; improved linkages between the PDO and the El Nino/Southern Oscillation and regional climate; current efforts focus on broad basin-wide impacts, yet management focuses on a much smaller scale – the scale of individual rivers. This is one of many examples that demonstrate the importance of relevant high spatial resolution climate information, identified as a major need for a wide variety of resource managers.

C. Protecting Life and Property

National Security and Societal Instability.

Societal objectives: Address or prevent national security risks associated with instabilities, large population shifts, or conflict associated with climate change-induced food and water shortages, increased health problems including the spread of disease, flooding, heat waves, other extreme weather events, and coastal erosion from stronger storms and sea level rise. Example: Africa is an important case in point. Climate-induced tensions are currently a main contributor to instability in several parts of Sub-Saharan Africa, and the region will continue to be vulnerable to climate change because of multiple environmental, economic, political, and social stresses. Increased temperatures, greater seasonal variability in rainfall, and associated agricultural losses would be devastating to many African nations which are already challenged by persistent poverty, frequent natural disasters, weak governance, and high dependence on agriculture. Many other regions, including the Middle East and Central and Southeast Asia are also vulnerable. It is believed that there will be an increase in 'climate change' refugees, who will move into developing and developed countries with greater economic opportunities. The United States will need to anticipate and plan for growing immigration pressures both at home and in other countries.

Decisions needed: Policies and action plans designed to mitigate the impacts of climate change-induced national security risks. For example, new agricultural practices may be introduced and new economic assistance programs developed that could reduce the risk of conflict.

Decision-makers: U.S. Department of State, USAID

Climate service information needs: historical information on climate variability; regional (downscaled or high spatial resolution) weather and climate predictions on the time scales of seasons to decades.

Mitigating Adverse Human Health Outcomes.

Societal objectives: An ability to anticipate (predict or forecast) adverse health outcomes associated with climate change and variability and therefore limit their impact. Example: The strong linkages between environmental conditions and health suggest that there is an extraordinary opportunity to focus on prevention by utilizing climate and weather observations and prediction capabilities to anticipate adverse health outcomes. An ability to anticipate these outcomes is a major step towards an increased ability to identify in advance and then reduce the risks associated with a wide-range of environmentally sensitive diseases and conditions. A growing number of examples demonstrate that weather and climate have a significant impact on human health. Climate variability and change have the potential to impact the number and intensity of heat waves, the distribution and risk of vector-borne diseases such as West Nile Virus, Dengue fever, Lyme disease, and the risk of food-borne or water-borne bacteria and viruses. The distribution and abundance of infectious disease vectors such as ticks, mosquitoes, and rodents are tied to climate variables. A number of food-borne and water-borne diseases are linked to extreme events, particularly droughts, floods and increases in temperature. Currently, public health professionals focus on surveillance and response as the primary mechanism to address adverse health conditions.

Decisions needed: Response to adverse health outcomes in advance, either through active mitigation prior to an outbreak (e.g. mosquito control), public alerts that can modify behavior and susceptibility, or medical community preparation (availability of pharmaceuticals, treatment capabilities). Long-term policy decisions could alter changes in health infrastructure, or investment in vaccines, etc.

Decision-makers: Health professionals, CDC (Center for Disease Control and Prevention)

Climate service information needs: Authoritative information on weather and climate parameters associated with causes of adverse health outcomes; regional downscaled (fine spatial resolution) climate predictions; ability to connect climate and health research enterprises.

Mainstreaming Climate Change Adaptation in Urban Areas.

Societal objectives: Ensure that complex and vulnerable areas of society are robust to climate change and variability. Example: New York City provides a particular case in point. The New York City Climate Change Adaptation Task Force was launched in August 2008 to secure the city's critical infrastructure against rising seas, higher temperatures and fluctuating water supplies projected to result from climate change. The Climate Change Adaptation Task Force is part of PlaNYC, the city's long-term sustainability plan, and is composed of over 30 city and state agencies, public authorities and companies that operate the region's roads, bridges, tunnels, mass transit, and water, sewer, energy and telecommunications systems – all with critical infrastructure identified as vulnerable to severe weather and flooding.

Decisions needed: Policy to ensure adequate design criteria and construction codes, infrastructure hardening, relocation, particularly to address vulnerability to changes in storm intensity and flooding.

Decision-makers: Municipal governments; related state and federal agencies, insurance and construction industries.

Climate service information needs: Authoritative climate and weather information that would enable governments to relocate and/or secure vulnerable installments as well as better plan for future infrastructure investments; provide a reasonable basis for changes in design criteria and construction codes; the level of credible and authoritative data and information that would enable many cities to develop concrete action plans without costly duplication of effort in our nation's cities; expertise to support decision-making under conditions of uncertainty; effective ways for expert knowledge to be incorporated into public actions; and strategies for maintaining consistent and effective attention to long-term climate change even as municipal governments cycle through their administrations.

Adaptation through Infrastructure Relocation.

Societal objectives: Robust decisions when adaptation becomes a necessity due to rising sea level, melting permafrost, and storm-driven erosion or other climate-induced change. Example: Alaskan villages, once protected by sea ice cover, are now subject to intense winter waves and erosion and are literally being washed into the sea. Moving villages is expensive and a key issue is to only move them once. The locations must also continue to provide access to the natural resources needed for subsistence. Additional examples: A number of active coastal military installations in the

continental United States are at a significant and increasing risk of damage, as a function of flooding from worsened storm surges in the near-term. In addition, two dozen nuclear facilities and numerous refineries along US coastlines are at risk and may be severely impacted by an increased frequency or intensity of storms.

Decisions needed: Decision on where and when to move infrastructure.

Decision-makers: Village governments, state agencies, and the Army Corps of Engineers in the case of relocating the villagers and their supporting infrastructure. National, state, regional, and municipal governments; federal agencies with authority over vulnerable sites (e.g. Department of Defense, Nuclear Regulatory Agency), insurance and construction industries in the case of nationally-significant infrastructure.

Climate service information needs: Authoritative estimates of future sea level rise, ice melt, severe weather, and storm erosion. Each of these factors requires information about future temperatures, precipitation, sea ice, and storminess at the kilometer to tens of kilometer scales. In the case of moving whole villages, the impacts on living resources, including their abundance and availability, are also necessary as well as changes in hydrology to meet potable and wastewater requirements. Given the rapid changes in these factors in the past 20 years, reliable estimates of future rates of change are also needed. Data sources must be able to fulfill the requirement of "best information available" to survive likely litigation.

II. Definition of a National Climate Service

Vision: The National Climate Service will provide information to the nation and the world to assist in understanding, anticipating, and responding to climate, climate change, and climate variability and their impacts and implications.

Mission: The Service will inform the public through the sustained production and delivery of authoritative, timely, and useful information to enable management of climate-related risks, opportunities and local, state, regional, tribal, national, and global impacts.

Key Attributes: The Service will achieve its mission by promoting active interaction among users, researchers, and information providers. The Service will be user-centric, by ensuring that scientifically-based information is accessible and commensurate with users' needs and limitations. The Service will provide such usable information and enable development of decision support tools through a sustained network of observations, modeling, research activities, and user outreach and assistance.

III. Implementation of a National Climate Service

The *Climate Services External Review Committee* recommended that that NOAA lead an effort, with its partners, to compare and contrast specific national options for the development of climate services. This review was to be conducted by Tiger Teams that would examine the pros and cons of four options:

1. a national climate service federation that would determine how to deliver climate services to the nation
2. a non-profit corporation with federal sponsorship
3. a national climate service with NOAA as the lead agency with specifically defined partners, and
4. a weather and climate services within NOAA developed from an expanded and improved weather services

A. **Brief Descriptions of Each Climate Service Option**.

A short description of each option is provided for context in the discussion of the pros and cons by the Coordinating Committee.

Option 1. The Climate Service Federation. A National Climate Service Federation would consist of federal agencies and regional groups of climate information providers. The regional groups might well include representative users. These groups would drive the national organization, which would have responsibility for national infrastructure including the climate observing system, the national modeling capability, and a focused climate research enterprise. Option 1 initially considered a conventional collection of federal agencies (like USGCRP) but also concluded that other models were possible, including a nonprofit or FFRDC. A government chartered corporation like TVA would represent another model. Government agencies with climate programs would join as members and federal funds would be provided to the Federation. A governing board composed of high level federal, tribal, state, and local government; private sector; NGO; and academic representatives oversees the entire Federation.

The National Climate Federation is user-driven and regionally focused. It is the single source of climate information from all agencies and other providers and has the resources to influence the programs of its members.

Option 2. Non-Profit National Climate Service. The non-profit (NP) organization's sole vision and mission is to work with partners to provide users with climate information and tools at scales and in formats they find useful (e.g., Federal agencies, local and regional decision makers, service providers, etc). This is in contrast to how Federal agencies must operate with many agendas that are at times in conflict with one another, like NOAA trying to balance a Commerce, fisheries, and weather service agenda. It provides its products and services through partnerships with public, private, and academic sectors versus building extensive in-house capabilities or competing with these sectors. It will require that the Federal government continue to financially support core climate policy, research, and operational activities (e.g., data collection and archiving, modeling, etc.). Whether these activities would continue to be done within the Federal government would be negotiated on a case by case basis to ensure that the NCS products and services are robust and meet national needs. There may be things like supporting the IPCC or country-to-country agreements that may have to stay within the Federal government and be coordinated with the NP. It will also require that NOAA and the other climate agencies define their research and operational roles in climate

services and negotiate with the NP how their efforts fit into the NCS. This is a true collaborative partnership and will require strong leadership within the Federal government and a willingness to work in new and novel ways. The NP can create these creative partnerships and business approaches because it is outside the government and less burdened by complex federal rules and regulations, while also providing needed Federal oversight mechanisms. Other key characteristics include:

- It is based on existing non-profit models, like the University Corporation for Atmospheric Research and the National Center for Atmospheric Research.
- It is sponsored and overseen by a Federal agency on behalf of the Federal climate leadership and agencies.
- The NP-Federal interface provides a collaborative mechanism to deliver the agreed upon NCS products and services by picking only the most efficient and effective partnerships between the public, private, and academic sectors.
- Like other existing NP it could be created by a sponsoring agency or by presidential or congressional charter.
- A small, skilled planning committee will develop the governance bylaws and structure and establish the preliminary NP Board, which is made up of public, private, and academic sector representatives that have full fiduciary responsibilities for the success of the NP like any other corporate board members.
- The Board fires and hires the President and ensures that the President fulfills the NCS mission and meets partner and user needs.
- The Board would be responsible for electing Board members or create a NP membership that would elect Board members.
- It is a relatively small organization with a management structure optimized to be responsive to user identified needs.
- It works with users and partners at all scales (local, regional, national, and international) to provide the most efficient and effective products and services.

Option 3. NOAA as the lead agency with specified partners. Option 3 presents a middle ground between the decentralized options 1 and 2 and the expanded weather/climate service of option 4. It creates a flexible National Climate Service through a strategic partnership in which NOAA serves as the lead entity. This model incorporates a vision and mission of a Climate Service that would be located in NOAA, and consistent with NOAA's responsibilities and the perceived comparative advantages of NOAA and that of its defined partners. No agency or organization can do the job alone, but NOAA has more of the attributes and mandates within the domain of the physical climate system to play the lead role. At the same time, it acknowledges the critical need for other partners, given their attributes, and mandates, to make necessary observations, further refine climate models, vulnerability assessments, and to document impacts and inform risk management, which will be central to assisting the Nation address future climate changes and climate impacts. Specifically NOAA brings to the partnership the following:

- Predictive capacity of atmospheric and oceanic changes, supporting research, and long-term observations which are already recognized as part of NOAA's mission;
- A mandate to operate at both the domestic and international level;
- Established relationships that exist with major stakeholders;
- Sophisticated scientific and computational infrastructure that is already in place;
- The ability to build on existing capability rather than require a new bureaucracy be developed;
- Strong interest within agency for development of climate service; and

- Offices well represented regionally, which enhances to ability for extension and outreach, as well as coordination with partners.

Option 4. The National Weather and Climate Service. A national weather and climate service would serve as an outlet for NOAA climate services. It builds upon the existing service components' extensive connections at the regional, state and local levels and expertise in effectively delivering products and services. It is formed by the merger of elements including the National Weather Service and the NOAA Data Centers, and thus is capable of providing a broad range of data and information from historical information through climate projections of a few years. To enable the provision of decadal through centennial time scales, it builds upon the research components of NOAA and provides an effective outlet for the products and services developed by those components. But to do so, the service components' capacities in climate will need to be expanded through additional staff resources and training. Likewise, the research component should also be strengthened with sufficient resources, especially computational resources, to meet the challenges posed by the longer-term climate and climate change questions.

The Service will need to maintain the strong partnerships with other climate services providers (especially those organizations operating at the important interface between the Federal Government and the user community such as the Regional Climate Centers, the State Climatologists, Sea Grant Extension, NGOs, etc.) and strong linkages to research arms of NOAA and other agencies. NOAA and the Service must recognize and respect the private sector's strengths and capabilities in supporting the various economic sectors of the nation, providing effective linkages in both the planning and execution of the development of the Climate Service.

B. A Comparison of Climate Service Options and Guiding Principles

The *Climate Services External Review Committee* listed a series of principles and objectives that are characteristics of a successful climate service. The Tiger Teams completed an analysis of the pros and cons for each Option based on this set of guiding principles as a way of informing decisions in the development of a National Climate Service. Each of these guidelines is listed below, followed by a brief assessment of the Coordinating Committee:

- *Serve to develop products and information that will promote a variety of societal benefits (Review Committee report lists a number of examples which are not repeated here).*

Assessment: The more active partners that are entrained, the more likely the service is to provide a broader range of societal benefits.

- *Reflect the full range of users, ranging from those who can define their needs and are ready to make use of specific information to those who have limited experience and for which the utility of climate information is not yet clear.*

Assessment: The more active partners that are entrained and the more effectively those partners are engaged, the more likely the service is to reflect the full range of users.

- *Address the full range of time scales of interest to society without artificial or arbitrary divisions based on days, weeks, months, years or decades.*

Assessment: NOAA already captures the weather component, and basic climate information. Therefore addressing the full range of timescales should build from NOAA's capabilities.

- *Promote the extension of climate information to climate system information so that the fundamental problems associated with the climate system and diverse regions (e.g. the coastal region) and sectors (e.g. ecosystems, water, human health, agriculture, energy, insurance, social and economic infrastructure, national security, etc.) can be addressed.*

Assessment: The more that active regional and sectoral partners are entrained, the more likely the service will be capable of expanding from one that addresses only traditional meteorological variables to one that addresses the fuller set of climate and earth system contributions. In addition, a climate service model that is problem-based is also more likely to expand the scope of climate services.

- *Support problem-based assessments and improved decision-making that are on global, regional, sectoral, and integrated scales.*

Assessment: A Climate Service contribution to global or national assessment reports and decision-making requires an authoritative voice. One way to assure an authoritative voice is strong tie to the Federal Government. Regional and sectoral assessment reports and decision-making requires a direct connection to resident expertise.

- *Create a science-based and research–supported capability that ensures that information is accessible, includes data, interpretation and integration, promotes communication and education, and promotes innovation and interaction.*

Assessment: Every Option includes a science-based and research-supported capability but the federated options (Options 1 and 2) have a greater breadth and scope, and define a broader connection to the research and education communities. The federal agency-based Options are more authoritative and have a stronger connection to operations.

- *Create an active community of interaction that promotes the 3-way involvement of researchers, users, and climate information providers that is engaged throughout the process from planning, execution, assessment, and improvement and involves the active use of the information within the service.*

Assessment: Every Option promotes 3-way involvement of users, researchers, and climate information providers, but this process is more nimble outside of Federal rules and regulations. (e.g., FACA, corporate participation, pooled funding)

- *Recognize, incorporate and promote a "cascade" of roles extending from nationally-provided and vetted products, to defined roles of mission agencies, to a variety of interfaces with users (including regional or boundary interfaces such as Regional Integrated Science and Assessments (RISAs), Regional Climate Centers, state climatologists, NGOs, and the private sector), to the active engagement of a wide range of users.*

Assessment: NOAA and other Federal agencies have currently defined relationships and roles with a broad range of partners (e.g., RCCs, RISAs, SCs, private sector, NGOs, etc.) but their roles in a National Climate Service need to be described. The federated Options have promise, but roles among partners are less defined.

- *Define the role of various federal agencies.*

Assessment: The roles of the Federal participants need to be co-developed by the agencies in every Option. None of these Options work without stronger Federal coordination mechanisms and stronger leadership.

- *Recognize that there are significant foundations required for a robust climate service underpinned by*
    - *A robust climate observing system*
    - *High spatial resolution climate system prediction and projection models with demonstrated skill.*

Assessment: The foundations required for a robust climate service, including the observing system, data stewardship, and climate models, are either inherently governmental functions or require sustained government support. All Options make this assumption.

- *Ensure that climate services are integrated with active research with feedbacks that will directly impact the generation of new climate service capabilities and climate services, and in turn, will directly influence research directions. This must be based on integrated, cross-cutting and end-to-end research that will support the production of climate system information. Fundamentally, this must be founded on the development of skillful forecasts, predictions and projections, and span a better understanding of human and natural systems and how they respond to change.*

Assessment: The federated Options are more likely to impact the generation of new service capabilities and in turn, new research directions, because they are more closely connected to users and the research community.

- *Include specific mechanisms to entrain successful products into the operations and capacity of the service.*

Assessment: Transition to operations requires sustained government support. The more distributed the Option, the more challenging it is to provide mechanisms that ensure the transition from research to operations.

C. <u>Prominent Strengths and Greatest Challenges associated with each Option</u>

The Coordinating Committee utilized the reports from each Tiger Team to create a list of prominent strengths and greatest challenges associated with each Option.

Option 1. The Climate Service Federation.

Prominent Strengths

- Flexible, can operate without the same level of burden of complex rules and regulations
- Strong tie to users and the research community through a bottom-up approach
- "give and get" approach ensures that the service is defined by a broad set of engaged and active partners

- Proposed direct budget line
- No competing agenda – the sole focus is on climate services

Greatest Challenges

- The "voice" of the Climate Service and the development of its "vision" is distributed and may not be coherent
- A federation defined by a board and distributed set of partners may not be viewed as authoritative
- Special legislation is required and there is no previous model to follow – it will take time to stand up this Option
- Leadership that is defined by a board of governors is a step away from the federal leadership

Option 2. Non-Profit National Climate Service

Prominent Strengths

- Nimble and flexible, can operate without the burden of complex rules and regulations
- A good balance between centralized leadership, well connected to federal leadership, and a broad range of users and partners
- No competing agenda – the sole focus is on climate services
- Defined budget from a lead agency

Greatest Challenges

- May not be able to work formally with other governments, represent the U.S., or handle transfers of funds from the non-profit to government agencies
- As a non-governmental agency, there may be more risk associated with budget stability or with liability associated with providing services. Federal authorization (a challenge in itself) may be needed to limit the liabilities and provide budget stability
- Will take more time to establish the non-profit Option

Option 3. NOAA as the lead agency with specified partners.

Prominent Strengths

- Builds on existing strengths and mandates
- Can be implemented quickly
- Can speak with an authoritative voice
- Inherently governmental functions are supported
- One-stop shopping

Greatest Challenges

- The governance model presents challenges – can other federal agencies "instruct" NOAA to satisfy specific needs and can NOAA and the climate service be certain of commitments from other agencies?
- Will have to compete with diffferent agendas and missions of each agency
- A modest re-organization must be accomplished
- The connection to the breadth of the research and user community will require new approaches

Option 4. The National Weather and Climate Service.

Prominent Strengths

- Builds on existing strengths and mandates, and existing units within NOAA
- Has the potential for a seamless transition from current capabilities
- Can speak with an authoritative voice
- Inherently governmental functions are supported
- Integrates weather and climate time scales
- One-stop shopping

Greatest Challenges

- The breadth of disciplines is not within NOAA, and would require new hiring and better connections to diverse users and researchers/expertise
- NWS has a weather-centric set of priorities that may place climate at a disadvantage
- A modest re-organization must be accomplished
- NOAA as a "go-it-alone" model may have difficulty becoming a National Climate Service that represents the breadth of topics and partnerships required

D. **Key Implementation Conclusions**

Each Option has significant strengths and weaknesses. A successful strategy for developing a National Climate Service relies on five components.

1. Internal reorganization of NOAA that enables greater connectivity of weather and climate functions is a necessary step for success.
2. Each federal agency needs to collaboratively define its role and level of commitment in an NCS and there needs to be a lead federal entity.
3. Success of an NCS requires recognized, clear, authoritative, responsible leadership within the Federal System at the highest level possible.
4. An NCS requires a defined, independent budget large enough to influence the direction of the Service and achieve its mission.
5. An NCS requires an interface best described by a federated structure (i.e., non-profit or federation) because it has a stronger connection to users and the research community.

IV. Assessing the Success of the Climate Service

Simple qualitative and quantitative measures of performance relative to the mission and attributes of a National Climate Service offer an opportunity to gauge progress, improve program performance, and demonstrate program success. The National Research Council report, *Thinking Strategically: The Appropriate Use of Metrics for the Climate Change Science Program* (2005), provides significant guidance on the importance of considering the full range of metrics that reflect the success of a program, including process metrics (measure a course of action taken to achieve a goal), input metrics (measure tangible quantities put into place to achieve a goal), output metrics (measure products and services delivered), outcome metrics (measure results that stem from the use of the outputs), and impact metrics (measure long-term societal, economic and environmental consequences). The most important of these classes of metrics for a National Climate Service are listed below:

Process Metrics

- The National Climate Service has an effective leader at the highest possible level of government
- The Service has sufficient authority to allocate resources, direct research and operations, and facilitate progress.
- The Service is a clear, authoritative source of information
- The Service has a well-articulated strategic plan that includes goals, implementation and integration
- The Service includes a functioning peer review process that involves all appropriate stakeholders
- The Service has a strategy for setting priorities and allocating resources among different elements of the programs, including federal and non-federal partners
- The Service has mechanisms in place that facilitate broad use and understanding of its products and results

Input Metrics

- The applications and products have sufficient foundation in research, based on the linkages between climate and human endeavors and interests, to ensure that they are useful and effective in decision-making
- There is a sufficient commitment of resources (people, infrastructure, financial) to ensure that the mission can be carried out, including synthesis and assessment activities, transition from research to operations, and services that enable the use of data and information by a broad spectrum of users
- There is sufficient commitment of resources to promote unanticipated discoveries and develop unanticipated operational products of use to society, investigate competing ideas, and foster innovative approaches
- There is sufficient commitment to the foundations of a climate service, including a robust climate observing system and high spatial resolution climate model development and application to ensure its success

- The program leverages existing federal and non-federal resources and capabilities

Output Metrics

- The products and results of the Service are accessible, credible and useful
- The products and results of the Service satisfy a broad range of needs, from regions and sectors to assessment and synthesis
- The Service includes a broad and diverse community of engaged users
- The infrastructure has been created that promotes and supports the mission of the Service
- Stakeholder-based assessments demonstrate the utility of Service products and services in informing management and promoting effective decisions
- New results and new products are communicated to an appropriate range of stakeholders

Outcome Metrics

- The Climate Service has promoted new avenues of research and discovery that has resulted in new and useful products or services
- The Service has provided new knowledge of the linkages between climate and human endeavors and interests, including an increased understanding of uncertainties in the use of climate information
- The Service has resulted in more consistent and reliable climate predictions and projections, increased confidence in our ability to utilize this information for the public and private good, and facilitated more effective decision making
- Research results have become operational products
- The institutional and human capacity to provide and utilize climate information has increased because of the Climate Service
- The measurements, analysis and products are being utilized for a wide variety of applications and decisions

Impact Metrics

- The public understanding of climate and climate impacts has increased
- The Climate Service has benefited society – by enhancing economic vitality, protecting life and property, and promoting environmental stewardship and sustainability
- The Service has informed policy and demonstrably improved decision-making across a broad spectrum of regional, sectoral, national and global domains

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Appendix II. Tiger Team Reports

The Tiger Team Reports that follow are meeting summaries that reflect the discussions of each group rather than formal reports. They were designed to inform the Coordinating Committee in its efforts to compare and contrast the four major options under consideration.

Tiger Team #1 – A Climate Service Federation

6-7 November 2008
Washington, D.C.

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Affiliations indicated for identification and do not imply organizational endorsement. Not all authors agree with all specific recommendations – this document reflects an attempt to synthesize the concerns of the participants in looking to "flesh out" the concept of the Climate Service Federation, and does not imply a personal endorsement of this implementation mechanism relative to the others being considered.

Summary

The National Climate Service Federation consists of regional groups of climate information providers as well as federal agencies. The regional groups might well include representative users. These groups will drive the national organization, which would have responsibility for national infrastructure as the climate observing system, the national modeling capability, and a focused climate research enterprise. This national organization could itself be a nonprofit or FFRDC, or a more conventional government entity. A governing board oversees the entire Federation. It would consist of information providers and users from federal, tribal, state, and local government, the private sector, NGOs, and academia.

Climate Service Federation

There is an enormous and growing demand for climate information, from the need for drought impacts in the American West to the need for sea level and storm information along all of the national coastline. Yet the provision of climate information is spread among so many sources – inside and outside the government – that a fresh approach is needed to simplify its availability. The challenge is too great for any existing organization, including the federal government or any of its agencies. Federal resource managers, state, local and tribal governments, and private businesses all recognize that a changing climate greatly complicates their ability to plan for tomorrow. To meet this challenge we describe a possible implementation of a Federation concept for Climate Services, which unites a network of climate information providers under a single federal umbrella to be supported largely with federal funds. It will provide climate variability forecasts on the scale of weeks to years,, and provide climate change scenarios on the scale of decades to centuries.

This option presents an opportunity to provide some direction to climate science, and it has lacked a clear national voice in the science community. The federation could provide that voice in much the same way that the IPCC provides an international voice. Right now, communities have no clear idea what to expect in their home towns, and the work done by our respective agencies is not communicated well, even to each other. What the Federation has the potential to do is to provide credence and visibility to the science and services within individual groups and agencies. It provides a unifying direction and a mechanism that allows us to work together to provide science-based services to support adaptation and mitigation decisions. And therefore, mitigation and adaptation decision support should be where the Federation plays a role.

The Federation would consist of regional groups of climate information providers as well as federal agencies; they might well include representative users. These groups would drive the national organization, which would have responsibility for such essentially national infrastructure as the climate observing system, the national modeling capability, and a focused climate research enterprise (see Figure 1). These would be subsets of the total national investment in climate observations, models, and research, and the delineation of what constitutes the area of responsibility for the service as opposed to that of the current entities providing these capabilities would need to be agreed upon by those entities and the Federation prior to the implementation of the Federation. This national organization could itself be a nonprofit or FFRDC, or a more conventional government entity. A governing board would oversee the entire Federation. It would consist of information providers and users from federal, tribal, state, and local government; the private sector; NGOs; and academia.

This concept has a number of features that make it particularly attractive. The Federation model:

- Connects demand for adaptation information at regional scale with a national program
- Can harness scientific, observational capabilities to provide actionable products and services to users
- Is regionally and issue focused, empowering regional entities, and thus is inherently responsive to local/regional needs, incorporating the notion of direction by consent of the governed
- Responds to requirements driven from across the spectrum of users, from the small community and private sector needs to large corporations and governments
- Fits into existing government structure without necessitating reorganization
- Draws on strengths of private sector, academic community, and government to provide climate services
- In its flexibility, has the potential to evolve more rapidly to evolving needs
- Could create a new voice for climate services with high-level access

Services of a National Climate Service

A Federation-led NCS must provide recognized and vetted information from local (watershed) to global scales to a variety of users on a regular basis for which timely delivery of products is important. It is not intended to be all-inclusive in its applications, and does not include products primarily designed for the research community. In the list that follows, the focus is on providing data and services using currently available data and supporting its future evolutionary development. It does not extend to the dramatic expansion of observational or modeling capability, or the retrospective study of climate evolution through historical reprocessing of data sets. The NCS should:

- Maintain and improve the climate record
- Provide historical climate information
- Provide the backbone and standards for the present climate observing system and ensure continuity of broader climate observations
- Prepare probable forecasts of climate variability/change from seasonal to centennial scales, with characterized reliability
- Communicate effectively with the public
    - Stakeholder engagement that informs research/modeling/observations enterprise
    - Stakeholders must have strong influence in direction of service
- Be the authoritative voice for climate information
    - Use the RISA model to streamline bureaucratic data assurance processes
- Conduct assessment as ongoing process, punctuated by meetings where users are informed in the course of the process;
- Assess state of knowledge for user-driven issues
- Coordinate dissemination of climate information to regional entities
- Develop and provide decision support tools: e.g. water availability, soil moisture, information for crop yield forecasts
- Become a centralized clearinghouse for climate adaptation experience: information, tools, best practices

The Federation will also have a research component, with motivation coming from the user community, including assessment and adaptation research. It does not include all climate-related research in the US, but rather focuses on that research which can contribute to evolutionary improvements in the data and models being provided by the Federation to users. It is expected that a much wider research effort will continue to be supported by the Federal government, accompanied by investments of others (e.g., states through their university systems), and this research will be coordinated with that of the Federation through the active involvement of those bodies in Federation governance.[1]

Federation Organizational Issues

Much of the discussion in this Team revolved around issues of membership and governance, and in the criteria for membership in the Federation. The value of the enterprise will create demand for inclusion. As a start, a number of groups constituted the classes of membership:

- Government agencies at all scales
- Agency aggregations, e.g. CCSP
- Private sector
- Tribes
- Universities
- NGOs/community action groups
- Other stakeholders

[1] See discussion under "Areas of Consensus and Disagreement"

With this in mind, several key aspects of the governance of the Federation model were enumerated:

- All members are providers of service[1]
- The Staff serves at the pleasure of and reports to a governing board comprised of Secretary level federal members, representatives of the user communities, and private citizens. The board would be appointed by the President and Congress, serving six year staggered terms. Non-federal members represent the regions.
- The "top level" is seen as representatives of state, local and federal government
- Regional level is where the interaction will take place between local users. There is thus a need for regional components on the ground.
- There is a clearly identified component to deal with national/global level data and models; this would be implemented out of the core headquarters.
- Membership would include:
    - Mandatory (providers): NOAA, NASA, USGS, DOE, USDA, EPA, HHS, states, organizations representing users (e.g. state/county/local govt organizations, private sector) and NGOs
        - Providers must be generating information valuable for outside of their organization
        - Core only has power given to it by members
- The Federation could be governmental with an embedded nonprofit, to add adaptability and flexibility.
- Organizational models might include the Smithsonian and Resolution Trust

Several aspects of budget and agency authority were highlighted. There is a need for an independent budget line; if it is in one agency, there is a chance to be seen as client of that agency. The funding line would sit at the Cabinet department level and must be integrated with the "normal" process for formulating the President's budget. The Federation must also have the authority to pool agency resources and independently distribute them to accomplish its mission.

A Federation Charter must include support for global observations, research, and modeling activities to balance against a potential focus on near-term mandates. The relationship between the elements of these components carried out inside the Federation and the (presumably, but not necessarily, larger) parts carried out outside MUST be defined by the Federation and its partners at the inception of the Federation. An an example, the Gravity Recovery and Climate Experiment (GRACE) satellite mission (a US-German international partnership organized by NASA and its German counterpart, DLR), would almost certainly not have evolved from a regional, bottom-up program. The development of such programs is expected to be carried out outside the Federation by its partners; once the value of its data is recognized, however, the Federation and its partners would work to facilitate the use of such data by the Federation in its development of observational and modeling products, and then the develop plans that could support the continuation of those observations into the future as part of the Federation's ongoing efforts. The Federation is the US point of contact for the Global Climate Observing System and similar organizations, and has a responsibility to interact with its Partners to provide effective national representation of the entire US effort (including those elements not under the direct control of the Federation).

Areas of Consensus and Disagreement

In the course of development of this option, there was agreement on a range of issues, but there were also areas where consensus was not reached. These ultimately may be the most revealing, as they highlight issues that a Climate Service must deal with regardless of the ultimate model.

Some particular areas of consensus are as follows:

- Regional inputs are important but not the only sources of input.
- A major element of those (or most of those) in the federation should be the provision of data used by others.
- The Federation will have significant Federal and non-Federal participation.
- There needs to be some mechanism for getting input from a broad class of users (not just data providers).
- There has to be some kind of authority in the federation – both budgetary and administrative.
- There should be a research component so that the quality of the services provided can be improved.
- The climate services federation needs to have a close and clear link to the overall national climate program.

Areas of disagreement in many ways are a matter of degree. These include:

- *Should membership on regional groups include both users and providers?* One clear perspective was that members of the Federation should be solely providers of climate information, and that user inputs would come from the governing board. In this view, the Federation would be a collection of federal, academic, and private sector entities collaborating to provide data, information, and forecasts to a wide range of users about climate past, and to the extent possible, climate in the future. How that information would be applied to problems in specific industries, in specific locations, and for various purposes including government concerns about adaptation to climate change would be the responsibility of users. However, a strong point was made that if the Federation is to be both "bottom-up" and user-driven, both users and providers of climate information need to be represented on these groups, and users need to be in a position to drive the information products that a Climate Service would provide.
- *How expansive is the research program relative to those of the agencies involved?* Basic research, of the sort that brought us to our current understanding, is strongly needed. That is research that is not driven by immediate needs. On the other hand, users need a way to influence the direction of research. A construct was to provide a research budget in the Federation that could be used to leverage or influence the budgets of those with more substantial resources.
- *Does the Federation oversee the Federal climate science program (CCSP follow-on) or the other way around?* The CCSP has had some success in coordinating research, following on from the USGCRP, but it has no independent budget or authority and could well be changed radically in a new administration. It is a research coordinator and as such is not the entity from which to build a new service but one that would benefit from having a permanent "house. There was considerable debate regarding the extent of climate-related research that is carried out outside the Federation by entities which are part of the Federation, and of the relationship between the Federation and a future CCSP
- *Do the regional members drive the federation or are they partners with the federal members?* By definition, the Federation is a "bottom-up" entity. There was agreement, to some extent, that a

federation exists under the notion of the consent of the governed. Members belong because of their perceived benefit, not by fiat or decree.

Guiding Principles and Objectives for Examining the Options

As specified in the Terms of Reference, the Team examined how aspects of a climate service might be served or disserved by the Federation option, as listed in the pros and cons shown below.

The scope of the proposed climate services must (not in any particular order):

1. Serve to develop products and information that will protect the public good and promote a variety of societal benefits including

    a. Improve prediction and projection capabilities on the time scales that contribute to societal benefit
    PRO
    - Direct involvement of embedded user community
    - Includes research community
    - Improved coordination of provider community
    - Accumulating data on impacts

    CON
    - Large groups can be ponderous and slow to make decisions
    - Potential for inflated demands/expectations

    b. Promote a better understanding of how climate change and variability can promote an improved understanding of other environmental components
    PRO
    - Multiple perspectives provide insights into a variety of environmental parameters not provided by a single agency
    - Best for attacking multidisciplinary problems
    - Links operational and research agencies
    - Facilitates end-to-end research

    CON
    - Danger of being drawn in too many directions and too far onto the applied side

    c. Improve decision-making capabilities in particular sectors and regions,
    PRO
    - Sectors and regions are represented and engaged/members
    - Polar bear example: DOI focus led to use of ESA as tool
    - As resource management agencies deal with particular issues, could promote more efficient, policy-relevant decisions

    CON
    - Size and complexity could slow down response
    - Potential confusion over information quality
    - Dominance by federal agency reps could threaten regional actions

- Diametrically opposed agendas of members (say NGO vs agency) could create conflict

d. Engender new natural and social science capabilities that may have large expected and unexpected benefit, and

PRO

- Regional and sectoral focus will frame problems in terms of human system/natural system interactions
- Broad-based consideration would be more efficient than sector-based assessment

CON

- Possible failure to focus

e. Promote improved federal, state and regional adaptation and mitigation strategies and policies.

PRO

- Would promote improved information base, if not improved policies
- Will generate increased interest and attention to the problem
- More transparent process for local users, which increases legitimacy

CON

- Need to protect development of information that is not ready for public distribution (100 pages of comments on 10 pages of work)
- Adaptation will be trial-and-error process; what are liability issues? Need to communicate risk adequately but eschew recommendations

f. Promote a more informed citizenry

PRO

- Greater level of involvement and understanding
- Allows for more direct engagement of user groups
- Explicit communication/outreach; increased number of access points

CON

- Regionally-oriented structure could encourage duplicate efforts as different regions carry out similar efforts, and also could underemphasize national and/or global concerns as they contribute to regional issues.

2. Reflect the full range of users, ranging from those who can define their needs and are ready to make use of specific information to those who have limited experience and for which the utility of climate information is not yet clear.

PRO

- Users or their representative organizations are members of the federation

CON

- Users will know the nature of their problem, but not necessarily the information to consider alternatives
- Regional orientation could complicate ability of those concerned about national and global issues to have voices heard

3. Address the full range of time scales of interest to society without artificial or arbitrary divisions based on days, weeks, months, years or decades.

PRO

- Federation will have an improved process for addressing time scales from seasons-centuries

CON

- Will not provide daily-weekly forecasts
- Regional emphasis could encourage efforts that provide high spatial resolution answers at the expense of more fundamental science that underpins the models but does not support near-term product delivery because of the time lag associated with their study

4. Promote the extension of climate information to climate system information so that the fundamental problems associated with the climate system and diverse regions (e.g. the coastal region) and sectors (e.g. ecosystems, water, human health, agriculture, energy, insurance, social and economic infrastructure, national security, etc.) can be addressed.

PRO

- Facilitates collaboration between users and science

CON

5. Support problem-based assessments and improved decision-making that are on global, regional, sectoral, and integrated scales.

PRO

- Structure inherently addresses a range of scales

CON

- Getting a regionally-oriented entity to pay attention to global issues is a challenge.

6. Create a science-based and research–supported capability that ensures that information is authoritative, accessible, includes data, interpretation and integration, promotes communication and education, and promotes innovation and interaction.

PRO

- Explicit in design

CON

7. Create an active community of interaction that promotes the 3-way involvement of researchers, users, and climate information providers that is engaged throughout the process from planning, execution, assessment, and improvement and involves the active use of the information within the service.

PRO

- Explicit in design

CON

8. Recognize, incorporate and promote a "cascade" of roles extending from nationally-provided and vetted products, to defined roles of mission agencies, to a variety of interfaces with users (including regional or boundary interfaces such as Regional Integrated Science and Assessments (RISAs), Regional Climate Centers, state climatologists, NGOs, and the private sector), to the active engagement of a wide range of users.

9. Define the role of various federal agencies

   PRO
   - No lead agency; all are invited, none are in charge
   - Leadership of federation could decide distribution of funds

   CON
   - Leadership model yet to be determined; where to house, who to lead
   - Potential for interagency conflict
   - No single agency budget advocate (suggest that federation fall under a Secretary)
   - Need for new money
   - Need to articulate clearly "What's in and what's out" of the Federation and then define an interaction mechanism that will assure connectivity on those things that are not part of it.

10. Recognize that there are significant foundations required for a robust climate service underpinned by

    a. A robust climate observing system

       PRO
       - Creates a larger constituency to support climate observations. Example: cuts in BIA stream gauge support

       CON
       - Does not resolve difficult long-term observing system problems
       - Could be difficult to get regional support for those things that are national and/or global in scope.

    b. High spatial resolution climate system prediction and projection models with demonstrated skill SEE ABOVE

    c. Continuity of the climate data record/data stewardship and the development and sharing of tools to support the utilization of the data

11. Ensure that climate services are integrated with active research with feedbacks that will directly impact the generation of new climate service capabilities and climate services, and in turn, will directly influence research directions. This must be based on integrated, cross-cutting and end-to-end research that will support the production of climate system information. Fundamentally, this must be founded on the development of skillful forecasts and predictions and span a better understanding of human and natural systems and how they respond to change.

PRO

- Explicitly provides mechanism for users to influence research directions and development of improved climate service capabilities

CON

- Need to be sure that longer-term, larger scale basic research does not get de-prioritized because of shorter-term, smaller-scale interests of the regional entities that support the Federation

12. Include specific mechanisms to entrain successful products into the operations and capacity of the service

PRO

- Creates the opportunity for uniform delivery of wide range of products
- Creates activity that has license to state requirements for product

CON

- Researchers may not want to transition successful products
- Need to have good mechanism for Federation to be able to grow its scope to enable it to utilize advances that come from outside it.

Overall:

PRO

- Potential for better return on investment, since users are defining products, rather than products waiting for users

CON

- Would require legislation

Implementation Issues

The Federation needs to have an independent budget to leverage agency budgets, with this budget serving as the basis for collaboration between Federation and agencies. It is essential to have a central, federal component because of the need for a high-level federal leader, controlling a budget, who speaks for the entire enterprise.

The Federation would likely require authorizing legislation. A charter needs to be developed prior to legislation. Non-governmental group should host drafting body consisting of researchers, government (at all levels) managers, and users.

Performance Measures

This discussion was keyed around the 2005 NRC report *Thinking Strategically: The Appropriate Use of Metrics for the Climate Change Science Program.* Some of the specific measures and considerations applicable for this option include

- Existence of a leader with sufficient authority to allocate resources…
- Peer review is not necessarily a measure; for policy, must consider Data Quality Act (Federation does not have policy role)
- When information being used, is there any benefit (Impact metric)? The NRC impact metrics are fairly comprehensive.
- If carbon accounting is part of mission, how effective is the monitoring program? Is carbon monitoring part of the NCS?
    - NCS could provide assessment of state of science, sources/sinks, etc.
    - Should be the place of objective information; could inform policy and aid decision-making.

Tiger Team #2 – Non-Profit

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Option Focus: A National Climate Service (NCS) led or facilitated by a non-governmental organization outside the government (e.g., non-profit, FFRDC, etc).

Non-profit Tiger Team Charge. Given the Coordinating Committee's NCS definition and principles below, our team was asked to examine the following issues:

1. **Purpose/Characteristics.** Clarify why this option should be pursued and what it would do.
2. **Implementation.** Define how it would work, who would be involved, and develop a diagram that shows how it might be structured. Create rough timelines and requirements to implement the option.
3. **Performance.** Provide insights into how success will be judged and performance metrics
4. **Principle Pros/Cons.** Develop pros and cons of this option relative to the principles.
5. **Examples.** Examine how our option would address the examples provided by the Coordinating Committee.
6. **Briefing Package.** Create a rough brief packaging – the elevator speech and powerpoint on our option.

Team Summary. Below is a brief summary of our response to the six elements of our charge.

Purpose/Characteristics. The following is what we agreed were the basic characteristics of a non-profit NCS:

- Satisfies all of the guiding principles and definition of a national climate service (as provided by the Coordinating Committee and No-Profit Tiger Team revision).
- An agile, responsive, and adaptive organization whose primary function is connecting climate science with decision making.
- Provides and manages a process for multiple modes of engagement of users, private sectors, public (local, state, regional, federal, tribal) agencies, research communities, and non-governmental organizations.
- Fosters innovation, entrepreneurship and partnerships.

- Is an information hub, harvesting the science in an additional effort that leverages but does not replace existing federal climate science and technology investments (e.g. CCSP and others).
- Mines the talent in a variety of external networks and federal agencies and focuses that talent on development and delivery of decision relevant information products.
- Addresses both a long-term strategy as well as satisfying near term requests
- Has an ongoing mechanism for feedback of research priorities to the federal science programs.
- Provides streamlined, effective and efficient contractual and intellectual property agreements.
- Provides a built in evaluation and assessment process that allows the organization to constantly refresh its processes and its products while continuing to provide high quality climate services. This would ensure easy access and usability.
- Builds capacity for incorporating science into climate sensitive decisions.
- Nurtures a virtual network of regional, local, international, and sectoral expertise.

Implementation. Figures 1, 2, and 3 below provide the overall structure and description of our option. We believe this approach is the most effective management approach of the various options being explored by the Coordinating Committee to ensure that the NCS is responsive to user identified needs and unfettered by the many restrictive federal rules and regulations. Below are our comments on how this option could be implemented:

- **Approaches.** We had substantial discussion about what it would take to actually implement this option. For starters, someone needs to want this! We discussed how current models got started like NIDIS, NCAR, NFWF, etc. NIDIS was sponsored by the Western Governors Association and established through congressional legislation rather quickly, but was based on relationships and interest developed with the WGA over several years. NFWF and NCAR also took several years to create by their respective communities working with a sponsoring agency. The NCS could involve +12 research and regulatory agencies – far more complex then these other models. So, getting this created quickly will be challenging. Neither of the Presidential candidates are talking about climate services – at best they are discussing carbon emission mitigation approaches such as cap and trade. It is likely that working to gain support from WGA-like or other user groups will take several years. Probably the only "quick" approach to implementing a NCS is through the current presidential transition process. UCAR and other organizations are sponsoring a "transition document" that makes weather and climate related program, management, and budget recommendations and collecting nominations for key weather and climate positions in the next administration (see http://www.ucar.edu/td/). NOAA will also be asked for transition information at some level. These are near-term opportunities to raise these issues to the incoming administration and congressional leaders.
- **Initial Planning Committee and Early Steps.** Regardless of the path, the creation of this organization will require a small high-level planning committee with members who are knowledgeable about the integration and use of problem-oriented climate science, decision maker engagement and needs, development of products, delivery of services, and can help develop the structure, governance, and bylaws of the Non-Profit (NP). It is essential that this planning committee solicit input using a variety of interactive methods from users, the private sectors, federal

agencies, public decision entities, state and local governments, and research communities. This planning phase could be facilitated through a non-federal organization. Perhaps, the NRC Spring 2009 climate summit would be one near-term venue to get this stakeholder input on the NCS and legislative or executive branch direction could initiate this early NCS planning committee effort. The planning committee should specifically work towards the development of the overarching NP charter. We expect this overall initial planning effort will require at least one year.

- **Critical NP Governance Elements.** There are several critical governance elements needed to make the NP successful. These elements reflect the NP characteristics mention above and the proposed structure highlighted in Figures 1, 2, and 3, including:
  - The NP governance and structure can be based on existing NP models (NFWF and NCAR) although the NCS NP may have some unique features given the breadth of its mission (research, operations, numerous federal agencies, local-to-national users, etc).
  - The NP board membership should be 12-15 board members that reflect key groups (e.g., federal agencies, research communities, private sectors, public decision sectors, user communities, etc.). However, the board members should be focused on bringing their perspective to the service - not representing any particular organizational group.
  - The NP board will appoint a NP President/Director.
  - The federal oversight role may be done through a single federal agency but that agency must specifically be representing broader federal governmental interests and not the interest of just that agency.
  - Federal funding must be a direct pass through to the NP. While the sponsoring agency is a cooperative partner and has an oversight role in the NCS on behalf of the broader federal interests, the NP board must have full legal, fiduciary, policy, and accountability responsibilities over the NP activities.
  - There must exist a definitive senior federal climate leadership (Cabinet-level, OSTP, OMB) that can provide high-level, integrated federal program, budget, and policy guidance to the NP and oversee the federal climate research program (separate from the NP). This interaction will also provide a two-way mechanism for the NP to work with the federal climate leadership to ensure the federal climate research investments and priorities are responsive to NP needs (see Figure 1). The NP could help in the coordination activities of the federal climate research program, but only to the level that it does not interfere with the inherent internal federal budget development and oversight responsibilities and confidentiality requirements.
  - The NP should ultimately be chartered by White House or Congressional action (e.g. a presidential or congressional commission).
- **NP Programmatic and Management Infrastructure.** We expect that a successful NP NCS will require an investment that is comparable to the existing climate science and observing investment level (e.g., CCSP), although it would be phased in over time and refined as exact services are defined. However, we expect the core NP staff (100-200 people) and infrastructure to be relatively small and acting in many ways as a "virtual organization" that delivers services across a range of scales and sectors via partnerships with other organizations. Funding for the NP will include the core human and physical infrastructure as well as the "virtual" networks and the work that collectively will be done. The NP infrastructure includes (see Figure 2):

- exemplary finance and administration function that develops contractual mechanisms, intellectual property mechanisms, and audit/finance/budget processes
- evaluation and assessment capacity
- decision-support function that includes the design, development and novel use of information systems and other tools
- capacity building function that works with decision communities to build confidence and capability to use information (education, training, and outreach)
- modeling function that is an expert group that assess, synthesize, translate multiple model based outputs to meet user needs without building large in-house modeling capability. It will interface with external modeling groups (climate, environmental, decision, and economic)
- observation function that works with the many federal, international, and regional observing networks to ensure that sustained observing systems and data are available to address climate services needs; we do not anticipate that the NP would be operating complex observing systems
- robust network of regional and sectoral entities such as RISAs, RCCs, state climatology offices, university outreach centers, etc.

This infrastructure will be mobilized in a team effort to address problem focused issues. There will be a need to have a capacity in the NP and with its networks and users to mutually scope and frame the problems; reconcile supply and demand of information that is needed; support the needed research and product development (a product can be a process in addition to a model, tool, prediction, etc); and build the user capacity to use the information in their decision making.

Figure 1: Relationship within the Federal Government

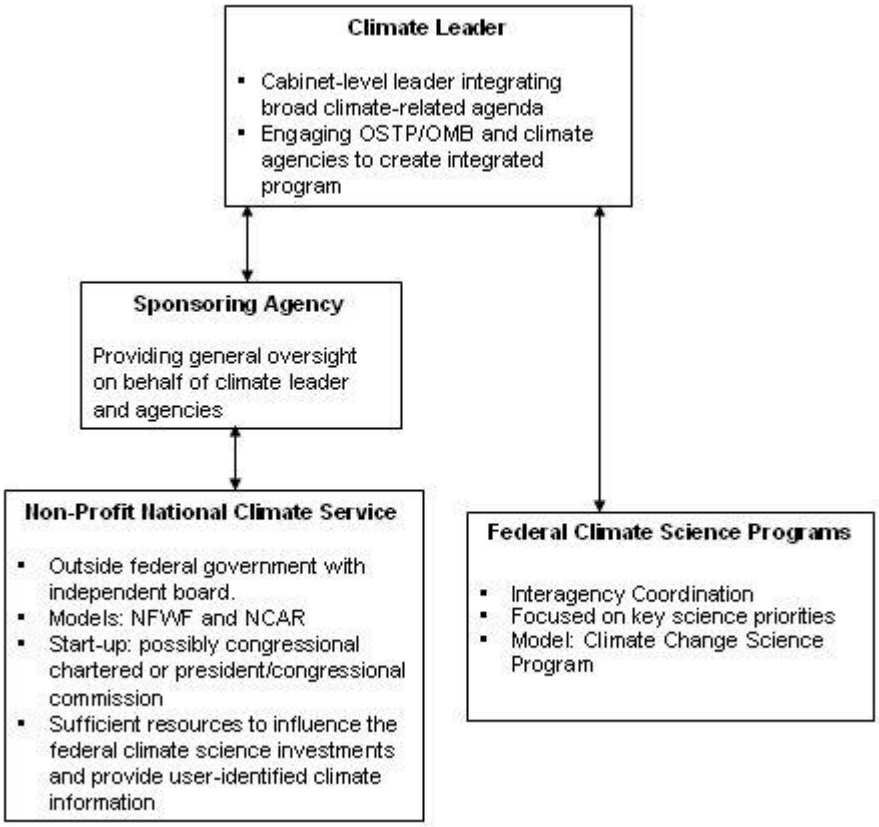


Figure 2: Non-profit National Climate Service Structure

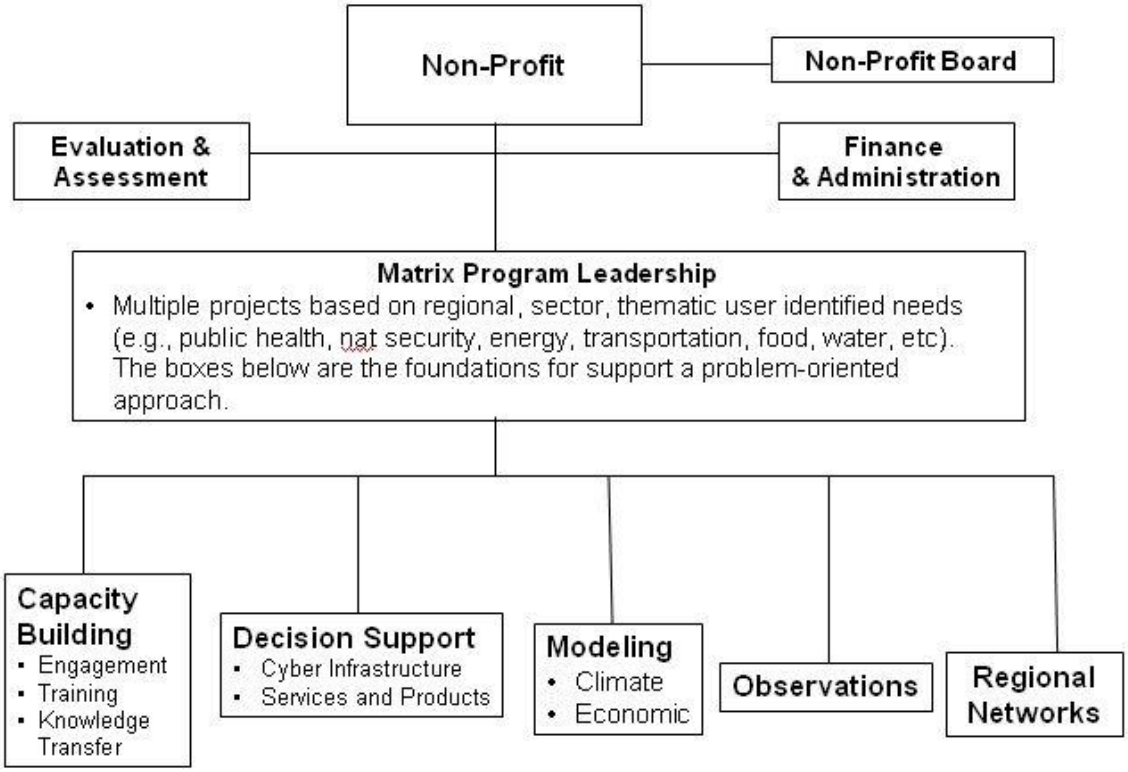
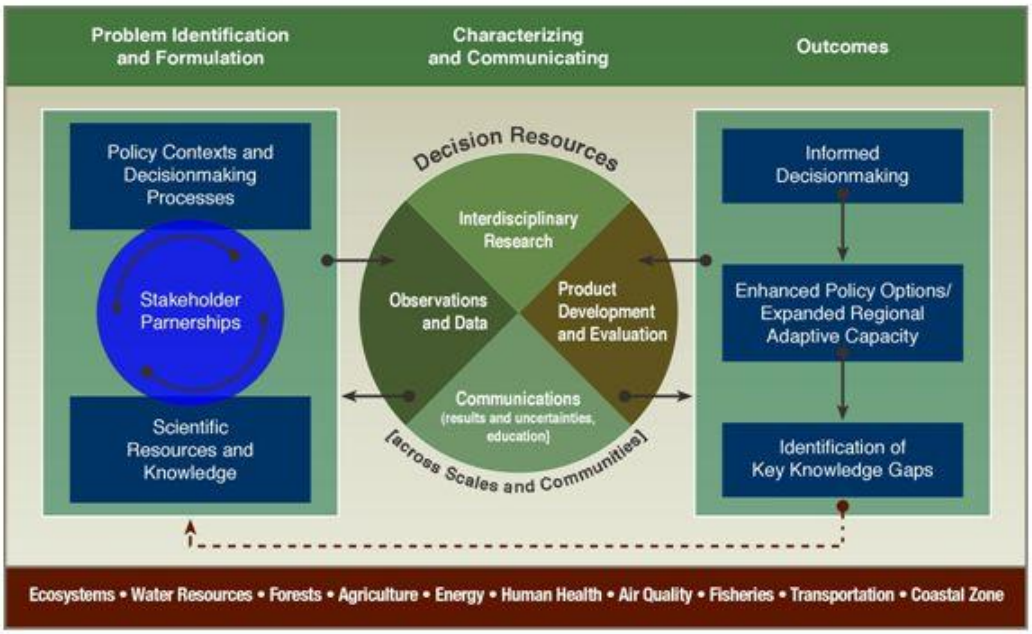


Figure 3: Schematic of National Climate Service Problem Formulation, Communicating, and Outcome Process



Performance. We discussed both quantitative and qualitative metrics and how the various metric approaches outlined in the recent NRC metric report (i.e., process, input, output, outcome, and impact) could be applied to the NP option. As mentioned above, we recommend that the NP actually have an evaluation and assessment capacity and make that investment a high priority and part of the early organizational planning. In our opinion, one of the most effective performance metric approaches would be having the NP President (with help from the Board) create an "actionable" strategic plan that would guide the implementation of the organization into the future – a set of clear and measurable strategic goals and objectives created so each employee's contribution to these goals and objectives could be effectively incorporated into their performance appraisal. This kind of structure can be the difference between an effective management tool and a wispy plan that gathers dust on a shelf. With such a management tool, managers and staff should be able to see that budget allocations are made consistent with the strategic goals and objectives and how their own efforts are supporting the strategic direction of the organization. This tool can also be very powerful to the overall morale of an organization (people are clear on the organization's philosophy and direction) and can also be used to report on the overall performance of the organization (are we achieving the commitments we made). Strategic planning is hard and people are can be very cynical about it its value, but doing it right can be a very powerful and critically important investment in an organization's future. The Coordinating Committee attempted to include actionable goals and objectives in the NCS definition. We applaud that effort and would recommend that the NP make a commitment to create such an actionable strategic plan.

Principle Pros/Cons. Below you will find the detailed pros/cons our team developed for each principle. In summary, we found this option to mostly have pros relative to these principles largely due to the fact that its primary focus is to have a strong interactive and responsive connections with stakeholders and users (federal agencies, local and regional decision makers, service providers, etc) and can be substantially more nimble and flexible than a bureaucracy operating under today's federal rules and regulations. This organization would be driven by user identified problems and try to address issue by mining the very best skills from the various sectors (public, private, academic, etc) versus building a centralized bureacracracy. A major pro is the fact that this organization has a single agenda versus NOAA or a federation of agencies that is operating in an environment with many agendas that are at times in conflict with one another (CCSP priorities versus agency priorities, NOAA trying to balance a Commerce, fisheries, weather service, etc agenda). We did think that many of the principles had redundant themes (e.g., supporting or being responsive to user needs). The few cons that were raised included:

- This approach may not be successful unless the federal government can embrace prudent but creative risk taking, novel partnerships, new ways of doing business, and supporting a cooperative partnership environment in which a NP can thrive.
- Such a non-profit could be substantially more responsive to user needs than the other federal-oriented options, but the challenging and complex nature of coordinating and balancing all the possible demands on the NP and a broad network of distributed partners is likely to be riskier than the traditional federal approach – without the right leadership and support this could fail.
- Being outside the government, there could be issues on whether the NP is seen as a "trusted" and "authoritative" source of leadership and information.
- The NP might not be able to support something as inherently governmental as the IPCC or aspects that require country-to-country agreements.
- While we believe the NP will generate much wider user buy-in, a NP may be easier to cut than a federal program – will this be robust enough to weather tough budget environments and continue the needed long-term infrastructure?

Examples. We were asked to examine whether the NP could effectively address the situations described in the examples provided by the Coordinating Committee. We reviewed the examples and concluded that some of them were written as success stories and some as problems that needed to be addresses. We decided in the interest of our short time together to not analyze each of these examples since we believe the user-oriented nature of the NP would optimize how issues highlighted in these examples would actually be addressed. We saw no barriers in the NP to address any of these situations (stewardship of resources, mitigation strategies, supporting a green economy, protecting life and property). In fact, it was our opinion that the NP could also be organized along these dimensions.

Pros/Cons of Guiding Principles. Below you will find our pro/con analysis of how the NP option addresses these principles (summarized above).

13. Serve to develop products and information that will protect the public good and promote a variety of societal benefits including
    a. Improve prediction and projection capabilities on the time scales that contribute to societal benefit
    b. Promote a better understanding of how climate change and variability can promote an improved understanding of other environmental components
    c. Engender new natural and social science capabilities that may have large expected and unexpected benefit, and
    d. Promote improved federal, state and regional adaptation and mitigation strategies and policies.
    e. Promote a more informed citizenry
        - **Pro:** Will work only if link between NP and CCSP is strong. Can enable and nurture broader range of partners than NOAA-only options. Can build models that are more responsive to user needs. Can engage with bottom-up system easier and with more flexibility.
        - **Con:** Being outside the Federal government can make it difficult in international interactions, but it can be done. Maximum flexibility and pressure to respond to diverse needs could lead to lack of focus. NP may not have same authority as Federal organization. Issues on potential NCS competition with private sector.

14. Reflect the full range of users, ranging from those who can define their needs and are ready to make use of specific information to those who have limited experience and for which the utility of climate information is not yet clear.
    a. **Pro**: Keep focused on problem rather than forecast or type of forecast. Great ability to engage a full range of users, including those that have limited experience.
    b. Con: Complicated nature of the NP structure may be hard to penetrate for users. Will it be a trusted source? Who will pay of the private sectors wants the information more than the public sector.

15. Address the full range of time scales of interest to society without artificial or arbitrary divisions based on days, weeks, months, years or decades.
    a. **Pro**: May be more open to weather versus climate issue than NOAA and would be very responsive to users. The problem-focus will make it easier to overcome these artificial weather/climate boundaries.

b. **Con:** Don't see any.

16. Promote the extension of climate information to climate system information so that the fundamental problems associated with the climate system and diverse regions (e.g. the coastal region) and sectors (e.g. ecosystems, water, human health, agriculture, energy, insurance, social and economic infrastructure, national security, etc.) can be addressed.
    a. **Pro**: Problem-focused approach builds systems analysis that integrates across sectors and regions. Can create information that is more responsible to user needs rather than "stuck in agencies".
    b. **Con:** Don't see any.

17. Support problem-based assessments and improved decision-making that are on global, regional, sectoral, and integrated scales.
    a. **Pro**: Problem-based framework is well suited to regional and sectoral assessments.
    b. **Con:** May or may not be as well positions to respond to IPCC-like activities.

18. Create a science-based and research–supported capability that ensures that information is accessible, authoritative, includes data, interpretation and integration, promotes communication and education, and promotes innovation and interaction.
    a. **Pro**: Dealing with fundamental cyber infrastructure issues would be a strength of this model. Wide ranges of communication techniques are characteristic of boundary organizations. RISAs provide a strong example of communication with users. Nonprofit must be conscious of providing support for communication issues.
    b. **Con:** Don't see any.

19. Create an active community of interaction that promotes the 3-way involvement of researchers, users, and climate information providers that is engaged throughout the process from planning, execution, assessment, and improvement and involves the active use of the information within the service.
    a. **Pro**: This model would work much better given the user interface.
    b. **Con:** Don't see any.

20. Recognize, incorporate and promote a "cascade" of roles extending from nationally-provided and vetted products, to defined roles of mission agencies, to a variety of interfaces with users (including regional or boundary interfaces such as Regional Integrated Science and Assessments (RISAs), Regional Climate Centers, state climatologists, NGOs, and the private sector), to the active engagement of a wide range of users.
    a. **Pro**: Combination of bottom-up and top-down. Every agency wants to participate and agencies must articulate what it contributes to the NCS. Should allow for influencing CCSP research to be relevant to user needs.
    b. **Con:** Roles of mission agencies must be explicitly defined to work with NP.

21. Define the role of various federal agencies

a. **Pro**: Could define more tightly across problems and not in terms of what agencies want to do. Funding incentives could strongly influence agency roles and participation. Could more tightly define efforts in terms of adaption, services, products, etc.
b. **Con:** Will require leadership and resources to make happen. If underfunded or lack of clarity on roles, it will likely fail.

22. Recognize that there are significant foundations required for a robust climate service underpinned by
    a. A robust climate observing system (ex. Continuity of data or data stewardship.)
        - **Pro:** Closer to user side; more responsive to new observation requirements. Support of governors, national security, and central to keeping long term observations. Fosters observing system support from user perspective (and can identify user needs) rather than just scientific perspective.
        - **Con:** Sense of vulnerability to funding reductions for long-term efforts like observing systems. Nonprofit can support, but not operate, observing system.
    b. High spatial resolution climate system prediction and projection models with demonstrated skill
        - **Pro:** same as a
        - **Con**: same as a.

23. Ensure that climate services are integrated with active research with feedbacks that will directly impact the generation of new climate service capabilities and climate services, and in turn, will directly influence research directions. This must be based on integrated, cross-cutting and end-to-end research that will support the production of climate system information. Fundamentally, this must be founded on the development of skillful forecasts and predictions and span a better understanding of human and natural systems and how they respond to change
    a. **Pro**: This would be the only agenda of the NP, rather than NOAA's many agendas. Can help with integration of the NWS into climate services. In NCAR experience, weather and climate are tending to merge. Feedback mechanism refocuses research into high priority climate issues.
    b. **Con:** Potential competition with NWS offices.

24. Include specific mechanisms to entrain successful products into the operations and capacity of the service.
    a. **Pro**: Could better take services developed in one region and transfer to another – i.e., better capacity building and partnership with a broad range of users.
    b. **Con:** Less centralized, more need for coordination to avoid potential redundancy, gaps, and public-private sector competition.

Tiger Team # 3 – Create a national climate service with NOAA as the lead agency with specifically defined partners

21-22 October 2008
Silver Spring, MD

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Summary

Option 3 presents a middle ground between the decentralized options 1 and 2 and the expanded weather/climate service of option 4. It creates a flexible National Climate Service through a strategic partnership in which NOAA serves as the lead entity.

The Team evaluating Option 3 (Create a national climate service (NCS) with NOAA as the lead agency with specifically defined partners) first developed a working conceptual model of how such a partnership might be organized (Fig. 1). This model incorporates a vision and mission of a Climate Service that would be located in NOAA, and consistent with NOAA's responsibilities and the perceived comparative advantages of NOAA and that of its expected partners. The Team proposed changes to the Draft Climate Service Definition which was then used throughout the working session which the Team felt best reflects the vision and definition.

The Team proposes the following changes to Draft Climate Service Definition:

The National Climate Service will assist the nation and the world in understanding, anticipating, and responding to climate, climate change, and climate variability and their impacts and implications. The Service will inform the public through the sustained production and delivery of authoritative, timely, useful information about impacts on local, state, regional, tribal, national, and global scales.

The service shall be user-centric, by ensuring that the information is accessible, consistent with users' ability to respond and based on user needs and limitations. The service will provide such usable information through a sustained network of observations, modeling, and research activities.

NCS in this option would have the following attributes:

- draws upon established relationships and capitalizes on joint research and operational experience of NOAA;
- builds upon the experience and proven abilities of established partners, yet allows for future integration of new relevant partners in response to changing climate conditions and impacts;
- transforms climate data into timely and authoritative climate information relevant to user needs; and
- integrates both providers and the users, which operate within the system at all the relevant levels, local, regional, and global, and to the multiple stakeholders and decision-makers, into the data and information flow.

Why NOAA as lead agency with specifically defined partners**?**

No agency or organization can do the job alone, but NOAA has more of the attributes and mandates within the domain of the physical climate system to play the lead role. At the same time, it acknowledges the critical need for other partners, given their attributes, and mandates, to further refine climate models, vulnerability assessments, and to document impacts and inform risk management which will be central to assisting the Nation address future climate changes and climate impacts. Specifically NOAA brings to the partnership the following:

- Predictive capacity of atmospheric and oceanic changes[^] and long-term observations[±] which is already recognized as part of NOAA's mission;

[^] Other partners will complement the capacity of NOAA as they bring documentation, understanding of the land, natural systems, and cryosphere that will be necessary to understand and predict changes in the larger climate system.

[±] Many of the elements of the global observing systems are in place although it is deficient (GCOS 2003; WMO TD No. 1143) and thus an expanded network through strategic partnerships would enhance the NCS' ability to provide needed data to effectively manage climate impacts. Further, a coordinated effort, initiate by a lead agency, would to better integrate the currently fragmented observing systems (NOAA/NWS, FAA's Automated Surface Observing System, USGS' Stream Gauge Network, USDA's

- A mandate to operate at both the domestic and international level;
- Established relationships that exist with major stakeholders;
- Sophisticated scientific and computational infrastructure that is already in place;
- The ability to build on existing capability rather than require a new bureaucracy be developed;
- Strong interest within agency for development of climate service; and
- Offices well represented regionally, which enhances to ability for extension and outreach, as well as coordination with partners.

The Boundaries of a NOAA-Led National Climate Service

A NOAA-led climate service would be the authoritative provider of climate information for a wide variety of collaborators and stakeholders. If realized, the service will be the source of climate information and related translational products that will enable the public and all relevant decision-makers to make better informed, cost-effective decisions regarding the effects of climate change, and related adaptation and mitigation strategies that deal with these impacts.

The NOAA-led climate service is NOT intended to obviate or supplant the decision-makers or their mandated authorities related to dealing with the effects and impacts of climate change on trust resources, public or private lands, or the public welfare in general. Such a responsibility was considered by the Tiger Team to be well beyond the scope of a NOAA-led effort and requires the leadership of other Federal agencies (and the significant participation by a wide host of other public and private entities). However, an organizational structure suited to dealing with the impacts of climate change, parallel to the NOAA-led climate information model described in this document, might very well be warranted, with strong, formal linkages to the NOAA-led climate service.

Requirements of a NOAA-Led Climate Service

In order to be successfully implemented, the model described in this document requires a formal, well-defined organizational structure with the appropriate authorities. The Tiger Team discussed a CCSP-like model in which all relevant climate service participants (the agencies) voluntarily coordinate their respective workplans with NOAA serving as the lead agency in coordinating the workplans about a common set of strategic goals that would be developed in consultation with all climate service participants. This model was considered to be less than effective, based upon the previous experiences of Tiger Team members with similar frameworks, including CCSP.

Although the Tiger Team did not have the time to thoroughly discuss or analyze different organizational models, several members recommended that the NOAA-led effort would gain great efficiency from having some level of workplan development and funding authority over the other participating agencies. Without some type of authority in final workplan development or funding implementation, joint goal sharing and prioritization of climate service product development would be extremely difficult at best and would lead to less than optimal performance of the service in delivering high-priority products.

Snowpack Telemetry and Remote Automated Weather Stations network, and WGA's National Integrated Drought Information System) would create a more comprehensive and cohesive observing system.

Attributes of Option 3

Each of the Tiger Teams was charged to evaluate the strengths and weaknesses of its option regarding the ability to achieve the desired outcomes for a Climate Service, as described in the Climate Working Group report of the Vail meeting. Below is a listing of these pros and cons as derived by the Tiger Team for this option:

- Serve to develop products and information that will promote a variety of societal benefits including
    - Improve prediction and projection capabilities on the time scales that contribute to societal benefit

        - PROS
            - Involves a range of players
            - Will address major issues
            - Provides a clear line responsibility for task
            - Will create a clear authoritative source of climate information
            - Given the ability to leverage the attributes and expertise of the various partners, may prove to be the most cost-effective and timely mechanism
            - NOAA has capacity and comparative advantage
            - Could help other agencies (and other offices within NOAA) meet legislative mandates under changing climate conditions

        - CONS
            - Could weaken case for or commitment of active role for other science agencies (NASA, NSF, DOE) involvement
            - Could impede progress in understanding by prematurely forcing standardization
            - NOAA may not have resources to meet demands for climate information nor the ability to control the direction of new resources
            - Complexity of multiple partners is cumbersome and is likely to cause conflict and delay
            - Could require high level engagement (executive office) to bring other partners to the table
            - Other agencies could redirect actions away from these priorities

    - Promote a better understanding of how climate change and variability can promote an improved understanding of other environmental components

        - PROS
            - With the assumption of enhanced coordinate across agencies and monitoring systems this “leader with associates” model offers, option 3 could provide more consistency in the interpretation of past climatic conditions, regional climate forecasts, and future projections

        - Network could facilitate spin-offs of applied projects to address specific needs
        - Partners could drive priorities
        - Provides a direct mechanism for agencies and others with information to inject it into the Climate Service

    - CONS
        - Agencies that are responsible for environmental components could be overly dependent on Climate Service for climate information and may not have their priorities addressed
        - A highly centralized and formal role for NOAA could make other agencies less likely to try new things
        - Multi-stakeholder environment may not be flexible enough in some cases to respond quickly (a challenge)

- Improve decision-making capabilities in particular sectors and regions

    - PROS
        - Likely to identify high-priority areas
        - Will support multiagency missions
        - Will provide resource agencies and managers with a nationally vetted, authoritative source of information
        - Builds on existing capacity (e.g. RISA, NOAA-led interagency NIDIS, Coastal Services Center)
        - Could encourage more experimental approaches to management
        - Improves coordination and leveraging of additional resources related to particular problems and multiple scales
        - Could fill a major gap in regional information
        - Could support regional initiatives of states on climate issues

    - CONS
        - Different time frame and criteria for production of science and needs of decision-makers
        - Buy-in from other agencies could be an issue
        - Not necessarily a flexible mechanism
        - With more partners, tendency to spread resources broadly
        - Default position might be an emphasis on large (i.e. global) scales

- Engender new natural and social science capabilities that may have large expected and unexpected benefit

    - PROS

        - User needs may inform social science requirements (e.g. new capabilities through RISA)

    - CONS

  - Promote improved federal, state and regional adaptation and mitigation strategies and policies

    - PROS
        - Collaboration may enhance creativity and enhance the development of strategies;
        - Consistent understanding of the nature of climate change at regional and local scales will improve cooperation and coordination across agencies and governments (e.g. federal, state, local);
        - Facilitate the exchange of lessons learned and experimental innovation;
        - NOAA has experience in serving clients on applied questions related to drought and weather conditions, e.g. NIDIS, Pacific Northwest Salmon issues, fire management

    - CONS
        - If the mandate of the climate service extended to adaptation and mitigation, a single lead agency could inhibit ability to develop adaptation strategies and policies

  - Promote a more informed citizenry

    - PROS
        - Will enhance the visibility and legitimacy of climate forecasts and projections

    - CONS
        - Forecasts and projections, as any other scientific information, could be (and frequently are) politicized

- Reflect the full range of users, ranging from those who can define their needs and are ready to make use of specific information to those who have limited experience and for which the utility of climate information is not yet clear.

    - PROS

        - The commitment to create a partner group will create a formal mechanism to identify priorities;
        - A consistent set of projections that covers the nation "wall to wall" will provide a floor or minimum set of climate conditions that can meet the needs of users
        - Will tend to develop a core set of information for all users quickly

    - CONS
        - Tendency to move to a "one size fits all"
        - A targeted approach under a climate service will focus on a set of priorities and not necessarily meet the needs of all users – especially those unable to articulate needs

- Address the full range of time scales of interest to society without artificial or arbitrary divisions based on days, weeks, months, years or decades.

    - PROS
        - NOAA will have capacity to ensure coordination between the climate service and the NWS

    - CONS
        - Integrating climate and weather could do a better job of this on the delivery

- Promote the extension of climate information to climate system information so that the fundamental problems associated with the climate system and diverse regions (e.g. the coastal region) and sectors (e.g. ecosystems, water, human health, agriculture, energy, insurance, social and economic infrastructure, national security, etc.) can be addressed.

    - PROS
        - Will provide applied agencies and users with consistent climate information to promote better decision making – effective application of this information will remain in the hands of the partners but will take place through partnerships with the climate service as needed

    - CONS

        - As an inherent aspect of the complexity of the climate system, gaps will continue to exist in use and application of information and uncertainties in addressing cross-sectoral risks.

- Support problem-based assessments and improved decision-making that are on global, regional, sectoral, and integrated scales.
  Note that information provided by a climate service will support but will not carry out problem-based assessments

    - PROS
        - The partner structure of this option may encourage strategic linkages among partners to tackle such problem-based assessments. And given the broader network created by the combined partners, it may enhance dissemination of information to decision-makers or previously unengaged sectors.
        - Can ensure that cross-scale problems are identified and responses are integrated effectively and externalities across scales are addressed (International-Federal-State-local)
        - Provides the beginning of an organizational structure to support assessments and strategic allocation of resources.

    - CONS
        - In setting up problem-based assessments, may exclude some of the users
        - Interagency agreements to address complex (cross-scale, multi-stress) environmental risks are difficult to craft and implement effectively
        - Without cross-organizational coordination, assessments may not be complete nor serve users as well

- Create a science-based and research–supported capability that ensures that information is accessible, includes data, interpretation and integration, promotes communication and education, and promotes innovation and interaction.

    - PROS
        - NOAA has recognized history of doing science-based service, and other science-based organizations would likely be a part
        - Builds on existing NOAA climate communication and educational outreach capacity

    - CONS
        - There is a limited track record of translating information to managers in particular agencies, but it has yet to be proven in a multiagency setting.
        - Could become very conservative given preexisting service or operational culture

- Create an active community of interaction that promotes the 3-way involvement of researchers, users, and climate information providers that is engaged throughout the process from planning,

execution, assessment, and improvement and involves the active use of the information within the service.

- PROS
  - Public sector and NGOs have history of active community of interaction

- CONS
  - Need to avoid reaching out only within the lead agency or simply stove piping information into individual agencies
  - Data and information quality can be compromised without adequate attention and guidance on the part of the partner organization taking the lead on this.

- Recognize, incorporate and promote a "cascade" of roles extending from nationally-provided and vetted products, to defined roles of mission agencies, to a variety of interfaces with users (including regional or boundary interfaces such as Regional Integrated Science and Assessments (RISAs), Regional Climate Centers, state climatologists, NGOs, and the private sector), to the active engagement of a wide range of users.

  - PROS
    - Brings all of the historical connections between agencies and users into play
    - Augments existing service links as a basis for expansion
    - Allows interagency connections to evolve
    - NOAA currently has mechanisms to provide for information and data flow and development of the program

  - CONS
    - If the organizational structure of this option is not carefully formulated with relevant role and responsibilities and terms of reference, too much centralization could result and thereby restrict interactions with users and others.
    - Will NOAA have the skill and authority to bring multiple partners and stakeholders to the table initially and sustain their program involvement and as the Service progresses?

- Define the role of various federal agencies

  - PROS
    - Ready-made set of interactions to build upon
    - Balance between enhanced participation and manageable scope
    - Given multi-player structure, option has the ability to suggest new partners not initially represented

            - By going to lead agency, tap into experience base and existing roles

        - CONS
            - Lack of incentive to have roles evolve
            - Without well-defined and justified roles, enhance risk of conflict
            - Lead agency may limit participation and default to established modes of operation
            - May not be optimal set of agency roles based on existing roles

- Recognize that there are significant foundations required for a robust climate service underpinned by
    - A robust climate observing system
        - PROS
            - Promotes a diverse portfolio of observing system assets
            - With a lead, there is an oversight, a responsibility for the observing system
            - Access to non-traditional sources of data
            - With NOAA brokering standards and consistent data collection policy, better prospects for long-term climate record
            - Better chance of coherent data archival system
            - Easier to coordinate international partnerships and agreements (single point of contact)
            - Network of world class scientists and research institutions

        - CONS
            - US-centric effort may not engage international players
            - Organizations have difficulty in prioritizing between competing needs, e.g. weather and climate observations (NPOESS)
            - Involvement of non-federal organizations may require incentives to assure their participation
            - Implement via MOUs or legislation? The former is easier to disregard

    - High spatial resolution climate system prediction and projection models with demonstrated skill
        - PROS
            - Lead agency has demonstrated skill
            - Existing capabilities; SEE ABOVE

        - CONS

- Ensure that climate services are integrated with active research with feedbacks that will directly impact the generation of new climate service capabilities and climate services, and in turn, will directly influence research directions. This must be based on integrated, cross-cutting and end-

to-end research that will support the production of climate system information. Fundamentally, this must be founded on the development of skillful forecasts and predictions and span a better understanding of human and natural systems and how they respond to change.

- PROS
  - Best of options at capturing integrated nature of the information system
  - Perhaps more cost-effective; between incremental and comprehensive change
  - Can provide impact of climate change on shorter-term variability
  - Community of partners could aid in transition from research to operations

- CONS
  - How would the lead agency engage its partner agencies to assess and respond to local concerns?
  - Agencies typically have not done well at incorporating social and behavioral research – but user-driven focus on regional may force this

- Include specific mechanisms to entrain successful products into the operations and capacity of the service SEE ABOVE

  - PROS

  - CONS

Our report has responded to the issues that were given to us. However, we did not have the time to focus on the governance structure and functions of the partnership arrangement. Before a decision is made on a recommended structure, it is important to provide some detail on the way that the partnership arrangement will deal with different cultures, needs and perspectives. We recognize that the partners that would be part of this arrangement (particularly those who are users of the science) may have very different expectations about their involvement. There would be a gaping hole in the decision process if those issues are not considered.

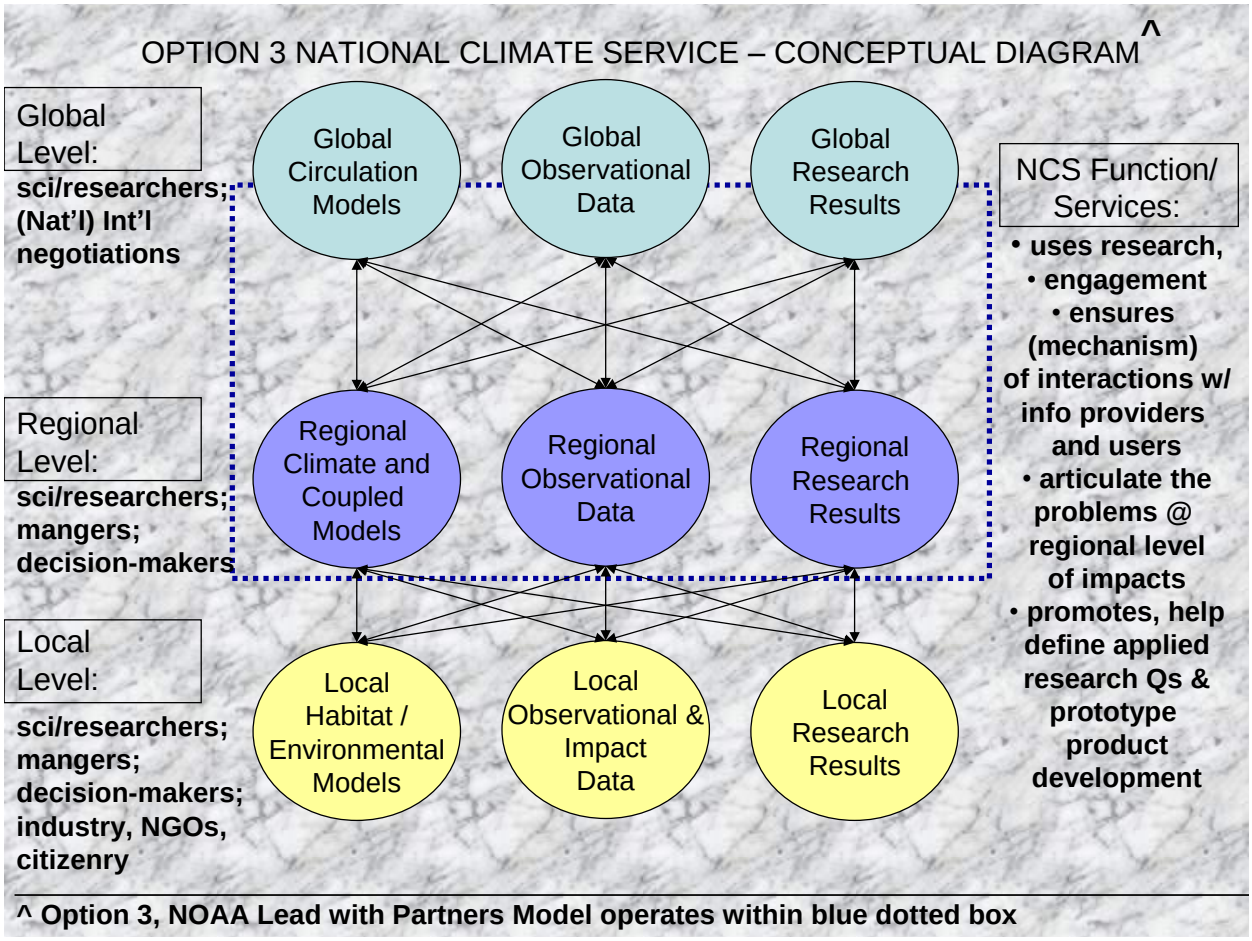

Figure 1. NCS conceptual diagram of Option 3 "NOAA as the lead agency with specially defined partners."

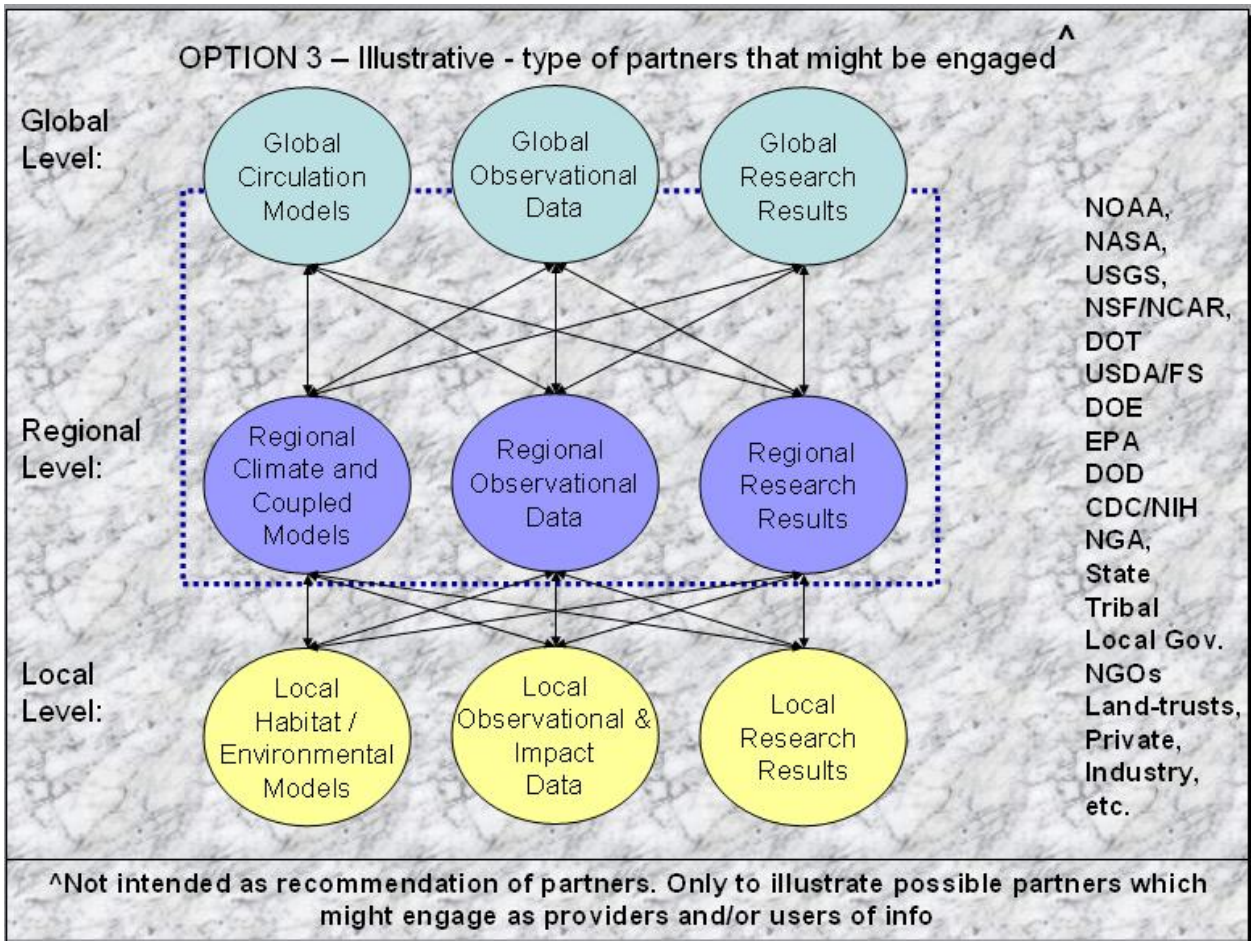

Figure 2. Illustrative of the type of partnerships (not intended to be comprehensive or reflect recommendations.)

Tiger Team #4 - Expand and Improve Weather Services into Weather and Climate Services within NOAA

19-21 October 2008
Silver Spring, MD

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This National Weather and Climate Service would serve as an outlet for NOAA climate services. It builds upon the existing service components' extensive connections at the regional, state and local levels and expertise in effectively delivering products and services. It is formed by the merger of the National Weather Service and the NOAA Data Centers thus capable of providing a broad range of data and information from historical information through climate projections of a few years. To enable the provision of decadal through centennial time scales, it builds upon the great research components of NOAA and provides an effective outlet for the products and services developed by those components. But to do so, the service components' capacities in climate will need to be expanded through additional staff resources and training. Likewise, the research component should also be strengthened with sufficient resources, especially computational, to meet the challenges posed by the longer-term climate and climate change questions.

The Service will need to maintain the strong partnerships with other climate services providers (Especially those organizations operating at the important interface between the Federal Government and the user community such as the Regional Climate Centers, the State Climatologists, Sea Grant Extension, NGOs, etc.) and strong linkages to research arms of NOAA and other agencies. NOAA and the Service must recognize and respect the private sector's strengths and capabilities in supporting the various economic sectors of the nation, providing effective linkages in both the planning and execution of the development of the Climate Service.

This organizational structure could be a major component of any of the options considered in this overall study.

Elements of a National Weather and Climate Service

The existing National Weather Service contains several components of a climate service at present time. These components include:

At the national level

Climate Services Division (CSD)

Climate Prediction Center (CPC)

At the regional level

Climate Services Program Manager (CSPM)

At the local office (WSO and RFC)

Climate Services Focal Point (CSFP)

The various observation networks including the Historical Climate Network and the COoperative Observer Program (COOP).

Recommendation #1: The CSFP positions should be converted to full time equivalent climate services positions replacing the present add-on duties for the meteorologist and hydrologist positions at each Weather Forecast Office (WFO) and River Forecast Center (RFC).

Benefit: There will be a person in each field office dedicated to climate services, including delivery, outreach, product knowledge, and user engagement.

Challenge: Establishing or modifying an FTE at each of the 122 WFOs and 13 RFCs will require a potential restructure of WFO/RFC staff or a new position at each office requiring significant resources.

Elements to be added to make the National Weather and Climate Service:

Recommendation #2: Move the NESDIS data centers (NCDC, NODC, and NGDC) with their linkages to the Regional Climate Centers and the State Climatologists into the NW&CS.

Benefits: The climate networks (including data collection and archiving and instrument maintenance) will be managed out of this new service

Challenges: Moving the centers into a new line office (IT systems, education and outreach, etc.) and deciding on the management structure for the data centers will need to be thought out carefully. There could be some cost associated with this move.

Recommendation #3: Add a cadre of social scientists and economists to meet the needs of improved linkages with the user communities.

Benefits: Social scientists can help the NW&CS interpret the needs of users, discover more effective ways to communicate scientific information, and evaluate the effectiveness of education and outreach efforts. Economists can quantify the benefit of

new and existing climate services, estimate costs of climate impacts and develop metrics.

Challenges: Resources are needed to employ new staff.

Elements that should remain in their present NOAA offices.

Recommendation #4: The major climate related research activities in OAR, including GFDL, ESRL, AOML, PMEL, the Climate Program Office with its activities, especially the RISAs, the Sea Grant Extension program (which can serve as an outlet for Climate Services), and the NOS Coastal Services Center (not a research activity, per se, rather a focused applications activity supporting the coastal and marine needs) should remain in their current NOAA offices.

As you move into the decadal to centennial time scale, you move away from operations and heavily into the research domain. Although these organizations produce important climate information, especially in the decadal to centennial range, their activities are mostly research (except the NOS CSC), which, in the opinion of the Tiger Team, should reside under the direct management of OAR rather than that of the operational community, while still maintaining close linkages with the operational service organization. This is the model currently successful in the present NWS – OAR research cooperation, and should be extended to the National Weather and Climate Service.

In addition, NOAA, via NWS, has an operational responsibility in the intraseasonal to interannual (ISI) timeframe, climate data, and the delivery of information. However, NOAA does not own all climate research out to decadal to centennial, nor does it own climate scenarios developed for climate change research and assessments. Thus this structure focuses on climate services directly in NOAA's purview and allows for a larger interagency structure to coordinate the longer time scales.

Benefits: Least disruptive to OAR activities; appropriately allows for an interagency structure for climate change research; and preserves the weather and climate linkage out to 1-3 years.

Challenges: Must ensure a tight linkage for effective transfer of research to operations and operations to research. Formal standing committees at national and regional levels might be effective tools for harvesting research results and collecting requirements to effect these linkages.

Additional elements for the NW&CS

Recommendation #5: A mechanism to link with the private sector and the academic community. NOAA can not provide all the services required by the nation, but must depend on the broader community.

Benefits: This will promote greater understanding and cooperation between these communities and the efforts of the federal government that will contribute to the service.

Challenges: Establishing an effective mechanism that actually incorporates feedback and information into NOAA's operations and plans. The committee structure mentioned under Recommendation 4, above, might serve this function.

How It Would Work

The organizational structure defined would produce those products that range from the historical climate record through the present conditions (both weather and climate), the near term forecast out to two weeks or so, and the seasonal to interannual forecasts out to about 2 – 3 years. It would also have the mission of disseminating those products and any other information required by users. The decadal to centennial products would primarily be produced as the result of assessments based on research efforts (such as the IPCC Assessment Reports, National Assessments, etc). The team believed that the NW&CS would be charged with providing the results of those assessments and not with duplication or their generation. As improvements in the one to two decade projections are realized the production of those projections may be assumed by the NW&CS.

A formal and substantial linkage needs to be established between the NW&CS and the supporting research elements. Attention to the transition from research to operations and the acceptance of the research community of the requirements of the service is essential for the long term health of the Service.

Formal and substantial linkages must be established at the regional level to ensure the unique needs of the regional stakeholders are met. The natural synergy that can be exploited from the union of the Service regional managers, the RCCs the SCs and the RISAs, should ensure success in this area.

Metrics for the Climate Service

Metrics need to be tied to the definition of the Climate Service and should measure:

1. The delivery of Information and Products. This can include everything from counts of contacts as done by several of the climate providers at present to the frequency of satisfying the needs of the users.
2. The quality of the services delivered. This should include measures of the accuracy and timeliness of products, completeness of the archive, time delay from request of information to receipt of that information, etc.
3. Success in transitioning research to operations.
4. Research activities addressing service requirements.
5. Address the impacts and outcomes for the user community. This includes tracking how information is used by the recipients through periodic user surveys conducted by an external evaluator.

External evaluation of the service is important. Aperiodic evaluations by the National Research Council (NRC) are recommended as well as an ongoing evaluation by an independent standing committee which includes elements of the user communities.

Implementation Steps

The following implementations steps should ensure a smooth transition to the new NW&CS:

1. Develop a clear mission statement for the NW&CS
2. It is the understanding of Tiger Team #4 that NOAA is currently taking steps to establish a National Climate Service Portal involving NESDIS, NWS, NOS, CPO and several others, lead by NCDC. It is a fully collaborative effort designed to provide a unified web access for climate data and products. This is a beneficial early step that would assist users through the myriad of sites that currently contain climate information and products. The initial implementation of such an access mechanism should include all of the NW&CS products and services. As the Service matures, the access should also link to other agency information sets. Development of the portal should be informed by the experience of the NIDIS drought portal. Crosslink this access with the existing NWS site, weather.gov, (and vice versa), to facilitate the seamless nature of the product suite. **Note**: This effort is under-resourced and we recommend this project get proper attention as this effort has a substantial payoff in user satisfaction and confidence in a new service.
3. Establish regional coordination mechanisms among the various elements including RISAs, RCCs, SCs, Regional Climate Program Managers, Climate

Focal Points, private sector, academic sector. **Note**: This can be accomplished in part by extending the very successful partnerships established by the NWS and the private sector. These groups have established a team and are developing a strategy paper to define the mechanism suggested (to be completed in ~January 2009)

4. Move the National Data Centers into the NW&CS as a whole. This transition should be relatively straightforward based on the present NESDIS organizational structure. **Note**: this is a modest cost option that should require no additional people or facilities, although it is recognized that the data centers are currently under-resourced. Some savings may be possible at the national management level, although probably not much. Some costs may be associated with the full integration of IT assets, etc.
5. Convert the existing part-time, voluntary climate focal points in the NWS WFOs and RFCs to full time positions requiring climate expertise. Ensure training for these positions, both initial and routine training. **Note**: This is a cost item in terms of FTEs or it would require a restructuring of positions at the WFOs and RFCs. The present climate services focal point program is performing well in many locations, but is effectiveness is uneven across the country. Even if resources do not permit full implementation this step at present, it should remain as a goal.
6. Establish formal mechanisms for linkages with the research community. This includes mechanisms for identifying requirements for improved and new capabilities and mechanisms for transitioning research to operations (e.g., successful products developed by the RISAs need to be transitioned to operations for sustained support). Mechanisms need to be established to entrain the broad academic community into partnerships with the NW&CS, possibly building on the small grant program of COMET that has been very successful in the weather community.
7. Add a cadre of social scientists and economists to the NW&CS, including program evaluators. **Note**: Another cost item, but this capability is needed to achieve full potential.

Key Issues

The team felt there was a need to address the following key issues in the near term:

1. Interagency coordination needs to be real and effective. NOAA has a reputation of going it alone in many cases; ‘coordinating’ only after internal decisions have been made that are difficult to reverse. This option allows for the implementation of Option 1 or 2 which may be needed to integrate climate research across the federal government.
2. Similarly, true partnerships are needed with the private sector, academia, state climate offices, and NGOs, as well as the internal research activities.

3. Critical IT infrastructure must be maintained for modeling, data storage and archiving. A backup for the climate activities is as necessary as one for weather.
4. Multi-model ensemble techniques, now recognized as the best approach to intraseasonal to interannual forecasts require significant computational capability.
5. The integrity of the data networks must be maintained and the existing networks brought up to climate activities standards.
6. A critical need exists for effective downscaling of climate projections to smaller regional and temporal scales.

Evaluation of Option 4

The team evaluated option 4 against all the criteria listed in the Climate Working Group Vail Report. The detailed evaluation is provided in the Appendix. The team used this evaluation process to adjust the option as weaknesses were identified. For example, the team recognized the lack of social scientists and economists in the NOAA activities and therefore recommended the addition of this capability to the new National Weather and Climate Service.

Advantages of option 4

1. From every practical standpoint, this option is the simplest to implement. The NWS already has several of the necessary components. The data center move should be relatively easy; they already have the linkage with the RCCs and SCs that is a part of this option. By leaving the OAR activities in tact, one eliminates the very difficult problem of separating the climate research from the rest of the research infrastructure in the NOAA mission. Although a reprogramming action would need to be submitted to Congress, legislation would not be required for the creation of the new organization.
2. The NWS has a long history of effective weather product dissemination. By converting the voluntary, part-time climate focal points to full-time positions having climate expertise, this tradition could readily be transferred to climate product dissemination.
3. This organization simplifies the seamless distribution of information ranging from past history through present conditions to weather forecasts and forecasts of inter-seasonal to interannual. By using the various national and international assessment reports as a source, decadal to centennial projections could also be made available to the users through the climate focal points.
4. The close linkages with the “boundary organizations” (RCCs, SCs, etc) will enable effective support to a wide variety of users around the nation.

5. The retention of the NOAA research components (CPO, GFDL, ESRL, AOML, PMEL, etc) as a part of OAR will maintain the administrative independence of the climate research activities. Were these research activities to be combined with the operational organizational components, there would be a risk, when adverse budgetary conditions arose, of the operational activities siphoning resources from the perceived less urgent research programs. This model requires a close linkage between the research and operations, in order to assure operational requirements for research are being addressed and that research results can find their way into operations.

Disadvantages of Option 4

1. The Nation is clearly entering into a period of fiscal constraints, and the additional costs associated with this option could serve as an impediment to implementation. The major costs are associated with the conversion of the climate focal points to full-time positions and the addition of social sciences and economics personnel to the organization. These positions are important to the overall success of the new organization and their addition should be a high priority.
2. The separation of research from operations, while being beneficial as described in Advantage 5, above, does make it sometimes difficult to coordinate effectively. Attention will be needed at NOAA senior managerial levels to ensure an effective coordination across the line offices.
3. Significant efforts will be required to distill the results of national and international assessments into meaningful products for the new climate service to disseminate to the users.
4. The federal government planning process is not sufficiently open to engage fully the user community in the pre-decisional phase. NOAA in general and NW&CS in particular must modify the process to ensure user needs, especially emerging needs, can influence the planning process before the plans have become set in concrete. For too long, NOAA has viewed user interaction as simply telling the user what NOAA would provide.
5. The assurance of a robust climate observing system will be costly in the environment of increasing fiscal constraints. This issue will face any climate service organization.
6. The present NWS has the mission of providing information for the protection of life and property. Care must be exercised to ensure that this mission is not diluted with the creation of the NW&CS.
7. Even with additional personnel in the field offices, it will be challenging for them to meet increasing demands for climate information, particularly for those users who need extensive assistance (such as building climate change projections into state water plans). Partnerships with other service providers, including state climate offices, NGOs, and private sector, will be required to meet these demands.

Tiger Team 4 - Appendix

Pros and Cons (from the terms of reference and the Climate Working Group's Vail Report)

The Tiger Team spent a substantial amount time examining the following objectives and evaluating the advantages and disadvantages of the NW&CS proposal with respect to each of them. This discussion is not exhaustive, rather it identifies those factors viewed most important by the team.

1) Serve to develop products and information that will protect the public good and promote a variety of societal benefits including
   a) Improve prediction and projection capabilities on the time scales that contribute to societal benefit
      i) PROS:
         (1) Essential structural elements already exist at NWS HQ, Regions and local offices.
         (2) Intraseasonal-interannual capability already exists; research resides outside of the NW&CS, but is strongly linked to it
         (3) Weather climate linkages are strengthened
         (4) Simplest and easiest organization to implement
         (5) Climate test bed exists
         (6) Ability to do better on sharing computational capability
         (7) CPC has expertise in downscaling; may be applicable to climate projections
      ii) CONS:
         (1) For decadal-centennial time scales, capability lies outside the NW&CS and partly outside of NOAA. Need strong interagency cooperation
         (2) Improvements in dec-cen require different classes of model (e.g., interactive carbon cycle) that are unrealistic to pull into the Service.

   b) Promote a better understanding of how climate change and variability can promote an improved understanding of other environmental components
      i) PROS:
         (1) Significant capabilities reside within NOAA and with NOAA's partners (RISAs, RCCs SCs Sea Grant, etc), although this tends to be more focused toward the short term climate variability than longer term variations and climate change.
         (2) The current CPC has a significant national outreach related to short-term climate variability and attendant impacts.

(3) Climate services focal points exist within the NW&CS field office structure
(4) Climate change issue has been effective in getting diverse groups to the table

ii) CONS:
(1) RFCs hardly known outside of the water community
(2) All environment issues have their own variability, not necessarily associated with climate and climate change
(3) Much of the knowledge in the longer time scales lies in research, RISAs, etc, would require close coordination and sustained interaction with the users. Need a full time commitment.
(4) Climate services focal points do not have the resources and time allocated to uniformly circulate within the world of users.
(5) Uneven knowledge base across offices

c) Improve decision-making capabilities in particular sectors and regions,

i) PROS:
(1) Current capabilities partially address resource management needs and the provision of regionally-specific information for decision-making out to I-SI time scales.
(2) The NWS infrastructure does enable communication of weather (and climate) information to regions and sectors.
(3) NWS seen as a trusted source; field office personnel work with state officials on numerous issues (e.g., severe weather, drought).

ii) CONS
(1) No Social Scientist on existing staff and this would be a cultural change for NWS personnel.
(2) This is a major task, with most expertise on the research side. Experience with the RISAs, RCCs, and SCs indicates that an ongoing and sustained interaction with the end users is essential to improving decision support at regional scales.
(3) Improving information for sector-specific decisions may be more the province of the private sector or even other agencies rather than an expanded NWS.
(4) Decisions on adaptation to and mitigation of climate change tend to fall far outside the suite of capabilities/information products that NWS currently provides. This again largely falls in the research rather than operational domain.
(5) Lack of time to devote to in-depth interactions.

d) Engender new natural and social science capabilities that may have large expected and unexpected benefit, and

i) PROS:
(1) Innovations developed in field offices may filter upward into new national products and services.

(2) The addition of the social scientist cadre would assist in overcoming some of the CONS discussed below.

ii) CONS:

(1) Would need to have a cadre of social scientists; but where would they reside?

(2) NOAA has always been concerned with physical science; would require cultural change.

(3) Social science capabilities are quite limited in the current NWS. Again, there is the question of how much NWS wants to expand and potentially diffuse its current service capabilities. Social science research is still inadequate within NOAA as a whole, and is recognized as shortcoming in the current U.S. CCSP, but steps are underway to expand this capability.

e) Promote improved federal, state and regional adaptation and mitigation strategies and policies.

i) PROS

(1) There are efforts underway on a subset of issues, e.g., drought and NIDIS, to improve information for adaptation.

(2) RISAs address these adaptation and mitigation issues regionally

(3) Hurricane insurance risk provides a model for adaptation, for better or worse

ii) CONS

(1) Expertise lies largely outside of NWS. IPCC WGII and III issues are not in NWS domain. The major work in NOAA on carbon monitoring that may inform mitigation exists within OAR (ESRL) and climate change projections that may inform adaptation and/or mitigation strategies are produced at GFDL, as well as elsewhere. Adaptation/mitigation involves several agencies encompassed within the U.S. CCSP. These activities again tend to be more in the province of research than a direct extension of current NWS into climate.

(2) Legal and cultural barriers inhibit NWS personnel from providing recommendations beyond clarifying scientific questions (e.g., reticent to answer questions like what to do about climate change).

f) Promote a more informed citizenry

i) PROS

(1) NWS has long-standing experience with this for weather and, to a lesser extent, climate.

(2) NWS has an established communications infrastructure for promoting an informed citizenry.

ii) CONS

(1) Considerably more training would be needed and personnel devoted to developing a comparable capability for climate, particularly for issues related to longer-term climate variability and change.

(2) Need to be careful to maintain authoritative voice in light of political pressure.
(3) Most Certified Consulting Meteorologists do not accept anthropogenic climate change; nor do 60% of broadcast meteorologists. Nature of operational weather does not bring them in close contact with climate.

2) Reflect the full range of users, ranging from those who can define their needs and are ready to make use of specific information to those who have limited experience and for which the utility of climate information is not yet clear.
   i) PROS
      (1) Good outreach for CPC through ISI time scales. NWS has good knowledge and experience working with a broad range of users on weather and, to a lesser extent, climate information, especially for short-term climate variations.
      (2) Many interactions with users.
      (3) NWS field offices are highly visible points-of-contact for a wide range of information requests.
   ii) CONS
      (1) Weather forecasters will inevitably focus on shorter-term variability.
      (2) Voluntary Climate Services Focal Points are not resourced to uniformly deal with users. A lot to expect for part-timers. (motivation for recommending the conversion of the climate focal points from part-time to full-time)
      (3) Difficult to reach those with limited experience who may NOT initiate contact with the NWS.

3) Address the full range of time scales of interest to society without artificial or arbitrary divisions based on days, weeks, months, years or decades.
   i) PROS
      (1) Implementation of a paradigm of seamless weather and climate predictions and information provision across time scales from “nowcasts” to climate change may be more feasible under the proposed option.
      (2) Providing a seamless suite of weather and climate information is part of the current NWS vision.
   ii) CONS
      (1) No time in NWS for assimilating large volume of IPCC, etc., information.
      (2) Connectivity on time scales out to centennial time scales; use IPCC assessments.
      (3) A major new focus on long-term projections would require a large change in NWS culture and scientific capabilities. Reorganization would be essential.
      (4) Requires extensive training to enhance knowledge and abilities of field staff on decadal and longer time scales.

4) Promote the extension of climate information to climate system information so that the fundamental problems associated with the climate system and diverse regions (e.g. the coastal region) and sectors (e.g. ecosystems, water, human health, agriculture, energy, insurance, social and economic infrastructure, national security, etc.) can be addressed.
    i) PROS
        (1) Current interactions across exist in NOAA (largely coordinated through the Climate Goal) to develop and provide a broader range of climate information, leading to climate system (or earth system) information to address complex issues in ecosystems, water, human health, etc.
    ii) CONS
        (1) Could non-physical climate issues – e.g. ocean acidification – be adequately addressed in this model? Who knows the experts?
        (2) Learning the interaction between climate and sectors or regions takes time and continuous interaction with users; NWS may not have sufficient staff to do this.

5) Support problem-based assessments and improved decision-making that are on global, regional, sectoral, and integrated scales.
    i) PROS
        (1) NWS has considerable experience on weather-related assessments, and to a much lesser extent, on some climate phenomena (e.g., national drought products). Could provide assessment capability through RISAs, RCCs, Sea Grant, etc. Could NOAA interface with IRI on global assessments?
        (2) Already a NOAA component to Joint Ag Weather Facility (JAWF)
        (3) This option allows for an overarching, interagency National Climate Service (Option 1 or 2) that would develop these assessments.
        (4) Field offices are usually aware of and engaged with problems and issues within their areas of responsibility.
    ii) CONS
        (1) In the U.S., the CCSP has been conducting problem-based assessments directed as issues of high national significance, e.g., through the CCSP Synthesis and Assessment Products. These are generally produced jointly by several agencies, and frequently involve experts outside of federal agencies, including international participation. Global assessments have been conducted under the WMO, e.g., the IPCC reports. Ozone assessments are another example, but again include a wide range of expertise. Current expertise in these large national and international assessments within NOAA is largely within OAR. As a practical matter, NOAA does not and will not have the capability to "go it alone" on many assessments related to climate impacts and adaptation.
        (2) With experience, it became clear that climate scientists did not know what users need. This model has people who do not know users in charge of user interface.

(3) Requires broad expertise base extending beyond scientific and technical aspects; ability to place science in other contexts (economic, social values, environmental values).

6) Create a science-based and research–supported capability that ensures that information is accessible, authoritative, includes data, interpretation and integration, promotes communication and education, and promotes innovation and interaction.
   i) PROS
      (1) This is basically a definition of the climate service, and the proposed organization accomplishes this objective
      (2) NWS already integrates research and data and connects with users.
   ii) CONS
      (1) Staffing needs to bring this to field levels.

7) Create an active community of interaction that promotes the 3-way involvement of researchers, users, and climate information providers that is engaged throughout the process from planning, execution, assessment, and improvement and involves the active use of the information within the service.
   i) PROS
      (1) There have been significant efforts in this area, largely through efforts undertaken by "interface organizations" like the RISAs, RCCs, state climatologists, Sea Grant specialists, and potentially with training extension agents at universities.
      (2) Have the nucleus to build on, but need to advance.
      (3) Need for climate data interpreters. Providers and interpreters are key. Many intermediaries.
      (4) Fits within NWS mandate as a mission agency.
   ii) CONS
      (1) The past NOAA approach of the "Talking head" needs to be replaced with true interaction. Need to change course along the way as changing requirements and needs dictate. NOAA planning process is so structured that it leaves no room to alter course. Must include users and other agencies up-front as equal partners.

8) Recognize, incorporate and promote a "cascade" of roles extending from nationally-provided and vetted products, to defined roles of mission agencies, to a variety of interfaces with users (including regional or boundary interfaces such as Regional Integrated Science and Assessments (RISAs), Regional Climate Centers, state climatologists, NGOs, and the private sector), to the active engagement of a wide range of users.
   i) NOT APPLICABLE TO OPTION 4

9) Define the role of various federal agencies
   i) PROS

(1) Incorporating all functions within a single organization allows more command-and-control and relies less on formal partnerships.

ii) CONS

(1) Different agencies bring different perspectives and helps assure the products and information meet the needs of their constituencies (e.g., USDA has specific needs for their field offices).

10) Recognize that there are significant foundations required for a robust climate service underpinned by

a) A robust climate observing system (ex. Continuity of data or data stewardship.)

i) PROS

(1) NOAA has had a lead role in development and maintenance of a robust weather observing system. Most of climate observing system is a byproduct of weather.

(2) NOAA maintains elements of a climate observing system that include satellites, the Climate Reference Network, Historical Climate Network, various components of an ocean observing system, and baseline observatories for trace gases (e.g., the Mauna Loa observatory).

(3) Climate as a core function would elevate concern about the observing network within the field offices that maintain the stations; may lead to better maintenance and more use of the data from those systems.

ii) CONS

(1) A robust climate observing system does not presently exist. Developing and maintaining such a system will require time and large investments.

(2) Many of current observations are not available to NOAA climate activities. Need to incorporate range of non-NOAA data in assessments, such as RAWS, SNOTEL. NCS needs access to this. Who will take this on?

(3) NWS/NOAA has had great difficulty modernizing their climate observing system (coop); not sure if they are capable of doing so even with adequate funding. There seems to be a paralysis in the planning process.

b) High spatial resolution climate system prediction and projection models with demonstrated skill

i) PROS

(1) Progress on ISI prediction; but communication of uncertainty is lacking, e.g. difference in skill between temperature and precipitation.

(2) Getting computing capability to approach 1 – ½ km resolution, but limitation is in verification from observations

(3) The NWS and GFDL have extensive experience and expertise in developing weather and climate prediction and climate projection models. There are well-established organizations and infrastructures in place to help accomplish this objective.

ii) CONS

(1) Improved skill needed

(2) Increasing spatial resolution to the scales needed for decision-makers will require major investments in computing infrastructure, science advances, and improvements in data delivery systems.

11) Ensure that climate services are integrated with active research with feedbacks that will directly impact the generation of new climate service capabilities and climate services, and in turn, will directly influence research directions. This must be based on integrated, cross-cutting and end-to-end research that will support the production of climate system information. Fundamentally, this must be founded on the development of skillful forecasts and predictions and span a better understanding of human and natural systems and how they respond to change
    i) PROS
        (1) Basic elements are in place. RISAs feed back into research program.
        (2) CPC/Hydrology interaction through Climate Test Bed has had success in Colorado River ensemble streamflow prediction.
        (3) Problem-based focus tends to drive, which has contributed to RISA successes. Problem-solving tends to bring groups together.
    ii) CONS
        (1) Need for better accountability for research to operations transition
        (2) Need to develop better pathways to feed results from use back upwards into basic and applied research through formal evaluation and mechanisms for sharing results upward beyond program managers.
        (3) Less expertise in human and natural systems; needs to expand on 'human impacts' research such as RISA and SARP.

12) Include specific mechanisms to entrain successful products into the operations and capacity of the service
    i) PROS
        (1) There is a long history and experience of transferring research into operations in the current NWS.
        (2) As successful products and services are identified in regional and field offices, they can be 'harvested' for national replication. A process already exists to develop new products locally and submit them for adoption and organizational approval.
    ii) CONS
        (1) RISAs successful in engaging users, but users become dependent on the specialized product set.
        (2) The transition of research to operations into operations in NWS is sub-optimal (the "Valley of Death"). Would this be made even more difficult by assuming a far broader mission?
        (3) Since RISAs develop products and are not operational, to whom to they transition?
        (4) Extending to longer time scales (e.g. policy, carbon) would require a radical culture change from NWS.