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CLIMATE SERVICES: WHERE DO WE GO FROM HERE?

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1. INTRODUCTION

Over the past several years, the notion of climate services has blossomed on the agenda. From the National Research Council (2001) report to a new Climate Services Division within the National Weather Service to discussions within the American Association of State Climatologists, organizations have been wrestling with how to develop a climate services infrastructure. The problem is as diverse as the perspectives, and the solutions as numerous as the participants. One thing all share, however, is that they are all bound together through the American system of federalism. Federalism shares responsibilities and functions among multiple constituent governments. Deciding which governmental unit performs what function is achieved through bargaining. This paper discusses the process of that bargaining and applies it to developing a modern climate services infrastructure.

2. DEFINING CLIMATE SERVICES

No single definition of climate services seems to capture the vast diversity of needs or applications. That is part of the problem in developing a climate services infrastructure. Climate services means different things to different people. From the local farmer wanting to know about drought conditions to the federal agency conducting global climate change research, each application involves getting information on the state of Earth's climate. Each person is different, each application unique. In the most general sense, perhaps climate services is simply helping people use climate information. It involves collecting data, analyses, research, and knowledge relevant to a particular application and helping an individual apply it to particular circumstances. Thus, at the heart of climate services is the flexibility for individuals to tailor climate information to their own particular needs.

Climate services is more than the provision of data. It involves providing context that turns data into information. It includes applying theories of the climate system or paradigms of understanding ecosystems to an individual's need. It is a process of two-way communication. It is a process which may be eased through technology, but it cannot be solved through technology alone. Humans must be able to access and understand climate information in order to improve their decision-making abilities, and that often requires interaction with another human.

Any organization which provides climate information can be considered a climate services provider. However, it is generally recognized that the "climate services partnership" consists of four organizations: the National Climatic Data Center (NCDC), the American Association of State Climatologists (AASC), the regional climate centers, and the National Weather Service (NWS). In addition to these four organizations, several others are directly active, although perhaps not formally recognized as such. These include the Natural Resources Conservation Service (NRCS), university Extension programs, and the National Oceanic and Atmospheric Administration's (NOAA) Regional and Integrated Science and Assessments program (RISA). Descriptions of some of these agencies' activities are included in Appendix A. Additional organizations are discussed in the National Research Council's (2001) report on climate services.

Over the years, relationships among these entities have been at times harmonious, at times contentious, and at times virtually unnoticed. Each organization serves a particular clientele or purpose, and often after dealing with particular needs, little time is left to examine the big picture. There is plenty of work to go around among these organizations, and demand for climate services increases each year. As knowledge of the climate system increases, so do opportunities for applications of that knowledge. As societal vulnerability increases, especially through human choices (Mileti 1999), the need for information to reach decision-makers is magnified.

Climate services, like all other services provided by government, have multiple points-of-entry to the system and multiple providers. These are structured within a federalist framework: namely a federal government and fifty semi-autonomous states. In addition to the constitutional entities, services are also provided by a myriad of local entities, including municipal governments and non-governmental organizations. Sorting out responsibilities among these diverse entities requires an ongoing negotiation and coordination.

3. FEDERALISM

Climate services are enmeshed within the framework of federalism. Federalism is the framework that governs relationships between constituent governments. At times one or the other arena may dominate, but shifts occur in the balance of power that creates a dynamic, fluid system. The glue that holds the process together is that each arena relies upon the

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others. State governments cannot provide the services they do without support of federal government. Federal government cannot reach individual decision-makers as effectively as can local governments. Resources and knowledge are shared among governments, both horizontally and vertically (Nice and Fredrickson 1995). Each arena operates within an "area of competence" (Peterson 1995), but it does not function in isolation. Climate services is no different; most of the services are provided locally while most of the infrastructure is national.

The structure of federalism has its roots in the development of the Constitution. The debate over the Constitution centered around the nature of the relationship between the states and a national government. Under the Articles of Confederation, the United States was composed of sovereign entities, with a weak central government. The "experiment" proved untenable, as states pursued their own self-interests, often threatening the union itself. From these experiences, it became apparent to the framers of the Constitution that the role of the national government had to be strengthened. The Constitution therefore established a more powerful national government, but retained sovereignty in areas not defined as national powers by the Constitution.

The roots of the shifting balance of power between states and the national government lie in the structure of federalism. First, federalism is marked by constitutional ambiguity (Nice and Frederickson 1995; Fisher 1985). Multiple branches of government at the national level and multiple arenas of government, enshrined within the federalism structure, assure that there are multiple points of entry into the policy process. Each of these branches and arenas compete for power. At various times, resources and social contexts will favor one or the other, thus causing a shift between the two. Because of the constitutional ambiguity, each of these contestants can make a claim for being the proper authority to execute that power.

A second reason for the shift of powers lies in the nature of the Supreme Court. In the last twenty-five years, decisions have at one time favored national government power, while at other times appeared to favor the states. In *Usery* (1976), the Court maintained that "traditional government functions" for state and local governments were immune from federal regulation of wage and hour laws. However, the doctrine proved unworkable, and was reversed in *Garcia* (1985). Thus, states power was re-established in 1976, only to be withdrawn ten years later. Recent rulings have apparently shifted the balance back in favor of the states (Wise 1998). However, even though the federal government's legal powers have been more limited by recent decisions, the Court has approved the use of requirements attached to grants (Jensen 1999). Because many state and local government functions rely upon federal grant money, federal power is still strong.

The third reason for a shifting balance of power is the structure of federalism itself. Elazar (1984) defines federalism as an organization in which power is allocated between and among constitutionally equal units. This allocation of power is subject to political negotiation. Shannon (1994) asserts that the stages of federalism result from a political dynamic rather than a constitutional structure. Anton (1989) sees federalism as more a system of rules, rather than an organization. These rules are subject to interpretation.

A single form of federalism does not capture the true dynamic of the American system. Wright (1988) demonstrates how power shifts between the various entities over time. Manifestations of several doctrines are present at any given time, giving rise to a fluid balance-of-power. Furthermore, these negotiations of the rules are open to almost an infinite number of permutations. Local governments also engage in the process of defining relationships, such that actors are not limited to a single national government and fifty states.

Aside from the federal entities – the Congress, the Executive Branch, and the Courts – states are a significant factor in the institutional balance of power as well. Nice and Fredrickson (1995) list innovation as a key benefit of federalism. States can pursue different policies, the results of which may be adopted by other states or on a national scale. In recent years, much of the policy innovation being adopted has come through state initiatives, especially in the area of welfare reform. Furthermore, states and local governments are more resilient than the federal government (Shannon 1994). They must balance their budgets, which forces them to make tough decisions on policy and allocations. The federal government, by contrast, has been able to sidestep many of these issues through the use of deficit financing.

The reason for the continuing controversy is that the system of federalism under which we live was purposefully designed to promote such controversy. Madison's vision of factions competing against factions requires that there be multiple arenas in which these factions may unite and pursue their objectives. Schattschneider (1960) shows how groups select the arena in which they have the best chance of achieving a desirable outcome. At some stages, the federal government may provide a better arena, while at other times state or local governments may serve their purposes better. Some policies fare better in one arena than another, so the contest is both temporally and spatially dependent.

The system is a political dynamic. Grodzins' (1966) analogy of marble cake comes to mind. Functions are so intertwined between the various branches and arenas that the functions become inseparable. The proper roles must be determined through negotiation, sometimes more conflictual, but often achieved through political bargaining. All institutions play a critical role in this relationship. If any were removed from the debate, arenas would be closed off, voices excluded from the process, and the advantages of federalism would be extinguished.

4. STAGES OF FEDERALISM

The political dynamics of federalism has changed the nature of federal-state relationships over time. Shannon (1994) identified four distinct periods of federalism: Small Government, New Deal, Great Society, and the Middle Class Dynamic. These four categories have been adopted here, except the last phase is termed New Federalism for reasons discussed below.

4.1 *Small Government*

The early stages of the Republic were a time of testing the powers of the states and national government. Up until the Civil War, some states attempted to nullify or ignore federal policies. These doctrines, called nullification and interposition, were among the root causes of the Civil War. The outcome of the war permanently established the strength of the national government and ended serious discussion of the two doctrines. From that time forward, federal policies could be challenged in the courts, but could not be disregarded.

Even as the strength of the national government grew during this time, the scope and power of the national government remained limited. Up until the early twentieth century, the national government did not have a substantial income stream; therefore its undertakings were usually small and tended to focus upon its core constitutional duties of national defense.

The incipient weather and climate services actually grew out of the national government's role in defense. Beginning in 1870, the U.S. Army Signal Corps began a weather program. It started to consolidate weather observations collected from its forts and from other sources, and supplemented those observations with a network of volunteer observers. The primary purpose of these observations was to better understand climate and weather, particularly in the frontier areas of the western United States.

The data collected by the Army Signal Courts proved to be valuable in support not only of military affairs but also to agrarian issues. In 1890, the collection of weather information was consolidated into the Weather Bureau and transferred to the Department of Agriculture. Among its charges was to measure and report on the climate of our nation, which it began doing through a regular series of publications that summarized a month's weather and climate for each state.

4.2 *The New Deal*

Beginning in the 1930s, the relationship between the federal government and the states became more complex. The New Deal marked a watershed transition in the involvement of the federal government in activities which were previously left to the states. Included in the New Deal were programs for employment, infrastructure development, job training, and social security. These programs were primarily run at a national level but required involvement of the states. Commensurate with the growth of federal government programs was a growth of income available to the federal government, especially through income taxes and other taxes established shortly after the turn of the century.

The growth of weather and climate services mirrored the growth of other federal programs. Weather and climate information proved to be valuable to the nation's commerce, particularly for the developing aviation industry. In 1940, the Weather Bureau was transferred to the Department of Commerce, emphasizing the shift in focus that had been developing over the preceding years. Reflecting the now dual emphases of weather and climate, the Weather Bureau created a Climatological Services Division to oversee the longer-term climate needs. In 1951, climatic data record-keeping was consolidated from the Weather Bureau and Air Force and Navy Tabulation units to the Weather Records Center, later renamed the National Climatic Data Center (NCDC).

During the 1950s and 1960s, the Climatological Services Division established a state climatologist program. State climatologists were designated in Weather Bureau field offices, and received instructions from federal offices via Climatological Services Memorandums. The de-centralization allowed some degree of local autonomy for individual offices to tailor programs to fit local needs.

Even though weather and climate applications expanded and began to affect more local arenas, the functions of providing the information remained within the national government, consistent with that era's conception of federalism. Weather and climate information was collected and provided by federal agencies, often through local offices directly controlled by those agencies.

4.3 *The Great Society*

The Great Society programs of the 1960s marked another transition in national-state relations. Whereas the New Deal programs were primarily run directly by the national government, Great Society programs were principally administered by state and (especially) local governments, with funding coming from the federal government. As funds later became more restricted, this introduced complexities into federal-state relationships that persist to present (e.g., Kincaid 1990).

During the Great Society, the national government first committed resources to growing new services, but then later had to withdraw that funding when resources became more limited. Climate services again mirrored this trend. The growth of the state climatologist program in the 1960s mirrored much of the services-oriented growth in social programs which were the hallmark of the Great Society. As budget pressures mounted in the late 1960s and early 1970s, the national government had to scale back its involvement in service provision. However, the decade of new services created new demands for those services, demands which would have to be addressed by state governments.

The budget pressures hit the Environmental Science Services Administration (renamed the National Oceanic and Atmospheric Administration in 1970), just as it hit all federal agencies. One of their decisions was to terminate the state climatologist program. In 1973, at the request of NOAA Administrator Robert White, several states took over the state climatologist programs from NOAA. State climatologists met occasionally in subsequent years, often facilitated by NCDC. The group formally created the American Association of State Climatologists in 1976, to voice their perspectives in actions related to the provision of climate services. During the next several years, the AASC participated in discussions relating to the cooperative observer network and legislation creating the National Climate Program in 1978.

While some viewed the termination of the state climatologist program as abandonment by NOAA, in retrospect it actually transformed the nationally-dominant climate services arena to a truly mixed federalist system. Although most states only provided token support, such as naming a state climatologist but providing few resources to support an office, several states did make commitments to climate services. These states now lead the way in innovative services and serve as models for states that are now turning their attention toward reducing vulnerability to climatic extremes. Furthermore, the vacuum created by states lacking active state climatologist programs spurred the development of regional climate centers, a vital piece in the current federalist partnership.

4.4 *New Federalism*

The current state of federalism is dominated by the doctrine of New Federalism. Conlan (1998) describes two forms of New Federalism. The first, under President Nixon, was aimed at sorting out responsibilities between the national and state governments. Nixon's goal was to minimize federal involvement in service provision, returning those functions to the discretion of state officials. Block grants were a centerpiece of the proposed legislation, which would retain funding for the programs, but provide more discretion to local managers. The second form was that employed by President Reagan. Reagan envisioned a more limited role for government overall, especially that of the national government. While Nixon wanted to devolve many programs to the states, several of Reagan's policies aimed at ending programs entirely or turning them over to the private sector. The Reagan approach represented a philosophical return to the pre-1930s system of dual sovereignty, in which each arena was left to its own resources to address its needs.

Over the past decade, the willingness of national government to engage in state and local issues has re-emerged. In many ways, states have become reliant upon federal funding for local programs, ranging from Medicaid to Homeland Security. This, however, operates within the tension of the Nixon and Reagan New Federalism, in which elements of the federal government are seeking to reduce their involvement or provide more local discretion within them.

Throughout much of the 1980s, climate services were provided primarily through state organizations, the regional climate centers, and NCDC. In recent years, other federal agencies have emerged as important components of a national climate service, most notably the National Weather Service (NWS) and the Regional Integrated Science and Assessments (RISA) program. This again is consistent with larger trends of federalism; the national government's re-engagement with state and local activities within the last several years. Beginning in 2000, the NWS began turning its attention toward climate services, with the re-creation of the Climate Services Division. The intervening experiences with the Great Society and the emergence of independent state entities providing climate services prohibits a return to the "New Deal" model of climate services; rather now the NWS must work collaboratively with state and regional partners. At present, this approach is working well. The NWS recently joined the formal climate services partnership established between the AASC, NCDC, and regional climate centers.

With growing federal deficits and cash-strapped states, it may be difficult to envision growth in a services-oriented endeavor. Federal agencies are beginning to feel budget pressures similar to those felt in the 1970s and 1980s, which led to reduced involvement in climate services activities. However, even though states are struggling with budgets now, their resiliency will prove ultimately to be an asset to the climate services infrastructure. Because states are required to balance their budgets, difficult choices have already been made. As the economy begins to recover, budget situations in the states should begin to improve, and opportunities for new spending will grow. Federal agencies may not be able to invest much in local services due to their budget situation, but through collaboration with state agencies they can achieve their objectives.

5. CLIMATE SERVICES PARTNERSHIPS

Given the political dynamics of federalism and the diverse applications of climate knowledge, what is the "best" structure for climate services? The simple answer is: whatever meets particular needs. Because needs vary, there is no single "best" structure. The key to climate services therefore is to provide flexibility. Although applications vary, they all rely upon a common set of knowledge about the state of the Earth's climate. Having a common repository for that information, not unlike a national library, provides the maximum flexibility to local services providers.

Focusing on climate services from a functional, rather than jurisdictional, perspective shows that each climate services partner can contribute to a national climate services infrastructure. The following represent core needs for a climate services infrastructure:

1. Continue to improve the quality of historical data archives;
2. Integrate diverse data sources;
3. Facilitate access to information;
4. Enhance local capabilities to provide information;
5. Expand knowledge of climate and its interface with society.

Over the past several years, NCDCs Cooperative Data Modernization Program (CDMP) has digitized many historical documents, including pre-1948 daily observations, original records, and historical climate publications. These efforts make climate histories more accessible to those who need the information, without having to travel to Ashville, North Carolina, to read the records directly. In cooperation with NCDC, several state climate offices and regional climate centers have examined records to identify discrepancies, resolve processes for comparing events across instrument or network configuration changes, and develop uniform datasets that make application of the information easier. State climate offices are a particular source of looking at data on a scale not possible with the existing staff levels at NCDC, but findings need to be reported to and integrated into NCDCs data archives.

The second of these needs, integrating diverse data sources, addresses stakeholder needs for information in addition to the basic climate and weather variables now collected. These include high-resolution climate analysis data, non-federal and non-NOAA observation networks, and climate prediction information. Collecting information into central repositories provides 'gateways' to information, allowing easy comparison of data and common products from each source. In addition to standard meteorological variables, information such as streamflow, groundwater levels, snowpack and soil moisture needs to be included.

Accessing information is sometimes a challenge, due to the multiplication of datasets and formats. Information provided from a state climate office may not match that provided from a regional climate center, for example, due to differences in databases or analyses techniques. The regional climate centers, NRCS, and NCDC have developed a system that addresses some of these issues. The ACIS system provides a common database, synced with NCDC archives, and a common set of query and display tools. The system is available to state climate offices, NWS forecast offices, and other climate services providers. In addition, some of the products produced from ACIS are available for direct public use through the regional climate centers. These kind of collaborative activities reduce discrepancies of information and limit duplication of efforts in designing multiple databases. Similar activities for other databases and for information about the climate system would enable climate services providers to speak with a common voice.

National and regional organizations have taken the lead in developing tools for archiving, quality-assuring, and retrieving climate data, but an effective climate services system relies upon the individual interactions that occur on a daily basis. Many users of the climate information system may not know what information is appropriate or how to properly interpret the information they can retrieve. This is where local offices are essential. Over the past several years, the AASC has been encouraging states to strengthen their state climate offices through the AASC-Recognized State Climate Office (ARSCO) process. In order to achieve ARSCO certification, a state climate office must possess a set of minimum capabilities to provide services. Because the AASC has already undertaken these efforts, the national climate services partners can utilize this capability to reach local clientele. However, most state climate offices have few resources and tend to be reactive, waiting for clients to come to them rather than seeking out those who could – or should – be using available climate information.

States tend to respond to incentives. Federal programs aimed at local services provide matching funds to encourage states to participate. Medicaid, transportation, and education are some areas in which matching incentives are used. It is not certain whether or not states would respond to similar incentives for climate services, but a pilot project may be warranted. Federal funding can provide an opportunity for a state climate office to add human and technical resources, enabling the office to access and apply information from the federal and regional partners, and enabling the office to exchange information with other local providers, such as NWS forecast offices, NRCS field offices, and university Extension. Some examples of potential collaboration between state climate offices and NWS forecast offices are given in Appendix B.

The last need, research, addresses both advancing our understanding of the Earth's climate and how people use climate information. In one regard, as we learn more about interrelationships between components of the climate system, our abilities to understand the present and predict the future increase. Because stakeholder needs for information revolve around the ability to make informed decisions, including likely future scenarios, advancing the state of understanding is critical. Equally critical, however, is understanding the way people select and interpret information. While vulnerability to climate extremes may be, to some extent, objectively measured, risk remains an unknown. Risk is an evaluation of vulnerability based on individual perceptions and assumptions (Dake 1992). It is necessary to understand the individuals in order to guide them toward decisions to reduce vulnerability. Research on this process will aid climate services providers to more effectively transform the perspectives of individuals and render them more open to accepting advice from climate scientists. RISA has led the way in these types of research.

6. CONCLUSIONS

Just as national-state relationships have changed over time, so too have the mechanisms for providing climate services. The principal providers today reflect the federalist structure: national, regional, state and local organizations, sometimes working together and sometimes working in competition. Activities are intertwined between the providers, much like the marble cake analogy. Understanding this complex relationship is a key step in planning for future successful relationships.

Can a marble cake be separated? The concept of "sorting out" primary functions would do just that. In reality, there are no clear boundaries in climate services. The data needed by national partners originate at local levels, and local needs are met through use of national datasets. Along the way, each provider adds elements that improve the end product. While it may be useful to identify the strengths of each provider, trying to separate functions entirely would likely be a futile task. Some overlap of functions and responsibilities actually enhances the ability of organizations to communicate and collaborate with the other partners.

Both federal agencies and states have rightful claims to their roles, and recognizing that the process of negotiation can resolve ambiguities in definition of those roles is a key to moving forward. At present, federalism is a roughly equal balance-of-power between the states and a national government. Whereas states were dominant early in the Republic and the national government was dominant during the New Deal, both have matured and grown in capacity to provide those services. The key is to recognize the strengths and benefits of each partner.

Recognizing trends in federalism suggests that state and local climate services providers will play an important role in coming years. The NWS, while re-engaging climate services, cannot afford to dedicate full-time staff in its field offices to provide climate services, as it did through the 1950s and 1960s. The current model of federalism requires cooperation between arenas of government to resolve issues and provide services. Federal agencies and states must rely upon each other to accomplish their missions. One of the goals in the NOAA strategic plan is to "understand climate variability and change to enhance society's ability to plan and respond." While NOAA is quite capable of achieving the first part of the goal, it will require collaboration of others to achieve societal response.

In order to restructure the climate services infrastructure to meet the ever-expanding needs of society, climate services partners must look forward and set aside historical jurisdictional boundaries. As needs expand, all partners will have many opportunities to help society respond to climate shifts and variability. Focusing upon the core strengths of each and developing overlapping expertise to enable effective communication will stretch the limited resources of federal and state budgets to achieve the maximum benefits.

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APPENDIX A: Selected Climate Services Partners

National Climatic Data Center (NCDC)

The National Climatic Data Center is the principal repository of climate observations collected from NOAA operated networks. The repository includes quality-assurance routines to check each observation that enters their archive. Data are collected, checked, and made available in a timely fashion. NCDC maintains more than 500 digital data sets, many of which are available on CD-ROMs that make large volumes of data easily accessible to researchers and applications.

NCDC provides climate services ranging from filling requests for data to issuing periodic and regular publications. NCDC annually produces over 1.2 million copies of climate publications that are sent to individual users and 33,000 subscribers. They receive nearly two million requests for data each year and record over 100 million hits on their web site. They summarize climate data in a set of periodic publications, including state-by-state publications of daily and monthly observations.

NCDC also issues reports on the climate and summaries of events and trends. Among their most important publications are decennial updates of climate "normals" for each state and long-term observing site. These normals are a benchmark for planning in a wide range of activities, from construction to agriculture to water resources management.

Regional Climate Centers (RCCs)

There are six regional climate centers that monitor climate and provide timely delivery of climatic information. The centers assist state and federal agencies in coordinating climate activities. Members may serve on committees and commissions, participate in drought and climate monitoring, and support federal resource management agencies. Activities in which they collaborate include agriculture, climate change, energy, environment, human health, risk management, transportation, and water resources.

Regional centers are a key link in communication between state and federal offices. They work closely with NCDC and other federal organizations, coordinate between the six regional centers, and provide services and information to state climatologists and state climate offices. They help fill gaps where state offices are less active or vacant. They respond to requests for climate information, much as do state offices, and help users identify the best source of information, which sometimes may be a state climate office or a federal office.

Some of the regional centers maintain historical climate databases in addition to those available from NCDC. The centers work closely with federal data sources to summarize weather and climate events in their respective regions and provide products that allow individuals to gauge climate conditions in specific areas. Regional centers provide feedback to federal agencies on a larger scale than individual state offices, particularly on events that span state borders. They are also important sources of information for periodic 'state of the climate' reports that are produced by other agencies.

State Climate Offices

State climate offices provide climate data services for state agencies and citizens. Although there can be one for each state, several states do not have an active office. Most offices provide tailored services to meet specific user needs, act as a liaison for climate issues to state agencies, clarify ambiguities in information, and engage in services-related research and product development. Many are active in discussion lists, such as the Drought Monitor, that share local information to other external entities. Several states operate or are involved with state data collection systems.

State climate offices have a self-regulating system to assure that they are capable of providing basic climate services. Through the AASC Recognized State Climate Office (ARSCO) certification, states capabilities are validated in the areas of communication capabilities, information services, research, outreach, and monitoring and impact assessments. As of November 2003, 24 states qualified for ARSCO certification. Eighteen states had active state climate offices, but have not yet been certified.

In addition to providing services, many state climatologists provide an essential data stewardship role. They are among the first to identify discrepancies in the data records, raise questions of data quality for particular stations, and document conditions under which data are collected. State Climatologists are typically either employees of state agencies or are faculty or staff members of state-supported universities. Several are active with regional climate change and climate vulnerability risk assessments.

National Weather Service (NWS)

Although the National Weather Service's principal duties are issuing warnings to assure public safety and issuing forecasts for several days into the future, they play an important role in climate monitoring and prediction. The NWS maintains several critical observing systems. Most important for climate assessments is the cooperative observer network (coop). The coop network consists of daily reports of weather conditions from approximately 8,000 sites nationally. Local observers have been recording daily weather for more than 100 years, yielding a long-term climate record. These data allow researchers and service climatologists to examine local trends and relate it to global trends and expectations. The NWS is presently developing plans to modernize the coop network, which has tremendous implications for the other partners.

The NWS also is responsible for surveying and documenting storm damage. This is done as part of their warning verification process, but their findings are an important source of information for state climate offices, regional climate centers, and NCDC. Over time, documenting events provides a record of climate

extremes that enable risk analysis and examination of local climate changes.

The NWS forecast offices are among the most visible partners. Each day, forecast offices field inquiries ranging from individuals wanting a forecast for a particular date or event to people seeking a more detailed explanation of why the weather or climate is behaving a certain way. Office personnel bring a range of expertise to address these questions, and often interact with state climate offices to address climate-based analyses of events. Forecast offices are perhaps the primary dissemination means for information produced by the NWS' parent organization, the National Oceanic and Atmospheric Administration (NOAA).

The NWS is also home to several climate-related organizations, including the Climate Prediction Center, which issues seasonal and longer-term outlooks. The Climate Services Division oversees the NWS climate prediction program and is an important link between other climate services providers, including NOAA's Climate Observations and Services Program, Regional Climate Centers, Regional Integrated Sciences and Assessments Program, state climate offices, NWS forecast offices, and regional headquarters.

Natural Resources Conservation Service (NRCS)

The mission of the National Resources Conservation Service is to provide "leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment." The NRCS, a part of the U.S. Department of Agriculture, maintains field offices in every state, with a local office located in most counties. This provides a direct, local link to stakeholders.

Managing natural resources and the environment depends heavily on climate conditions. The NRCS is one of the developers of ACIS, a database and set of query tools that allow providers quick and easy access to historical information for any given location in the United States. NRCS offices use climate information as a basis for planning decisions and advice to local clientele.

Agricultural Extension

Agricultural extension has been a backbone of climate services for more than 100 years. The Hatch Act, signed in 1887, created a network of agricultural experiment stations to "conduct original research, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry." In 1914, the experiment stations were supplemented by the Cooperative Extension Service, created by the Smith-Lever Act of 1914. The Extension Service was created for the purpose of taking findings from the research community to the fields of farmers in their respective states.

Extension offices, like NRCS field offices, exist in nearly every county in the United States. Because they deal with a similar clientele, their activities are sensitive to climate and weather conditions. Extension offices provide a wide array of information on managing pests, disease, and crop selection – each of which can be managed more effectively and in a more environmentally friendly fashion through the use of weather and climate information.

Risk Management Assistance Organizations

Organizations such as the National Drought Mitigation Center (NDMC) act as a conduit for information tailored to particular issues. The NDMC operates the Drought Monitor, a weekly assessment of drought conditions across the United States. In addition to the weekly assessments, the NDMC acts as a resource for information about drought and mitigation strategies and helps states to develop mitigation plans.

Other similar organizations exist for other issue areas. NOAA's Coastal Services Center provides expertise on coastal issues, ranging from research to site-specific analyses of issues. The Coastal Services Center is directly administered by NOAA, while the NDMC is affiliated with academia, although it receives substantial support from NOAA and USDA.

Regional Integrated Science and Assessments Program (RISA)

The Regional Integrated Science and Assessments Program in the NOAA Office of Global Programs examines the climate-environment-society interface and assesses the reliability of knowledge and robustness of data. Each of these factors affects the working of an ecosystem. RISA focuses research on economic and human dimensions in environmental research, information infrastructures, and relationships between federal, university, non-governmental, and private sector efforts.

The goals of the program are to characterize the state of knowledge of climate variations, identify knowledge gaps, provide an informed basis for responding to climate-related risks, and establishing priorities in basic research. RISA seeks to inform the development of place-based decision support and services in responding to and mitigating physical and attendant technological risks.

The RISA Program's experience with local stakeholders, decision-support dialog, and applying environmental information to assess vulnerability are important elements of climate services framework.

APPENDIX B: Opportunities for Collaboration between NWS Forecast Offices and State Climate Offices

The National Weather Service's re-engagement with climate services presents new opportunities and challenges to reconstruct the way citizens receive weather and climate information. The National Weather Service brings new capabilities to the twenty-five year collaboration between state climate offices, the regional climate centers, and the National Climatic Data Center.

The Climate Services Partnership, consisting of state climate offices, as represented through the AASC, the six regional climate centers, and NCDC, has invested more than two decades in developing a climate information dissemination system to reach local users. The NWS can capitalize upon this existing infrastructure to provide additional information, especially regarding seasonal and longer-term outlooks, through these established information channels, bringing climate services beyond the reporting of historical events and trends. State climate offices, in turn, can capitalize upon the 24/7 nature of local NWS Forecast Offices, to provide easier access to climate information for citizens. The following are some thoughts on how collaboration between the all four partners can move climate services into the forefront of people's decision-making.

1. **Sharing information with the public.** A user should be able to find information easily with minimal referrals. Jurisdictional boundaries in providing basic services must be eliminated. The regional climate centers, NCDC, state climate offices, and the NWS have developed tools to provide basic information, and these should be the foundation for all basic services, whether provided through NCDC, regional centers, state climate offices, or NWS forecast offices.

2. **Shared expertise.** Climate services providers should be aware of the activities of each provider and seek assistance as needed. Many state climate programs have been in existence for a decade or longer. The perspectives they have of dealing with individuals, state agencies, and stakeholder groups can help the NWS to focus its new products and services to meet these needs. Similarly, NWS personnel's focus on current weather and forecasts can be a tremendous resource for people looking to blend historical precedents with current events or trends.

3. **Reaching local constituencies.** State climate offices already have established linkages with communities and state agencies. Through collaboration with other partners, state climate programs can be a conduit not only for assessments of climate and trends, but for more detailed forecast information often needed by decision-makers. Collaboration between the partners can produce better quality of information that can then be shared at local levels through aggressive outreach and education programs.

4. **Training local forecast office focal points.** Local focal points will be part-time and have other duties, in addition to providing climate information. State climate offices tend to have a long-term, permanent presence in the state, which can be a great asset to new NWS focal points. By sharing expertise, state climate offices can help during periods of transition in local offices and help new focal points learn more about local climate.

5. **Developing new products and services.** As new needs are identified, partners can collaborate on developing new ideas, new tools, and new information that can be useful to any of the partners. This includes development of web sites. NWS policies limit the ability for NWS offices to provide external sources of information, such as state summaries, on their websites, but state offices have fewer restrictions. Comprehensive websites to combine historical data records, current assessments, and forecasts and outlooks would enable forecast office personnel to more easily answer basic climate questions and for state climate offices or regional centers to find information about forecasts, especially those downscaled to local communities.

6. **Quality-assurance.** Looking over data in national archives to find errors requires a tremendous investment in time and detailed knowledge of observing systems and local factors that can influence a climate station's readings. State and regional climate offices and NCDC have extensive experience that will improve the quality of data served through NWS forecast offices. Likewise, those who use data may notice errors. NWS staff can report errors to the state climate office which will then be coordinated with national data records at NCDC and the regional climate centers.

7. **Issuing assessments and joint statements.** Joint development of assessments of severe weather and climate events bridges detailed summaries of events to historical context. Each office has expertise to contribute to the process. An example is the "event summaries" publication series by the Oklahoma Climatological Survey, which combines meteorology, impacts, and historical precedents. Combining the NWS offices expertise on the immediate event with state climate offices understanding of historical events improves both the assessment of the event and the context in which it occurred.