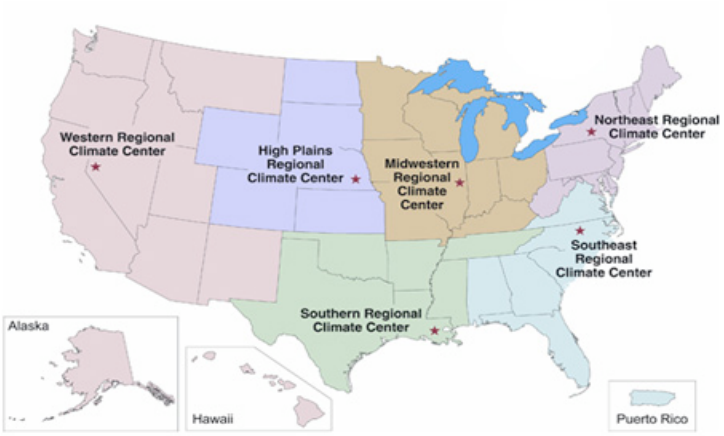
Dr. Arthur DeGaetano
Director Northeast Regional Climate Center
Cornell University

Expanding Climate Services at the National Oceanic and Atmospheric Administration (NOAA): Developing the National Climate Service
Testimony before the Committee on Science and Technology, Subcommittee on Energy and Environment
United States House of Representatives
May 5, 2009

Mr. Chairman and distinguished Members: Thank you for inviting me to testify before this subcommittee, to address the expansion of climate services within the National Oceanic and Atmospheric Administration (NOAA). I am a Professor in the Department of Earth and Atmospheric Sciences at Cornell University and Director of the Northeast Regional Climate Center (NRCC). The NRCC is one of six Regional Climate Centers (RCCs) that have been supported by Congress for nearly 25 years. Over this time the RCC Program, administered by NOAA, has provided basic climate services in a timely, efficient and reliable manner to a variety of climate sensitive sectors within their regions. I hope this experience will serve as a model for expanded climate services in the years to come, particularly with regard to the vital requirement that climate services be regional in nature and responsive to stakeholder needs, and transition to a comprehensive Service that can meet sector needs to respond to future uncertainty in a changing climate.

The six RCCs serve all fifty states in the nation. Through its history, the RCC Program has coordinated with partners in the NOAA National Climatic Data Center (NCDC), the NOAA National Weather Service (NWS), the American Association of State Climatologists (AASC), NOAA Cooperative Institutes and research programs, numerous state and federal agencies, private industries, and individual citizens to deliver a comprehensive suite of climate services at national, regional, state and local levels. This successful effort provides jointly developed products, services, and capabilities that enhance the delivery and usefulness of climate information to the American public. As NOAA and Congress work to help society adapt to climate change and variability, these collaborative efforts form a framework for data stewardship, climate services, climate

assessment, and applied research geared toward helping individuals, communities, government agencies, and industries make informed decisions using climate information.



Strong Congressional support for the RCC program over the last two decades has allowed for development of trust-based relationships between the Centers and decision makers from various economic sectors. These relationships have been fruitful for both the users as well as the RCCs. Decision makers receive the data and information they need in a format, time-frame, and manner that is most useful for their application, while the RCCs capitalize on the feedback received from users of climate information to develop robust and efficient data delivery systems, drive applied research projects, and synthesize the climate-related applications that impact social and economic sectors within their regions.

Dependable relationships with credible partners, accumulated climate knowledge and a robust computing infrastructure are critical components for effective climate services at local to national scales. Attempting to recreate this efficient, established, proven, and reliable system, would be wasteful in terms of resources and disruptive to a large user base that relies upon operational RCC data products 24 hours a day. Through this testimony, I hope to elucidate several key characteristics of climate services based on the accumulated experience of the RCC program. Examples are used to illustrate existing features that could be incorporated into an expanded National Climate Service. Drawing upon their history and familiarity with user communities, the RCC's vision for a National Climate Service includes:

- Providing services based on direct interaction with climate stakeholders
- Enhancing established climate service partnerships
- Distributing accurate and unbiased climate data, data-products, and summary information in response to changing user needs
- Developing decision support tools through interdisciplinary applied research

- Educating stakeholders on emerging regional climate issues
- Developing adaptation strategies for changing environmental, technological and societal conditions

Key Components of a National Climate Service

Integration – Local to National

In partnership with NOAA and the American Association of State Climatologists (AASC), the RCCs envision an integrated climate service structure that supports improved decisions to enhance industries, protect the environment, and promote public safety at state, regional and national levels. Through integration, national climate services will benefit from

- Access to local data sources from regional, state, local and private networks
- Dynamic products that span time scales from historical to real-time to near term forecast to longer range climate projection
- Local knowledge of climate impacts, climate extremes and emerging issues
- Synchronized data values and consistent analyses

Such a structure is already in place within the RCC regions.

- The Western RCC (WRCC) has teamed with the State of California to integrate NOAA data with observations from a variety of state, local and other federal networks. This expanded data network, when linked to WRCC analysis software and interpretive human expertise, informs decisions related to water resources, fire risk and air quality.
- At all RCCs, a distributed climate data access system (ACIS) enables state climate offices to respond to requests for climate information from engineers, insurance companies, banking institutions and energy firms using the most up-to-date NOAA data and standardized processing routines.
- Crop disease risk models developed by the Northeast RCC merge hourly NOAA data, observations from privately operated weather stations and NWS gridded forecasts. NRCC data systems provide a mechanism for NWS access to the private climate observations.

Active Local Stakeholder Engagement

Through decades of experience, the RCCs have learned that effective and meaningful climate services must be defined broadly to satisfy stakeholder needs. Climate services should satisfy the domain-specific needs of stakeholders in ways that can be directly assimilated into their business practices and decision strategies. Effective climate services should include:

- Two-way dialogs between climate scientists and users of climate information
- Timely access to quality climate data, products, and analyses from integrated data sources that incorporate state, regional, and national data networks
- General and specific assessments of climate conditions at pertinent spatial and temporal scales
- Responsiveness to new climate issues as they arise, such as adaptation to climate change and variability
- Access to research results pertaining to basic and applied climate issues
- Decision support tools developed for domain-specific applications

An example from the Northeastern United States epitomizes this strategy. Heating degree days have been used as a common measure of heating demand, and hence fuel usage, for decades. These data, available from NOAA and a variety of other sources, have typically been tabulated on a weekly basis from Sunday through Saturday. Through discussions with UBS, a nationwide investment firm, the NRCC learned that this definition of a week did not coincide with energy trading practices which operated on a Friday-Thursday time interval. The mismatch in summary period affected the accuracy of the forecast models used by the industry. By working with these companies and the NOAA Climate Prediction Center, the NRCC now provides these data to USB and other investment firms in a format that addresses their needs.

Adaptation Strategies for Climate and Environmental Change

A core component of a National Climate Service should include the capacity and ability to provide data and insight on climate change adaptation strategies. The RCCs have been increasingly called upon for information related to future climate conditions. Users are more aware of variations in climate conditions and require information to assist them in managing year-to-year climate variations and adapting to changing climate conditions. As with traditional approaches to solve past problems, those that focus on climate change adaptation require extensive stakeholder dialogue. Furthermore, the inherent uncertainly of longer-term climate projections makes established trust between climate service providers and decision makers an even more important component of climate adaptation research, outreach and service. Again from past experience, it is

evident that these types of relationships can best be established at local, state and regional levels. To address climate change adaptation a national climate service should:

- Assess vulnerability to climate change impacts and research appropriate strategies and plans to reduce such vulnerability at local, state, regional, and national levels
- Develop dynamic climate information products, databases, decision tools, and services for decision-makers and policymakers at multiple temporal and spatial scales
- Educate stakeholders about the potential uncertainties in climate projections and work with decision makers to determine how best to apply these projections in light of uncertainty

Users are more comfortable when tools for climate adaptation are derived from existing climate products and decision support systems available through established relationships. Most of the data, tools and products currently provided by the RCCs can be used or modified to support climate change adaptation. The climate services partners such as the RCCs and AASC have the expertise to help local sectors identify vulnerabilities in relation to climate. The key to using these tools effectively will be to understand how climate is changing - what might change, what will be the magnitude, and over what time periods. For example, a crop yield model used currently to project seasonal yields can be used to plan for adaptation to climate change by providing outcomes for different scenarios of temperature, precipitation, and other climate-related inputs in the model. New risk-management tools can be developed to help utilize these results for making decisions about adaptation. Because of the RCC understanding of many stakeholder needs, the RCCs help agencies determine critical climate thresholds that will impact a particular sector.

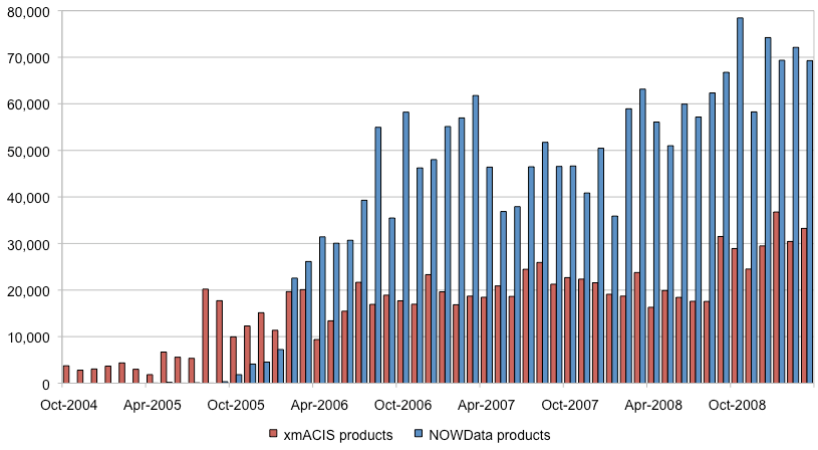
Innovative Environmental Data Management

The RCCs have been in the forefront of developing operational climate data support systems. The Applied Climate Information System (ACIS) is the foundation for RCC data management and electronic information delivery. ACIS was developed to provide operational efficiency, redundant reliability, and flexibility to accommodate evolving information system configurations and needs.

ACIS is becoming an effective operational component of international GEOSS activities through a partnership with the Northrop Grumman Corporation. The flexible design of ACIS provides data to web servers and services, automated data delivery systems, and on-demand data polling from remote users and user applications. The RCCs envision such a system as a key component of a National Climate Service. It already provides operational support to federal climate service providers and the general pubic through:

- **xmACIS**
  An interface for NOAA partners to access RCC data products and data holdings that alleviates the need to maintain and update separate databases at individual local NWS offices.
- **NOWData**
  An abbreviated version of xmACIS designed for use by the general public and available on each local NWS office website.
- **ThreadEx**
  A product developed in collaboration with the RCCs, NWS, NCDC, and The WeatherChannel to standardize the reporting of weather extremes.
- **AgACIS**
  Specially designed climate data products for use by Natural Resource Conservation Service field offices in each of the 3140 U.S. counties.
- **WxCoder III**
  A web-based interface that allows NOAA Cooperative weather observations to be entered electronically, providing timely access and eliminating the need to digitize handwritten observations.

These systems deliver tens of thousands of products every month and provide a cost-effective method to deliver NOAA and non-NOAA climate data and products to the public.



Information systems such as ACIS also provide a means for linking decision support tools developed through NOAA research programs such as the Regional Integrated

Sciences and Assessments (RISA), Sector Applications Research Program (SARP) and Transition of Research Applications to Climate Services (TRACS) program to real-time operational climate databases. The RCCs expect that ACIS will be required to transition these research results into operational products. Such data systems will also be advantageous, as they have the ability to seamlessly incorporate data from disparate networks, remote-sensing platforms and meteorological and climatological models into existing decision tools.

Responsiveness to Local and Regional Issues

A national climate service must be closely attuned to regional issues and ready to provide nimble and appropriate responses as anomalous climate conditions develop or unanticipated situations arise. Under such circumstances, the value of a National Climate Service is more clearly apparent. Effectively addressing these issues requires:

- Local knowledge of important political, environmental and social considerations
- Established trust-based stakeholder relationships
- Pre-existing tools, data and information ready for rapid application
- A network to engage stakeholders at state and local levels, such as the one that exists through the 50 state climatologists, the USDA Cooperative Extension Service and NOAA Sea Grant

The regional diversity of local climate issues that need to be addressed by a National Climate Service is best illustrated by examples from each of the RCCs.

The Midwestern RCC

The Midwestern Regional Climate Center (MRCC) monitors the climate in the nation's major corn and soybean growing region and provides tools for producer and agribusiness decisions. A method to produce county-level soil moisture measurements based on radar and precipitation measurements is used to produce up-to-date maps of soil moisture estimates in the Midwest. During the growing season, crop yield models provide yield estimates of corn and soybeans. Numerous agribusinesses, ranging from large international conglomerates such as Cargill, Inc. to seed companies and local producers, rely on RCC data and products to assess current conditions and provide guidance for operational decisions.

The Southeast RCC

The Southeast Regional Climate Center (SERCC) is taking the lead in exploring links between climate and health, largely because of the existing expertise of Center staff, the location of a major School of Public Health on the same campus, and the presence of the Centers for Disease Prevention and Control in the southeast region. At the federal level, RCC staff participates in an interagency working group assessing likely responses to public health threats posed by climate change. Major emerging roles for the Center are provision of information about climate variability and change at the local level in a form understandable to and usable by local, state and federal public health organizations, and assistance in translating the information into an assessment of potential health impacts.

The SERCC is also linking the health-related work with the disaster-related concerns of the Department of Homeland Security. SERCC, along with the Southern Regional Climate Center, is involved with assessing the direct physical threats posed by hurricanes to the Atlantic and Gulf coastlands. In addition, SERCC is in a position to assist in the development of strategies to deal with the health aftermaths of a hurricane strike.

The Southern RCC

Since 1992, the SRCC has provided decision support to the Louisiana Governor's Office of Homeland Security and Emergency Preparedness during tropical storm and hurricane events affecting Louisiana coastal communities. SRCC personnel provide observational data and interpretation of official NOAA forecasts and warnings that help emergency managers make informed decisions on evacuations, emergency sheltering, resource staging, rescue missions, and other critical decisions that depend on continually changing assessments of risk. In the past few years, LSU has increased its support of these activities providing additional services that include damage and mortality modeling, storm surge modeling, and post-storm recovery support in which the SRCC plays a major role.

The Northeast RCC

The NRCC frequently deals with urban issues related to water resources and temperature extremes. It has ties to corporations ranging from energy providers to investment banking firms. In addition, agriculture is an important industry in the region. Climate related decisions in this sector have both economic and environmental

implications. Coastal issues are also within the realm of the center, given it is bordered by both the Atlantic Ocean and Great Lakes. A project that syntheses these interrelated issues deals with the management of agricultural nitrogen. Across department collaborations at Cornell have resulted in the creation of Adapt-N, a web-based tool that links high resolution climate data derived from Cooperative Network observations, radar estimates and meteorological model initialization fields with soil nitrogen and crop yield models. Adapt-N provides recommendations for nitrogen application rates in maize that incorporate ambient weather conditions. These recommendations optimize corn yield, while minimizing nitrogen losses. Nitrogen runoff within the Upper Susquehanna River Basin and ultimately Chesapeake Bay is a primary concern of the NY Department of Environmental Conservation and the Susquehanna River Basin Commission. Farmers using the tool also derive an economic benefit via more efficient nitrogen use.

The Western RCC

The WRCC addresses a broad spectrum of climate issues and user needs. For example, federal and state land management agencies rely on WRCC for data products supporting wildland fire decision-making, including data management of the 2400 sites of the national Remote Automated Weather Station (RAWS) network, and archival of National Lightning Detection Network data for fire management use. WRCC has worked closely with the National Park Service nationwide on needs for and provision of weather and climate data and information for operations, research, and public interpretation of climate.

Drought has been present in the West every year since 1995 as a serious and persistent problem. WRCC has played an influential role in the development and implementation of the National Integrated Drought Information System and its western activities. The West has warmed much more than the rest of the U.S. over the past 35 years; this has significant implications for future water supplies, most of which rely on snowpack. Adaptation to climate variability and change are becoming a major WRCC theme. This Center specializes in mountain environments, the source of water, timber, recreation, minerals, renewable energy, and tourism, all greatly affected by climate. The region is over 50 percent public land, and WRCC interacts with numerous federal, regional, tribal, state and county resource management agencies to monitor, understand,

and provide sustainable utilization of these shared resources. Ecosystem services and environmental health are now seen as vital to the western economy, and are strongly tied to climate. WRCC provides front-line information delivery capability for NOAA, and in turn knowledgably informs and participates in development of improved information capabilities tailored to the unique needs of this diverse region.

The High Plains RCC

The High Plains Aquifer (Ogallala) is one of the world's largest aquifers. About 27 percent of the nation's irrigated land overlies this aquifer and about 30 percent of the U. S. ground water used for irrigation comes from the High Plains Aquifer. Clients using the HPRCC irrigation tools can select the nearest weather stations, the crop that will be addressed, its maturity level, emergence date, and enter local precipitation from the field of interest, if available. The output provides an estimate of how much additional water the soil can hold and a projection of soil water relative to crop water stress level. The goal is to keep the water in the soil well above the stress level and to leave enough room in the soil for any rainfall anticipated from the forecast. Informed scheduling of irrigations reduces the number of irrigations and thus conserves water, reduces energy used for pumping, minimizes run-off, and maintains potential yields (even in semi-arid climates).

The HPRCC is also engaged in climate variability and climate change analyses to build tools for current clients to provide assessments on possible climate change impacts on the Plains: future frost-free seasons, heat during the growing season, impacts on water use/yield and shifting of crop production zones.

Interdisciplinary Collaborations

Climate is just one of many issues that decision makers must consider. Thus effective climate services must have the ability to synthesize non-climatic influences and data sources. Interactions between climatic and non-climatic factors are often non-linear, particularly in situations where the climate and associated factors are changing. Economists, social scientists, communication specialists, innovative instruction experts, agronomists and entomologists represent interdisciplinary collaborations that the RCCs have fostered to address climate related problems. Scientists from these and other

diverse fields are critical components of national climate services. An efficient means of integrating scientists is through the inclusion of research universities as partners in a National Climate Service. A National Climate Service-university relationship also benefits climate services in general by:

- Leveraging resources for research funds from federal, state, and private sponsors
- Fostering unique interdisciplinary collaborations
- Providing substantial cost sharing support
- Establishing links to Cooperative Extension and Sea Grant

The RCCs, AASC and RISAs currently provide ties to major U.S. universities. Each year the RCC base funding is leveraged considerably through external grants and contracts. The RCC directors are on faculty at major research universities and they maintain active research programs that further the goals of national climate services in data quality, novel data products and climate related decision modeling.

Concluding Remarks

The United States needs a comprehensive National Climate Service that has the ability to address the broad spectrum of climate needs facing the Nation. These needs are spread across a wide diversity of disciplines and economic sectors that touch nearly every aspect of society. The existing core set of organizations and capabilities provides a useful and functional initial framework. To meet newer challenges, this patchy and incomplete infrastructure requires consistent and reliable support, augmentation of capabilities, and much better integration across a wide variety of boundaries. NOAA capacities and programs such as those we have outlined will be integral and necessary components but, alone are not sufficient. Climate is so pervasive an issue that the success of a National Climate Service, on the scale and broad scope that we need, can only derive from a sense of shared ownership of the Service among its widely scattered participants: federal, regional, state and local agencies and organizations inside and outside government. It is my opinion that this nation has the talent, the attitude, the motivation, and the resources to provide global leadership in this crucial endeavor.

In closing, I thank the committee for inviting me to testify today.