DEPARTMENT OF AGRICULTURE WEATHER PROGRAMS

The Nation's food and fiber products are a critical resource impacting our domestic and international economic situation and are essential for ensuring our national security and shaping foreign policy. Weather is the most important factor influencing the Nation's variability in crop yields and related production. The United States Department of Agriculture (USDA) monitors global weather and agricultural developments through the Joint Agricultural Weather Facility (JAWF). The JAWF provides critical information to decision-makers formulating crop production forecasts, programs that provide natural disaster assistance to U.S. farmers and ranchers, emergency relief programs, and trade policy. USDA operates specialized weather observing networks such as SNOTEL, SCAN, and RAWS that provide vital data and information used to forecast seasonal water supplies in the West, to support national conservation programs, and to monitor the health of the Nation's forests. USDA conducts supporting research that focuses on understanding the interactions of weather and climate with plants, animals, forests, and forest ecological systems.

METEOROLOGICAL PROGRAMS

Numerous agencies within the United States Department of Agriculture (USDA) require a wide range of high quality weather and climatological data to successfully carry out their missions. Some of the diverse applications that require accurate, timely, and comprehensive data include crop monitoring and weather impact assessment, agricultural yield and productivity modeling, natural resource conservation planning, forest fire potential monitoring, irrigation scheduling, water supply information, reinsurance and compliance programs, crop disaster assistance and emergency relief programs, integrated past management, crop yield modeling, and agricultural research studies. The following is a brief description of agency weather activities.

OFFICE OF THE CHIEF ECONOMIST /WORLD AGRICULTURAL OUTLOOK BOARD

The World Agricultural Outlook Board (WAOB) is located within the Office of the Chief Economist (OCE).

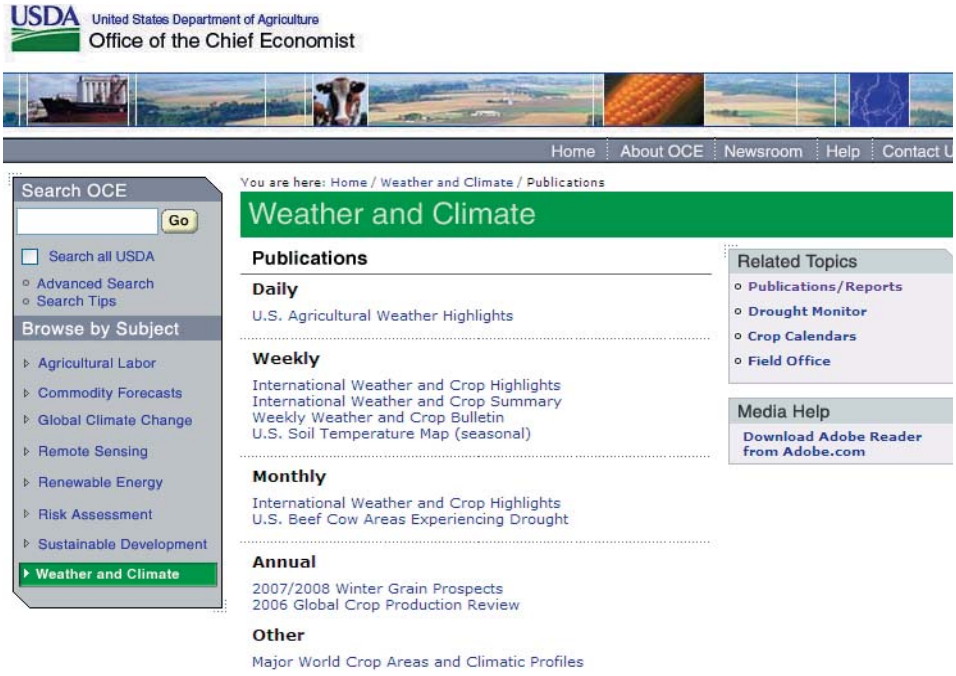

Figure 3-USDA-1. Joint Agricultural Weather Facility Web Site.

The WAOB's primary objectives are consistency, objectivity, and reliability of outlook and situation-related material, including weather information, developed within the USDA. The WAOB coordinates all weather and climate information and monitoring activities within USDA. The WAOB also manages the Joint Agricultural Weather Facility (JAWF), which serves as the focal point in the Department for weather and climate information and impact assessment.

JAWF was created in 1978 as an operational unit, and is jointly managed by the USDA/OCE/WAOB and the U.S. Department of Commerce (DOC)/National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS)/National Centers for Environmental Prediction (NCEP)/Climate Prediction Center (CPC). The primary mission of the JAWF is to routinely collect global weather data and agricultural information to assess the impact of growing season weather conditions on crops and livestock production prospects. JAWF meteorologists work as a team, monitoring global weather conditions and crop developments on a daily basis, and preparing real-time agricultural assessments (Figure 3-USDA-1). These assessments keep USDA commodity analysts, the OCE, and the Secretary of

Figure 3-USDA-2. Special agricultural assessment example - severe freeze in California citrus areas from January 11-16, 2007.

Agriculture and top staff well informed of worldwide weather-related developments and their effects on crops and livestock. In addition to providing routine assessments, OCE/WAOB agricultural meteorologists at JAWF are frequently requested to prepare special assessments when adverse or anomalous weather conditions (e.g., droughts, heat waves, freezes, floods, and hurricanes) are observed in major crop-producing regions. Many of these special assessments are prepared using a Geographic Information System (GIS) to overlay weather data and information on crop-producing areas for detailed analysis. An example of an assessment made during a significant freeze event in California citrus areas from January 11-16, 2007, is shown in Figure 3-USDA-2. When integrated with economic analyses and information, these routine and special crop-weather assessments and analyses provide critical information to decision-makers formulating crop production forecasts, trade policy, and disaster relief. They also help identify potential agricultural markets for U.S. products around the world. Inputs from OCE/WAOB/JAWF are integrated into USDA's monthly foreign crop production estimates. Weekly briefings on global weather and crop developments are provided to USDA top staff.

JAWF serves as the USDA focal point for weather data received from the Global Observing System, a worldwide network of nearly 8,000 meteorological reporting stations managed by the World Meteorological Organization (WMO). The WMO data are stored and maintained at JAWF in a sophisticated data warehouse that utilizes advanced database technology. These data are used at JAWF and other USDA agencies for a number of agricultural applications. The agricultural meteorologists of OCE/WAOB/JAWF merge these weather data with climatological analyses and global agronomic data to determine the weather's impact on crop development and yield potential. A major source of domestic weather and climate data that are often used in special operational crop and weather analyses for the United States comes from the NWS's Cooperative

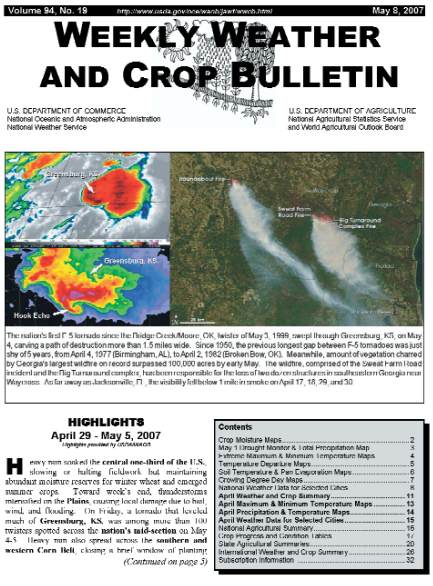

Figure 3-USDA-3. *Weekly Weather and Crop Bulletin* is a joint effort of between the Departments of Agriculture and Commerce.

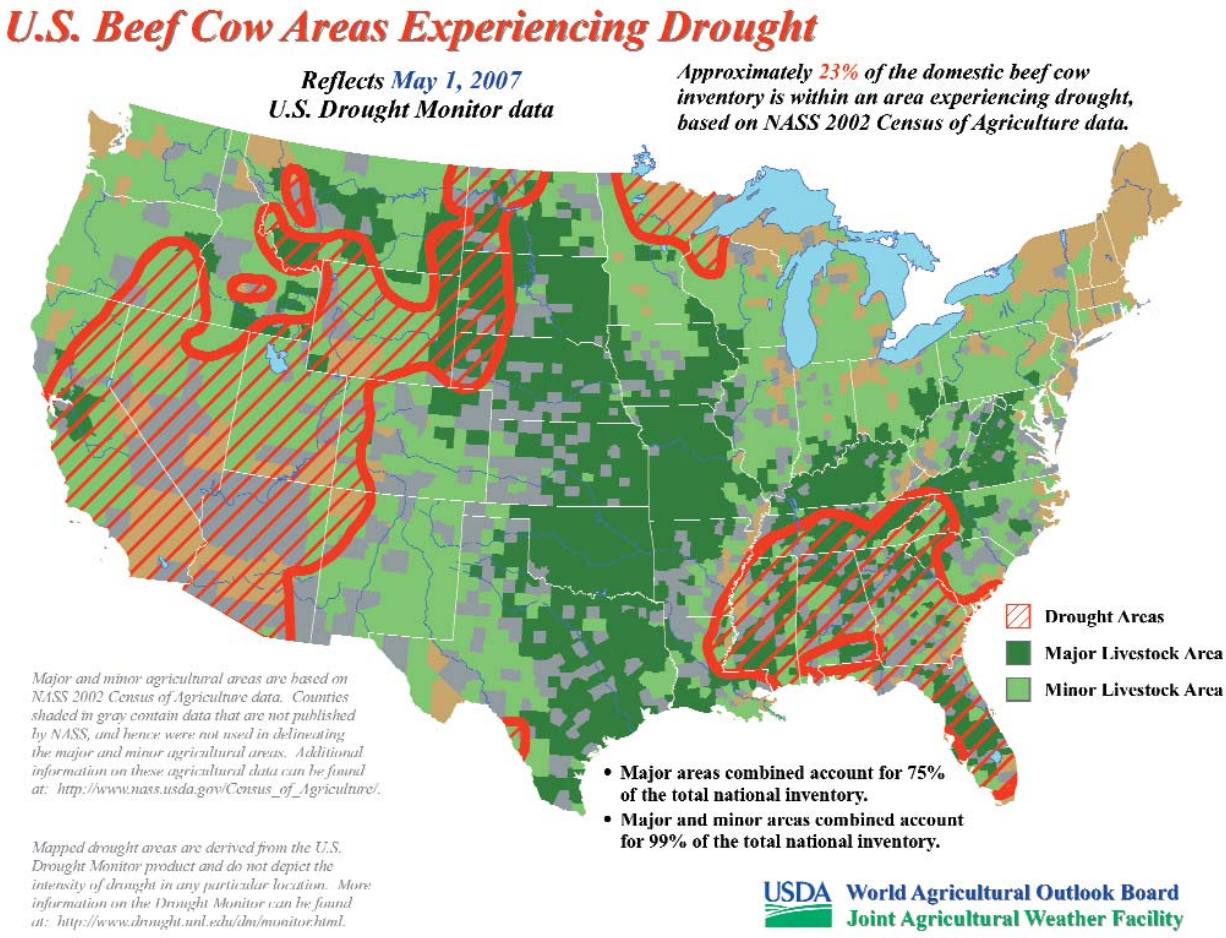

Figure 3-USDA-4. A monthly update of United States beef cow areas experiencing moderate or more intense drought.

Observer (COOP) Network of over 3,500 daily reporting stations.

JAWF's flagship publication is the *Weekly Weather and Crop Bulletin (WWCB)*. The WWCB is jointly produced by USDA/OCE/WAOB, USDA/National Agricultural Statistics Service (NASS), and the DOC/NOAA/NWS/NCEP/CPC. First published in 1872 as the *Weekly Weather Chronicle*, the publication has evolved over the past 135 years into one that provides a vital source of information on weather, climate, and agricultural developments worldwide. The publication is a shining example of how two major departments (USDA and DOC) within the Federal government can mutually cooperate, combining meteorology and agriculture to provide a service that benefits the economic well being of the nation. The WWCB highlights weekly meteorological and agricultural developments on a national and international scale, providing written summaries of weather and climate conditions affecting agriculture, as well as detailed maps and tables of agrometeorological information that is appropriate for the season (Figure 3-USDA-3). The WWCB also provides timely weather and crop information between the monthly *Crop Production and World Agricultural Supply and Demand Estimates* reports, issued by USDA/NASS and USDA/OCE/WAOB, respectively. The WWCB is available in electronic form from the OCE web site at http://www.usda.gov/oce/weather/index.htm.

Knowledge of historical climate data and agricultural production patterns in agricultural regions around the world is critical in JAWF's assessments of weather's impact on crop yields. In September 1994, OCE/WAOB/JAWF published the *Major World Crop Areas and Climatic Profiles (Agricultural Handbook No.664)*. This reference handbook provides the framework for assessing the weather's impact on world crop production by providing information on climate and crop data for key producing regions and countries. Coverage includes major agricultural regions and crops, including coarse grains, winter and spring wheat, rice, major oilseeds, sugar, and cotton. World maps show the normal developmental stage of regional crops by month. An electronic version of the handbook was developed to provide periodic updates to the printed version as additional data become available. The electronic version is available from the OCE web site at http://www.usda.gov/oce/weather/pubs/Other/MWCACP/index.htm.

Drought is one of the most costly natural disasters affecting the United States. In the summer of 1999, a monitoring tool known as the *Drought Monitor* was developed to help assess drought conditions in the United States. The *Drought Monitor* is a collaborative effort between Federal and academic partners, including the University of Nebraska-Lincoln National Drought Mitigation Center, OCE/WAOB/JAWF, NOAA/NWS/CPC, and NOAA/NESDIS/National Climatic Data Center. Approximately ten lead-authors rotate the responsibility of preparing the *Drought Monitor*. Produced on a weekly basis, the *Drought Monitor* is a synthesis of multiple indices, outlooks, and impacts depicted on a map and in narrative form. The official Web site for the *Drought Monitor* can be found at http://www.drought.unl.edu/dm/monitor.html. The *Drought Monitor* is released each Thursday at 8:30 a.m. Eastern time. Because the *Drought Monitor* is prepared in a GIS system, it can be overlaid on agricultural data, to create agricultural weather products that quantify the spatial extent of drought affecting various agricultural commodities (Figure 3-USDA-4). These agricultural weather products, along with the *Drought Monitor*, serve as the main source of information for briefing the Department's Drought Task Force on U.S. drought developments.

The *North American Drought Monitor (NADM)* is a cooperative effort between drought experts in Canada, Mexico, and the United States to monitor drought across the continent. The NADM was initiated at a workshop in April 2002, and is part of a larger effort to improve the monitoring of climate extremes on the continent. Issued monthly since March 2003, the NADM is based on the end-of-month U.S. *Drought Monitor* analysis and input from scientists in Canada and Mexico. Major participants in the NADM program include the entities involved with the production of the U.S. *Drought Monitor*, as well as Agriculture and Agrifood Canada, the Meteorological Service of Canada, and the National Meteorological Service of Mexico. The NADM Web site is: http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/nadm-map.html.

USDA's Chief Meteorologist is currently serving on the Management Group of the World Meteorological Organization's (WMO's) Commission for Agricultural Meteorology (CAgM). He continues to lead an effort to enhance the flow of more accurate and timely global agricultural weather information through an ongoing project utilizing Internet technology. The World AgroMeteorological Information Service (WAMIS) is a dedicated web server that provides agrometeorological bulletins and advisories issued by WMO Members to the global agricultural community as well as training modules to aid Members in improving their agrometeorological products. Currently, 29 member services contribute advisories and bulletins to the WAMIS web server. The WAMIS web site is: http://www.wamis.org. The Chief Meteorologist also serves as CAgM's focal point to WMO's Natural Disaster Prevention and Mitigation (DPM) Program.

The OCE/WAOB/JAWF opened a field office in Stoneville, Mississippi, in October 1998. The OCE field office in Stoneville, Mississippi is co-located with the Mississippi State Delta Research and Extension Center (DREC) and USDA's Agricultural Research Service (ARS) Mid-South Area Jamie Whitten Delta States Research Center. The field office was established to build an agricultural weather network. The goal of the network is to link agricultural weather data collection networks already in existence but not part of the current National Weather Service (NWS) basic reporting network. In partnership with USDA's Natural Resources Conservation Service (NRCS), Soil Climate Analysis Network (SCAN) sites were installed in the Delta to enhance the regional network.

FOREST SERVICE

Research

Air pollution effects (primarily nitrogen deposition and ozone) remain a serious threat to forest health in some parts of the U.S. Forest Service Research (FSR) is describing long-term effects of air pollution on forests of the Sierra Nevada, Colorado, the North East and southwestern Wyoming. Although nitrogen and sulfur atmospheric deposition have been studied for many years in eastern forest watersheds, and FSR has demonstrated that increased nitrogen deposition can affect water quality and ecosystem function in western forests. FSR has been developing, in cooperation with the European Union ICP and National Forest Systems, a comprehensive approach to critical loads in selected forest ecosystems across the U.S. to improve knowledge of potential nationwide impacts. FSR is also working closely with universities on developing measures for critical levels of ozone on public lands. During 2006, FSR SRS developed the first critical loads map for the entire United States which is being published after peer review.

Smoke from forest fires and other biomass burning is a national concern as use of prescribed fire in ecosystem management increases. Exposure of fire fighters and citizens to forest fire smoke, changes in visibility and haze, and smoke contributions to regional and local air pollution are of concern. FSR is the world leader in developing emissions factors from fires and modeling its dispersion. FSR has conducted research on impacts of smoke on human health; relationships

between on-site meteorology and smoke dispersion; consequences of smoke to visibility in Clean Air Act Class I Areas; and potential of smoke to exacerbate ozone episodes. FSR has provided basic research to support states' air regulatory programs and EPA's development of air quality standards. Through five consortia for advanced atmospheric modeling (www.fs.fed.us/fcamms), real-time smoke and fire weather research products are supplied to fire and air quality managers continuously with predictions of impacts made out to 72 hours in the future.

National Forest Service

The weather program provides key liaison with the Satellite Telemetry Interagency Working Group (STIWG) on satellite services and with the National Weather Service, USDI, and NWCG on the delivery of fire weather forecasting, critical for safety and effectiveness of fire fighting and for flash flood warnings and water supply forecasts. The weather program oversees the standards for approximately 1000 remote automated weather stations across the country. These stations form the basis for the assessment of fire danger, the pre-positioning of fire fighting resources and the conducting of prescribed fire operations. The costs include contracts for the delivery of this information to agency personnel, fire weather forecasters, and state forestry agencies that use the data in real-time for critical decisions.

Wildland Fire Management

This program uses meteorological data and interpretation skills data for decision making regarding wildland fire management. The Forest Service State and Private Forestry, Fire and Aviation Management program operates a network of over 850 remote automated weather stations (RAWS) in a national network of over 2200 stations. The network provides real-time information which is key in the highly utilized weather information management system (WIMS) used by fire agencies across the country.

The program provides liaison with the Satellite Telemetry Interagency Working Group (STIWG) and its associated Technical Working Group, the National Weather Service (NWS) USDI agencies including the Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), Bureau of Indian Affairs (BIA), and National Park Service (NPS), State fire protection agencies, and NWCG on the delivery of fire weather forecasting, critical for safety and effectiveness of fire fighting and for flash flood warnings. The RAWS Program oversees the standards for over 2200 remote automated weather stations across the country and manages the Interagency RAWS Website to support the program. The website address is: http://www.fs.fed.us/raws. These stations form the basis for the assessment of fire danger, the pre-positioning of fire fighting resources and the conducting of prescribed fire operations. The costs include maintenance support contracts, maintenance training sessions, contracts for the delivery of this information to agency personnel, fire weather forecasters, and state forestry agencies that use the data in real-time for critical decisions.

The agency weather program works with the predictive services unit at the National Interagency Fire Center (NIFC, Boise, ID) in providing technical support and oversight to 10 Geographic Coordination Centers and works closely with the Forest Service Research and Development staff in the oversight of the 5 fire consortia for Advanced Modeling of Meteorology and Smoke locations. This effort, in cooperation with NOAA and EPA, will provide valuable smoke forecasting and air quality information to fire and air quality programs.

NATURAL RESOURCES CONSERVATION SERVICE)(NRCS)

Snow Survey and Water Supply Forecasts - Monitoring

Snowmelt provides approximately 80 percent of the streamflow in the West. The NRCS, in partnership with other Federal and state agencies, operates the Snow Survey and Water Supply Forecasting Program (SS&WSF) in 11 Western States and Alaska. To accurately forecast seasonal water supplies, the program collects critical snow and climate data from high elevation snowpacks in the mountainous West. The data collection system includes 935 manual snow courses and 732 automated SNOTEL (SNOw pack TELemetry) monitoring stations throughout the Western States and Alaska. These data, along with information from 740 stream gauges, 399 major reservoirs, and 3,200 climatological observing stations are merged into a hydroclimatic database that is used to produce real-time watershed analyses and water supply forecasts. Monitoring is done in partnership with Federal, state, and local agencies, power companies, irrigation districts, and the Provincial Government of British Columbia. This information is the basis for water management decisions under international treaties with Canada and Mexico.

The SNOTEL automated data collection system plays an important role by providing near real-time remote hydrometeorological data required to evaluate snowpacks, potential in-stream water supplies and drought risk. The SNOTEL network can provide hourly precipitation, temperature, and snowpack depletion information that significantly improves flood stage forecasts and the monitoring of other life threatening snow-related events. SNOTEL information enables emergency management agencies to effectively mitigate drought and flood damages. An added benefit during the late

spring and summer is the availability of hourly climate data which is used to monitor and assess forest and wildfire potential.

Additionally, the SS&WSF Program supports research to improve monitoring technology, data reliability, data quality, water supply forecasting, and water resource modeling.

Water Supply Forecasts

Monthly water supply forecasts are produced each year, January through June, in partnership with the National Weather Service (NWS). The purposes of water supply forecasts are to: (1) help irrigators make the most effective use of limited water supplies for agricultural production needs; (2) assist the Federal government in administering international water treaties with Canada and Mexico; (3) assist state governments in managing intrastate streams and interstate water compacts; (4) assist municipalities in planning the early management of anticipated water supplies and drought mitigation; (5) operate reservoirs to satisfy multiple use demands including hydropower generation; (6) mitigate flood damages in levied areas and downstream from reservoirs; and (7) support fish and wildlife management activities associated with species protection legislation.

During a typical forecast season, the NRCS SS&WSF Program issues over 11,000 seasonal water supply forecasts for 711 locations in 12 Western States. The water supply forecasts are coordinated and peer-reviewed by a number of Federal agencies and cooperators to ensure highest quality and accuracy. Major cooperators include the Bureau of Reclamation, Corps of Engineers, Bonneville Power Authority, state and local agencies, power utilities, irrigation districts, Tribal Nations, the Provincial Government of British Columbia, the Yukon Territory, and Mexico. The primary users of this information include agricultural, municipal, industrial, hydropower, and recreation. Recent Federal legislation related to endangered species protection has placed increased emphasis on timely and accurate forecasts.

The NWCC recently implemented a *Daily Water Supply Guidance Forecast* product for 138 western basins. The procedure uses SNOTEL snowpack and precipitation to calibrate and generate an updated water supply volume forecast everyday. This product provides water managers with intra-month water supply forecast trend analysis between the coordinated monthly water supply forecasts. The product is accessible from the following location http://www.wcc.nrcs.usda.gov/wsf/daily_forecasts.html.

The Natural Water and Climate Center (NWCC) web site (http://www.wcc.nrcs.usda.gov) provides snow data, analyses, GIS maps, and forecasts to approximately 80,000 users. The web site logged over 16 million user accesses to data reports and products during the water year 2006.

Drought Assessment

The SS&WSF Program provides a variety of climate and water supply products that are used to assess Western drought. These include SNOTEL snowpack and precipitation analysis in the mountains, water supply forecasts, and state Surface Water Supply Indexes (SWSI). These products are critical to the weekly production of the interagency *Drought Monitor* web based report. A cooperative, nationwide network of approximately 143 Soil Climate Analysis Network (SCAN) sites in 39 states monitors soil temperatures and soil moisture to support national drought monitoring, production agriculture, and climate change research.

Climate Information

NRCS provides climate data and products that directly support agriculture and conservation activities nationwide through the NWCC webpage and AgACIS (Agricultural Applied Climate Information System) which is accessible through the NRCS Electronic Field Office Technical guide webpage. AgACIS is an internet-based climate data delivery system developed in partnership with the six NOAA Regional Climate Centers. AgACIS provides the NRCS field offices, USDA, and partners with Internet access to thousands of climate datasets collected by scores of Federal, state, and county networks. Digital maps of monthly and annual precipitation and temperature for the United States are available from the NWCC webpage (Figure 3-USDA-5). NRCS' long-range planning is supported by the Generation of Weather Elements for Multiple (GEM) applications model, which has been used to generate future climate data sets for more than 250 locations nationwide. GEM is being integrated with several NRCS environmental models and is being used for the NRCS Conservation Effects Assessment Program (CEAP). Monthly precipitation averages and growing season length information required for wetlands analysis are also available from the NWCC webpage at over 6,000 locations in the United States, plus Guam and Puerto Rico. Finally, wind roses for 237 NWS stations in the United States, plus offices in Guam and Puerto Rico are now available from the NWCC webpage. A wind rose gives a very succinct but information-laden view of how wind speed and direction are typically distributed at a particular location. Wind roses are useful planning tools for agricultural and natural resource planning.

AGRICULTURAL RESEARCH SERVICE

Research in this area focuses on how annual variation in weather impacts crop and animal production, hydrologic processes, the availability of water from watersheds, and the environmental and economic sustainability of agricultural enterprises. ARS scien-

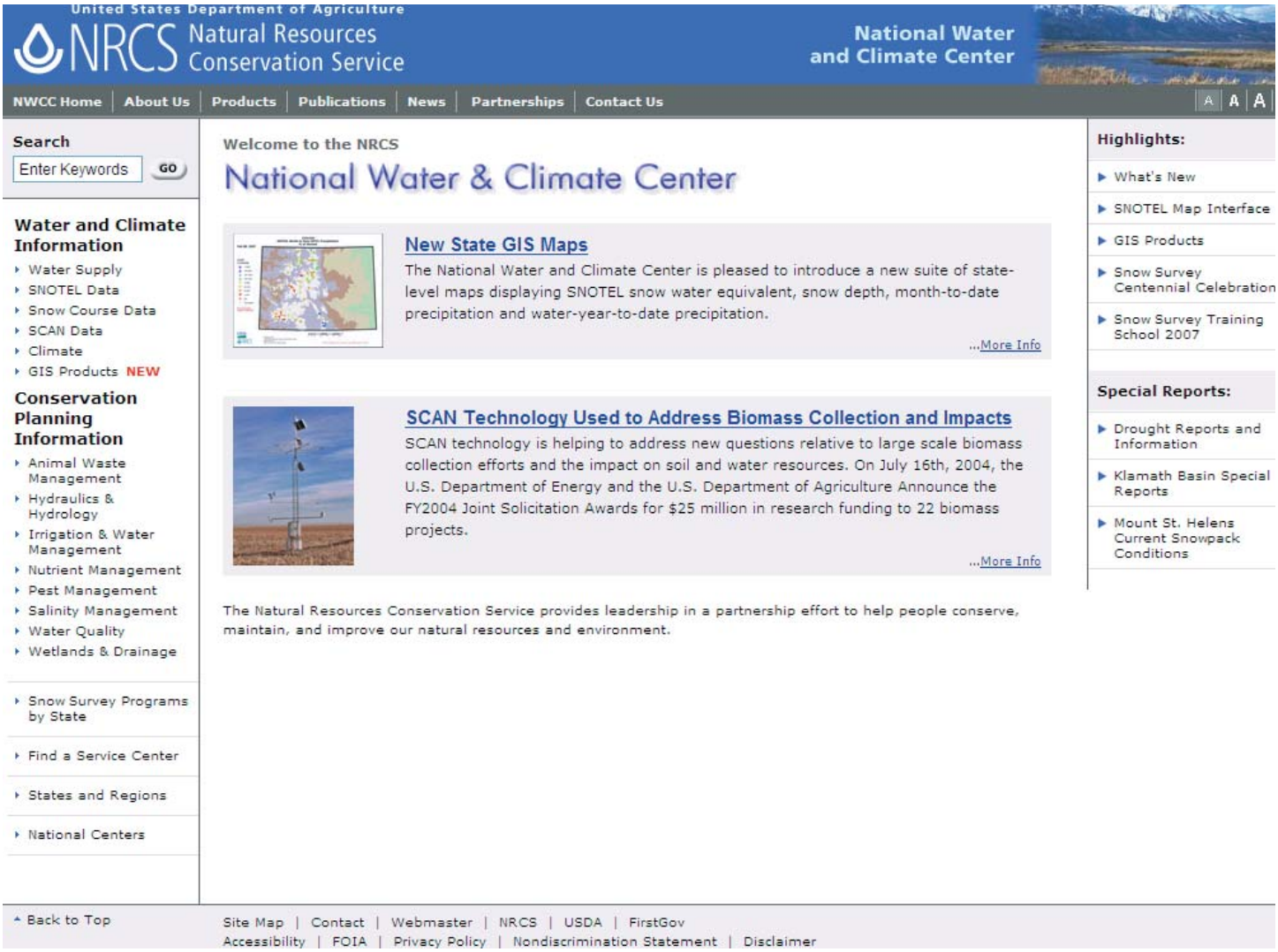

Figure 3-USDA-5. Natural Resources Conservation Service Web Site, where digital maps of monthly and annual precipitation and temperature are available.

tists are developing algorithms and decision support systems with the NRCS, NASA, and NOAA to improve prediction of snowpack distribution and timing of snowmelt and water availability in the Western United States. ARS is working with scientists at NOAA, NASA, OCE/WAOB/JAWF, and various land grant universities to improve the accuracy and precision of predicting and assessing the impact of drought across the United States. ARS scientists are leading development of new technology to mitigate the impact of drought by developing agricultural management systems that are more water efficient and which use non-potable water supplies to augment irrigation water supplies during times of drought.

Other research includes development of a new stochastic storm-generator model, and methodology that uses contemporary weather radar systems to determine rainfall amounts and spatial distributions to better characterize the variability of precipitation associated with individual storms. This information will be useful for developing best management practices to reduce soil loss and sedimentation, and for predicting when and where flooding may occur.

Additional research is being conducted to integrate seasonal weather forecasts, information on extended climate departures from normal, the occurrence of extreme weather events, corresponding agricultural responses to weather and climate variations, and associated uncertainties into planning and management decision aids readily useable by agricultural producers. The research is conducted in collaboration with the NOAA, NASA, and land grant university scientists forecast developers. The ARS experimental watershed program actively participates in the NWS effort to modernize the Cooperative Observer (COOP) Network to ensure agriculture's needs are addressed by the national surface observation network.

ARS scientists conduct research to understand the processes of air pollution emissions from agricultural enterprises and the effects of air quality

upon agriculture production. ARS scientists are working with agricultural producers, EPA, industry, and university scientists to develop and test control measures that will reduce gas emissions for a wide variety of agricultural enterprises. ARS scientists have recently developed and transferred to NRCS a new decision support system to predict and help minimize wind erosion in the Great Plains region of the Nation.

COOPERATIVE STATE RESEARCH, EDUCATION AND EXTENSION SERVICE

CSREES funding supports research projects that collect, process and utilize long-term weather and climate data to provide current and future use as a base of information for the projection and prediction of climatic trends related to environmental impacts of human activities, soils, crops and domestic animals on agro ecosystems, forests, and rangelands. Broader areas of study involve climate dynamics, carbon and water cycling, and their role in global change. The impact of changes in UV and ozone level studies also fit into this broad global category.

Historical climate changes are related to trends visible from present data gathering studies, enabling prediction of future crop production and irrigation needs. CSREES funding supports studies on the impact of climate and weather on food and fiber production and on natural resource protection. These studies relate to forest plant growth, rangeland productivity, cropping system selection, livestock production practices and natural resource management.

Man's impact on climate systems is also well represented in studies of both micro-and macro-climatic change. These involve studies dealing with the climatic impact on air quality, water quality and point/non-point pollution related to agricultural practices and forest and urban development. Studies on climatic impact on nutrient cycling and carbon sequestration and emission are supported with CSREES funds. Research is also being supported that quantifies the impact of climate change on the incidence and severity of plant and animal diseases and pest, invasive species, and biodiversity.

The National Research Initiative (NRI) has funded projects on a wide variety of weather and climate related research in collaboration with other US Federal agencies. NRI's Global and Climate Change Program's current focused research areas are carbon cycling and land use dynamics. Other NRI areas of research related to weather and climate change range from fundamental plant drought tolerance studies to using meteorological data to forecast market performance.