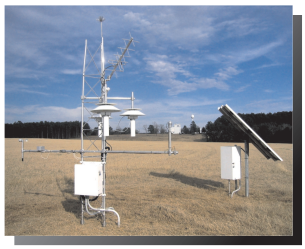
Powered by ACIS
NOAA Regional Climate Centers

Applied Climate Information System



The ACIS Design Concept

The Applied Climate Information System (ACIS) developed and maintained by the NOAA Regional Climate Centers (RCCs) is designed to manage the complex flow of information from climate data collectors to the end users of climate information. Its purpose is to both alleviate the burden of climate information management for people that require climate information to make management decisions and to manipulate data for basic and applied research. ACIS brings historical climate information and near real-time data together under one umbrella system where they are fused into quality products to assess historical climate trends, enhance daily operational decisions, or assist with any number of climate dependent activities.

ACIS information is delivered to end users as value-added products that are readily used in daily operations. These products are tailored to user needs, easily accessed, and delivered in a format specified by the user. The products can be pulled from web sites, automatically delivered to the user via scripting programs, or integrated directly into locally developed computer simulation or management models.

ACIS Benefits

Climate data management is time consuming and labor intensive. In the past, resource managers, decision makers, and researchers struggled to administer local archives of climate information to support their specific needs. This diverted time and resources from their primary tasks because local climate archives require maintenance, updating, and software modifications. Reliance on ACIS to provide needed climate information frees decision makers, managers, and researchers from these data management tasks. This results in improved decision support and reduction in organizational resources devoted to data management activities.

Custom Design

The NWS uses ACIS custom interfaces to satisfy internal climate data needs (xmACIS) and the need for supplying climate information to the general public (NOWData)

Beyond physical infrastructure, ACIS incorporates the collective knowledge of Regional Climatologists and information technology experts to address the needs of climate data users in a variety of sector-specific disciplines. ACIS is an evolving system that is continually updated with new sources of data, new products to meet specific user demands, and state of the art technologies to deliver these products to users in efficient and cost effective ways.

State and Federal agencies use ACIS to enhance their operations

- **NWS: NOWData, xmACIS**
- **NRCS: Custom interface and products**
- **USDA/JAWF: Data provision for mapping**
- **University of Washington: Uses ACIS data for near real-time soil moisture model**
- **State Climatologists: Web pages in the following States use ACIS data - LA, MS, OK , DE, PA, CA, NE, IL**

The Regional Climate Center Program is administered by the National Oceanic and Atmospheric Administration / National Climatic Data Center

NOAA Regional Climate Centers

Why is ACIS Unique?

Most climate data management systems focus on the storage of climate data and, at best, provide the ability to access data subsets or simple pre-defined summaries from single datasets. ACIS is unique among climate data management systems because it focuses on producing customer-driven, value-added products that combine data from multiple data sources. Product quality is assured through rigorous definition of station and individual station element compatibility defined in a metadata database.

Data and metadata archives, product access interfaces, and product generation capabilities exist at multiple RCCs. These capabilities are linked via the Internet to provide a seamless, robust and reliable product access system. Products can be generated and delivered to a user by extracting information from multiple RCCs data archives. This feature provides the ability to produce and deliver products that require access to unique regional datasets that may not be maintained at all RCC locations. This 'behind the scenes' feature of ACIS enables a user to specify a product without having to know where data within the ACIS system are stored and managed.

- **Produces multiple station summaries**
- **Obtains information from multiple data networks to improve geospatial density**
- **'Threads' similar stations to extend temporal data records**
- **Joins information from multiple observation intervals (hourly, daily, monthly...)**
- **Uses multiple climate observations to produce derived climate parameters and indices**

ACIS System Components

ACIS is a collection of reusable software modules that provide consistency between all processes in the system. Reusable modules offer a programming style that facilitates a maintainable and extensible system.

MetaData

Metadata is simply defined as data describing other data. ACIS metadata is managed using a relational database system that is queried extensively during the process of data discovery, data entry and extraction, and product generation. The metadata determines the availability of stations and station data elements required by a selected product, determines links between stations to expand temporal extent of data records, guides conversion of data collected in incompatible units, and evaluates the quality of data records based on data value flags. The ACIS metadata system is derived from Federal Geographic Data Committee (FGDC) compliant information obtained from the National Climatic Data Center (NCDC) and National Weather Service (NWS).

Metadata Components

- **Geographical Identifiers (coordinates, elevation, political boundaries, hydrologic areas, time zones, etc.)**
- **Station name, network identifier(s), and station id(s)**
- **Station history describing changes to station characteristics**
- **Time of observation and data elements measured**
- **Units of measure for each observed data element**
- **Definitions of quality control flagging systems**
- **Links between individual stations with homogeneous data records**
- **Summary of observation availability for each station and station element**

Climate Data

Climate data available in ACIS consists of in-situ observations collected from a variety of federal, regional, state, and local weather and climate networks. Both archive quality historical data and near real-time data ingested from operational data transmission streams are available. ACIS data are primarily used for the generation of operational climate products but also provide archive quality datasets. New data sources are continually added contingent on demand, need, time, and funding.

Data Ingest

Data ingest processes collect real-time data from Internet and satellite sources as well as historical data obtained using semi-automated file transfer methods. These sources disseminate data in different transmission formats. Ingest modules route the incoming data to quality control routines, examine data record headers to determine network ownership, and route the incoming data to local data and metadata archives. Data entry processes exist that allow for inclusion of unofficial, non-published station data. This allows for manual data entry/edit followed by 'injection' of these data into standard ACIS data ingest processes.

Quality Control

ACIS data are subject to a hierarchy of quality control that includes comparison to physical and climatological limits and inter-comparison of data elements. A more comprehensive system has been developed for ACIS that includes enhanced checks based on per-station statistical limits and an advanced geospatial regression model. This system is being tested by the RCCs and NCDC and shows great promise in identifying errors while minimizing mis-identification of data extremes that are valid observations. This system is scheduled for operational implementation in the first half of 2008. RCC Regional Climatologists will review observations flagged by the automated QC system as suspected errors. This two-tiered system of QC will ensure that data entered into ACIS will be of the highest possible quality.

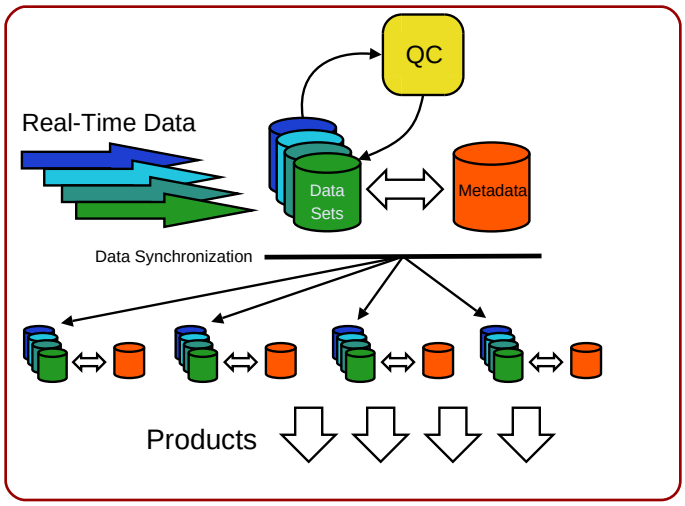
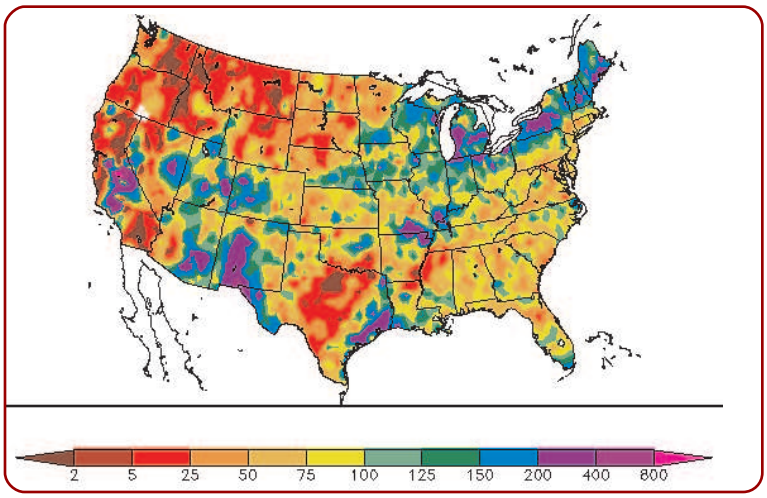


Diagram showing the processes of data capture, archive, quality control, and production of a value-added climate data product

Data Archive

ACIS data are currently stored using the Network Common Data Form (netCDF). This format lends itself to data access speed, efficient use of storage space, and acceptance by a wide community of climate data users. The implementation of redundant ACIS data stores at multiple RCCs ensures timely availability of data and products in the event of network or data center failure. Synchronization of datasets among the RCC data centers ensures that identical information is provided regardless of point of access. A remote switching system automatically distributes ACIS requests among available servers to provide distributed load and timely system response.



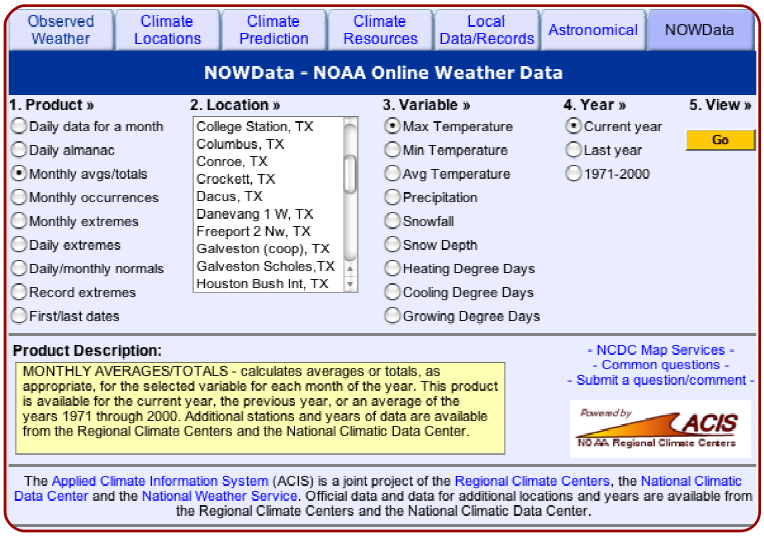
Percent of Normal Precipitation (7/10/2006 - 8/8/2006) produced using near real-time ACIS data.

Products

All output delivered via ACIS to an end user is classified as a product. A product can be a tabular data listing, a simple or complicated statistical analysis, a station metadata summary, or a graphical display. ACIS includes a wide array of standard products that adhere to rigid standards for data quality, use of certified statistical analysis routines, compliance to rules for interpreting data flags, and commonly accepted output formatting. New products submitted for inclusion to ACIS must undergo a review process that ensures compliance with these quality standards.

User Customized Products

- **Station selection**
- **Historic period of data record**
- **Observational elements**
- **Type of analysis**
- **Output format**
- **Other product-specific choices**



NOWData is used to satisfy climate data needs in every Weather Service Forecast Office across the United States.

User Interface

ACIS provides three distinct types of user interfaces that include standard or custom web browser access to data and products, a scripting interface using standards-based XML-RPC (eXtensible Markup Language – Remote Procedure Call), and direct programming to the ACIS application programming interface (API). Most users find the browser interface sufficient to meet their needs. Current browser interfaces to ACIS include CLimate Information for Management and Operational Decisions (CLIMOD), NOAA On-line Weather Data (NOWdata), xmACIS (custom NWS interface), and others.

The XML-RPC interface provides an intermediate level of access to ACIS that provides more options for user specification of products than the web interfaces. A user wishing to summarize rainfall records for all stations in a specific state or hydrologic region might use this interface to produce input files for a modeling application.

At the advanced access level a user can utilize the ACIS API to dynamically link decision support models to ACIS data resources. Direct access to ACIS through the API is the most efficient method to obtain data when operational needs require frequently updated climate information.

ACIS Vision

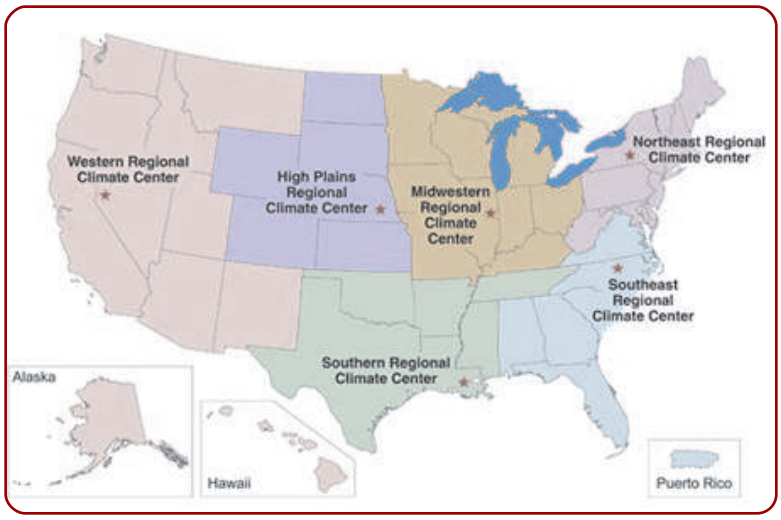
ACIS is a fully functional system with a flexible design. ACIS will evolve to incorporate additional data sources, generate new and improved data products, take advantage of emerging technologies, and respond to the needs of its users.

Future ACIS Enhancements

- **Expand climate data holdings:**
  - **SNOTEL (SNOpack TELemetry)**
  - **SCAN (Soil Climate Analysis Network)**
  - **RAWS (Remote Automated Weather Stations) network**
  - **U.S. Geological Survey precipitation and stream flow networks**
  - **Coastal data networks**
  - **Regional, State, and local mesonets**
  - **Include non-climatic data such as air quality**
- **Expand and enhance climate data products**
- **Enhance Geographic Information System (GIS) capabilities**
- **Develop relational database interfaces**

About the RCC Program

For over twenty years NOAA's Regional Climate Center Program has been recognized by Congress as vital to the efficient, coordinated delivery of NOAA climate services from national to local levels. The mission of the six centers is to provide quality data stewardship, improve the use and dissemination of climate data and information for the economic and societal good of the U.S., and conduct applied climate research in support of improved use of climate information.



High Plains RCC University of Nebraska Kenneth G. Hubbard	Lincoln, Nebraska (402) 472-8294
Midwestern RCC Illinois State Water Survey Steven D. Hilberg	Champaign, Illinois (217) 333-8495
Northeast RCC Cornell University Arthur T. DeGaetano	Ithaca, New York (607) 255-0385
Southeast RCC University of North Carolina Peter Robinson	Chapel Hill, North Carolina (919) 843-9721
Southern RCC Louisiana State University Kevin Robbins	Baton Rouge, Louisiana (225) 578-1063
Western RCC Desert Research Institute Kelly Redmond	Reno, Nevada (775) 674-7011