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The State Climatologist

MONITORING GLOBAL CLIMATE CHANGE WITH NOAA'S GCPS

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Dr. Kenneth D. Hadeen
Director, NCDC

Dr. Kenneth E. Kunkel
President, AASC

John P. Hughes
Editor, The State Climatologist

Global Greenhouse Warming has been a steadily growing issue during the 1980s. The drought of 1988 brought the subject of climatic change painfully into focus in the United States, while statements by world leaders at the 1989 Paris Economic Summit focused international attention on the need for global monitoring. NOAA's response to these issues, articulated by NOAA Undersecretary John Knauss' call for a system of "leading environmental indicators," demonstrated the need for an organized and coordinated monitoring and assessment mechanism using timely, reliable, and consistent information on the state of change in the environment. The Global Climate Perspectives System (GCPS) is a system being developed to meet these needs.

It is a coordinated project involving three NOAA components with support from the NOAA Climate and Global Change Program. The Global Climate Lab at NESDIS' National Climatic Data Center (NCDC) in Asheville, NC, is the lead center and will manage the data base and develop long-term data sets. The NWS Climate Analysis Center, in Suitland, MD, will provide current monthly station data from the GTS collective to update the GCPS in a near-real-time mode, while ERL's Climate Research Division, in Boulder, CO, will be responsible for developing some of the research data sets from the GCPS data base.

Global Historical Climate Network

The GCPS data base will initially consist of a global surface-based research-quality baseline data set called the Global Historical Climate Network (GHCN). The GHCN, being developed by NCDC with support from the Department of Energy (DOE), is an integrated station data base comprised of all existing monthly data available at NCDC, research collections provided by other investigators, and several national datasets (including previously unavailable data from the Soviet Union, China, and Mexico).

Since there will be some duplication between source data sets, a data quality assessment algorithm is being used to select the "best" value from the duplicate stations for those year/months where multiple values exist. The duplicate elimination algorithm employs robust statistics and the spatial analysis of scalar fields, as well as an *a priori* assessment of the data quality of each source data set. Nearest neighbor multiple regression (NNMR) estimates are calculated for each observed value. The NNMR estimates and the 95%

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE

NATIONAL CLIMATIC DATA CENTER IN COOPERATION WITH
AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

confidence interval are used to express our confidence in the observed value, with the NNMR equation's explained variance being used to assess our confidence in the estimated value.

The GHCN data consist of year/ monthly mean temperature, total precipitation, station pressure, and sea level pressure. Historical monthly COADS gridded marine data will eventually be loaded into the GCPS data base. The system is being designed to incorporate additional parameters (for example, snow data, ice cover, and upper-air data) and source datasets as they become available.

"The GHCN data consist of year/ monthly mean temperature, total precipitation, station pressure, and sea level pressure."

Bias Removal

Station history metadata and nearest neighbor comparisons will be used to identify data inhomogeneities. Adjustment algorithms developed by NCDC and ERL researchers and others will be used to remove biases caused by station relocations, changes in instrumentation, changes in observation practices, and changes in the surrounding environment (i.e., urban warming).

The station data will form the basis for several derived data sets. Monthly temperature, precipitation, and moisture anomaly index values will be calculated for a network of global climate divisions. A gridded data set will be calculated from the station data, as well as values for special (e.g., agricultural, hydrological, ecological, etc.) regions. Several derived quantities (such as normalized temperature and precipitation, percent area of selected regions experiencing extreme temperature or moisture conditions, etc.) will be calculated.

"The user can decide how he/she wants the data to appear on the map or time series graph, and will also be able to use the map interactively to define special regions."

GCPS Will Be User-Friendly And Functional

The GCPS will operate in a user-friendly, menu-based environment on state-of-the-art SUN SPARC II workstations. A master menu will allow the user to perform one of five functions: display spatial information on maps, generate a time series graph, extract data for display or downloading to diskette, generate a climatological summary or perform some other statistical analysis, and update a data set. Pull-down sub-menus will appear listing the choices allowed at each step of the process, with the choices depending on the function being performed.

The user can decide how he/she wants the data to appear on the map or time series graph, and will also be able to use the map interactively to define special regions. Long-term mean lines, filters, and trend lines of various types will be available for time series plots, along with the appropriate regression statistics.

What The User Won't See

Beneath the menu overcoat, the entire system will be driven by EMPRESS, a state-of-the-art data base management system (DBMS). GCPS station history, inventory, and catalog information will be accessed by EMPRESS from a metadata base that is being designed in conjunction with other major NCDC projects. The actual historical climate data will reside in separate files. EMPRESS will access the climate data base via an Access Module consisting of several FORTRAN and C language subroutines. EMPRESS will transfer the graphics and analysis operations to an Applications Module comprised of SAS, a FORTRAN/C subroutine library, and other software packages (including CRDTOOLS and NCAR Graphics). These modules can be expanded as the need for new formats and analyses arises. This complex software arrangement will be transparent to the user, since all that he/she will see is a series of menus and sub-menus managed by the EMPRESS DBMS.

In The Months Ahead...

With the GCPS, NOAA will soon be able to present a coordinated assessment of global and hemispheric mean temperature, precipitation, and pressure trends. But the NOAA system will eventually be able to do much more. Variability in special regions (for example, percent area of the world's wheat or rice belts in drought) can be exam-

ined. A variety of elements will be added to help "fingerprint" the multidimensional aspects of climatic change. Assessments for national and international commissions (such as the Intergovernmental Panel on Climate Change) will be made more efficient and convenient. New climate reference data sets can be generated for the research community through the GCPS system and data base. And NOAA will be able to provide a more complete response to questions asked by national and international policy makers and the news media.

"New climate reference data sets can be generated for the research community through the GCPS system and data base."

Development of the GHCN data base is nearing completion, while work on the software continues.

Bruce Baker
Richard R. Heim, Jr.
Robert G. Quayle
National Climatic Data Center

Computer Graphics and Climatology at the Kentucky Climate Center

The Kentucky Climate Center has employed a student computer programmer each year since 1978. Preference is given to hiring individuals who are completing their first year at the University with the expectation that they will work during their final three years. The students are physics, mathematics, or computer science majors who have significant programming skills. In particular, skills in computer graphics are desirable because of the wide range of applicability to climatological illustrations. Computer graphics capabilities have evolved as each student programmer contributed new applications.

"Computer graphics capabilities have evolved as each student programmer contributed new applications."

Most state climatologists have access to computers that greatly simplify the statistical analysis of climatological data. Some have access to mainframe computers which allow more complex statistical analyses and permit advanced graphics ability. At Western Kentucky University, we have a VAX 6320 and a graphics package (CA-DISSPLA) which can produce graphs ranging from simple bars to complex four dimensional contours. However, recent

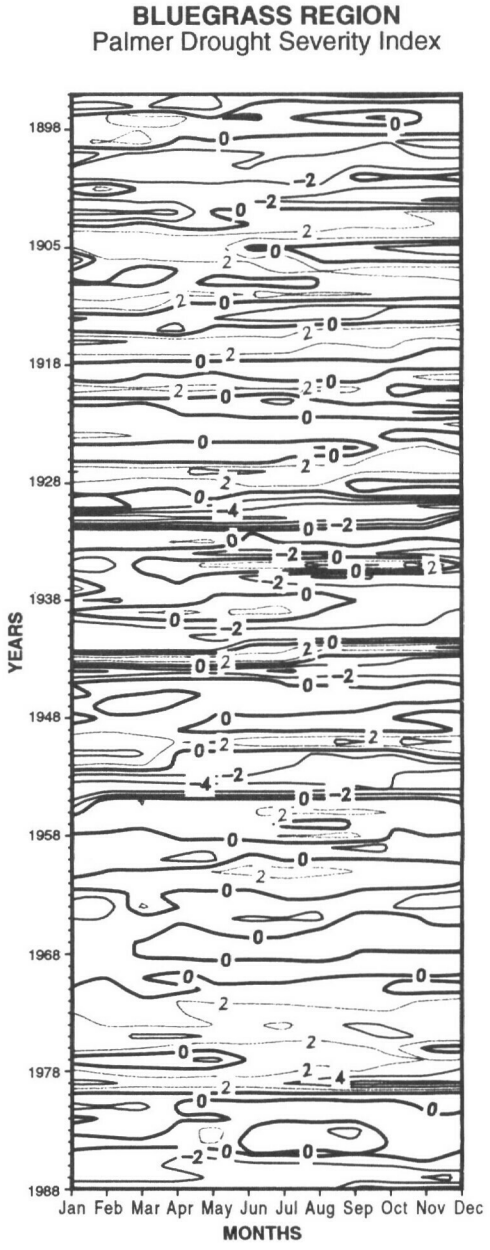


Fig.1

advances in microcomputer technology have made it possible for almost any user to access intricate computer graphics at a reasonable cost. We have improved our ability to communicate climatological data to the public by using advanced graphics.

Climatologists are usually more interested in patterns or trends. Three dimensional graphs are useful in this way. The Palmer Drought Severity Index (PDSI) data in Figure 1 are for the Bluegrass Division of Kentucky and extend from 1895 through 1988. The surface of the graphs has "valleys and mountains" where the valleys represent varying degrees of drought and the mountains either recoveries or wet periods. Although climatologists can see droughts and wet periods from the original data set of 1,128 entries, it is easier for the public and media—climatological laymen—to understand the graph even without extensive explanations of PDSI equations. Nevertheless, the graph makes pinpointing data from surface graphs difficult, especially in the early years which are farther away in the three dimensional space.

"...the graph makes pinpointing data from surface graphs difficult, especially in the early years which are father away in the three dimensional space."

The contour graph in Figure 2 depicts the same PDSI data set. Here, the droughts of the 1930s are clearly visible. The lack of seasonal persistence of drought is evidenced by the absence of non-linear contours. While these contoured data may be more legible to a climatologist, the average reader may lack an understanding of both the nature of contour graphs and of PDSI. The strengths of the contour graph (all points readable and no hidden surfaces) may be diminished by this lack.

"Using computer graphics for climatological data makes the data easier to communicate and interpret."

To harness the advantages of both the contour and the surface graphs, one can combine the two graphs into a single drawing. Figure 3 illustrates the usefulness of the combination. This graph is composed of a surface graph of Kentucky tornado occurrences by month and hour suspended over a contour graph of the same data. From the surface graph, one can see the magnitude of the trend towards tornadoes in the afternoon hours and spring months. The contours detail a concentration in March about 4 p.m. The combined graphic has the advantage of each of its component graphs. The casual reader may be drawn to the surface graph with its dramatic peak and have a subsequent urge for more detail satisfied by the contour graph.

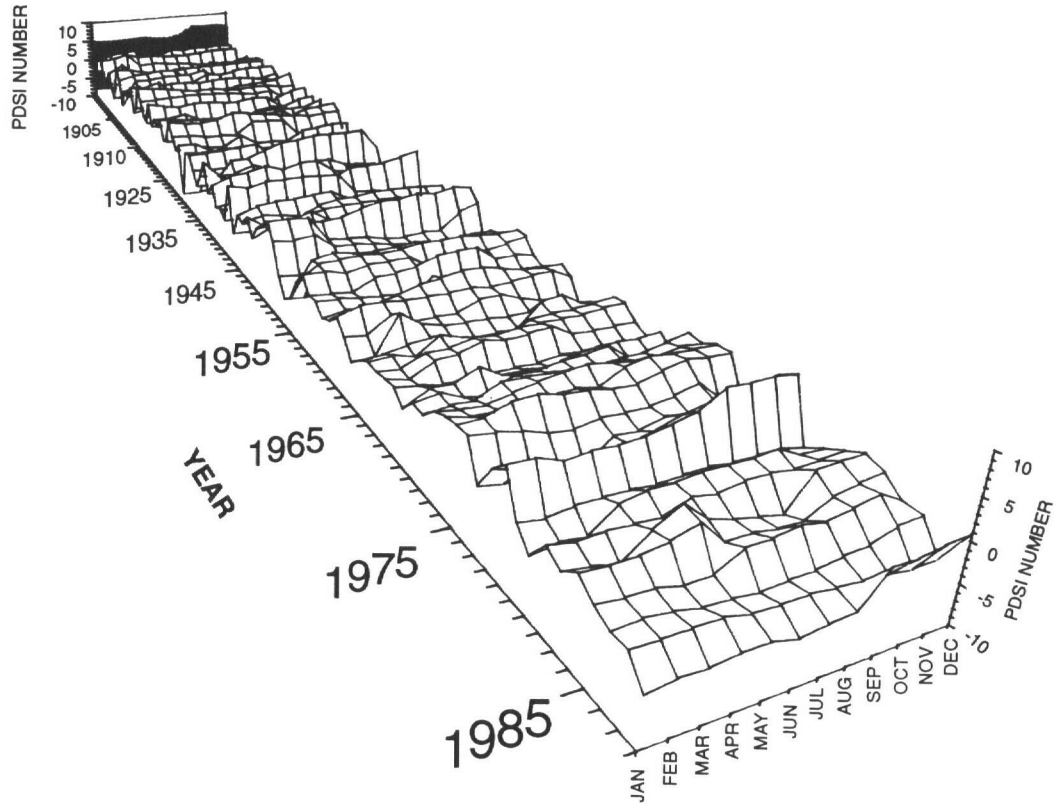
The graphics presented here are only a few examples of those routinely produced by the Kentucky Climate Center. Computer mapping is an important aspect of our public service as well. Using computer graphics for climatological data make the data easier to communicate and interpret. In many cases, graphics are the best way to convey information. Because these graphics capabilities are more readily available than they were in the past, most state climatologists can take advantage of new ways to present data to the public and to other climatologists.

John Ternent
Chief Programmer
Kentucky Climate Center

Glen Conner
State Climatologist for Kentucky

BLUEGRASS REGION
Palmer Drought Severity Index

Fig. 2



TORNADO OCCURRENCES IN KENTUCKY
1950 - 1986
by John Ternent

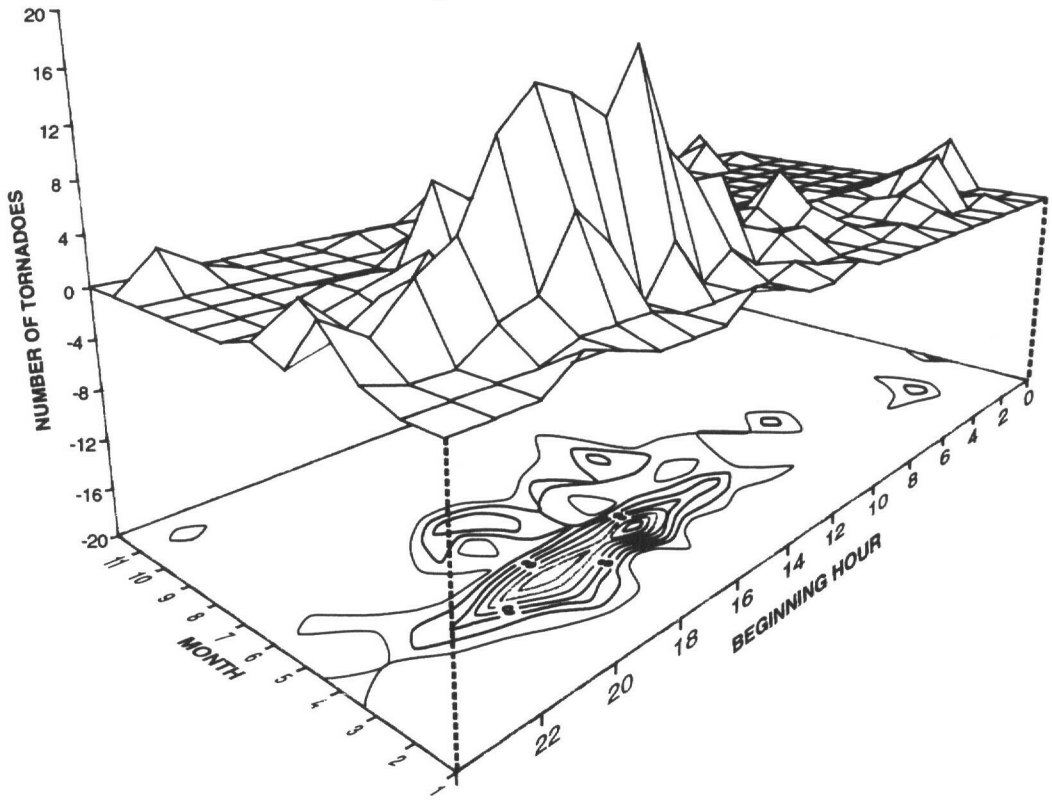


Fig. 3

In Memoriam

The Wisconsin State Climatology Office is very sorry to note the death of former State Climatologist Val Mitchell on December 30, 1991, after a long struggle with multiple sclerosis. Val received his M.S. (1967) and Ph.D. (1969) degrees from the University of Wisconsin-Madison under the direction of Professor Reid Bryson. His special interest was the effect of mountain topography on regional climate, an interest he developed during his youth in Salt Lake City, UT. Prior to being appointed Wisconsin State Climatologist, he taught and researched at Montana State University in Bozeman, MT. Val served as the State Climatologist from 1974 to 1982, when he retired due to increasing health problems associated with MS. Under his leadership, the State Climatology Office successfully completed the transition from Federal to state control, within the UW-Extension's Geological and Natural History Survey. Val carried out a wide variety of studies in theoretical and applied climatology; some of these still form the basis of ongoing work in the present State Climatology Office. However, service to the state and the community was his favorite part of the job.

In addition to his widely varied interests in climatology and meteorology, Val was dedicated to service in the LDS Church, including a two-year mission, service in youth programs and several administrative positions. His life was an example of patient yet cheerful endurance, strength in spite of adversity, a love of people and music, and a zest for life and all its joy.

Val is survived by his wife, Margo, and four adult children. Mrs. Mitchell's address is 6105 Monticello Way, Madison, WI 53719.

Pamela Naber Knox
Wisconsin State Climatologist

"It was a pleasure to renew acquaintances with many of you at our annual meeting in Anchorage."

"Recently, the Department of Commerce held a ceremony in honor of the Centennial of the National Weather Service and the cooperative network."

Anchorage Meeting

It was a pleasure to renew acquaintances with many of you at our annual meeting in Anchorage. I believe that we had a successful meeting with the discussion of important issues and the presentation of important information. I am sorry some of you were unable to attend and I will highlight some important points.

Total attendance at the meeting was near 45, which included some from the University of Alaska, the local National Weather Service staff, and the local Soil Conservation Service office. Around 40 members and associate members from the "Lower 48" were present. This is somewhat fewer than recent meetings, but certainly adequate for a viable meeting.

The Automated Surface Observing System (ASOS) is on the verge of its operational phase. The issue of climate data continuity was discussed at some length. Of relevance to this issue, the National Weather Service (NWS) is planning a minimum one-year period of concurrent manual and ASOS measurements. In addition, the NWS has funded a comparison study for temperature and precipitation between current technology and ASOS. These are positive developments and I believe the AASC can take at least some of the credit for these.

Recently, the Department of Commerce held a ceremony in honor of the Centennial of the National Weather Service and the cooperative network. This ceremony was attended by Mrs. Marilyn Quayle and several high level DOC officials. The AASC contributed $1,000 for the costs of the ceremony. In addition, President Mark Shulman attended as the representative of the AASC. He reports that the ceremony was very effective. He also reported that his presence was important in raising the visibility of the AASC at high levels of government. Thanks, Mark, for taking advantage of this opportunity on behalf of the AASC.

Issues of data quality control and validation came up frequently. Those of you who are regular attendees know that this issue comes up at every meeting. I wonder if we might benefit from a more in-depth treatment of this subject at one of our annual meetings. In particular, we could devote a half-day at our next meeting to discuss methodology and perhaps develop a set of recommendations. If you think it would be worthwhile, please let me know.

"The 1992 meeting of the American Association of state Climatologists will be on the campus of Western Kentucky University in Bowling Green, Kentucky."

New President

Our new President-Elect is Charlie Wax, the Mississippi SC. Congratulations, Charlie!!!

Ken Kunkel
Illinois State Water Survey

1992 AASC Annual Meeting

The 1992 meeting of the American Association of State Climatologists will be on the campus of Western Kentucky University in Bowling Green, Kentucky. Meetings will be on August 6th and 7th in the Kentucky Library and Museum. This is an appropriate place to meet in the Bicentennial Year celebrating Kentucky's admission as the 15th state in 1792.

"...my forecast is that the weather in the cave will be clear, dark, and about 56°F so bring along a light jacket or sweater."

You will receive registration details and forms within a few weeks. A registration fee of about $60 is anticipated. For the long-range planners, the local arrangements are shaping up this way. Those flying in will arrive in Nashville, Tennessee. It is a major hub for American and also is served by Delta, Southwest, Northwest, and other major airlines. Bowling Green is located about 65 miles north of Nashville on Interstate 65. It is presumed that most of you will be renting a car but the registration form will ask about your interest in a University shuttle between Nashville and Bowling Green since no commercial service exists. A block of rooms is being held at Bowling Green's Mariott Fairfield Inn (which is having its grand opening on March 26th). The rooms will be about $37 per night, per room. A hospitality room will be open for your arrival at the Inn on the evening of the 5th and for continental breakfast the next three mornings.

A University bus will provide transportation from the Inn to the Kentucky Library for the meetings on the 6th. Lunch will be provided in a lovely setting in the Museum. The bus will return you to the Inn and, later, from the Inn to the banquet that night. The similar schedule will apply to the 7th except that you will have that evening free.

A Spouse Tour by University bus will be scheduled for the 6th. Possibilities being explored are Shakertown established in 1807, Riverview (The Hobson House), a horse farm, and the Kentucky Museum.

On Saturday, the 8th, a field trip is planned to experience the karst landscape of south-central Kentucky. It will include a visit to Lost River (a karst window), the sinkhole plain, and Mammoth Cave National Park. At the park, we will have a special tour of a portion of the 340 miles (yes, miles!) of explored passages and hear about the research in cave meteorology and radon transport. By the way, my forecast is that the weather in the cave will be clear, dark, and about 56°F so bring along a light jacket or sweater. We hope most of you will stay for this tour.

You can expect to receive at least two mailings. One will be the official registration materials which you will receive in a few weeks. The other will be a visitor's packet which will help you plan a vacation in Kentucky before or after our meeting. We look forward to being your host. Meanwhile, if you have any questions or tourist advice, please call me at (502) 745-5983.

Glen Conner
State Climatologist for Kentucky

NCDC Produces Global Marine CD-ROM

Features

Menu-driven, window-based geographical selection procedure

Analysis/display software for climatological means of atmospheric/oceanographic data observed within 1 and 5 degree areas covering the global marine environment for 1850-1970. Elements include air/sea temperature, dewpoint, scalar wind speed, sea-level pressure, wave height, wind/current roses, probability of superstructure icing/gale-force winds.

Means available as grid-point or contoured values.

Printer configuration for graphics output.

Extraction to ASCII files.

Help/documentation available for all screens/tables.

System Requirements

IBM-PC compatible

CD-ROM drive with MS-DOS extensions

Hard/floppy drive for user file storage

EGA graphics card

470K of RAM memory

MS-DOS Version 3.21 or higher

Mouse (optional)-Microsoft compatible

Cost/Availability

Available from the National Climatic Data Center, Customer Service, (704) 259-0682, $50

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