# 4B.8 ACCESSING GEOGRAPHIC INFORMATION SERVICES AND VISUALIZATION PRODUCTS AT NOAA'S NATIONAL CLIMATIC DATA CENTER

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## ABSTRACT

The main goal in developing and deploying Geographic Information Services (GIS) at NOAA's National Climatic Data Center (NCDC) is to provide users with simple access to data archives while integrating new and informative climate products. Users who are presented with data discovery options which flow into detailed product selection maps can search using standard "region finder" tools or gazetteer (geographical dictionary search) functions. Each tabbed selection offers steps to help users progress through the systems. A series of additional base map layers or data types have been added to provide companion information. New map services include: Severe Weather Data Inventory, Local Climatological Data, Divisional Data, Global Summary of the Day, and Normals/Extremes products. Our GIS related products provide Open Geospatial Consortium (OGC) compliant Web Map Services (WMS), Web Feature Services (WFS), and Federal Geographic Data Committee (FGDC) metadata as a complement to the map viewers. Efforts to provide quality assurance and increased performance include collocation of base maps and stations and Asynchronous JavaScript and XML (AJAX) implementations.

## 1. GIS: GLOBAL DATA ACCESS

The National Climatic Data Center provides GIS access to US and global datasets and products. These resources can be found through the NCDC home page http://www.ncdc.noaa.gov, through the NCDC GIS portal page http://gis.ncdc.noaa.gov, or from the "Map Product" search option in the Climate Data Online (CDO) application, http://cdo.ncdc.noaa.gov. Access to surface datasets include global hourly, daily, monthly data; US hourly and 15 minute precipitation, US Climate Reference Network (USCRN); NEXRAD levels II and III, and paleoclimatology data. The new GIS services that will be reviewed here included Local Climatological Data, Divisional Data, Global Summary of the Day, Severe Weather Data Inventory, Normals and Extremes, and Global Hourly.

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In addition to providing dynamic maps to access data, NCDC offers WMS which provides maps or images and WFS which provides spatial features. These services may be used from OGC compliant applications to directly access data and metadata. KMZ files used directly within 3D GIS viewers (e.g. ArcExplorer, Google Earth) are also available for popular data sets. Data sets from NCDC are recorded in FGDC compliant metadata which are harvested into catalog portals like Geospatial One-Stop and Global Change Master Directory.

Value added layers or data types are also included with GIS dynamic maps showing agriculture regions, coastal hazards, population density, global ecoregions and wetlands, state and regional climate divisions, National Transportation Atlas database layer. Topography DRG (digital raster graphics; 1:1.5 million) and visual imagery DOQ (digital orthophoto quadrangle; 1:300000) provide additional functionality and can be viewed at local extents.

Station and geographic gazetteers provide advanced search functions which allow users to rapidly isolate stations or areas of interest. The region finder tool allow user to quickly "zoom in" to a known spatial polygon or area.

Performance issues for dynamic GIS maps are always a concern. NCDC has constructed a secure failover load sharing infrastructure. Technologies that have allowed us to increase performance include: reducing the amount of client side code by implementing AJAX and streaming map output back to a browser results in lower image authentication delays.

## 2. LOCAL CLIMALOGICAL DATA

The LCD provides users with a standard form for U.S. stations, displaying hourly, daily, and monthly surface data parameters. This product has been in existence in some form since 1949 and is very popular with many customers. Over 2000 U.S. stations are included, updated daily with the latest data, after completion of all automated quality control. 90 USCRN stations and approximately 270 "first-order" National Weather Service stations' data undergo additional quality control. These data are used for the LCD as the final data for those stations. In this way, users can be assured that the LCD forms they receive are always the "latest and greatest" available at that time.

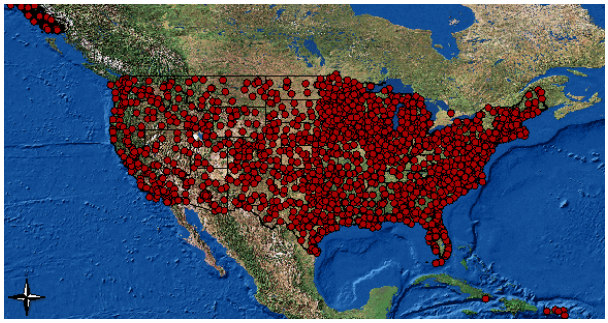

**Figure 1. Local Climatological Data station distribution.**

Along with our regular map services a KMZ file of LCD stations is available. These can be used with the ArcExplorer or Google Earth applications as displayed in figure 2. The “pushpins” can be expanded to provide links directly into the CDO/LCD access system.

**Figure 2. Stations for the Local Climatological product displayed in Google Earth.**

## 3. GLOBAL SUMMARY OF THE DAY

GSOD is a product of the Integrated Surface Dataset (ISD) and the data are now available in CDO and through the GIS interface. It consists of 13 daily summary parameters such as maximum/minimum temperature, precipitation, wind speed, dew point, and snow depth. Over 9000 global stations are included, updated daily. Users have the option of graphing the data or receiving an ASCII text tabular product. Also, all GSOD global data can be downloaded via FTP. Some stations have data from as early as the 1920’s.

The data are normally available about 2 days after the current day. Basic and advanced tools are provided for users to navigate, identify, select, and graph online data. Figure 3 shows the distribution of stations around India; note the graph function has been activated and temperature selected as the variable to graph. Station selection (by left mouse click) will initiate the activated function.


**Figure 3. 13 different variables from the Global Summary of the Day stations can be graphed.**

The mean daily values described in the output file are based on the hours of operation for the station. The daily extremes and totals--maximum wind gust, precipitation amount, and snow depth—will only appear if the station reports the data sufficiently to provide a valid value. Therefore, these three elements will appear less frequently than other values. Also, these elements are derived from the stations' reports during the day, and may comprise a 24-hour period which includes a portion of the previous day. The data are reported and summarized based on Greenwich Mean Time (GMT, ending at 2359Z each day) since the original synoptic or hourly data are reported and based on GMT.

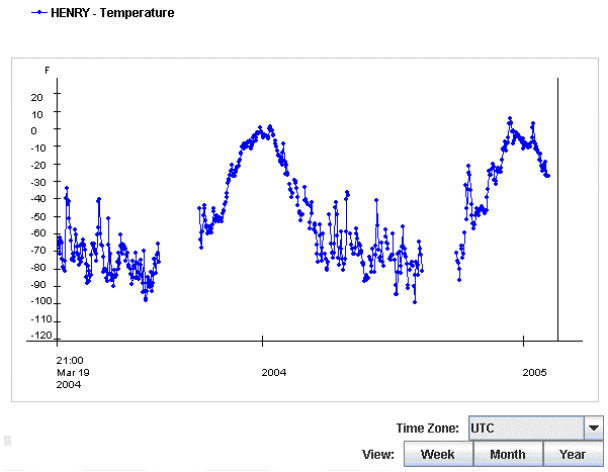


**Figure 4. Temperature graph of station Henry in Antarctica.**

As for quality control (QC), the input data undergo extensive automated QC to correctly decode as much of the synoptic data as possible, and to eliminate many of the random errors found in the original data. These data

are quality controlled further as the summary of day data are derived. The graphics tool used to display data is Multigraph, an Open Source tool, (Phillips, 2004). An example of the Antarctic station Henry is displayed in figure 4. The applet has the ability to stretch either the X or Y axis for scaling or additional data.

## 4. DIVISIONAL DATA

U.S. climate divisional data are produced monthly for the 344 climate divisions, with data from 1895 to present. Climate stations within each division are used to compile divisional averages for temperature, precipitation, drought indices, and heating/cooling degree days. Drought data include: Palmer Drought Severity Index (PDSI); Palmer Hydrological Drought Index (PHDI); Palmer "Z" Index (ZNDX); and Modified Palmer Drought Severity Index (PMDI). Also, state, regional, and national averages are included. Users have the option of graphing the data or receiving an ASCII text tabular product. For more information on divisional data calculations see on-line documentation http://cdo.ncdc.noaa.gov/CDO/DIV_DESC.txt.

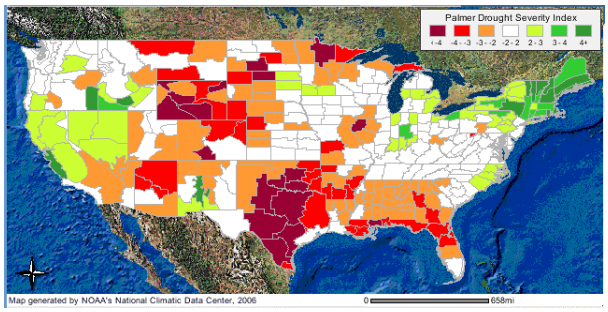


**Figure 5. September 2006 Palmer Drought Severity Index**

NCDC provides GIS access to tabular and graphical divisional data output. The map in figure 5 displays the Palmer Drought Severity Index by division for the entire U.S. These maps are computed from the most recently completed month. Display of other divisional variables can be accomplished by selecting the “Data Types” tab. Variables are separated by division, region, state, and nation. Figure 6 depicts a histogram of drought indices available through the GIS map graph function. This is displayed through the Multigraph tool and can automatically scale or fetch additional data.

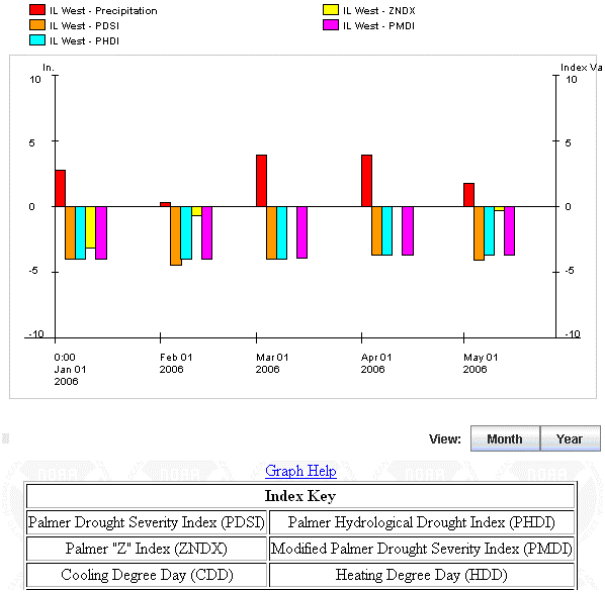


**Figure 6. Graph depicting a histogram of the historical drought indices.**

## 5. SEVERE WEATHER DATA INVENTORY

The Severe Weather Data Inventory (SWDI) provides efficient and user-friendly access to an extensive archive of severe weather data (Ansari, S. et.al. 2006). The current datasets in the SWDI include:

- National Lightning Detection Network (NLDN) strike locations (see figure 7.)
- Tornado, Mesocyclone and Hail signatures from Level-III NEXRAD Radar Data
- Storm Reports from NOAA’s Storm Prediction Center

The SWDI allows users to search based a distance from an address, town or specific coordinate. The search results may be visualized on a map or a timeline representing the data summarized by day. In addition, the results may be exported to Shapefile, NetCDF or KML. Future plans include additional search options and the inclusion of additional datasets such as watch and warning polygons.

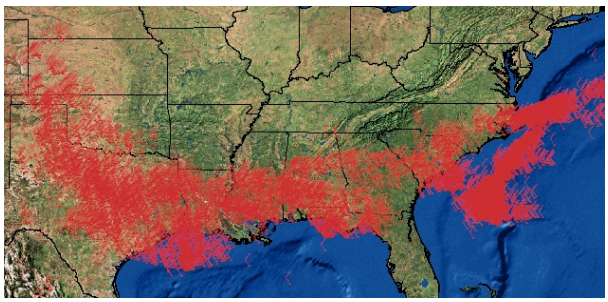

**Figure 7. SWDI Lightning Detector Network**

## 6. DYNAMIC NORMALS AND EXTREMES DATA

Daily and Monthly Normals data are available through the NCDC GIS interface for over 8000 U.S. stations. These data include Daily Normals Serial (a data set of daily values where estimated data have replaced values that were originally missing), Daily Normals Smooth (a data set of daily values calculated from monthly averages using interpolation), and Monthly Normals Sequential (a data set of monthly values that have been adjusted for changes in station instrument type, placement, and observing practices and where estimated data have replaced any originally missing values). The dynamic normals access system allows users to select their desired location, time period, and parameter, and then calculates the normal/average values for the period. There are 19 products (e.g., daily cooling degree days, greatest consecutive days with, see figure 8.) which use the U.S. "normals" datasets as input. This contrasts with NCDC's standard normals products, which strictly used 1971-2000 as the base period

**Station**: ASHEVILLE REGIONAL ARPT **State**: North Carolina **ID**: 310300
**Latitude**: 35° 26' **Longitude**: -82° 32' **Elevation**: 652.3 m
**Period of record**: 1964 - 2001

**Dynamic Normals Product**: Consecutive Days For Selected Thresholds
**Product Number**:1 of 1
**Data Source**: Daily Normals Serial

| | Greatest Consecutive Number of Days With | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature (F) | | | | | | | | | | | Precipitation (IN) | | | | |
| | Max | | | | | | Min | | | | | | | | | |
| Month | >= 100 | >= 90 | >= 70 | >= 50 | <= 32 | <= 0 | >= 70 | >= 50 | >= 32 | <= 32 | <= 0 | >= 0.01 | >= 0.10 | >= 0.50 | >= 1.00 |
| Jan | 0 | 0 | 4 | 19 | 7 | 0 | 0 | 3 | 13 | 31 | 2 | 8 | 5 | 3 | 1 |
| Feb | 0 | 0 | 3 | 21 | 3 | 0 | 0 | 2 | 10 | 27 | 1 | 8 | 6 | 2 | 2 |
| Mar | 0 | 0 | 10 | 22 | 2 | 0 | 0 | 4 | 20 | 13 | 0 | 11 | 7 | 3 | 2 |
| Apr | 0 | 0 | 16 | 30 | 0 | 0 | 0 | 8 | 30 | 6 | 0 | 8 | 5 | 3 | 2 |
| May | 0 | 2 | 31 | 31 | 0 | 0 | 0 | 23 | 31 | 2 | 0 | 7 | 4 | 3 | 2 |
| Jun | 0 | 6 | 30 | 30 | 0 | 0 | 0 | 30 | 30 | 0 | 0 | 12 | 7 | 3 | 2 |
| Jul | 0 | 16 | 31 | 31 | 0 | 0 | 3 | 31 | 31 | 0 | 0 | 9 | 6 | 2 | 2 |
| Aug | 1 | 8 | 31 | 31 | 0 | 0 | 1 | 31 | 31 | 0 | 0 | 14 | 10 | 4 | 3 |
| Sep | 0 | 2 | 30 | 30 | 0 | 0 | 1 | 30 | 30 | 1 | 0 | 9 | 5 | 2 | 2 |
| Oct | 0 | 0 | 22 | 31 | 0 | 0 | 0 | 14 | 31 | 5 | 0 | 6 | 5 | 3 | 2 |
| Nov | 0 | 0 | 9 | 30 | 1 | 0 | 0 | 6 | 25 | 13 | 0 | 5 | 4 | 2 | 2 |
| Dec | 0 | 0 | 4 | 24 | 4 | 0 | 0 | 4 | 14 | 21 | 3 | 6 | 3 | 2 | 1 |
| Ann | 1 | 16 | 31 | 31 | 7 | 0 | 3 | 31 | 31 | 31 | 3 | 14 | 10 | 4 | 3 |
| Occ | Aug1983 | Jul1977 | Aug2001 | Aug2001 | Jan1977 | | Jul1980 | Aug2001 | Aug2001 | Jan1977 | Dec1983 | Aug1966 | Aug1966 | Aug1994 | Aug1967 |

**Figure 8. Sample output from the Dynamic Normals**

Monthly extremes also allow users to select their desired location, time period, and parameter, and provide the extreme values for the period. There are 30 products (e.g. maximum precipitation by month) which use mostly U.S. data as input. The monthly extremes product is available for over 5000 stations. An output example is shown in figure 9.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

**Precipitation; Most; By Month**
Date Range Selected: 1952 to 2005

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

**314788/99999, Lake Texaway 2 Sw**, North Carolina
Station POR For Element **TPCP: 1952 to 2006**
Lat. 35°07'N, Lon. 82°58'W
Elev. 3079 ft. above sea level

| Month | Precipitation (inches) | Date(s) |
|---|---|---|
| 1 | 21.88 | 1998 |
| 2 | 15.72 | 1966 |
| 3 | 21.58 | 1977 |
| 4 | 14.44 | 1964 |
| 5 | 20.09 | 1978 |
| 6 | 22.88 | 2005 |
| 7 | 23.03 | 2005 |
| 8 | 21.61 | 1969 |
| 9 | 31.45 | 2004 |
| 10 | 20.29 | 1970 |
| 11 | 20.95 | 1992 |
| 12 | 16.69 | 1982 |
| All | 31.45 | See Above |

**Figure 9. Precipitation Monthly extreme sample**

## 7. GLOBAL HOURLY DATA

Although access to the 8000+ stations in the global hourly data set has been available through GIS for some time, there have been additions to the functionality. Station symbology classifications based on 10 year summaries of global hourly data allows users to change color coding. There are 12 hourly summaries available through CDO and dynamic GIS (dew point, wind speed, temperature, pressure, relative humidity, ceiling height and visibility, flying conditions, and sky cover). Specific period of records for summaries can be generated or pre-calculated 5 and 10 year summaries can be accessed. All of these summaries have been categorized to allow users to modify the station symbology on the fly (Baldwin, 2004). This allows global or regional analysis of station averages as demonstrated in figure 10.

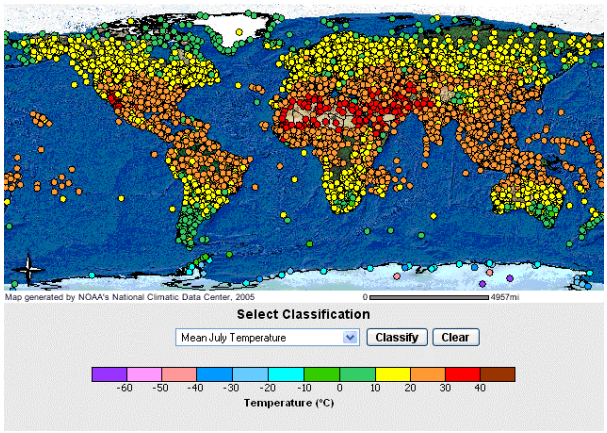


**Figure 9. 10 year mean July temperature**

Additionally the global hourly GIS map provides access to wind rose graphs for stations recording data for the latest 10 years. A sample is shown in figure 10.

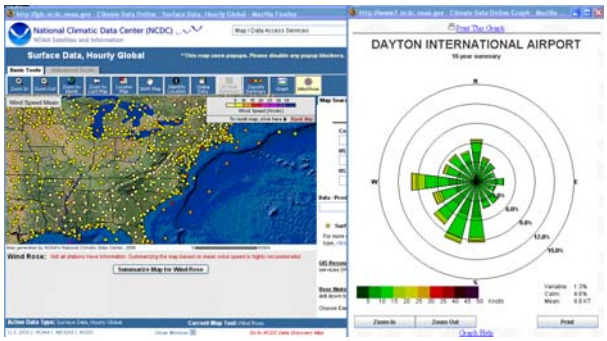


**Figure 10. Dynamic GIS map and wind rose diagram.**

## 8. CONCLUSION

A brief overview of GIS product recently made available by NOAA's National Climatic Data Center. The products described are available from the NCDC homepage http://gis.ncdc.noaa.gov.

Other individuals contributing to the development of these dataset and products include Brian May, Doug Ross, Tom Whitehurst, Pete Jones, Fred Smith, Scott Chapal, Dee Dee Anders, Richard Heim, Ron Ray, Jay Lawrimore, and Kathy Hawkins.

## 9. REFERENCES

http://sourceforge.net/projects/multigraph, Phillips, M., November 29, 2004, SourceForge, Multigraph is an interactive java software product for the display of scientific data.

Ansari, S., H. Frederick, B. R. Nelson and S.A. Del Greco, 2006: The Severe Weather Data Inventory: Spatial query tools, web services and data portals at NOAA's National Climatic Data Center. *86th AMS Annual Meeting, combined preprints CD-ROM, 9-13 January 2006, Atlanta GA, 22nd Conference IIPS [International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology]*, American Meteorological Society, Boston, Mass., File 11.4, 9 pp. (January 2006).

Baldwin, R.T. and Reid, G., 2005: Symbology modification for climate studies, 2005. *2005 ESRI International User Conference Proceedings, [July 25-29, 2005, San Diego, CA]* (Conference published CD-ROM and Online, July 2005: http://gis.esri.com/library/userconf/proc05/index.html).