# J2.2 RECENT ADVANCES IN IN-SITU DATA ACCESS, SUMMARIZATION, AND VISUALIZATION AT NOAA's NATIONAL CLIMATIC DATA CENTER

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## ABSTRACT

During the past two years, NOAA's National Climatic Data Center (NCDC) has developed several new online capabilities and products for customers. This includes expanded access to global datasets, data summarization, and a Geographic Information System (GIS) interface. The new capabilities and products include:

- Access to global datasets of integrated surface and marine data.
- Data summarization capabilities using the integrated surface data.
- A "local climatological data" product featuring improved data quality and quantity.
- Access to the full period of record of NCDC's Serial Publications and other imaged products and forms.
- User-friendly GIS capabilities to quickly locate data of interest.
- New data graphing capabilities for selected data.
- Access to numerous climate normals products.
- A new data search page, where users can query for available products based on type of data, location, and time resolution.

This paper briefly describes and illustrates these new capabilities.

## 1. GLOBAL DATA ACCESS

Through the NOAA National Data Center (NNDC) Climate Data Online (CDO) system, NCDC provides easy access to global datasets of surface and marine weather/climate data, described below. This includes the full period of digital record available, along with daily updates to the system for the most recent data. CDO is also integrated with our Geographic Information System (GIS) interface, so that users can utilize either the menu-driven CDO interface or the map-based GIS interface. The URL is:
http://cdo.ncdc.noaa.gov/CDO/cdo

NCDC, in conjunction with Federal Climate Complex (FCC) partners (US Air Force and Navy), developed the global Integrated Surface Data (ISD, formerly Integrated Surface Hourly) database to address a pressing need for an integrated global database of surface climatological data.

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ISD is gradually being expanded to incorporate additional sources of surface data. The period of record is 1901 to present, and over 100 original sources are already incorporated into this dataset. The CDO system allows users to select data by region, country, state, and station, and for any desired time period. Output formats include a simplified space-delimited format with the key climatic elements, and a more advanced format which allows the user to select just the elements desired—e.g., temperature and dew point.

The International Comprehensive Ocean Atmosphere Data Set (ICOADS) comprises data from as early as the 1784 to present, and includes data integrated from numerous sources. CDO allows users to select data by latitude-longitude "square" for any desired time period. Output formats include the often-used "common marine" format (formerly DS1129), a space-delimited format, and the ICOADS archive format.

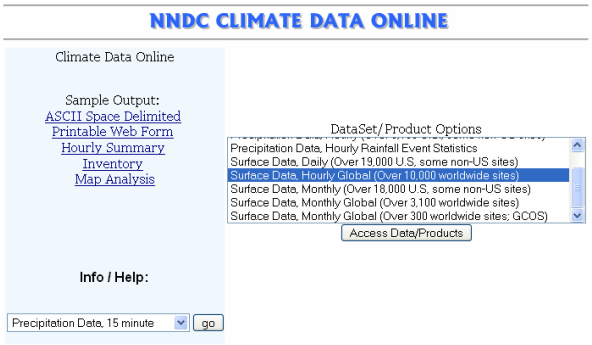


**Figure 1. CDO Interface.**

## 2. GLOBAL INTEGRATED SURFACE DATA (ISD) SUMMARIES

After an excellent joint effort with the U.S. Navy (collocated with NCDC in the Federal Climate Complex), the ISD summary system is now online within our Climate Data Online system, and through our GIS interface. Fourteen different summaries can be generated, such as ceiling-visibility, dew point statistics, temperature statistics, flying conditions (different categories), relative humidity, sky cover, sea level and station pressure, and wind speed/direction. The summaries are available as "pre-generated" 5 and 10-year summaries, or as "on-the-fly" summaries for user-selected periods. The global surface database used as input has over 10,000 active stations. The URL is:
http://cdo.ncdc.noaa.gov/CDO/cdo

**NNDC CLIMATE DATA ONLINE**

**Surface Data, Hourly Global: Summaries(DS3505)**

ISH Summary
POR 01/01/1995 - 12/31/2004
Temperature Summary for 87750099999/BAHIA BLANCA AERO
1995/01/01 00:00 to 2004/12/31 23:59

| HOUR (UTC) | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | mean | 23.6 | 21.8 | 19.7 | 14.6 | 11.5 | 8.4 | 7.7 | 9.5 | 11.3 | 14.8 | 18.0 | 21.3 | 15.2 |
| | stdv | 4.0 | 4.3 | 4.2 | 3.6 | 3.7 | 3.8 | 3.9 | 4.1 | 4.0 | 4.2 | 4.4 | 4.8 | 4.1 |
| | #obs | 294.0 | 268.0 | 292.0 | 276.0 | 295.0 | 286.0 | 306.0 | 299.0 | 287.0 | 301.0 | 285.0 | 259.0 | 3448.0 |
| 1 | mean | 22.1 | 20.5 | 18.6 | 13.8 | 10.9 | 7.7 | 7.1 | 8.7 | 10.4 | 13.8 | 16.7 | 20.1 | 14.2 |
| | stdv | 4.0 | 4.2 | 4.1 | 3.7 | 3.8 | 4.0 | 4.0 | 4.1 | 4.1 | 4.2 | 4.1 | 4.5 | 4.1 |
| | #obs | 274.0 | 258.0 | 284.0 | 267.0 | 285.0 | 264.0 | 286.0 | 289.0 | 279.0 | 268.0 | 265.0 | 252.0 | 3271.0 |
| 2 | mean | 21.0 | 19.5 | 17.8 | 13.2 | 10.5 | 7.3 | 6.6 | 8.1 | 9.7 | 13.2 | 15.9 | 18.9 | 13.5 |
| | stdv | 3.8 | 4.1 | 4.1 | 3.8 | 3.9 | 4.1 | 4.1 | 4.3 | 4.1 | 4.3 | 4.1 | 4.3 | 4.1 |
| | #obs | 273.0 | 260.0 | 285.0 | 269.0 | 278.0 | 277.0 | 287.0 | 284.0 | 272.0 | 272.0 | 269.0 | 254.0 | 3280.0 |
| 3 | mean | 20.3 | 18.8 | 17.1 | 12.7 | 10.0 | 7.0 | 6.4 | 7.8 | 9.3 | 12.5 | 15.3 | 18.2 | 13.0 |
| | stdv | 3.8 | 4.0 | 4.2 | 3.9 | 4.0 | 4.3 | 4.2 | 4.4 | 4.2 | 4.1 | 4.2 | 4.4 | 4.1 |
| | #obs | 299.0 | 274.0 | 304.0 | 292.0 | 306.0 | 291.0 | 306.0 | 300.0 | 289.0 | 298.0 | 287.0 | 274.0 | 3520.0 |
| 4 | mean | 19.7 | 18.2 | 16.7 | 12.4 | 9.7 | 6.8 | 6.2 | 7.5 | 8.9 | 12.1 | 14.8 | 17.3 | 12.5 |
| | stdv | 3.8 | 4.1 | 4.3 | 4.0 | 4.2 | 4.3 | 4.5 | 4.5 | 4.3 | 4.0 | 4.2 | 4.3 | 4.2 |
| | #obs | 278.0 | 253.0 | 278.0 | 271.0 | 277.0 | 268.0 | 280.0 | 280.0 | 257.0 | 255.0 | 248.0 | 247.0 | 3192.0 |

**Figure 2. ISD Summary Sample.**

## 3. LOCAL CLIMATOLOGICAL DATA (LCD) PRODUCT

The LCD system provides users with a standard LCD form for U.S. stations, displaying hourly, daily, and monthly surface data parameters. The ISD data referenced above are now used as input. The LCD product has been in existence in some form since 1949 and is very popular with many customers. The new system provides access to over 1500 stations' data after completion of all automated quality control, with a one-day lag time (e.g., January 15 data available on January 16). Then, approximately 270 "first-order" National Weather Service stations' data undergo additional quality control, and these data are then "fed" into the LCD system as the final data for those stations. In this way, users can be assured that the LCD forms they receive through this system are always the "latest and greatest" available at that time. The system URL is: http://cdo.ncdc.noaa.gov/ulcd/ULCD

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

PRELIMINARY LOCAL
CLIMATOLOGICAL DATA
HOURLY OBSERVATIONS TABLE
W B HARTSFLD/ATLA INTL APT (ATL)
ATLANTA, GA
(08/2005)

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

Elevation: 971 ft. above sea level
Latitude: 33.640
Longitude: -84.427
Data Version:
This form contains Quality Controlled data.

| Date | Time | Station Type | Sky Conditions | Visibility | Weather Type | Dry Bulb Temp (F) | Dry Bulb Temp (C) | Wet Bulb Temp (F) | Wet Bulb Temp (C) | Dew Point Temp (F) | Dew Point Temp (C) | Rel Humd % | Wind Speed (MPH) | Wind Dir | Wind Gusts (MPH) | Station Pressure | Press Tend | Sea Level Pressure | Report Type | Precip. Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0011 | 11 | SCT008 BKN039 OVC050 | 10.00 | | 73 | 23.0 | 72 | 22.4 | 72 | 22.0 | 97 | 7 | 120 | | 29.02 | | M | SP | |
| 01 | 0051 | 11 | FEW010 OVC060 | 10.00 | | 73 | 22.8 | 71 | 21.6 | 70 | 21.1 | 90 | 5 | 140 | | 29.02 | 0 | 30.09 | AA | |
| 01 | 0151 | 11 | FEW010 OVC080 | 10.00 | | 73 | 22.8 | 70 | 21.3 | 69 | 20.6 | 87 | 9 | 110 | | 29.01 | | 30.08 | AA | |
| 01 | 0211 | 11 | SCT009 BKN080 OVC090 | 10.00 | | 73 | 23.0 | 71 | 21.6 | 70 | 21.0 | 90 | 9 | 080 | | 29.01 | | M | SP | |
| 01 | 0219 | 11 | BKN009 BKN065 OVC090 | 10.00 | | 73 | 23.0 | 71 | 21.6 | 70 | 21.0 | 90 | 10 | 070 | | 29.00 | | M | SP | |
| 01 | 0251 | 11 | OVC009 | 10.00 | | 73 | 22.8 | 71 | 21.6 | 70 | 21.1 | 90 | 9 | 080 | | 29.01 | | 30.07 | AA | |
| 01 | 0301 | 11 | FEW007 OVC013 | 10.00 | | 73 | 23.0 | 71 | 21.6 | 70 | 21.0 | 90 | 10 | 070 | | 29.01 | | M | SP | |
| 01 | 0329 | 11 | FEW010 OVC016 | 10.00 | | 73 | 23.0 | 71 | 21.6 | 70 | 21.0 | 90 | 7 | 090 | | 29.00 | | M | SP | |
| 01 | 0351 | 11 | BKN020 OVC110 | 9.00 | | 73 | 22.8 | 70 | 21.3 | 69 | 20.6 | 87 | 8 | 090 | | 29.00 | 6 | 30.07 | AA | |

**Figure 3. LCD Product Sample.**

## 4. IMAGES AND PUBLICATIONS SYSTEM

The Climate Data Modernization Program (CDMP) has made it possible for publications and forms from as far back as the 1800's to be easily retrieved, viewed, and printed by any user with web access. NCDC has placed thousands of these previously inaccessible publications and images online to the public. The Images and Publications System (IPS) system now provides access to the five serial publications: Local Climatological Data, Climatological Data, Hourly Precipitation Data, Monthly Climatic Data for the World, and Storm Data, for the full period of record for each publication. Also, the system provides access to Cooperative climate data forms. The Cooperative station forms reach back to as early as the 1800s for some locations, extending forward through 2005, with over 8000 stations now active. These are the original (often hand-written) forms from the observers, which are scanned and provided as PDF images. Many additional forms and images from historical collections are being added to this system. The URL is: http://www7.ncdc.noaa.gov/IPS/.

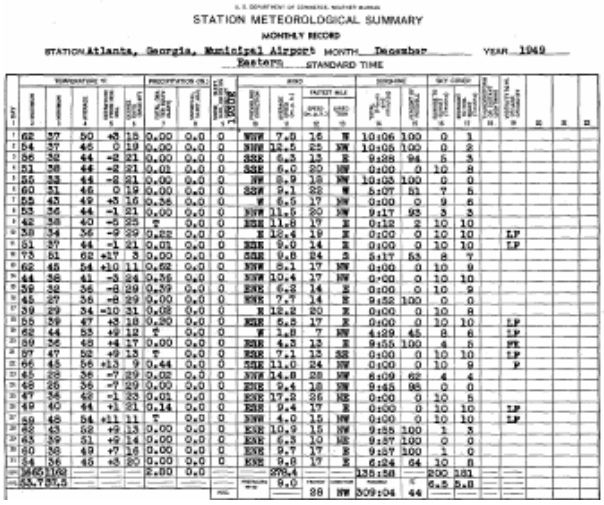
STATION METEOROLOGICAL SUMMARY
MONTHLY RECORD
STATION Atlanta, Georgia, Municipal Airport MONTH December YEAR 1949
Eastern STANDARD TIME

**Figure 4. Atlanta Airport Original Form.**

## 5. GEOGRAPHIC INFORMATION SYSTEM (GIS) CAPABILITIES

A new and improved GIS map services interface is now online. It's more user-friendly with some additional features, and provides a direct interface to all CDO datasets. The datasets now included are:

-Global Climate Observing System (GCOS) global monthly data.
-Global monthly data from CLIMAT bulletins.
-Global hourly and synoptic data from the Integrated Surface Data.
-U.S. daily data from National Weather Service cooperative and first order stations.
-U.S. monthly data from National Weather Service cooperative and first order stations.
-U.S. hourly precipitation data from National Weather Service cooperative and first order stations.
-U.S. 15-minute precipitation data from National Weather Service cooperative and first order stations.

Collectively, this includes data from over 50,000 observing stations worldwide. Monthly, daily, and hourly refer to the time resolution of the data – e.g., "monthly" includes data such as mean temperature and total precipitation for each month of available data. A variety of climatic elements are available for each dataset, with temperature and precipitation data being the most common; but many other parameters such as visibility, wind speed and direction, dew point, pressure, snowfall, snow depth, cloud data, etc, are available for some of the stations.

The interface provides basic and advanced options, with additional features available in the "advanced" menu. Once a station is selected, the user is then directed into the CDO system to select the desired time period and retrieve the data. Additional features, layers, datasets, and options will continue to be added to the system. This is part of a NOAA National Virtual Data System (NVDS) coordinated effort to provide user-friendly access to NOAA data and products. To access this interface, click on "*search by map*" on NCDC's homepage:
http://www.ncdc.noaa.gov.

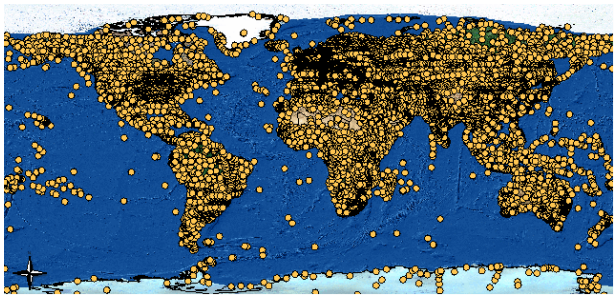

**Figure 5. GIS Interface Sample Map (ISD global data).**

As a new feature of the GIS interface, selected data types can be graphed for user-selected stations and periods of interest. This capability will continue to be expanded for additional data types, etc.

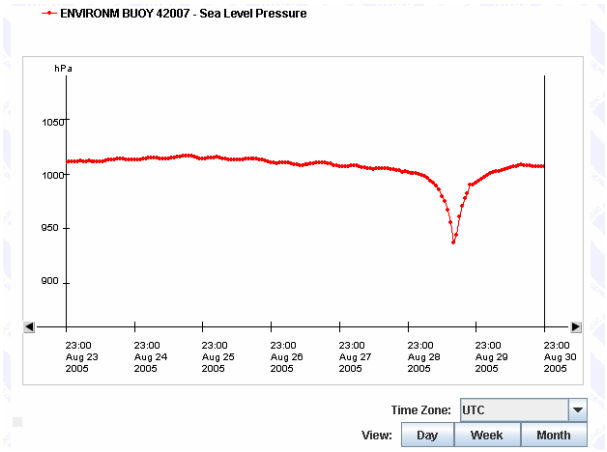


**Figure 6. Graph of Sea Level Pressure During Passage of Hurricane Katrina.**

## 6. CLIMATE NORMALS ACCESS

All U.S. climate normals products are accessible through a single interface. This includes the monthly, daily, precipitation probabilities, degree days to selected temperature bases, climate divisional, snow, and frost/freeze normals for the 1971-2000 standard climate normals period. The climate normals are among the most-used of any of NCDC's products. The system URL is:
http://www5.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl

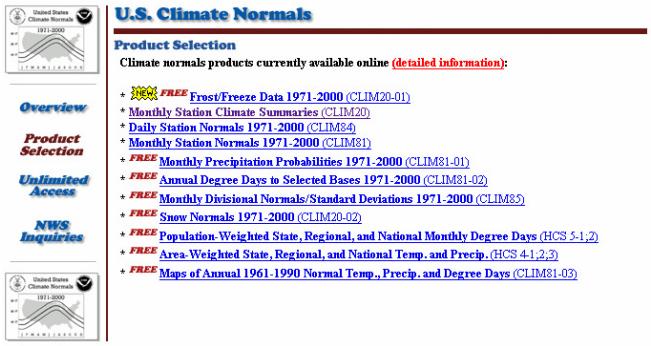


**Figure 7. Climate Normals Interface.**

## 7. DATA SEARCH SYSTEM

A new data search system is available, to search data holdings by data type, general location, and time resolution. This was developed as a result of a number of recommendations at recent NOAA data users workshops, and allows for a quick query of, for example, data/products containing hourly rainfall data for the U.S., or daily temperature data globally. The URL is: http://www.ncdc.noaa.gov/oa/mppsearch.html.


**Figure 8. Data Search Interface.**

## 8. CONCLUSION

We have briefly described and illustrated some of the online products and services recently made available by NOAA's National Climatic Data Center. All of the capabilities and services described above are accessible via NCDC's homepage: http://www.ncdc.noaa.gov. These services will continue to be expanded, and will be better integrated for ease of customer use and discovery.

A large number of individuals have contributed to the development of these services, including the authors (Dee Dee Anders, Rich Baldwin, Neal Lott), Doug Ross, Vickie Wright, Tom Whitehurst, Mark Lackey, Jeff Duska, Fred Smith, Pete Jones, Glen Reid, Debbie Franklin, Kathy Hawkins, Brian May, Mark Phillips, Ron Ray, and Dan Dellinger.