NOAA's 1981-2010 Climate Normals: A Preview

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1. Introduction

The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is responsible for producing official climate normals (i.e., 30-year averages) of numerous climatological variables every ten years for U.S. locations. The primary variables include air temperature, precipitation, and derived products such as heating and cooling degree days. NOAA's official climate normals were last produced for the 1971-2000 period, but the development of the 1981-2010 climate normals is already well underway. Here, we will provide a general preview of the 1981-2010 product, stressing key additions and improvements over the last installment, and highlighting a few preliminary results.

2. Background

The World Meteorological Organization (WMO) requires member nations to compute climate normals every 30 years. The last WMO-mandated normals period was 1961-1990 and the next will cover the 1991-2020 time period. The WMO also *recommends* that member nations re-compute their climate normals every decade (WMO 1989). Both the 1971-2000 normals and the 1981-2010 normals were and will be, respectively, computed in accordance with the WMO recommendation. However, the main customers of NOAA's climate normals are users from a broad array of American industry, as well as the American public. For example, NOAA's climate normals are used by state governments to regulate power companies, by agricultural interests to determine what plant species to cultivate in a given location, by local meteorologists in placing a given day's weather in a historical context, and in countless other applications.

The 1971-2000 climate normals consist primarily of station-based monthly and daily normals of temperature (maximum, minimum, and mean), precipitation, and heating/cooling degree days. They also include various divisional and population-based aggregations, phenological/agricultural parameters, distribution characteristics such as standard deviations and percentiles, and other supplemental normals. Currently, a more detailed description of NOAA's 1971-2000 climate normals can be found on this website:

http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html

3. Changes and additions for 1981-2010

At present, we plan to change the methodology for calculating several normals products, and add new products and variables. There are currently no plans to eliminate any products from the 1971-2000 installment. The most notable changes and additions for 1981-2010 are detailed below.

a. Higher-quality monthly temperature data

Previous installments of climate normals utilized monthly temperature data that had undergone less-sophisticated and/or ad hoc quality control. The 1981-2010 monthly temperature normals will be based on mean monthly temperature data from the National Weather Service's Cooperative Observer Program (COOP) stations that have undergone extensive quality control (Menne et al. 2009) and bias adjustment (Menne and Williams 2009). As described in the next section, the adjustments made

at the monthly level will be 'passed through' to the daily temperature normals as well.

b. Daily temperature normals based on daily data

In the 1971-2000 climate normals, daily temperature normals were calculated using a cubic spline fit through the monthly temperature normals – no daily data were utilized to refine the shape of the annual cycle. Using daily temperature data from the Global Historical Climatology Network – Daily (GHCN-D) Database (the primary source dataset for the 1981-2010 Normals), we will utilize daily data in the computation of daily temperature normals for 1981-2010. The daily temperature normals will be derived from a constrained harmonic fit of the raw daily normals. Twelve constraints will insure that the daily normals for a calendar month match the monthly temperature normals described in the previous section.

c. Direct computation of degree days

Previous installments of NOAA's climate normals have relied on a method described by Thom (1954) and Thom (1966) for computing estimates of heating/cooling degree day normals. For the 1971-2000 normals, daily and monthly degree day normals were calculated directly from daily data for First Order Stations, but were based on a modification of the "Thom Method" for all other stations. Building on the incorporation of daily temperature data described in the previous section, the 1981-2010 degree day normals will be calculated from daily temperature data.

d. Daily precipitation normals

In the 1971-2000 installment of NOAA's climate normals, daily precipitation and snowfall normals were calculated as the monthly total divided by the number of days in each month. For example, for a station with a mean January precipitation (i.e., liquid equivalent) normal of 3.1 inches, the daily precipitation normal was reported as 0.1 inches for each day in January. This will no longer be provided. Instead, for the 1981-2010 normals, various metrics of typical daily precipitation will be provided, such as the probability of precipitation for each day of the year, the median of daily non-zero (and non-trace) values, month-to-date and year-to-date totals, etc. These metrics will provide users with a more appropriate gauge of the likelihood of measureable precipitation on a given day of the year, as well as typical precipitation amounts for specific days and accumulated totals. This general approach will be followed for both precipitation (i.e., liquid equivalent) as well as snowfall amounts.

e. Normals derived from hourly data

Also new in this installment of the normals product is the use of hourly data to compute selected hourly, daily, and monthly normals. The hourly data are obtained from a subset of NCDC's Integrated Surface Data known as ISD-Lite. Climate normals will be computed for approximately 250 stations whose observations are reported at the hourly timescale. These stations are almost entirely comprised of First Order Stations that are operated and maintained by the National Weather Service or the Federal Aviation Administration, and are primarily located at airports. Note that many of these stations changed from manual observations to Automated Surface Observing System (ASOS) measurements in the 1990s, resulting in inhomogeneities in the station time series. At present, procedures for accounting for these inhomogeneities have not been established.

Hourly, daily, and monthly normals of temperature, dew point, sea level pressure, and wind will be computed. This second computation of temperature normals will facilitate comparisons between the customary definition of 'mean temperature' – the average of the daily maximum and minimum temperature – with a mean daily temperature derived as the average of 24 hourly values. Considering the aforementioned inhomogeneity issue as well as the limited quality control applied to ISD-Lite, care should be taken when interpreting climate normals derived from hourly observations.

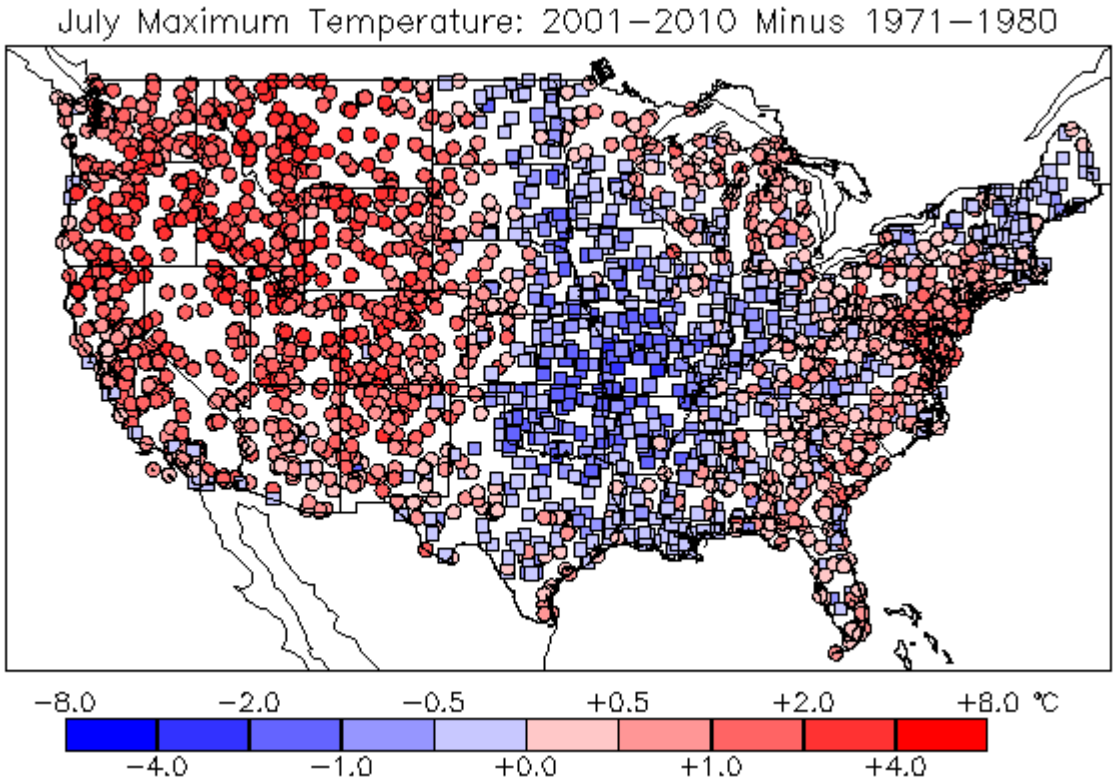

Figure 1. The difference between the decade-averaged maximum temperatures in July for the 2001-2010 period and the 1971-1980 period. Red circles (blue squares) indicate positive (negative) anomalies, i.e., warmer (cooler) conditions in the most recent decade versus the decade cycling off of the normals computation.

4. Preliminary Results

Given observed climate change, there is a great deal of interest in how NOAA's climate normals will change as what is widely viewed as a 'cold decade' cycles off and a 'warm decade' is added to the average. Here, we show the preliminary differences between 2001-2010 averages and 1971-1980 averages for July maximum temperatures (Figure 1) and January minimum temperatures (Figure 2). These two cases coincide with peak energy demand for cooling and heating, respectively. Note that these plots were generated using the higher-quality monthly data described in Section 3a, which were not available when NOAA's official 1971-2000 were calculated, requiring that care be taken in interpreting these results versus the official 1971-2000 normals. Further, note that since these are differences between individual decadal averages, estimated changes between the 1981-2010 normals and the 1971-2000 normals are one-third of the plotted values. Given that there are nearly 10,000 stations with monthly temperature data, a geographically-representative subset of stations were included in the plots.

Figure 1 shows that July maximum temperatures were cooler in the most recent decade versus 1971-1980 for much of the central part of the country, while the opposite is true for the western third of the country. Collectively, temperatures were ~0.5°C warmer in the most recent decade. In contrast, Figure 2 shows that conditions across the country were warmer for January minimum temperatures in the past decade, except for the extreme Southeastern U.S. On average, conditions were ~2.0°C warmer in 2001-2010 versus 1971-1980.

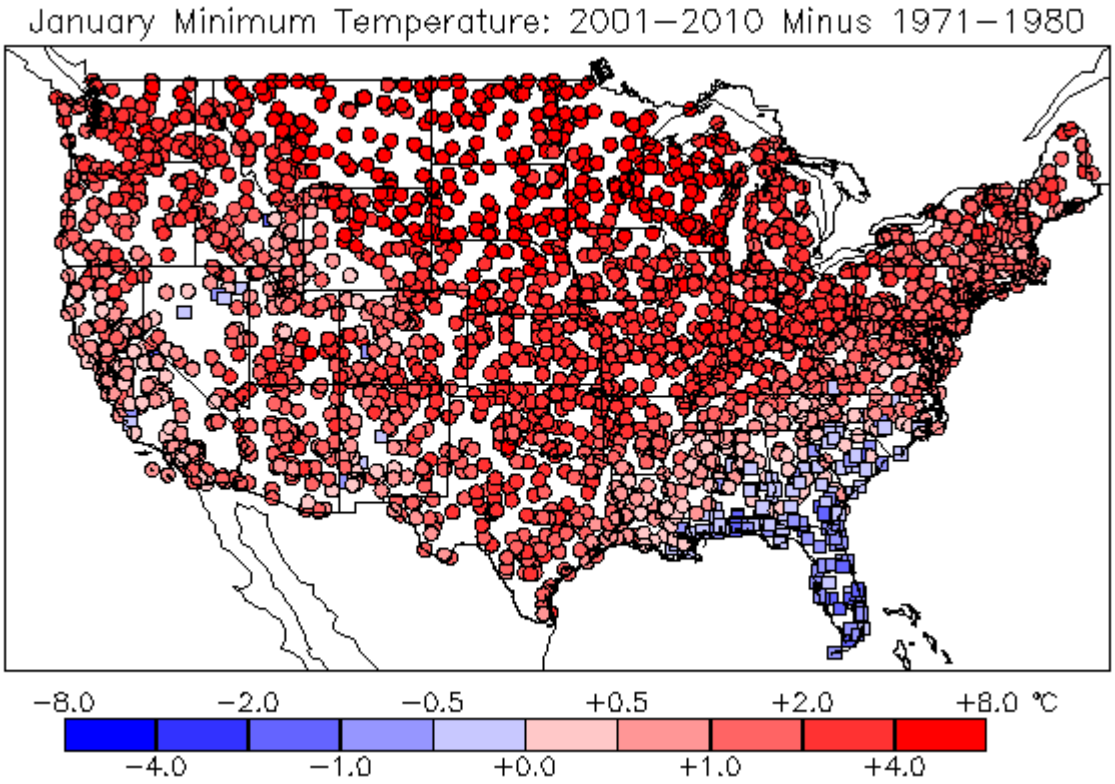

Figure 2. Same as Figure 1, but for January minimum temperatures.

5. Additional Information

We currently plan to release NOAA's official 1981-2010 climate normals in two waves. The main set of normals (station-based monthly and daily normals of temperature, precipitation, snowfall, and degree days) are scheduled to be made available to the public by October 2011, followed by a release of all other climate normal products by April 2012. All the information contained herein is preliminary and subject to change. Final documentation will be made available as NCDC technical reports and/or manuscripts published in peer-reviewed journals.

NOAA's official 1981-2010 climate normals are not to be confused with NCDC's efforts to improve the climate normals metric, as described by Arguez and Vose (2010). Currently, NCDC's Alternative Climate Normals project is a set of experimental products undergoing further evaluation, whereas the former is sanctioned an official NOAA product. For further information on alternative climate normals, click on 'alternative-normals' on the following site: http://www1.ncdc.noaa.gov/pub/data/aarguez/

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