ALTERNATIVE NORMALS, VERSION 1.0

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1. Introduction

NOAA's National Climatic Data Center (NCDC) has recently released Version 1.0 of Alternative Normals, a suite of new data products that provides alternatives to the official 30-year NOAA normals that are produced only once per decade. Alternative Normals of monthly temperatures (maximum, minimum, and mean) were first released in June 2009 via a webcast to energy industry representatives, many of whom provided beta testing feedback. Currently, the values are up-to-date through 2008 and will be updated once per year. Alternative Normals are currently comprised of three distinct alternatives to the traditional 30-year normals: Annual Updates, OCN, and Hinge Fit normals. Here, we provide a brief summary of Alternative Normals, analyze the latest results, and provide access information.

2. Background

Alternative Normals (formerly known as Optimal Normals; Arguez and Vose 2009) is a suite of experimental products that are intended to supplement NOAA's official Climate Normals, which are computed only once per decade (the last time was for the 1971-2000 period). The goal of Alternative Normals is to provide climate normals that are more representative of the current state of the climate at the time of reporting, implicitly accounting for the effects of climate change. The first phase of products – Phase One – consists of 3 products: (1) Annual Updates, (2) OCN, and (3) Hinge Fit Normals. These methods are described in Section 3. Other methods are currently in the product development phase. We anticipate including additional methods in subsequent versions of Alternative Normals. Currently, Alternative Normals are only computed for monthly-averaged temperatures: maximum, minimum, and mean. As is customary, "mean" temperature is defined as the average of daily maximum and minimum temperature. We anticipate that additional variables will be included in subsequent versions of Alternative Normals. At this point, only stations in the contiguous United States are included.

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3. Data and Methods

a. Source Data

The data used in these analyses largely come from the U.S. Cooperative Observer Network, often referred to as the COOP Network. Some additional stations are identified by Weather-Bureau-Army-Navy (WBAN) numbers. Rigorous quality control (QC) has been applied to these data. In addition, missing and flagged values were estimated based on interpolation of neighboring non-suspect data, creating serially-complete station time series. For additional information regarding the QC and the interpolation, please consult Menne et al. (2009) and Menne and Williams (2009). Additional information can also be found at the following web address:

http://www.ncdc.noaa.gov/oa/climate/research/ushcn

Note that in the articles referred to above, the QC and interpolation was applied to the United States Historical Climatology Network (USHCN). USHCN is a ~1200 station subset of the ~9000 station COOP data set used in the computation of Alternative Normals. Currently, there is no peer-reviewed article that describes the new quality-controlled and interpolated COOP data.

As described in the webpage listed above, several different flags were utilized to indicate suspect data values. In addition, some data values were missing in the raw COOP data. The FILNET procedure described in the references above was utilized to interpolate both missing and flagged values, using the time series of nearby stations. For monthly-averaged temperatures, this method is robust.

In very few cases, the interpolation routine was not able to compute reasonable estimates of missing or flagged values. This results in missing values in the adjusted and interpolated data set used here. If any missing values exist, during the range of years used for each technique (described below), the station was not included in the Alternative Normals products.

Please be advised that the most recent installment of NOAA's official climate normals, covering the 1971-2000 period, did NOT utilize this new adjusted and interpolated COOP data set. Therefore, interpretations should be made with care.

b. Methodology

Version 1.0 of Alternative Normals includes data through 2008. The adjusted and interpolated COOP data include time series for 9233 stations. The Alternative Normals products are computed for 9168 stations. The 65 stations that were not included had missing values in their time series. We only include stations for which we are able to produce values for all methods and variables.

We utilize flags to indicate whether or not an individual computation satisfies a completeness criterion. Generally, a value is flagged if more than 20% of the data used in the computation were estimated and/or interpolated. For OCN and Hinge Fit, the completeness criterion is a bit more complicated, as described below.

For each variable and method, 13 values are produced per station: one for each month, and an annual value. Annual values are computed via a weighted average of monthly values, accounting for the number of days per month. If any of the monthly values are flagged, the annual value is also flagged. All values are reported in tenths of degrees Celsius.

The specific methods are described below. Since these methods are all described in Livezey et al. (2007), users are highly encouraged to read this paper for more information. We deviate slightly from their recommendations, and these caveats are described in sub-section iv below.

(i) Annual Updates

The Annual Update is simply a rolling 30-year average. NOAA's official normals are only computed once per decade. The Annual Update through 2008 is computed using the most recent 30-year period, which is 1979-2008. The monthly normals are computed using a simple arithmetic average of the 30 values from 1979-2008 for each station. Estimated/interpolated values are included in the average, and the normals are flagged if more than 6 values (20%) were estimated.

(ii) OCN

OCN stands for "Optimal Climate Normals" and is a technique that was developed at NOAA's Climate Prediction Center (CPC) in the early 1990s. CPC scientists use OCN as an ingredient in their short-term forecasts. Essentially, OCN is an N-year average, i.e., an average over a time period that can be different than 30 years long. OCN were first described in Huang et al. (1996). In that paper, the authors utilized a data analysis method (based on one-year lead forecast skill) to conclude that a uniform 10-year average for monthly temperature normals should be used. Livezey et al. (2007) used statistical theory to facilitate the determination of N for individual monthly station time series. The equation for determining N is based on the slope, the residual lag-1 autocorrelation (i.e., the "redness"), and the standard deviation of the monthly time series. They argue that N should be computed separately for each monthly station time series. We adopt the latter view.

Livezey et al. (2007) recommend use of the Hinge Fit (described below) to compute the residual lag-1 autocorrelation parameter. To accomplish this, we utilize data from 1940-2008. The Hinge point is fixed at 1975. OCN Normals are flagged if more than 20% of the values in either the 1940-1975 period or the 1976-2008 period are estimated. However, estimated values are included in the averages.

(iii) Hinge Fit

The Hinge Fit method is not based on an average in any shape or form. Rather, it consists of a piecewise continuous fit from 1940 to the present. From 1940 to 1975, the fit is constrained to be a constant value. Thereafter, the fit is linear. The Hinge Point is fixed at 1975. The linear component is free to have negative, zero, or positive slope. The value for 2008 is simply where the linear fit passes through 2008. As with OCN, we utilize 1940-2008 values and require that both the constant and linear pieces be at least 80% "complete," otherwise the Hinge Fit values are flagged.

(iv) Caveats

There are two main differences between the procedure we follow and the Livezey et al. recommendation. First, Livezey et al. argue in favor of a hybrid normal, which picks either the OCN or the Hinge Fit Normal based on time series characteristics. At this time, we do not provide a hybrid normal; rather, we provide the OCN and Hinge Fit normals individually. Second, Livezey et al. set all negative lag-1 autocorrelations to zero. We retain negative values, and further details on this matter can be found by accessing the ftp directory below.

4. Alternative Normals through 2008 versus 1971-2000 Averages

Comparisons between the Alternative Normals in 2008 (Version 1.0) and the 1971-2000 averages are displayed in Figure 1. July maximum temperatures and January minimum temperatures are highlighted because they represent the warmest and coldest times of the year, respectively, and therefore have an outsized influence on temperature-sensitive industries such as electric and gas power generation.

The signs of the differences (positive or negative) are largely uniform between the methods, whereas the magnitudes are not. Generally, July maximum temperatures are warmer than the 1971-2000 averages for the West and along much of the Eastern

Seaboard, and cooler in much of the Midwest. January minimum temperatures are largely warmer than the 1971-2000 averages across the entire country, punctuated by positive differences of up to 4°C along much of the U.S.-Canada border.

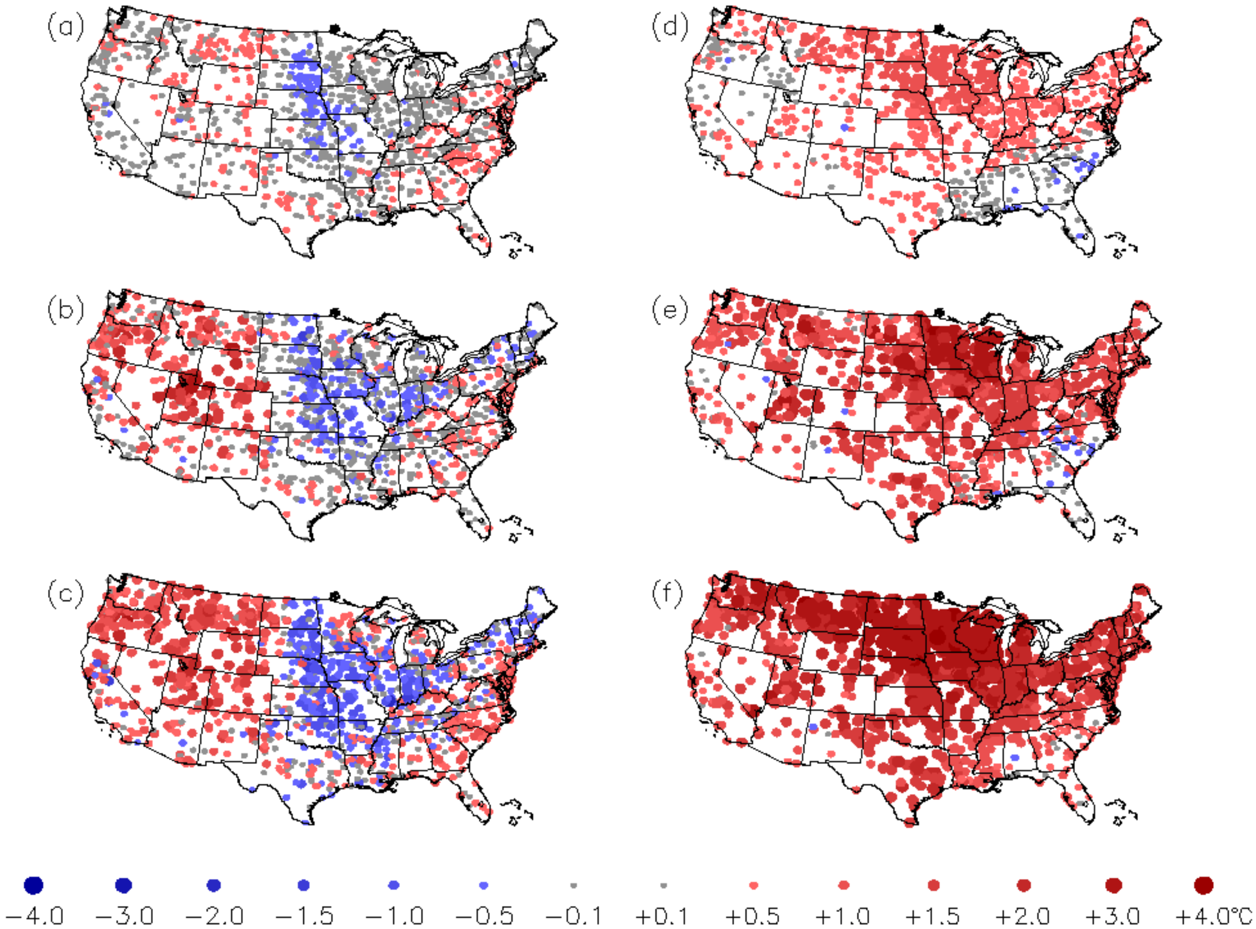

Figure 1. The differences between the 2008 Alternative Normals and the 1971-2000 averages. The panels on the left show July maximum temperature differences for (a) Annual Updates, (b) OCN, and (c) Hinge Fit. January minimum temperature differences are presented in the panels on the right for (d) Annual Updates, (e) OCN, and (f) Hinge Fit. Note that these 1971-2000 averages may differ from the official 1971-2000 climate normals, as described in the text. Red (blue) circles indicate that the Alternative Normals are warmer (cooler) than the 1971-2000 averages. A Gray circle indicates an absolute difference of 0.1°C or less.

These results are largely in line with the findings of Arguez et al. (2009).

Not surprisingly, the most intense differences (both positive and negative) occur for the Hinge Fit method and the smallest deviations are observed for the Annual Updates, with OCN differences largely in between. This is evidence of the large trends in the underlying time series. The Annual Update is calculated by simply averaging 30 values without regard to their temporal ordering, essentially smoothing out relative outliers in the first and second halves of the time series (generally of opposite sign if there is a strong trend). In contrast, the Hinge Fit is adept at accentuating trend effects as opposed to undermining them, and temporal ordering is therefore critical. The OCN method can be considered a compromise between the other two approaches. Unlike the Annual Update, the OCN method adapts to large trends by averaging over a time period less than 30 years, resulting in alternative normals that better reflect the progression of the trend. And unlike the Hinge Fit, the OCN method does not implicitly assume that the trend continues indefinitely into the future, thereby moderating the intensity of the values.

5. Accessing Alternative Normals

Alternative Normals, Version 1.0 reside on NCDC's ftp server, which can be accessed either by anonymous ftp or through a web browser. Users not familiar with file transfer protocol (ftp) should utilize their web browser. All pertinent files can be accessed with the following links:

ftp://ftp.ncdc.noaa.gov/pub/data/aarguez/alternative-normals

http://www1.ncdc.noaa.gov/pub/data/aarguez/alternative-normals

In addition to the data files, the directory contains numerous auxiliary documents, including manuscripts and presentations. Users should pay close attention to the ‘readme.txt’ file. This file contains up-to-date details including an in-depth description of directory and file formats, in addition to much of the information included here.

6. References

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