Computational Procedures for the 1981-2010 Normals: Hourly Products

Scott Applequist, NCDC; Anthony Arguez, NCDC; Imke Durre, NCDC; Michael F. Squires, NCDC; Russell S. Vose, NCDC; and Xungang Yin, STG, Inc.

1. Overview

The 1981-2010 U.S. Climate Normals being released by NOAA's National Climatic Data Center (NCDC) during 2011 include a suite of descriptive statistics based on hourly observations at a few hundred stations from across the United States and its Pacific territories. Statistics are provided as 30-year averages, frequencies of occurrence, and percentiles (Table 1) for each hour and day of the year.

We encourage use of these products for examination of the diurnal change of a particular variable. Temperature and precipitation normals created for the daily, monthly, seasonal, and annual time scales are also available.

Table 1. Statistics Produced for the 1981-2010 Hourly Normals	
Temperature, Dew Point, Mean Sea Level Pressure	Average hourly value
	10th and 90th percentiles of hourly values
Heating and Cooling Degree Hours	Average hourly value (base 65°F)
Heat Index and Wind Chill	Average hourly value
Clouds	Hourly percent frequency of clear, few, scattered, broken, and overcast conditions
Wind	Prevailing and secondary wind direction and percent frequency
	Average wind speed and percentage of calm winds
	Mean wind vector direction and magnitude

The above-mentioned statistics are referred to as "traditional normals" and are calculated directly from the available data.

The remainder of this document describes the procedures used to compute the various parameters. Section 2 provides a brief description of the data and the station selection criteria

for traditional normals. The computational procedures for traditional normals are explained in section 3.   Figures and other material will be incorporated into a forthcoming Journal article on all of these computations.

2. Data

The statistics are computed from the ISD-lite dataset for which more information can be found here: (http://www.ncdc.noaa.gov/oa/climate/isd/index.php?name=isd-lite).

262 stations were selected from the ISD-lite data based on their completeness and membership in a list of what were known as "first order stations."   These are typically airport locations with the needed 24 hours/day observations to make hourly normals meaningful.   All stations had at least 27 of the 30 years represented.

3. Computational procedures for traditional normals

Data configuration

Each hourly normal is computed on the basis of 450 possible values.   This is the aggregation of the value for a particular date and time, plus and minus 7 days, over each of 30 years.   If fewer than 350 valid values are present, the output is given as the special value -9999.   No normals are computed for February 29, but data for February 29 is included in the 15 day window for leap years.   The original data has been shifted from Greenwich Mean Time to an end product in local standard time.

Quality control

The following conditions will cause a value to be flagged as invalid prior to the computation of normals:

> Any value exceeding the world record for that variable.
> Streaks of constant values longer than 24, 48, 72, and 24 hours for temperature, dew point, mean sea level pressure, and wind speed respectively.
> Mean sea level pressures that exhibit "wrap-around" values where, for example, values in excess of 1059 hPa are recorded as 960 hPa.
> A dew point value exceeds the temperature value.   Both are flagged as invalid.
> Within a 450 observation sample, temperature and dew point values outside 7 standard deviations of the mean value are removed.   This process iterates up to 10 times until there are no values outside the 14 standard deviations range.

Derived variables

Heat index was computed when the temperature exceeded 80°F and relative humidity was greater than 40%. In instances when these criteria were not met, the temperature replaced the heat index in the sample set. Thus the heat index normal is a temperature as influenced by heat index.

Similarly, wind chill was computed when the temperature was less 50°F and the wind speed was greater than or equal to 3 mph. The wind chill value is set equal to the temperature if these conditions are not met. The wind chill normal is a temperature as influenced by the wind chill.

Wind normals are comprised of the following:
> The average speed of all wind speed values.
> The frequency of winds less than or equal to 3 mph.
> The direction and magnitude of the mean wind vector. These are computed by first decomposing the wind observation into u and v components. The average of each component is computed. A mean wind vector is then assembled from the average components.
> For winds greater than 3 mph, each is counted in a 45° wide directional bin centered on 0, 45, 90, …, 315 degrees. Counts in these bins are rescaled to account for a bias introduced by wind directions being even multiples of 10. The identity of the two bins with the highest counts, along with their overall frequencies, is provided.

Cloud frequencies in categories clear, few, scattered, broken, and overcast. These are computed from valid observation values from 0 to 8 inclusive representing eighths of sky coverage. An obvious observational preference was noticed to reporting values 0, 2, 4, 7, and 8. We therefore included any reports of 1, 3, 5, and 6 with the next higher category.

Cooling degree hour normals were computed by subtracting 65 from each valid temperature in the sample of 450. Positive differences were summed and divided by the number of valid values. Heating degree hour normals were computed in a similar manner.

4. Summary

Averages (normals), percentiles, and frequencies of occurrence of the above at the hourly time scale are available at 262 locations in the US and its territories. The recommended use of these products is in examination of the diurnal change of a particular variable and how that change may shift over the annual cycle. For daily, monthly, and seasonal values, please use the normals products created for those time scales.