CALMAC Weather Files User Guide

Introduction to the CALMAC Weather File User Guide

The purpose of this User Guide is to outline the information regarding the weather files posted on CALMAC.org, including how to download and understand the weather files.

Definitions

Weather normalized energy savings

Energy or demand response savings calculations typically include estimates of the effect of weather on the amount of energy or peak demand used before and after installation of energy efficiency or demand reduction measures.

Since weather is never the same from year-to-year, the best overall estimate of the weather effect on savings is produced by using a typical or average set of weather data covering an agreed span of years, and for an agreed set of locations. Once this set of weather data is used in the engineering and statistical models, the results are weather normalized savings estimates.

One issue faced by evaluators and energy modelers when normalizing savings is the choice of the span of years of weather data to include in the "typical year" weather file. If too few years are included, then the "typical year" data will potentially have a large variation with respect to the "true" average year. However, if the span of years is too large, then resulting "typical year" may conceal trends in the weather data over the period of years covered.

California has developed a series of various "typical year" weather file data sets, each having its own application. These data sets are discussed in the next section

Overview of the typical weather file standards used in California

The various weather data sets are defined by the range of years of weather data that are included, the method of calculating the typical month included in each dataset, and the weather station mix in each dataset. The following are the main datasets developed for California:

1. ***CZ2010*** typical year files span 1998 through 2009 (a 12-year period of record) and were the standard weather files adopted by the California Energy Commission for Title 24 compliance calculations from 2010 through 2022. There are 86 CZ2010 files covering 86 weather stations in California. As required by the California Energy Commission, the CZ2010 use statewide "typical months".
2. ***CZ2018*** typical year files span 2006 through 2017 (a 12-year period of record) and represents a more recent 12 year span of time than CZ2010. It should be noted that (1) CZ2018 includes the same 127 locations as the historical weather data, (2) uses location-specific "typical months", and (3) "2018" refers to the year of creation, rather than the Title 24 version. These files are also sometimes referred to as CALEE2018.
3. ***CZ2022*** typical year files span 1998 through 2017 (a 20-year period of record) and were adopted by the California Energy Commission for Title 24 Version 2022. Like the CZ2010, CZ2022 uses

statewide “typical months”, which resulted in 97 locations, with 30 locations dropped due to missing data.

Process of creating the weather files[1]

For more information see section 4 of PGE0450 referenced in footnote 1.

1. **Data sources -** Weather station data are from the Integrated Surface Database and the National Solar Radiation Database. The Integrated Surface Database is maintained by the National Center for Environmental Information (NCEI). Satellite-derived solar radiation data originates from the National Solar Radiation Database (NSRDB) maintained by the National Renewable Energy Laboratory.
2. **Quality control and addressing missing data** - The biggest challenge encountered in processing the observed climatic data is how to deal with missing data elements. This project treats missing data elements in the following different ways depending on their importance and whether there are any meaningful ways for interpolation.
    a. For those elements regarded as stochastic, such as wind direction and present weather, the approach is to use a "step function" that repeats the last available data element for half of the duration and repeats the next available data element for the remaining half of the duration of the missing interval.
    b. For those elements regarded as sequential, such as pressure, wind speed, cloud cover, opaque cover, ceiling, and visibility, the approach is to use linear interpolations.
    c. A more elaborate interpolation procedure has been developed for dry-bulb and dew point temperatures, partly because of its importance in building energy simulations and partly because diurnal temperature profiles are relatively predictable.
    d. The reporting of liquid precipitation, i.e., rainfall, is rather distinct and requires special treatment. Although the original intent was to simply pass on what was reported, i.e., multiple and often overlapping reports of rainfall amount and duration, this is judged to be not very usable and frequently misleading to users. Hence, an attempt has been made to interpret and reconcile the reported rainfall amounts and durations, that are then reported as simple hourly values.

Historical Weather Files

The historical weather data is organized by year, starting with 2014 for 131 locations, of which 122 have data for all 8 years. Current year data is updated daily. Data for the current year uses modeled solar radiation data. The year prior to the current year also used modeled solar radiation data until the satellite-derived radiation data for the year prior to the current year becomes available. The weather data for the year prior to the current year is updated, using the satellite-derived radiation data, in approximately July of the current year.

[1] For detailed information, including file naming conventions, formats, and data processing procedures, refer to: Update of California Weather Files for Use in Utility Energy Efficiency Programs and Building Energy Standard Compliance Calculations, CALMAC Study ID PGE0450.00. This study is available for download on the CALMAC Searchable Database, found elsewhere on this site.

Obtaining the weather files

Downloading weather files

There are two methods for obtaining weather files from CALMAC.org. Method 1) go to https://www.calmac.org/weather.asp, scroll to the table with the weather data by city, click on the weather file you'd like and it will automatically download to your computer. On this page you can download typical weather files (CZ2010, CZ2018, and CZ2022) and historical weather files (2014-2022) for all cities or certain cities. Method 2) use the CALMAC Application Programming Interface (API)[2] in your program to access the data directly. The instructions for the use of the CALMAC API can be found at https://www.calmac.org/apiguide.asp.

Extracting weather files

When a weather file for a particular site is downloaded you will receive a zip file containing six files. One of the files is a text file labeled "importing FIN4 files into Excel" which, when opened, supplies clear instructions on how to import the FIN4 file into Excel.

Understanding workbook tabs after importing the weather data into Excel

Each Excel workbook tab automatically includes graphs of some of the parameters presented in the spreadsheet. In addition, the text file in the download folder gives a simplified description of the parameters seen across the top of the four tabs in the spreadsheet. A more complete description of the headers and the data presented in the various tabs is presented below:

Sheet 2 Tab – presents the hourly recorded values for the variables for the entire year.

1. Row 1 contains the header information on the weather station:
    1. Station Name,
    2. World Meteorological Organization (WMO) Station Number,
    3. Latitude (N+, S-),
    4. Longitude (E+, W-),
    5. Elevation (m),
    6. WMO region number,
    7. Time Zone, ISO-3166 3-letter Country Code, and
    8. Köppen climate classification.
2. Rows 2 and 3 contain the column headings, from left to right:
    1. Year,
    2. Month,
    3. Day,
    4. Hour,
    5. Dry-bulb Temperature (C),
    6. Dew Point Temperature (C),
    7. Pressure (mb),
    8. Sky Cover (tenths),
    9. Opaque Cover (tenths),
    10. Wind Speed (m/s),
    11. Wind Direction (degrees),

[2] APIs are code inserted into a user's program so the program can automatically download the weather from multiple sites and/or can routinely download sets of data. It is intended for the more sophisticated user.

12. Global Horizontal (W/m2),
13. Direct Normal (W/m2),
14. Present Weather,
15. Rainfall (0.1mm),
16. Visibility (m),
17. Ceiling Height (m), and
18. SolarZ.

For all the recorded parameters, i.e., everything but the solar radiation, there are optional single capital letter flags to indicate that the value is interpolated (L = linear, F = Fourier Series, R = repeat last available value, etc.).

Daily Tab – Repeats the pattern described above for the Sheet 2 tab but supplies average daily values, using the same header information and variable descriptors. Only a subset of the variables are reported.

Average Day by Month Tab – Repeats the pattern described above for the Sheet 2 tab, only reporting the average day by month values, using the same header information and variable descriptors. Only a subset of the variables are reported.

Number of Observations Tab – Reports the statistics on missing data for a subset of the variables.

For all tabs it may be necessary to move the graphs out of the way to see the data.

Question/issue contact information. If you have questions about the downloading, interpretation or data quality of the data downloaded from CALMAC, email Admin@CALMAC.org. We will do our best to answer your questions.