

Format of CWEEDS Files

The first record in a CWEEDS file using the WY3 format is a comma separated header record containing location and related information. The following is an example:

CWEEDS2023, SIOUX LOOKOUT A, ON, CAN, 6037776, 50.11, -91.91, -6.00, 383.1

CWEEDS2023	year that file was updated (using 2011 version of HORZ processing software)
SIOUX LOOKOUT A	location name
ON	province/territory
CAN	country
6037776	station identifier
50.11	latitude
-91.91	longitude
-6.00	time zone expressed as offset in hours relative to UTC
383.1	elevation (m)

Data records in WY3 format consist of 8,760 identical fixed format records (8,784 records for leap years), one for each hour of each day of each year. Each record is 120 characters (plus 2 for CR/LF) in length and is organized according to the table below.

All WY3 values are in Local Standard Time. Irradiance and illuminance fields contain data integrated over the hour; meteorological fields contain observations made at the end of the hour. For example, hour 12 contains irradiance/illuminance from hour 11 to 12 and meteorological observations made at hour 12.

Field Number	Data Positions	Flag Position(s)	Data element
001	001-007	--	ECCC station identifier
002	008-008	--	File source code (always 'B')
003	009-018	--	Year, Month, Day, Hour (YYYYMMDDHH)
101	019-022	--	Extraterrestrial irradiance, kJ/m ²
102	023-026	027-028	Global horizontal irradiance, kJ/m ²
103	029-032	033-034	Direct normal irradiance, kJ/m ²
104	035-038	039-040	Diffuse horizontal irradiance, kJ/m ²
105	041-044	045	Global horizontal illuminance, 100 lux
106	046-049	050	Direct normal illuminance, 100 lux
107	051-054	055	Diffuse horizontal illuminance, 100 lux
108	056-059	060	Zenith luminance, 100 Cd/m ²
110	061-062	063	Minutes of sunshine, 0-60 minutes
201	064-067	068	Ceiling height, 10 m
202	069-072	073	Sky condition (see below)

203	074-077	078	Visibility, 100 m
204	079-086	087	Present Weather (see below)
205	088-092	093	Station pressure, 10 Pa
206	094-097	098	Dry bulb temperature, 0.1 °C
207	099-102	103	Dew point temperature, 0.1 °C
208	104-106	107	Wind direction, 0-359 degrees
209	108-111	112	Wind speed, 0.1 m/s
210	113-114	115	Total sky cover, 0-10 in tenths
211	116-117	118	Opaque sky cover, 0-10 in tenths
212	119-119	120	Snow cover (0 = no snow cover, 1 = snow cover)

Sky condition: Coded by layer in ascending order; four layers are described; if less than four layers are present, the remaining positions are coded 0. The code for each layer is:

- 0 = Clear (less than 0.1 cover)
- 1 = Thin scattered
- 2 = Opaque scattered (0.1-0.5 cover)
- 3 = Thin broken
- 4 = Opaque broken (0.6-0.9 cover)
- 5 = Thin overcast
- 6 = Opaque overcast (1.0 cover)
- 7 = Obscuration
- 8 = Partial obscuration

The flag is left as '9' only if all four layers are missing. It is written as 'E' if at least one of the layer has the flag 'E'.

Present Weather: Eight single digit codes as explained below.

Occurrence of thunderstorm, tornado or squall:

- 0 = None
- 1 = Thunderstorm - lightning and thunder. Wind gusts less than 50 knots, and hail, if any, less than 3/4 inch diameter.
- 2 = Heavy or severe thunderstorm - frequent intense lightning and thunder. Wind gusts 50 knots or greater and hail, if any, 3/4 inch or greater diameter.
- 3 = Report of tornado, funnel cloud or waterspout.

If several phenomena occur simultaneously, the highest WYEC2 value is reported.

Occurrence of rain, rain showers or freezing rain:

- 0 = None
- 1 = Light rain
- 2 = Moderate rain
- 3 = Heavy rain
- 4 = Light rain showers
- 5 = Moderate rain showers
- 6 = Heavy rain showers
- 7 = Light freezing rain
- 8 = Moderate or heavy freezing rain

If several phenomena occur simultaneously, the highest WYEC2 value is reported.

Occurrence of drizzle, freezing drizzle:

- 0 = None
- 1 = Light drizzle
- 2 = Moderate drizzle
- 3 = Heavy drizzle
- 4 = Light freezing drizzle
- 5 = Moderate freezing drizzle
- 6 = Heavy freezing drizzle

If several phenomena occur simultaneously, the highest WYEC2 value is reported.

Occurrence of snow, snow pellets or ice crystals:

- 0 = None
- 1 = Light snow
- 2 = Moderate snow
- 3 = Heavy snow
- 4 = Light snow pellets
- 5 = Moderate snow pellets
- 6 = Heavy snow pellets
- 7 = Light ice crystals
- 8 = Moderate ice crystals

If several phenomena occur simultaneously, the highest WY3 value is reported, except for the values 1,2,3 which are reported before any other.

Occurrence of snow showers or snow grains:

- 0 = None
- 1 = Light snow showers
- 2 = Moderate snow showers
- 3 = Heavy snow showers
- 4 = Light snow grains
- 5 = Moderate snow grains
- 6 = Heavy snow grains

If several phenomena occur simultaneously, the highest WY3 value is reported, except for the values 1,2,3 which are the first ones to be reported.

Occurrence of ice pellets, ice pellet showers, or hail:

- 0 = None
- 1 = Light ice pellets
- 2 = Moderate ice pellets
- 3 = Heavy ice pellets
- 4 = Light hail
- 5 = Moderate hail
- 6 = Heavy hail
- 7 = Light ice pellet showers
- 8 = Moderate or heavy ice pellet showers

If several phenomena occur simultaneously, the highest WY3 value is reported.

Occurrence of fog, blowing dust or blowing sand:

- 0 = None
- 1 = Fog
- 2 = Ice fog
- 4 = Blowing dust
- 5 = Blowing sand

If several phenomena occur simultaneously, the highest WY3 value is reported.

Occurrence of smoke, haze, dust, blowing snow or blowing spray:

- 0 = None
- 1 = Smoke
- 2 = Haze
- 3 = Smoke and haze
- 4 = Dust
- 5 = Blowing snow

If several phenomena occur simultaneously, the highest WY3 value is reported.

Flags

Flag characters indicate if the associated value is missing, was estimated, modelled, or observed. Some fields have no flag, others have 1- or 2-character flags as follows:

Field	Flag type / comment
001-003	None (record identification fields)
101	None (calculated extraterrestrial irradiance is always present)
102-104	2 character (irradiance values)
105-212	1 character (all remaining fields)

For 1-character flags, the following flags are used:

- blank Value was observed (that is, not derived with a model and not altered).
Exception: irradiance and minutes of sunshine flags are written as blank though they are interpolated to change the time base from local apparent to local standard time.
- A Value has been algorithmically adjusted (e.g. some values in CWEC files are smoothed at the beginning and end of months).
- E Value was missing and has been replaced by a manual estimate.
- I Value was missing and has been replaced with one derived by interpolation from neighboring observations.
- M Value was missing and has been replaced with one derived with a model (model used depends on element).

- Q Value is derived from other values (e.g. illuminance data which are not observed).
- S Irradiance is a SUNY value.
- N Value is from NARR time series.
- T Value is interpolated with the specific procedure for gaps 3 hours or shorter.
- 9 Value is missing; data positions contain 9s as well.

2-character flags for radiation values (on WY3 irradiance fields 102, 103 and 104), are a 1-character flag (as defined above) followed by a blank.

CWEC and TDY files

The CWEC and TDY files are created by concatenating twelve typical meteorological months selected from the CWEEDS files to generate an artificial typical year of 8,760 hours. The method is based on the TMY procedure developed in the 1980s by Sandia National Laboratory in the U.S. The Sandia method is described in Hall et al. (1978) and NREL (2008). The method was used in Canada by the WATSUN Lab at the University of Waterloo (Siurna et al., 1984). The original Sandia TMY software (Fortran source code) was acquired and adapted to ECCC data formats. The software was further modified by Numerical Logics and subsequently provided to ECCC in 2012.

A detailed description of the Sandia method is provided in NREL (2008). An outline of the steps used for CWEC files in the method follows.

- Daily values are compiled from the CWEEDS files of the elements used to select the typical months i.e. GHI, temperature, dew point and wind speed (for those months without any missing hourly values (only DNI for TDY files)).
- Finkelstein-Schafer (FS) statistics, with assigned relative weights on solar, T, Td, and WS values are used to identify the five candidate months for each month of the year whose cumulative probability distributions (CDF) of daily values used with the weighting scheme most closely match the CDF of all of those months from the entire long-term data set. Months with any missing data in the weighted fields are blocked. There needs to be 5 unblocked months in the period or a TMY file is not generated.
- The five candidate months are ranked with respect to the closeness of the mean and median of each month to that of the long-term data set.

- Persistence statistics concerning the frequency and run lengths of consecutive days above and below fixed percentiles are compiled.
- Persistence criteria are used to exclude the month with the longest run, the month with most runs, and any months with zero runs from the candidate months from the third step above. The highest ranked month not excluded by the persistence criteria is selected as the typical month. It sometimes happens (fewer than 10% of the locations) that all of the 5 highest ranked months for a particular month are excluded by the persistence criteria and a TMY software does not generate a CWEC file – in these cases the script processing the files reruns the TMY software with a prescribed list of months to use including the accepted months and the highest ranked month which was previously excluded.
- The 12 selected months are joined to make a nominal year and the 6 hours on each side of the month boundaries are smoothed by interpolation to remove step changes in the hourly data.

The following weights are used in generating CWEC files to reflect the assumed influence the various elements have on building energy usage.

Element	Max dry bulb	Min dry bulb	Mean dry bulb	Max dew point	Min dew point	Mean dew point	Max wind speed	Mean wind speed	Daily solar (GHI)
Weight (%)	5	5	30	2.5	2.5	5	5	5	40

For TDY files, all of the weighting (100%) is on DNI reflecting the high influence DNI has on the performance of concentrating solar energy collection systems.

The ECCC software TMY software was run with each CWEEDS file to generate corresponding CWEC and TDY files. Log files were also generated for each run which provides details of the process including which months, if any, were blocked from consideration due to missing data, the year corresponding to each selected typical month, excluded months due to the persistence criteria and other related information. The CWEC, TDY and their log files were moved to the corresponding CWEEDS location folder. Note that since all gaps in the critical fields in the CWEEDS files were filled either by interpolation or NARR data, there were no blocked months and all months in the CWEEDS files were considered for selection.