Churchill Weather Station Data for Dashboard

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Brief description of calculations added to datalogger program, where measurements come from, and other info for purpose of community data stream.

Instrument List

Sensor Type	Model	Manufacturer	Parameters Measured
Barometric Pressure Sensor	BaroVUE10	BaroVUE	Barometric Pressure
Wind Monitor (2D)	05108-45-L	R.M. Young Company	Wind Speed Wind Direction Wind Chill (with Temp)
Radiation Sensor (Pyranometer)	CMP6-L	Kipp & Zonen	PAR Flux Density
Temperature Sensor	HMP155A	Vaisala	Temperature Relative Humidity Wind Chill (with Wind) Dew Point Temp Heat Index

Anemometer Height: 5.59 m

Wind Chill Calculation

Wind chill was calculated based on calculations by the National Weather Service and Campbell Scientific Application note (also based on National Weather Service).

Using wind speeds in km/h and temperatures in degrees Celsius

Used wind profile calculation to determine wind speed at 1.5 m (relevant for humans)

$$v_2 = v_1 \frac{\ln\left(\frac{h_2}{z_0}\right)}{\ln\left(\frac{h_1}{z_0}\right)}$$

- Used surface roughness length for water (0.0002 m), can discuss whether smooth surface/open terrain would be more appropriate (0.024 m).

$Tw\ (°C) = 13.127 + 0.6215T - 11.362v^{0.16} + 0.396Tv^{0.16}$

Wind chill calculation not applied in winds < 4.8 km/h or temperatures > 1.7°C (reports same as air temperature)

References:

https://www.weather.gov/safety/cold-wind-chill-chart

https://s.campbellsci.com/documents/es/technical-papers/windchil.pdf

https://wind-data.ch/tools/profile.php?lng=en

Heat Index Calculation

HI =-42.379 + 2.0490(T) + 10.143(RH)-0.22476(T)(RH) - (6.8378 x 10 -3)(T^2) - (5.4817 x 10^{-2})RH^2 + (1.2287 x 10^{-3})(T^2)RH + (8.5282 x 10^{-4}) (RH^2)(T) - (1.99 x 10^{-6})(T^2) (RH^2)

Where: HI = heat index in degrees Fahrenheit

Tf = temperature in degrees Fahrenheit

RH = relative humidity in percent form (e.g., for an RH value of 65% enter 65 in the formula not .65)

Apparent temperature based on relative humidity

Only applied in RH > 40% and temperatures above 26°C

References:

https://s.campbellsci.com/documents/us/technical-papers/heatindx.pdf

Radiation

Radiation sensor is a pyranometer which measures solar radiation intensity. Wavelengths ranging from 285 to 2800nm. Output for this is Flux Density in W/m^2.

- Intensity

PAR is radiation accounts only for wavelengths used by plants (400-700 nm). This can be estimated from flux density by multiplying by 2.1. Output for this is PAR in µmol/m^2/s.

- Radiation flux

Dew Point Calculation

Temperature which water droplets condense – how much water is in the air

$$T_d = \frac{A_3 * L_n\left(\frac{V_p}{A_1}\right)}{A_2 - L_n\left(\frac{V_p}{A_1}\right)}$$

T_d = Dew Point Temperatuer

A1, A2, A3 = Constants

V_p = Vapour pressure (calculated with RH and Temperature)

Innate calculation in CRBasic

Table Output

Current Program: cmo_weatherst_v4.2.CR1X

Table output is currently set to record a value every 15 minutes, the datalogger is also set to automatically collect data and save in the D:/ every 15 minutes. A new table was created for this purpose so that original files are not affected.

D:/Weather Station Data/CR1000X_CMO_MET_churchill_weather.dat

Table data with units

Field	Units
Barometric Pressure	kPa
Flux Density	W/m^2
PAR	$\mu mol/m^2/s$
Air Temperature	Degrees Celsius
Relative Humidity	%
Wind Speed	Km/h
Wind Direction	Degrees
Wind Direction Standard Deviation	Degrees
Heat Index	Degrees Celsius
Wind Chill	Degrees Celsius
Dew Point Temperature	Degrees Celsius