Texas A&M Electric Grids Weather Data Description

The purpose of the Texas A&M Electric Grid Weather Data depository is to provide convenient access to past, present and future weather data in a format that can be readily used by power system analysis software. To accomplish this, the depository contains historical hourly ERA5 weather data [1] from 1/1/1940 to about five days before the present stored in the PoWer Weather (*.PWW) files for North America, with the footprint shown in Figure 1 (a description the PWW format is given later in this document). The available data is on a 0.25 degree grid, with 38,497 grid points. To keep the file size manageable, the weather is store by calendar year quarter, with each file about 650 MB. To make downloading easier, data for each decade is stored in a single *.zip file, with each file being about 9 GB. In addition, historical data is available for just the US state of Texas, with all the data in a single zip file with a size of 6 GB. Currently the historical files contain temperature, dew point, 10m wind speed, 10m wind direction, 100m wind speed, cloud cover percentage, global horizontal irradiance and direct horizontal irradiance.

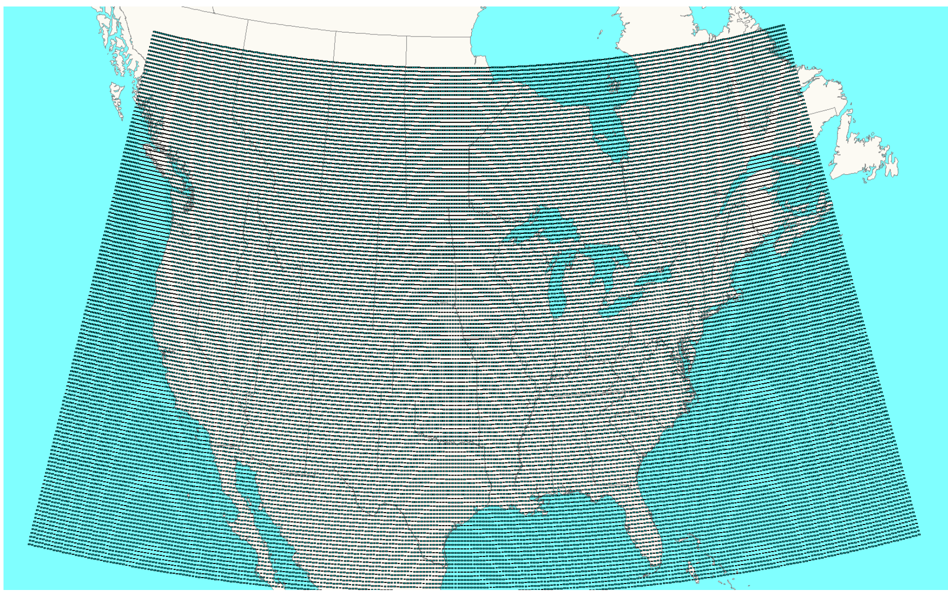

Figure 1: Available North America 0.25 Degree Weather Data

In addition, the site contains *.PWW format weather forecasts for the same North American footprint. The forecasts are obtained from the US National Weather Service using the NOAA Operational Model Archive and Distribution System [2]. The forecasts, which also use the same 0.25 degree grid, are for 15 days, with the first five days hourly then the next ten every three hours. Forecasts are updated every six hours with the run time for the forecast given the *.PWW file name. For example the Forecast_NorthAmerica_Run2024-03-11T18Z was run on March 11, 2024 at 18:00 UTC. Currently the forecast files contain temperature, dew point, 10m wind speed, 10m wind direction, 100m wind speed, and cloud cover percentage.

When using the ERA5 data please provide an appropriate citation (e.g., [1]). Also, when using any of the data on this website in a publication please cite [3] (with an downloadable copy of this paper available at overbye.engr.tamu.edu/publications/. For more details on how weather data can be used in power flow software using the PFW modeling approach see [4].

[1] Hersbach, H., Bell, B., Berrisford, P., Biavati, G., Horányi, A., Muñoz Sabater, J., Nicolas, J., Peubey, C., Radu, R., Rozum, I., Schepers, D., Simmons, A., Soci, C., Dee, D., Thépaut, J-N. (2023): ERA5 hourly data on single

levels from 1940 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS), DOI: 10.24381/cds.adbb2d47

[2] US National Weather Service, NOAA Operational Model Archive and Distribution System (NOMADS), https://nomads.ncep.noaa.gov/

[3] F. Safdarian, M. Stevens, J. Snodgrass, T. J. Overbye, "Detailed Hourly Weather Measurements for Power System Applications," 2024 IEEE Texas Power and Energy Conference (TPEC), College Station, TX, Feb. 2024.

[4] T. J. Overbye, F. Safdarian, W. Trinh, Z. Mao, J. Snodgrass, and J. Yeo, "An Approach for the Direct Inclusion of Weather Information in the Power Flow," 56th Hawaii International Conference on System Sciences (HICSS), Lahaina, HI, January 2023; hdl.handle.net/10125/102961

March 2024

PoWer Weather (*.pww) File Format

Version 1: Initial Release, September 2023

This document describes the data format for *.pww files, which contains sampled weather data in a binary format. Specifically data is stored for a specified number of dates/times, a specified number of locations, and a specified number of weather fields.

The binary format uses little-endian order. The types allowed are: double-precision 64-bit floating-point numbers (DOUBLE), singled 32-bit integers (INT32), signed 16-bit integers (INT16), bytes (BYTE), and single-byte ASCII null-terminated strings (STRING). All weather dates and times (DATETIME) are stored using a DOUBLE that represents the days from 12/30/1899 (which is identical to the format used with EXCEL except it correctly treats 1900 as a non-leap year) and are always Coordinated Universal Time (UTC) values. All latitude and longitude values are stored using their decimal values and must be between -90° and 90° for the latitudes and -180° to 180° for the longitudes.

Name	**Bytes**	**Type**	**Description**	**Example**
KEY1	2	INT16	Use decimal number 2001 followed by 8065 to confirm the file type.	Hex: D1 07 81 1F
KEY2	2	INT16		
VERSION	2	INT16	Use decimal code 1 for this current version	Hex: 01 00
First DATETIME in File (FIRST)	8	DOUBLE	First and last DATETIMEs in the file. By reading these fields the time range of the file can be quickly determined. The last DATETIME (LAST) must be at or after the first value (FIRST).	2.75 is January 1, 1900 at 6 p.m. (UTC)
Last DATETIME in File (LAST)	8	DOUBLE		
Minimum Latitude	8	DOUBLE	These four values give the bounding geographic rectangle for the data in the file, which allows the file contents to be quickly determined.	25,37,-103,-97 bounds the US state of Texas.
Maximum Latitude	8	DOUBLE		
Minimum Longitude	8	DOUBLE		
Maximum Longitude	8	DOUBLE		
META_STRINGS	2	INT16	Number of strings in the metadata section. If there are no strings enter 0.	1
(Metadata)	Variable	STRING	META_STRINGS number of ASCII strings terminated with 1-byte null characters. These optional strings can be used to describe the file contents.	ERA5 Data
Number of datetime values (COUNT)	4	INT32	Number of datetime values. For example, 168 if the file contains hourly sampled values for a week. Samples are usually uniform but do not need to be uniform.	168
Sampling time in seconds (SAMPLE)	4	INT32	If the data is uniformly sampled, this field gives the sampling rate in seconds. If the data is not uniformly sampled, enter a 0. For uniformly sampled data, the first sample is at FIRST.	3600
Number of weather measurement locations (LOC)	4	INT32	Number of weather measurement locations (LOC). These can be either regular latitude-longitude grid points, weather stations, or a combination. Each LOC is specified in a later section using	

			the format given in **Table 1: Weather Measurement Location Format**.	
LOC optional identifier field count (LOC_FC)	2	INT16	Number of optional identifier fields for each weather measurement location, with details given in Table 1.	2
LOC optional field names	Vari able	STRINGs	Set of LOC_FC strings	Placename ICAO
Number of weather variable types (VARCOUNT)	2	INT16	The number of weather value types contained in the file. These values are then stored for each datetime and location.	
Weather variable types (TYPE)	Vari able	INT16s	VARCOUNT INT16 in which each one gives the weather variable type (TYPE). The types are described in the below **Table 2: Weather Variable Types**. If TYPE is < 1000 then the variable is stored as a BYTE; otherwise it is stored as ana INT16.	
Type Byte Count (BYTECOUNT)	2	INT16	This is a check value that gives the total number of bytes stored for each datetime/location. It is the number of TYPES < 1000 * 1 + number of TYPES >= 1000 * 2.	3
(Variable DATETIME points)	Vari able	DOUBLEs	If SAMPLE is greater than zero then this section is skipped. Otherwise it contains SAMPLE DATETIME values in increasing order corresponding to the sample points.	
(Location Data Section)	Vari able	Set of **Table 1** values followed by the LOC_FC STRINGs	This section contains data for the weather measurement locations. Hence there are LOC records, with each one containing the required fields given in Table 1 followed by the LOC_FC optional identifiers.	
(Data Section)	varia ble		This section contains the actual data for each of the COUNT datetime values. Data is written by datetime, and within each datetime by each of the weather variable types for all the LOC locations in the order the measurements are given in the Location Data Section. For example, for a particular timepoint all the temperatures are written, then all the dewpoints, etc. Total data in bytes for each datetime is LOC*BYTECOUNT. As a specific example, assume a file two has datetime values (H1 and H1), two stations (A and B) and just one weather variable, temperature in F (type 102). Then assume at H1 the temperatures at A and B are respectively 75F and 80F, and at H2 the values are 78F and 82F. Using the type 102 format of adding 115 to the temperature (see Table 2), then the data section bytes are 190, 195, 193, 197.	

Weather Measurement Location Format

Table 1: Weather Measurement Location Format

Field	Bytes	Type	Description	Example
Latitude	8	DOUBLE	Latitude in decimal degrees.	40
Longitude	8	DOUBLE	Longitude in decimal degrees.	-88
AltitudeM	2	INT16	Altitude in meters.	100
Name	variable	STRING	Name of location	KCLL
Country	variable	STRING	Country code, usually two character	US
Region	variable	STRING	Region code; for the US this is the state abbreviation	TX

Weather Variable Types

The weather variables types are each specified by an INT16 type (TYPE). If TYPE is < 1000 then the variable values are stored as BYTEs; otherwise they are stored as INT16s. For a BYTE an invalid value is always indicated by 255. For an INT16 an invalid value is always indicated by a -32,768.

Table 2: Weather Variable Types

Variable Type Value	Description	Example
101	Surface (2m) temperature in C plus 100. So freezing is 100.	110
102	Surface (2m) temperature in F + 115 (valid range is from -115° F to 139° F)	50
103	Surface (2m) dewpoint in C plus 100.	105
104	Surface (2m) dewpoint in F + 115 (valid range is from -115° F to 139° F)	6
105	Surface (10m) wind speed in meters per second (m/s)	5
106	Surface (10m) wind speed in mph	11
107	Surface (10m) wind direction in degrees divided by 5 degree increments with 0 north18 (i.e., 90/5) east, etc.	15
109	100m wind speed in m/s	7
110	100m wind speed in mph	16
119	Total cloud cover in percentage (0 is clear, 100 fully overcast)	50
120	Global Horizontal Irradiance (GHI) in W/m^2 divided by 5; hence the maximum value of 254 corresponds to 1270 W/m^2.	200
121	Direct Horizontal Irradiance in W/m^2 divided by 5; hence the maximum value of 254 corresponds to 1270 W/m^2.	150
1101	Surface (2m) temperature in C multiplied by 100; use this if more accuracy is available.	1050 is 10.5° C
1103	Surface (2m) dewpoint in C multiplied by 100; use this if more accuracy is available.	1050 is 10.5° C
1105	Surface (10m) wind speed in m/sec multiplied by 100; use this if more accuracy is available	550 is 5.5 m/s
1109	100m wind speed in m/s multiplied by 100	660 is 6.6 m/s
1120	Global Horizontal Irradiance in W/m^2	931
1121	Direct Horizontal Irradiance in W/m^2	835