PowerWorld Weather (*.pww) File Format

Version 1:Thomas J Overbye, Initial Release, September 2023

Version 1: Thomas J. Overbye, Added meta data field support, April 2024

Version 2: Thomas J. Overbye, Added fields to indicate the total number of valid measurements of each type, January 2025

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), signed 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 either a 8065 VERSION 1 files or 8066 for VERSION 2 or higher files.	Hex: D1 07 81 1F
KEY2	2	INT16		
VERSION	2	INT16	Use decimal code 2 for this current version; decimal 1 for versions before 2025	Hex: 02 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. Starting in April 2024, this section can contain fields, with one field per line. The format for fields is "<fieldname> field value. Currently PowerWorld supports four fields. The first, "<Average> yyyy1 yyyy2", is used to indicate that file contains average data with yyyy1 indicating the starting year, and yyyy2 indicating the ending year.	ERA5 Data <Average> 1940 1979 <Minimum> 1980 2023 <Maximum> 1940 2023 <WindPDF> Rayleigh

			The second and third, "<Minimum> yyyy1 yyyy2" and "<Maximum> yyyy1 yyyy2" indicate the file has respectively minimum and maximum values. Only one of these three fields should be used in a file. The fourth, <WindPDF> ppp is used to indicate the PDF function to assume with the average wind speeds; valid entries are "None" or "Rayleigh".	
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	Variable	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)	Variable	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
Number of valid measurement for each variable type	Variable	INT32	Only included if VERSION >= 2 Tells the number of valid measurements for each of the weather variable types. Hence there are a total of VARCOUNT variables. If all the values for a particular variable type are valid then the number is LOC * COUNT.	

(Variable DATETIME points)	Variable	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)	Variable	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)	variable		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 variable 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
111	80m wind speed in m/s. When reading 80m wind, it is immediately converted to 100m wind. Hence a 10m wind field must be provided before loading this type.	6
112	80m wind speed in mph. When reading 80m wind, it is immediately converted to 100m wind. Hence a 10m wind field must be provided before loading this type.	15
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
122	Vertically Integrated Smoke; rounded value of 40*log(mg/m^2) for values of mg greater than 1; otherwise use a 0 or 1 to indicate none. Note, this uses the common (base 10) log function.	92 = 100 mg/m^2
135	Wind Gust at Surface in m/s	13
136	Wind Gust at Surface in mph	27
150	Percent Frozen Precipitation at Surface (%)	50
151	Precipitation Rate at Surface (kg/m^2/hour) same as (mm/hour)	
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
1122	Vertically Integrated Smoke in mg/m^2	250