Monthly To Daily Weather Convertor

MODAWEC

User Manual

Version 1.0

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MODAWEC User Manual

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Model objective: to generate daily precipitation, maximum temperature and minimum temperature based on monthly weather variables for EPIC (Environmental Policy Integrated Climate) and other hydrological or crop growth models

Citation: Users should cite the following publication for the application of the MODAWEC model:

Liu J., Williams J.R., Wang X., Yang H., 2009. Using MODAWEC to generate daily weather data for the EPIC model. *Environmental Modelling & Software* 24 (5): 655-664.

Application:

Liu J., Fritz S., van Wesenbeeck C.F.A., Fuchs M., Obersteiner M., Yang H., 2008. A spatial explicit assessment of current and future hotspots of hunger in Sub-Saharan Africa in the context of global change. *Global and Planetary Change.*64 (3-4): 222-235.

*. This User Manual (Version 1.0) is prepared by Dr. Junguo Liu.

CONTENT

1. File Structure

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┌────────────────────────┐                   ▼
│  Temp.pcp (default)    │           ╭──────────────────╮
└────────────────────────┘           │   MODAWEC.EXE    │
┌────────────────────────┐           ╰──────────────────╯
│  Temp.tmx (default)    │                    │
└────────────────────────┘                    ▼
┌────────────────────────┐    ┌─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
│  Temp.tmn (default)    │    ┌────────────────────────┐
└────────────────────────┘    │  Temp.dly (default)    │
┌────────────────────────┐    └────────────────────────┘
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└────────────────────────┘    │  Temp.wp1 (default)    │
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│  Temp.ext (default)    │    ┌────────────────────────┐
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└─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─┘    └────────────────────────┘
                              └─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
Input files (5 files per run)   Output files (3 files per run)
```
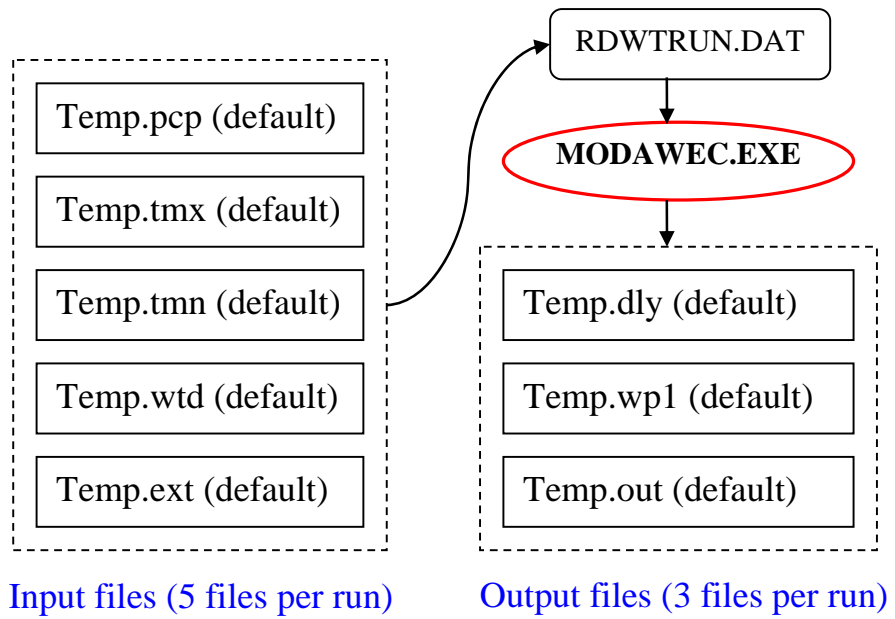
Figure 1. MODAWEC 1.0 File Structure

2. INPUT FILES

2.1 MODAWEC Input Data: *.pcp

Following is a brief description of the variables in the precipitation input file. They are listed in the order they appear within the file.

Variable name	Definition
YEAR	The year in which the monthly precipitation data are presented
JAN	Monthly precipitation in the 1st month
FEB	Monthly precipitation in the 2nd month
MAR	Monthly precipitation in the 3rd month
APR	Monthly precipitation in the 4th month
MAY	Monthly precipitation in the 5th month
JUN	Monthly precipitation in the 6th month
JUL	Monthly precipitation in the 7th month
AUG	Monthly precipitation in the 8th month
SEP	Monthly precipitation in the 9th month
OCT	Monthly precipitation in the 10th month
NOV	Monthly precipitation in the 11th month
DEC	Monthly precipitation in the 12th month

The format of the monthly precipitation file with one record is:

Variable name	Line #	Position	Format	F90 Format
YEAR	1-END	space 1-8	integer	I4
JAN	1-END	space 9-16	real	free
FEB	1-END	space 23-24	real	free
MAR	1-END	space 31-32	real	free
APR	1-END	space 39-40	real	free
MAY	1-END	space 47-48	real	free
JUN	1-END	space 55-56	real	free
JUL	1-END	space 63-64	real	free
AUG	1-END	space 71-72	real	free
SEP	1-END	space 79-80	real	free
OCT	1-END	space 87-88	real	free
NOV	1-END	space 95-96	real	free
DEC	1-END	space 103-104	real	free

Note: All inputs are in free format. The only requirement is at least one blank space must be placed between data items.

2.2 MODAWEC Input Data: *.tmx

Following is a brief description of the variables in the monthly maximum temperature input file. They are listed in the order they appear within the file.

Variable name	Definition
YEAR	The year in which the monthly maximum temperature data are presented
JAN	Monthly maximum temperature in the 1st month
FEB	Monthly maximum temperature in the 2nd month
MAR	Monthly maximum temperature in the 3rd month
APR	Monthly maximum temperature in the 4th month
MAY	Monthly maximum temperature in the 5th month
JUN	Monthly maximum temperature in the 6th month
JUL	Monthly maximum temperature in the 7th month
AUG	Monthly maximum temperature in the 8th month
SEP	Monthly maximum temperature in the 9th month
OCT	Monthly maximum temperature in the 10th month
NOV	Monthly maximum temperature in the 11th month
DEC	Monthly maximum temperature in the 12th month

The format of the monthly maximum temperature file with one record is:

Variable name	Line #	Position	Format	F90 Format
YEAR	1-END	space 1-8	integer	free
JAN	1-END	space 9-16	real	free
FEB	1-END	space 23-24	real	free
MAR	1-END	space 31-32	real	free
APR	1-END	space 39-40	real	free
MAY	1-END	space 47-48	real	free
JUN	1-END	space 55-56	real	free
JUL	1-END	space 63-64	real	free
AUG	1-END	space 71-72	real	free
SEP	1-END	space 79-80	real	free
OCT	1-END	space 87-88	real	free
NOV	1-END	space 95-96	real	free
DEC	1-END	space 103-104	real	free

*2.3 MODAWEC Input Data: *.tmn*

Following is a brief description of the variables in the monthly minimum temperature input file. They are listed in the order they appear within the file.

Variable name	Definition
YEAR	The year in which the monthly minimum temperature data are presented
JAN	Monthly minimum temperature in the 1st month
FEB	Monthly minimum temperature in the 2nd month
MAR	Monthly minimum temperature in the 3rd month
APR	Monthly minimum temperature in the 4th month
MAY	Monthly minimum temperature in the 5th month
JUN	Monthly minimum temperature in the 6th month
JUL	Monthly minimum temperature in the 7th month
AUG	Monthly minimum temperature in the 8th month
SEP	Monthly minimum temperature in the 9th month
OCT	Monthly minimum temperature in the 10th month
NOV	Monthly minimum temperature in the 11th month
DEC	Monthly minimum temperature in the 12th month

The format of the monthly minimum temperature file with one record is:

Variable name	Line #	Position	Format	F90 Format
YEAR	1-END	space 1-8	integer	free
JAN	1-END	space 9-16	real	free
FEB	1-END	space 23-24	real	free
MAR	1-END	space 31-32	real	free
APR	1-END	space 39-40	real	free
MAY	1-END	space 47-48	real	free
JUN	1-END	space 55-56	real	free
JUL	1-END	space 63-64	real	free
AUG	1-END	space 71-72	real	free
SEP	1-END	space 79-80	real	free
OCT	1-END	space 87-88	real	free
NOV	1-END	space 95-96	real	free
DEC	1-END	space 103-104	real	free

2.4 MODAWEC Input Data: *.wtd

Following is a brief description of the variables in the monthly wet days input file. They are listed in the order they appear within the file.

Variable name	Definition
YEAR	The year in which the monthly wet days data are presented
JAN	Monthly wet days in the 1st month
FEB	Monthly wet days in the 2nd month
MAR	Monthly wet days in the 3rd month
APR	Monthly wet days in the 4th month
MAY	Monthly wet days in the 5th month
JUN	Monthly wet days in the 6th month
JUL	Monthly wet days in the 7th month
AUG	Monthly wet days in the 8th month
SEP	Monthly wet days in the 9th month
OCT	Monthly wet days in the 10th month
NOV	Monthly wet days in the 11th month
DEC	Monthly wet days in the 12th month

The format of the monthly wet days file with one record is:

Variable name	Line #	Position	Format	F90 Format
YEAR	1-END	space 1-8	integer	free
JAN	1-END	space 9-16	real	free
FEB	1-END	space 23-24	real	free
MAR	1-END	space 31-32	real	free
APR	1-END	space 39-40	real	free
MAY	1-END	space 47-48	real	free
JUN	1-END	space 55-56	real	free
JUL	1-END	space 63-64	real	free
AUG	1-END	space 71-72	real	free
SEP	1-END	space 79-80	real	free
OCT	1-END	space 87-88	real	free
NOV	1-END	space 95-96	real	free
DEC	1-END	space 103-104	real	free

2.5 MODAWEC Input Data: *.ext

The .EXT file contains data for estimating the standard deviations of maximum temperature TMX and minimum temperature TMN. The first line contains data for maximum temperature and the second line contains data for minimum temperature. For each line, 12 variables are included, and each variable is for a month. The format for each variable is free so the only requirement is to place a blank space between each monthly value.

There are 3 options: (1) If known the actual standard deviations (SDTX and SDTN) can be entered (2 lines, 12 values each); (2) The temperature extremes may be entered (highest and lowest daily temperature recorded for each month for the site). In this case the model estimates the standard deviation to be 1/3 of the temperature difference between extreme and mean; (3) If no information is available the user enters 999. for each month for both SDTX and SDTN. In this case the model uses the equations from the literature

$SDTX=MAX(0.5,5.8-0.09*SMX)$
$SDTN=MAX(0.5,5.2-0.13*SMN)$

where SMX is the mean maximum temperature and SMN is the mean minimum temperature for each month.

For the first two options, the program sums the input values in line 1 and compares with the sum of TMX. If they are extremes their sum will be greater than the sum of TMX. If they are SDTX their sum will be less than the sum of TMX. Similarly, the program can judge whether users give SDTN or lowest daily temperature recorded for each month.

3. MODAWEC RUN FILES: RDWTRUN.dat

RDWTRUN.dat file contains names of input files, names of output files, and values of two parameters b1 and b2.

Variable name	Definition
RUNNAME	Run name. RUNNAME provides the name of input files. Default value is " TEMP". In this case, the input files to the MODAWEC program are *temp.tmn*, *temp.tmx*, *temp.wtd*, *temp.pcp* and *temp.exe*.
OUTPUTNAME	Output name, which provides the name of output files. Default value is " TEMP". In this case, the output files are *temp.dly*, *temp. wp1*, and *temp.out*.

b1	Value of parameter b1.
b2	Value of parameter b2.

Every line includes four variables. The position and format of the variables are as follows:

Variable name	Line #	Position	Format	F90 Format
RUNNAME	1-END	space 1-8 (input the year in column 3)	Character	unrestricted
OUTPUTNAME	1-END	space 9-16	Character	unrestricted
b1	1-END	space 17-24	Decimal	F8.3
b2	1-END	space 25-32	Decimal	F8.3

Each line stands for one run, and the model can simulate multiple runs (i.e. multiple stations) at one time. When the executable file MODAWEC.EXE is activated, it will first visit RDWTRUN.dat. For each run (or each line), MODAWEC will search input files with RUNNAME. Output files will be named after the OUTPUTNAME.

The default values of b1 (0.75) and b2 (0.5) generally give good results. However, when necessary, users can adjust these values for own projects.

!!Important: please leave an empty line at the end of the file.

4. OUTPUT FILES

4.1 MODAWEC Output Data: *.dly

The format for historical daily weather data is explained below:

Every line includes nine variables. These nine variables are:

Variable name	Line #	Position	Format	F90 Format
YEAR	1-END	space 1-6 (input the year in column 3)	4-digit integer	I4
MONTH	1-END	space 7-10	2-digit integer	I2
DAY	1-END	space 11-14	2-digit integer	I2
SOLAR RAD.	1-END	space 15-20	Decimal	F8.2
MAX TEMP	1-END	space 21-26	Decimal	F8.2
MIN TEMP	1-END	space 27-32	Decimal	F8.2
PREC	1-END	space 33-38	Decimal	F8.2
RH	1-END	space 39-44	Decimal	F8.2
WIND SPEED	1-END	space 45-50	Decimal	F8.2

!!Note: In the current version, only daily precipitation, Tmax and Tmin are generated. Other variables are mentioned here because the generated files (*.dly) have the same format as the daily weather input files in EPIC.

4.2 MODAWEC Output Data: *.wp1

Filename.wp1 file (lines 3 to 15 each have 12 variables, one for each month, January – December)

Variable name	Definition
TITLE	Description of dataset
OBMX	Average monthly maximum air temperature (deg C)
OBMN	Average monthly minimum air temperature (deg C)
SDTMX	Average monthly standard deviation of daily maximum temperature (deg C)
SDTMN	Average monthly standard deviation of daily minimum temperature (deg C)
RMO	Average monthly precipitation (mm)
RST2	Average monthly standard deviation of daily precipitation (4,1), (mm). (4) May be left zero if daily rainfall is input (1) May be left zero if unknown (enter zero).
RST3	Average monthly skew coefficient for daily precipitation (4,1). (4) May be left zero if daily rainfall is input (1) May be left zero if unknown (enter zero).
PRW1	Average monthly probability of wet day after dry day (5,4). (5) May be left zero if unknown and average number of days of rain per month (WVL) is available (4) May be left zero if daily rainfall is input.
PRW2	Average monthly probability of wet day after wet day (5,4). (5) May be left zero if unknown and average number of days of rain per month (WVL) is available. (4) May be left zero if daily rainfall is input.
DAYP	Average number days of rain per month (6), (days). (6) May be left zero if rainfall is generated and wet/dry probabilities are available.
WI	Monthly max 0.5h rainfall (3 options), (mm). 1. Monthly maximum .5 hour rainfall (mm) for period in YWI. 2. Alpha (Mean .5 hour rain/mean storm amount). 3. Blanks or zeros if unknown.
OBSL	Average monthly solar radiation (MJ/M**2 or LY (Langley)), (3 options) May be input in MJ/M**2 or LY. Special note if you intend to use daily weather files: Entering MJ/M**2 here indicates you will be reading MJ/M**2. Entering LY here indicates you will be reading LY. MJ/m**2 = LY * .0419 (1) May be left zero if unknown.
RH	Average monthly relative humidity (fraction), (3 options). 1. (Fraction, e.g. .75) 2. Average Monthly dewpoint temp (Deg C) 3. Blanks or zeros if unknown. NOTE: Conversion using 'E' in the number for English, will convert the number entered to Deg C for dewpoint temperature. May be left zero unless a PENMAN equation is used to estimate potential evaporation see variable IET.

The format of the monthly weather statistics file is as follows:

Variable name	Line #	Position	Format	F90 Format
TITLE1	1	Unrestricted	character	unrestricted
TITLE2	2	Unrestricted	character	unrestricted
OBMX	3	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
OBMN	4	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
SDTMX	5	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
SDTMN	6	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
RMO	7	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
RST2	8	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
RST3	9	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
PRW1	10	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
PRW2	11	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
DAYP	12	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
WI	13	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
OBSL	14	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2
RH	15	space 1-7 (Jan), 8-13 (Feb), …	Decimal	F6.2

!!Note: In the current version, only monthly statistics on precipitation and temperature are generated. Other variables are mentioned here because the generated files (*.wp1) have the same format as the monthly weather statistics in EPIC.