



# BreakPoint Climate Data Generator 2.0

Created By Joseph Trotochaud  
USDA ARS National Soil Erosion Research Laboratory  
Purdue University Department of Agricultural and Biological Engineering



## Information Sheet

**ABSTRACT:** WEPP uses two types of climate inputs for simulation. Predictions are typically done using the CLIGEN weather generator while calibration/validation is done using a breakpoint time-series climate file. Until now, breakpoint files have been created using a fortran program which required extensive manual manipulation of observed datasets (Gete, 1995). This sheet details the operation of a new climate generator which removes most of the manual manipulation involved in the old method. The Excel-based program presented here vastly simplifies and speeds up the creation of breakpoint climate files.

### MATERIALS AND METHODS:

Using an Excel-based VBA macro, breakpoint climate input files for use with the WEPP model can be created based on observed precipitation, temperature, solar radiation, wind direction and speed, and dewpoint temperature data. The following sections explain how each of these datasets is used within the macro to create a breakpoint file. While not all operations are explained within this information sheet, the VBA script contains extensive comments throughout which the user is invited to explore.

**Precipitation:** Instantaneous precipitation data is heavily modified by the macro. Zero precipitation values are removed while zeros are added back in to create the breakpoints. Blank or missing precipitation data is assumed to be zero.

**Minimum and Maximum Temperature:** Temperature can be input one of two ways. If daily minimum and maximum temperature data is available, this can be placed directly into the inputs sheet. Alternately, minimum and maximum temperature can be calculated by the macro by placing hourly temperature data into the supplemental section of the inputs sheet.

**Solar Radiation, Wind Speed, Wind Direction:** Solar radiation values which are blank are assumed equal to the monthly average. Nothing else is done to these data.

**Dew Point Temperature:** Dew point temperature can be input one of ways. If measured dew point temperature is available, this can be entered directly into the inputs sheet. Alternately, average daily temperature and relative humidity can be used to calculate dew point temperature according to (Lawrence, 2005).

### INSTRUCTIONS FOR USE:

To create a breakpoint file based on observed data, simply drop the observed data into the inputs sheet in the proper columns. The chart at right explains the units, timescales, and location on the inputs sheet for each variable required. Once data have been placed in the inputs sheet, press the "Process Data" button on the "Start Here" sheet. After the workbook autosaves, the user will be prompted to enter in the start and end dates for the breakpoint file; this will trim the data entered in the input sheet to the desired period only.

The user will then be prompted for the timestep of the observed precipitation data (i.e. 10 for 10-minute data, 15 for 15-minute data, etc. After the precipitation data has been processed, the user is prompted for more station information; this information appears at the top of the breakpoint file and only the "Number of Years in Data Used" is needed for actual calculations. The macro then creates continuous time series for each variable and calculates summary statistics, both of which are subsequently displayed on the "DataViewer" tab.

On the DataViewer tab, the user can examine the data which will be used to create the breakpoint file and modify any values which are obvious outliers or may represent sensor error. Pressing the "Create Breakpoint File" then formats the data and exports it as a text file to a directory specified by the user.

In between user prompts, there are calculations done by excel that can take several minutes to complete. Excel may even appear to lock up from time to time, especially after the prompt for the timestep of the observed precipitation data. Be patient, excel is still running in the background. The total runtime of the macro will vary based on processor speed, amount of RAM, and number of years being included. An estimate based on using several different computers and input records is between 2-4 minutes per year when using 10-minute precipitation data.

**Table 1: Data Requirements for the Inputs Sheet**

<u>Variable</u>	<u>Units</u>	<u>Timescale</u>	<u>Inputs Sheet Columns</u>
Precipitation	mm	Sub-daily	B:C
Minimum Temperature	C	Daily	E:F
Maximum Temperature	C	Daily	H:I
Solar Radiation	Langleys	Daily Cumulative	K:L
Wind Speed	m/s	Daily Average	N:O
Wind Direction	Decimal Degrees (0: N, 90:E, etc)	Daily Average	Q:R
Dew Point Temperature	C	Daily Average	T:U
Air Temperature	C	Sub-daily	Y:Z
Relative Humidity	% (0-100)	Daily Average	AB:AC

**DATA FORMATTING:** The charts on the following page can help answer most important questions regarding the format the data needs to be in, and below are examples of acceptable and unacceptable inputs sheets:

	A	B	C	D	E	F
1	Date	Rainfall_mm		Date/Time	Tmin	
2		4/25/2004 1:10		10/21/2004 0:00		11.15
3		4/25/2004 1:20		10/22/2004 0:00		10.73333
4		4/25/2004 1:30		10/23/2004 0:00		10.41667
5		4/25/2004 1:40		10/24/2004 0:00		9.68333
6		4/25/2004 1:50	0	10/25/2004 0:00		7.22
7		4/25/2004 2:00	0	10/26/2004 0:00		
8		4/25/2004 2:10	0	10/27/2004 6:00		
9		4/25/2004 2:20	0	10/28/2004 0:00		
10		4/25/2004 2:30	0.1	10/29/2004 0:00		
11		4/25/2004 2:40	0	10/30/2004 0:00		8.08333
12		4/25/2004 2:50	0.39	10/31/2004 0:00		7.98333
13		4/25/2004 3:00	0.1	11/1/2004 12:00		6.46667
14		4/25/2004 3:10	0.81	11/2/2004 0:00		5.78333
15		4/25/2004 3:20		11/3/2004 0:00		6.7
16		4/25/2004 3:30		11/17/2004 0:00		10.35
17		4/25/2004 3:40	0.1	11/18/2004 0:00		9.61667
18		4/25/2004 3:50	0	11/19/2004 0:00		9.48333
19		4/25/2004 5:10	0	11/20/2004 0:00		9.71667

**Fig. 1: An acceptable inputs sheet.** Note the missing values, odd hours in the Tmin, different starting dates, and missing dates/time for 11/4-11/16 in Tmin. All of these can be dealt with by the macro.

	A	B	C	D	E	F
1	Date	Rainfall_mm		Date/Time	Tmin	
2		4/25/2004 1:10	-9999	10/21/2004 0:00		11.15
3		4/25/2004 1:20	-9999	10/22/2004 0:00		10.73333
4		-9999	-9999	10/23/2004 0:00		10.41667
5		-9999	-9999	10/24/2004 0:00		9.68333
6		4/25/2004 1:50	0	10/25/2004 0:00		7.22
7		4/25/2004 2:00	0			
8		4/25/2004 2:10	0			
9		4/25/2004 2:20	0			
10		4/25/2004 2:30	0.1	10/30/2004 0:00		8.08333
11		4/25/2004 2:40	0	10/31/2004 0:00		7.98333
12		4/25/2004 2:50	0.39	11/1/2004 12:00		6.46667
13		4/25/2004 3:00	0.1	11/1/2004 15:00		5.78333
14		4/25/2004 3:10	0.81	11/1/2004 22:00		6.7
15		4/25/2004 3:20		11/17/2004 0:00		10.35
16		4/25/2004 3:30		11/18/2004 0:00		9.61667
17		4/25/2004 3:40	0.1	11/19/2004 0:00		9.48333
18		4/25/2004 3:50	0	11/20/2004 0:00		9.71667

**Fig. 2: An unacceptable inputs sheet.** Note the special identifiers (-9999), blank rows in Tmin, and multiple entry for a single day (11/1) in the Tmin data. Also, the first row should not contain any data, only headings.

**OTHER INFORMATION:**

Upon pressing the “Process Data” button, all of the data from the inputs sheet is copied to the “Raw” sheet as a backup in case anything goes wrong.

Two additional macros have been included on the “Start Here” sheet. The “Aggregate Daily Data” button activates a sheet which contains a macro for converting sub-daily data to average daily data. This can be used if any of the variables which specify daily data in table 1 are available only in sub-daily timesteps. The other macro is called “Clear All Sheets”, which clears all but the original data and any other sheets added by the user from the workbook. Original data is stored in the “Raw” sheet.

In between user prompts, there are calculations done by excel that can take several minutes to complete. Excel may even appear to lock up from time to time. Be patient, the process can take anywhere from 5-20 minutes depending on the number of years being put into the breakpoint file.

**REFERENCES:**

Gete, Zeleke, T. Winter, D. Flanagan. (1999). BPCDG: Breakpoint Climate Data Generator for WEPP Using Observed Standard Weather Data Sets. <http://www.ars.usda.gov/Research/docs.htm?docid=18565>

Lawrence, M. G. (2005). The relationship between relative humidity and the dewpoint temperature in moist air: A simple conversion and applications. Bulletin of the American Meteorological Society, 86(2), 225-233.

*Data Formatting: What does my data need to look like?*

While the macro has been written to take into account most of the common issues found in long time-series datasets, there are a few exceptions which can still cause errors in the breakpoint file. The table below addresses most of these issues, while a few special notes follow:

- Make sure the length of your data does not exceed the memory capabilities of Excel (Excel 2003: 65536 rows, Excel 2007/2010/2013:1048576 rows)
- WEPP can only have 300 breakpoints in a day, which is only a problem if precipitation data is measured more frequently than. The macro will tell you if there are more than 300 in a day.
- Precipitation data must be incremental (i.e. not cumulative). The macro will not break down cumulative precipitation data.
- The Date/Time timestamp of the input data must be a format that is recognized by Excel’s serial value system. Consult the Excel Help for more information. It is unlikely that timestamps will be in a format not recognized by excel.

Can my data have...	Answer:
... a measured value without a timestamp?	NO, though this is very unlikely
... a timestamp with no measured value?	YES, the value for that timestamp will typically be set equal to the monthly average
... days without a timestamp or measured value?	YES, these timestamps will be inserted and typically set equal to the monthly average
... gaps in the data which appear as empty rows?	NO, empty rows signify the end of a record in the macro, so a row with nothing at all in it will cause the macro to skip all subsequent rows.
... multiple datapoints with the same timestamp?	NO, if these exist, there are more serious problems with your data that need to be fixed by hand first
... negative solar radiation, precipitation, or wind data?	
... Special identifiers for missing data such as “-”, “error”, or “-999”?	NO, these need to be removed manually by using find and replace.
... multiple years with the same month missing from every year of the dataset?	NO, this will cause the averages to be very low or zero for many averages which are used to assume missing values.
... daily data with odd hourly timestamps?	YES, so long as each day only contains one measured value.
... different starting and ending dates between variables?	YES, the macro will fill in data at the beginning and end for each variable individually