MacMetGen 1.1.0 User's Guide

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1. Introduction

This document describes the design of MacMetGen (MACCS Meteorological file Generator) 1.1.0 and usage instructions. MacMetGen is controlled by options in an input file. MacMetGen extracts meteorological data from gridded meteorological data files and generates a MACCS formatted meteorological file for the MACCS code. The MacMetGen code has been tested with North American Mesoscale 12-km (NAM12), Global Data Assimilation System 0.5-degree (GDAS0P5), and Weather Research and Forecasting 27-km (WRF27) meteorological files downloaded from the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory (ARL) ftp server. These meteorological data sets provide high quality data with sufficient spatial and temporal resolution to provide representative wind fields.

2. Code Structure

MacMetGen 1.1.0 is written in FORTRAN. The MacMetGen code (MacMetGen.exe) operates in two steps:
1. Meteorological data are extracted from the meteorological files and output to an intermediate surface data file containing a subset of data at ground level needed by MACCS.
2. The data from the intermediate data file are read and a MACCS formatted weather file is generated.

3. Assumptions

MacMetGen is based on the following assumptions:
1. Each meteorological file name contains the string YYYYMMDD, where YYYY is the year of the weather day, MM is the month of the weather day, DD is the day of the month for the weather day. The complete file name is defined by the prefix and postfix character strings added to the date portion. These parameters are defined in the MacMetGen input file.
2. The format of the meteorological files is expected to contain data corresponding to the following variable names, U10M, V10M, T02M, TCLD, PBLH, DSWF, HGTS, and TEMP. Additionally, one of the following variables must be defined, TPP1, TPP3, TPP6, or PRT6.
3. The first entry of the first day is at 0000 hours.
4. Gaps in sequential days in the intermediate surface data file are treated as deliberate.
5. If less than 365 days of meteorological data are provided, MacMetGen repeats the data from the intermediate surface data file until 365 days are generated.

6. If more than 365 days of meteorological data are provided, MacMetGen only uses the first 365 days of surface data.
7. Calculated wind speeds are set to be between 0.5 m/s and 30 m/s to align with MACCS expectations.
8. The stability class is determined according to criteria documented below.

If any of these assumptions become obsolete or invalid, the source code will need to be modified.

4. Running MacMetGen

MacMetGen is written in FORTRAN and compiled to run on a 64-bit Windows operating system. A run is initiated by typing 'MacMetGen.exe –i file' in a Command Prompt window, where file is the path and name of the input file. If the command line syntax is specified incorrectly, a syntax statement displays the correct command line syntax.

5. Input Files

The input file for MacMetGen contains the parameters for the calculation. The input file contains values that control the data extraction location, intermediate surface data and output MACCS-formatted meteorological file names, meteorological data, and MACCS meteorological file settings. The specific format of the input file is discussed in Section 7.

The first option in the input file indicates whether the intermediate surface data file has already been created. This allows the user to bypass this step if it has already been completed in a previous calculation. If this option is selected, then the remaining parameters in this section are not used, but still need to be included and valid. The data extraction location is indicated by listing the latitude and longitude. The intermediate and output file names are specified by listing the full or relative path and file name.

The file names of the meteorological data file are specified by the directory of the files and the prefix and suffix of the file names combined with the YYYYMMDD designation. The meteorological data are specified in the input file by defining consecutive date ranges. For each group, the first and last day in the date range are listed in the input file. For example, to request meteorological data in the months of March, April, and May of 2015, the first day should be set to 20150301 (March 1, 2015) and the last day should be set to 20150531 (May 31, 2015). A single day can be selected by setting the first and last day of the group as the same. When multiple groups are specified, meteorological data for each group are extracted and collated into the intermediate surface data file. For example, setting the first group as 20150101 (January 1, 2015) to 20150131 (January 31, 2015) and the second group as 20140101 (January 1, 2014) to 20140131 (January 31, 2014) produces a single intermediate surface data file with the meteorological data from January 2015 followed by January 2014.

The MACCS-formatted meteorological file is generated based on the contents of the intermediate surface data file. The MACCS meteorological file settings specify the parameters used to generate the MACCS-formatted meteorological file. The number of minutes between entries specifies the period for the weather data in MACCS. The number of sectors specifies the

number of compass sectors in the MACCS grid. The stability class type determines the method used to determine the stability class. The UTC time zone determines the difference between the local time used in MACCS and UTC time used in the meteorological files.

The option to print mixing height data for each time period indicates whether the mixing height is output for each time period or as morning and afternoon mixing heights. The morning and afternoon mixing heights specify the mixing heights to be used in MACCS for the four seasons (winter, spring, summer, and fall). If the option to print mixing height data for each time period is selected, then the remaining parameters in this section are not used, but still need to be included and valid.

Three methods to determine stability class are included in MacMetGen. The first method, the Delta Temperature Delta height (DTDZ) method, determines the stability class based on the vertical temperature gradient near the surface of the Earth. MacMetGen calculates the vertical temperature gradient by comparing the surface temperature and the temperature at the next elevation that is at least 100 m above the surface in the meteorological file. For each time period, the vertical temperature gradient is compared with the criteria shown in Table 1 (NRC 2007) to determine the stability class.

The second method to determine stability class, Turner's method, is based on net radiation index, wind speed, and cloud cover. For each time period, MacMetGen follows the procedure shown in Figure 1, using the criteria shown in Figure 2 and Figure 3.

The third method to determine stability class, the Solar Radiation/Delta Temperature (SRDT) method, is based on the amount of solar radiation, wind speed, and vertical temperature gradient near the surface of the Earth. "The SRDT method retains the basic structure and rationale of Turner's method while obviating the need for observations of cloud cover and ceiling" (EPA 2000). For each time period, MacMetGen determines the stability class using the criteria shown below in Figure 4.

Table 1. Stability Class as a Function of Vertical Temperature Gradient. (NRC 2007)

Vertical Temperature Gradient Delta T/Delta Z [K/100 m]	Stability Class
< -1.9	1 (A)
-1.9 to -1.7	2 (B)
-1.7 to -1.5	3 (C)
-1.5 to -0.5	4 (D)
-0.5 to 1.5	5 (E)
1.5 to 4.0	6 (F)
> 4.0	7 (G)

Procedure for Determining the Net Radiation Index

1. If the total cloud[1] cover is 10/10 and the ceiling is less than 7000 feet, use net radiation index equal to 0 (whether day or night).

2. For nighttime: (from one hour before sunset to one hour after sunrise):
   (a) If total cloud cover ≤ 4/10, use net radiation index equal to -2.

   (b) If total cloud cover > 4/10, use net radiation index equal to -1.

3. For daytime:

   (a) Determine the insolation class number as a function of solar altitude from Table 6-5.

   (b) If total cloud cover ≤5/10, use the net radiation index in Table 6-4 corresponding to the isolation class number.

   © If cloud cover >5/10, modify the insolation class number using the following six steps.

   (1) Ceiling <7000 ft, subtract 2.

   (2) Ceiling ≥7000 ft but <16000 ft, subtract 1.

   (3) total cloud cover equal 10/10, subtract 1. (This will only apply to ceilings ≥7000 ft since cases with 10/10 coverage below 7000 ft are considered in item 1 above.)

   (4) If insolation class number has not been modified by steps (1), (2), or (3) above, assume modified class number equal to insolation class number.

   (5) If modified insolation class number is less than 1, let it equal 1.

   (6) Use the net radiation index in Table 6-4 corresponding to the modified insolation class number.

Figure 1. Procedure for Using Turner's Method (EPA 2000)

Table 6-4

Turner's Key to the P-G Stability Categories

Wind Speed		Net Radiation Index						
(knots)	(m/s)	4	3	2	1	0	-1	-2
0,1	0 - 0.7	1	1	2	3	4	6	7
2,3	0.8 - 1.8	1	2	2	3	4	6	7
4,5	1.9 - 2.8	1	2	3	4	4	5	6
6	2.9 - 3.3	2	2	3	4	4	5	6
7	3.4 - 3.8	2	2	3	4	4	4	5
8,9	3.9 - 4.8	2	3	3	4	4	4	5
10	4.9 - 5.4	3	3	4	4	4	4	5
11	5.5 - 5.9	3	3	4	4	4	4	4
≥ 12	≥ 6.0	3	4	4	4	4	4	4

Figure 2. Extracted Table 6-4 from EPA (2000).

Table 6-5

Insolation Class as a Function of Solar Altitude

Solar Altitude Φ (degrees)	Insolation	Insolation Class Number
60 < Φ	strong	4
35 < Φ ≤ 60	moderate	3
15 < Φ ≤ 35	slight	2
Φ ≤ 15	weak	1

Figure 3. Extracted Table 6-5 from EPA (2000).

Table 6-7

Key to Solar Radiation Delta-T (SRDT) Method for Estimating

Pasquill-Gifford (P-G) Stability Categories

	DAYTIME			
	Solar Radiation (W/m^2)			
Wind Speed (m/s)	≥ 925	925 - 675	675 - 175	< 175
< 2	A	A	B	D
2 - 3	A	B	C	D
3 - 5	B	B	C	D
5 - 6	C	C	D	D
≥ 6	C	D	D	D

	NIGHTTIME	
	Vertical Temperature Gradient	
Wind Speed (m/s)	< 0	≥ 0
< 2.0	E	F
2.0 - 2.5	D	E
≥ 2.5	D	D

Figure 4. Extracted Table 6-7 from EPA (2000).

6. Output Files

The output files for MacMetGen are the intermediate surface data file (with the specified name in the input file) and the output MACCS formatted weather file (with the specified name in the input file). These are created in the directories specified in the input file.

7. Input File Contents and Valid Ranges

The input file format, along with examples are shown below in Table 2.

Table 2. MacMetGen Input File Format

Line Number	Expected Input	Example
1 to 5	Five Comment lines	! --- ! ! An input file for a MacMetGen run ! --- ! ! Generate surface data parameters ! --- !
6	Comment	! Surface data file already created? (0=no, 1=yes) Skip to making output met file
7	Create surface data file flag, value must be 0 or 1	0
8	Comment	! Surface data file name
9	Path and name of surface data file	Z:\Documents\ADT\MACCS weather generation\testing\test\test.csv
10	Comment	! Latitude, Longitude
11	Latitude and Longitude, separated by white space, in decimal degrees, -90 < Latitude < 90, -360 < Longitude < 360	35.226665 -85.09111
12	Comment	! Number of groups to run
13	Integer indicating number of meteorological file groups (x)	2
14	Comment	! First and last day for each group [YYYYMMDD]
15 to 14+x	First and last date for each group in YYYYMMDD format separated by white space.	20150101 20150131 20140101 20140131
15+x	Comment	! Meteorology directory
16+x	Path to folder containing meteorological files	U:\meteorology\nam12
17+x	Comment	! Weather file prefix
18+x	Prefix, may be blank	
19+x	Comment	! Weather file suffix
20+x	Suffix, may be blank	_nam12
21+x to 23+x	Three Comment lines	! --- ! ! Output met file parameters ! --- !
24+x	Comment	! Output met file
25+x	Path and name of output file	Z:\Documents\ADT\MACCS weather generation\testing\test\test_srdt.MET
26+x	Comment	! Number of minutes between entries (15, 30, or 60)
27+x	Value must be 15, 30 or 60	60
28+x	Comment	! Number of sectors (16, 32, 48, or 64)

Line Number	Expected Input	Example
29+x	Number of compass sectors, value must be 16, 32, 48 or 64	64
30+x	Comment	! Stability class type (0=dT/dz, 1=Turner's Method, or 2=SRDT)
31+x	Stability class method, value must be 0, 1 or 2	2
32+x	Comment	! UTC time zone (-7=MST,UTC-7, -5=EST,UTC-5, 0=GMT,UTC+0, 1=CET,UTC+1)
33+x	UTC time zone, value between -12 and 14	-5
34+x	Comment	! Print mixing height data from file on each line (0=no, 1=yes)
35+x	Option to output mixing height data for each time period	1
36+x	Comment	! Morning mixing heights in m (for days 1-91, 92-182, 183-273, 274-365)
37+x	Morning Mixing Height in m by season (day 1 is January 1) Four numbers separated by white space.	581.5 520 420 490
38+x	Comment	! Afternoon mixing heights in m (for days 1-91, 92-182, 183-273, 274-365)
39+x	Afternoon Mixing Height in m by season. Four numbers separated by white space.	1110.7 1790 1820 1000

8. References

EPA (2000). "Meteorological Monitoring Guidance for Regulatory Modeling Application." EPA-454/R-99-005. February 2000.

NRC (2007). "Meteorological Monitoring Programs for Nuclear Power Plants, Revision 1." Regulatory Guide 1.23. March 2007.