Moderate Spectral Atmospheric Radiance and Transmittance Code

MOSART v2.0

Volume I: Installation Reference Manual

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Table of Contents

1	Int	roduction	1
2	De	livery Format and Hardware Requirements	1
3	Ins	talling the MOSART Code and Utilities	1
	3.1	Setting Directory Paths	2
	3.2	Executing Floating-point Test: FPTEST	3
	3.3	Installing Data bases: INSTDB	3
	3.4	Testing MOSART Execution	5
	3.5	Cleaning-up	5
4	Oth	ner Utilities	5
A	Appendix A: Input Test File		
A	Appendix B: FPTEST Output		

1 Introduction

The Moderate Spectral Atmospheric Radiance and Transfer (MOSART) computer program calculates atmospheric transmission and radiation from the ultraviolet through the microwave spectral regions (wavenumbers of 0 - 50,000 cm⁻¹ or wavelengths of 0.2 μ m to infinity). This volume of the User's Manual describes the installation of the various model elements used in MOSART. The other volume in the User's Manual describes how to run the code (Vol. II: User Reference Manual).

In addition to the main MOSART code, a set of utility codes is also included in this distribution. The utility codes delivered with MOSART include:

- ASCBIN: Converts binary files to ASCII and vice-versa
- BBTEMP: Converts radiance to equivalent blackbody temperatures
- CRFILE: Assists in preparing the MOSART input file
- FPTEST: Tests machine dependent operations
- INSTDB: Installs direct access binary data bases
- MRFLTR: Degrades the spectral output using a filter function
- TERTEM: Calculates diurnal terrain material temperatures
- VISUAL: Converts visible radiance to luminance and determines color

2 Delivery Format and Hardware Requirements

MOSART v2.0 is supplied on a CD-ROM, which includes the executable codes of MOSART and associated utilities, ASCII versions of various data bases, and a number of files that the user may find useful. The MOSART code and utilities, as provided on the CD-ROM, require approximately 350 MB of disk space. During installation, additional disk space (up to another 200 MB) may be required for such things as installing the data bases and running test cases.

At present, only the Red Hat Enterprise Linux[®] 5 operating system is actively supported. Other versions of Linux may work, but all Linux versions have not been tested.

Versions of MOSART for Windows, Mac OS X, and other versions of Unix may be available upon special request. Contact MOSART User Support for more information (MOSART@ssd5.nrl.navy.mil).

3 Installing the MOSART Code and Utilities

To install MOSART and the associated data bases and utilities, first copy the files from the CD to a directory of your choosing. The directory structure on the CD should be retained on your computer.

Once MOSART is properly installed, the executable can be placed and executed from anywhere on the computer. However, to insure that the executables and data bases are found during run time, it is necessary to define the paths (directories) for the newly installed MOSART codes and data bases. Instructions on how to define the MOSART paths are provided in Section 3.1 below. Instructions for completing the remaining installation steps and for running installation tests are provided in Sections 3.2 - 3.5.

3.1 Setting Directory Paths

The data bases used by MOSART (the molecular data bases, the global scene/altitude data base, the global climatology data base, the global atmospheric profile data bases, the global hydrology data base, and the SAG/NRL data bases) are installed with a default directory path. To insure that MOSART can access all necessary files, the MOSART directory path should be reset for each installation. The path for the new installation is specified by the Unix/Linux set environment command *setenv* (or *export* for bash).

It is strongly recommended that the directory path be as global as possible to permit the MOSART program to be executed from anywhere in the computer directory system. Accordingly, the recommended method for setting the data base directory path is to place the path definition in the *.cshrc* file (or other appropriate file). For csh and related shells, the path may be defined by:

setenv MOSART_DBPATH <data_base_directory>

For bash, the equivalent definition is:

export MOSART_DBPATH =<*data_base_directory*>

where *<data_base_directory>* is the full path to the Data directory in the directory structure copied from the CD-ROM.

NOTE: The *MOSART_DBPATH* environment variable must be set in the *.cshrc* (or other appropriate file) for each user who intends to run MOSART.

If placing the *setenv* (or *export* for bash) command in the *.cshrc* file (or other appropriate file) is not possible or convenient, the *setenv* (or *export* for bash) command must be executed just before the command to execute MOSART (and INSTDB during the installation of the data bases as discussed in Section 3.3).

If there is no entry in *.cshrc* for *MOSART_DBPATH* and *setenv* command is not executed prior to the execution of MOSART, then the default value that is hard-wired in the code is used, which is a directory path that may or may not exist on the host computer. Contact MOSART User Support for more information (MOSART@ssd5.nrl.navy.mil).

Although not required, users may find it convenient to also define a path to the executables for MOSART and related utilities. This will allow MOSART to be easily executed from any directory that contains formatted MOSART input files. For example, the path to the MOSART executable may be defined for csh and related shells, and then added to the user's path by including the following lines in the *.cshrc* (or equivalent) file:

setenv MOSART_TOP <executables_directory>
set path=(\$path \$MOSART_TOP)

For bash, the equivalent definitions are:

export MOSART_TOP =<executables_directory>
export path=\$path:\$MOSART_TOP

where *<executables_directory>* is the full path to the MOSART executable directory.

3.2 Executing Floating-point Test: FPTEST

The MOSART code is delivered with a floating-point test code that determines a number of capabilities of the computer and operating system. It is strongly recommended that FPTEST is the first code to be executed. The output from FPTEST will be automatically sent to the file *fptest.log*. This file should be retained and used if numerical debugging is necessary. The output from the FPTEST utility is useful in debugging certain problems a user may encounter with the MOSART code. This information should be provided, together with sample *.in, *.out, and *.log files (and a screen dump, if appropriate), with any questions concerning a problem encountered with MOSART or its utilities.

To execute FPTEST, simply enter ./*fptest* on the command line. A sample *fptest.log* is shown in Appendix B for a Linux computer using a MOSART executable compiled with the gfortran compiler.

3.3 Installing Data bases: INSTDB

The second code that should be executed is the utility that installs the binary direct access data bases, INSTDB. The MOSART v2.0 code uses six (6) direct access binary data bases that require installation from ASCII files. These data bases include:

- Molecular Band Model Parameters
- Global Climatology Data Base
- Global Ecosystems/Scene Background Data Base
- Global Climatology Profile Data Base (new)
- Global Hydrology Data Base (snow cover, ice cover, ice temperature)
- Global Oceanic Data Base (sea surface temperature and salinity

MOSART v2.0 code can operate with different sets of molecular data bases:

- The UFTAPE data base used (and installed with) MODTRAN 3.7, or
- Any combination of MOSART data bases and the UFTAPE data base.

However, if the MOSART code cannot find any of the MOSART data base files, it uses default values (e.g., sea level altitude, ocean background, model atmosphere, surface air temperature, no cloud cover). The MOSART v2.0 code is designed to automatically determine the required record length for each binary direct access data file.

The data base installation code, INSTDB, is fully automated. To execute INSTDB, simply enter ./*instdb* on the command line (after defining the data base directory path *MOSART_DBPATH* as discussed in Section 3.1 above). Due to the size of the data bases being installed, this may take a few minutes. Output from INSTDB is written to the file *instdb.log*. An example of *instdb.log* file is below (note that a full path name is provided for each file name in the *instdb.log* file):

```
Conversion completed for MOLBMP96 Molecular

The file properties are:

Number of records = 154209

Check sum = 31463097

Existence = T

OPENed = T
```

```
Access type
                      = DIRECT
    Format type
                      = UNFORMATTED
    Record length
                      =
                          60
    Device number
                           62
                      =
                      = /home/work/Data/cornette/Data/UFTAPE3.5A
    File name
    Action allowed
                      = READWRITE
Conversion completed for Global Climatology
  The file properties are:
    Number of records =
                             24840
    Check sum
                           7155602
                      =
    Existence
                     =
                            т
    OPENed
                     =
                            т
    Access type
                     = DIRECT
    Format type
                     = UNFORMATTED
    Record length
                      = 156
    Device number
                      =
                           32
    File name
                      = /home/work/Data/cornette/Data/global.dat
    Action allowed
                      = READWRITE
Conversion completed for Scene Background
  The file properties are:
    Number of records =
                             64800
    Check sum
                      =
                            783011
    Existence
                            т
                     =
                     =
    OPENed
                           т
    Access type
                     = DIRECT
    Format type
                     = UNFORMATTED
    Record length
                     = 216
    Device number
                      =
                          36
    File name
                      = /home/work/Data/cornette/Data/ecosys.dat
    Action allowed
                      = READWRITE
Conversion completed for Hydrology (Water/Snow/Ice/SST)
  The file properties are:
    Number of records =
                             64800
    Check sum
                           6246849
                 =
    Existence
                      =
                            т
    OPENed
                     =
                            т
                     = DIRECT
    Access type
    Format type
                      = UNFORMATTED
    Record length
                     = 152
    Device number
                      =
                          33
    File name
                      = /home/work/Data/cornette/Data/hydro.dat
    Action allowed
                      = READWRITE
Conversion completed for Oceanic (Sea Temp and Salinity)
  The file properties are:
    Number of records =
                           1036800
    Check sum
                  =
                           9198245
    Existence
                      =
                           т
                      =
    OPENed
                            т
    Access type
                     = DIRECT
                      = UNFORMATTED
    Format type
    Record length
                      = 104
                    =
    Device number
                           34
                      = /home/work/Data/cornette/Data/sstsss.dat
    File name
    Action allowed
                      = READWRITE
Conversion completed for Atmospheric Profile
  The file properties are:
    Number of records =
                              2664
    Check sum
                      =
                            41448
    Existence
                            т
                      =
    OPENed
                            т
                      =
    Access type
                      = DIRECT
    Format type
                      = UNFORMATTED
    Record length
                      = 2776
    Device number
                      =
                           35
                      = /home/work/Data/cornette/Data/profile.dat
    File name
    Action allowed = READWRITE
```

3.4 Testing MOSART Execution

A test input file, *test.in*, is supplied with the MOSART software and it is installed in folder test/ along with a number of other test files. The file *test.in* is listed in Appendix A. For comparison, test outputs are contained in the folder test/out for all the test cases. This test program (*test.in*) requires approximately 1-2 seconds of CPU time for a typical computer.

The code should be executed by inputting from within the /test directory:

./mosart test

Note that user provides only the file root (e.g., *test*), and MOSART will append the appropriate file type suffixes, e.g., *test.in*, *test.out*, *test.log*.

<u>If the execution test is successful, the following information should be output to the terminal (or device '*'):</u>

STOP Normal Termination

Additional summary information is output to *test.log* along with any warning messages. Some of the features may differ slightly between different types of computers (e.g., the STOP statement), but the numerical results should be essentially the same for each platform.

3.5 Cleaning-up

During the above installation procedures, a number of files were created that are not required after installation. The executables FPTEST and INSTDB can be deleted, and the ASCII data files (located in Data/ASCII/) can be compressed, or if it is necessary to save space, these ASCII data files can be deleted.

However, do **NOT** delete or compress the files in Data/ASCII/NRLDAT and do **NOT** delete *fptest.log*.

4 Other Utilities

In addition to the MOSART code and the installation utilities FPTEST and INSTDB, the following utilities are included and installed with the MOSART distribution:

- ASCBIN: ASCII-Binary Conversion
- BBTEMP: Blackbody Temperature Converter
- CRFILE: Input File Creator
- MRFLTR: MOSART Filter Code
- TERTEM: Terrain Temperature Calculator
- VISUAL: Visual (Luminance) Converter

Information on using these utilities is provided in the MOSART User Reference Manual.

Appendix A: Input Test File

The following is the MOSART v2.0 input file *test.in* that is used for the MOSART execution test (see Section 3). The corresponding output and log files are *test.out*, and *test.log*, respectively.

Moderate Spectral Atmospheric Radiance and Transmittance (MOSART) (Ver. 2.0) User-specified Parameters -----Header Test Case No. 1 Printout Switch (S/M/L) Large Delete Existing Files (Y/N) Yes Terrain Temperature Calcul. (Y/N) No Multiple Scattering Calcul. (Y/N) No ExpSumFit Method (None/Wisc/Malk) ... Malkmus/Laguerre No. of Terms (1-10,12,15) 4 Solar/Lunar Ephemeris (Y/S/L/N) No Exoatmospheric Solar Data newkur Analytic Phase Function (CS/HG) CS Analytic earth/skyshine model (Y/N) ... No Climatology (Temp/Humidity/Wind) None None None Position Parameters -----Coordinate Reference (Obsvr/Source) ... Source Latitude (deg) (+ North, - South) 50:00:00.0 Longitude (deg) (+ East, - West) -100:00:00.0 Day of the month (integer) 21 Month of the year (integer) June Year (integer) 1991 Time of day (24-hr HH.MMSS/HH:MM:SS) .. 12:00:00.0 Time zone LST Geometry Parameters -----Observer Azimuths (deg) (<=8) 0. 90. 180. 270. Azimuth Reference (Relative/True) True No. Index Obs. Alt. Sr/Tn.Alt. Sl.Rng. Earth Ang. Obs.Angle Src. Angle Length (km) Switch (km) (km) (deg) (deg.) (deg.) ***** 1 Se 100.0 1.0 ***** ***** 1.0 0 Be 100.0 ***** ***** **** **** 0 2 90.0 1.0 ***** ***** **** 3 Ce 100.0 -90.0 0 4 100.0 **** 120.0 ***** **** Ce -6.0 0 **** **** 5 Cz 100.0 1.0 **** 0.0 0 6 Cl 100.0 1.0 ***** **** 46:00 -98:12 * **** 7 Ae 1.0 **** **** ***** **** * ***** ***** ***** ***** 8 He 1.0 1.0 * ***** -7.0 **** ***** **** * 9 Le 400.0 ***** **** ***** 10 100.0 1.0 ***** * Le 400.0 -200. **** ***** **** ***** 11 Le 400.0 **** **** ***** -19.75 **** 12 Le End of Geometry Data/ Spectral Parameters -----Spectral Calculations (MO/MM) MO Wavenumber or Wavelength (WN/WL/FR) ... WN Initial wavenumber (cm**-1/um/GHz) .. 3000. Final wavenumber (cm**-1/um/GHz) 3000.

Appendix B: FPTEST Output

Sample FPTEST outputs from a Linux computer using a MOSART executable compiled with the gfortran 4.1-2 compiler on a Linux operating system.

MOSART Radiative Environment Summary (Ver. 2.00c) 27 Apr 2010 09:25:39 Floating Point Number Test 2 Radix = Number of bits in INTEGER 32 _ Little-endian representation Floating-point addition with IEEE rounding Gradual underflow Two's complement representation Register and storage calculations have different precisions No. of guard digits = 0 ---- REAL ---- DOUBLE PRECISION ---- INTEGER ----Precision = 6 15 No. of bits in significand = 24 53 31 8 11 No. of bits in exponent = Smallest exponent for 1+e = -23 -52 Smallest exponent for 1-e -24 -53 = Maximum exponent = 128 1024 Minimum exponent = -125 -1021 Pi (3.1415926535897932384626) = 3.141592741 3.14159265358979312 e (2.7182818284590452353603) = 2.718281746 2.71828182845904509 Logarithm (base 10) of radix = 0.301030010 0.30102999566398120 = 0.301030010 0.30102999566398120 = 3.402823466E+38 1.79769313486231571E+308 = 1.192092896E-07 2.22044604925031308E-016 Large Positive number 2147483647 Largest relative spacing Smallest relative spacing = 5.960464478E-08 1.11022302462515654E-016 Smallest normalized number = 1.175494351E-38 2.22507385850720138E-308 Smallest denormalized number = 0.000000000E+00 0.000000000000000E+000 Positive Infinity = +Infinity +Infinity Negative Infinity = -Infinity -Infinity Positive Signaling NaN = NaN NaN Negative Signaling NaN = NaN NaN Positive Quiet NaN = NaN NaN Negative Quiet NaN NaN NaN = 0.00000000E+00 0.00000000000000E+000 Positive Zero = Negative Zero = 0.00000000E+00 0.00000000000000E+000

It appears that this computer complies with IEEE Standard 754.

All file handling assumes that only the latest version of a file is saved.

This computer does not initialize variables.

This computer MAY operate in static mode.