2 Getting Started

2.1 Purpose

This chapter discusses general aspects of MM5 modeling system programs, including

- what are required on your computer in order to compile and run MM5 programs;
- where and how to obtain program tar files and utility programs;
- function of a job script (or a job deck);
- parameter statement and namelist;
- how to set up, compile and run the modeling system programs;
- date representation in MM5 modeling system;
- where to find data to run MM5.

2.2 Program portability

MM5 modeling system programs, TERRAIN, REGRID, LITTLE_R/RAWINS, INTERPF, NESTDOWN, INTERPB, RIP/GRAPH and MM5, can all be run on Unix workstations, PC running Linux, Cray's and IBM's. Running MM5 programs on a Linux PC requires Portland Group Fortran and C compilers. The primary reasons for this choice are 1) it supports Cray pointers which are used in several programs, including MM5 model; and 2) it has a Fortran 90 compiler.

MM5 modeling system programs are mostly Fortran programs that require compilation on your local computer. Some (Fortran 77) programs need recompilation each time you change model configuration. Others (Fortran 90) programs need only be compiled once. A user should try to know your computer and compiler. Find out how much usable memory you have on the computer, and what version of compiler you have. This information can come handy when you encounter problems when compiling and running the modeling system programs and report problems to mesouser. If you are thinking about purchasing a computer, get at least 0.5 to 1 Gb memory and a few Gb of disk. As most of the MM5 preprocessor programs are being migrated to Fortran 90, you will need a f90 compiler too to compile the programs. The following table lists the source code type and compiler required to compile them:

Program Name	Source Code	Compiler required
TERRAIN	Fortran 77	f77 (or f90)
REGRID	Fortran 90	f90
LITTLE_R	Fortran 90	f90
RAWINS	Fortran 77	f77 (or f90)
INTERPF	Fortran 90	f90
MM5	Fortran 77	f77 (or f90)
NESTDOWN	Fortran 90	f90
INTERPB	Fortran 90	f90
GRAPH/RIP	Fortran 77	f77 (or f90)

MM5 programs do not require NCAR Graphics to run. It is a matter of convenience to have it, since a few programs use it to help you configure model domains and prepare data. Some of the vitualization software that come with the MM5 system (RIP and GRAPH programs) is based on NCAR Graphics. NCAR Graphics is a licensed software, but part of it has become free and this is the part that MM5 modeling system requires. For more information on NCAR Graphics, please see its Web page: http://ngwww.ucar.edu/.

2.3 Prerequisite

There are a few things a user needs to prepare before starting running jobs on your workstation.

- If you have NCAR Graphics on your system, make sure you have the following line in your .cshrc file:

  `setenv NCARG_ROOT /usr/local`
  or
  `setenv NCARG_ROOT /usr/local/ncarg`

This enables a user to load NCAR Graphics libraries when compiling programs which use NCAR Graphics (Terrain, little_r, Rawins, RIP and Graph).

- If you need to remotely copy files between two workstations, make sure you have an *.rhosts* file on both workstations. A typical .rhosts file looks like this:

  `chipeta.ucar.edu username`
  `blackforest.ucar.edu username`

- Make sure that you browse through the ***~mesouser*** directories on the NCAR's computers, or ***mesouser/*** directory on anonymous ftp. All job decks, program tar files, data catalogs,

and utility programs reside in the directory.

2.4 Where to obtain program tar files?

MM5 modeling system programs are archived in three locations: NCAR's anonymous ftp, NCAR IBM-accessible disk, and NCAR's Mass Storage System (MSS).

On the ftp site, the source code tar files are archived under /mesouser/MM5V3:

/mesouser/MM5V3/TERRAIN.TAR.gz
/mesouser/MM5V3/REGRID.TAR.gz
/mesouser/MM5V3/LITTLE_R.TAR.gz
/mesouser/MM5V3/RAWINS.TAR.gz
/mesouser/MM5V3/INTERPF.TAR.gz
/mesouser/MM5V3/MM5.TAR.gz
/mesouser/MM5V3/MPP.TAR.gz
/mesouser/MM5V3/NESTDOWN.TAR.gz
/mesouser/MM5V3/INTERPB.TAR.gz
/mesouser/MM5V3/GRAPH.TAR.gz
/mesouser/MM5V3/RIP.TAR.gz
/mesouser/mm53dvar/3dvar.tar.gz

On NCAR's IBM, the source code tar files and job decks reside in ~mesouser/MM5V3:

~mesouser/MM5V3/TERRAIN.TAR.gz
~mesouser/MM5V3/REGRID.TAR.gz
~mesouser/MM5V3/INTERPF.TAR.gz
~mesouser/MM5V3/LITTLE_R.TAR.gz
~mesouser/MM5V3/RAWINS.TAR.gz
~mesouser/MM5V3/MM5.TAR.gz
~mesouser/MM5V3/MPP.TAR.gz
~mesouser/MM5V3/NESTDOWN.TAR.gz
~mesouser/MM5V3/INTERPB.TAR.gz
~mesouser/MM5V3/GRAPH.TAR.gz
~mesouser/MM5V3/RIP.TAR.gz
~mesouser/MM5V3/CRAY/*.deck.cray
~mesouser/MM5V3/IBM/*.deck.ibm

On MSS, the source code tar files are archived in /MESOUSER/MM5V3

/MESOUSER/MM5V3/TERRAIN.TAR.gz
/MESOUSER/MM5V3/REGRID.TAR.gz
/MESOUSER/MM5V3/INTERPF.TAR.gz
/MESOUSER/MM5V3/LITTLE_R.TAR.gz
/MESOUSER/MM5V3/RAWINS.TAR.gz
/MESOUSER/MM5V3/MM5.TAR.gz
/MESOUSER/MM5V3/MPP.TAR.gz
/MESOUSER/MM5V3/NESTDOWN.TAR.gz
/MESOUSER/MM5V3/INTERPB.TAR.gz
/MESOUSER/MM5V3/GRAPH.TAR.gz
/MESOUSER/MM5V3/RIP.TAR.gz

Previous releases are also available on ftp and MSS. To obtain files from IBM and MSS, you need to have an NCAR SCD computing account. To access program tar files from NCAR's anonymous ftp site, do the following (taking MM5 tar file as an example):

```
# ftp ftp.ucar.edu
Name: anonymous
Password: your-email-address
ftp> cd mesouser/MM5V3
ftp> binary
ftp> get MM5.TAR.gz
ftp> quit
```

Once you download these tar files, use Unix gunzip command to decompress the .gz files,

```
gunzip MM5.TAR.gz
```

and untar the file by using the command

```
tar -xvf MM5.TAR
```

After you untar the file, a program directory will be created. In this example, an MM5 directory will be created with all source code files inside it.

All utility programs are archived under MM5V3/Util/ directory on ftp and NCAR IBM-accessible disk. The list of the utility programs are:

Program/script Name	Function
cray2ibm.f	convert Cray MM5 binary data to IBM binary data
cray2ibm-intermediate.f	convert Cray intermediate binary data to IBM binary data
ieeev3.csh	convert Cray binary data to standard 32-bit IEEE data
readv3.f	read program for MM5 V3 modeling system output
v22v3.tar.gz	program tar file to convert V2 data to V3
v32v2.tar.gz	program tar file to convert V3 MM5 model data to V2
tovis5d.tar.gz	program tar files to convert MM5 model data to Vis5D data
MM5toGrADS.TAR.gz	program tar files to convert MM5 model data to GrADS data

2.5 What is Contained in a Program tar File?

A program tar file contains all source code (excluding NCAR Graphics), makefile, and instructions (in README file) required to compile and run that particular program. As an example, the files contained in program RAWINS tar file are listed below:

CHANGES	Description of changes to the program
Diff/	Will contain difference files between consecutive releases
Makefile	Makefile to create the program executable
README	General information about the program directory
Templates/	Job script directory
con.tbl	Table file for plots
map.tbl	Table file for plots
src/	Program source code directory and low-level makefile

2.6 Steps to run MM5 modeling system programs

Typically there are several steps to set up and run the modeling system programs. For detailed instruction on how to compile and run a particular program, read the respective chapter and README file inside the tar file.

For FORTRAN 77 programs TERRAIN, and RAWINS:

1) Type make x.deck to create job script to compile and run the program.

2) Edit x.deck to select appropriate shell variables, parameter statements, and namelist.

3) Type x.deck to (compile and) run the program.

For **FORTRAN 77 program GRAPH:**

1) Edit include files if necessary.

2) Type make to create the program executable.

3) Type graph.csh n m mm5-modeling-system-output-file to run.

For FORTRAN 90 programs REGRID, LITTLE_R, INTERPF, INTERPB and NESTDOWN:

1) Type make to compile the program.

2) Edit either the job script and/or namelist.input file.

3) Type the executable name to run the program, e.g. regridder

2.7 Functions of Job Decks or Scripts

Most of MM5 modeling system programs have a job deck or script to help you run the program. Some are called x.deck, and some are x.csh. While x.deck can be used either for a batch job (such as on an IBM) or interactive job, x.csh is only for interactive use. They have very similar functions. When using these job decks or scripts, they assume the program source code is local. Most also expect all input files are local too.

To obtain an appropriate job script for your computer, type 'make x.deck' to create a deck for program x (program name in lower case, e.g. make terrain.deck).

The general job deck construct and functions are the following:

- job switches, which usually appear in the first part of a deck;
- parameter statements used in Fortran 77 programs to define domain and data dimensions;
- FORTRAN namelist used during program execution to select runtime options;
- a section that does not normally require user modification, which links input files to Fortran units, create executable based on parameter statement setup, and obtain data from anonymous ftp sites (such as in the case of TERRAIN program)

2.8 What to Modify in a Job Deck/Script?

2.8.1 Shell Variables

Since the MM5 modeling system is designed for multiple applications, there are many options on how a job may be run. These options include different sources for inputting terrestrial and meteorological data, ways to do objective analysis, running the model with or without 4DDA option, and whether an MM5 job is an initial or restart run, etc. A user is required to go through the shell variables and make appropriate selections for your application.

The following is an example taken from the *pregrid.csh*, and the selection is with regarding to the type of global analysis to be used to create the first guess fields:

```
#
# Select the source of 3-d analyses
#

#  set SRC3D = ON84
#  set SRC3D = NCEP
   set SRC3D = GRIB  # Many GRIB-format datasets
```

Other examples of shell variables are listed below and they need to be defined by users for each program of the MM5 modeling system:

Program Name	*Shell Variables*
TERRAIN	ftpdata,Where30sTer
REGRID/pregrid	SRC3D,SRCSST,SRCSNOW,SRCSOIL,VTxxx
RAWINS	INOBS, SFCsw, BOGUSsw,InRaobs,InSfc3h,InSfc6h
MM5	STARTsw, FDDAsw (in IBM batch deck only)

These shell variables will be discussed in detail in the other chapters of this document.

2.8.2 Parameter Statements

The FORTRAN 77 MM5 modeling system programs require a user to set parameter statements in a deck or script (TERRAIN and RAWINS), or directly in an include file (GRAPH), which are typically used to define the parameterized dimensions for a FORTRAN 77 program before compilation takes place. The unix ***cat*** command is used in a deck to create FORTRAN include files containing these parameter statements. These are direct modifications to the source code, implying that strict FORTRAN syntax must be observed. The usage of *cat* is shown below:

```
cat > src/param.incl << EOF
     PARAMETER (.....)
     ......................
EOF
```

This creates a Fortran include file param.incl in the src/ directory and this include file will be used by a number of subroutines during compilation. As an example, the following is taken from *terrain.deck*:

```
cat > src/parame.incl.tmp << EOF
C IIMX,JJMX are the maximum size of the domains, NSIZE = IIMX*JJMX
       PARAMETER (IIMX = 136, JJMX = 181, NSIZE = IIMX*JJMX)
EOF
```

2.8.3 Fortran Namelist

The MM5 modeling system uses FORTRAN namelist to provide a way of selecting different options without re-compiling the program. If the namelist is inside a shell script or a deck, the unix ***cat*** command is used to create namelist files from the shell script during the execution of the shell script. The variables in the namelist for each program are described in detail in other chapters of this document. The format is the following

```
cat > nml << EOF
&xxxx
.........
&END
EOF
```

Where xxxx is the name of the namelist. Since the namelist is not a ANSI 77 standard, the FORTRAN 77 compiler used by different machines may have different syntax for the namelist. Namelist for FORTRAN 90 programs doesn't have this problem. The following is an example of namelist MAPBG from program TERRAIN for Cray, SGI, SUN and Compaq:

```
&MAPBG
 PHIC  =   36.0,      ; CENTRAL LATITUDE (minus for southern hemesphere)
 XLONC =  -85.0,      ; CENTRAL LONGITUDE (minus for western hemesphere)
 IEXP  =    .T.,       ; .T. EXTENDED COARSE DOMAIN, .F. NOT EXTENDED.
 AEXP  =   360.,       ; APPROX EXPANSION(KM)
 IPROJ = 'LAMCON',     ; MAP PROJECTION
&END
```

For most Fortran 90 programs, edit namelist file *namelist.input* directly.

After the user has 1) correctly set the shell variables, 2) modified the parameter statements, and 3) set up the FORTRAN namelist, there is typically no more user modification required in the deck. The rest of the script can be treated as a black box.

2.9 How to Build the Executable and Run the Program?

After you set the parameter statement either in a deck or directly in include file for any FORTRAN 77 program, type

`x.deck,` or **`x.csh`**

to compile and run the program. Or type

`make`

to compile, and then type **`x.deck`** to run.

For FORTRAN 90 program, simply type **`make`** to compile, and type the executable name to run.

2.9.1 Creating FORTRAN Executable

Unix make utility is used to generate FORTRAN executable in the MM5 modeling system. The rules and compile options a *make* command uses are contained in the *Makefile* for programs TERRAIN, REGRID, LITTLE_R/RAWINS, INTERPF, INTERPB, NESTDOWN, RIP and GRAPH, and *configure.user* for program MM5. For more information on make, please see Chapters 3 and 9 of this document.

2.9.2 Linking files to Fortran units

For most FORTRAN 77 programs, files with file names are typically linked to Fortran units prior to execution of the program inside a deck or shell script. For example,

```
ln -s terrain.namelist fort.15
```

This command makes a soft ‘link’ between filename terrain.namelist and Fortran-unit number 15.

2.9.3 Execution

`timex ./X.exe >&! X.print.out,` or **`time ./X.exe >& X.print.out`**

Where X is the program name. And Unix command timex or time is used to get a timing of the executable run. Example:

```
#
#       run MM5
#
timex mm5.exe >&! mm5.print.out
```

At the end of your mm5.print.out file, you will see something like:

```
real   1028.8
user   1009.7
sys    2.4
```

which tells you how long the mm5 job has taken in terms of wallclock time (real).

2.10 Input Files

MM5 modeling system programs require several datasets to run. Mesouser provides the terrestrial datasets for program TERRAIN. Programs REGRID, LITTLE_R and RAWINS will require other archived data or data in real-time to run.

Since V3.6, maximum snow albedo data at 1 degree resolution can be ingetsted into the model via REGRID using the ALMX_FILE file which is supplied with the REGRID.TAR.gz file. It is suggested that this file be used if one intends to use the Noah LSM option in MM5. Monthly albedo fields at 0.15 degree resolution can also be ingested via REGRID for Noah LSM use. These data are available from

/MESOUSER/DATASETS/REGRID/MONTHLY_ALBEDO.TAR.gz,

or from

ftp://ftp.ucar.edu/mesouser/MM5V3/REGRID_DATA/MONTHLY_ALBEDO.TAR.gz

2.11 Output Files

When a job is completed, certain output files are generated, which are named program-name_DOMAINx (e.g., REGRID_DOMAIN1, LITTLE_R_DOMAIN1, etc.). It is up to the user to archive the output. If you want to keep the output files, move them to a disk where you can keep them. If you run the same program again, these files will be overwritten.

2.12 Representation of Date in MM5 Modeling System Programs

Date is represented in the MM5 modeling system programs by up to 24 characters in the form of yyyy-mm-dd_hh:mm:ss:xxxx, where yyyy represents 4-digit year, mm 2-digit month, dd 2-digit day, hh 2-digit hour, mm (again) 2-digit minutes, ss 2 digit second, and xxxx ten thousandths of a second (optional). This replaces the 8-digit integer date representation, YYMMDDHH, in previous modeling system codes. For example, 1200 UTC 13 January 2003 is represented as 2003-01-13_12:00:00 in the model. Note that all model times are referring to Universal Time or Greenwich Mean Time, and not local time.

2.13 Where to Find Data at NCAR?

The Data Support Section of NCAR's Scientific Computing Division provides catalogs of data MM5 modeling system programs REGRID and LITTLE_R/RAWINS use. in mesouser directory ~mesouser/catalog on NCAR's IBM, or anonymous ftp's /mesouser/catalog. These catalogs are copies from the Data Support Section of NCAR/SCD from

ftp://ncardata.ucar.edu/datasets/dsNNN.x

where NNN.x is a dataset identifier. Most datasets that MM5 uses are listed below:

Dataset Identifier	Dataset Name
DS082.0	NCEP GLOBAL TROPO ANALS, DAILY 1976JUL-1997MAR
DS083.0	NCEP GLOBAL TROPO ANALS, DAILY 1997MAY-CON (GRIB)
DS083.2	NCEP Final Analysis (GRIB, 1 degree resolution) 1999SEP15 - CON
DS090.0	NCEP Global Reanalysis, 6 hourly, monthly (1948-Current)
DS111.2	ECMWF TOGA GLOBAL SFC & UPPER AIR ANALS, DAILY 1985-CON
DS115	ECMWF Global Reanalysis (1979-1993)
DS609.2	NCEP Eta model output (GRID212) 1995MAY01- CON
DS240.0	U.S. NAVY FNOC N.HEM SEA SFC TEMP ANALS, DAILY 1961NOV-1993DEC
DS353.4	NCEP ADP GLOBAL UPPER AIR OBS SUBSETS, DAILY 1973-CON
DS464.0	NCEP ADP GLOBAL SFC OBS, DAILY JUL1976-CON

Information on NCEP/NCAR Reanalysis Project and on European Center Reanalysis can be found at URL

http://dss.ucar.edu/pub/reanalyses.html

The NCEP Eta model data (the AWIP data, GRID 212) and NCEP Final Analysis are recent additions to NCAR's archive. Information about the data can be found at URL

http://dss.ucar.edu/datasets/ds609.2.html

and

http://dss.ucar.edu/datasets/ds083.2.html

When choosing to run the Noah land-surface model option in MM5, one can use the NNRP, AWIP or Final Analysis datasets at NCAR. These datasets contain additional fields required by LSM to initialize soil temperature and moisture. A recent addition which can also be used as input

to the Noah LSM option, is the AGRMET data supplied by AFWA. AGRMET data provides soil temperature, soil moisture, soil water, land-sea mask and soil height data. One can use this dataset in combination with any other 3-dimensional meteorological analyses. This dataset can be obtained from:

/MESOUSER/DATASETS/AGRMET/

This data is available since October 2002. Documentation regarding this data is available from:

http://www.mmm.ucar.edu/mm5/mm5v3/data/agrmet.html

A sample of the catalog for NCEP dataset DS083.0 is shown below:

```
Y47606          1998OCT01-1998OCT31, 12524 BLKS,  86.0MB
Y48077          1998NOV01-1998NOV30, 12120 BLKS,  83.3MB
Y48277          1998DEC01-1998DEC31, 12524 BLKS,  85.9MB
```

The MSS filenames correspond to these files are

```
/DSS/Y47606
/DSS/Y48077
/DSS/Y48277
```

A sample of the catalog for NCEP Global upper air observation dataset DS343.4 looks like

```
Y47652    1998OCT01-1998OCT31, 9096 BLKS                 LIST A98
Y48086    1998NOV01-1998NOV30,  8688 BLKS                LIST A98
Y48286    1998DEC01-1998DEC31,  8541 BLKS, SEE NOTES -   LIST A98
          NOTE:ADPUPA 1998DEC15 MISSING                  LIST A98
```

Similarly, the MSS file name corresponding to the Oct 1998 dataset is

```
/DSS/Y47625
```

File specifics for all global analysis used as input to REGRID are no longer required. Shell scripts are provided to access the data MASTER file (same file as in mesouser/catalog/catalog.*), find the MSS file names, and obtain them based user selected data source and date. If you run RAWINS at your local computer, you will still need to go to the catalog, find the file name on MSS, and access them from NCAR's computer. Note that you need to use -fBI option with msread to obtain observations to be used on your workstation. A small utility program, *fetch.csh*, may be used to obtain observational data too.

If you don't have access to NCAR's data, you need to consider where you can obtain similar data to run the modeling system.

2.14 Other Data Sources

Seaice fractional data is available from the *Near Real-TimeSSM/I EASE-Grid Daily Global Ice Concentration and Snow Extent. Boulder, CO, USA: National Snow and Ice Data Center.*
This data can be obtained from their web site:

http://nsidc.org/data/nise1.html

Please become a registered user before downloading data (no charge).

If you are interested in running MM5 in real-time, a good source of data can be obtained from NCEP's ftp server: *ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com*. NCEP provides a number of datasets from their global and regional models at this site.

For example,
Eta 40 km data:
eta/prod/eta.YYYYMMDD/eta.tXXz.awip3dYY.tm00
(eg. *eta/prod/eta.20021223/eta.t18z.awip3d12.tm00*)

GFS/AVN 1deg data:
avn/prod/avn.YYYYMMDD/gblav.tXXz.pgrbfYY
(eg. *avn/prod/avn.20021223/gblav.t12z.pgrbf12*)

FNL 1deg data:
fnl/prod/fnl.YYYYMMDD/gdas1.tXXz.pgrbfYY
(eg. *fnl/prod/fnl.20021223/gdas1.t12z.pgrbf12*)