4. How to Use TERRAIN

The purpose of this chapter is to provide users with detailed information on how to successfully set up the shell script to run the TERRRAIN program on the NCAR CRAY Y-MP (shavano). To use the TERRAIN shell script, the user needs to have a basic knowledge of UNIX. An example of the TERRAIN shell script is shown in Appendix A. The standard version of the TERRAIN shell script can be found on shavano under /u1/mesouser/MM5/Terrain/terrain.deck or on anonymous **ftp** account under /mesouser/MM5/Terrain/terrain.deck.

4.1 TERRAIN C-shell script

The default shell on shavano is the C-shell. All the MM5 system shell scripts are also C-shell and can be used in either batch or interactive mode. Users can copy the .login and .cshrc files from the /u1/mesouser directory if they do not know how to set up their own C-shell environment on shavano.

In this section, the discussion focuses on describing the shell variables that require user modification and the shell variables that are hard-wired. Since the MM5 is not a frozen system, new developments are constantly being added to the existing program. The information listed here may not be up-to-date with the TERRAIN shell script in the mesouser disk on shavano. Please contact the mesouser manager (send e-mail to mesouser@ncar.ucar.edu) if you have any questions on setting up the TERRAIN shell script.

4.1.1 Shell variables that require user modification

The following shell variables must be set for the standard TERRAIN submittal (remember that all the shell variables are case sensitive).

#QSUB option value

This syntax is a shell command that specifies the UNICOS Network Queuing System (NQS) options for batch jobs. If the script is executed interactively, the QSUB options will be ignored by the shell. The NQS "option values" listed in the TERRAIN shell script that require user modification are described below.

#QSUB -q queue: This option sets the queue. The description of shavano job queues can be found in the document "Charges for SCD Computing Resources" (SCD 1993).

#QSUB -lM nMw: This sets the maximum memory used for the entire script. If the user is using high-resolution terrain, especially the 30-second data, it is better to use the memory estimation equation in section 5.1.2 to find an estimation for the value n (n is a real number referring to the requested memory in mega-words; 1 mega-word equuals 8 megabytes).

#QSUB -lT n: This is the maximum CPU time, in seconds, needed to execute the entire script (no grace period). The TERRAIN program is usually inexpensive. A 100 second CPU time per domain is a very conservative estimate for a normal-size domain.

Users do not need to have an exact estimate of the maximum memory or CPU time for their TERRAIN script. However, the combination of these two numbers decides which NQS batch queue the job goes to, and, hence, the priority of the job (smaller CPU/memory request = higher priority). All the pre- and post-processor job decks in the mesouser disk are default to the pr_Ml_Ts queue.

ExpName

This is the user's experiment name. It is used to set up the MSS output pathname. If the user does not modify the shell variable OutTerr, the TERRAIN MSS output names are the character strings of /username/$ExpName/TERRAIN_DOMAIN$DomId. The MSS name for the TERRAIN plot file is /username/$ExpName/TERRAIN_PLOT and the tar file is /username/$ExpName/terrain.tar, where username is the user's shavano login name in upper case. Shell variable DomId specifies the domain ID number. The terrain tar file contains the TERRAIN namelist, mods, source code, executable, and ASCII outputs.

OutTerr

This shell variable defines the MSS output pathname. In normal submittal, this variable does not need to be changed. However, if the user needs to output the terrain MSS files under another user's login name, then the variable OutTerr should be required (note that this variable only provides the MSS pathname; the file name is hard-wired in the TERRAIN shell script).

The TERRAIN shell script allows a maximum of only 10 domains to be written out to the MSS at any submittal. Although the TERRAIN program does not have any limitation on how many domains one can generate, the MM5 shell script allows a maximum of 9 model initial input files. Therefore, there is no point of generating more than 9 nested domains which have higher terrain resolution than the coarse domain at any terrain submittal. A brief description of the TERRAIN output format and a simple subroutine that reads the TERRAIN output can be found in Appendix E. The TERRAIN input and output units are listed in Appendix F.

RetPd

This variable is used to set the retention period in days for the MSS files. This is one of the options in the local NCAR mswrite command.

Host

This variable is used to remote copy the TERRAIN plot file from shavano to the user's local machine. If the local machine is a VAX, please see Appendix D on how to ftp the files to and from shavano. The shell variable Host should have a form of username@host.domain:/usr/tmp/username, where username is the user's login name on his/her local machine, host.domain is the local machine's address, and /usr/tmp/username is the directory to which the user wants to the TERRAIN plot file to be copied.

In order for the remote shell facility to work on another machine without logging on, such as **rcp**, you must have a file called .rhosts in the login directory on each remote machine that you want to copy to or from. The .rhosts file should contain a list of machine and username pairs

host1.domain1 username1

host2.domain2 username2

For example, if the mesouser wants to have remote access between shavano and local machines mmm1 and mmm2, the .rhosts file on shavano should have the lines

mmm1.ucar.edu mesouser1

mmm2.ucar.edu mesouser2

and the .rhosts file on machine mmm1 and mmm2 should have the lines shavano.ucar.edu mesouser

shavano mesouser

Note that in this example there are two entry lines for shavano. Users need to test out on their local machines to see whether only one is needed. Users also need to protect their .rhosts files to avoid security problems by using the following command

chmod 600 .rhosts

If the mesouser wants to **rcp** the TERRAIN plot file back to machine mmm1 under directory /usr/tmp/mesouser1, the Host variable should be set to

set Host = mesouser1@mmm1.ucar.edu:/usr/tmp/mesouser1.

FillCo

This is a switch to indicate whether the final terrain height and land-use plots are color filled (FillCo = T). Usually, when one wants to produce color slides, it is preferable to have color filled terrain height and land-use plots. If the user wants to print out the plots from a non-color laser printer, then the color filled switch should be turned off (FillCo = F).

PltDev

This is a switch to indicate the plotting device on TAGS to which the user wants to send the plots. If FillCo = T, then the user can send the color filled plots to TAGS to produce slides or film. If FillCo = F, then microfiche is produced. The users also have the option to turn the plotting switch off (plots will not be sent to TAGS) by setting the PltDev to none.

Compile

This switch indicates whether the user wants to compile the TERRAIN code with the user's own modification. Since TERRAIN dynamically allocates the memory, there is no need to compile the code each time the domain dimensions are changed. If Compile = No, the shell script reads in the TERRAIN executable from the NCAR MSS. If Compile = Yes, the shell script generates a new executable file with the user's own mods. For more information on how the shell script does the compilation, please see the section on "shell variables that are black box to the user."

TerPlt

This switch indicates whether the user wants to plot the terrain height and land-use fields. If TerPlt = F, TERRAIN do not generate the terrain height and land-use fields. When the user runs the TERRAIN program for a new domain setup, it is better to run TERRAIN more than once. The first TERRAIN submittal should plot only the map background. In this way, the user can save computer time and make sure the domain setup is correct. The second and subsequent TERRAIN submittals should have TerPlt = T. When TerPlt = T, the shell script sets the TERRAIN namelist variable IFTER to TRUE, and the TERRAIN program generates the terrain height and land-use fields.

After the user defines the shell variables ExpName, OutTerr, RetPd, Host, FillCo, PltDev, Compile, and TerPlt, there are no more shell variables that require modification. If the user is not interested in knowing the rest of the TERRAIN shell script, one can skip the next section and go to section 4.2 which describes how to set up the TERRAIN namelists.

4.1.2. Hard-wired shell variables and script

The portion of the TERRAIN shell variables and script described in this section required NO user modifications. However, if the user needs to run the TERRAIN program on the CRAY machine at another site, this section must be read in order to make proper modifications to the TERRAIN shell script.

DomId:

This shell variable is used in the UNIX **foreach** loop to add the domain ID number to the MSS output file name.

MesoUser

This variable gives the directory name on shavano from which the TERRAIN shell script will access all the necessary files to run the TERRAIN program. These files include t_map.tbl, t_con.tbl, t_luco.tbl, t_mapfi.tbl, t_confi.tbl, raobsta, and t_stand.mods.

ja

This UNICOS command starts the job accounting information. The -c option produces the command report. The -h option replaces physical I/O data with the largest amount of memory process used at one time. The -l option provides additional information. The -s option produces the summary report.

batchname

This is the UNICOS command that defines the batch output name for jobs submitted through MIGS (Masnet/Intenet Gateway Server). The TERRAIN batch output name is called terrain.out. If the batchname command is not available on the other CRAY machines, one can use "#QSUB -o name" to specify the batch output name.

nupdate

This is the CRAY source code maintenance utility. Users that need to compile the TERRAIN source code should copy their terrain mods to the directory where the TERRAIN program is running or put it on their login directory with the file name "t_my.mods". The shell script will first check whether there is any standard modification (t_stand.mods) in the local working directory, and, if not, it then searches the user's login directory. If it still can not find the t_stand.mods, it then searches the mesouser directory for t_stand.mods. The script uses nupdate with the t_stand.mods, t_my.mods, and the original source code to create a new TERRAIN source code.

msread

This is a local NCAR command that copies a MSS file to UNICOS disk via the NCAR Local Data Network (LDN).

mswrite

This is a NCAR local command that copies an existing UNICOS disk file to the MSS via the NCAR LDN.

cf77

This command is used to compile and load the FORTRAN program on shavano.

assign -a aliasfile fort.nn

This command is used to assign FORTRAN file characteristics. The -a aliasfile specifies the pathname of the file to open a requested data file. nn is the unit number. If the user wants to assign a FORTRAN file as single precision IEEE format, he or she needs to add -Ff77 -Nieee after the -a aliasfile.

date

This command prints and sets the date.

sendtg

This is a local NCAR command that sends a gmeta file to TAGS (Text and Graphics System).

4.2 TERRAIN local input file

This section describes the TERRAIN shell script local namelists input file mif. The following options in the shell script must be set for standard TERRAIN submittal.

4.2.1 Namelist MAPBG

The variables in this namelist are used to set up the map background information for the TERRAIN program.

PHIC	Central latitude in degrees for the coarse domain. If this value is negative, the central latitude is located in the southern hemisphere.
XLONC	Central longitude in degrees for the coarse domain. If this value is negative, the central longitude is located in the western hemisphere.
IEXP	Logical flag to use the expanded coarse domain for TERRAIN, DATAGRID, and RAWINS. The expanded grid is used to expand the area over which the objective analyses are performed (in RAWINS), so as to obtain better analysis near the model domain boundaries. If IEXP is true, use the expanded grid. If IEXP is false, do not use the expanded grid.

AEXP — Approximate expansion (km) of the grid on all sides of the coarse domain. The number of grids that is expanded on all sides of the coarse domain is defined as

$$INCR = INT(AEXP/DIS(1) + 1.001)$$

Therefore, the expanded coarse domain dimensions are

$$IXEX = NESTIX(1) + INCR * 2$$

$$JXEX = NESTJX(1) + INCR * 2$$

where DIS(1), NESTIX(1), and NESTJX(1) are the coarse domain grid distance, I, and J dimensions respectively.

IPROJ — Map projection for the mesoscale grid. IPROJ is a character string contains six characters. TERRAIN has three choices for the map projection: Lambert Conformal ('LAMCON'), Polar Stereographic ('POLSTR'), and Mercator ('MERCAT').

4.2.2 Namelist DOMAINS

This namelist contains information necessary to set up the model domains. Except for variable MAXNES, all other variables in this namelist are one dimensional arrays. Each array element represents the information on one domain.

MAXNES — Maximum number of domains to be created by TERRAIN program.

NESTIX — This array defines the number of domain grid points in the $I(y)$ direction for MAXNES number of domains. For the coarse domain, NESTIX does not include expansion if IEXP = T.

NESTJX — This array defines the number of domain grid points in the $J(x)$ direction for MAXNES number of domains. For the coarse domain, NESTJX does not include expansion if IEXP = T.

DIS This array defines the grid separation (km) of the domains.

NESTI This array defines the I location in its mother domain of the nest domain point (1,1)

NESTJ This array defines the J location in its mother domain of the nest domain point (1,1)

MTHRD This array defines the origin of the domain (mother domain ID). The domains' ID numbers are determined by the array index of the above arrays. The domains' ID numbers are from 1 to MAXNES. The coarse domain should always have the ID number of 1. Since the coarse domain is the first domain, its mother domain's ID is also 1 (MTHRD = 1). The nest domains do not necessarily need to be in any sort of order. However, the user should alway be clear about the domain's and its mother domain's ID numbers. If multiple nest domains and levels are intended, the best way to set up the arrays NESTIX, NESTJX, DIS, NESTI, NESTJ, and MTHRD is to draw a picture and label all the domains and their ID numbers.

RID This array defines the radius of influence in unit of grid points for Cressman-type objective analysis.

NTYPE This array defines the domain's source terrain and land-use data type.

1) 1-degree global terrain and land-use

2) 30-minute global terrain and land-use

3) 10-minute global terrain and land-use

4) 5-minute global terrain and 10-minute global land-use

5) 30-second regional terrain (contains 48 states in the USA and part of Canada) and 10-minute global land-use

4.2.3 Namelist OPTN

This namelist contains options to set up a TERRAIN run.

IFTER Logical flag indicating whether to plot only domain maps. The true or false values are passed in from the shell variable TerPlt. No user modification is required.

DATASW Logical flag indicating whether the user wants to specify the source terrain and land-use type.

.TRUE. user specifies the source data type.

.FALSE. TERRAIN program specifies the source data type.

NSTTYP The nest domain type.

1 one-way nested. The nest model domains do not have feedback to their mother domains.

2 two-way nested. The nest model domains provide feedback to their mother domains.

IFANAL Logical flag that indicates which scheme is used to interpolate the source terrain data.

.TRUE. Cressman-type objective analysis

.FALSE. Overlapping parabolic interpolation

ISMTHTR This variable selects the type of smoother.

1 uses 1-2-1 smoother

2 uses two pass smoother/desmoother

IFFUDG Logical flag that indicates whether the user wants to fudge the land-use values.

.TRUE. Yes

.FALSE. No

IFTFUG Logical flag indicating whether the TERRAIN program should use land-use type 7 (water) to redefine the terrain height to –0.001 meter for a better coastline.

.TRUE. Yes

.FALSE. No

IPRNTD Logical flag indicating whether the grided latitude and longitude values should be printed out by the TERRAIN program.

IPRTHT Logical flag indicating whether the grided terrain heights should be printed out by the TERRAIN program.

IPRTLU Logical flag indicating whether the grided land-use values should be printed out by the TERRAIN program.

TRUELAT1 Real number used to define the first true latitude for the map projection.

TRUELAT2 Real number used to define the second true latitude for the Lambert Conformal map projection. When TRUELAT1 and TRUELAT2 are default value of 91.0, the standard map background will be created with the TRUELAT1 and TRUELAT2 reset in program for different map projections (Lambert: TRUELAT1=60, TRUELAT2=30; Polar: TRUELAT1=60, TRUELAT2=0; Mercator: TRUELAT1=0, TRUELAT2=0)

IFILL Logical flag indicating whether the terrain height and land-use plots are color filled. The value of IFILL is passed in from the shell variable FillCo, and no user modification is required.

4.2.4 Namelist FUDGE

This namelist is used to fudge the land-use values if the logical flag IFFUDG from the namelist OPTN is set to be .TRUE.

IFFUG — This array indicates whether there are any land-use fudge values for each domain.

NDFUG — One dimensional array indicating the number of fudge points for each domain.

IFUG — Two-dimensional array indicating the I location of the fudge point. It is dimensioned by (100,MAXNES).

JFUG — Two-dimensional array indicating the J location of the fudge point. It is dimensioned by (100,MAXNES).

LNDFUG — Two-dimensional array indicating the land-use category of the fudge point. It is dimensioned by (100,MAXNES).

4.2.5 Namelist FUDGET

If the logical flag IFTFUG from namelist OPTN is set to be .TRUE., four variables need to be defined in this namelist. The variables in this namelist are used to set up an area in which if the grid point land-use category is 7, terrain heights for that grid are reset to –0.001 meter to obtain a better coastline. This option is designed for a situation when there are islands off the continent with narrow water areas between them. If the domain grid spacings are large, the interpolation schemes may generate fictitious land bridges between the continent and the islands. Since this option can change the terrain height for any inland lakes, when the user defines this area, there should be no lakes within the specified domain.

STARTLAT	Latitude of the lower-left corner of the terrain fudge domain.
ENDLAT	Latitude of the upper-right corner of the terrain fudge domain.
STARTLON	Longitude of the lower-left corner of the terrain fudge domain
ENDLON	Longitude of the upper-right corner of the terrain fudge domain.