2. Input Data

The TERRAIN program uses three kinds of data as input:

model domains setup,

map and color tables and RAOB station file for plotting, and

source terrain height and land-use data.

The first kind of data is provided by the user as the namelist variables input in the shell script (Appendix A) which will be explained in Chapter 4. The second kind of data is black box for the user, that is, no user modification is required. In this section, we focus on the description of the third kind of data — the source terrain height and land-use data.

2.1 Data source and type

2.1.1 Terrain height

There are five types of terrain height data with resolutions of 1 degree, 30, 10, and 5 minutes, and 30 seconds. The 1-degree, 30-, 10-, and 5-minute data cover the whole globe (see Table 2.1a). The 1-degree and 30-minute data are from PSU/NCAR combined terrain/land-use tapes (Larkin 1985) and contain the land elevation. The ocean depth is set to be zero. The 5-minute data are from the National Data Center. Both the ocean depth and the land elevation are provided (SCD Computer News, March 1992). The vertical resolution is 1 meter. Because of the cavities of 10-minute data in the PSU/NCAR tapes, the 10-minute data are created by a 9-point weighted average method from the 5-minute data. The highest resolution, 30-second terrain height data, is from the Defense Mapping Agency. It has a vertical resolution of 1/20 feet. This dataset covers the region from 23° to 51°N and from 130° to 60°W, an area that includes the contiguous United States and a small portion of Canada (SCD Computer News, March 1992). Both the ocean depth and missing data are set to the value of 4,000 feet (−1218 m).

2.1.2 Land-use

The land-use data only have three resolutions: 1 degree, 30 minutes, and 10 minutes (Table 2.1b). Each type of data has 13 land-use categories that range from urban land to savannah (Table 2.2). All of the land-use data come from the PSU/NCAR combined terrain/land-use tapes. Higher resolution land-use data can be incorporated into the source land-use database when they become available.

2.2 Data reconstruction

Since all the terrain and land-use data have different formats and the highest land-use resolution is only 10 minutes, it is necessary to reconstruct each data and separate the terrain and land-use data into two different files. The reconstruction procedure includes: (1) re-arranging the data, (2) separating the terrain height and land-use data into two different output files, (3) compressing and packing the data to save disk space, and (4) outputting data in 64-bit binary format.

Both the terrain height and land-use data are re-arranged in the latitude circle. Each record contains the initial longitude to the end longitude of a particular type of data at one latitude. The latitude data are re-arranged from their initial latitude to the end latitude. Therefore, higher resolution terrain and land-use data have a longer record length and a larger total number of records per file. The beginning and end latitude, longitude, and data intervals for each type of the data are listed in Table 2.3. The unit for terrain height is in meters. Each lat-long box of the 13 land-use categories are represented by a percentage (from 0% to 100%). The terrain height is packed into a 16-bit integer with 4 data in a 64-bit word; and the land-use data are packed into an 8-bit integer with 8 data in a 64-bit word. The reconstructed data files are archived in the NCAR Mass Storage System (MSS).

If the users want to use their own source datasets, they must reconstruct the data files to the format mentioned above. The subroutines for packing the data are given in Appendix B. A few lines of modifications to the subroutines SETUP in the TERRAIN program are needed to provide the information on the initial latitude and longitude, the total number of records, the resolution, the missing value, and the MSS file names.

2.3 Supplementary datasets and IEEE format

2.3.1 Supplementary datasets

If the users want to use the old 10-minute terrain height data from the PSU/NCAR combined tapes or the 5-minute data from the NCAR Air Force tapes, these source datasets have already been reconstructed and archived in MSS. The PSU/NCAR 10-minute data are a global dataset, but the 5-minute Air Force data are a local dataset which covers a region from $8°5'$ N to 75°N and both the ocean depth and missing data are set to be the value of −999. Considerable data are missing in the 5-minute Air Force dataset. A few lines of modification to the TERRAIN program are needed to use these data files, and minor changes in the job script are needed to read the data file from MSS to disk (Appendex C).

2.3.2 IEEE format

The single precision IEEE format data are usually supported by the UNIX operating system. If the data are in the single precision IEEE format, they are portable between the CRAY machines and any type of workstation. All the terrain-height and land-use source data were also archived in MSS with the IEEE format. However, the workstation version of the TERRAIN program is still under development. The mesouser manager will notify users when it becomes available. In IEEE format, terrain height is packed into a 16-bit integer with 2 data in a 32-bit word, and land-use data are packed into an 8-bit integer with 4 data in a 32-bit word.

To use the IEEE format data files on shavano, a few lines of modifications to the TERRAIN program are needed for subroutines NUNPACK, IUNPACK, RDLDTR, and SETUP. In the TERRAIN shell script, the *msread* and *assign* commands also need to be modified. (Appendix C).

2.4 Hints and caveats

Because of the large amount of terrain and land-use data in archive, it is impossible to check the correctness of the data point by point. The user should "always" take a careful look at the final results. If the final results are not satisfactory, use the land-use or the terrain height fudge options provided in the TERRAIN shell script. The user may need to run TERRAIN several times to get a reasonable terrain height and land-use for the MM5 model. Please report any detected errors in the terrain and land-use archive to the mesouser manager (send e-mail to mesouser@ncar.ucar.edu).

Table 2.1a. Terrain Height Source Data

Resolution	Data source	Coverage	Size
1 deg. (111.0 km)	PSU/NCAR	Global	180x360
30 min. (55.0 km)	PSU/NCAR	Global	360x720
10 min. (18.5 km)	Geophysical Data Center	Global	1080x2160
5 min. (9.25 km)	Geophysical Data Center	Global	2161x4320
30 Sec. (0.925 km)	Defense Mapping Agency	51N,23N 130W,60W	3361x8401

Table 2.1b. Land-use Source Data

Resolution	Data source	Coverage	Size
1 deg. (111.0 km)	PSU/NCAR	Global	180x360x13
30 min. (55.0 km)	PSU/NCAR	Global	360x720x13
10 min. (18.5 km)	PSU/NCAR	Global	1080x2160x13

Table 2.2 Description of land-use categories and physical parameters for summer (15 April-15 October) and winter (15 October-15 April)

Landuse Integer Identification	Landuse Description	albedo(%)		Moisture Avail. (%)		Emissivity (% at 9 μ m)		Roughness Length (cm)		Thermal Inertia (cal cm^{-2} k^{-1} $s^{-1/2}$)	
		Sum	Win	Sum	Win	Sum	Win	Sum	Win	Sum	Win
1	Urban land	18	18	5	10	88	88	50	50	0.03	0.03
2	Agriculture	17	23	30	60	92	92	15	5	0.04	0.04
3	Range-grassland	19	23	15	30	92	92	12	10	0.03	0.04
4	Deciduous forest	16	17	30	60	93	93	50	50	0.04	0.05
5	Coniferous forest	12	12	30	60	95	95	50	50	0.04	0.05
6	Mixed forest and wet land	14	14	35	70	95	95	40	40	0.05	0.06
7	Water	8	8	100	100	98	98	.01	.01	0.06	0.06
8	Marsh or wet land	14	14	50	75	95	95	20	20	0.06	0.06
9	Desert	25	25	2	5	85	85	10	10	0.02	0.02
10	Tundra	15	70	50	90	92	92	10	10	0.05	0.05
11	Permanent ice	55	70	95	95	95	95	5	5	0.05	0.05
12	Tropical or sub tropical forest	12	12	50	50	95	95	50	50	0.05	0.05
13	Savannah	20	20	15	15	92	92	15	15	0.03	0.03

Table 2.3 Source Data Information

Resolution	Initial lat., lon.	End lat., lon.	Interval in minute
1 deg. (111.0 km)	89.5°N 179.5°W	89.5°S 179.5°E	60.0
30 min. (55.0 km)	89.75°N 179.75°W	89.75°S 179.75°E	30.0
10 min. (18.5 km)	89.833°N 179.833°W	89.833°S 179.833°E	10.0
5 min. (9.25 km)	90.0°N 180.0°W	90.0°S 179.9167°E	5.0
30 sec. (0.925 km)	51°N 130.0°W	23.0°S 60.0°E	0.5