Data Format for
Global 10 Minute Elevation Data
from the U. S. Navy

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Global elevation data at a resolution of 10 minutes was prepared by the Navy Fleet Numerical Oceanography Center at Monterey. For each 10x10 minute area, the set includes modal elevation, minimum elevation, maximum elevation, orientation of ridges, terrain characteristics, and urban development. This is archived by the NCAR Data Support Section (DSS) in a packed binary format. Parameters available are identical to those described in documents by Meteorological International, Inc. and the Fleet Numerical Oceanography Center, but the DSS has made some changes to the set. The data is now organized somewhat differently with each tape block containing all data for a 5x5 degree area. The data format has been changed and a few coding changes were made for consistency with the format. The information content of the original set has been preserved entirely.

The tape contains 2592 tape blocks, each 962 60-bit words in length. A single block contains all data within a 5x5 degree square. Each block is labelled with the latitude and longitude of its southwest corner. The tape is ordered beginning with the block for 90s,0 and moving eastward for 72 blocks then the next 72 blocks beginning at 85s,0 etc. Within a tape block there are data values for 900 10'x10' squares. These values apply to a 30x30 array where the data points are ordered beginning in the southwest corner of the box and scanning eastward then the next row 10 minutes north, and ends with the data point for the northeast corner of the box (See figures below).

Each tape block has the following format.

Bits	Meaning
1-9	Latitude of SW corner of box where (0=90s,5=85s,90=equator,175=85n,180=90n,etc.)
10-18	Longitude of SW corner of box in degrees east.
19-57618	900 64-bit groups containing data for each point (see below).
57619-57660	Unused.
57661-57720	60-bit checksum of previous 961 60-bit words (can be ignored by most users).

Each 64 bit group has the following format.

Bits	Code	Description
1-6	RR	Estimate of the number of significant ridges.
7-12	DD	General direction of ridges.
13-21	HMO	Terrain elevation - Modal height.
22-30	HHI	Terrain elevation - Maximum height.
31-39	NLO	Terrain elevation - Minimum height.
40-45	C1	Primary characteristics of terrain.
46-50	C2	Secondary characteristics of the terrain.
51-57	WWW	Percentage of water surface.
58-64	URB	Percentage of urban development.

Significant Ridges -

Subjective estimate of number of ridges and their orientation in tens of degrees (00-18).

Terrain Elevation -

Elevation in feet = (packed value - 100)*100.

Note that zero values do not necessarily indicate ocean surface. Use primary terrain characteristic to identify ocean.
Inland water bodies are coded with the elevation of the water surface (except in minimum field where it is always zero).

Characteristics of the Terrain -

0- salt or lake bed.
1- flat or relatively flat.
2- desert (or, for high latitudes, glaciers or permanent ice).
3- marsh.
4- lake country or atoll.
5- major valleys or river beds.
6- isolated mountains, ridge or peak.
7- low mountains or hills.
8- average mountains.
9- extremely rugged mountains.

62- ocean (identified in primary only).

Percentage of water -

For ocean areas at sea level the value is 100, for all other areas the range is 00 to 99 (large lakes or inland seas will not be coded as 100).

Percentage of Urban Development -

Not updated (reflects highly subjective judgements from the maps used).

General Information

The modal terrain height has been contoured at NCAR, and major problems identified in these plots have been corrected by the Navy. Distribution summaries of all parameters indicate that there are still some invalid elevation values and unexplained code values, especially in the terrain characteristics field. As of this date no further information is available on these problems. Occasional occurences of full range values (all bits on) are assumed to indicate missing data.

The data distribution summaries showed a strong tendency for elevation values to cluster around multiples of 500 feet. This is probably due to the contour intervals in the original maps or to some other characteristic in the method of reading map values.

The true resolution of the data is reduced to 20 minutes poleward of 70 degrees latitude, but data values are still present for each 10 minute square. More information on the original data format, the sources of the data, the methods of reading the data, and the routines designed for the Navy to read the original format is available in documentation by the Fleet Numerical Oceanography Center and Meteorology International, Inc.

General Information Update - Dec 1984

Various users have noted a large number of bad data points in the minimum elevations. A few bad points in the modal and maximum elevations have also been identified. An attempt has been made to remove these bad points and replace them with estimated values. The minimum values from a previous edition of the data were found to have many fewer problems and these values were used for all minimum elevations north of 30 South. Checks for unreasonable values and gradients were run and comparisons of min, mode, and max were made. The results of these tests were manually inspected and where estimates seemed better than the original values, they were inserted in the set. Checks were run on the minimum, modal, and maximum elevation only. No checks were run on the other parameters.

There are most likely still some erroneous values in the set, but most of the totally unreasonable values have been removed. Note that the minimum elevations are coded as zero for all water surfaces regardless of the true elevation of the water surface (even when this surface is below sea level). In some areas the elevation values are constant over one degree areas indicating that the resolution is not truly 10 minute in those areas. In general, the modal elevations seem to be more reliable than the minimum or maximum.

This corrected set will be the primary archive set, but the uncorrected earlier versions are available on request.

Roughness Computations

Stephano Tibaldi, European Center for Medium Range Weather Forecasting, has used these elevations to compute estimates of surface roughness. His method for computing roughness length (Z) over a user-defined area containing multiple 10’ squares is given on the following page. Note that his relative maximum are determined by examining the 8 surrounding squares. When looking at data which is poleward of 70 degrees, use every other point to compensate for the true resolution of 20’.

Formula to compute the roughness length Z_o:

$$Z_o = \sqrt{\frac{N}{F}}\left(\sum p_i \bar{h}_i^{\,2} - \left(\sum p_i h_i\right)^2\right)$$
$$+ \sum \sqrt{\frac{n_i}{f_i}}\, p_i \frac{(\bar{h}_i - h_i^{\min})(h_i^{\max} - \bar{h}_i)}{4}$$

where:

N = number of relative $\bar{h}_i$ maximum in the user-defined grid square

F = surface area of the user-defined grid square

n_i = number of significant ridges in the 10' grid square

$\bar{h}_i$ = mean height in the 10' grid square

$h_i^{\max}$ = maximum height in the 10' grid Square

$h_i^{\min}$ = minimum height in the 10' grid square

f_i = surface area of the 10' grid square

p_i = proportion of the user-defined grid square occupied by the i^{th} 10' grid square

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