SRTM30 Documentation (best viewed with monospaced font, such as courier)

1.0 Introduction

SRTM30 is a near-global digital elevation model (DEM) comprising a combination of data from the Shuttle Radar Topography Mission, flown in February, 2000 and the the U.S. Geological Survey's GTOPO30 data set. It can be considered to be either an SRTM data set enhanced with GTOPO30, or as an upgrade to GTOPO30.

It is formatted and organized in a fashion that mimics the GTOPO30 convention so software and GIS systems that work with GTOPO30 should also work with SRTM30. GTOPO30 is described in the file 'GTOPO30 Documentation' included here, and this SRTM document describes only the differences and additional files contained in SRTM30. The GTOPO30 data set can be downloaded from http://edcdaac.usgs.gov/gtopo30/gtopo30.html.

The SRTM data resulted from a collaborative effort by the National Aeronautics and Space Administration (NASA) and the National Imagery and Mapping Agency (NIMA), as well as the participation of the German and Italian space agencies, to generate a near-global digital elevation model (DEM) of the Earth using radar interferometry. The SRTM instrument consisted of the Spaceborne Imaging Radar-C (SIR-C) hardware set modified with a Space Station-derived mast and additional antennae to form an interferometer with a 60 meter long baseline. A description of the SRTM mission can be found in Farr and Kobrick (2000).

Synthetic aperture radars are side-looking instruments and acquire data along continuous swaths. The SRTM swaths extended from about 30 degrees off-nadir to about 58 degrees off-nadir from an altitude of 233 km, and thus were about 225 km wide. During the data flight the instrument was operated at all times the orbiter was over land and about 1000 individual swaths were acquired over the ten days of mapping operations. Length of the acquired swaths range from a few hundred to several thousand km. Each individual data acquisition is referred to as a "data take."

SRTM was the primary (and pretty much only) payload on the STS-99 mission of the Space Shuttle Endeavour, which launched February 11, 2000 and flew for 11 days. Following several hours for instrument deployment, activation and checkout, systematic interferometric data were collected for 222.4 consecutive hours. The instrument operated virtually flawlessly and imaged 99.96% of the targeted landmass at least one time, 94.59% at least twice and about 50% at least three or more times. The goal was to image each terrain segment at least twice from different angles (on ascending, or north-going, and descending orbit passes) to fill in areas shadowed from

the radar beam by terrain.

This 'targeted landmass' consisted of all land between 56 degrees south and 60 degrees north latitude, which comprises almost exactly 80% of the total landmass.

1.1 Generation of SRTM30

SRTM radar echo data were processed into elevation information in a systematic fashion using the SRTM Ground Data Processing System (GDPS) supercomputer system at the Jet Propulsion Laboratory. Elevation data were mosaiced into more than 14,000 one degree by one degree cells and formatted according to the Digital Terrain Elevation Data (DTED) specification for delivery to NIMA, who is editing it and using it to update and extend their DTED products.

Sample spacing for the fundamental data set is 1 arc-second in latitude and longitude (approximately 30 meters at the equator), consistent with NIMA's existing DTED Level 2 product. By agreement between NIMA and NASA this product is under control of NIMA and is subject to limited distribution, using procedures similar to those for the existing DTED products.

A second product, with sample spacing of 3 arc-seconds was generated by a 3x3 averaging of the 1 arc-second data, and is being systematically released to the public on a continent-by-continent basis. These 3 arc-second data were then further averaged 10x10 to produce 30 arc-second data commensurate with GTOPO30.

Since the SRTM elevation data delivered to NIMA are unedited, they contain occasional voids, or gaps, where the terrain lay in the radar beam's shadow or in areas of extremely low radar backscatter where an elevation solution could not be found. Globally these voids amount to no more than 0.15% of the SRTM data, but in some regions such as the Himalayas or northern Africa they are extensive enough to be evident even after the 10x10 averaging.

To construct SRTM30, mosaics were constructed at 30 arc-second spacing in tiles that matched the GTOPO30 tiles. Then the results were combined with GTOPO30 such that each sample contains an SRTM data point where SRTM data were valid, or GTOPO30 data where the SRTM data were void. Since the SRTM mission was only able to map up to approximately 60.25 degrees north latitude values above this point are completely from GTOP30.

The geodetic reference for SRTM data is the WGS84 EGM96 geoid as documented at http://www.nima.mil/GandG/wgsegm/, and no attempt was made to adjust the vertical reference of either data set during the combination.

2.0 Data Format

SRTM30 has been divided into the same tiles as GTOPO30, except that since the data do not extend below 60 degrees south latitude the corresponding tiles, as well as the Antarctica file in GTOPO30, have not been generated.

The following table lists the name, latitude and longitude extent, and elevation statistics for each SRTM30 tile.

	Latitude		Longitude		Elevation			
Tile	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Mean	Std.Dev.
w180n90	40	90	-180	-140	-22	6098	448	482
w140n90	40	90	-140	-100	-108	4635	731	596
w100n90	40	90	-100	-60	-35	2416	337	280
w060n90	40	90	-60	-20	-13	3940	1626	932
w020n90	40	90	-20	20	-179	4536	402	426
e020n90	40	90	20	60	-188	5472	213	312
e060n90	40	90	60	100	-156	7169	509	697
e100n90	40	90	100	140	-110	3901	596	455
e140n90	40	90	140	180	-26	4578	415	401
w180n40	-10	40	-180	-140	-3	4120	832	860
w140n40	-10	40	-140	-100	-174	4228	1322	745
w100n40	-10	40	-100	-60	-171	6543	367	609
w060n40	-10	40	-60	-20	-22	2504	217	160
w020n40	-10	40	-20	20	-138	3958	438	298
e020n40	-10	40	20	60	-422	5778	724	557
e060n40	-10	40	60	100	-46	8685	1807	1889
e100n40	-10	40	100	140	-147	7213	690	911
e140n40	-10	40	140	180	-42	4650	530	728
w180s10	-60	-10	-180	-140	-41	1784	191	294
w140s10	-60	-10	-140	-100	-5	910	79	133
w100s10	-60	-10	-100	-60	-752	6813	1080	1359
w060s10	-60	-10	-60	-20	-127	2823	411	294
w020s10	-60	-10	-20	20	-24	2498	1088	404
e020s10	-60	-10	20	60	-26	3408	889	453
e060s10	-60	-10	60	100	-3	2557	251	262
e100s10	-60	-10	100	140	-33	1360	290	172
e140s10	-60	-10	140	180	-43	3119	278	265

The 8 files included for each tile in GTOPO30 are also present in SRTM30, using the following extensions:

Extension	Contents
DEM	digital elevation model data
HDR	header file for DEM
DMW	world file
STX	statistics file
PRJ	projection information file
GIF	shaded relief image
SRC	source map
SCH	header file for source map

In addition several additional files are included using these extensions:

Extension	Contents
dif	difference between SRTM30 and GTOPO30
jpg	color coded shaded relief image
num	number of valid point included in the 10x10 average
std	standard deviation of the elevations used in the average

Further information on the contents of the files is provided below.

2.1 DEM File (.DEM)

Same as GTOPO30

2.2 Header File (.HDR)

Same as for GTOPO30

2.3 World File (.DMW)

Same as for GTOPO30

2.4 Statistics File (.STX)

Same as for GTOPO30

2.5 Projection File (.PRJ)

Same as for GTOPO30

2.6 Shaded Relief Image (.GIF)

Same as for GTOPO30, except that brightness is also modulated by the elevation. This is a actually a greyscale version of the .jpg file noted below.

2.7 Source Map (.SRC)

Same as for GTOPO30, except a new source code has been added for SRTM data. The codes are now:

Value	Source
0	Ocean
1	Digital Terrain Elevation Data
2	Digital Chart of the World
3	USGS 1-degree DEM's
4	Army Map Service 1:1,000,000-scale maps
5	International Map of the World 1:1,000,000-scale maps
6	Peru 1:1,000,000-scale map
7	New Zealand DEM
8	Antarctic Digital Database
9	SRTM data

2.8 Source Map Header File (.SCH)

Same as for GTOPO30

2.9 Difference file (.dif)

16 bit signed integers indicating the difference between the SRTM30 DEMs and the corresponding GTOPO30 tiles. Calculated as
difference = SRTM30 value - GTOPO30 value.

2.10 Color Shaded Relief Image (.jpg)

Color coded shaded relief image of the data in each file. Colors were assigned by elevation, then manipulated to produce a pleasing image - thus they cannot be related directly to elevation.

2.11 Number of Points in Average (.num)

8 bit integers indicating the number of valid data points that were included in the 10x10 averaging process.

2.12 Standard Deviation (.std)

16 bit integers indicating the standard deviation of the data points used in the averaging. This is thus an indication of topographic roughness useful in some applications.

3.0 References

Farr, T.G., M. Kobrick, 2000, Shuttle Radar Topography Mission produces a wealth of data, Amer. Geophys. Union Eos, v. 81, p. 583-585.

Rosen, P.A., S. Hensley, I.R. Joughin, F.K. Li, S.N. Madsen, E. Rodriguez, R.M. Goldstein, 2000, Synthetic aperture radar interferometry, Proc. IEEE, v. 88, p. 333-382.

DMATR 8350.2, Dept. of Defense World Geodetic System 1984, Its Definition and Relationship with Local Geodetic Systems, Third Edition, 4 July 1997. http://164.214.2.59/GandG/tr8350_2.html

Lemoine, F.G. et al, NASA/TP-1998-206861, The Development of the Joint NASA GSFC and NIMA Geopotential Model EGM96, NASA Goddard Space Flight Center, Greenbelt, MD 20771, U.S.A., July 1998.

Other Web sites of interest:

NASA/JPL SRTM: http://www.jpl.nasa.gov/srtm/

NIMA: http://164.214.2.59/nimahome.html

STS-99 Press Kit: http://www.shuttlepresskit.com/STS-99/index.htm

Johnson Space Center STS-99:
http://spaceflight.nasa.gov/shuttle/archives/sts-99/index.html

German Space Agency: http://www.dlr.de/srtm

Italian Space Agency: http://srtm.det.unifi.it/index.htm

U.S. Geological Survey, EROS Data Center: http://edc.usgs.gov/