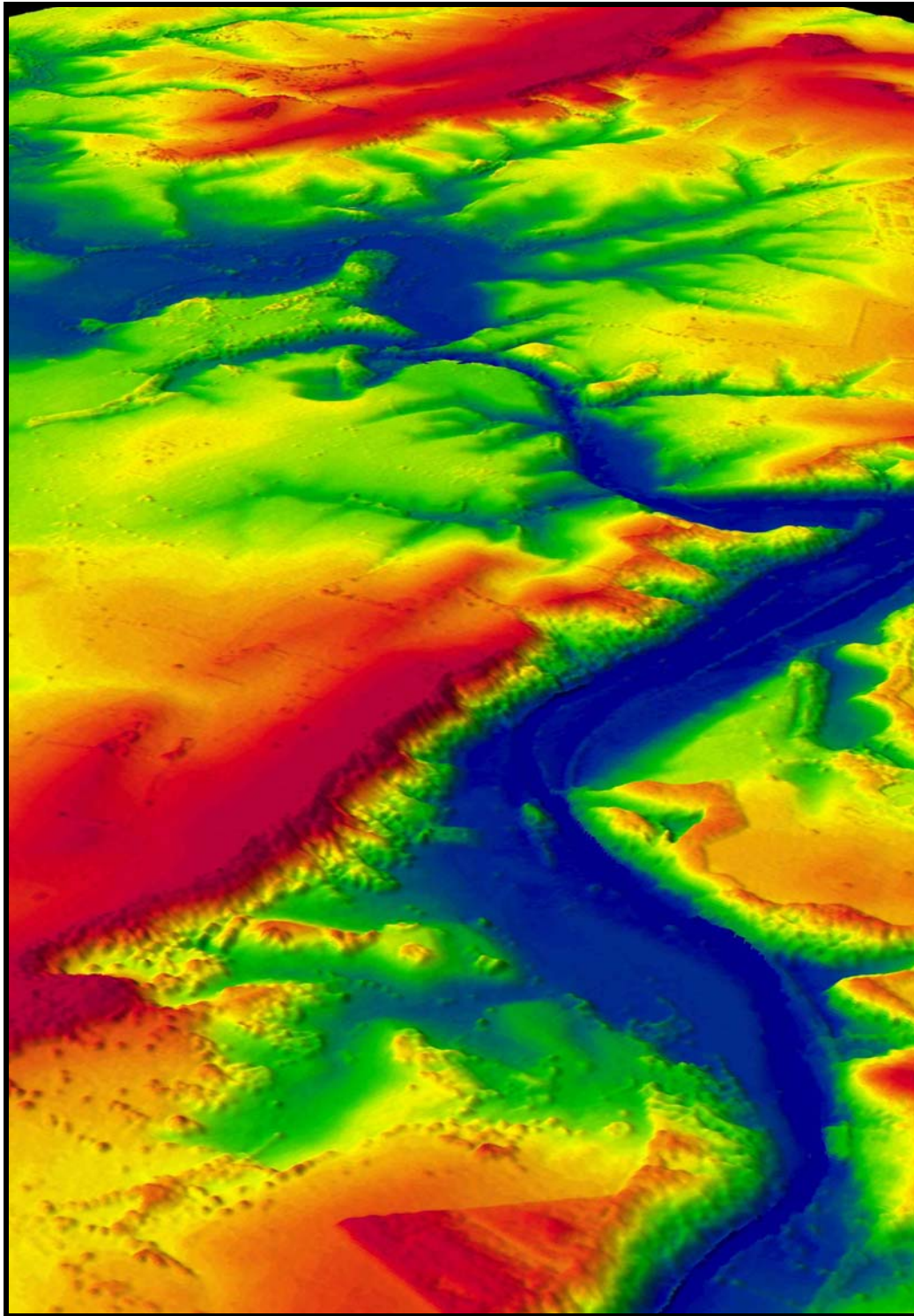


# GLOBAL Terrain Product Handbook and Quick Start Guide



Perspective view of NEXTMap Britain GT1 Digital Surface Model  
in Shaded Relief colored by elevation value.

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# Document History

<b>Date</b>	<b>Version</b>	<b>Change</b>
January 14, 2000	Version 1.0	Initial Release
February 25, 2000	Version 1.1	Includes explanations of how water data are processed, DEM holes filled, DEM accuracies are measured and how they compare with DTEDs; describes the pricing structure for partial tiles and expands the list of enhanced (non-standard) products that can be purchased.
March 28, 2000	Version 1.2	Reorganizes chapter on Enhancements and Applications; now called Value Added Products
May 29, 2000	Version 1.3	Adds reference to SCH Interim Delivery
August 1, 2000	Version 1.4	Changes the tile width transition to 56° latitude
March 9, 2001	Version 2.0	Updates GT Product Specifications (incorporate GTF and IM1 products, DT products (bald earth DTMs). Clarification of null values. Updates Value Added Products.
June 13, 2001	Version 2.1	Updates GT Product Specifications. Incorporation of GT Quick Start Guide into Appendix A.
April 19, 2002	Version 2.2	Updates GT Product Specifications with NEXTMap Britain Products
July 1, 2002	Version 2.3	Updates GT Product Specifications

## Corporate Information

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The company names and product names mentioned herein are trademarks or registered trademarks of their respective owners.

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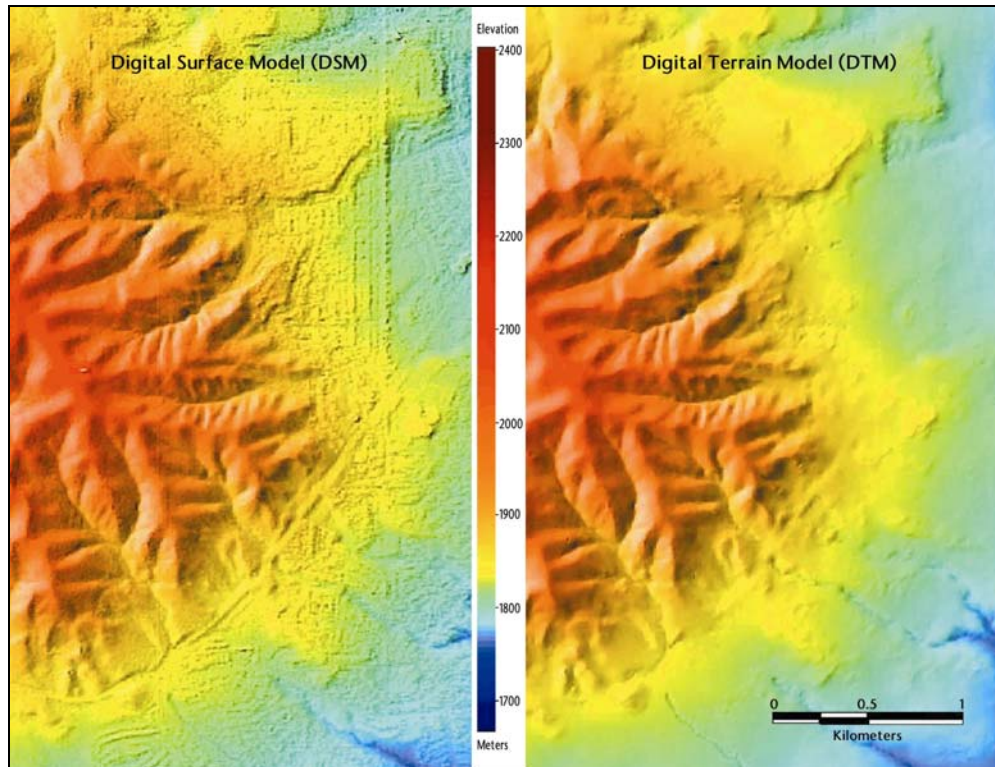


# GLOBAL Terrain Product Specifications

## Digital Elevation Models (DEM)

Intermap offers two versions of digital elevation models (DEM).

- The Digital Surface Model (DSM) is a first-surface DEM.
- The Digital Terrain Model (DTM) is a bald-earth DEM.



### Product Performance Parameters used to characterize Digital Elevation Products:

*Vertical and Horizontal Accuracy* – the degree to which information on a map or in a digital database matches true or accepted values<sup>1</sup>.

*Post Spacing* – distance between independent elevation measurements.

*Projection* – conversion of locations on the earth's surface from spherical to planar coordinates<sup>2</sup>.

*Datum* - a set of parameters and control points used to accurately define the three-dimensional shape of the earth<sup>2</sup>.

*Geoid Model* – surface of the earth's gravity field, which estimates mean sea level.

*Data Format* – file format in which data is delivered.

<sup>1</sup> <http://www.colorado.edu/geography/gcraft/notes/notes.html>

<sup>2</sup> *Understanding GIS, The ARC/INFO Method*, ESRI, Inc., 1994.

## DSM Specifications:

DSM Level	GTF	GT1	GT2	GT3
<b>Vertical Accuracy*</b>	+/- 0.50 m RMSE	+/- 1.0 m RMSE	+/- 2.0 m RMSE	+/- 3.0 m RMSE
<b>Horizontal Accuracy*</b>	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°
<b>Post Spacings</b>	5.0 meters	5.0 meters	5.0 meters	5.0 or 10.0 meters
<b>Nominal Contour Interval</b>	1 m (or 5 ft)	3 m (or 10 ft)	6 m (or 20 ft)	10 m (or 30 ft)
<b>Projection</b>	UTM	UTM	UTM	UTM
<b>Horizontal Datum</b>	WGS-84	WGS-84	WGS-84	WGS-84
<b>Vertical Datum</b>	EGM-96	EGM-96	EGM-96	EGM-96
<b>Geoid Model</b>	EGM-96	EGM-96	EGM-96	EGM-96
<b>Data Format</b>	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata
<b>Tile Size</b>	7.5 min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5 min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5 min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5 min. x 7.5 min. 15 min x 7.5 min (Alaska)
<b>File Size</b>	28mb	28mb	28mb	28mb (5m postings) or 7mb (10m postings)

The accuracy of the digital model of the ground's topography is a function of the sensor's "view of the ground." Therefore the accuracy statements above are applicable to the height of the first surface for features in the tile. The accuracy applies to the ground surface when the area has ground coverage free of continuous vegetation or free of continuous roof coverage in heavily urbanized centers.

### Accuracy Constraints

Slope (%)	Accuracy
<20	On Spec
20-30	Spec plus 30%
>30	Spec * 3

The DSM contains measurements of the first reflective surface as illuminated by the sensor. The elevation points are derived from radar energy returned to the antennae from the first surface it encounters. The surface may be that of structures such as buildings or towers, or of vegetation such as trees or crops. In the case of ‘soft’ surfaces, such as those of vegetation, the returned signals are reflected by the tree canopy itself, as well as by the branches and tree trunks within the canopy. Thus the elevation of the forested areas should not be assumed to be at the top of the canopy, but rather some level below the surface.

In mountainous terrain, there may be voids in the DEM. If the DEM contains void areas, elevation measurements from “second look” data sets are used to fill these areas. If the second look data set cannot fill the void, mathematical interpolation is used so that the final DEM is fully populated. For more information on DEM voids, see the section on Radar Artifacts.

### **Digital Terrain Model (DTM)**

The DTM has a GLOBAL Terrain code designation of DT and is the ‘bald-earth’ model that references the elevation measurements of the bare terrain. The DTM product is a result of subtracting the measurement of the height of the majority of structures and discernable vegetation from the DSM product. The Intermap DTM product is produced using TerrainFit™, Intermap’s proprietary and automated process whereby a bald-earth DTM is derived from the DSM. In areas where spatially extensive structures or forests exist, this derived surface may deviate further from the true ground elevation measurements than in areas having less surface obstructions.

### **Vertical Accuracy**

The vertical accuracy of the DTM is a function of the accuracy of the DSM source data from which it is derived. This cannot be certified in densely forested or heavily urbanized areas, or in areas where the average terrain slopes exceed 20 degrees. Therefore, the vertical accuracy of the DTM is also affected by these factors. For more detailed information on TerrainFit™, please reference the white paper [Automatic Generation of Bald Earth Digital Elevation Models from Digital Surface Models Created Using Airborne IFSAR](#) located on the Intermap website ([www.intermaptechnologies.com/intermap\\_library.htm](http://www.intermaptechnologies.com/intermap_library.htm))



The following table provides relative accuracies of the DTM with respect to that of the source DSM. The qualifications noted above apply.

<b>DSM Source Data</b>	<b>GT1</b>	<b>GT2</b>	<b>GT3</b>	
<b>DTM Specifications</b>	<b>DT1</b>	<b>DT2</b>	<b>DT3</b>	
<b>Vertical Accuracy</b>	+/- 1.0 m RMSE	+/- 1.5 m RMSE	+/- 2.5 m RMSE	+/- 4.0 m RMSE
<b>Horizontal Accuracy</b>	+/- 1.25m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°
<b>Post Spacings</b>	5.0 meters	5.0 meters	5.0 meters	5.0 or 10.0 meters
<b>Nominal Contour Interval</b>	1.5 m (or 5 ft)	4.5 m (or 15 ft)	7.5 m (or 25 ft)	12 m (or 36 ft)
<b>Projection</b>	UTM	UTM	UTM	UTM
<b>Horizontal Datum</b>	WGS-84	WGS-84	WGS-84	WGS-84
<b>Vertical Datum</b>	EGM-96	EGM-96	EGM-96	EGM-96
<b>Geoid Model</b>	EGM-96	EGM-96	EGM-96	EGM-96
<b>Data Format</b>	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata	32-bit BIL with NSDI metadata
<b>Tile Size</b>	7.5min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5min. x 7.5 min. 15 min x 7.5 min (Alaska)	7.5min. x 7.5 min. 15 min x 7.5 min (Alaska)
<b>File Size</b>	28mb	28mb	28mb	28mb (5m postings) or 7mb (10m postings)

The accuracy specification for contours produced using the DTM products can be lower than the accuracy specification produced using the DSM. Since the DTM is a derived product and contours are then derived from the DTM, the contours themselves are a second-order derived product. Given an adequate number of bare ground points measured in the original DSM, the two derived products may not suffer inordinate degradation.

## Origin

The origin of DEM products is measured from the center of the upper-left corner pixel. The measurement at each post spacing represents the value at the center of the pixel.

## **Void masks**

A file containing a “map” of the void areas is available as an optional product. These files are provided as binary masks in 8-bit BIL format having the identical ground coverage as the associated DEM.

## **Correlation files**

An optional product associated with the DEM is the radar correlation data file. The data set is co-registered with the DEM and contains data indicating the relative antennae correlation (agreement) of the relative strength of each received signal from each antenna. This data set is available as a co-registered 8-bit BIL file in strip format.

## **Void or Null values**

If a DEM has regions that contain no data (a partial tile for example), these pixels are assigned a void or null value. Intermap sets this no data flag to the value -32767, consistent with the USGS value for null data.

## **Overlap/Tile Size**

GT elevation products are created with overlap. This allows for seamless mosaics. The tile size of GT products is 7.5min x 7.5 min – consistent with the USGS 1:24,000 series maps in the US.

## Orthorectified Radar Image (ORRI)

The GLOBAL Terrain Orthorectified Radar Image (ORRI) is a radar image which has 1.25m or 2.5m ground resolution, 8-bit image depth, and is delivered in GeoTIFF format. The ORRI is the standard image product offered by GLOBAL Terrain. For all sites, both primary and secondary imagery where available will be contrast enhanced. Non-enhanced imagery is available as an optional product, for an additional cost<sup>3</sup>.

### Image Specifications:

ORRI Level	IM1	IM2
<b>Pixel Size</b>	1.25 meter	2.5 meter
<b>Horizontal Accuracy</b>	+/- 1.25 meters horizontal (1 sigma) on slopes less than 20°	+/- 2.5 meters horizontal (1 sigma) on slopes less than 20°
<b>Projection</b>	UTM	UTM
<b>Horizontal Datum</b>	WGS-84 Ellipsoid	WGS-84 Ellipsoid
<b>Image Decorrelation</b>	Less than 10%	Less than 10%
<b>Image Depth</b>	8-bit	8-bit
<b>Image Format</b>	GeoTIFF with associated NSDI metadata	GeoTIFF with associated NSDI metadata
<b>Tile Size</b>	7.5 min x 7.5 min 15 min x 7.5 min (Alaska)	7.5 min x 7.5 min 15 min x 7.5 min (Alaska)
<b>File Size</b>	128mb	32mb

#### Note:

ORRIs are subject to pixels with no recorded value in areas where no radar signal was returned. The percentage of the number of pixels without a value in the image is recorded in the metadata and Quality Control (QC) report files. In some circumstances secondary look images may be available that can provide the user with a source of image information for the areas that are missing in the primary look image. These secondary images can be produced as separate image tiles and are not merged or mosaicked with the primary images.

<sup>3</sup> ORRIs created prior to August 2000 are non-enhanced. Older existing site mosaics will be enhanced and new image tiles cut, as the production schedule allows. For all new acquisitions after August 2000, a non-enhanced image will be included in an archive folder, but will not be the delivered product.

## NEXTMap Britain Products

Intermap's first country-wide elevation data set comprises England, Wales and the southern half of Scotland, a total of 200,000 km<sup>2</sup>. The entire data set will have DSMs with 1m vertical accuracy (RMSE). Select areas will be available with a vertical accuracy of 50cm RMSE. These products may be ordered in any file format and in any customer-defined Area of Interest (AOI) – please contact Customer Service for more information.

Up-to-date status reports on the collection and processing of NEXTMap Britain can be found at [www.globalterrain.com/nextmap](http://www.globalterrain.com/nextmap).

Product	GTF DSM	GTF DTM	GT1 DSM	GT1 DTM
<b>Vertical Accuracy</b>	+/- 0.50 m RMSE	+/- 1.0 m RMSE	+/- 1.0 m RMSE	+/- 1.5 m RMSE
<b>Horizontal Accuracy</b>	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°	+/- 2.5m horizontal (1 sigma) on slopes less than 20°
<b>Post Spacings</b>	5.0 meters	5.0 meters	5.0 meters	5.0 meters
<b>Projection</b>	British National Grid (BNG)	BNG	BNG	BNG
<b>Horizontal Datum</b>	BNG	BNG	BNG	BNG
<b>Vertical Datum</b>	Newly	Newly	Newly	Newly
<b>Data Format</b>	Arc GRID	Arc GRID	Arc GRID	Arc GRID



# Properties of both DEMs and ORRIs

## Coverage

GLOBAL Terrain offers an array of standard products. Products begin with a prefix that designates the type of product. The prefix DT designates a Bald Earth Digital Terrain Model (DTM). The prefix GT designates a First Surface Digital Elevation Model (DSM). The Prefix IM designates an Orthorectified Radar Image (ORRI). The prefix GI indicates both the ORRI and the DEM. The number following the prefix indicates the maximum root mean square error (RMSE) in meters inherent in the vertical data. For example, GT2 denotes a DEM product with an absolute height error of 2 meters RMSE, or less. (GTF represents a vertical RMSE of 0.50 m).

Please visit the GLOBAL Terrain Store at <http://www.globalterrain.com/> for current product availability and pricing.

## File Naming

The file naming convention for GT products describes the type of product and its location. This convention is based on a 1° x 1° block of tiles. At less than 56° latitude, the blocks are composed of 64 tiles each with an area defined by 7.5 minutes of longitude and 7.5 minutes of latitude – similar to the USGS 1:24,000 quad. At more than 56° latitude, the angular width of a tile doubles to 15 minutes to compensate for the convergence of lines of longitude as they approach the poles.

In the file name the tiles are identified first by the product designation prefix, followed by the degree of latitude and longitude of the lower right hand corner of the block. Then they are identified by row (letter, increasing north) and column (number, increasing west).

For example, tile **GT2N32W117G3v1**:

Product Type:	<b>GT</b> is a First Surface Digital Elevation Model.
Product Level:	<b>2</b> is a Level 2 product (2m vertical accuracy).
Geographic Loc.:	<b>N32W117</b> are the geographic coordinates for the lower right corner of the block that encompasses this tile.
Tile:	<b>G3</b> is the row and column of the actual tile.
Version:	<b>v1</b> is version 1, the first final product for this location.



## File Formats

Digital elevation products are delivered in 32-bit generic binary Band Interleaved by Line (bil) file format. The georeferencing information and image dimensions are contained in an accompanying metadata file. This is the standard file format for GT DEM products (other file formats are available, please consult Customer Service for more information). This generic file is easily ingested into the majority of image processing, GIS and visualization software packages. For step-by-step instructions on importing the data into a specific software package, please consult the GLOBAL Terrain Quick Start Guide located in Appendix A of this Handbook.

Orthorectified radar image products are delivered in 8-bit GeoTIFF format. The image dimensions and georeferencing information are contained in the accompanying header. This is the standard file format for GT ORRI products.

## Metadata

A metadata file describes, in a highly structured form, key elements of the associated data file. The metadata file is National Spatial Data Infrastructure (NSDI) compliant ([www.fgdc.gov](http://www.fgdc.gov)) and is provided in HTML, XML and text formats. See Appendix A for a sample Metadata File.

## Delivery Media

Data sets are delivered on ISO 9660 standard CD-ROM media. 8mm tape or DLT tape media are available upon request, for an additional price. Analog plots (prints) are not included as a standard deliverable. Plots and photographic products can be purchased through services offered by Intermap.

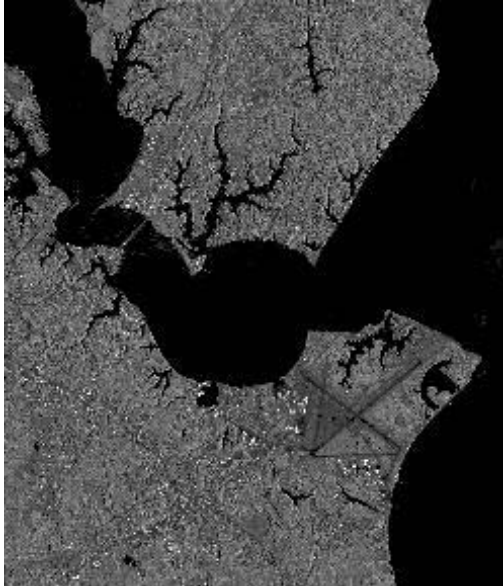
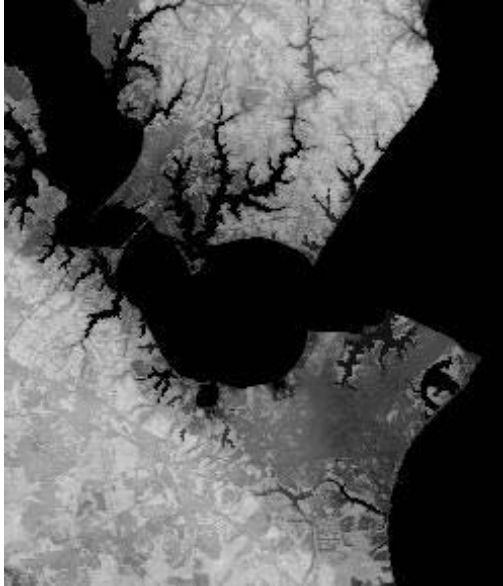
## Tile Folders

Tile data is packaged in folder format. The name of the folder is the name of the tile. For example tile N58W134C2 would be packaged in a folder named N58W134C2. The following files are included in each folder:

- **dsm2v1.bil** – Digital Surface Model (DSM) 32-bit generic binary bil file.
- **DSM2THNV1** – DSM thumbnails in JPEG and GeoTIFF format.
- **dsm2v1** - NSDI compliant DSM Metadata in HTML, XML and text file formats
- **dtm2v1.bil** – Digital Terrain Model (DTM) 32-bit generic binary bil file.
- **DTM2THNV1** - DTM thumbnails in JPEG and GeoTIFF format.
- **dtm2v1** - NSDI compliant DTM Metadata in HTML, XML and text file formats
- **orripv1.tif** - ORRI 8-bit GeoTIFF
- **ORRIPTHNV1** - ORRI thumbnails in JPEG and GeoTIFF format
- **orripv1** - NSDI compliant ORRI Metadata in HTML, XML and text file formats.
- **qcv1.pdf** - QC report in Adobe PDF format

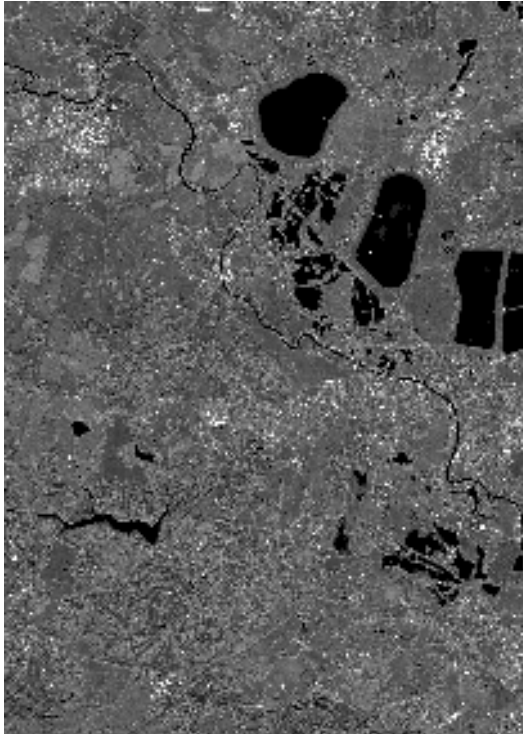
# Thumbnails

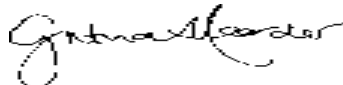
DEM grayscale with 50m post spacing in GeoTIFF and JPEG formats are included in the tile folders. ORRI thumbnails are also included in the tile folders. These are enhanced images derived from a 50m pixel. These will have no associated accuracy statements. These products provide quicklook support and are keyed to locational database inquiries.

Orthorectified Radar Image (ORRI) thumbnail	Digital Elevation Model (DEM) thumbnail
	

# QC Report

This is the final report available in Adobe Portable Document Format (PDF)<sup>TM</sup>. This report contains both systematic and ancillary information about the final ORRI and DEM products. It contains a thumbnail image with operator comments about both the elevation and image data for a particular tile associated with a specific geographic location. QC reports are included in the tile folder.



<b>Tile</b>	<b>GT2N51W000D5V1</b>	
<b>Area</b>	<b>Thames River</b>	
Quality point	Comment	Checked by
Seams	None	MM
Missing DEM	None	MM
Motion	None	MM
Corvec	None	MM
%Shadow	Less than 1	MM
%Decorrelation	Less than 1	MM
Phase Unwrap	None	MM
Other		
This data has been checked and approved for delivery		
		
Date	08-02-00	

Parameters and Coordinates			
Projection	UTM	UTM Easting (meters)	
Central scale	0.9996	Min	Max
UTM Zone	30	664,329.5	674,487.0
Central Meridian	3 degrees West	UTM Northing (meters)	
False Easting (meters)	500,000	5,694,163.5	5,708,441.0
False Northing (meters)	0		

## Pricing

GLOBAL Terrain products are sold on a per tile basis with an end user license (License Options are described on page 18). NEXTMap Britain products can be ordered with a custom Area of Interest (AOI). Full terms, including specific pricing for geographic regions, can be found at [www.globalterrain.com](http://www.globalterrain.com) and for NEXTMap Britain products at <http://www.globalterrain.com/nextmap>.

## Partial Tile Pricing

Where a tile contains water or is incomplete (a partial tile), the following pricing structure applies:

- 100% water tiles are available free of charge with a minimum order of 2 tiles.
- 0% - 10% land-covered tiles are available free of charge with a minimum order of 2 tiles.
- 11% - 25% land-covered tiles are priced at 25% of the full tile value.
- 26% - 75% land-covered tiles are priced at 50% of the full tile value.
- 76% - 95% land-covered tiles are priced at 75% of the full tile value.
- 96% - 100% land-covered tiles are priced at 100% of the full tile value.

The GLOBAL Terrain website provides an assessment of water coverage and computes the associated price.

## Volume Terms and Pricing

- Tiles 1-15 priced at 100% of full price.
  - Tiles 16-30 priced at 50% of tile price.
- Tiles 31 and beyond priced at 30% of tile price.

# Licensing

GLOBAL Terrain (GT) products are provided to the user under the terms of one of several limited, non-transferable, non-exclusive license agreements.

- End User License Agreement (EULA) – permits the license holder to use the map products internally.
- Value Added License Agreement (VARLA) – permits the license holder to use the map products to develop and sell value added products to a third party market.
- Academic User License Agreement (AULA) – permits the license holder to use the map products for academic purposes.
- Demo User License Agreement (DULA) – permits the license holder to evaluate, demonstrate, market, and promote the map products.

The terms and conditions of these agreements are available on the GLOBAL Terrain website: [www.globalterrain.com](http://www.globalterrain.com).



## Software Interoperability

GLOBAL Terrain products are designed to work with a wide variety of software applications. DEM data are delivered as 32-bit generic binary files with associated National Spatial Data Infrastructure (NSDI) compliant metadata, and ORRI data are delivered as 8-bit GeoTIFF files with associated NSDI compliant metadata. These generic file formats allow GT elevation products to be easily imported into the major GIS, visualization and image processing packages. Header information (such as number of rows, columns, xy locations, etc.) taken from the GT metadata and input into the software package enables easy ingestion of the GT data products.

GT elevation products are easily imported into the following software packages:

**GIS:** ESRI ArcInfo and ArcView, MapInfo

**Visualization:** Skyline, ESRI 3D Analyst, 3D Nature, PCI Fly!, ERDAS Virtual GIS and Stereo Analyst, Vertical Mapper

**Image Processing:** ERDAS Imagine, ENVI, ER Mapper, PCI ImageWorks, Earth

- For step-by-step instructions on how to import GT products into these packages, please refer to the ***GLOBAL Terrain Quick Start Guide*** located in Appendix A of this document.

# Accuracy

## DEMS

The accuracy of a DEM data set is characterized by the root mean square error (RMSE) of the vertical observations. RMSE takes into account both random and systematic errors. First determined are the differences between a set of known (true) elevations and the measured values at those same locations. The RMSE is the square root of the mean square of these differences. With some qualifications, the RMSE can be related to the probability that any particular data sample lies within specific error bounds. For example, if the RMSE is 1 meter, it implies (for small biases at least) that 67% of the samples should lie within 1 meter of the true values, or that 90% of the samples should lie within +/- 3.3 meters of truth.

The GT product nomenclature includes the DEM's nominal vertical accuracy. For example, GT2 products reference a nominal vertical error of +/- 2 meters RMSE.

The three dimensional detail that can be represented by a DEM depends on the horizontal sample spacing or posting as well as the vertical accuracy. Terrain features that vary more rapidly than the grid spacing will not be apparent in the DEM and vice versa. The DEM's nominal horizontal accuracy is expressed in the same terms as its vertical accuracy. For example, a GT2 product carries a nominal horizontal error of +/- 3 meters RMSE or less. A complete list of horizontal and vertical accuracies available for GT products is located in the table beginning on page 8. In each case a minimum of 95% of the observations will fall within three times the stated RMSE error.

Accuracies indicated above are in relation to the first reflective surface, or to ground not obscured by vegetation cover. In checking elevations taken from the model, any vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal tolerance. GCPs used for data validation must be located such that they do not fall in areas of radar shadow or immediately adjacent to structures or trees.

Vegetation represents a special case in terms of vertical accuracy of the DSM. Depending on the type and density of the canopy, the radar phase may become corrupted due to volume scatter so that the calculated height is misplaced within the canopy. The extent of the misplacement cannot be accurately predicted or quantified.

The accuracy of the GT DEMs has been verified by empirical studies conducted by independent agencies<sup>4</sup>. The validation exercises have been undertaken by comparing the GT DEM to surveyed GCPs and to photogrammetrically-derived DEMs. In both cases, the comparisons were made over hundreds of observations in varying types of

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<sup>4</sup> Please see the paper *Summary of Independent Evaluations of STAR-3i DEMs* by J. Bryan Mercer at the following site: [http://www.intermaptechnologies.com/intermap\\_library.htm](http://www.intermaptechnologies.com/intermap_library.htm)

terrain. The photogrammetrically derived DEMs were compiled from 1:20,000 scale aerial photography. The GCPs were surveyed using DGPS techniques. The GT DEMs are exposed to a rigorous quality control process in which obvious anomalies in the surface are removed. The surface is edited and interpolated over such areas and over areas of radar shadow.

The orthorectified image product has a nominal horizontal accuracy expressed as a root mean square error (RMSE). The nominal horizontal error within the imagery is identical to the horizontal error inherent in the DEM. For example, an IM2 orthorectified image carries a nominal horizontal error of less than +/- 2.5 meters RMSE, while an IM1 ORRI carries a nominal horizontal error of less than +/- 1.25 meters RMSE.

## Independent Validation and Verification

The accuracies of our GT DEM products have been independently validated and verified. The table below lists these test reports by date – copies are available upon request<sup>5</sup>.

Acq'n Date	Report Date	Test Region	Terrain Type	Flight Alt.(AGL)	DEM Spacing	Size of Test Area (kmxKm)	Author	Truth	No. of Pts.	$\sigma$ (m)	Mean Offset (m)	RMSE (m)
Sept,'95	Dec,'96	Cholame Hills	Mixed <sup>1</sup>	39,000'	5m	10 x 16	TEC <sup>2,5</sup>	Photo DEM	6M	1.7	-1.4	2.2
Sept,'95	Dec,'96	Camp Roberts	Mixed	39,000'	5m	16 x 10	TEC	Photo DEM	6M	1.5	-1.4	2.1
Sept,'97	May '98	Freiburg	Mixed	20,000'	2.5m	8 x 18	INS <sup>3</sup>	GPS	44	0.9	-1.3	1.6
			Flat	20,000'	2.5m	9 x 18	INS	GPS	20	0.7	-1.1	1.3
			Sloped	20,000'	2.5m	7 x 20	INS	GPS	24	1.0	-1.4	1.7
			Flat	20,000'	2.5m	8 x 20	INS	Trig Pts	78	1.3	-0.9	1.5
Dec'97	June '98	Walnut Gulch	Mountains	24,000'	10m	2.9 x 1.3	NASA <sup>4</sup>	Photo DEM	40K	0.8	0.2	0.8
<b>Notes:</b>												
1	Mixed terrain refers to a mixture of flat and moderately sloped terrain, with slopes up to +/- 35 degrees											
2	TEC is the US Army Topographic Engineering Center - Ray Norvelle was report author. A separate report on this data set was written by Carling and Davis, with similar results											
3	INS is the Institute of Navigation at the University of Stuttgart, Germany - A. Kleusberg and H.G. Klaedtke were authors											
4	NASA Stennis Space Center did the evaluation. Ground truth DEM supplied by USDA-ARS for the San Pedro Watershed Sub-Basin 11											
5	Norvelles' report was very detailed and in it he noted a number of anomalies in certain situations (ravines, slopes, trees)											

<sup>5</sup> Please see the paper *Summary of Independent Evaluations of STAR-3i DEMs* by J. Bryan Mercer at the following site: [http://www.intermaptechnologies.com/HTML/research\\_papers.htm](http://www.intermaptechnologies.com/HTML/research_papers.htm)

## Datums and Projections

A datum is a standard model used for referencing locations on the earth. Datums are designed to enable easy calculations of locations and therefore only approximate reality. Nonetheless, as they are fully defined, they provide accuracy and reproducibility of measurement. Most horizontal datums represent the earth as an ellipsoid surface (though some are spherical) and are defined by their center, orientation, and major and minor axes. Vertical datums are based on leveling, tidal and gravity measurements and are very poorly defined. All systems map coordinates into the ellipsoidal datum and then apply a vertical datum adjustment so measurements represent height above mean sea level.

A projection is a systematic representation of a three dimensional object onto a two dimensional surface. There are many different map projections in use today to represent all or parts of the earth.

GLOBAL Terrain DEM and ORRI data are referenced to the World Geodetic System 1984 (WGS 84) horizontal and vertical datums based on the Earth Gravitational Model 1996 (EGM96) geoid. The horizontal coordinates are cast on the Universal Transverse Mercator (UTM) projection. The elevation data are provided in orthometric heights (that is, heights are above mean sea level) through the application of the EGM96 vertical datum. This is described in detail below.

### EGM96 and WGS84

During airborne data collection, Intermap uses GPS as its baseline for determining coordinates of points on the earth's surface. GPS is used as a standard with the WGS84 datum, which provides latitude, longitude and height reference in a standard ellipsoid datum fully defined by the ellipsoid's center, and major and minor axes.

This WGS84 ellipsoidal datum approximates the shape of the earth on a global scale. However, the earth is not a perfect ellipsoid, but has been described as a lumpy pear or potato. This shape is inferred by measuring how the gravity field varies in height from the earth's center of mass for some constant gravitational force (equipotential surface). There have been numerous efforts to measure this surface using ground, airborne and satellite detectors. It is colloquially referred to as mean sea level (MSL) and defines the potato shape described above.

This surface is also called a geoid and is the proper vertical datum to reference for orthometric heights. As a standard, Intermap references all GT data to the EGM96 geoid model. In the US it is very common to use the NGS models. However, these are US-based models. EGM96 provides a worldwide geoid model. Because Intermap engages in mapping projects around the world, this model has been chosen

as the standard. Thus the orthometric heights provided will contain any errors present in this model.

The EGM96 model contributes less than 0.5 RMSE in areas where accurate gravity data are available for input in the model calculation. However, in regions of the world that lack measurement data, which includes most of the third world countries, the model could induce as much as 1 to 2 m RMSE contribution. It is important to note that the geoid model by definition is a very low frequency. The EGM96 model is only defined for gravity anomalies that are at a scale of 100km and over. Any gravity anomalies that could affect the orthometric height that are smaller than 100km will not be reflected in the model. Intermap can provide airborne gravity data coincidentally with the DEM information. These measurements can be used to densify the standard models to the 10km level. This can be crucial for high accuracy surveys in regions with poor measurement data.

For more information on this model, developed jointly by NASA, NIMA and the Ohio State University, go to <http://cddisa.gsfc.nasa.gov/926/egm96/egm96.html>

Information about WGS84 can be found at the NIMA homepage, <http://164.214.2.59/GandG/wgs-84/ga.html>

The DEM and image data can be referenced to other datums and projections on request through the customization services offered by Intermap Technologies. Please contact Customer Service for more information.

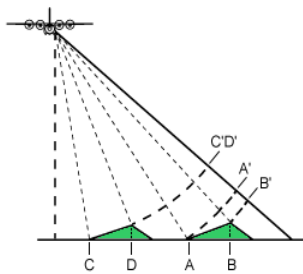


## Radar Artifacts

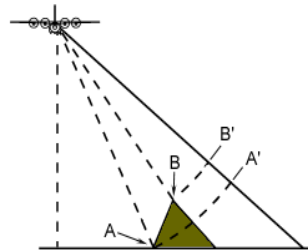
The SAR sensors, and the interferometric process in the case of STAR-3*i*, result in certain geometric and radiometric attributes unique to DEMs and imagery derived from radar. An appreciation of these attributes is essential to the interpretation of the data. The most important influences on the radar-derived imagery and DEMs are foreshortening, layover, shadow, noise, decorrelation and interpolation effects. Each of these phenomena contributes “artifacts” in certain circumstances. Many of these artifacts are removed from the GT data sets through the quality control and editing processes. The editing process has been designed to remove obvious anomalies from the data without filtering. The objective is to preserve as much of the original data content as possible.

### Foreshortening and Layover

Foreshortening is spatial distortion in which terrain slopes facing a side-looking radar’s illumination swath are mapped as having reduced range extent. Layover is an extreme form of foreshortening in which the top of a reflecting object (e.g. mountain) is closer to the radar (in slant range) than the lower part of the object. The image of such a feature appears to have fallen over towards the radar. This effect can be seen in orthorectified imagery in mountainous areas and in areas of tall buildings. The artifact manifests itself as “smears” or “stretching” of the imagery immediately in front (i.e. towards the radar) of very tall objects.



Foreshortening

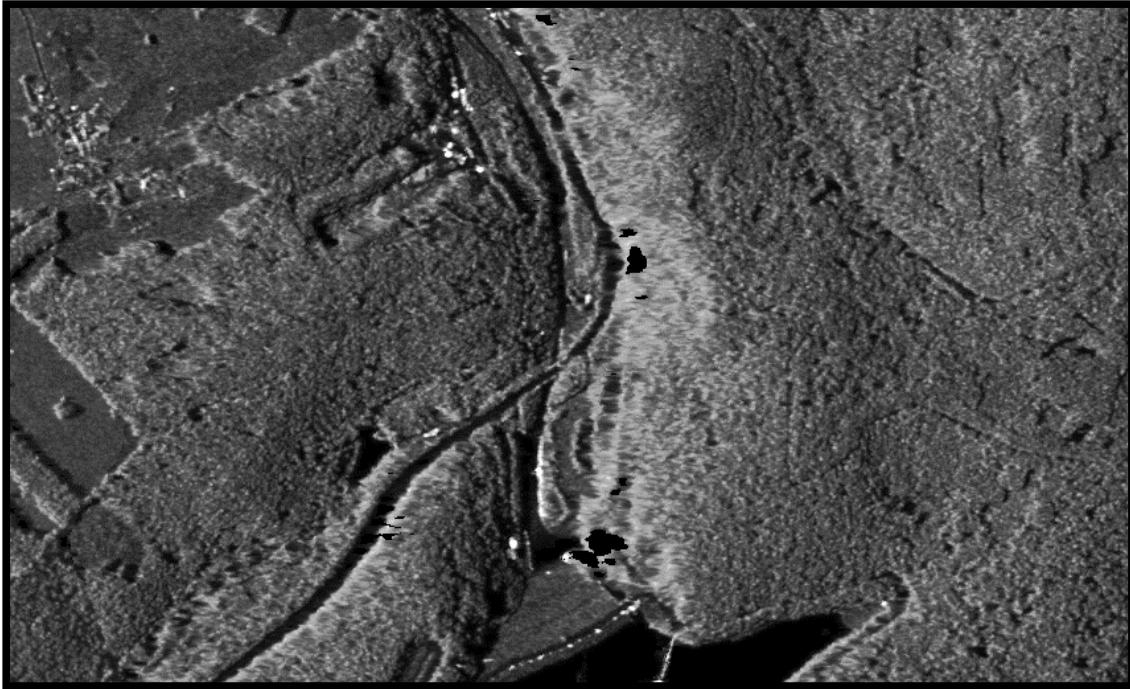


Layover

The left hand side above illustrates foreshortening. When all of the points have been projected onto the same distance plane (represented as A', B', etc), it becomes clear that C and D are the same distance from the aircraft. A is still in front of B but not by an amount that truly represents their relative positions. The points on the right hand side of the figure are also projected and here the effect is even more exaggerated. A is actually closer to the aircraft when measuring along the ground plane. But when projected onto the same (time) line, B is closer than A because of

its height. Therefore the radar signal from B is recorded before the signal from A, and no information can be discerned from the points in between them.

The effects of terrain foreshortening are largely removed from the DEM. Elevation data are interpolated across areas of layover. In areas of tall buildings the layover can result in displacement of the building height as represented in the DEM. The displacement is towards the radar from its true position and is dependent upon the height of the building and the position of the building within the strip.



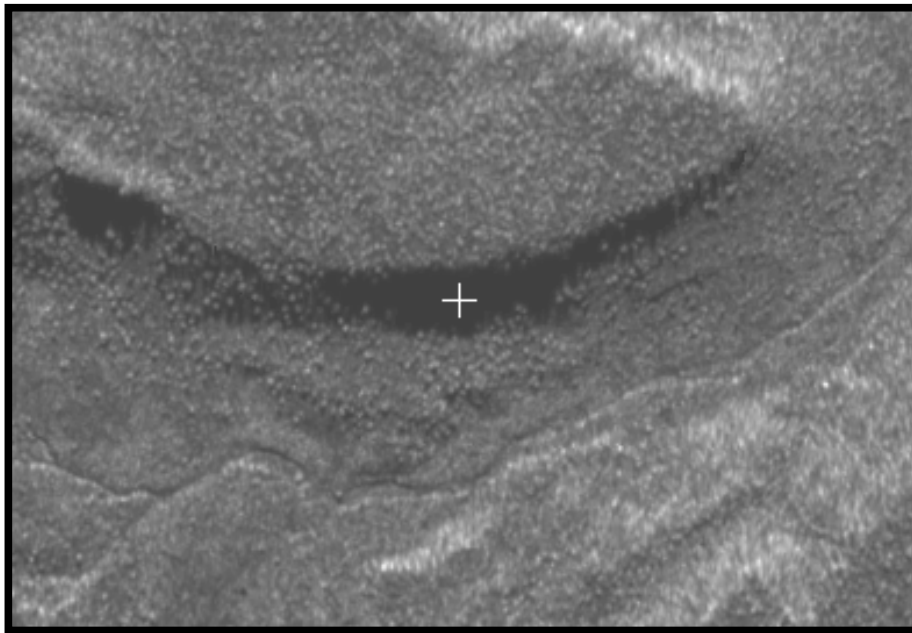
Stretching of imagery in area of layover

## Shadow

Radar shadow occurs in regions that are not illuminated by the radar as a result of blockage by intervening features. Such areas have no reflectivity and appear as very low or zero intensity values - black on the image. The radar shadow is an important image component that facilitates feature interpretation.

The effects of radar shadow are largely removed from the DEM. Elevation data are interpolated across areas of shadow. In areas of shadow, the raw DEM will sometimes exhibit an artificial depression or an artificial height as the processor attempts to follow a trend in the surface. These effects are largely removed in the editing process.

In some circumstances the radar data are collected from two different look directions. When dual look data are available, and where the DEMs exhibit anomalies, the DEMs are derived utilizing height data from the second look direction. Image data from different look directions are seldom combined. Imagery combined from different look directions would be very difficult to interpret.



Radar Shadow

## Noise

There is a certain amount of high frequency variation in both the image and the height data sets.

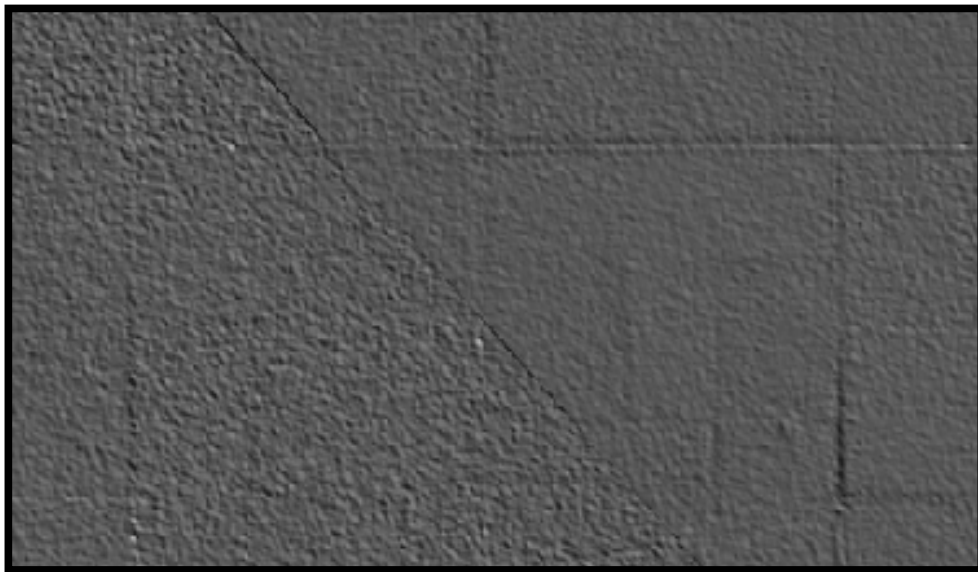
### Image

The high frequency variation in the image data is coherent imaging noise termed speckle. The speckle is fully random in the STAR-3*i* system; it is not range dependent.

### DEM

The high frequency variation in the DEM data is a product of the signal-to-noise ratio which decreases from the near to far range across the track. Therefore, the noise increases with the distance from the antenna. The difference in the noise between the near and far range of the strip can sometimes be seen at the seam where DEMs from two strips are mosaicked together.

The noise is not filtered from the data sets as it represents “texture” which can be useful in data analysis.



Near range / Far range mosaic seam in DEM



## Radiometric Properties

The image (magnitude) data are characterized by a clustering of intensity values at the low end of the gray scale. Typically the image is comprised of intensity values between zero and one hundred twenty. There are fewer than 5% of the observations above 120, although valid data do occur beyond the typical 8-bit image range.

The imagery is delivered in enhanced form, with the un-enhanced image available as an optional product.



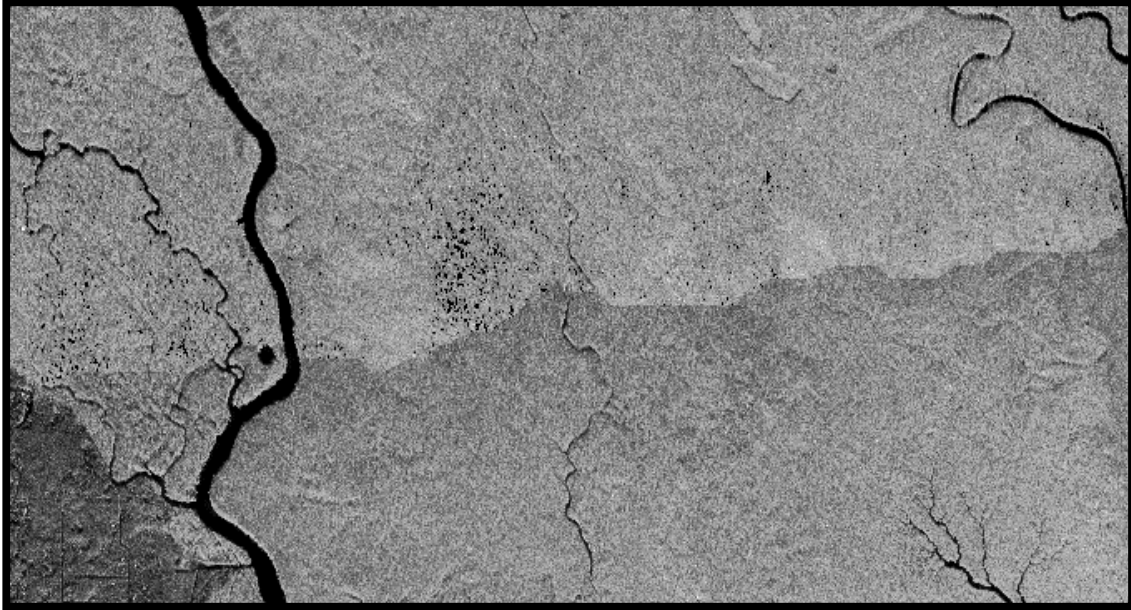
Enhanced IM2 image.



Un-enhanced IM2 image.

There is a gradual “fall off” of intensity from the near to the far range across track (perpendicular to the flight line). The across track difference in radiometry can sometimes be detected at mosaic seam lines. When the flight lines are oriented in a cardinal direction the “fall off” is mitigated by signal processing. When the flight lines are not in a cardinal direction the across track difference in radiometry can be more pronounced.





Near range / far range mosaic seam in IM2 image.

Note that this is an extreme case and not the normal result of mosaicking “off cardinal” strips.

## De-correlation

The interferometric process is dependent upon the simultaneous acquisition of two images from slightly different perspectives. These image sets are then interfered by a digital correlation process to extract height data. This process assumes the difference in measurement is due to the height/perspective change. However, this measurement can be corrupted for many reasons including:

- target motion
- foreshortening/layover
- poor signal-to-noise ratio
- target saturation

In these cases, the target is said to be de-correlated and no height values are available.

De-correlation “features” are small areas of null values that appear as black holes in the data. The effects of de-correlation are largely removed from the DEM during interpolation and editing processes.

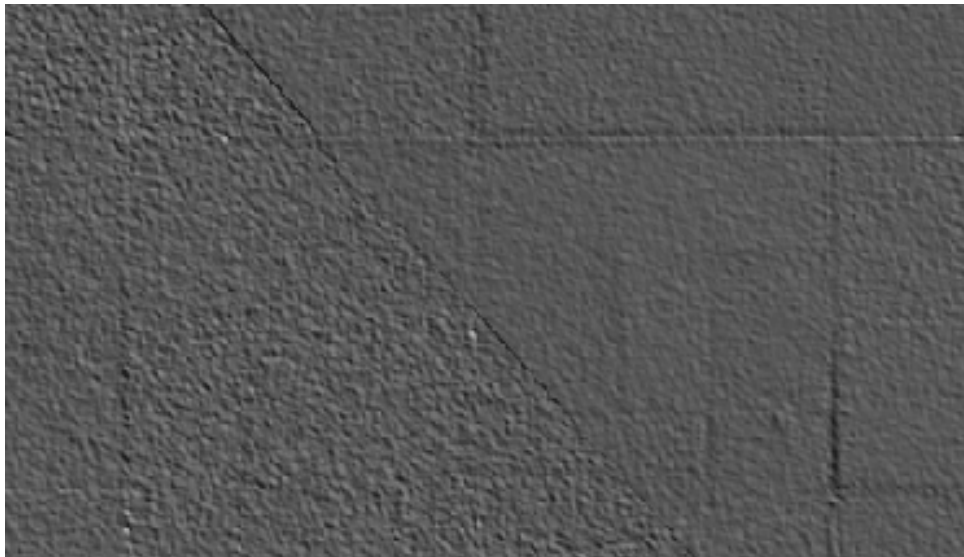
In the figure below, targets that are saturated appear as white regions. The radar scales its responsiveness to cope with this saturation and consequently loses data to de-correlation (black regions to the left of the white areas).

Area of decorrelation in IM2 image (black areas).



## DEM Mosaic Seams

The DEM tiles are constructed from strip-to-strip mosaics. The strips and the associated seam lines can be many kilometers in length. There can be very slight “twisting” and “tilting” of these strips along their length. These twists and tilts can manifest themselves as minor “steps” along the seam lines. These steps are typically 20 cm to 50 cm in magnitude, well within the product specification. The DEMs are created by merging the data from overlapping strips. The strip-to-strip steps are more apparent in areas of flat, uniform terrain, or in areas of tree cover. The seams are carefully checked to ensure that there are no feature offsets across seam lines that exceed the horizontal error budget.



Strip-to-strip seam in GT2 DEM.

The seam is along the diagonal line. The other lines are berms and field boundaries.

## Phase Unwrapping

The elevation information is derived from the difference in phase between two separate microwave returns. Because the magnitude of this phase difference can only be measured between 0 and  $2\pi$ , there is an inherent phase ambiguity since, for example, a given difference of  $\pi$  could well be  $2\pi$ , or  $4\pi$ , etc. This ambiguity is resolved through the use of a phase unwrapping technique.

The phase unwrapping process encounters difficulty when the strength of the radar signal falls below a certain threshold. This problem can occur with targets such as smooth water, or in areas of shadow. In these cases the process has difficulty separating the signal from the noise. If the processor cannot determine whether to begin unwrapping the phase using  $\pi$ ,  $2\pi$ , etc., it cannot complete the process and no elevation information is derived. When no elevation information is derived for an area, the corresponding image is not formed. The result can be minor irregularities in shorelines or shadow edges where land areas appear to be truncated. In rare and extreme situations small islands have not been acquired.



Shoreline truncated by inability to unwrap phase history data.

## Calibration and Aircraft Motion

The Intermap data collection systems are very accurately calibrated to control the constant differential phase error between the two antennae. The calibration results in data that are within specification; however, on flat terrain very low-level artifacts may be present from un-compensated differential phase errors. Very small periodic DEM “ripples” in the range dimension can occur at a consistent location in range and are continuous along the strip.

The orientation of the antennae pair is adjusted to compensate for aircraft attitude relative to the flight line. When aircraft motion exceeds the limits modeled within the processing algorithms, along track (azimuth) “ripples” can appear in the DEM data. These errors are predicted utilizing precise aircraft motion measurements. Where the ripples are predicted to exceed allowable limits, the strip is re-flown. The number of ripple events is carefully controlled during the data acquisition process.

The DEM ripples in both azimuth and range are small artifacts, typically in the order of 20 cm to 30 cm in height. The ripples are evident only in areas of flat, uniform terrain and are well within the product specification.

## Water Values

Radar pulses do not reflect well off bodies of water, which makes it difficult to collect elevation data from these features. Intermap approaches this difficulty in several ways:

1. The elevations of lakes greater than 400m wide are calculated by taking good values around the shore and then setting the lake values to lower than this boundary.
2. Rivers wider than 40m over an extended distance are progressively leveled and stepped with the corresponding shoreline. For an inland waterway, the process starts at the estuary with a value of 0 – this corresponds to sea level.
3. Small lakes and other water bodies are leveled if they are out of spec or contain spikes.
4. If a coastline is lower than the adjacent ocean or sea, the elevation of the coast will be negative and will be feathered up to 0 (sea level).
5. In regions where there are extreme tides, elevations can be one to two meters different than what they would be if measured from sea level.

## Geoid Issues

The geoid can be thought of as the surface of the earth that is defined by average sea level, or where sea level would be if there were no landmasses. (More



precisely, it is defined as a surface of equal gravitational potential that corresponds to average sea level). Elevations of landmasses can be measured in relation to the geoid, which is set to 0.

In underdeveloped regions far from coastal areas, it is possible that the geoid has not been well determined, resulting in elevation measurements that are not as accurate as they would otherwise be. Intermap can provide a value added product to overcome this difficulty to some extent. If the geoid is underdetermined for a particular tile, it is noted on the QC report for that tile.

More information about gravity products, including a technical paper, can be found at [www.intermaptechnologies.com](http://www.intermaptechnologies.com). For more information on the current gravitational potential model that is used by Intermap go to <http://cddisa.gsfc.nasa.gov/926/egm96/egm96.html>.



## Value Added Products

Intermap offers the following classes of value added products to the standard GLOBAL Terrain offerings:

1. Enhanced DEMs
2. Un-enhanced ORRIs
3. Strip-based products
4. Map-based products
5. Photogrammetrically-derived DEM
6. Cartographically-enhanced contours
7. STARplus Products

These are described in more detail below. Prices vary according to the level of effort required to complete the work. If you require a value added product not mentioned here, contact Intermap for more information.

### 1. Enhanced DEMs

Intermap does a first order edit on GT DEMs and offers several other procedures to further enhance their usefulness, including:

- Aerial photography, to more clearly define urban areas, and to facilitate such applications as RF propagation modeling
- Orthorectification enhancement, using gravity data (where available) to compensate for regions where the standard geoid models are not well defined.
- Cartographic editing, to compile breaklines and other features.

### 2. Un-enhanced ORRIs

Intermap offers un-enhanced orthorectified radar imagery as an optional product. The enhanced ORRI is the standard deliverable.

### 3. Strip-based Products

Intermap can deliver an intermediate product referred to as an SCH Interim Delivery. SCH data are produced in strip form (called segments) during the interferometric processing stage. They include:

- Mag File – measurements of the magnitude of the reflected radar signal.
- Cor File – data that correlates the radar signal received at each of the antennae on the aircraft.
- DTE File – digital terrain elevations, derived from phase differences of the reflected signal.
- HDR (header) File – a text file that contains information about file size and dimension.

- PAR (parameter) File – a text file that contains information about radar geometry and motion compensation.
- Void Mask – binary mask containing map of the void area in 8-bit BIL format having the identical ground coverage as the associated DEM.

The digital data are delivered on 8mm tape or DLT because of the large file size. A printout that lists the files on tape is included.

### **Not included in an SCH Interim Delivery**

An SCH Interim Delivery does not include geoid corrections. Instead, segments are referenced to their own spherical datum. The segments are projected in SCH datum as opposed to a more common projection system such as WGS84.

Note: Final Product Quality Control Processes are not run against SCH files. The only quality checks completed are:

- Visual check to ensure complete segment information.
- Comparison of elevation points in overlap areas.

### **Known Discrepancies**

In some deliveries, the file size as reported in the header does not directly correspond to the actual file size of the data. The reason for this has to do with the way segments are formed.

Occasionally, certain characteristics in terrain will cause a discontinuity in the formation process. This can happen in areas where water meets land and causes islands to be overlooked or shorelines to appear unnaturally straight. When areas are found that have missing data, the segment is started at the spot just prior to the problem. Typically the spot is well into the segment. When the new segment is run, it is given a “B” name with the original segment renamed to “A”. Most times, the “B” segment is very short and is only needed to fill in the small area of question. It is during this formation of the “B” segment that the discrepancy of file size happens. Most of the time, it is the DTE that is affected. On rare occasions, the COR file can be affected as well. The process tends to truncate the last few lines of the “B” segment. For example, the header file could read 778 lines of data while the DTE file may only have 776 lines. The MAG and COR files remain consistent with the number of lines indicated in the header.

The missing few lines are compensated for as there is always ample overlap when one compares the coverage of the “B” segment with the “A” segment. This very small discrepancy does not impact the rest of the process as the segments are then combined to create mapsheets – the final delivery.

## 4. Map-based Products

Several map based products are available that build on the standard GT tiles.

These include:

- Mosaicked cor files to assist in void location
- TLMs – topographic line maps which are derived from ORRIs and DEMs for a particular region (described below)
- Tiles can be transformed to other projection systems using other horizontal and vertical datums.
- Hard-copy plots of DEMs or ORRIs

### Topographic Line Maps

A topographic line map (TLM) is constructed from ORRIs and DEMs for a region and contains information about:

- Contours and spot elevations
- Hydrography
- Land cover classification
- Cultural features such as roads, buildings and harbors.

## 5. Photogrammetrically Derived DEMs

Intermap offers photogrammetric services in its Ottawa office. Please contact customer service for more information on this option.

## 6. Cartographically enhanced contours

Intermap can produce contours from the DEM data. Please contact customer service for more information on this option.

## 7. STARPlus Products

Intermap has developed an image product that fuses Landsat 7 imagery with IM1 or IM2 Orthorectified Radar Imagery. The resulting STARPlus product retains the accuracy and resolution of the ORRI while adding color enhancements from the Landsat 7 image. Please contact customer service for more information on this product.

## Quality Control and Data Editing

The GLOBAL Terrain DEM data sets are carefully reviewed for anomalies. Where these anomalies render the data out of specification or produce serious imperfections in the DEM, the data are manually edited.

Spikes and depressions out of specification are edited. Spikes are checked against the image data to ensure that they do not represent towers or isolated structures, which will not be removed. Rivers and canals are leveled only if they are wider than 40 meters. Secondary drainage and “single line” rivers are edited for spikes and depressions out of specification. The edits performed on the DEMs are not intended to result in data sets supporting cartographic quality contours.

Shoreline areas are edited to produce flat lakes, oceans and reservoirs. Water bodies are flattened if they are 400 square meters or larger, or if they contain depressions/spikes that are out of specification. The radar does not image bridges, particularly high bridges, properly. In some circumstances the bridge deck is simply removed from the DEM. Similarly, major transmission lines can produce the effect of linear aberrations in the DEM. In severe cases this aberration is removed from the DEM. Airport surfaces are edited when out of spec.

Urban core areas are mostly edited for depressions out of specification. De-correlation, shadow and multi-path effects in areas of tall buildings result in a very complex and confusing surface.

Correlation data, in support of autoclassification processes, can be made available though customization services offered by Intermap Technologies.

## Appendix A: GT Quick Start Guide

### Loading a DEM into ESRI ArcInfo:

1. Open the metadata file associated with the DEM.
2. Copy the following information from the metadata into a blank text file, using the format shown below:

NCOLS	2801
NROWS	2801
XLLCORNER	123456.7
YLLCORNER	123456.7
CELLSIZE	5
NODATA_VALUE	-32767
BYTEORDER	MSBFIRST

XLL and YLL above refer to the X and Y coordinates of the lower left corner of the DEM.

3. Save the newly created file as a header file. Use the same name as the .bil file, but with a .hdr extension (sample.hdr, sample.bil), and in the same directory. The file name must be lowercase and must not start with a number.
4. Start ArcInfo and run the 'floatgrid' command, which will convert a file of binary floating point numbers to a grid. An example of the 'floatgrid' command is shown below:

```
Arc> floatgrid sample.bil output_name
```

5. Start ArcEdit, open a display, set the map extent, select the image and draw it, as shown in the following sample command lines:

```
Arc> arcedit  
Arcedit> display 9999  
Arcedit> mapextent output_name  
Arcedit> image output_name  
Arcedit> draw
```

### Loading an ORRI into ESRI ArcInfo:

To load an 8-bit geotiff GT ORRI file into ArcInfo, do the following:

1. Start ArcEdit and open a display.
2. Set the mapextent, select the image, and draw the image, as shown in the following sample command lines:

```
Arc> arcedit  
Arcedit> display 9999  
Arcedit> mapextent sample.tif  
Arcedit> image sample.tif  
Arcedit> draw
```

## Loading a DEM into ESRI ArcView 3.x:

1. Open the metadata file associated with the DEM.
2. Copy the following information from the metadata into a blank text file, using the format shown below:

NCOLS	2801
NROWS	2801
XLLCORNER	123456.7
YLLCORNER	123456.7
CELLSIZE	5
NODATA_VALUE	-32767
BYTEORDER	MSBFIRST

XLL and YLL above refer to the X and Y coordinates of the lower left corner of the DEM.
3. Save the newly created file as a header file. Use the same name as the .bil file, but with a .hdr extension (sample.hdr, sample.bil), and in the same directory. The file name must be lowercase and must not start with a number.
4. Activate a view.
5. From the File menu, choose Import Data Source (this requires the Spatial Analyst module).
6. Select the type of raster file to import. You can choose between ASCII, Binary, USGS DEM, and US DMA DTED. Choose Binary and press OK.
7. With the next dialog, navigate to the directory that holds the raster files you want to import. Make sure the List Files of Type is set to "All Files." Highlight the .bil file to import. Press OK. A grid data set will be created for each file you select.
8. Provide a name and directory to place each of the new grid data sets created. Grid data set names must be less than 14 characters long and cannot contain a "." or space. Press OK.
9. After the raster files have been imported to grid data sets, you can add the new grid data sets to a view as themes with the Add Theme button.

## Loading an ORRI into ESRI ArcView:

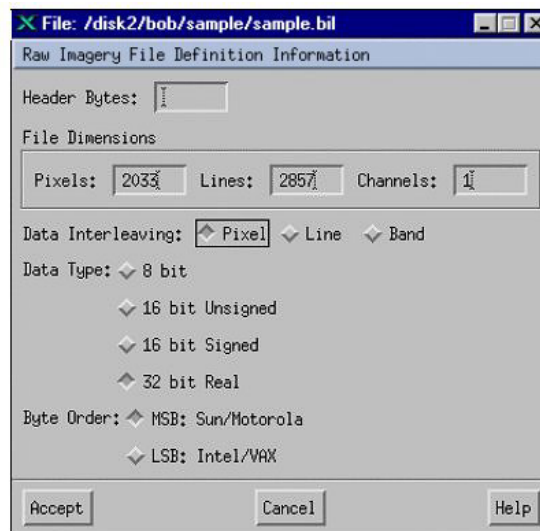
1. Open a new view.
2. From the menu bar select "View" and then select "Add Theme".
3. In the dialog box, select the directory path and the file to be opened, and set the data source type to "Image Data Source". Click "OK".
4. Back in the main view window, click the box beside the listed .tif filename and the 8-bit geotiff image will be displayed.



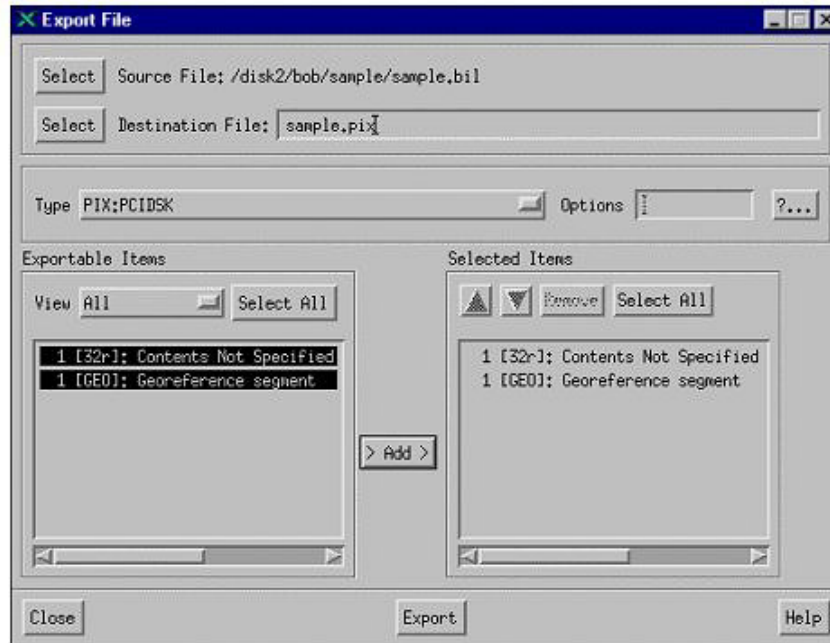
## Loading a DEM into PCI ImageWorks:

To load a 32-bit binary floating point .bil GT DEM into PCI ImageWorks, do the following:

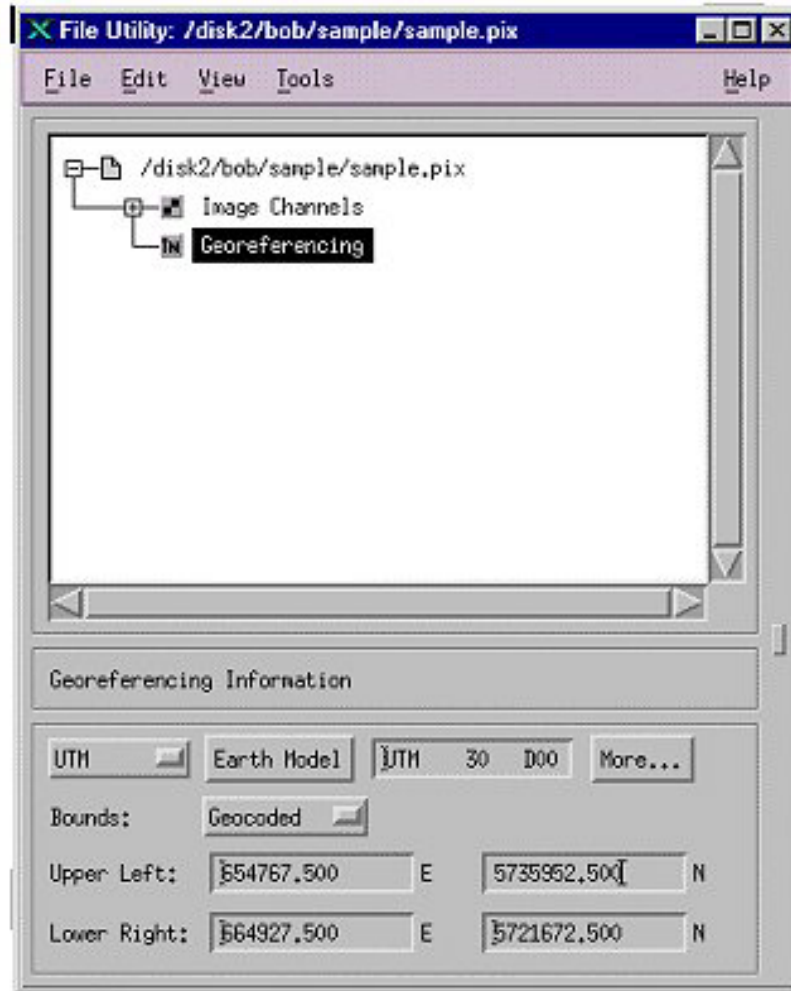
1. Start PCI ImageWorks.
2. Select the “Use Image File” option and from the submenu. Find and select the .bil file to be loaded and click “OK”.
3. In the dialog box, a message indicates that the file is not a recognized database. You will be asked if you want to define the input as a raw file. Click “Yes”.
4. Check the corresponding .txt file to find out how many pixels and lines are in the file.
5. In the “File Definition Information Box”, enter the number of pixels and lines (pixels=columns, lines=rows). Change the “Data Type” to “32-bit Real”, and set “Channels” to “1”.



6. In the dialog box that pops up asking to save the definition as an .aux file, click “Accept” and then click “No”.
7. Back in the ImageWorks Configuration box, set the “Image Planes” option to “1 32-bit Real”, then click on “Accept & Load”.
8. The image should now be displayed, though it is not georeferenced. To do this, first export the file to a PCI .pix format by selecting “File” from the menu bar and then selecting “Utility”. A File Utility window appears. Then from the “File” menu, select “Export To”.
9. Enter a new file name, set the type to .pix and select the items to export – the 32-bit real channel and the georeferencing segment. Click “Export”.



10. Load this new .pix file into the active view window by selecting “File” from the menu bar, and then selecting “Load Image” and typing the new file name.
11. To see the current georeferencing information, select “File” from the menu bar, then select “Utility” and from the submenu, click “Georeferencing”. The current information (incomplete) can be seen at the bottom of this menu.
12. Based on information found in the .txt file, fill in the georeferencing data. Note that ImageWorks expects edge-referenced pixels. Refer to Pixel Origin for PCI ImageWorks for more information.



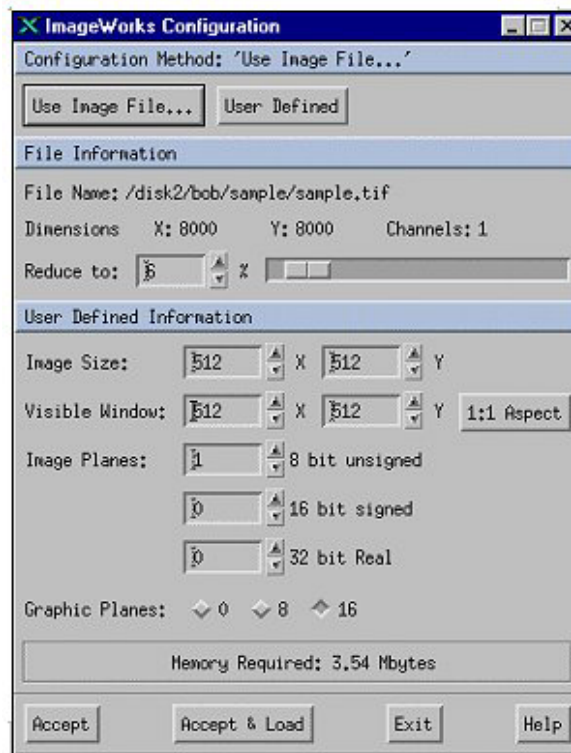
## Pixel Origin for PCI ImageWorks

ImageWorks expects coordinates of a DEM to be referenced to the outside edge of the pixel. To do this, you need to specify coordinates of the upper left corner of the upper left pixel, and the coordinates of the lower right corner of the lower right pixel. Otherwise, the pixel spacing (as calculated by ImageWorks) and placement of vertical values will be wrong.

## Loading an ORRI into PCI ImageWorks

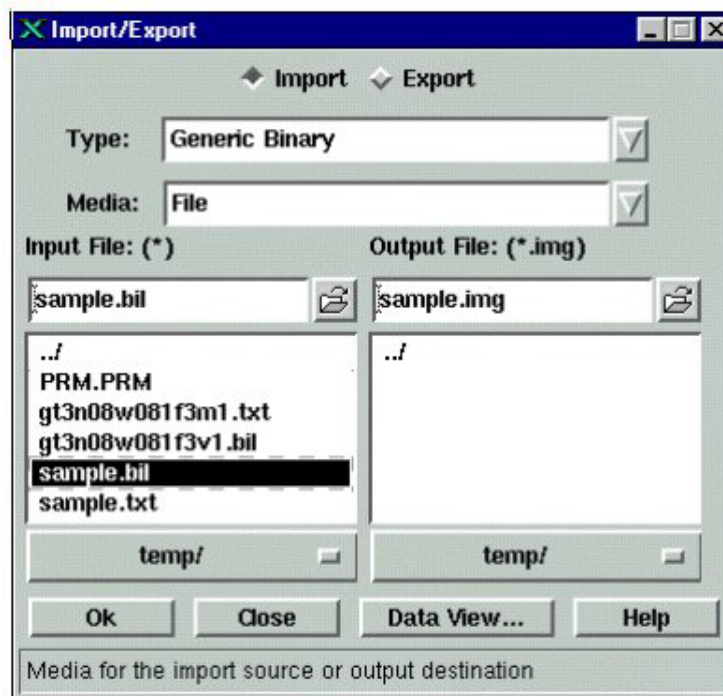
1. Start PCI ImageWorks.
2. Select the “Use Image File” option and from the submenu that pops up, find and select the .tif file to be loaded.
3. In the ImageWorks Configuration menu, leave the “Image Planes” option on “1 8 bit unsigned” and click “Accept & Load”.
4. To export the file to a PCI .pix format, select “File” from the menu bar, then select “File Utility”. From the submenu select “File” and “Export To”. Enter a new file name, set the type to .pix and select the items to export – the 8-bit image channel and the georeferencing segment. Click “Export”.
5. Load this new .pix file into the active view window by selecting “File” from the menu bar, and then selecting “Load Image” and the new file name.
6. PCI will automatically update georeferencing information from a geotiff file, so you don’t need to make any changes here. This can be checked, though, by selecting “File” from the menu bar, and then selecting “Utility”. From the submenu, select “Georeferencing”.

**Warning:** If you modify the preset georeferencing information, the original information cannot be restored.

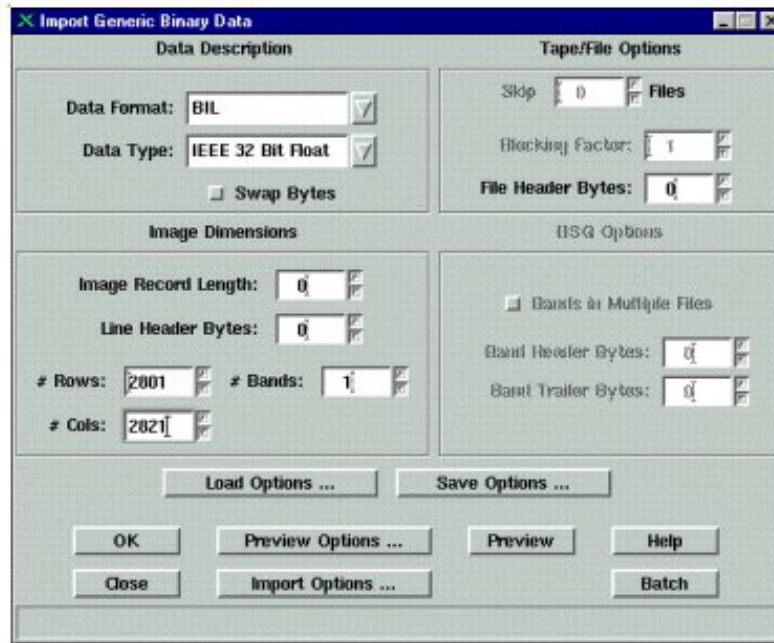


## Loading a DEM into ERDAS IMAGINE

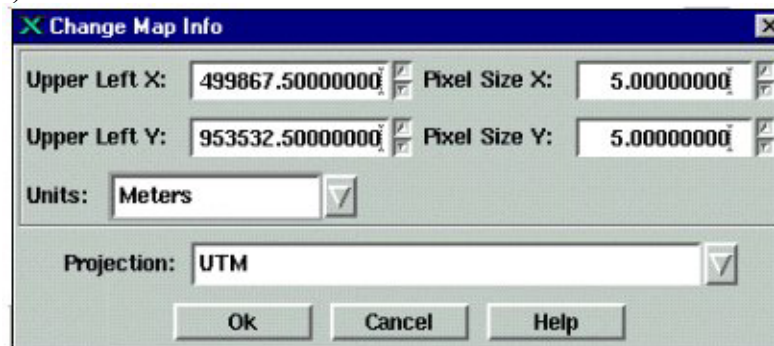
1. Start IMAGINE.
2. Select the “Import/Export” option to convert the GLOBAL Terrain DEM .bil file into an ERDAS .img file.



3. In the new submenu, select “Import”, set the “Type” to “Generic Binary”. Then set the “Media” to either “CD-ROM” or “file” depending on the location of the .bil file. Finally, select “Input” and “Output” directories.
4. After clicking “OK”, another submenu will appear. Set “Data Type” to “IEEE 32 Bit Float”, set the “# rows” and “# cols” (values for these can be taken from associated GT metadata file (in .txt format). Click the Swap Bytes button (only in the Windows version – leave this option off in the UNIX version). Click “OK” to import.

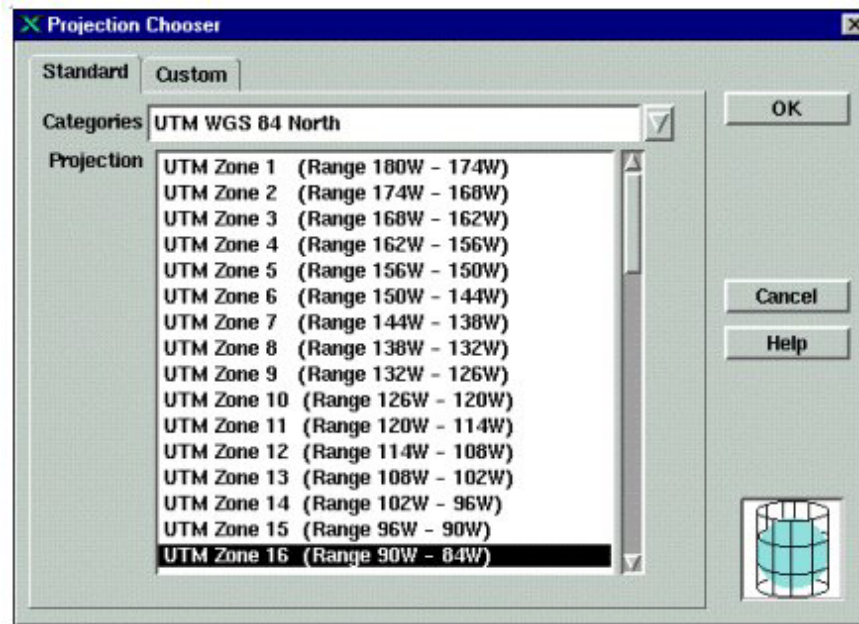


5. Load new .img file into IMAGINE then, from the viewer menu bar, select “File”. Then select “Open”, “Raster Layer” and specify new .img file.
6. Image is now viewable, but not properly referenced. To begin referencing, select “Utility”, and “Layer Info”. In this new submenu, the MapInfo and Projection Info panels are incomplete and need to be edited.
7. In new submenu, select “Edit” and “Change Map Model”. The information to enter here can be found in the associated .txt file. Enter the Upper left georeferencing data (UTM), pixel size (5) units (meters) and projection (UTM). Click “OK”.



8. Select “Edit”, then select “Add/Change Projection”. In the submenu, select the “Standard” option, change the “CateGORRIes” option to “UTM WGS 84 North” (or South), and select proper UTM zone (from associated .txt file). Click “OK”.





9. The “Layer Info” menu should now be complete and the .img file ready for IMAGINE.

## Loading an ORRI into ERDAS IMAGINE

1. Start IMAGINE.
2. Select the “Import/Export” option to convert the GLOBAL Terrain ORRI .tif file into an ERDAS .img file.
3. In the new submenu, select “Import”, set the “Type” to “TIFF”. Then set the “Media” to either “CD-ROM” or “file” depending on the location of the .tif file. Finally, select “Input” and “Output” directories.
4. After clicking “OK”, another submenu will appear. Click “OK” to import.
5. Load new .img file into IMAGINE. From the viewer menu bar, select “File”. Then select “Open”, “Raster Layer” and specify new .img file. (The georeferencing from the original GeoTIFF will be saved in the newly imported .img file).

## Loading a DEM into MapInfo Vertical Mapper

1. Convert the \*.bil DEM into an ASCII “XYZ” format text file (e.g., Easting, Northing, Elevation) using third-party software (such as PCI EASI/PACE)
2. From the “File” menu in MapInfo, select “Open Table...” and set “Files of Type” to “Delimited ASCII”.
3. Select desired text file and click “Open”.
4. Select delimiter (e.g., Tab or Space).
5. For most cases, the default “File Character Set” can be used.
6. If text file has column headings (e.g., Easting, Northing, Elevation), click the “Use First Line” for “Column Titles” check box. Otherwise, leave it unchecked.
7. Click “OK” to load the text file into MapInfo. For large text files, this step can take several minutes and MapInfo may appear to have “frozen”.
8. To create a Vertical Mapper Grid file select “Vertical Mapper” from the menu bar. Then select “Create Grid and Interpolation”.
9. Select “Rectangular (Bilinear) Interpolation”. Click “Next” to continue.
10. Under “Select Table to Grid”, choose the table that was created in Step 7.
11. Under “Select Column”, select the column containing the elevation information.
12. Under “X Column”, select the column containing the x (Easting) coordinate information.
13. Under “Y Column”, select the column containing the y (Northing) coordinate information.
14. Click the “Projection...” button.
15. Under “Category”, select “Universal Transverse Mercator (WGS 84)”.
16. Under “Category Members”, select the desired UTM Zone for the data set and click “OK”.
17. Type in a Data Description (e.g., Elevation)
18. Select the correct unit (e.g., meters) from the “Unit Type” dropdown box. Click “Next” to continue.
19. Set “Cell Size” to 5 meters and leave the “Search Radius” as the default value.
20. Use the “Browse” button to select a filename and location for the new grid file. Click “Finish” to generate the grid file.

## Loading an ORRI into MapInfo

1. Obtain coordinate information for 3 pixels within the image (usually the upper-left, lower-left and lower-right corner pixels). The coordinates must refer to the upper-left corner of each pixel, and not to the center of the pixel.

For example:

An ORRI that is 1000 pixels wide and 2000 lines long, with a pixel size of 2.5 meters, is to be registered. The upper-left coordinate is given in UTM (WGS 84) coordinates (referenced to the center of the pixel) and is (450500 E, 5400850 N).

The coordinates required to register the image would be as follows:

Point 1 (Upper-Left): 450498.75 E 5400851.25 N

Point 2 (Lower-Left): 450498.75 E 5395853.75 N

Point 3 (Lower-Right): 452996.25 E 5395853.75 N

In a general case, given the upper-left center of pixel coordinate for the image, the number of pixels and lines that make up the image, and the pixel size:

Map X	Map Y	Image X	Image Y
Given Upper-Left Easting – half the Pixel Size	Given Upper-Left Northing + half the Pixel Size	0	0
Point 1 Easting	Point 1 Northing – {(Number of Lines – 1) x Pixel Size}	0	Number of Lines – 1
Point 1 Easting + {(Number of Lines – 1) x Pixel Size}	Point 2 Northing	Number of Pixels – 1	Number of Lines – 1

2. From the menu bar in MapInfo, select “File” and then “Open Table...” and set “Files of Type” to “Raster Image”.
3. Select desired raster file and click “Open”.
4. Click the “Register” button.
5. Click the “Projection...” button.
6. Under “Category”, select “Universal Transverse Mercator (WGS 84)”.
7. Under “Category Members”, select the desired UTM zone for the ORRI and click “OK”.
8. Click the “Units...” button.
9. Select “meters” from the drop-down menu and click “OK”.
10. Click anywhere within the image to select Point 1.
11. Set Map X to the calculated Easting coordinate set Map Y to the calculated Northing coordinate. Set Image X to “0” and set Image Y to “0” (for Upper-Left pixel). Click “OK”.

12. Repeat Steps 10 and 11 for Point 2 and Point 3. For Point 2, Image X and Image Y would be “0” and the Number of Lines minus 1, respectively. For Point 3, Image X and Image Y would be the Number of Pixels minus 1 and the Number of Lines minus 1, respectively.
13. Click “OK”.

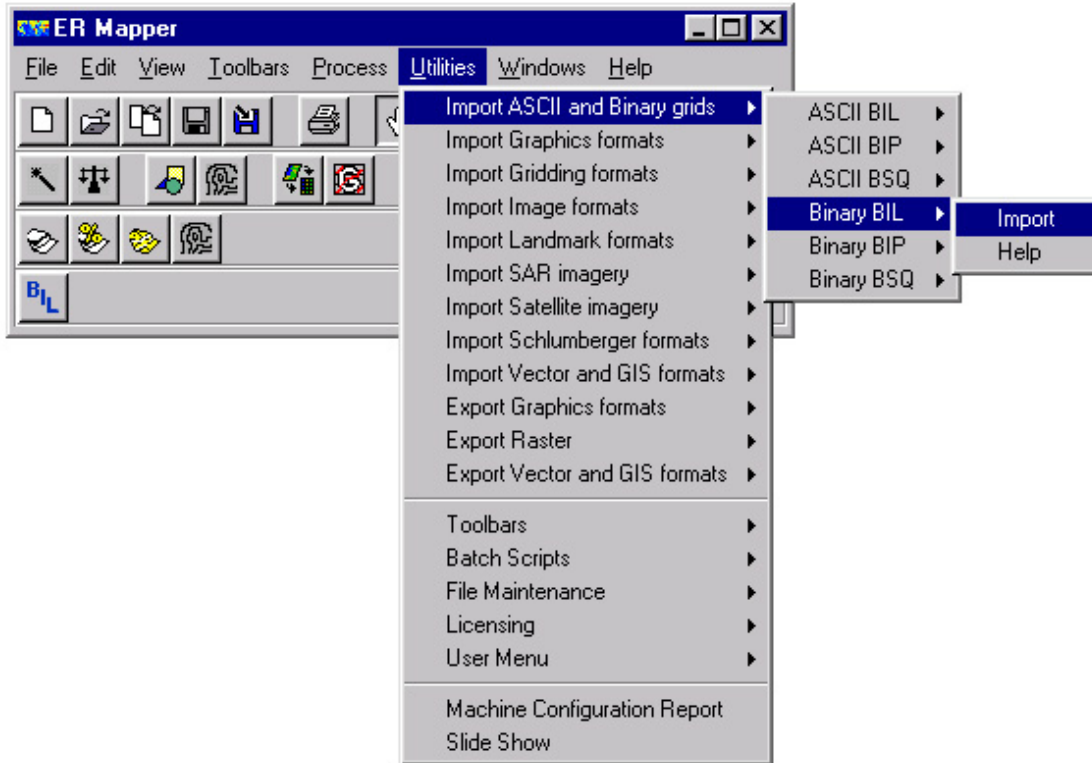
## Loading a DEM or ORRI into ER Mapper

Both the 32 Bit Binary DEM and GeoTIFF image can be viewed in ER Mapper or ER Viewer in their present formats simply by “File – Open”, however the DEM file requires a standard ARC/INFO header file, an example of which is given below. The coordinates in the ARC/INFO header file are referenced to the center of the upper left DEM pixel, whereas ER Mapper references the upper left of the upper left pixel and does not make a correction when reading the header file. In order to correct for this discrepancy the “ulxmap” and “ulymap” coordinates must have a half pixel subtracted and added, respectively when creating the header file. The DEM row, column, pixel size and georeferencing information for the header file can be extracted from the metadata file supplied with the data. Both programs can display the two-dimensional UTM georeferencing of the DEM and GeoTIFF but ER Mapper requires the DEM to be imported and registered before any three-dimensional georeferencing can be displayed.

### Sample ARC/INFO Header File

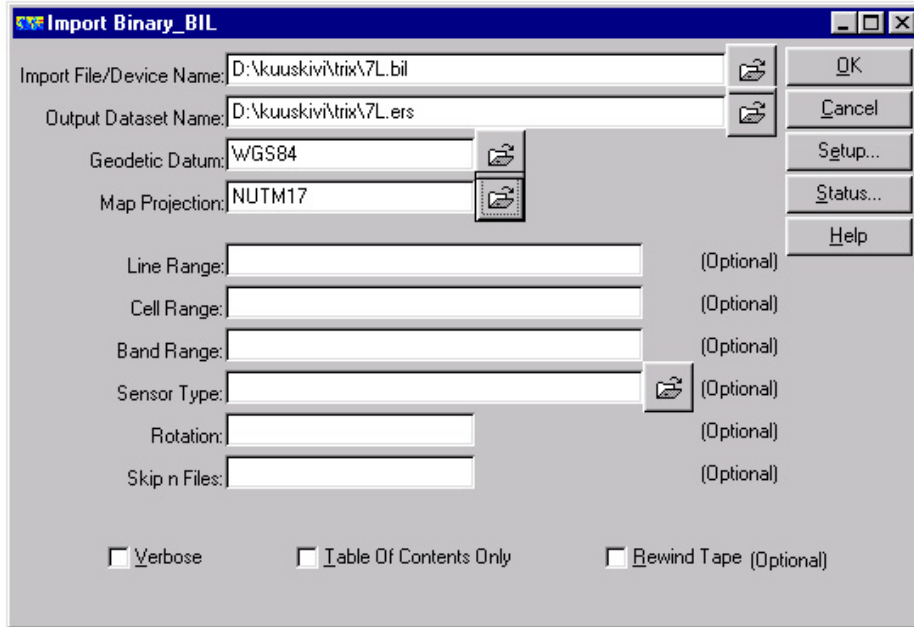
ncols	2811
nrows	2811
nbands	1
nbits	32
byteorder	M
layout	BIL
ulxmap	555557.50
ulymap	9958662.50
xdim	5.0
ydim	5.0

Once the header file has been created, the DEM can be imported through the “Utilities” menu.

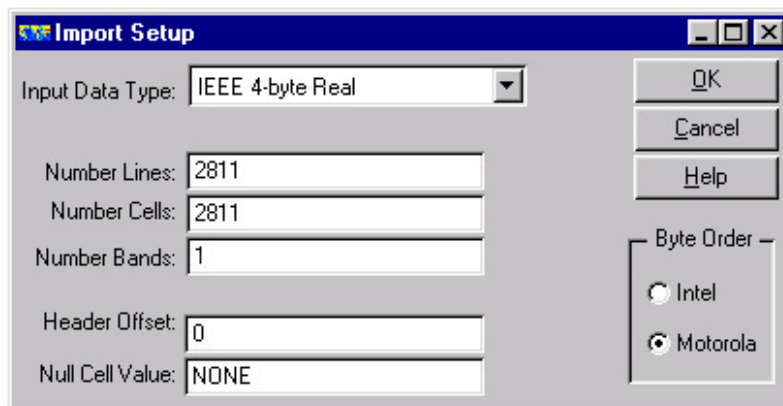


On the “Import Binary\_BIL” window, enter the DEM BIL file in the “Import File/Device Name” field and an output name in the “Output Dataset Name”. “Geodetic Datum” and “Map Projection” information can be retrieved from the metadata file supplied with the DEM. All other fields are optional. Once the information has been entered click on the “Setup” button.

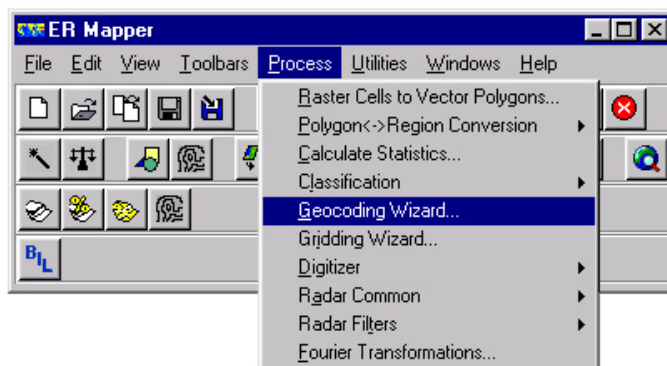




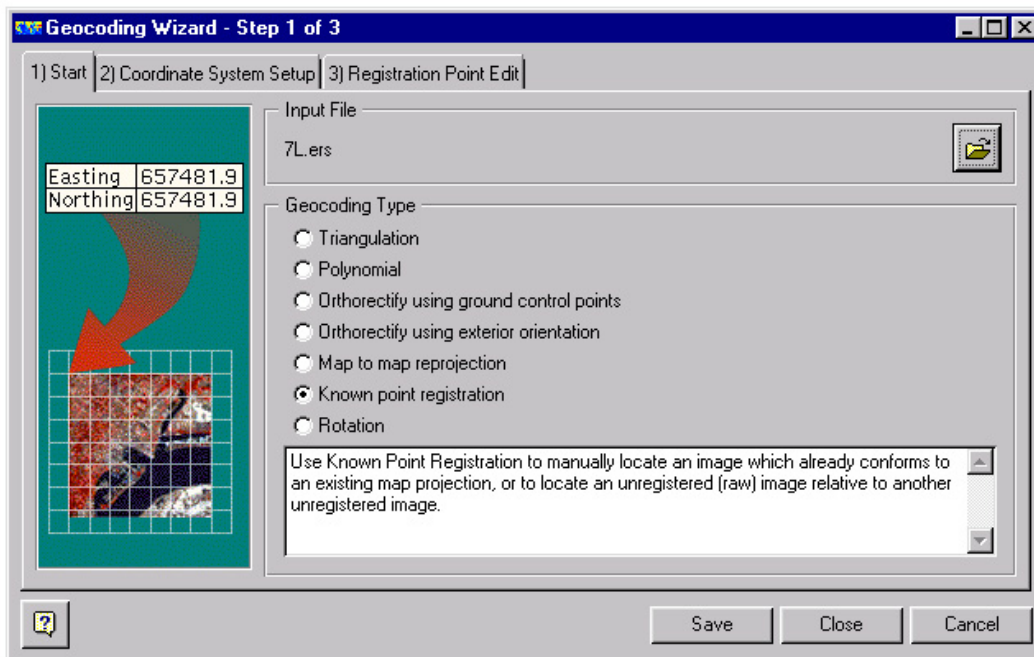
In the “Import Setup” window set “Input Data Type” to “IEEE 4-Byte Real”, “Byte Order” to “Motorola” and “Number of Bands” to “1”. Get “Number of Lines” (Rows) and “Number of Cells” (columns) values from the metadata file. When complete click “OK” and then “OK” on the “Import Binary\_BIL” window and the DEM will start to import into an ER Mapper format.



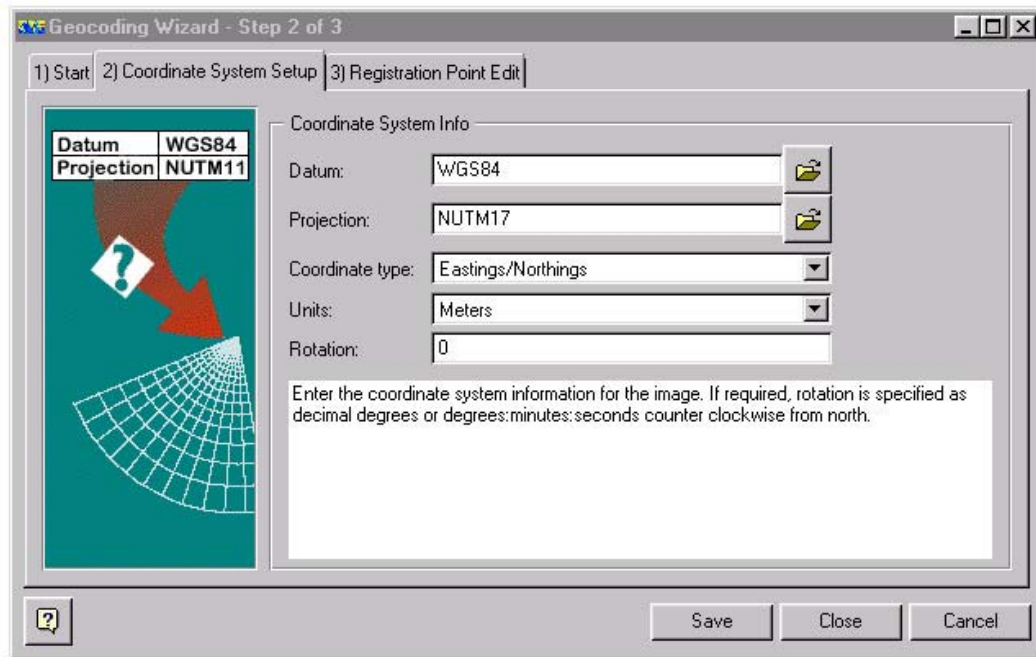
Once the DEM has been imported, the elevation values can be viewed, but to get the easting and northing coordinates the file has been georeferenced. Georeferencing information is added through the “Process – Geocoding Wizard...” menu.



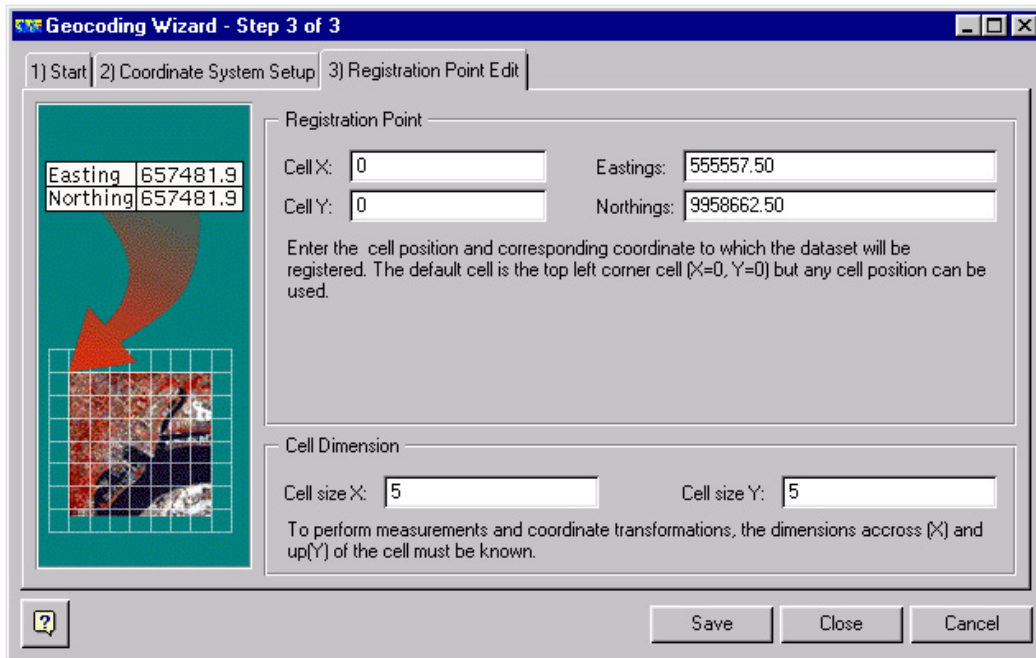
On the “Start” window enter the name of the imported “.ers” DEM in the “Input File” field and click the “Known point registration” option.



On the “Coordinate System Setup” window, the “Datum”, “Projection” and “Coordinate type” fields should be correct but the “Units” should be changed to the appropriate unit of measure.



On the “Registration Point Edit” window, change “Cell size X” and “Cell size Y” to the values from the metadata file and the “Eastings” and “Northings” to the values from the ARC/INFO header file. Click “Save” and “Close” and the ER Mapper file will now be fully georeferenced.



# Appendix B: Sample DEM Metadata file

**GLOBAL Terrain: "GT2N51E001D3V1"**

Metadata also available as - [[Parseable text](#)] - [[XML](#)]

## Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Metadata Reference Information](#)

### *Identification Information:*

*Citation:*

*Citation Information:*

*Originator:* Intermap Technologies Inc.

*Publication Date:* 19991205

*Title:* GLOBAL Terrain: "GT2N51E001D3V1"

*Edition:* 1

*Geospatial Data Presentation Form:* Digital Elevation Model

*Series Information:*

*Series Name:* GLOBAL Terrain Digital Surface Models

*Issue Identification:* Version 1

*Publication Information:*

*Publication Place:* Denver, CO

*Publisher:* Intermap Technologies Inc.

*Online Linkage:* <[URL:http://www.globalterrain.com](http://www.globalterrain.com)>

*Online Linkage:* <[URL:http://www.intermaptechnologies.com](http://www.intermaptechnologies.com)>

*Online Linkage:* <[URL:http://www.globalterrain.com/gt.asp#Product Handbook](http://www.globalterrain.com/gt.asp#ProductHandbook)>

*Description:*

*Abstract:*

This data set is a digital elevation model (DEM) product that populates the GLOBAL Terrain product catalog. The DEM products are generated using the Intermap STAR-3i airborne interferometric synthetic aperture radar (SAR) system mounted in a LearJet 36A aircraft.

The GLOBAL Terrain Digital Surface Model (DSM) data files are digital representations of cartographic information in a grid form. DSMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. These digital data files are produced by

Intermap Technologies Inc.(Intermap) as part of the GLOBAL Terrain product line and are licensed in 7.5-minute tiles for areas located between 0 and 56 degrees North/South. Data for locations above 56 degrees North are licensed in 15-minute by 7.5-minute tiles.

GLOBAL Terrain DSM products represent the first reflective surface as illuminated by the radar. Accuracy statements are based on areas of moderate terrain. Diminished accuracies are to be expected in areas of extreme terrain and dense vegetation.

GLOBAL Terrain DSMs are produced within four classes of vertical accuracy. GTF DSMs have an accuracy of 0.5m Root Mean Square Error (RMSE) or better. GT1 DSMs have an accuracy of 1.0m RMSE or better. GT2 DSMs have an accuracy of 2.0m RMSE or better. GT3 DSMs have an accuracy of 3.0 RMSE or better. No in-scene ground control points are required for GT2 and GT3 products provided that the DGPS ground station is within 200 km of the data acquisition area. The GTF and GT1 products do require in-scene ground control.

The DSM data for 7.5-minute units correspond to the USGS 1:24,000 and 1:25,000 scale topographic quadrangle map series for available areas in the United States and throughout the world. Each 7.5-minute DSM is based on 5- by 5-meter, or 10- by 10-meter post spacing using the Universal Transverse Mercator (UTM) projection. Each 7.5- by 7.5-minute block provides full coverage with overlap into adjacent sheets.

*Purpose:*

The purpose of this data set is to provide a source for current and accurate digital elevation models with vertical accuracy of between 0.5 meter and 3 meters and post spacing of 5 or 10 meters.

The DSMs are used as a fundamental layer of information in Geographic Information Systems (GIS) and Spatial Information Decision Support Systems (DSS). A number of the priority layers of spatial information recognized by the National Spatial Data Infrastructure may be derived from GLOBAL Terrain DEMs, including elevation, hydrography, slope, aspect, and shoreline delineation.

*Supplemental\_Information:*

The STAR-3i system employs three principle technologies: X-band Horizontal -Horizontal (HH) polarized SAR, a ring laser-based inertial measurement unit (IMU), and Differential Global Positioning System (DGPS). STAR-3i was developed by the Environmental Research Institute of Michigan (ERIM) under contract to the U.S. Defense Advanced Research Projects Agency (DARPA).

The system is comprised of two X-band radar antennae that collect data simultaneously. The set of acquired data are "interfered" by a digital correlation process to extract terrain height data and geometrically correct radar images. STAR-3i uses post-processed DGPS data, together with precise inertial measurement data, to attain highly accurate positioning control. Precise terrain height and positioning data are enhanced by careful calibration of the baseline separating the two antennae.

The STAR-3i system accuracy has been independently validated by tests conducted by the U.S. Army Topographic Engineering Center, the Institute of Navigation, Stuttgart University and by NASA. A summary of test results are accessible at <http://www.globalterrain.com>.

The GLOBAL Terrain folder name describes the geographic location of a tile. The GLOBAL Terrain file name encapsulates the GT processing level and the product version number. A complete explanation of the GLOBAL Terrain file name can be found in the GLOBAL Terrain Product Handbook. <http://www.globalterrain.com/gt.asp#ProductHandbook>.

*Time\_Period\_of\_Content:*

*Time\_Period\_Information:*

*Range\_of\_Dates/Times:*

*Beginning\_Date:* 19980801

*Ending\_Date:* 19980808

*Currentness\_Reference:*

The above dates refer to the time of field data acquisition and therefore reflect ground conditions at that time.

*Status:*

*Progress:* Complete

*Maintenance\_and\_Update\_Frequency:* Ongoing

*Spatial\_Domain:*

*Bounding\_Coordinates:*

*West\_Bounding\_Coordinate:* 0.625

*East\_Bounding\_Coordinate:* 0.750

*North\_Bounding\_Coordinate:* 51.500

*South\_Bounding\_Coordinate:* 51.375

*Keywords:*

*Theme:*

*Theme\_Keyword\_Thesaurus:* MEL\_Scientific-Engineering\_Field\_Thesaurus

*Theme\_Keyword:* Elevation

*Theme\_Keyword:* Cartography

*Theme\_Keyword:* Geodesy

*Theme\_Keyword:* Geography



*Theme\_Keyword:* Hypsography

*Theme\_Keyword:* Mapping

*Theme\_Keyword:* Photogrammetry

*Theme\_Keyword:* Stereophotogrammetry

*Theme\_Keyword:* Topography

*Theme\_Keyword:* Radar

*Theme\_Keyword:* Interferometric

*Theme\_Keyword:* Remote

*Theme\_Keyword:* Sensing

*Theme\_Keyword:* SAR

*Theme\_Keyword:* DEM

*Theme\_Keyword:* DTM

*Theme\_Keyword:* DSM

*Theme\_Keyword:* ORRI

*Theme\_Keyword:* ORI

*Theme\_Keyword:* STAR-3i

*Theme\_Keyword:* INSAR

*Theme\_Keyword:* IFSAR

*Theme\_Keyword:* IFSARE

*Theme\_Keyword:* GEOSAR

*Theme\_Keyword:* height

*Stratum:*

*Stratum\_Keyword\_Thesaurus:* MEL\_Environmental\_Domain\_Thesaurus

*Stratum\_Keyword:* Terrain

*Stratum\_Keyword:* Earth

*Stratum\_Keyword:* Surface

*Stratum\_Keyword:* Bald

*Stratum\_Keyword:* Ground

*Stratum\_Keyword:* First

*Place:*

*Place\_Keyword\_Thesaurus:* None

*Place\_Keyword:* England

*Place\_Keyword:* Thames

*Place\_Keyword:* River

*Temporal:*

*Temporal\_Keyword\_Thesaurus:* None

*Temporal\_Keyword:* 1998

*Temporal\_Keyword:* August

*Access\_Constraints:* Purchase

*Use\_Constraints:* License Agreement

*Point\_of\_Contact:*

*Contact\_Information:*

*Contact\_Position:* Vice-President E-Business

*Contact\_Organization\_Primary:*

*Contact\_Organization:* Intermap Technologies Inc.

*Contact\_Address:*

*Address\_Type:* mailing address

*Address:* 9785 South Maroon Circle, Suite 150

*City:* Denver

*State\_or\_Province:* CO

*Postal\_Code:* 80112-5928

*Country:* USA

*Contact\_Voice\_Telephone:* (303) 708-0955

*Contact\_Facsimile\_Telephone:* (303) 708-0952

*Contact\_Electronic\_Mail\_Address:* [<mailto:info@globalterrain.com>](mailto:info@globalterrain.com)

*Browse\_Graphic:*

*Browse\_Graphic\_File\_Name:*

[<URL:http://www.gtserver.com/thn/gt/large/GT2N51E001D3V1.jpg>](http://www.gtserver.com/thn/gt/large/GT2N51E001D3V1.jpg)

*Browse\_Graphic\_File\_Description:* Thumbnail of DEM in greyscale

*Browse\_Graphic\_File\_Type:* 8 bit jpeg

*Data\_Set\_Credit:*

This data was produced by the Airborne Operations group and the GT Products group at Intermap Technologies Inc.

*Security\_Information:*

*Security\_Classification\_System:* GLOBAL Terrain End User's License Agreement (GTEULA)

*Security\_Classification:* License Agreement.

*Security\_Handling\_Description:*

The user agrees to read and abide by the License Agreement. Copyright Intermap Technologies Inc., 1997-2000. All rights reserved. Refer to the license document on the website.

[<URL:http://www.globalterrain.com/gt.asp#GT20EULA>](http://www.globalterrain.com/gt.asp#GT20EULA).

*Native\_Data\_Set\_Environment:*

This data is delivered on interoperable media with metadata, thumbnail images and quality control report. The data set was developed on a Sun ULTRA SPARC 2 computer system running Solaris (UNIX).

*Cross\_Reference:*

*Citation\_Information:*

*Originator:* Intermap Technologies Inc.

*Publication\_Date:* 19991205

*Title:* GLOBAL Terrain: "GT2N51E001D3V1.tif"

*Edition:* 1

*Geospatial\_Data\_Presentation\_Form:* Orthorectified Radar Image (ORRI)

*Series\_Information:*

*Series\_Name:* GLOBAL Terrain Orthorectified Radar Images

*Issue\_Identification:* Version 1

*Online\_Linkage:* [<URL:http://www.globalterrain.com>](http://www.globalterrain.com)

*Online\_Linkage:* [<URL:http://www.intermaptechnologies.com>](http://www.intermaptechnologies.com)

*Online\_Linkage:* [<URL:http://www.globalterrain.com/gt.asp#ProductHandbook>](http://www.globalterrain.com/gt.asp#ProductHandbook)

*Online Linkage:*

[<URL:http://www.gtserver.com/thn/im/large/IM2N51E001D3V1.jpg>](http://www.gtserver.com/thn/im/large/IM2N51E001D3V1.jpg)

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*Data Quality Information:*

*Attribute Accuracy:*

*Attribute Accuracy Report:*

Calculation of the digital elevation model is described in the GT Product Handbook User's Guide.

[<URL:http://www.globalterrain.com/gt.asp#Product Handbook>](http://www.globalterrain.com/gt.asp#Product Handbook)

*Logical Consistency Report:*

[<URL:http://www.gtserver.com/thn/pdf/gt2n51e001d3v1.pdf>](http://www.gtserver.com/thn/pdf/gt2n51e001d3v1.pdf)  contains a final Quality Control report.

*Completeness Report:*

Coverage maps are provided for each area of acquisition.

[<URL:http://www.globalterrain.com/GTCoverage.html>](http://www.globalterrain.com/GTCoverage.html)

*Positional Accuracy:*

*Horizontal Positional Accuracy:*

*Horizontal Positional Accuracy Report:*

All data products are 2.5 meters RMSE or better in horizontal accuracy.

For details, see [<URL:http://www.globalterrain.com/gt.asp#Product Handbook>.](http://www.globalterrain.com/gt.asp#Product Handbook)

*Vertical Positional Accuracy:*

*Vertical Positional Accuracy Report:*

GT2 data products are 2 meters RMSE or better in vertical accuracy. For

details, see [<URL:http://www.globalterrain.com/gt.asp#Product Handbook>.](http://www.globalterrain.com/gt.asp#Product Handbook)

*Lineage:*

*Process Step:*

*Process Date:* 19991205

*Process Description:*

This GLOBAL Terrain DSM data product was derived using Intermap Technologies STAR-3i airborne interferometric SAR data acquisition system. The flying height is 20,000 feet Above Mean Ground. The primary look direction is South. The secondary (alternate) look direction is North. Areas of missing data are interpolated using continuous curvature spline over non-data areas. The phase unwrapper utilized is Goldstein. Most incidences of non-data areas are due to radar shadow and layover due to steep terrain. Radar shadow is a factor of the local topography. It is often found in mountainous regions and the urban canyons of built-up areas. Occurances of non-data areas within a DEM are dependent on the look direction of the radar. Significant bodies of water are assigned an elevation which corresponds to the shoreline. Areas of null data are assigned the value -32767.

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*Spatial Data Organization Information:*

*Direct Spatial Reference Method:* Raster

*Raster\_Object\_Information:*  
*Raster\_Object\_Type:* Grid Cell  
*Row\_Count:* 2901  
*Column\_Count:* 2001

---

*Spatial\_Reference\_Information:*

*Horizontal\_Coordinate\_System\_Definition:*  
*Planar:*  
*Grid\_Coordinate\_System:*  
*Grid\_Coordinate\_System\_Name:* Universal Transverse Mercator  
*Universal\_Transverse\_Mercator:*  
*UTM\_Zone\_Number:* 31  
*Transverse\_Mercator:*  
*Scale\_Factor\_at\_Central\_Meridian:* 0.9996  
*Longitude\_of\_Central\_Meridian:* 3 degrees East  
*Latitude\_of\_Projection\_Origin:* 0  
*False\_Easting:* 500000.0 meters  
*False\_Northing:* 0.0 meters  
*Planar\_Coordinate\_Information:*  
*Planar\_Coordinate\_Encoding\_Method:* coordinate pair  
*Coordinate\_Representation:*  
*Abscissa\_Resolution:* 5.0  
*Ordinate\_Resolution:* 5.0  
*Planar\_Distance\_Units:* Meters  
*Geodetic\_Model:*  
*Horizontal\_Datum\_Name:* WGS84  
*Ellipsoid\_Name:* WGS84  
*Semi-major\_Axis:* 6378206.4  
*Denominator\_of\_Flattening\_Ratio:* 294.98  
*Vertical\_Coordinate\_System\_Definition:*  
*Altitude\_System\_Definition:*  
*Altitude\_Datum\_Name:* Mean Sea Level (EGM96)  
*Altitude\_Resolution:* 0.01 m  
*Altitude\_Distance\_Units:* meters  
*Altitude\_Encoding\_Method:* Implicit coordinate

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*Entity\_and\_Attribute\_Information:*

*Detailed\_Description:*  
*Entity\_Type:*  
*Entity\_Type\_Label:* 5 meter posting grid cell  
*Entity\_Type\_Definition:*  
The DSM is a 32 bit IEEE floating point value Big Endian organized in a one-channel binary interleaved file (BIL) on a 7.5-minute geographic (lat/long) grid in UTM projection. The origin of the pixel is center center.  
*Entity\_Type\_Definition\_Source:*  
<URL:[http://www.globalterrain.com/gt.asp#Product\\_Handbook](http://www.globalterrain.com/gt.asp#Product_Handbook)>

*Attribute:**Attribute\_Label:* Elevation value per grid cell.*Attribute\_Definition:* Height of the geoid, relative to mean sea level.*Attribute\_Definition\_Source:*[URL:http://www.globalterrain.com/gt.asp#Product Handbook](http://www.globalterrain.com/gt.asp#Product%20Handbook)*Attribute\_Domain\_Values:**Range\_Domain:**Range\_Domain\_Minimum:* -4.790*Range\_Domain\_Maximum:* 62.148*Attribute\_Units\_of\_Measure:* meters*Attribute\_Measurement\_Resolution:* 0.01 m*Overview\_Description:**Entity\_and\_Attribute\_Overview:*

Project Information

Project Area: Thames River

Intermap Project Number: 98512

Mission # (s): 156

Intermap Processing AML Version: 1.0.0, 20001116

ISO 9001 Certification No.: A8379

DEM Origin (Northeast corner)

UTM\_Easting\_(meters): Min. 334260 Max. 344260

UTM\_Northing\_(meters): Min. 5693760 Max. 5708260

*Entity\_and\_Attribute\_Detail\_Citation:*[URL:http://www.globalterrain.com/gt.asp#Product Handbook](http://www.globalterrain.com/gt.asp#Product%20Handbook)

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*Metadata\_Reference\_Information:**Metadata\_Date:* 20001201*Metadata\_Contact:**Contact\_Information:**Contact\_Position:* Vice-President E-Business*Contact\_Organization\_Primary:**Contact\_Organization:* Intermap Technologies Inc.*Contact\_Address:**Address\_Type:* mailing address*Address:* 9785 South Maroon Circle, Suite 150*City:* Denver*State\_or\_Province:* CO*Postal\_Code:* 80112-5928*Country:* USA*Contact\_Voice\_Telephone:* (303) 708-0955*Contact\_Facsimile\_Telephone:* (303) 708-0952*Contact\_Electronic\_Mail\_Address:* <mailto:info@globalterrain.com>*Metadata\_Standard\_Name:* FGDC Content Standards for Digital Geospatial Metadata*Metadata\_Standard\_Version:* FGDC-STD-001-1998