CEOS WGCV#24 Report: Terrain mapping sub-group (TMSG)

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CEOS WGCV Terrain Mapping

- **What is the mission of the Terrain Mapping Sub-Group (TMSG)?**
  - **To ensure that characteristics of digital terrain models produced from Earth Observation sensors at global and regional scale are well understood and that products are validated and used for appropriate applications.**
- **What are the specific objectives of this group?**
  - **To develop specifications for the generation of '*standardised terrain surface products with known accuracy*' from similar sensing systems in the context of data continuity,**
  - **to specify evaluation methods and statistics which give transparent information about the *quality and heritage of terrain models*.**
  - **To update the current dossier of test sites and identify new sites, particularly to satisfy the cal/val requirements of future missions and generally improve access to validation data sets.**
  - **To keep an up to date record of the current status of sensors which produce data for terrain mapping and of the DEMs available.**
  - **To produce a DEM requirements document with a science rationale, taking into account the output from SRTM.**
- **What is the relevance of TMSG to GEOSS 10-year Implementation Plan?**
  - **Six out of the Nine Societal Benefit areas state an urgent need for global topographic information of the highest possible quality, reliability and in some cases resolution (particularly disasters).**
  - **It could be argued that the other 3 areas (weather, biodiversity, ecosystems) have not yet thought through about the role of topography**

Overview

- **Programmatic status**
  - **2005 activities**
  - **Future activities**
- **Scientific status of DEM production & validation activities**
  - **Overview**
  - **ESA merged DEM (GETASSE30) for MERIS/AATSR land processing**
  - **ICESAT-GLAS**
  - **ASTER**
  - **C- and X-SRTM (IfSAR)**
- **Programmatic status and plans**
  - **WGISS/WGCV WTF**
  - **WGISS/ICEDS prototype**
- **Recommendations to CEOS WGCV #24 for consideration by CEOS Plenary #18 (London, 11/05)**

Programmatic Status - 2005 activities

- No Sub-group specific meetings held since 15 June 2004 (EDC)
- Feb06 Special Issue of Photogrammetric Engineering and Remote Sensing on "The Shuttle Radar Topography Mission – Data Validation and Applications". Call closed on 1 July 2005. Edited by Dean Gesch (EDC), JPM (UCL) and Tom Farr (JPL).
- 53 papers submitted, editors whittled this down to 15 to be sent out to 3 peer reviewers/paper. Overwhelming response to call has caused a few authors to complain that not all 53 papers were sent out to peer review but this was both impractical and would not meet PERS policy of only one special issue dedicated to SRTM and application
- SRTM conference (of the same title) was held at the USGS National Mapping Centre, Reston, Virginia, USA from 14-16 June 2005. Workshop co-sponsored by USGS, NASA, NGA, ISPRS and CEOS-WGCV. 183 attendees from 18 countries. Extremely positive feedback from attendees.
- Conference web-site includes final programme including all abstracts http://edc.usgs.gov/conferences/SRTM/WorkshopProgram.html
- A subset of all presentations, converted into PDF available by anonymous ftp from ftp://edcftp.cr.usgs.gov/pub/edcuser/gesch/outgoing/SRTM/Workshop/
- Significant progress on WTF (test site dossier). SRTM DEMs added to all test sites, where available. No progress on obtaining 30m SRTM-DEMs for all TMSG test-sites
- Significant progress on EO Data Portal - CEOS-WGISS ICEDS
  - Addition of ASTER-stereo DEMs as WMS layer so all SRTM gaps (including above 60ºN, below 56ºS) can now be evaluated as to whether ASTER-DEMs are available

Programmatic Status - future activities

- Report on meeting written by JPM (UCL) submitted to BNSC will shortly be posted on ICP2 web-site http://www.icp2.net/
- Report will form the starting point for articles in AGU-EOS transactions (led by Dean Gesch), ISPRS Highlights (led by JPM) and if possible CEOS Newsletter (led by JPM, advice sought on mechanics of this).
- TMSG working meeting planned for afternoon of 2/12/05 at ESA-ESRIN (immediately after FRINGE05) to discuss
  - TMSG test-sites: expansion to include sites in Africa, Asia and South America
  - Known issues web-site : planning issues
  - Best practice document revisited
  - Recent progress on spaceborne DEMs (SPOT5, X+ERS-tandem of Italy/Switzerland)
  - Quality assessment of GETASSE30 DEM employed by ESA for all systematic EO processing
  - Global GCP extraction from EO high resolution datasets (e.g. Landsat, ERS-IQL, SPOT, SRTM-amplitude)
- TMSG working meeting planned for ISPRS Commission IV Symposium (Goa, India, September 2006)
- CEOS-WGISS EO Data Portal project currently working towards
  - Addition of edited 3" SRTM DEMs (both WMS and WCS)
  - Addition of SRTM-derived land-water mask as vector layer (both WMS and WFS)
  - Addition of NASA JPL-onearth cascaded SRTM backscatter mask mosaic (WMS)
  - Addition of NASA-GSFC-cascaded ICESAT-GLAS profiles
- In concert with ISPRS, plan to revisit international standards for specification of orbital elements

Status of spaceborne DEMs - Coarse resolution production and validation

- **USGS-EDC-GTOPO30 and NOAA-NGDC/CEOS-GLOBE1 (30”≈1km) from Best Available Data (primarily US-NGA DTED1/0 and US-NGA-DCW) released in the mid-1990s. Detailed QA performed by NASA EOS-DEM Science WG. GTOPO30 operationally used for NASA-EOS processing.**
- **ERS-derived Radar Altimetry Corrected Elevation (ACE) at 30” (≈1km) developed under ESA funding by P. Berry (de Montfort University). No independent or thorough validation yet performed**
- **SRTM30 - merger of unedited SRTM (averaged from 1->3->30”) with GTOPO30. No independent or thorough validation yet performed.**
- **GETASSE30 - ESA-ESTEC (M. Bouvet) : merger of ACE-SRTM30-EGM96. No independent or thorough validation yet performed. Used operationally for MERIS data processing. See later for details.**
- **ICESAT: major problems with 2 out of 3 lidars for global data acquisition. Data acquisition limited to 1-2 month acquisitions, 3 times/year. However, significant improvement in polar landmass heights for Greenland and Antarctica and substantial new data on vegetation/biomass**

Status of spaceborne DEMs - Medium Resolution (30-90m) production

- **ERS-tandem IfSAR (raw data acquired primarily in 1995/6) global coverage. Few national DEMs produced (UK-LANDMAP, Switzerland-SARMAP, Italy-Telespazio). Limited by atmospheric WV refraction effects although PS solution feasible if sufficient scenes are available (mostly Europe). No dedicated DEM processing project.**
- **SRTM (X-: DLR/ASI; C- NASA/DoD). Near global coverage (80% of landmass). See later**
- **ASTER. Stereo coverage based on individual requests and limited processing duty cycle. After 5 years, most of the Earth's surface is covered in cloud-free stereo acquisitions but limited processing capabilities at EDC (2-3 DEMs/day) have restricted available relative DEMs. Increasing number of low-cost ASTER-DEM commercial software. Cost (COFUS) of ASTER level 1 data still an issue for large-scale systematic DEM production. JPM to negotiate TMSG access to ASTER-DSMs for test sites.**
- **SPOT-5 (and SPOT1-4). IGN/SPOT working on global commercial 10m DEM but no report since 6/04. JPM to negotiate access for TMSG to SPOT5-DSMs for TMSG test site areas.**
- **ALOS (PRISM). Update on launch-date (Q1/2006). GSI plan to contribute test sites in Asia. JPM to negotiate access for TMSG to PRISM-DSMs.**

Status of spaceborne DEMs - Medium Resolution (30-90m) validation

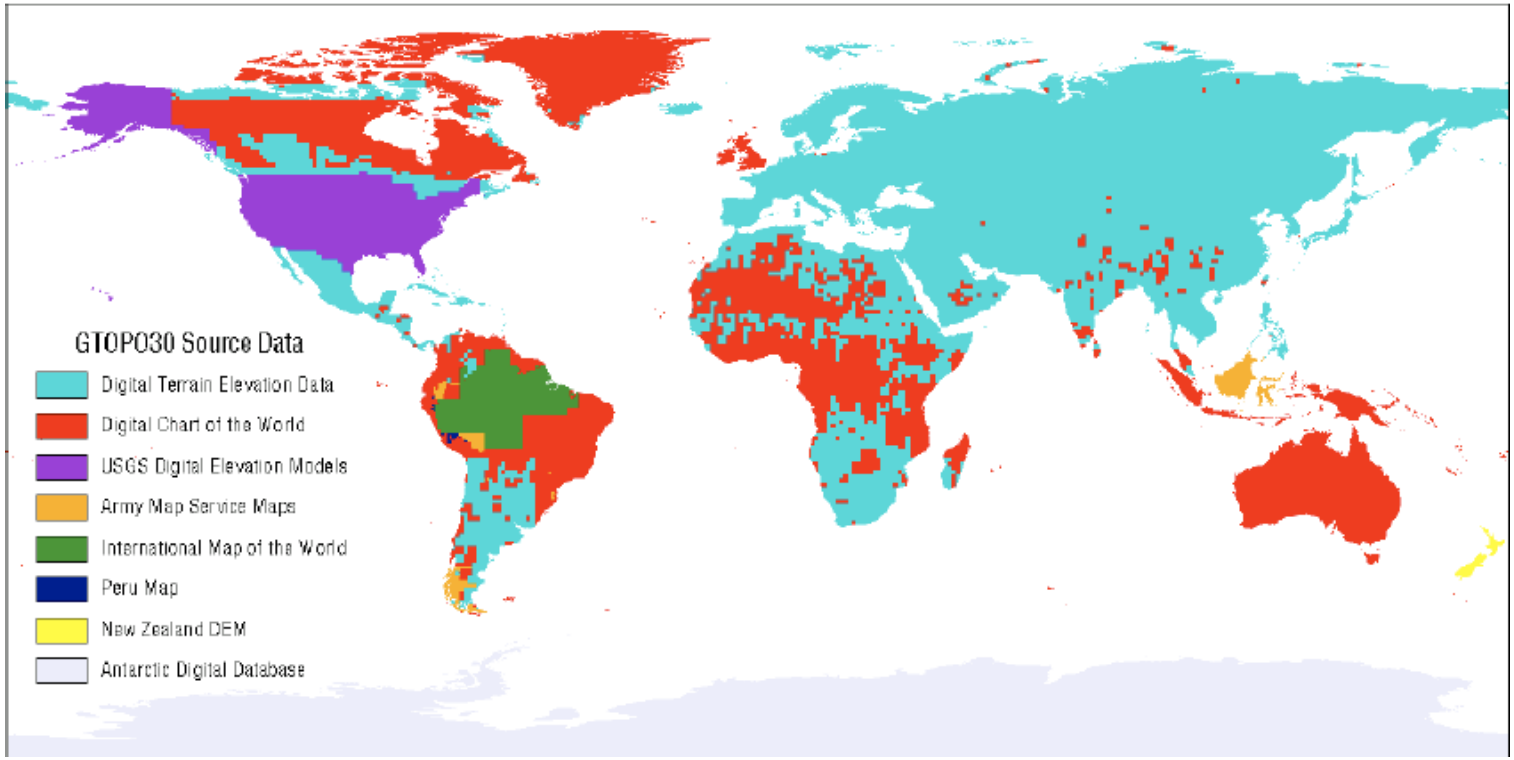
- **ERS-tandem IfSAR - validation results in public domain limited to UK-LANDMAP project http://www.landmap.ac.uk and TMSG web-site presentations**
- **SRTM (X-: DLR/ASI; C- NASA/DoD). Consensus that SRTM-DEMs from X- and C- meet DTED-2 specification for height (Zrms≤8m) dependent on radar penetration of vegetation/built settlements. See more details later**
- **ASTER. USGS tests indicate that RMSExyz<<30m with 9≤RMSEz≤20m depending on date of acquisition, accuracy of orbital modelling and quality of GCPs. See more details later**
- **ICESAT: For flat, non-vegetated areas intercomparison with (6-foot footprint) airborne lidar DEM shows: 0.1±0.22m. See more details later.**

ESA merged DEM (GETASSE30) for MERIS/AATSR land processing

Information courtesy of

Marc Bouvet, ESA-ESTEC

GTOPO30 used by NASA EOS processing chain - source DEMs

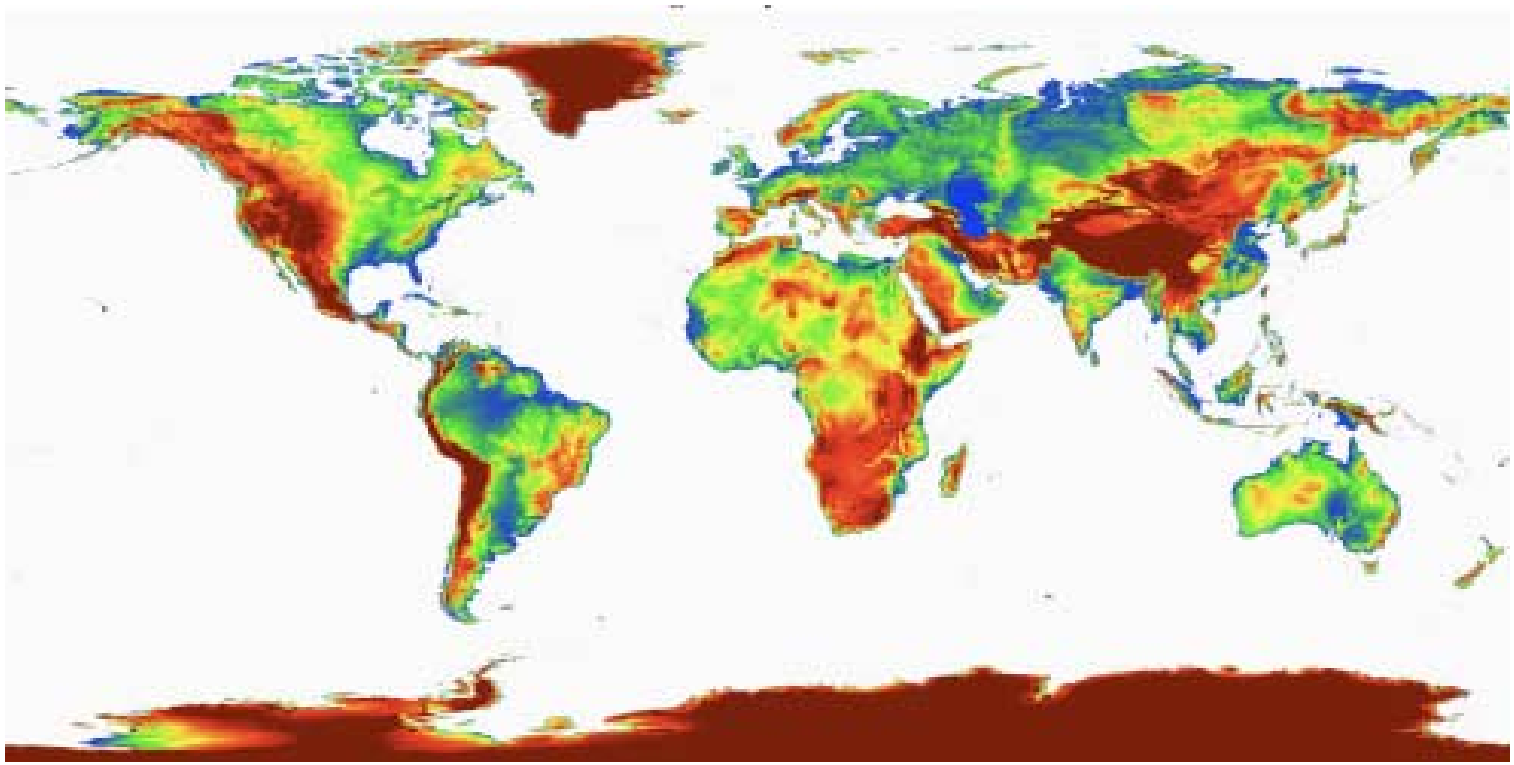


SRTM component of Unedited SRTM30

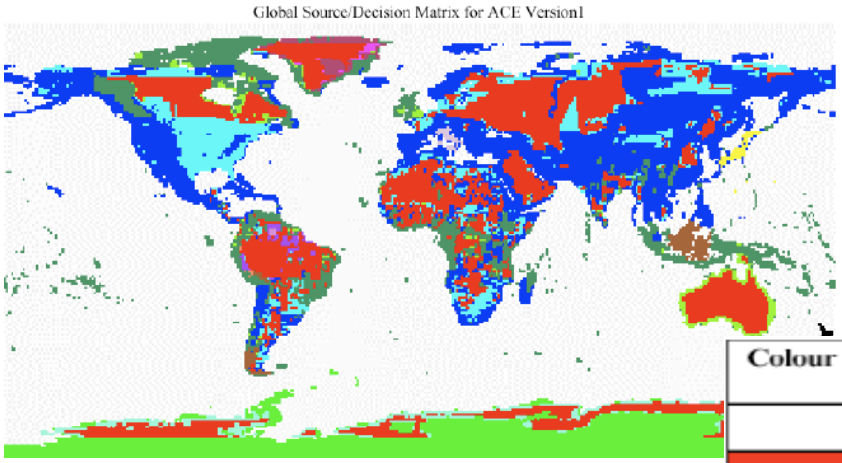
Complete 30” (≈1km) DEM can be downloaded from

ftp://edcftp.cr.usgs.gov/pub/data/srtm/SRTM30/SRTM30.tar

Modified GTOPO30 using ERS Radar Altimetry Corrected Elevation (ACE) used by ESA for processing chain

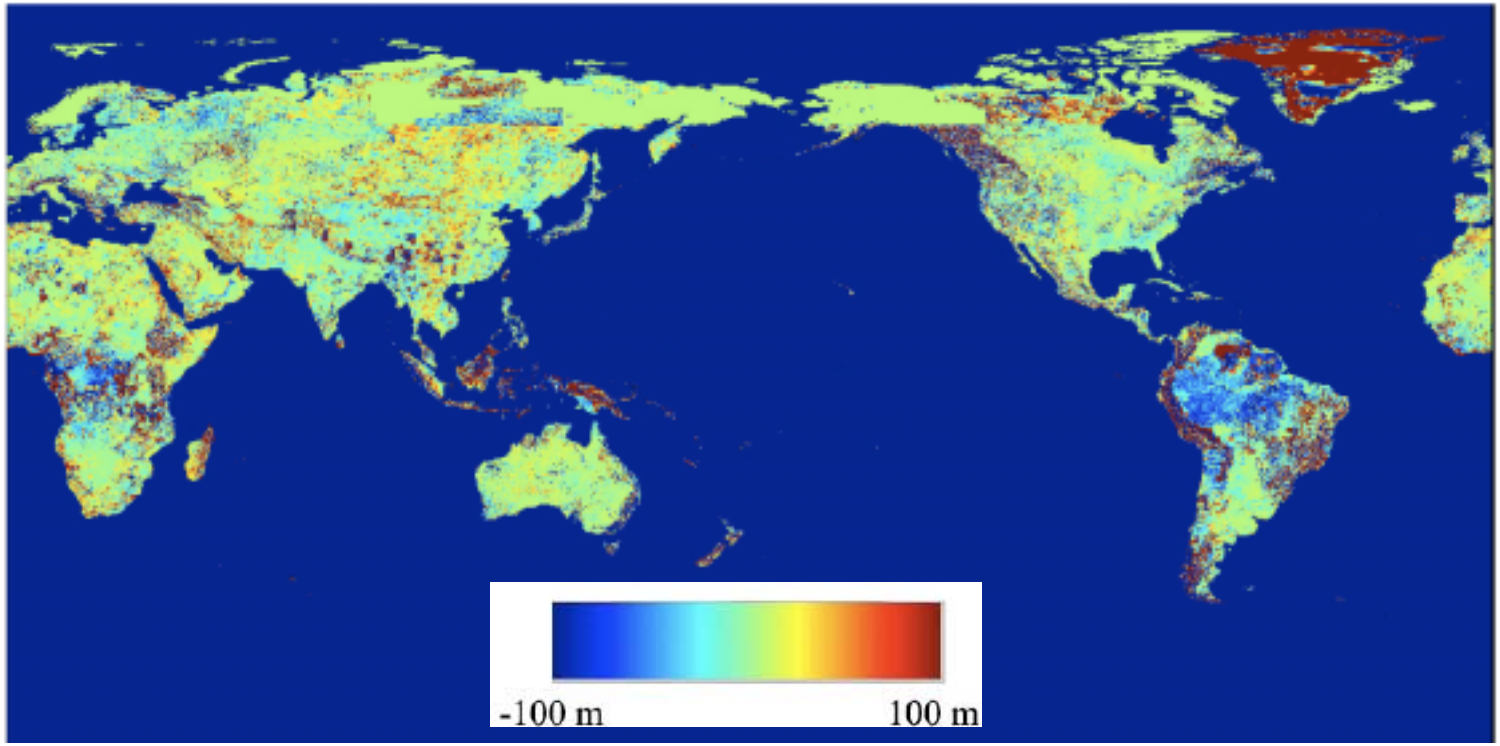


ACE source regions



Colour	No. Of 1° Tiles	Data Source
	39375	Ocean
	7270	Altimeter Derived DEM
	7079	DTED non-shifted
	2340	DTED shifted
	2992	DCW developed by DMA, converted to 30" grid by USGS, non-shifted
	415	DCW developed by DMA, converted to 30" grid by USGS, shifted
	73	DEM of Japan, from GSI non-shifted
	48	DEM for Italy, at high resolution from SGN, converted to 30" grid by NGDC
	61	DEM of New Zealand at 500m gridded by LCR, reprojected to 30" by USGS non-shifted
	208	DEM of Greenland by Zwally (and others)/NSIDC, converted to 30" by JPL non-shifted
	39	DEM of Greenland by Zwally (and others)/NSIDC, converted to 30" by JPL shifted
	231	Army Map Service 1:1, 000, 000-scale maps, digitized by GSI, gridded by USGS non-shifted
	2	Army Map Service 1:1, 000, 000-scale maps, digitized by GSI, gridded by USGS shifted
	95	International Map of the World 1:1, 000, 000-scale maps for part of Brazil adapted by GSI, gridded by USGS non-shifted
	11	International Map of the World 1:1, 000, 000-scale maps for part of Brazil adapted by GSI, gridded by USGS shifted
	5	Peru 1:1, 000, 000-scale maps for part of Peru by the Ministerio de Guerra of Peru, adapted by GSI, gridded by USGS non-shifted
	4556	SCAR Antarctic Digital Database, converted by USGS, repaired by NGDC non-shifted

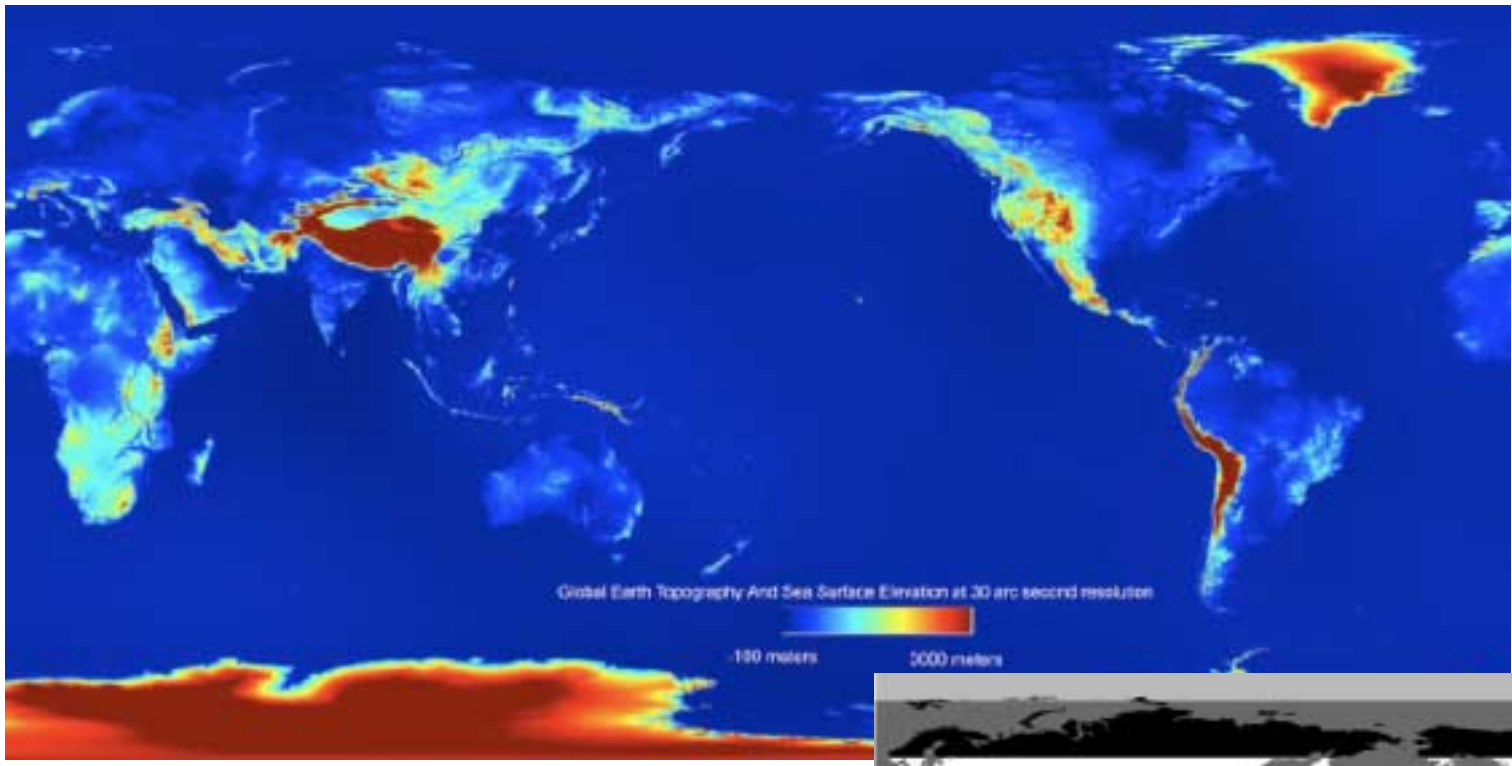
ACE-SRTM30 height differences



N.B. There are a number of noticeable features here:

- ACE is lower than SRTM30 for tropical forested areas, probably because the RA penetrates through the dense vegetated canopy
- There is a line at 60ºN associated with the changeover from SRTM-sourced to DTED-sourced regions
- ACE is considerably higher (≤300m) than the best available DEM from the Danish Geophysical Institute

GETASSE30 DEM used for MERIS land surface and atmospheric data processing



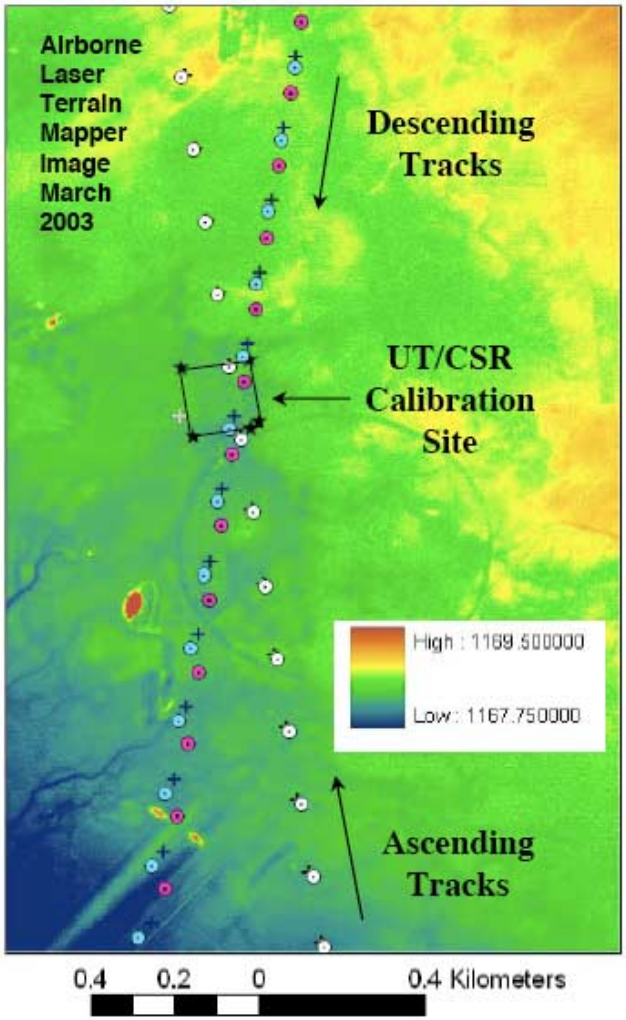
Future requirements for validation

- All global-scale products from NASA and ESA instruments are orthorectified using DIFFERENT DEMs with differences of up to several hundred metres
- The GTOPO30 and SRTM3 DEMs have been extensively validated and this validation documented
- However, no such validation has yet been performed of SRTM30, especially of the latest edited version of the DEM
- No validations have yet been performed of GETASSE30 and this only includes the unedited SRTM30 which has many artifacts
- There are no current "Known Issues" documentation of what impact the use of GTOPO30 or GETASSE30 artifacts has on derived global-scale land surface products
- There is an urgent need for NASA and ESA to validate these new DEMs and ensure interoperability between global-scale products in high relief areas (such as Greenland) as well as tropical areas to esnure that when data products may be merged in future, DEM artifacts will not dominate the signal

ICESAT-GLAS assessment

Thanks to Bob Schutz (UTA) and Dave Harding (NASA-GSFC)

White Sands Space Harbor (WSSH)

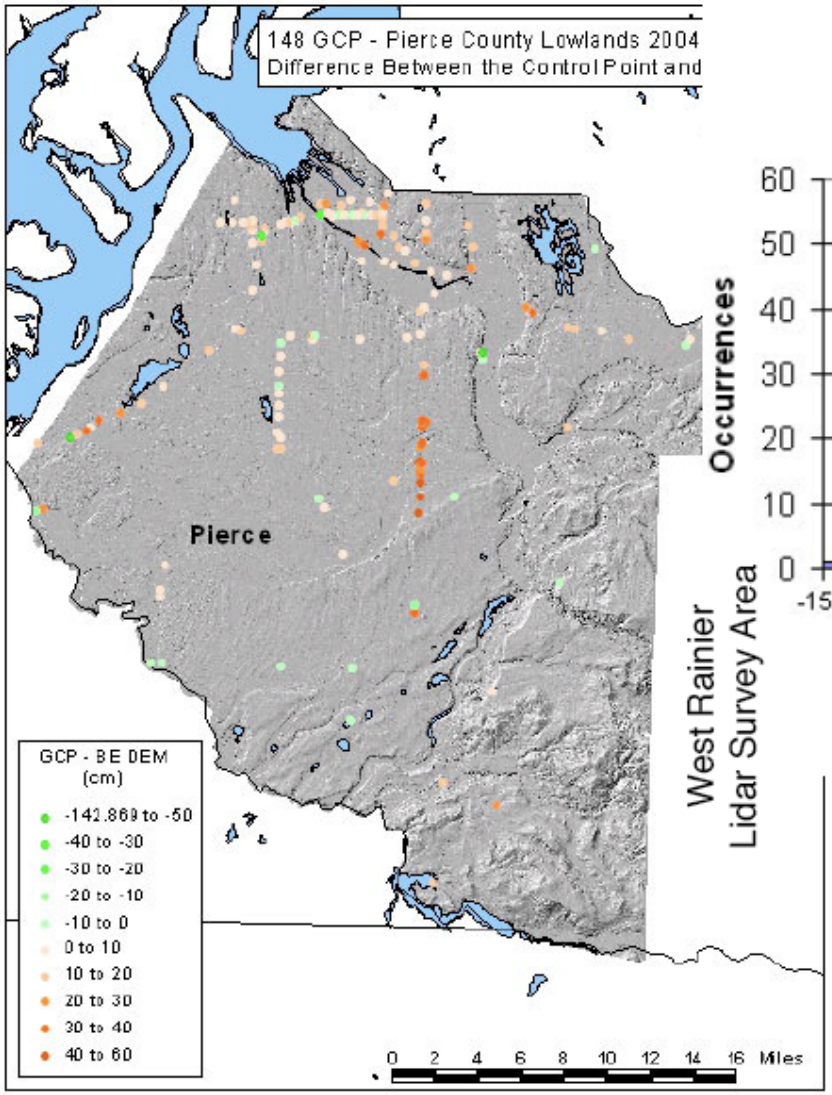


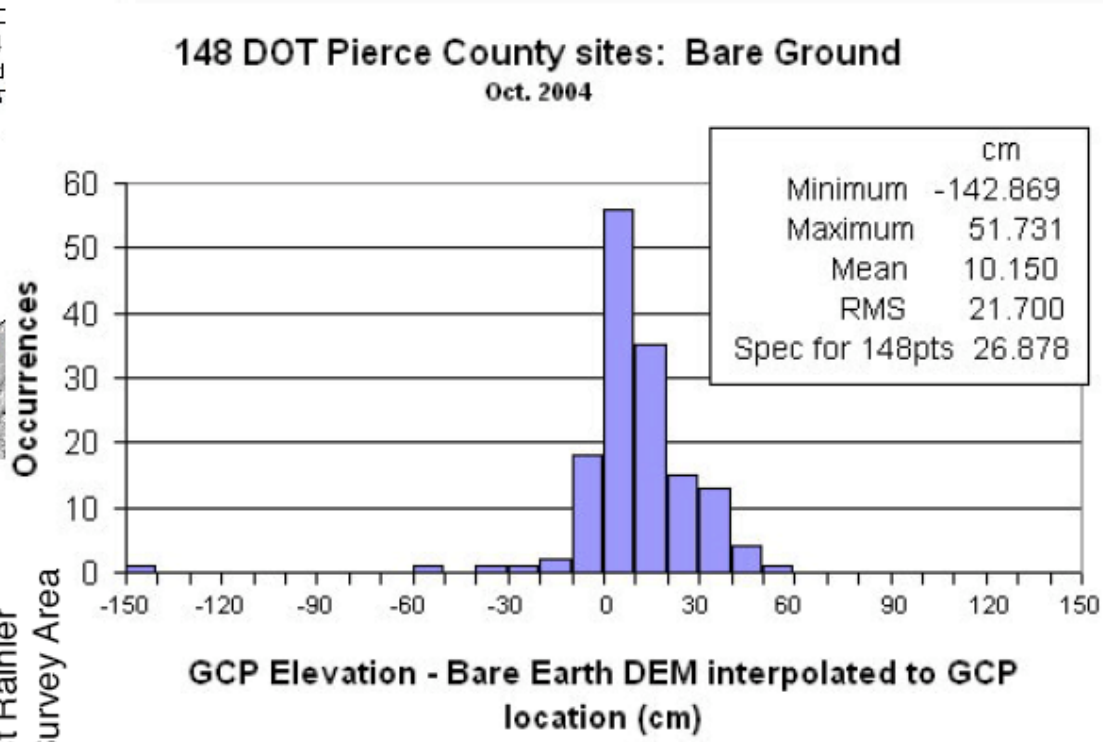
- WSSH area used for ICESat Cal/Val
- University of Texas Optech Airborne Laser Terrain Mapper used in March 2003 to create "lidar" refererence surface
- Area shown is 1.5 km x 2.5 km
- Elevation varies from 1169.5 m (red) to 1167.75 m (blue)
- No vegetation

WSSH Elevation Comparisons

- Lidar - SRTM
  - Mean = - 37.8 cm, RMS = 182.1 cm (67,517 points)
- ICESat – Lidar (near nadir points, ~ 0.3° from nadir)
  - 2a: mean = - 4.3 cm, RMS = 12.2 cm
  - 3a: mean = -6.6 cm, RMS = 10.5 cm
- ICESat – SRTM
  - 2a: mean = - 25.1 cm, RMS = 171.9 cm
- Are SRTM differences caused by elevation change between the 2000 flight of SRTM and 2003-2004 measurements of ICESat?

Western Pierce County Bald Earth DEM Validation Using 148 WA DOT Survey Points





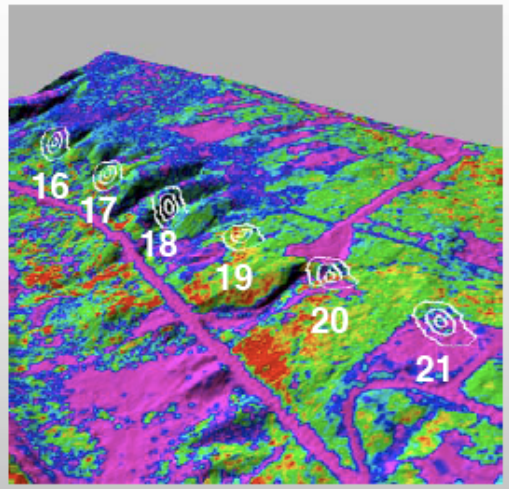
Flat, Non-vegetated Areas

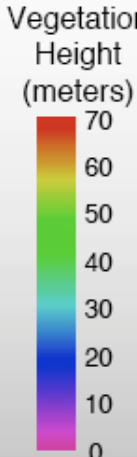
Mean elevation difference = 10 cm

RMSE = 22 cm

(from D. Martinez, PSRC)

Comparison to ICESat Received Echo Waveforms





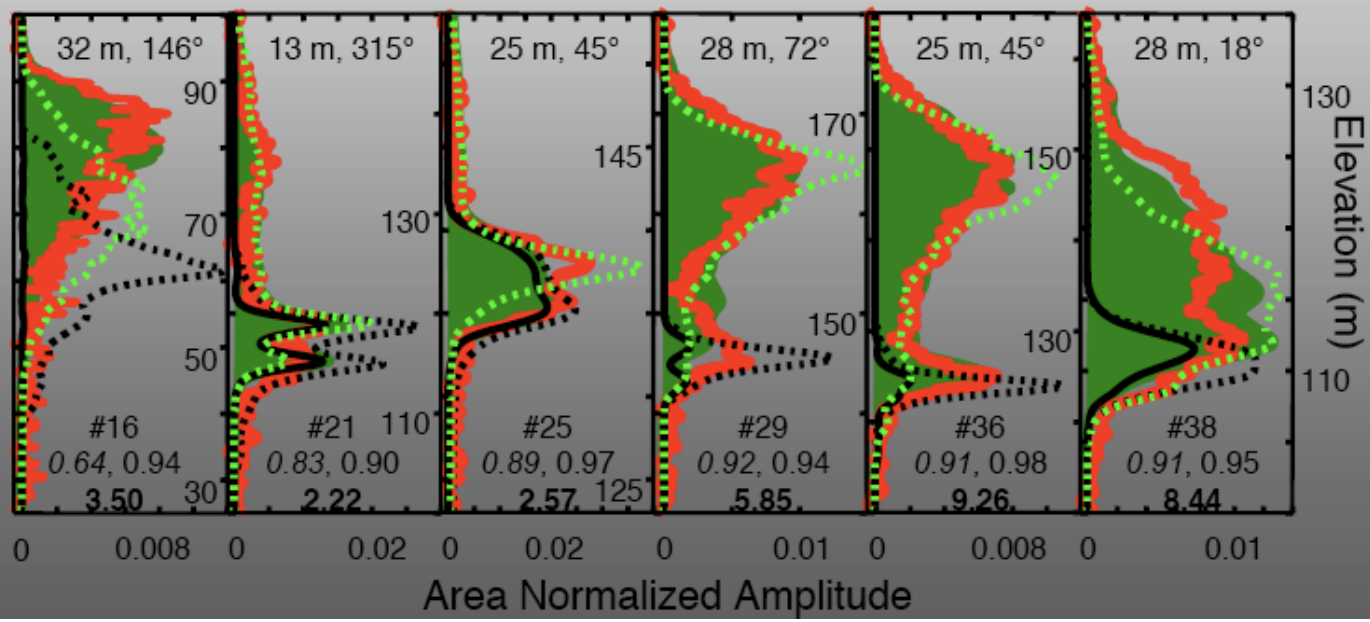
GLAS instrument model applied to TerraPoint airborne swath-mapping laser altimeter data.

Harding and Carabajal, GRL, 2005

Received echo

Model at location of best match

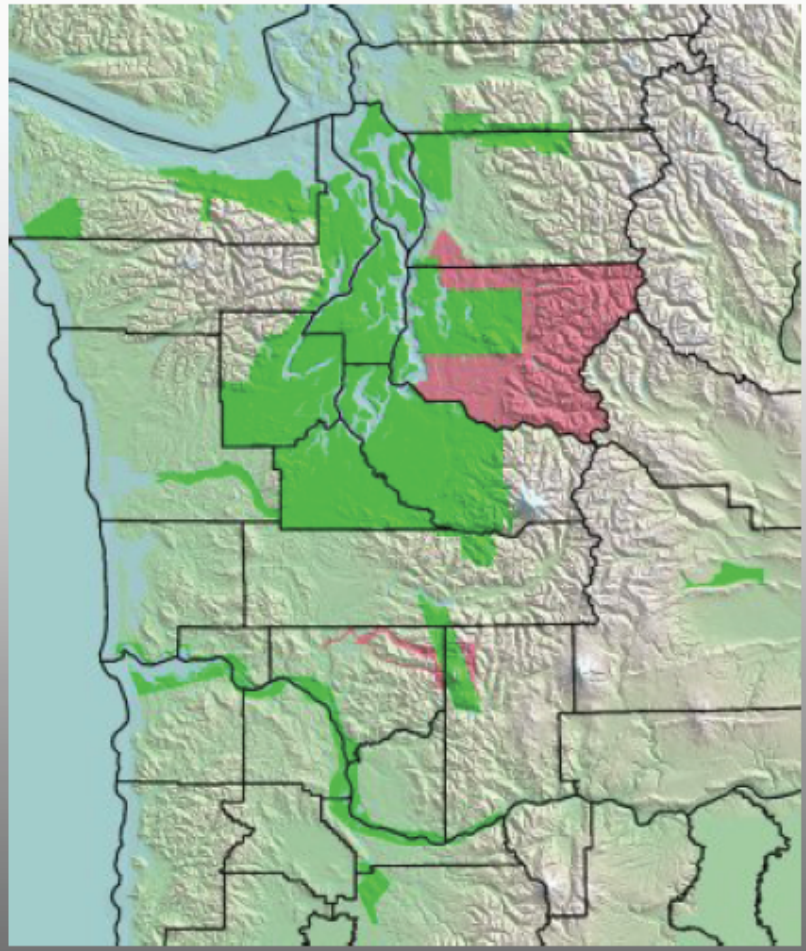
Ground contribution



Future research with ICESAT

- Understand the relationship between lidar waveforms and tree canopy 3D architecture
- Understand radar penetration depths (from C, X and in future L-band interferometry) and relate these to lidar waveforms and 3D canp[y architecture
- NASA-GSFC plan to add all ICESAT-GLAS tracks to CEOS-ICEDS EO Data Portal
- Exploit rich airborne lidar DSM/DTM (and in future airborne lidar waveform) for other spaceborne-derived DEMs in CEOS test site in Puget Sound (see next slide)

Puget Sound Lidar Consortium (PSLC)



Puget Sound Lidar Consortium

Other public surveys (limited canopy data)

Public-domain high-resolution topography

- Airborne lidar swath mapping
- http://www.pugetsoundlidar.org
- http://core2.gsfc.nasa.gov/lidar/terrapoint

- **Federal-local multi-agency collaboration**
  - Local counties and municipalities
  - Regional transportation council
  - USGS & NASA
- **Contract with TerraPoint, LLC**
  - Competitively selected commercial vendor
  - 2000-05 Jan-March leaf-off data acquisition
  - ~15,000 sq km of Puget Lowland mapped
  - 1 pulse per sq m = 15 billion laser pulses
  - Up to 4 discrete returns per laser pulse
  - Return intensity for more recent mapping
  - Deliverables:

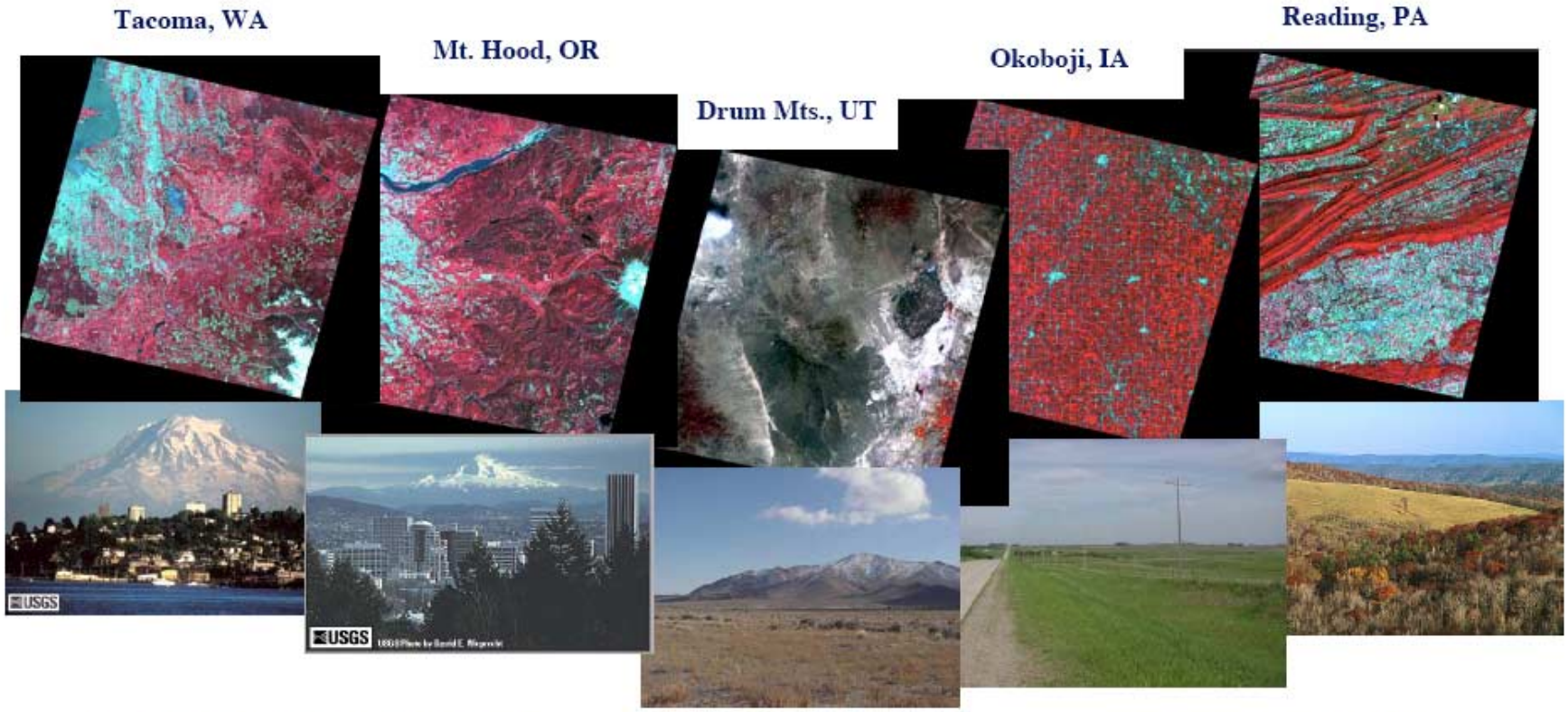
    classified point cloud (ground, canopy, buildings)

    highest surface and bald Earth DEMs (1.8 m grid)

ASTER DEM issues

Thanks to Bryan Bailey (USGS-EDC)

Study Site Selection and Characteristics



- Five sites selected
- Variable terrain
- Two ASTER scenes per site
- Early & recent dates
- Multiple pointing angles

USGS

General Methodology

- Generate DEM's from ASTER L1A data (30 m postings).
  - GDS and LP DAAC produced DEM's per our request.
  - We produced DEM's using SILCAST and AsterDTM software.
- Assess horizontal accuracies.
  - Used USGS orthophoto quads and topo maps to determine x-y offsets.
  - Calculate statistics to determine RMSEx and RMSEy values.
- Assess vertical accuracies.
  - Used USGS National Elevation Data (NED) as primary reference data.
  - Produced NED - ASTER DEM "difference" images.
  - Calculated means and standard deviations on all difference images.
  - Calculated RMSEz values from 25 randomly selected and evenly distributed points within each difference image.

Typical Ground Control Point Distribution

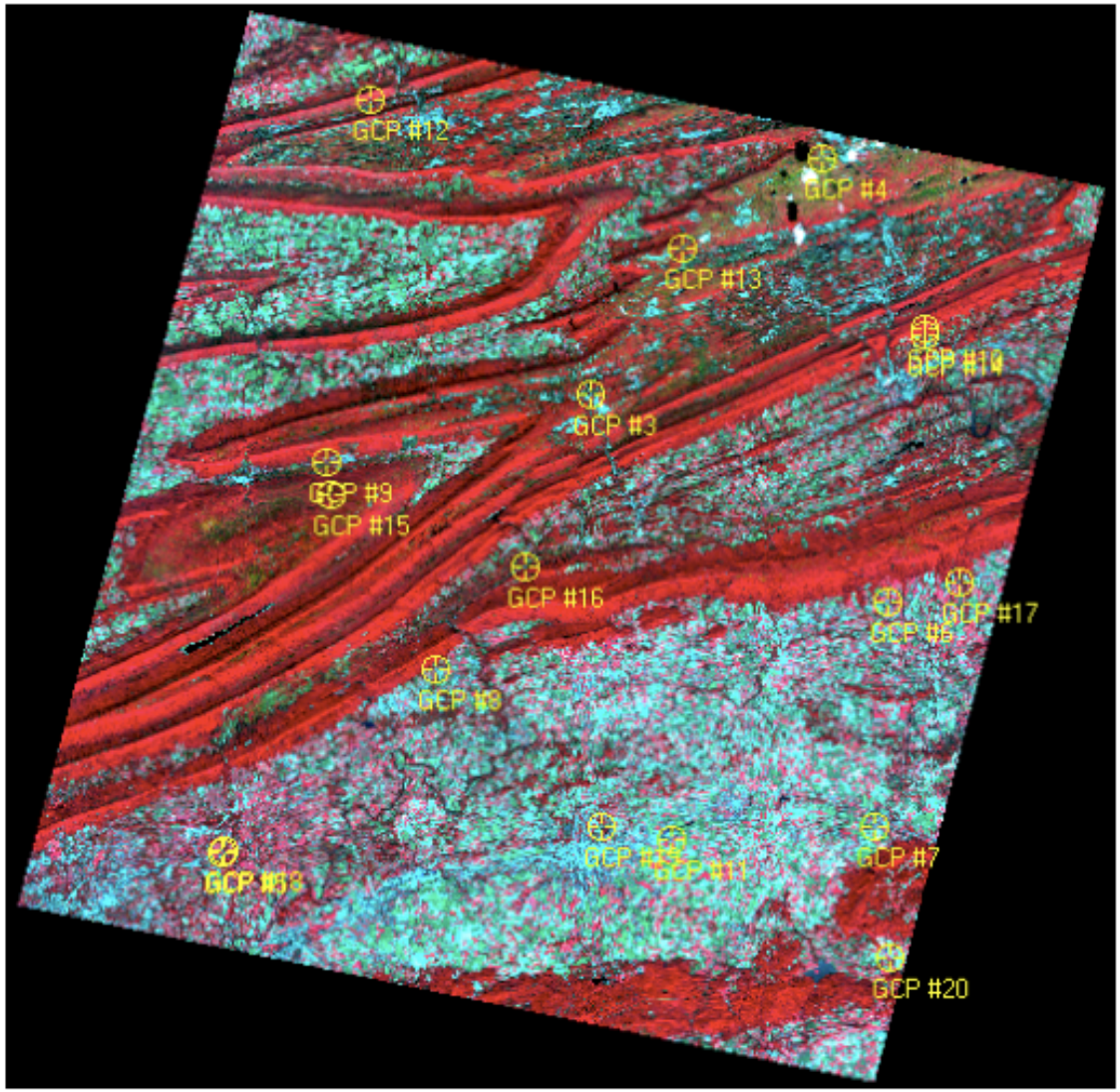
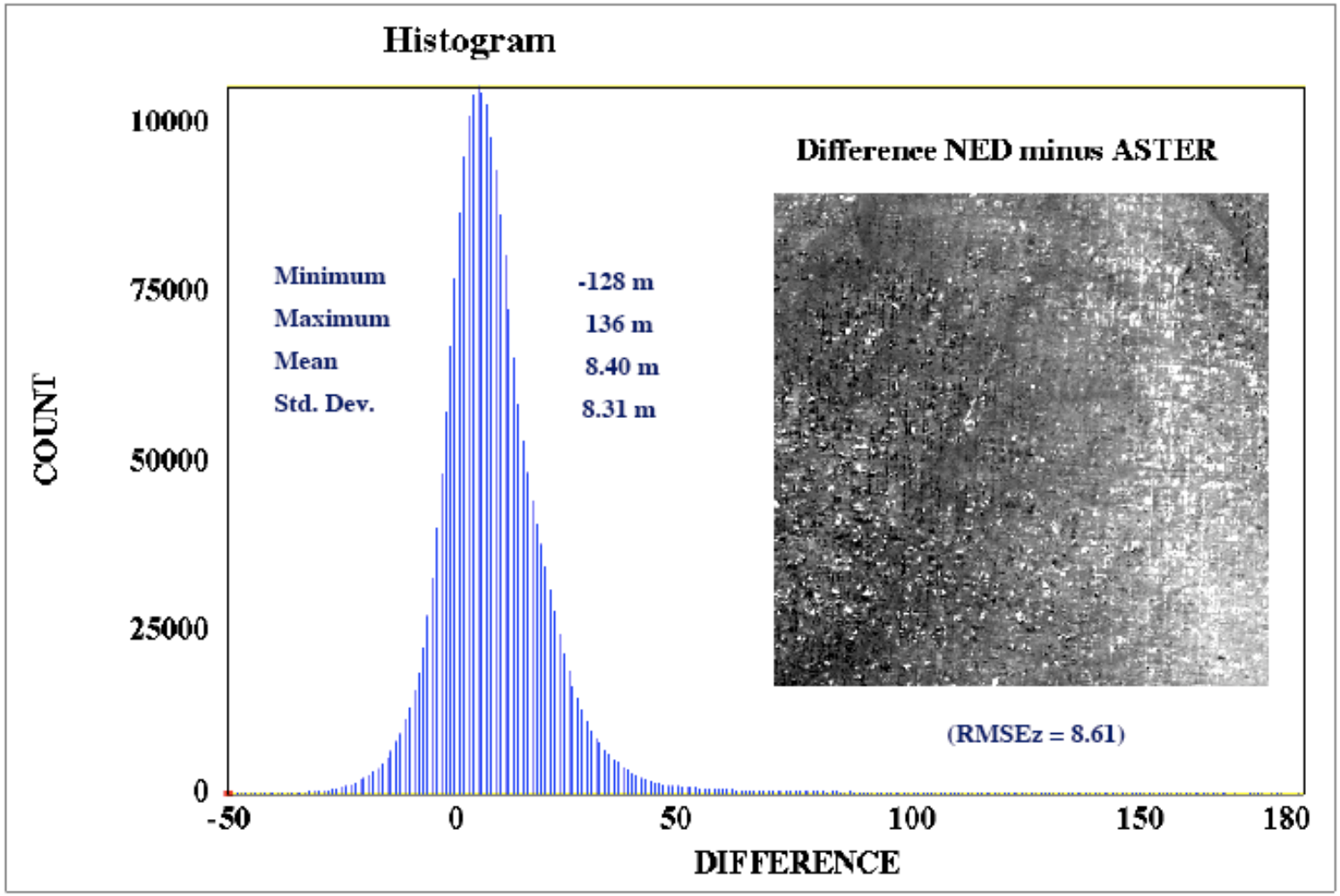


Image Statistics Derived from Difference Image



Vertical Accuracies by DEM Generation System

Software System		X	Y	Z				Z		
		RMSEx	RMSEy	Mean	Std Dev	RMSEz		Mean	Std Dev	RMSEz
SILC Early		16.98	14.08	10.46	15.40	14.36		7.04	13.89	11.64
SILC Recent		22.76	15.53	3.63	12.38	8.92				
GDS Early		50.71	10.60	9.68	14.23	14.00		10.13	15.87	15.68
GDS Recent		95.55	17.39	10.58	17.51	17.36				
SulSoft Early		20.66	21.99	24.47	18.69	18.97		22.70	20.33	18.99
SulSoft Recent		65.46	23.85	20.92	21.97	19.00				
DAAC Early		68.03	23.13	17.71	21.66	26.77		20.73	25.22	31.18
DAAC Recent		104.36	28.16	23.76	28.78	35.58				

* Recent S/W enhancements implemented by GDS, SulSoft, and LP DAAC since completion of this study may improve some results shown in this table.

Vertical Accuracies Compared: SRTM vs. ASTER DEM's

ASTER (SilCast)				
		Z		
Test Site	Acquisition Date	Mean	Std Dev	RMSEz
Drum Mountains, UT	31-Jul-00	-8.83	11.17	11.29
Mt Hood, OR	24-Sep-02	-21.79	15.91	20.02
Okoboji, IA	31-Aug-01	11.49	18.85	15.02
Reading, PA	05-Oct-01	-8.14	15.93	15.27
Tacoma, WA	28-Jun-00	2.03	15.15	10.22
	Average (Abs)	10.46	15.40	14.36
Drum Mountains, UT	20-Mar-04	0.15	8.78	8.78
Mt Hood, OR	27-Jul-04	-3.97	18.84	9.73
Okoboji, IA	22-Oct-03	-3.93	9.68	9.23
Reading, PA	06-May-04	4.61	11.67	8.50
Tacoma, WA	05-Jun-03	5.49	12.94	8.35
	Average (Abs)	3.63	12.38	8.92

SRTM				
		Z		
Test Site	Acquisition Date	Mean	Std Dev	RMSEz
Drum Mountains, UT	N/A	-2.20	2.95	2.78
Mt Hood, OR	"	-13.80	14.23	16.83
Okoboji, IA	"	4.71	1.78	4.83
Reading, PA	"	-5.63	6.25	8.02
Tacoma, WA	"	-1.99	10.75	7.91
	Average (Abs)	5.67	7.19	8.07

Future ASTER research

- Understand source of mean difference bias and relate this to land surface cover and orbital errors
- Investigate how accurately relative ASTER-DEMs can be corrected using SRTM-90m data
- Study error characteristics of ASTER vs SRTM to understand whether ASTER-DEMs can be used to fill in gaps in SRTM-DEM coverage
- Add ASTER-DEMs to CEOS-ICEDS EO Data Portal coverages

C- and X-band SRTM issues

Thanks to Paul Salamonowicz (NGA) and Marian Werner (DLR)

SRTM Accuracy Goals

- **SRTM Accuracy Design Goals at 90% Probability Level:**
  - Absolute Horizontal (AH) = 20 m
  - Absolute Vertical (AV) = 16 m
  - Random Vertical = 8m → Relative Vertical (RV) = 11 m

- **The accuracies associated with SRTM are defined as follows:**
  - **Absolute Horizontal (AH)** - 2-D horizontal error value such that if any point in the DTED cell or sub-cell is selected at random there is a 90% probability that its true horizontal position is within the AH value of a given position
  - **Absolute Vertical (AV)** – 1-D vertical error value such that if any point in the DTED cell or sub-cell is selected at random there is a 90% probability that the true elevation is within the AV value of the given elevation
  - **Relative Vertical (RV)** - 1-D vertical error such that if any two points in the DTED cell or sub-cell are selected at random there is a 90% probability that the true difference in elevation between them is within the RV value of the computed difference in elevation.
  - NOTE: Relative Horizontal (RH) error estimates are not provided for SRTM DTED® because it is difficult to measure with the coarse resolution data

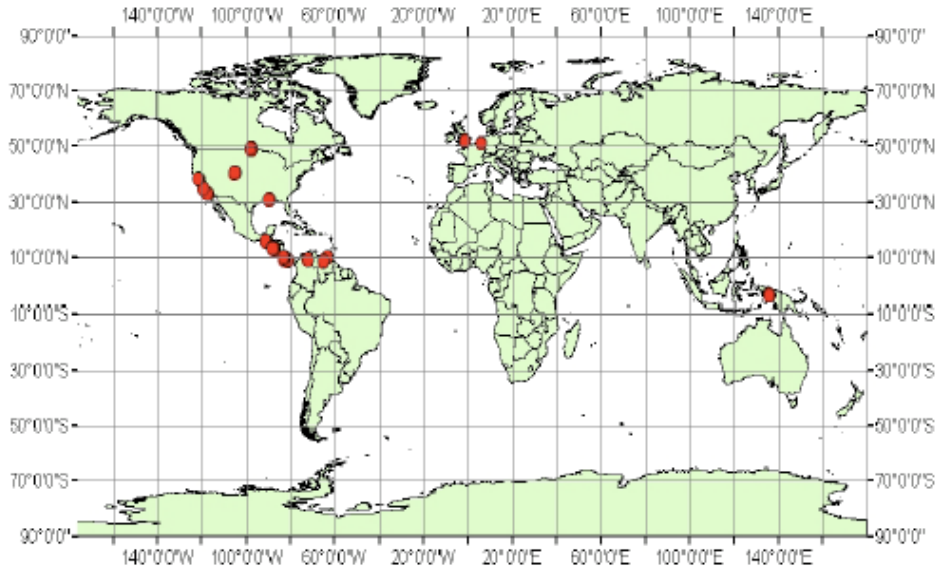
Overview of SRTM Products

- **Digital Terrain Elevation Data - Level 2® (DTED-2®)**
  - Consists of cells covering a 1° x 1° geographical area
  - Post spacing: 1” x 1” between equator and 50° latitude, 1” x 2” above 50° latitude
  - Vertical Reference: Mean Sea Level (MSL)
  - Provides cell wide error predictions at the 90% confidence level for: AH, AV, RH

- **Terrain Height Error Data (THED)**
  - Attempt to provide error estimates at a finer resolution than those provided with the DTED®
  - Provides an estimate of the elevation random error per post
  - Includes metadata known as Vertical Systematic Error Model (VSEM)
    - VSEM divides a cell into 64 sub-cells (8 x 8)
      - Each sub-cell covers 7.5’ x 7.5’ and contains 450 x 450 posts
    - VSEM Provides (at the 90% confidence level):
      - A representative random error per sub-cell
      - An estimate of the distance over which the error is correlated
      - An estimate of the long-wavelength (systematic) error
    - Based on the estimated errors above, the VSEM also provides an estimate of the absolute vertical (AV) and relative vertical (RV) errors on both a cell and sub-cell basis.

Ground Truth Data

- **Elevation Ground Truth**
  - Star-3i X-band IFSAR
    - 10 meter or 5 meter post spacing
    - Vertical Accuracy =1,2,3 m (1σ)
    - Horizontal Accuracy = 2.5 m (1σ)
  - 152 samples
  - Each sample covers approx. 1 sub-cell
  - Cover 21 unique geographic areas



Star-3i Data Samples

- **Land Classification Data**
  - The Global Land Cover 2000 (GLC2000)
    - The GLC 2000 was created as part of a project by the European Commission titled Global Environment Information System (GEIS)
    - Land cover classification was generated from SPOT-4 VEGETATION sensor
      - Contains Blue, Red, NIR, and SWIR channels
    - Worldwide data collected in 14 months from 1 November 1999 – 31 December 2000
    - The USGS/EROS Data Center participated in the classification of the data over North America.
    - More information on the dataset can be found at http://www.gvm.jrc.it/glc2000

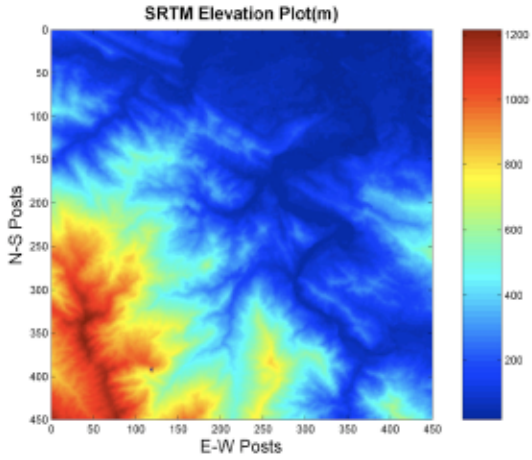
Reference: "Global Land Cover 2000 database, European Commission, Joint Research Centre, 003, http://www.gvm.jrc.it/glc2000."

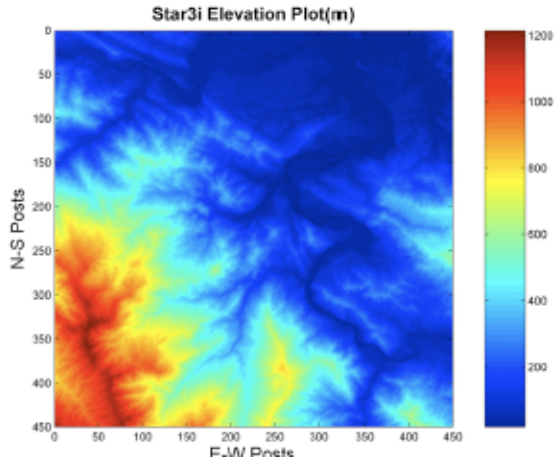
DTED-2® Analysis

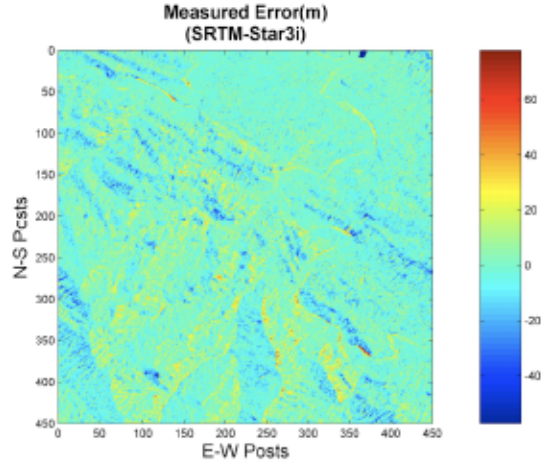
Sample of a Poor Sub-Cell: Panama – GT3N09W082C5V1

Error estimates at 90% Probability Level

	Pre Horizontal Adjustment				Post Horizontal Adjustment Shift X:-21m Shift Y: -6m			
	LW /Bias (m)	RRE (m)	AV (m)	RV (m)	LW /Bias (m)	RRE (m)	AV (m)	RV (m)
Predicted	4.9	6.9	8.5	9.7	4.9	6.9	8.5	9.7
Measured	3.0	15.1	15.6	21.1	2.1	12.2	12.2	16.9



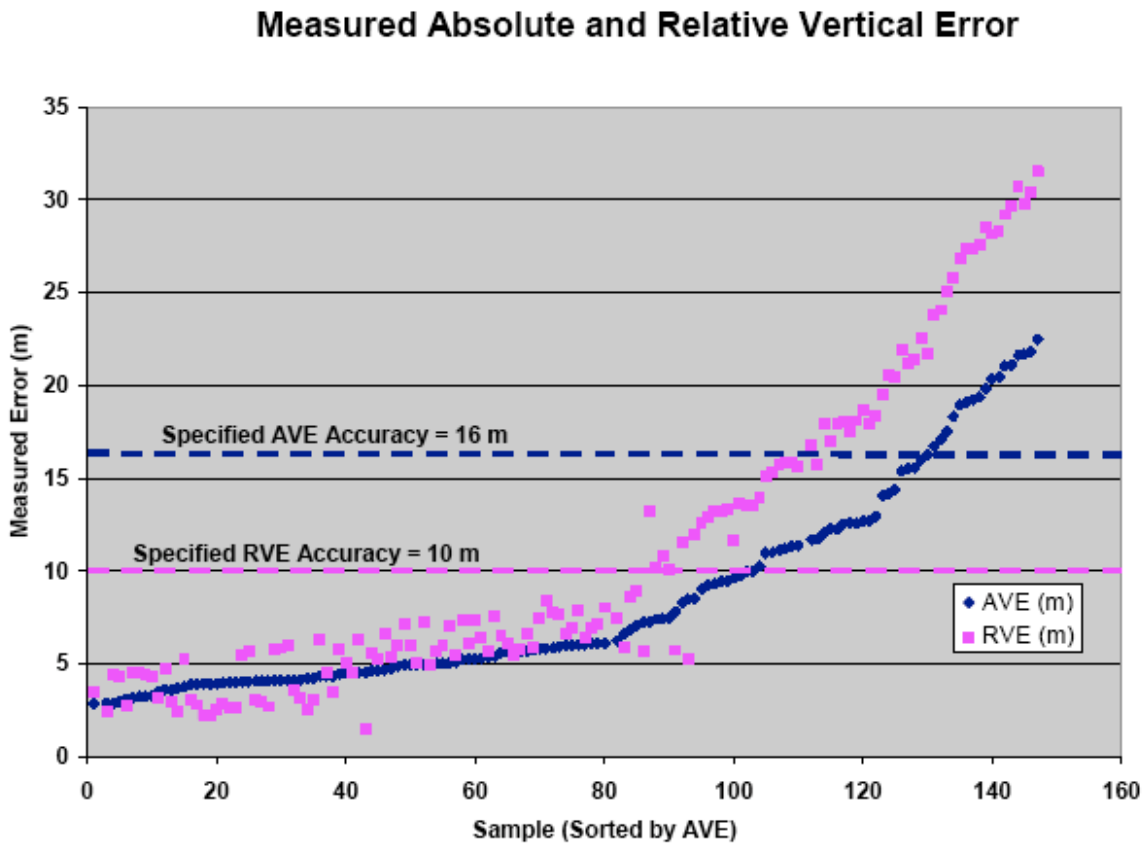




DTED-2® Vertical Accuracy Results

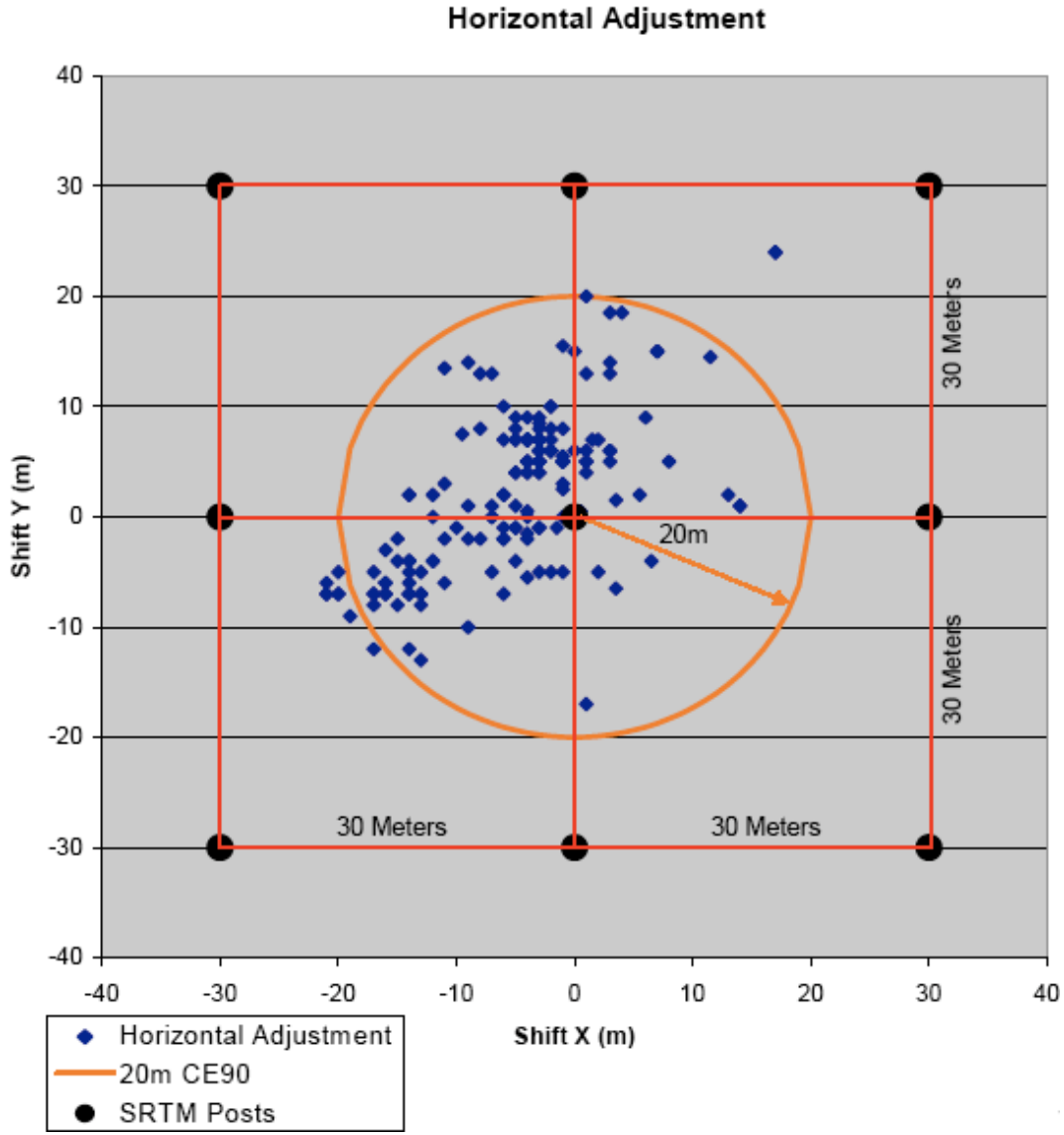
- The measured AV for the various samples show that most of them (88%) meet the SRTM specification
- Only 60% of the RV meet the specification

Note: Many of the samples used in this study are from regions that make IFSAR collection difficult



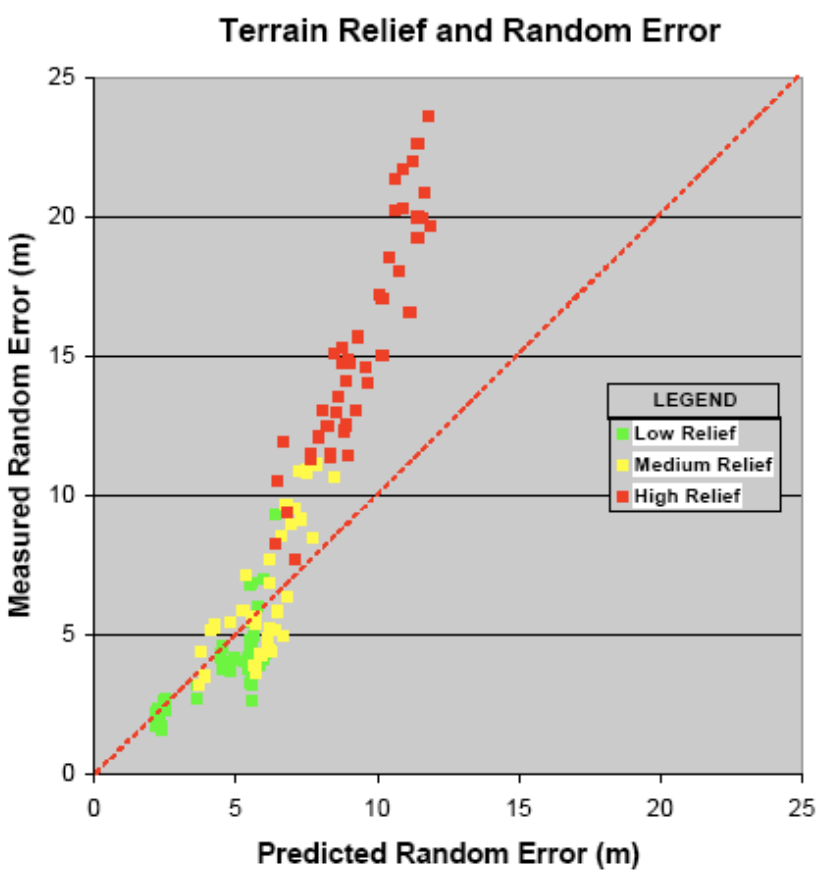
DTED-2® Horizontal Accuracy Results

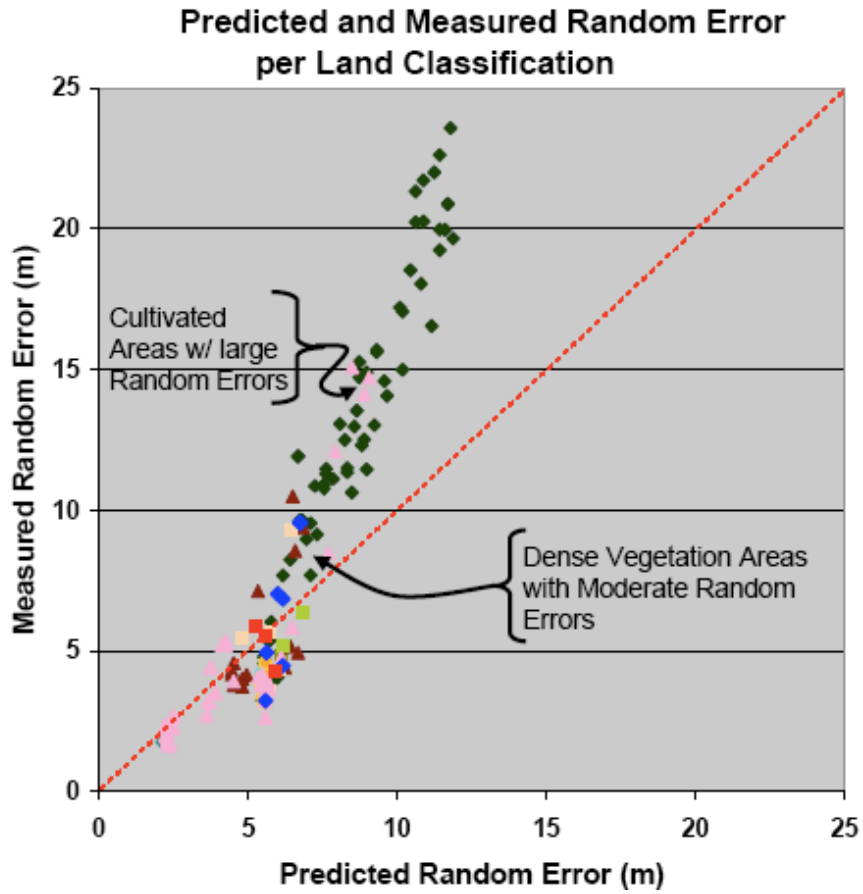
- Quality of the horizontal positioning of the SRTM data is very good
- Design spec for absolute horizontal accuracy was 20 meters at the 90% confidence interval
- The measured horizontal shifts are well within this value



SRTM / THED Error Analysis

Comparison of the random error plot based on terrain and based on land classification





Representative Sample

Average accuracy results for our sample at the 90% probability level

	Random	AV (m)	RV (m)	Global Percentage
Overall	8.11	8.38	10.90	100.00
Low Relief	3.69	4.79	5.04	67.03
Mid Relief	6.36	6.64	8.76	25.69
High Relief	15.46	15.18	21.36	7.28

- Using global percentages for relief to normalize SRTM accuracies based on the results of this study yields the following global accuracy estimate:

  AV = 6.0 m RV = 7.2 m Random = 5.2 m

- These compare well to the JPL results averaged across continents:

  AV = 6.8 m RV = 6.9 m

Validation: SRTM / X-SAR DEM over Germany

(Navigation Point Height) – (SRTM Height)

flat terrain				
	number	**μ**	**σ**	**RMS**
forested areas	2329	-6.20	6.74	9.16
urban areas	1683	-2.63	4.10	4.87
open landscape	**20786**	**-0.94**	4.31	**4.41**
Σ	24798	-1.55	4.84	5.08
moderate relief				
	number	**μ**	**σ**	**RMS**
forested areas	1970	-1.98	7.60	7.86
urban areas	725	-1.14	4.86	5.00
open landscape	**8000**	**+0.15**	4.54	**4.54**
Σ	10695	-0.33	5.33	5.34
highlands				
	number	**μ**	**σ**	**RMS**
forested areas	2272	-4.43	8.62	9.69
urban areas	766	-1.04	5.29	5.39
open landscape	**7693**	**-0.74**	5.36	**5.41**
Σ	10731	-1.54	6.37	6.55

Tab. 1: SRTM DEM validation against navigation points in the western part of Germany

Reference Data:

- 46231 Navigation Points (NPs), provided by AMilGeo Euskirchen, Germany
- Test area: western part of Germany 1000 km x 300 km
- The mean of the SRTM heights is in good accordance to the NPs for open landscape
- Urban and forested areas show the expected bias (= mean difference between surface and terrain height)
- Standard deviations correspond to the height errors induced by the uncompensated boom oscillations
- PDF of tree heights => higher RMS values for forested areas

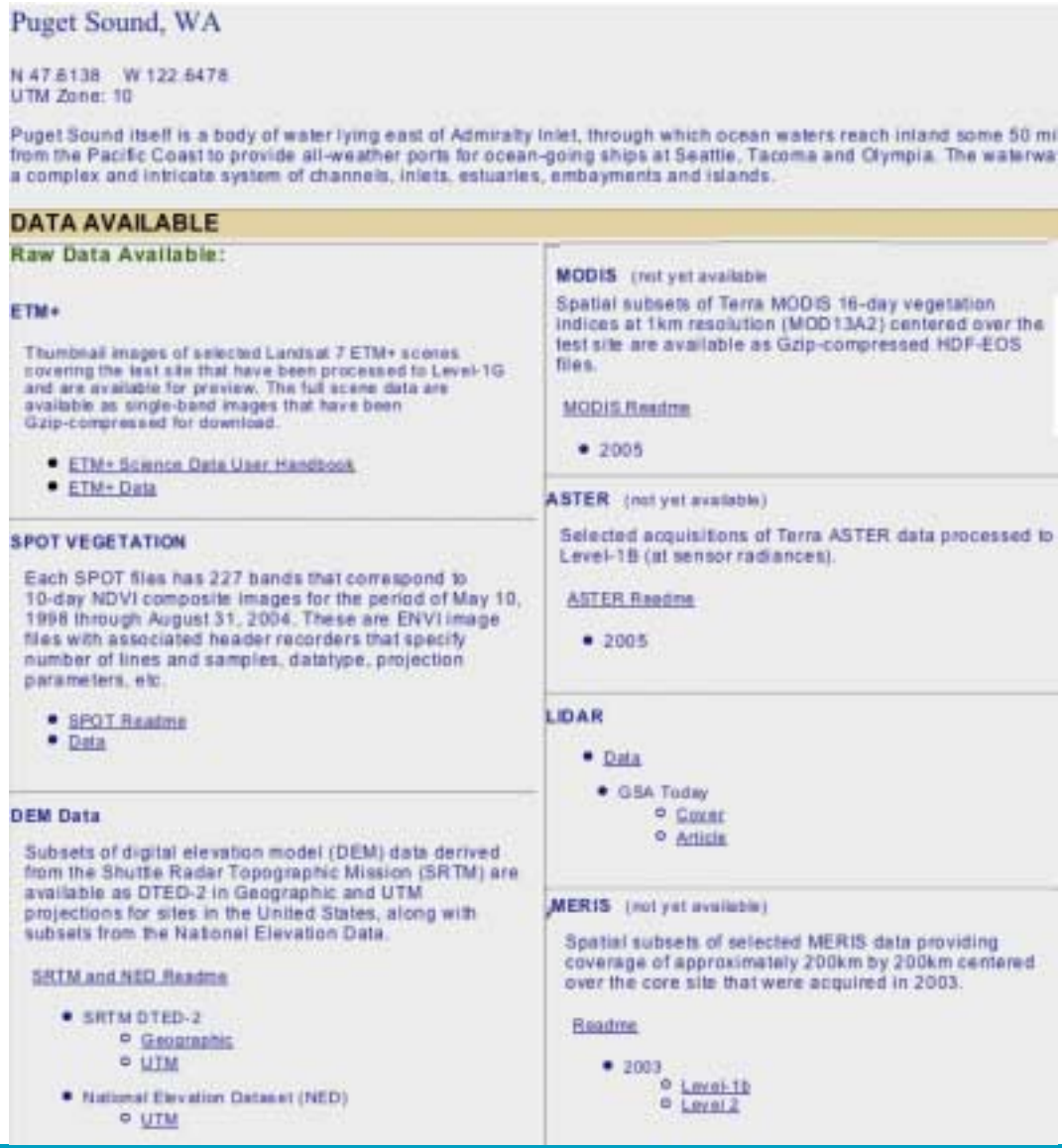
X- and C-SRTM DEM: Future Issues

- JPL have completed editing the SRTM 3" (≈90m) DEM and USGS now distribute this using anonymous ftp
- JPL have completed the orthorectification of the SRTM SAR amplitude subsetted by orbit and by a 1° x 1° tile
- At the workshop, NASA and USGS requested that NGA release the SRTM 1" (≈30m) DEM as well as the THED. NGA responded by stating that the US had various bi-lateral agreements with countries around the globe which prevented this. The debate continues but it should be noted that Scott Hensley (JPL) showed that the true resolution of SRTM-1" was some 45-60m cf. 30m
- User's priority (e.g. UN, GEOSS) is to fill gaps in SRTM coverage including above 60°N and below 56°S
- NASA has prioritised the re-processing of SRTM including X- and C- as well as ICESAT-GLAS
- DLR are awaiting the results of a national review on whether the proposed TANDEM-X (dual TerraSAR-X) will be funded

WGISS/WGCV Test Facility (WTF)

- Puget Sound test site populated with 30m SRTM (finished NGA-supplied called SRTM-DTED2®), all other NASA and ESA datasets and airborne lidar datasets
- All US WTF sites now have 1”(30m) SRTM-DTED2® and all non-US have 3”(90m) SRTM-DTED1®
- Would like to extend WTF to include
  - Other spaceborne DEM products (e.g. GETASSE30) for Puget Sound (e.g. SPOT-5, ERS-tandem, ALOS-PRISM)
  - Land cover information (US-NLCD at 30m, MODIS and GLC2000 at 1km and GlobCover at 300m)
  - Add other TMSG test sites in Europe (North Wales, Barcelona, Aix-en-Provence)
- How will this be supported as there are no committed resources and the future of transitioning WTF to an operational service is not agreed?
- This also applies to “Known Issues” which TMSG would like to kick-off using SRTM DEMs at EDC. However, it is hoped that if CEOS Plenary agree to the relevant Recommendation that this can go ahead
- SRTM workshop strongly endorsed recommendation for establishment of “Known Issues” web-pages for SRTM

Example of WTF datasets available



Puget Sound, WA

N 47.6138 W 122.6478
UTM Zone: 10

Puget Sound itself is a body of water lying east of Admiralty Inlet, through which ocean waters reach inland some 50 mi from the Pacific Coast to provide all-weather ports for ocean-going ships at Seattle, Tacoma and Olympia. The waterwa a complex and intricate system of channels, inlets, estuaries, embayments and islands.

DATA AVAILABLE

Raw Data Available:

ETM+

Thumbnail images of selected Landsat 7 ETM+ scenes covering the test site that have been processed to Level-1G and are available for preview. The full scene data are available as single-band images that have been Gzip-compressed for download.

- ETM+ Science Data User Handbook
- ETM+ Data

SPOT VEGETATION

Each SPOT files has 227 bands that correspond to 10-day NDVI composite images for the period of May 10, 1998 through August 31, 2004. These are ENVI image files with associated header recorders that specify number of lines and samples, datatype, projection parameters, etc.

- SPOT Readme
- Data

DEM Data

Subsets of digital elevation model (DEM) data derived from the Shuttle Radar Topographic Mission (SRTM) are available as DTED-2 in Geographic and UTM projections for sites in the United States, along with subsets from the National Elevation Data.

SRTM and NED Readme

- SRTM DTED-2
  - Geographic
  - UTM
- National Elevation Dataset (NED)
  - UTM

MODIS (not yet available)

Spatial subsets of Terra MODIS 16-day vegetation indices at 1km resolution (MOD13A2) centered over the test site are available as Gzip-compressed HDF-EOS files.

MODIS Readme

- 2005

ASTER (not yet available)

Selected acquisitions of Terra ASTER data processed to Level-1B (at sensor radiances).

ASTER Readme

- 2005

LIDAR

- Data
- GSA Today
  - Cover
  - Article

MERIS (not yet available)

Spatial subsets of selected MERIS data providing coverage of approximately 200km by 200km centered over the core site that were acquired in 2003.

Readme

- 2003
  - Level-1b
  - Level 2

WGISS EO Data Portal - Update on ICEDS wrt TMSG

- Drill-down to anywhere on the planet to scales of 1:25 000 (30m) for colourised hill-shaded SRTM-DEMs (unedited at present)
- Find out what archived DEM data is available for anywhere (e.g. NASA ASTER, courtesy of EDC) to fill gaps in SRTM DEMs
- Explore change (e.g. Landsat 5 to 7) using transparency and flicker and context (e.g. rivers, transportation networks) including SRTM-derived water features
- Interactive exploration of geographical relationships at the continental and global scale (e.g. sea-level rise impact of global population)
- http://iceds.ge.ucl.ac.uk

Recommendations to CEOS Plenary: TMSG

- Background: It has previously been agreed that spaceborne DEMs will be used preferentially for georadiometric processing of other EO data products. The existence of ACE and SRTM global DEM products is acknowledged. Current georadiometric processing at NASA uses non-EO data sources of dubious quality containing many artifacts. Current georadiometric processing at ESA uses an unvalidated DEM (GETASSE30)
- WGCV Requirement: Spaceborne DEMs should only be used for georadiometric processing if and only if their errors and artifacts have ben fully characterised
- Recommendation: CEOS recommends member space agencies evaluate the impact of using different sources, especially space-based DEMs for georadiometric processing of EO data products. CEOS further recommends that quantitative evaluation of spaceborne DEM products be performed and published as part of any future web infrastructure for validation
- WGCV Follow-up Activities: TMSG offer to provide, with suitable resourcing, the error characterisation required of these spaceborne DEMs as well as examples of “Known Issues” with downstream products caused by errors in the DEMs used for georadiometric processing.