CEOS-WGCV39 Terrain Mapping Sub-group: Current Status and Future Uncertainty

Jan-Peter Muller
j.muller@ucl.ac.uk

Point-of-Contact, GEOSS Task IN-02
Chairperson, CEOS-WGCV Sub-group on Terrain mapping from satellites
Chairperson, ISPRS Commission IV WG on “Global DEM Interoperability”
Head, Imaging Group
Professor of Image Understanding and Remote Sensing
HRSC Science Team Member (ESA Mars Express 2003)
Stereo Panoramic Camera Science Team Member (ESA EXOMARS)
MODIS & MISR Science Team Member (NASA EOS Project)
TerraSAR-X and TANDEM-X science team member (DLR-Astrium)

*partially supported by UK Space Agency
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 current space assets.
• Terrain mapping SG linked to ISPRS IV/3 on “Global DEM interoperability” and GEO task IN-02-C2.1 on “Global DEM”
• Annual technical workshops as part of an international conference
  • ISPRS Commission IV Symposium, Orlando, FL, 16-18 November 2010
  • 2011 symposium had to be abandoned due to Japanese tsunami
  • Special session at ISPRS Congress, Melbourne, 26 August – 2 September 2012
  • Invited talk & sessions at ISPRS Comm.IV Symposium, Suzhou, 18-20 May 2014
  • Planned sessions at ISPRS 2016 in Prague, Czech Republic, 12-19 July 2016
• News announcements as and when there is relevant news (included news on the release of the SRTM v3 aka SRTM-Plus)
• Emails to collect inputs for WGCV #39 (59 on email list, 4 responses in total)
• Everything done on a “best efforts” basis with minimal funding so limited ambitions to meet specific objectives
• Key goals are the generation of higher spatial resolution spaceborne DEMs (and bathymetric DEMs) and derived DTMs for next generation sensors
• Keen to move forward with studying impacts of DEM uncertainties on derived LPV, IVOS and SAR products
Overview

• Why does GEO need global topography/bathymetry?
• Current State-of-the-art in DEM production & quality assessment
  • Status of 30m NASADEM (provided by Bob Crippen, JPL)
  • Assessment of UK TanDEM-X (Lang Feng & JPM)
  • Euro-Maps3D (provided by Andreas Uttenthaler, GAF AG)
  • Data fusion using Cosmo-Skymed (provided by M. Liao, Wuhan)
  • Assessment of TanDEM-X i-DEM over CEOS-WGCV test site in Tasmania (provided by Medhavy Thankappan, Geoscience Australia)
• Status of tasks in IN-02-C2.1 Global DEM
• TMSG Future Uncertainty
Why does GEO need global topography/bathymetry?

- Global DEM required for 6 of the 9 societal benefit areas identified by the Implementation Plan of GEOSS 2005-2015, and for 2015-2025
- Natural disasters all require detailed knowledge of topography
  - either directly for volcanic dome monitoring, flood inundation areal predictions, landslides
  - or for downstream EO processing, e.g. InSAR for earthquake monitoring and possible prediction
- Poor bathymetric and topography knowledge hinders tsunami forecasts
- Tsunami a main spur for GEO implementation

30m height “flood-fill” based on SRTM-DTED1® 3’ (~90m)

2’ (~4km) Smith, Walter H.F., and David T. Sandwell, 1997
1. Reprocess the SRTM DEM

Use advanced software to reprocess raw SRTM data primarily to reduce the occurrence of DEM voids.

2. SRTM-ICESat Synergism

Use precise ICESat elevation profiles to correctly match overlapping SRTM swaths for seamless DEM mosaics.

…and then again fill remaining voids with ASTER GDEM and other best-available alternative DEMs, but with improved methods.
Results on a single data take – Himalaya Mountains

SRTM reprocessing for void reduction

standard

snaphu *

* SNAPHU: Statistical-Cost, Network-Flow Algorithm for Phase Unwrapping (Chen and Zebker, Stanford Radar Interferometry Research Group)

Marco LaValle, 2014
Reunion Island
Southeast Panama: Shorelines and Clouds

SRTM
Voids & Water Mask Errors

GDEM
Clouds & Shoreline Errors

SRTM Plus (v3)
Generally good at replacing bad GDEM with GMTED2010
Use of GMTED2010 in SRTM Plus (NASA v3)

Relates to:
* Voids in SRTM (always)
* Clouds in GDEM (some places)
* Misc Elevation Errors in SRTM / GDEM
  (e.g. SRTM interferometric unwrapping errors)
SRTM Void Fill Improvements

GDEM2 with glitch removal and interpolation based only upon GDEM2 morphometrics (preliminary results)

Can improve GDEM fill in SRTM Plus and NASADEM and in polar areas
SRTM1 v2 released to date at 1” (30m)

Mosaic created by L. Feng (UCL-MSSL). Gap due to be filled in August 2015
Announcements of Opportunity

Science Opportunities for the DEM products:

Announcements (release date, closing date)
- Intermediate DEM (from first global coverage, difficult terrain excluded, for selected regions only) 5.12.13, 14.3.14
- TanDEM-X DEM Autumn 2016??
### DEM Products for Scientific Use

#### Intermediate DEM (no global coverage)

<table>
<thead>
<tr>
<th>DEM Product</th>
<th>Spatial Resolution Absolute</th>
<th>Horizontal Accuracy CE90</th>
<th>Absolute Vertical Accuracy LE90</th>
<th>Relative Vertical Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEM (intermediate DEM)</td>
<td>~12m (0.4 arcsec @ equator)</td>
<td>&lt;10m</td>
<td>&lt;10m</td>
<td>Not specified</td>
</tr>
<tr>
<td>IDEM (1 arcsec)</td>
<td>~30 m (1 arcsec @ equator)</td>
<td>&lt;10m</td>
<td>&lt;10m</td>
<td>Not specified</td>
</tr>
<tr>
<td>IDEM (3 arcsec)</td>
<td>~90 m (3 arcsec @ equator)</td>
<td>&lt;10m</td>
<td>&lt;10m</td>
<td>Not specified</td>
</tr>
</tbody>
</table>
Intermediate DEM (IDEM): Distribution

Investigated area: ul-1r lon/lat -180 90 - 180 -90

Found cells: 2697
Total kbytes: 1517837008
Covered skm: 12656286.0
EOWEB – Data Distribution Server
Preliminary assessment of TanDEM-X i-DEM over the UK

Jan-Peter Muller, Lang Feng
May 2015
### Input Data Set

<table>
<thead>
<tr>
<th>Input Data Set</th>
<th>SRTM</th>
<th>Aster GDEM</th>
<th>i DEM</th>
<th>Blue Sky</th>
</tr>
</thead>
</table>

### Coverage

<table>
<thead>
<tr>
<th>Coverage</th>
<th>GLOBAL</th>
<th>GLOBAL</th>
<th>UK &amp; worldwide (3&quot;)</th>
<th>UK, N. Ireland</th>
</tr>
</thead>
</table>

### Source

<table>
<thead>
<tr>
<th>Source</th>
<th>NASA JPL/USGS</th>
<th>USGS</th>
<th>DLR-TerraSAR-X</th>
</tr>
</thead>
</table>

### Resolution

<table>
<thead>
<tr>
<th>Resolution</th>
<th>1 arc-second</th>
<th>1 arc-seconds</th>
<th>1&quot; (≈30m)</th>
<th>3&quot; (≈90m)</th>
<th>10m or 5m</th>
</tr>
</thead>
</table>

### Ellipsoid

<table>
<thead>
<tr>
<th>Ellipsoid</th>
<th>WGS84</th>
<th>WGS84</th>
<th>WGS84-G1150</th>
<th>OSGB36</th>
</tr>
</thead>
</table>

### Vertical Datum

<table>
<thead>
<tr>
<th>Vertical Datum</th>
<th>EGM96</th>
<th>EGM96</th>
<th>WGS84-G1150</th>
<th>ODN</th>
</tr>
</thead>
</table>

### Projection

<table>
<thead>
<tr>
<th>Projection</th>
<th>Geographic Lat/Lon</th>
<th>Geographic</th>
<th>Geographic</th>
<th>TM projection</th>
</tr>
</thead>
</table>

### Acquisition Date

<table>
<thead>
<tr>
<th>Acquisition Date</th>
<th>February 2000</th>
<th>February 2000</th>
<th>2011-13 (?)</th>
<th>-</th>
</tr>
</thead>
</table>
UK DEMs’ coverage

TerraSAR-X+TanDEM-X

Aerial stereo-photogrammetry

Working Group on Calibration and Validation
Coordinate systems must be the same.

Need to perform coordinate conversion.

- How to convert EO-DEM to OSGB36?
6.6 Approximate WGS84 to OSGB36/ODN transformation

The following Helmert transformation converts WGS84 (or ETRS89 or ITRS, the differences are negligible here) coordinates to ‘something like’ OSGB36 and ‘something like’ ODN heights. The error is up to five metres both horizontally and vertically. This is good enough for certain applications. This transformation is for use with equation (3). Note the remarks made about Helmert transformations in section 6.2.

\[
\begin{pmatrix}
\tau_x (\text{m}) \\
\tau_y (\text{m}) \\
\tau_z (\text{m}) \\
s (\text{ppm}) \\
r_x (\text{sec}) \\
r_y (\text{sec}) \\
r_z (\text{sec})
\end{pmatrix} = \begin{pmatrix}
-446.448 \\
+ 125.157 \\
- 542.060 \\
+ 20.4894 \\
- 0.1502 \\
- 0.2470 \\
- 0.8421
\end{pmatrix}
\]

**NOTE 1:** OSGB36 is an inhomogeneous TRF by modern standards. Do not use this transformation for applications requiring better than 5 metre accuracy in the transformation step, either vertically or horizontally. Do not use it for points outside Britain.

**NOTE 2:** OSGB36 does not exist offshore.
Coding and comparison results of two methods

<table>
<thead>
<tr>
<th>comparison</th>
<th>min</th>
<th>max</th>
<th>Mean(m)</th>
<th>Stdev(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odn-osgb36</td>
<td>-0.372</td>
<td>15.398</td>
<td></td>
<td></td>
</tr>
<tr>
<td>eDpisoid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The datum varies in OSGB36 national grid
Wales results

CEOS test site in Wales, W4-W3 and N51-N52 (UpperLeft:(-4°,52°), LowerRight:(-3°,51°))
b1(r): Aster
b2(g): IDEM
b3(b): SRTM
b4: BLUESKY

Ps:b is band

mask

UK DEM 30m after registration

Working Group on Calibration and Validation
<table>
<thead>
<tr>
<th>Basic Stats</th>
<th>Min</th>
<th>Max</th>
<th>Mean(m)</th>
<th>Stdev</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRTM30m-Bluesky30m</td>
<td>-13.751</td>
<td>41.582</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aster30m-bluesky 30m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRTM30m –Aster 30m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Stats</th>
<th>Min</th>
<th>Max</th>
<th>Mean(m)</th>
<th>Stdev</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEM30m-SRTM 30m</td>
<td>-15.992</td>
<td>25.4832</td>
<td>-0.603</td>
<td>5.829</td>
</tr>
<tr>
<td>IDEM30m-bluesky 30m</td>
<td>-15.911</td>
<td>41.819</td>
<td>1.136</td>
<td>7.274</td>
</tr>
<tr>
<td>IDEM30m - Aster30m</td>
<td>-41.598</td>
<td>26.683</td>
<td>0.729</td>
<td>10.865</td>
</tr>
</tbody>
</table>
Analysis areas in UK

- Birmingham
- MSSL, Surrey
- Wales
- Swanage, Dorset

Urban building area in Birmingham

Conclusion: in urban area, Bluesky is DTM. IDEM, SRTM, ASTER are higher than Bluesky
SAR backscattering is controlled by Radar Wavelength

Penetration ability to forest

- L-band 23.5 cm
- C-band 5.8 cm
- X-band 3 cm
- Swanage coast area
- Coast area: IDEM has Null values
- Visible optical wavelength can penetrate coastline water
Evaluation of the TanDEM-X Intermediate DEM for Terrain Illumination Correction in Landsat Data

Li, F. ¹, Jupp, D.L.B. ², Thankappan, M. ¹, Wang, L.W. ¹, Lewis, A. ¹ and Held, A. ²
Objectives

• Assess the impact of different sources of spaceborne DEMs on the georadiometric correction of surface spectral BRF (Bi-directional Reflectance Factors)
• Perform qualitative assessments from the “look-and-feel” of the output results as well as explore the correlation between cos (solar_elevation) and BRF
• Assessed the impact of using (a) SRTM at 30m; (b) iDEM at 12m; (c) iDEM at 30m as part of the topographic correction model which includes water vapour (NCEP), aerosols (AATSR) and BRDF (MODIS)
Geographical context & DEM profiles assessment

SRTM (black), iDEM (red)
Mosaic of terrain corrected Landsat false colour images (bands 4, 3, 2 for Landsat 7 and 5, 4, 3 for Landsat 8) using IDEM 12 m

False colour Composite of height, slope and curvature
Examples of terrain illumination correction

iDEM12 and iDEM30m show better georadiometric correction
Euro-Maps 3D is realized in a long-standing cooperation

Semi-automated, globally applicable workflow for consistent results

with production and quality assessment processes
IRS-P5 Cartosat-1

PAN-Fore & PAN-Aft
31° stereo viewing angle
Nominal B/H ratio 0.62

- Stereo optimized satellite
- Since 2005 continuous collection of stereo data
Highly reliable photogrammetric optical stereo approach

- Pixel based Semi-Global Matching
- Leading to a very sharp representation of the surface
Highly standardized and automated workflow benefiting from high data redundancy, leading to very reliable height information.
Full transparency of:
- source data,
- production and
- quality through several quality- and traceability layers
<table>
<thead>
<tr>
<th>Test site</th>
<th>Land cover/relief</th>
<th>LE90</th>
<th>CE90</th>
</tr>
</thead>
<tbody>
<tr>
<td>选址</td>
<td>Urban, hilly</td>
<td>3.9</td>
<td>4.2</td>
</tr>
<tr>
<td>喀布尔</td>
<td>Urban, hilly</td>
<td>3.4</td>
<td>2.2</td>
</tr>
<tr>
<td>苏克鲁</td>
<td>Agriculture, flat</td>
<td>5.3</td>
<td>4.0</td>
</tr>
<tr>
<td>亚达</td>
<td>Agriculture, forest, mountainous</td>
<td>5.5</td>
<td>5.9</td>
</tr>
<tr>
<td>阿达</td>
<td>Wetlands, agriculture, flat</td>
<td>3.6</td>
<td>9.4</td>
</tr>
<tr>
<td>纳沙普-北</td>
<td>Mountainous</td>
<td>3.9</td>
<td>4.6</td>
</tr>
<tr>
<td>纳沙普-南</td>
<td>Mountainous</td>
<td>4.1</td>
<td>5.8</td>
</tr>
<tr>
<td>迈尔克</td>
<td>Urban, agriculture, flat</td>
<td>6.3</td>
<td>4.3</td>
</tr>
<tr>
<td>海德堡</td>
<td>Forest, urban, agriculture, hilly</td>
<td>5.2</td>
<td>5.6</td>
</tr>
<tr>
<td>科伦特</td>
<td>Forest, urban, open cast mining, hilly</td>
<td>4.4</td>
<td>6.0</td>
</tr>
<tr>
<td>图恩</td>
<td>Urban, hilly</td>
<td>3.9</td>
<td>5.7</td>
</tr>
<tr>
<td>勒鲁夫1</td>
<td>Dry, flat</td>
<td>4.0</td>
<td>7.8</td>
</tr>
<tr>
<td>勒鲁夫2</td>
<td>Dry, flat</td>
<td>4.0</td>
<td>7.8</td>
</tr>
<tr>
<td>法伊特</td>
<td>Dry, very flat, salt lakes</td>
<td>3.6</td>
<td>7.4</td>
</tr>
<tr>
<td>乌姆索利</td>
<td>Forest, agriculture, flat</td>
<td>5.4</td>
<td>5.1</td>
</tr>
<tr>
<td>新元</td>
<td>Agriculture, forest, mountainous</td>
<td>8.4</td>
<td>7.4</td>
</tr>
<tr>
<td>莫拉</td>
<td>Agriculture, hilly</td>
<td>4.8</td>
<td>7.0</td>
</tr>
<tr>
<td>特里斯坦</td>
<td>Agriculture, hilly</td>
<td>6.5</td>
<td>4.1</td>
</tr>
<tr>
<td>雷西亚</td>
<td>Dry, flat</td>
<td>5.9</td>
<td>6.9</td>
</tr>
<tr>
<td>索普利</td>
<td>Forest, hilly</td>
<td>8.4</td>
<td>5.1</td>
</tr>
<tr>
<td>弗里德里希施泰因</td>
<td>Agriculture, forest, flat</td>
<td>3.3</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Tested and verified against GPS transects in 22 test sites:
- different landscapes and types of relief:
  - **CE90 6.7 m**
  - **LE90 5.1 m**

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Access to worldwide stereo data

- Yellow: General availability of suitable stereo data - new acquisitions needed for area-wide products
- Orange: Good stereo data availability for area-wide products - small gap can be filled with new acquisitions
- Red: Very good stereo data availability for area-wide products - no new acquisitions required
- Blue: Euromaps 3D available off-the-shelf

Status: 03.2015
<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post spacing</td>
<td>5 m</td>
</tr>
<tr>
<td>Spatial reference system</td>
<td>DD or UTM / WGS84</td>
</tr>
<tr>
<td>Height reference system</td>
<td>EGM96</td>
</tr>
<tr>
<td>Relative vertical accuracy</td>
<td>LE90 &lt;2.5 m</td>
</tr>
<tr>
<td>Absolute vertical accuracy</td>
<td>LE90 5-10 m</td>
</tr>
<tr>
<td>Absolute horizontal accuracy</td>
<td>CE90 5-10 m</td>
</tr>
<tr>
<td>File format</td>
<td>GeoTIFF (16-bit)</td>
</tr>
<tr>
<td>Tile-based DSM</td>
<td>0.5° x 0.5° tiles</td>
</tr>
<tr>
<td>Base data</td>
<td>IRS-P5</td>
</tr>
<tr>
<td>Ortho layer pixel size</td>
<td>2.5 m</td>
</tr>
</tbody>
</table>

HRE80 and HREGP accuracy requirements are fulfilled
# Euro-Maps 3D Prices

<table>
<thead>
<tr>
<th>Digital Surface Model</th>
<th>Price per km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product &lt; 50,000 km²</td>
<td>€ 7.50</td>
</tr>
<tr>
<td>Product &gt; 50,000 km²</td>
<td>€ 4.50</td>
</tr>
</tbody>
</table>

1) Minimum AOI size is 700 km²  
2) Minimum width of the AOI is 14 km

See also: [http://www.euromap.de/products/prod_001.html](http://www.euromap.de/products/prod_001.html)
Euro-Maps 3D

Kosovo

- Seamless mosaic
- ~ 130 Stereo pairs
- Multiple coverage of up to 8 stereo pairs

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Area-wide coverages: Example: Syria-Northern Iraq
Examples: Urban Structures

City of Aleppo, Syria
© 2015, GAF AG, includes Antiris material

City of Arbil, Iraq
© 2015, GAF AG, includes Antiris material

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Examples: Forest structures

Ferdinándi-váci, Croatia-Hungarian border
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Friedrichshafen, Germany
© 2015, GAF AG, includes Arctix material

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Examples: Geological Structures

Sinjar Mountains, Iraq
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Al Sukhna, Syria
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Bandar Abbas, Iran
© 2015, GAF AG, includes Antirx material

Aeolian Islands, Italy
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Water body editing
Ortho image & DSM
Validation of height values

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Infrastructure planning (cross border)
- Modelling (hydrological, geological, wind,...)
- Urban planning
- Oil & Gas exploration / monitoring
- Telecommunication network planning
- Radio propagation
- Site location assistance (wind turbines,...)
- Calculation of volumina (e.g. open cast mining,...)
- Optimization of fuel consumption (best route assessment,...)

Hazard analysis
- Slope and exposure
- Flood and flow regime

Visualization
- 2D (terrain impressions)
- 3D (fly through; low level flight planning; touristic applications)

Derivation of new data products
- Orthorectification of satellite data
- Digital terrain model creation
- Topographic mapping, e.g. contour lines
- Elevation input for 3D vector data, urban block models,...
Mining area, Hama, Syria
© 2015, GAF AG, Includes Antix material

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Infrastructure Planning

Oil & Gas exploration

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Fusion of high-resolution DEMs derived from COSMO-SkyMed and TerraSAR-X InSAR datasets

Mingsheng Liao
Wuhan University
Task description

- Fuse 10m InSAR DEMs generated from TerraSAR-X and Cosmo-Skymed
- Voids present in both DEMs (6.9% & 5.7% respectively). After fusion ≤0.13% have voids
- Test site of 10 x 10km, located in NW China
- ICESat and national DEMs from 1:50,000 maps used for validation
<table>
<thead>
<tr>
<th>Basic information of the two InSAR data pairs used</th>
<th>COSMO-SkyMed</th>
<th>TerraSAR-X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition date</td>
<td>3 and 4 June 2009</td>
<td>18 and 29 Apr 2008</td>
</tr>
<tr>
<td>Orbit direction (heading angle)</td>
<td>Descending (−171.22°)</td>
<td>Ascending (−13.40°)</td>
</tr>
<tr>
<td>Temporal baseline (days)</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Nominal incidence angle (°)</td>
<td>48</td>
<td>28</td>
</tr>
<tr>
<td>Normal baseline (m)</td>
<td>63</td>
<td>71</td>
</tr>
<tr>
<td>Height of ambiguity (m)</td>
<td>164</td>
<td>59</td>
</tr>
<tr>
<td>Doppler centroid frequency (master/slave at scene center)</td>
<td>555 Hz/−243 Hz</td>
<td>−2 Hz/−13 Hz</td>
</tr>
<tr>
<td>Azimuth/range bandwidth</td>
<td>3106.9 Hz/73.5 MHz</td>
<td>2765 Hz/150 MHz</td>
</tr>
<tr>
<td>Azimuth/range sampling spacing (single-look)</td>
<td>2.21 m/1.63 m</td>
<td>1.89 m/0.91 m</td>
</tr>
<tr>
<td>Ground coverage (α)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Cosmo-SkyMed + ICESat tracks](image1)

![TerraSAR-X](image2)
Working Group on Calibration and Validation
DEMs + Phase Coherence products

Cosmo-SkyMed DEM (left), Coherence (right)

TerraSAR-X DEM (left), Coherence (right)
Validation using ICESat & National DEM

<table>
<thead>
<tr>
<th>Elevation differences</th>
<th>COSMO-SkyMed DEM</th>
<th>TerraSAR-X DEM</th>
<th>Fused DEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (m)</td>
<td>Median (m)</td>
<td>SD (m)</td>
</tr>
<tr>
<td>(D_{1}) (GLAS elevation value—elevation value at the center of the 3 x 3 window)</td>
<td>(-6.41)</td>
<td>(-5.56)</td>
<td>6.81</td>
</tr>
<tr>
<td>(D_{2}) (GLAS elevation value—min. elevation value within the 3 x 3 window)</td>
<td>(-4.43)</td>
<td>(-4.34)</td>
<td>6.14</td>
</tr>
<tr>
<td>(D_{3}) (GLAS elevation value—median elevation value within the 3 x 3 window)</td>
<td>(-6.41)</td>
<td>(-5.45)</td>
<td>6.42</td>
</tr>
<tr>
<td>(D_{4}) (GLAS elevation value—max. elevation value within the 3 x 3 window)</td>
<td>(-9.52)</td>
<td>(-7.83)</td>
<td>6.95</td>
</tr>
</tbody>
</table>
GEO Task IN-02: Global Datasets
Role for Global DEM

- IN-02 Earth datasets consist of 2 sub-tasks:
  - C1: Advances in Life-cycle Data Management
  - C2: Development of Regional/Global Information and Cross-cutting Datasets
- IN-02 Point of Contact: Mike Abrams (JPL, ASTER PI)
- Proposed on 1-Feb-14 to CEOS Executive Officer, Kerry Sawyer, that activity continue into the next 3 year implementation period under CEOS wing to cover
  - 2014/15 release of SRTM V2 at 1 arc-second (≈30m)
  - 2016/17 release of TanDEM-X DEM at 3 arc-seconds (≈90m)
  - 2015/16 release of ALOS-PRISM DEM at 1 arc-seconds (≈30m)
  - 2017 release of re-processed NASADEM at 1 arc-seconds (≈30m)
- Unknown dates for creation of bathymetry of continental shelves using SAR & high resolution EO, once support is released
- What is the status of this recommendation?
• UK Space Agency recently performed review of CEOS commitments (report not yet available) for EOAC
• Decided to re-focus on WG Climate and withdraw support from TMSG
• JPM will have to step down at the end of WGCV39 if no space agency support can be found as without any support it will be impossible to continue
• UKSA not interested in supporting any TMSG-promoted activities
• CEOS-WGCV should review whether it wishes to continue with TMSG and if it does, seek a new chair for the future