Characteristics of ASTER GDEM Version 2

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ASTER GDEM Project

METI/Japan and NASA/USA in conjunction with ERSDAC and LPDAAC

<table>
<thead>
<tr>
<th>Data source</th>
<th>ASTER GDEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>2009 (ver.1)</td>
</tr>
<tr>
<td>Data collection</td>
<td>2000-2008(ver.1)</td>
</tr>
<tr>
<td>Posting</td>
<td>1 arc-second (30 m)</td>
</tr>
<tr>
<td>Coverage</td>
<td>83 degrees north - 83 degrees south</td>
</tr>
<tr>
<td>Missing data</td>
<td>Areas under constant cloud cover (filled by other DEMs)</td>
</tr>
</tbody>
</table>
# Status of GDEM Version 2

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tbody>
<tr>
<td>Month</td>
<td>6 7 8 9 10 11 12</td>
<td>1 2 3</td>
<td>11 12</td>
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</tbody>
</table>

- **Version 1 Release**
- **Trial Process**
- **Trial Version**
- **Version 2 Production** by SILC
- **New Data**
- **ASTER New Observation**
- **Now Validated by**
  - USGS
  - NGA
  - NASA/JPL
  - NASA/GSFC
  - University of Tokyo
  - ERSDAC
- **Version 2 Release (TBD)**
- **Beta Version**
- **Validation**
ASTER nadir- and backward-looking telescopes (Band3, NIR band) allow acquisition of stereo image pairs.

**Automated processing**

1. Image correlation matching between Band 3N and Band 3B
2. Determination of geolocation at the corresponding point for Band 3N and Band 3B
3. Calculation of elevation
ASTER GDEM Production

Produce scene DEM

All ASTER stereo observation (60km*60km*1.2 million scenes)

Calculate elevations by stacking

Global Coverage

ASTER GDEM

Elevation (m)
Number of stack (#)
Updates in GDEM Version 2

- **New algorithm**
  - **Finer horizontal resolution**
    The elevation is calculated by image matching of ASTER stereo pair. The kernel size for image correlation matching is changed to 5 by 5 pixel from 9 by 9 pixel.
  - **Offset adjustment**
    Every calculated scene DEM has elevation offset of -5m. This offset (-5m) is adjusted.
  - **Water body detection**
    GDEM version 1 could detect lakes larger than about 12km$^2$. This improves to 1km$^2$ in version 2.

- **New observed data**
  GDEM version 2 incorporates new ASTER data observed after September 2008. The voids and artifacts caused by lack of ASTER data will be improved.
Estimate Horizontal and Elevation Error

GSI 10m-grid DEM covers all the land of Japan

GSI (The Geospatial Information Authority of Japan)
Method to Estimate Horizontal Error

13 grid square = 169 grids
169 grids of elevation error (m)
SD of elevation errors (m)
Move 13 grid square and repeat
2 dimensional mapping
Calculate the lowest location

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</table>
Horizontal Error

N-S Geolocation Error (arc-second)

E-W Geolocation Error (arc-second)
Standard Deviation of Elevation Error

SD of Elevation Error (m)

Average of Version 1
Average of Version 2

Version 1
Version 2

0 2 4 6 8 10 12 14 16 18 20

553701 553702 553802 553703 553803 543701 543801 543702 543802 543703 543803 543704 543804 543701 543702 543801 543802 533703 533704 533803 533804 533701 533702 533801 533802 523703 523704 523803 523804
Offset Estimation

Offset is estimated in ‘Rice Farm’ and ‘Farm’ as open area.

“Subdivision Land Use Data of Digital National Land Information” produced by the GSI Japan.

<table>
<thead>
<tr>
<th>Land Use</th>
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<tbody>
<tr>
<td>Rice Farm</td>
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<tr>
<td>Farm</td>
</tr>
<tr>
<td>Forest</td>
</tr>
<tr>
<td>Bare</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Others</td>
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</table>
Offset Estimation

Offset is estimated as -0.7 m.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Peak</th>
<th>SD</th>
<th>RMSE</th>
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<tbody>
<tr>
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<td>-0.74</td>
<td>5.91</td>
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<tr>
<td>Farm</td>
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<td>Forest</td>
<td>+8.68</td>
<td>+7.98</td>
<td>13.26</td>
<td>15.85</td>
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</table>
Horizontal Resolution

Version 2

Version 1
## Method to Estimate Resolution

<table>
<thead>
<tr>
<th>GDEM</th>
<th>Version 2</th>
<th>Version 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resolution:</strong></td>
<td>1 arc-sec</td>
<td>2 arc-sec</td>
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<tr>
<td><strong>Reference DEM</strong></td>
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<td></td>
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<tr>
<td>(Degraded 10m DEM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resolution:</strong></td>
<td>3 arc-sec</td>
<td>4 arc-sec</td>
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<tr>
<td><strong>Elevation Error</strong></td>
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<tr>
<td><strong>Standard Dev.</strong></td>
<td>14.489</td>
<td>13.022</td>
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<td>13.122</td>
<td>13.993</td>
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</tbody>
</table>
Estimated Resolution

Standard Deviation of Elevation Error (m)

- GDEM Version 1
- GDEM Version 2

Horizontal Resolution (arc second) of Reference DEM:

- 2.4 (72m)
- 3.8 (114m)
## Error Estimation of Version 2

<table>
<thead>
<tr>
<th></th>
<th>Version 1</th>
<th>Version 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Error</td>
<td>0.82 arc-sec. to west</td>
<td>0.11 arc-sec. to west</td>
</tr>
<tr>
<td></td>
<td>0.47 arc-sec. to south</td>
<td>0.20 arc-sec. to north</td>
</tr>
<tr>
<td>Elevation Error</td>
<td>offset -6m</td>
<td>-0.7m</td>
</tr>
<tr>
<td></td>
<td>SD 14.8m</td>
<td>12.6m</td>
</tr>
<tr>
<td>Horizontal Resolution</td>
<td>3.8 arc-sec. (114m*)</td>
<td>2.4 arc-sec. (72m*)</td>
</tr>
</tbody>
</table>

*1 arc-second corresponds to 30m
Improvement of Voids in Northern Area

Version 2

Version 1
Improvement of Voids in Northern Area

Version 2

Version 1
Improvement of Artifacts

Version 1

S31E023 1200x1200 arc-second

Elevation (m)

Stacking Number

Filled:

01234567890123456789012
Improvement of Artifacts

Version 2

S31E023 1200x1200 arc-second

Elevation (m)

Stacking Number

1000 2000

filled 01234567890123456789012
Improvement of Artifacts

Ver.1

Ver.2
Improvement of Water Body

Version 1

Version 2

Lake Nicaragua

Elevation (m)

N11W086 1200x1200 arc-second
Improvement of Water Body

Ver.1

Lake Nicaragua

Ver.2

Lake Nicaragua

Graph showing improvements in water body with data for Ver.1 and Ver.2.
Improvements of Version 2

- #Stack increase to three or more in most of the lack area.
  - Voids in northern area
    - Decrease
  - Artifacts (step, Pit-in-bump, Mole-run, etc.)
    - Almost disappear

- New water body detection algorithm
  - Lakes are perfectly flat.
Main characteristics of ASTER GDEM version 2

- Resolution improves to 70m from 110m (version 1).
- Offset reduces to -0.7m from -6m (version 1).
- Voids in northern area decrease.
- Artifacts mostly disappear.
- Lakes are perfectly flat.