

ASTER GDEM 2 README

ADVANCED SPACEBORNE THERMAL EMISSION AND REFLECTION RADIOMETER (ASTER)

GLOBAL DIGITAL ELEVATION MODEL (GDEM) VERSION 2

October 2011

EXECUTIVE SUMMARY

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) is concurrently distributed from the Ministry of Economy, Trade, and Industry (METI) Earth Remote Sensing Data Analysis Center (ERSDAC) in Japan and the National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) Data Information System (EOSDIS) Land Processes (LP) Distributed Active Archive Center (DAAC) in the United States.

Version 2 is produced with the same gridding and tile structure as Version 1. Improvements over version 1 include the use of additional scenes to improve coverage, a smaller correlation kernel to yield higher spatial resolution, and an improved water mask.

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INTRODUCTION

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the National Aeronautic and Space Administration (NASA) spacecraft Terra is capable of collecting in-track stereo using nadir- and aft- looking near infrared cameras. Since 2001, these stereo pairs have been used to produce single-scene (60- x 60-kilometer (km)) digital elevation models (DEM) having vertical (root-mean-squared-error) accuracies generally between 10- and 25-meters (m). On June 29, 2009, NASA and the Ministry of Economy, Trade, and Industry (METI) of Japan released a Global Digital Elevation Model (GDEM) to users worldwide at no charge as a contribution to the Global Earth Observing System of Systems. This “Version 1” ASTER GDEM (GDEM 1.0) was compiled from over 1.2 million scene-based DEMs covering land surface between 83 degrees (°) north (N) and 83° south (S) latitudes. GDEM 1.0 is a 1 arc-second elevation grid divided and distributed as 1° x 1° tiles.

A joint U.S.-Japan validation team assessed the accuracy of GDEM 1.0, augmented by a team of 20 cooperators selected through an Announcement of Opportunity. In summary, GDEM 1.0 was found to have an overall accuracy of around 20-m at the 95 percent (%) confidence level. The team also noted several artifacts associated with poor coverage, cloud contamination, water masking issues, and the stacking process used to produce GDEM 1.0 from individual scene-based DEMs (ASTER GDEM Validation Team, 2009). An independent horizontal resolution study estimated the effective spatial resolution of GDEM 1.0 to be on the order of 120-m.

NASA and METI released a second version of the ASTER GDEM (GDEM 2) in mid-October, 2011. GDEM 2 has the same gridding and tile structure as GDEM 1.0, but benefits from the inclusion of additional scenes to reduce artifacts, higher horizontal resolution using a smaller correlation kernel (5 x 5 versus 9 x 9 used for GDEM 1.0), and an improved water mask. Also, a 5-m overall bias observed in GDEM 1.0 was removed in the newer version. GDEM 2 has an overall accuracy of around 17-m at the 95% confidence level, and a horizontal resolution on the order of 75-m.

ASTER GDEM CHARACTERISTICS

BASIC GDEM CHARACTERISTICS

The ASTER GDEM covers land surfaces between 83°N and 83°S and is comprised of 22,702 1° x 1° tiles. Tiles that contain at least 0.01% land area are included. The ASTER GDEM is distributed as Georeferenced Tagged Image File Format (GeoTIFF) files, and in geographic coordinates (latitude, longitude). The data are posted on a 1 arc-second (approximately 30-m at the equator) grid and referenced to the 1984 World Geodetic System (WGS84)/1996 Earth Gravitational Model (EGM96) geoid. The basic characteristics of the GDEM collection are summarized in the following table.

Table 1 ASTER GDEM Characteristics

°degree, DEM Digital Elevation Model, GeoTIFF Georeferenced Tagged Image File Format, m meter, DN digital number, WGS84 1984 World Geodetic System, EGM96 1996 Earth Gravitational Model,

Tile Size	3601 x 3601 (1° x 1°)
Pixel Size	1 arc-second
Geographic Coordinate System	Geographic latitude and longitude
DEM Output Format	GeoTIFF, signed 16-bit, in units of vertical meters Referenced to the WGS84/EGM96 geoid
Special DN Values	-9999 for void pixels, and 0 for sea water body
Coverage	North 83° to South 83°, 22,702 tiles

GDEM PACKAGE

The basic unit of the ASTER GDEM is the 1° x 1° tile. Each GDEM tile includes a DEM (.dem), a quality assessment (QA, .num), and this readme file (.pdf), all of which are compressed into a single ".zip". Both data files (.dem and .num) have dimensions of 3,601 samples by 3,601 lines, corresponding to the 1° x 1° tile area.

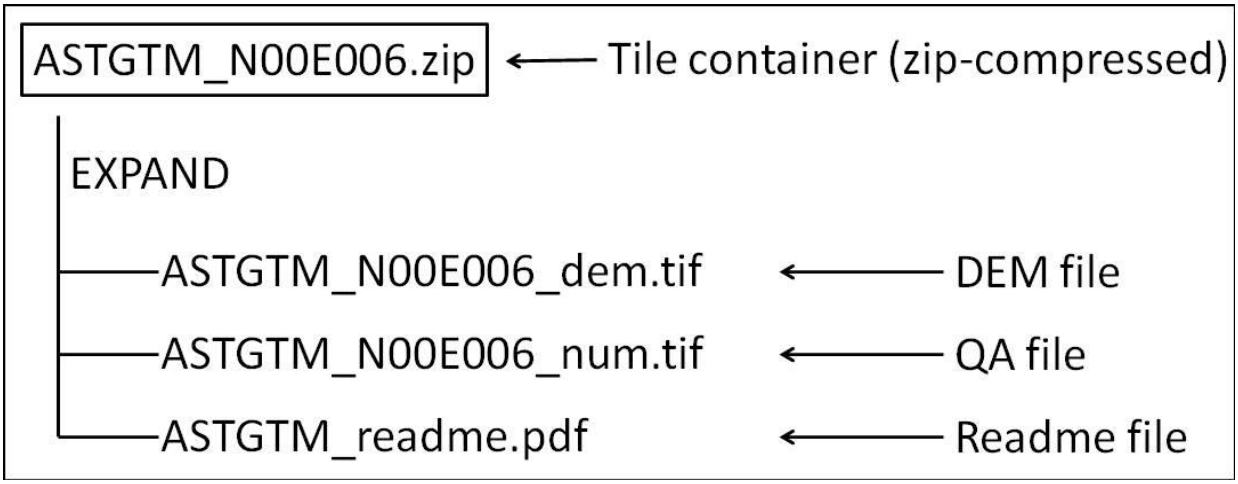

***Figure 1** ASTER GDEM File Structure*

The names of individual data tiles refer to the latitude and longitude at the geometric center of the lower-left (southwest) corner pixel. For example, the coordinates of the lower-left corner of the tile ASTGTM_N00E006 tile are 0 degrees north latitude and 6 degrees east longitude. ASTGTM_N00E006_dem and ASTGTM_N00E006_num files accommodate DEM and QA data, respectively. The rows at the north and south edges, as well as the columns at the east and west edges, of each tile overlap and are identical to the edge row and column in the adjacent tile.

QA File Description

The QA file indicates the number of ASTER stereo scene pairs ("stacking number") used to determine elevation at given pixel (if positive), or indicates the source of non-ASTER elevation data used to replace bad values in the ASTER GDEM (if negative).

Without adequate input, the automated cloud masking and statistical approaches used to select data for stacking are not totally effective in avoiding anomalous elevation values. The figure below shows the effect of the number of scene pairs used on elevation accuracy, as compared to over 18,000 geodetic reference points within the Conterminous U.S. The mean (red) and root-mean-square errors (blue) are high for stacking values below 5, but stabilize between 5 and 10 scene pairs. Thus a low stacking number can suggest less accurate GDEM elevations.

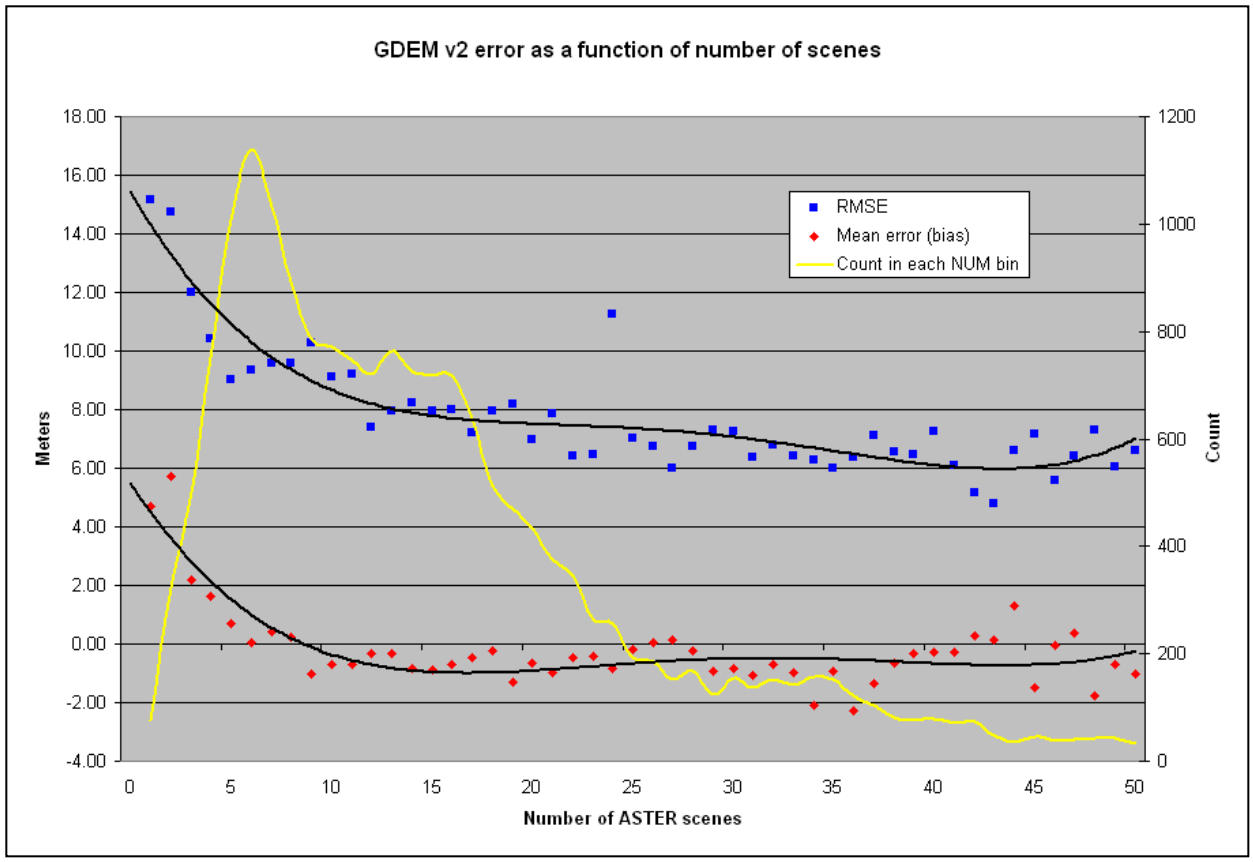

***Figure 2** The relationship between mean and RMS error, and the stacking number ("NUM"), using 18,000 geodetic control points as a reference over the Conterminous U.S. The yellow line indicates the number of pixels having a given stacking number value; thus "NUM" values below 3 or above 23 occur rarely in this region. Note that the occurrence of low "NUM" values can be more common over persistently cloudy regions, particularly at high latitudes.*

Negative values in the QA file indicate pixels that have been replaced with non-ASTER data. Replacement includes adjustment for offsets between the ASTER and reference DEM data. Each negative value is assigned to a specific replacement DEM, as shown in the table below.

Table 2 Anomaly Replacement Sources

SRTM3 Shuttle Radar Topography Mission 3, V3 Version 3, V2 Version 2, ° degrees, % percent, NED U.S. National Elevation Data, U.S. United States, CDED Canadian Digital Elevation Data, DEM Digital Elevation Model

Source	Description	GDEM QA Assignment
SRTM3 V3 (Void-filled version)	Posting: 3 arc seconds Coverage: North 60° to South 56° Only about 90% tiles of SRTM V3 are void filled	-1
SRTM3 V2	Posting: 3 arc seconds Coverage: North 60° to South 56°	-2
NED	Posting: 1 arc second Coverage: Conterminous U.S.	-5
CDED	Posting: 3 arc seconds for latitude; 3, 6 and 12 arc seconds for longitude, depending on latitude Coverage: all Canada territory	-6
Alaska DEM	Posting: 2 arc seconds Coverage: all Alaska territory	-11

GDEM VALIDATION SUMMARY

NASA and METI, in cooperation with the U.S. Geological Survey (USGS), Earth Remote Sensing Data Analysis Center (ERSDAC), and other collaborating members of the ASTER GDEM 2 Validation Team evaluated the new collection and compiled their findings in a report. This report can be downloaded from https://lpdaac.usgs.gov/ or from http://www.ersdac.or.jp/GDEM/E/3.html.

Substantial improvements were noted in the quality of GDEM 2 over the original GDEM 1.0, due specifically to the increased number of acquired ASTER stereo pairs and refinements to the production algorithm (water masking, smaller correlation kernel size, bias removal). These improvements include increased horizontal and vertical accuracy, better horizontal resolution, reduced presence of artifacts, and more realistic values over water bodies.

DISCLAIMER

While the ASTER GDEM 2 benefits from substantial improvements over GDEM 1, users are nonetheless advised that the products still may contain anomalies and artifacts that will reduce its usability for certain applications. The data are provided “as is” and neither NASA nor METI/ERSDAC will be responsible for any damages resulting from use of the data.

USE CONSTRAINTS

ASTER GDEM 2 is subject to user acknowledgment of redistribution and citation policies required by METI and NASA. Before ordering ASTER GDEM data, users must agree to adhere to these policies, which can be found on the LP DAAC ASTER Product Policies Web page at https://lpdaac.usgs.gov/lpdaac/products/aster_policies. When presenting or publishing ASTER GDEM data, users are required to include a citation stating, "ASTER GDEM is a product of METI and NASA."

USER SERVICES

ASTER GDEM users are welcome to contact either ERSDAC or LP DAAC support teams for information and assistance.

Earth Remote Sensing Data Analysis Center
ASTER GDS User Service
http://www.gds.aster.ersdac.or.jp/gds_www2002/service_e/inq.c_e/set_inq.c_e.html

LP DAAC User Services
https://lpdaac.usgs.gov/customer_service
Email: lpdaac@usgs.gov
Voice: 011 1 605 594 6116
Toll Free in U.S.: 888-573-3222
Facsimile: 011 1 605 594 6963

ACRONYM LIST

Acronym	Definition
°	Degree
%	Percent
AO	Announcement of Opportunity
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
CalTech	California Institute of Technology
CDED	Canadian Digital Elevation Data
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Model
DN	Digital Number
EGM96	1996 Earth Gravitational Model
ERSDAC	Earth Remote Sensing Data Analysis Center
GDEM	Global Digital Elevation Model
GDS	Ground Data Systems
GEOSS	Global Earth Observation System of Systems
GeoTIFF	Georeferenced Tagged Image File Format
km	Kilometer
LP	Land Processes
m	Meter
METI	Ministry of Economy Trade and Industry
N	North
NASA	National Aeronautics and Space Administration
NED	National Elevation Data
PDF	Portable Document Format
QA	Quality Assurance
RMSE	Root Mean Square Error
S	South
SRTM	Shuttle Radar Topography Mission
U.S.	United States
USGS	U.S. Geological Survey
WGS84	1984 World Geodetic System