ASTER Global Water Bodies Database 2019

Japan's Ministry of Economy, Trade, and Industry (METI)

National Aeronautics and Space Administration (NASA)

Jet Propulsion Laboratory, California Institute of Technology

User Guide

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Version 1

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1. Introduction

The ASTER instrument, launched onboard NASA's Terra spacecraft in December 1999, has an along-track stereoscopic capability using its near infrared spectral band to acquire the stereo data. ASTER has two telescopes, one for nadir-viewing and another for backward-viewing, with a base-to-height ratio of 0.6. The spatial resolution is 15 meter (m) in the horizontal plane. One scene consists of 4,100 samples by 4,200 lines which corresponds to about 60 km by 60 km ground area.

A number of 1,880306 scenes (Level-1A products) that was acquired from March, 2000 to November 31, 2013 was used to generate ASTER Global Digital Elevation Model (ASTER GDEM) version 3. ASTER GDEM was created by stacking all cloud-masked scene DEMs and non-cloud-masked scene DEMs, and statistical selection algorithm to remove abnormal data.

In addition to ASTER GDEM, the ASTER Global Water Body Database (ASTWBD) was generated as a by-product to correct elevation values of the water body surface like ocean, river, and lake. The ASTWBD was applied to GDEM such that it has a proper elevation value for water body surface. The ocean and lakes have a flattened, constant elevation value. Rivers have a stepped-down elevation value from their upper reaches to where they join another river or reach the ocean.

The ASTWBD is the only (near-) global raster data set; it delineates water bodies smaller than 0.2 sq. km. In addition, the data set defines what kind of water body is delineated: ocean, lake or river. Two other, less complete, data sets are publicly available. The Shuttle SRTM Water Body Dataset was created from the Shuttle SRTM SAR mission of 2000, and covers 60 degrees north to 54 degrees south at 30 m resolution and is available from the Land Processes Distributed Active Archive Center (LP DAAC) at lpdaac.usgs.gov. It is a binary vector, data set: water or no water.

The Landsat Global Surface Water Explorer, developed by the European Commission, is based on 32 years of Landsat data, and maps show change from 80 degrees north to 60 degrees south, at 30 m resolution and is available at https://global-surface-water.appspot.com/. The "occurrence" data set is a binary water/no-water raster data set, which does not identify the types of water bodies.

2. How ASTWBD Was Created

The ASTWBD was procured from the Sensor Information Laboratory Corp. (SILC) in Tokyo. SILC used proprietary software to extract water bodies from the ASTER images used to create the GDEM. In addition, considerable hand editing was done on each tile to improve the output from the automatic detection algorithms.

ASTWBD generation consisted of two parts: separation of waterbodies from land areas; and classification of detected waterbodies into three categories: ocean, river, and lake. The separation process was carried out during scene-based DEM generation using an algorithm that created the GDEM3. For ocean-waterbodies, the effect of sea ice was manually removed to better delineate ocean shorelines in high latitude areas, because virtually no ice areas along ocean shorelines are not identified as a sea-waterbody with zero elevation. This process was enhanced by reference to Google Earth and GeoCover images. For lake-waterbodies, the elevation for each lake was calculated from the perimeter elevation data using the mosaic image that covers the entire area of the lake. All lakes with an area greater than 0.2 square kilometers were identified. Rivers presented a unique challenge, because their elevations gradually step down from upstream to downstream. Initially, visual

inspection was required to separate rivers from lakes. A stepwise elevation assignment, with a step of one meter, was carried out by manual or automated methods, depending on the situation.

3. Data Set Container

The ASTWBD zipped tiles accommodate two files: an attribute (*.att) file and an elevation (*.dem) file. Both files have a dimension of 3601 samples by 3601 lines, which corresponds to 1 degree by 1 degree data area at 1 arc-second (~30 m) resolution. 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 ASTWBD_V001_N00E006 tile are 0 degree north latitude and 6 degrees east longitude. ASTWBD_V001_N00E006_dem and ASWBDV001_N00E006_att files accommodate DEM and attribute, respectively (Tables 1 and 2). The rows at the north and south edges as well as the column at the east and west edges of each tile overlap and are identical to the edge row and column in the adjacent tile. The data are in geographic latitude/longitude rectangular projection (also called *plate carree*). The data coverage is north 83 degrees to south 83 degrees. A set of ASTWBD includes 22,886 tiles.

Table 1. ASTWBD and GDEM3 tiles

	#tiles	GDEM3	ASTWBD	status
case1	16,833	tile	tile	Water present (ocean,lake,river) in tile
case2	6,053	tile	tile	no waterbody (=land) in tile
(subtotal)	22,886			number of ASTWBD or GDEM tiles
case3	36,874	no tile	no tile	ocean in entire tile
total # of tiles	59,760			# of tiles in latitude 83 [(83*2)*360=59,760]

4. Data Formats

The attribute file has four values: 0 for land, 1 for ocean, 2 for river, and 3 for lakes, in GeoTIFF format. The accompanying *.dem file has elevation values for all non-land pixels, and is also in GeoTIFF format. The data tiles cover 1 x 1 degree areas, and are in rectangular, geographic latitude/longitude projection.

Data formats are summarized in Table 2.

Table 2. Data formats

Tile Size	3601 x 3601 (1 degree by 1 degree)
Posting interval	1 arc-second (~30 m)
Geographic coordinates	Geographic latitude and longitude
Output format	ATT (attribute) file GeoTiff, 8 bits; DN values : 1 for ocean, 2 for river, 3 for lake, and 0 for land DEM (elevation) file: GeoTiff, signed 16 bits, 1m/DN, -9999 for land DEM referenced to the WGS84/EGM96 geoid

Coverage	North 83 degrees to south 83 degrees, 22,886 tiles for ASTWBD

5. Filename Convention

The ASTWBD product is a zipped file of the ATT file and corresponding DEM file.

Filename example: ASTWBDV001_N40W100_XXX.tif

ASTWBD = Product short name
2019 = Publication year
N or S = Northern hemisphere or Southern hemisphere
40 = Latitude of lower left corner
W or E = Western hemisphere or Eastern hemisphere
100 = Longitude of lower left corner
XXX = DEM or ATT for data file type
tif= GeoTIFF

6. How to Obtain Data

The following tools offer options to search the LP DAAC data holdings and provide access to the data:

Bulk download: LP DAAC Data Pool and DAAC2Disk
Search and browse: NASA Earthdata Search

The Digital Object Identifier (DOI) for the dataset is given below to provide a persistent link to the product information.

ASTWBD: ASTER Global Water Body Dataset – ASTWBD.001
DOI: 10.5067/ASTER/ASTWBD.001

7. Comparison with SRTM Water Body Dataset

As described earlier, the SRTM WBD covers the Earth's surface from 60 degrees north to 54 degrees south latitudes. It is distributed as 1 by 1 degree tiles, with 30 m postings, so direct comparison with the ASTWBD is straightforward. We examined tile N41W72 over Rhode Island. The tile contains lakes and ocean (Figure 1). SWBD is depicted in red; ASTWBD is white for lakes, and gray for ocean. Both data sets do well with lakes: ASTWBD identifies the lakes and ocean, and the corresponding *.dem file gives the water elevation. The SWBD data set outlines the lakes. Both miss a few lakes that the other finds. The coastline matches for the western half of the tile, but the SWBD has a glaring error starting at the point of land about midway along the coast, where the boundary takes off in a straight line heading southeast.

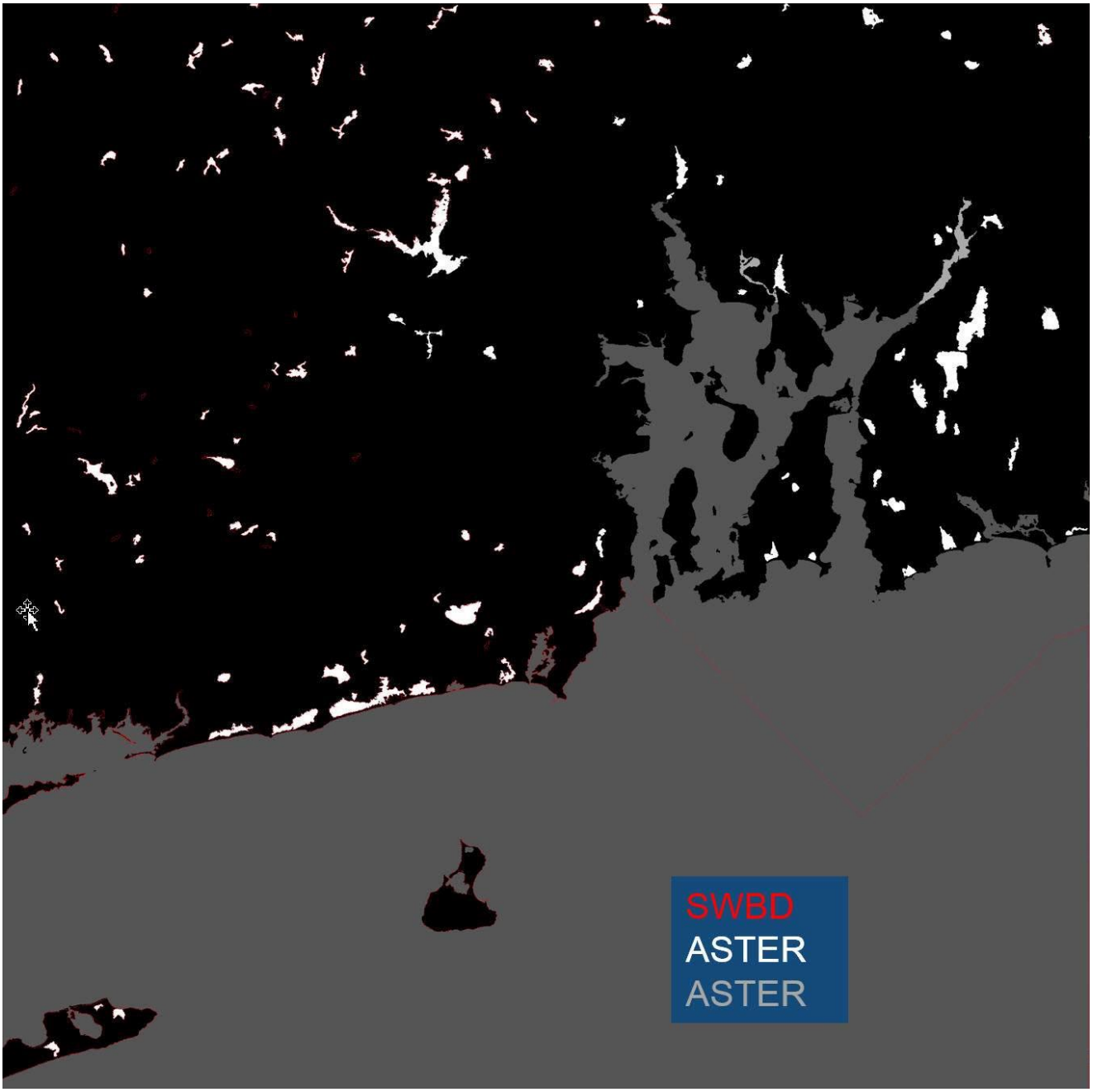

Figure 1. ASTWBD and SWBD for tile N41W72 over part of Rhode Island.

8. Key Processing Factors

The changes in the key processing factors for GDEM and ASTWBD from Version 1 to Version 2 to Version 3 are listed in Table 3.

Table 3 Key processing factors

Key processing factor	Version 1	Version 2	Version 3

Number of input scene DEMS	1,264,118	1,514,350	1,880,306
Posting interval	1 arc-second	1 arc-second	1 arc-second
Correlation kernel size	9 x 9 pixels	5 x 5 pixels	5 x 5 pixels
Minimum water body detection size	12 sq. km	1 sq. km	0.2 sq. km
Water body post-processing	Not applied	Applied	Separation of rivers from lakes
Filtering threshold value	40 m	40 m	40 m
Offset	-5 m offset observed	V1 offset removed	---
Release data	June 2009	October 2011	July 2018

9. References

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[2] NASA JPL. *NASA Shuttle Radar Topography Mission Water Body Data Shapefiles & Raster Files*. 2013, distributed by NASA EOSDIS Land Processes DAAC, https://doi.org/10.5067/MEaSUREs/SRTM/SRTMSWBD.003

[3] Fujisada, H. Urai, M. and A. Iwasaki, Advanced methodology for ASTER DEM generation, 2011, IEEE TGARS, vol.49, no.12, pp.5080-5091.

[4] Fujisada, H., Urai, M., Iwasaki, A., Technical methodology for ASTER Water Body Data Base, Remote Sens. 2018, 10, 1860.
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10. Acknowledgment

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