ATLAS/ICESat-2 L3B Mean Inland Surface Water Data, Version 2

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Jasinski, M. F., J. D. Stoll, J. Robins, J. Nattala, and D. Hancock. 2022. *ATLAS/ICESat-2 L3B Mean Inland Surface Water Data, Version 2.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ATLAS/ATL22.002. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/ATL22

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DATA DESCRIPTION

1.1 Parameters

This data set contains mean water surface heights for transects over inland water bodies by the six ICESat-2 beams. Data are reported at the center of the transect and include mean water surface height and the mean ATLAS 532 nm subsurface attenuation coefficient. The length and location of the beginning, end, and center of each transect is also reported.

This data set (ATL22) was derived from the ATLAS/ICESat-2 L3A Along Track Inland Surface Water Data (ATL13).

1.2 File Information

1.2.1 Format

Data are provided as HDF5 formatted files. HDF is a data model, library, and file format designed specifically for storing and managing data. For more information about HDF, visit the HDF Support Portal.

1.2.2 File Contents

Mean inland surface water data are provided for each beam in separate data groups within in the data files.

1.2.3 Data Groups

Within data files, similar variables such as science data, instrument parameters, and metadata are grouped together according to the HDF model. Figure 1 shows data groups and variables stored at the top level in ATL22 data files.

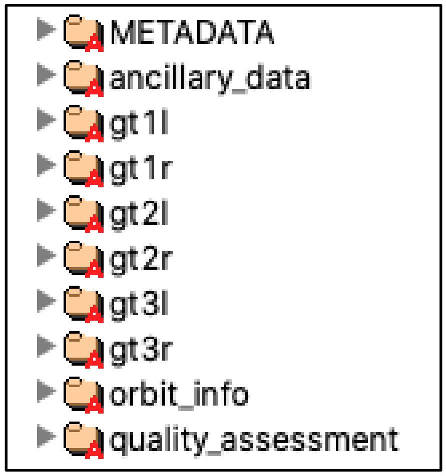

Figure 1. ATL22 Top-Level Data Groups and Variables

The following sections describe the data groups and their contents plus the variables stored at the top level in ATL22 data files.

For additional information, see the following technical references on the ATL22 data set landing page:

- ATL22 Data Dictionary (complete list of variables stored)
- Algorithm Theoretical Basis Document for Mean Inland Surface Water Data (ATBD for ATL22)

1.2.3.1 METADATA

ISO19115 structured summary metadata.

1.2.3.2 ancillary_data

Information ancillary to the data product such as product and instrument characteristics and processing constants.

1.2.3.3 gt1l – gt3r

Six ground track groups (gt1l, gt1r, gt2l, gt2r, gt3l, gt3r) that contain the per-beam data parameters. Parameters of interest include:

- Mean transect surface water height (transect_mean_ht_WGS84) above the WGS 84 ellipsoid;
- Mean orthometric surface water height (transect_mean_ht_ortho); i.e., height above the EGM2008 MSL;
- Water body type (inland_water_body_type); region (inland_water_body_region); and water body ID (inland_water_body_id).

- Short segment length flag (qf_sseg_length);
- Mean latitude (transect_lat), longitude (transect_lon), and time (transect_time) of inland water body transects;
- Mean ATLAS 532 nm subsurface attenuation coefficient (transect_mean_subsurf_atten).

The complete list of parameters for ATL22 is listed in "Table 5-2 | Output Parameters for ATL22 Mean Inland Surface Water ATL13 Algorithm" in the ATBD for ATL22.

1.2.3.4 orbit_info

Orbit parameters that are constant for a granule, such as the reference ground track (RGT) number, cycle, and spacecraft orientation.

1.2.3.5 quality_assessment

Quality assessment data for the granule as a whole, including a pass/fail flag and a failure reason indicator.

1.2.4 Naming Convention

Data files utilize the following naming convention:

Example:

ATL22_20190201001042_05280201_002_01.h5
ATL22_[yyyymmdd][hhmmss]_[ttttccss]_[vvv_rr].h5

Variable	Description
ATL22	ATLAS/ICESat-2 L3B Mean Inland Surface Water Data product.
yyyymmdd	4-digit year, 2-digit month, and 2-digit day of data acquisition.
hhmmss	2-digit hour, 2-digit minute, and 2-digit second of data acquisition start time in UTC.
tttt	4-digit reference ground track number. The ICESat-2 mission has 1,387 RGTs, numbered from 0001 to 1387.
cc	2-digit cycle number. Each of the 1387 RGTs is targeted in the polar regions once every 91 days. The cycle number tracks the number of 91-day periods that have elapsed since ICESat-2 entered the science orbit.
ss	2-digit segment number. Not used. Always 01.
vvv_rr	3-digit version and 2-digit revision number*

*NOTE: From time to time, NSIDC receives duplicate, reprocessed granules from our data provider. These granules have the same file name as the original (i.e. date, time, ground track, cycle, and segment number), but the revision number has been incremented. Although NSIDC deletes the superseded granule, the process can take several days. As such, if you encounter multiple granules with the same file name, please use the granule with the highest revision number.

Each data file has a corresponding XML file that contains additional science metadata. XML metadata files have the same name as their corresponding .h5 file, but with .xml appended.

1.2.5 Browse File

An HDF5 browse file is provided for each granule that contains various images representing the data. The main two, default1 and default2, show the transect mean orthometric height from ground track 1r and 3r, respectively.

1.3 Spatial Information

1.3.1 Coverage

Spatial coverage spans approximately 88° N latitude to 88° S.

1.3.2 Resolution

N/A

Data are averaged over individual inland water transects of varying sizes.

1.3.3 Geolocation

Latitudes and longitudes refer to the WGS 84 coordinate system. Surface water heights are provided as both heights above the WGS 84 ellipsoid (ITRF2014 Reference Frame) and as heights above mean sea level (EGM2008). The following table contains details about WGS 84:

Table 1. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	N/A
Longitude of true origin	Prime Meridian, Greenwich
Latitude of true origin	N/A
Scale factor at longitude of true origin	N/A
Datum	World Geodetic System 1984
Ellipsoid/spheroid	WGS 84

Geoid	EGM2008
Units	degrees
False easting	N/A
False northing	N/A
EPSG codes	4326 (WGS 84) 3855 (EGM2008)
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs
Reference	https://epsg.io/4326 (WGS 84) https://epsg.io/3855 (EGM2008)

For information about ITRF2014, see the International Terrestrial Reference Frame | ITRF2014 webpage.

1.4 Temporal Information

1.4.1 Coverage

14 October 2018 to 10 August 2022

1.4.2 Resolution

N/A

Data are averaged over individual inland water transects of varying time lengths.

2 DATA ACQUISITION AND PROCESSING

The following sections refer to the Ice, Cloud, and Land Elevation Satellite (ICESat-2) Project Algorithm Theoretical Basis Document (ATBD) for Mean Inland Surface Water Data (ATBD for ATL22 | V02, DOI: 10.5067/T5E9DIITUDN4). This ATBD provides a detailed description on the averaging of the ATLAS/ICESat-2 L3A Along Track Inland Surface Water Data (ATL13, V5). To obtain the ATBD for Mean Inland Surface Water Data, see Technical References on the ATL22 data set landing page.

2.1 Background

ATL22 is a derivative of the continuous, L3A product ATL13 Along Track Inland Surface Water Data product. ATL13 contains the high resolution, along track inland surface water profiles derived by analyzing the geolocated photon clouds from the ATLAS/ICESat-2 L2A Global Geolocated Photon Data (ATL03) product. Starting from ATL13, ATL22 computes the mean surface water quantities with no additional photon analysis. The two data products, ATL22 and ATL13, can be used in conjunction as they utilize the same orbit and water body nomenclature regardless of version numbers. Both products and all subsequent version of those products always contain the full record of ICESat-2 observations reprocessed from the beginning of acquisition in October 2018 to present.

ATL22 has been developed as a higher level (L3B), more convenient alternative to ATL13 for hydrologists, water resource engineers, scientists from other disciplines, and applied science users who only require the mean surface water products such as surface water height. Some potential applications for ATL22 are estimating river discharge and changes to water storage in a lake or reservoir. ATL22 offers valuable data especially in remote areas, such as high-latitude boreal zones where in situ data are sparse or non-existent. Furthermore, ATL22 can serve as a source of high-resolution data to calibrate other radar altimeters.

2.1.1 Inland Water Bodies

Inland water bodies are defined as contiguous continental water bodies of the following types: lakes and reservoirs greater than about 0.1 km^2; rivers greater than about 50-100 m wide; transitional water, including estuaries and bays; and a near-shore 7 km buffer. Globally about 1.5 million water bodies are defined by a unique IDs in ATL22.

2.1.2 Inland Water Body Transects

Water bodies are identified by a set of polygons. An ICESat-2 water body transect is any portion of an ICESat-2 beam that crosses a single water body that is interrupted by land (e.g., due to islands, bays, or peninsulas).

2.1.3 Inland Water Masks

An initial water mask of 0.1 km^2 was constructed to flag the existence of one or more water bodies in each grid cell. This mask improves ATL22 calculation efficiency by analyzing only those cells which have been flagged.

A second inland surface water mask is used to organize the ATLAS data in a logical manner. It consists of polygons that represent the outline of entire large river basins. See sections “3.4 | The ATL03 Inland Water Mask (Flag)” and “3.5 | ATL13/22 Inland Surface Water Mask (Shape File)” in the ATBD for ATL22 for more details on the two different inland water masks.

2.2 Acquisition

The ATL22 algorithm inputs ATL13 granules and averages inland water body data and related parameters as described in the following section.

2.3 Processing

- Four ATL13 granules (covering approximately 24-hours) are aggregated into one ATL22 file.
- The mean ellipsoidal height, mean orthometric height, and mean subsurface attenuation of a given beam transect are computed as the arithmetic mean of the respective ATL13 segment-rate output.
- The mean is computed over all non-anomalous ATL13 short segments in a transect and reported at a single index location for each beam in the transect based on the latitude and longitude of each segment.
- Latitude, longitude, and time for each ATL22 transect are computed based on the short segment index photon location within the transect that is closest to the arithmetic mean of the corresponding ATL13 data set.
- The length of a transect is defined as the distance between the start and end latitudes and longitudes of the first and last ATL13 segment in the ATL22 transect.
- In order to allow users to conveniently use ATL22 products, a number of attributes from the ATL13 source data are written to ATL22 files.
- For each ATL22 transect, the ATL13 input granule file name is provided (/metadata/lineage) as well as the water body region, the water body type, and the unique, water body reference identification number (atl13_gran_ndx) for the water body to which the transect belongs.
- ATL22 transect output also contains indices which point users to the start and end row (transect_start_sseg_idx and transect_end_sseg_idx) of ATL13 input arrays upon which the product is based.

2.4 Quality, Errors, and Limitations

Height accuracy depends on aggregation level and water state but is estimated to be about 10 cm for the strong beam. Section 4.3 “Data Product Precision and Evaluation” of the ATL22 ATBD details ICESat-2 precision, as well as ATL22 data product evaluation, assessment and validation activities, and calibration activities.

2.5 Instrumentation

See APPENDIX A: ATLAS/ICESAT-2 DESCRIPTION for a short instrument description

3 VERSION HISTORY

Version 1 (February 2022)

Note: Version 2 of this data set was derived from Version 5 of ATL13.

Version 2 was retired in March 2024.

4 RELATED DATA SETS

ATLAS/ICESat-2 L3A Along Track Inland Surface Water Data (ATL13)

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6 REFERENCES

M. Jasinski, J. Stoll, D. Hancock, J. Robbins, and J. Nattala. Algorithm Theoretical Basis Document (ATBD) for Mean Inland Surface Water Data, ATL22, Version 2, NASA Goddard Space Flight Center, Greenbelt, MD, 40 pp. (November 30, 2021), https://doi.org/10.5067/HB1X7RGLFRPP.

M. Jasinski, J. Stoll, D. Hancock, J. Robbins, J. Nattala, T. Pavelsky, J. Morrison, B. Jones, M. Ondrusek, C. Parrish, and the ICESat-2 Science Team, *Algorithm Theoretical Basis Document (ATBD) for Along Track Inland Surface Water Data, Version 5*, NASA Goddard Space Flight Center, MD, 124 pp. (August 21 2021), https://doi.org/10.5067/RI5QTGTSVHRZ.

7 DOCUMENT INFORMATION

7.1 Publication Date

February 2022

7.2 Date Last Updated

March 2022

APPENDIX A: ATLAS/ICESAT-2 DESCRIPTION

The ATLAS instrument and ICESat-2 observatory utilize a photon-counting lidar and ancillary systems (GPS and star cameras) to measure the time a photon takes to travel from ATLAS to Earth and back again and to determine the photon's geodetic latitude and longitude. Laser pulses from ATLAS illuminate three left/right pairs of spots on the surface that as ICESat-2 orbits Earth trace out six ground tracks that are typically about 14 m wide. Each ground track is numbered according to the laser spot number that generates it, with ground track 1L (GT1L) on the far left and ground track 3R (GT3R) on the far right. Left/right spots within each pair are approximately 90 m apart in the across-track direction and 2.5 km in the along-track direction. The ATL06 data product is organized by ground track, with ground tracks 1L and 1R forming pair one, ground tracks 2L and 2R forming pair two, and ground tracks 3L and 3R forming pair three. Each pair also has a Pair Track—an imaginary line halfway between the actual location of the left and right beams (see Figures A1 and A2). Pair tracks are approximately 3 km apart in the across-track direction.

The beams within each pair have different transmit energies—so-called weak and strong beams—with an energy ratio between them of approximately 1:4. The mapping between the strong and weak beams of ATLAS, and their relative position on the ground, depends on the orientation (yaw) of the ICESat-2 observatory, which is changed approximately twice per year to maximize solar illumination of the solar panels. The forward orientation corresponds to ATLAS traveling along the +x coordinate in the ATLAS instrument reference frame (see Figure A1). In this orientation, the weak beams lead the strong beams and a weak beam is on the left edge of the beam pattern. In the backward orientation, ATLAS travels along the -x coordinate, in the instrument reference frame, with the strong beams leading the weak beams and a strong beam on the left edge of the beam pattern (see Figure A2). The first yaw flip was performed on December 28, 2018, placing the spacecraft into the backward orientation. The current spacecraft orientation, as well as a history of previous yaw flips, is available in the ICESat-2 Major Activities tracking document (.xlsx).

The Reference Ground Track (RGT) refers to the imaginary track on Earth at which a specified unit vector within the observatory is pointed. During nominal operating conditions onboard software aims the laser beams so that the RGT is between ground tracks 2L and 2R (i.e. coincident with Pair Track 2). The ICESat-2 mission acquires data along 1,387 different RGTs. Each RGT is targeted in the polar regions once every 91 days (i.e. the satellite has a 91-day repeat cycle) to allow elevation changes to be detected. Cycle numbers track the number of 91-day periods that have elapsed since the ICESat-2 observatory entered the science orbit. RGTs are uniquely identified by appending the two-digit cycle number to the RGT number, e.g. 000103 (RGT 0001, cycle 03) or 138705 (RGT 1387, cycle 05).

Users should note that between 14 October 2018 and 30 March 2019 the spacecraft pointing control was not yet optimized. Thus, ICESat-2 data acquired during that time do not lie along the nominal RGTs, but are offset at some distance from the RGTs. Although not along the RGT, the geolocation information for these data is not degraded.

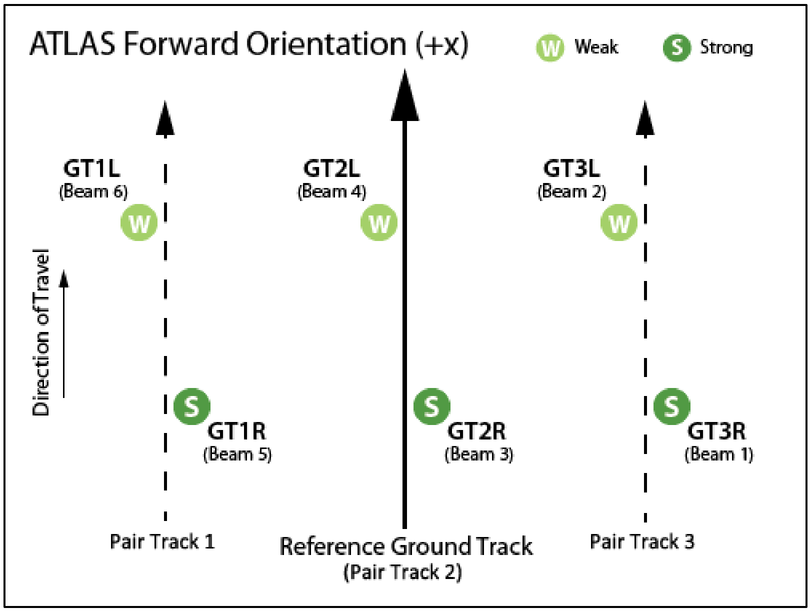

Figure A1. Spot and ground track (GT) naming convention with ATLAS oriented in the forward (instrument coordinate +x) direction.

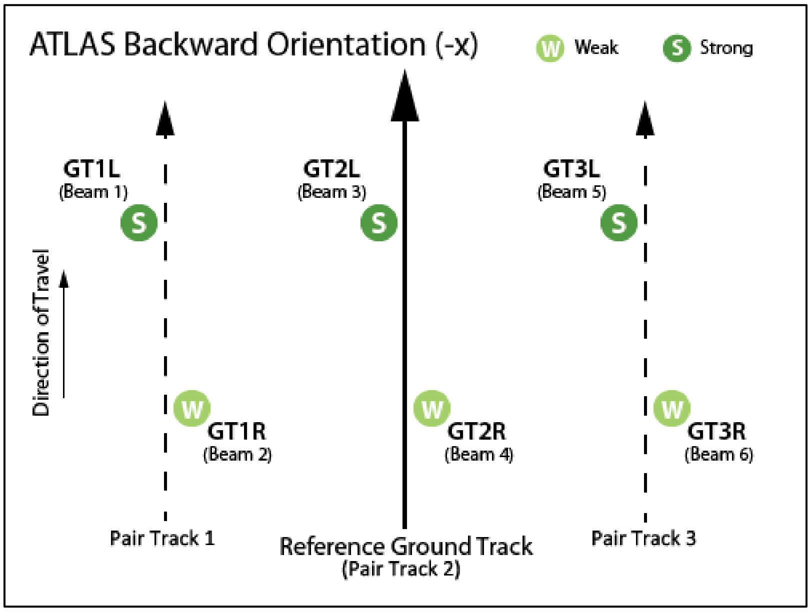

Figure A2. Spot and ground track (GT) naming convention with ATLAS oriented in the backward (instrument coordinate -x) direction.