1.0 DATA DICTIONARY

The following subsections list the data content of ATL21. Each subsection corresponds to a HDF5 group on the data product. The ATLAS Standard Data Products are designed to be self-documenting and contain additional descriptive information not presented here. The descriptive information within the data dictionary is limited to preserve readability.

1.1.1 Attributes

short_name	ATL21
title	SET_BY_META
level	L3B
description	This data set (ATL21) contains daily and monthly gridded polar sea surface height anomalies
Conventions	CF-1.7
citation	SET_BY_META
contributor_name	Alek Petty (alek.a.petty@nasa.gov), Ron Kwok (rkwok01@uw.edu), Marco Bagnardi (marco.bagnardi@nasa.gov), Nathan Kurtz (nathan.t.kurtz@nasa.gov), Jeff Lee (jeffrey.e.lee@nasa.gov), Jesse Wimert (jesse.wimert@us.kbr.com), David Hancock (david.w.hancock@nasa.gov)
contributor_role	Investigator, Investigator, Investigator, Investigator, Algorithm Developer, Algorithm Developer, Algorithm Developer
creator_name	SET_BY_META
date_created	SET_BY_PGE
date_type	UTC
geospatial_lat_max	0.0
geospatial_lat_min	0.0
geospatial_lat_units	degrees_north
geospatial_lon_max	0.0
geospatial_lon_min	0.0
geospatial_lon_units	degrees_east

granule_type	ATL21
hdfversion	SET_BY_PGE
history	SET_BY_PGE
identifier_product_doi	10.5067/ATLAS/ATL21.001
identifier_product_doi_authority	http://dx.doi.org
identifier_product_format_version	SET_BY_PGE
identifier_product_type	ATL21
institution	SET_BY_META
instrument	SET_BY_META
keywords	SET_BY_META
keywords_vocabulary	SET_BY_META
license	Data may not be reproduced or distributed without including the citation for this product included in this metadata. Data may not be distributed in an altered form without the written permission of the ICESat-2 Science Project Office at NASA/GSFC.
naming_authority	http://dx.doi.org
platform	SET_BY_META
processing_level	L3B
project	SET_BY_META
publisher_email	SET_BY_META
publisher_name	SET_BY_META
publisher_url	SET_BY_META
references	SET_BY_META
source	SET_BY_META
spatial_coverage_type	Horizontal
standard_name_vocabulary	CF-1.6
summary	SET_BY_META
time_coverage_duration	SET_BY_PGE

time_coverage_end	SET_BY_PGE
time_coverage_start	SET_BY_PGE
time_type	CCSDS UTC-A

1.1.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
crs	INTEGER_1 -	NOT_SET	Coordinate reference system identification for NSIDC Sea Ice Polar Stereographic (Hughes ellipsoid). Source: NetCDF
grid_lat	DOUBLE(:, :) -	degrees_north	Grid cell center latitude Source: Sea Ice ATBD
grid_lon	DOUBLE(:, :) -	degrees_east	Grid cell center longitude Source: Sea Ice ATBD
grid_x projection_x_coordinate	DOUBLE(:) -	meters	Grid cell center X value in projection grid Source: Sea Ice ATBD
grid_y projection_y_coordinate	DOUBLE(:) -	meters	Grid cell center Y value in projection grid Source: Sea Ice ATBD
land_mask_map	INTEGER(:, :) INVALID_I4B	1	Gridded map which describes each grid cell as land (=1) or ocean/sea ice (=0) Source: Sea Ice ATBD

1.2 Group: /ancillary_data

Contains information ancillary to the data product. This may include product characteristics, instrument characteristics and/or processing constants.

1.2.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
atlas_sdp_gps_epoch	DOUBLE(1) -	seconds since 1980-01-06T00:00:00.000000Z	Number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS Standard Data Product (SDP) epoch (2018-01-01:T00.00.00.000000 UTC). Add this value to delta time parameters to compute full gps_seconds (relative to the GPS epoch) for each data point. Source: Operations

Name Standard Name	Type(Dims) FillValue	Units	Description
control	STRING(1) -	1	PGE-specific control file used to generate this granule. To re-use, replace breaks (BR) with linefeeds. Source: Operations
data_end_utc	STRING(1) -	1	UTC (in CCSDS-A format) of the last data point within the granule. Source: Derived
data_start_utc	STRING(1) -	1	UTC (in CCSDS-A format) of the first data point within the granule. Source: Derived
end_cycle	INTEGER(1) -	1	The ending cycle number associated with the data contained within this granule. The cycle number is the counter of the number of 91-day repeat cycles completed by the mission. Source: Derived
end_delta_time time	DOUBLE(1) -	seconds since 2018-01-01	Number of GPS seconds since the ATLAS SDP epoch at the last data point in the file. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: Derived
end_geoseg	INTEGER(1) -	1	The ending geolocation segment number associated with the data contained within this granule. ICESat-2 granule geographic regions are further refined by geolocation segments. During the geolocation process, a geolocation segment is created approximately every 20m from the start of the orbit to the end. The geolocation segments help align the ATLAS strong a weak beams and provide a common segment length for the L2 and higher products. The geolocation segment indices differ slightly from orbit-to-orbit because of the irregular shape of the Earth. The geolocation segment indices on ATL01 and ATL02 are only approximate because beams have not been aligned at the time of their creation. Source: Derived

Name Standard Name	Type(Dims) FillValue	Units	Description
end_gpssow	DOUBLE(1) -	seconds	GPS seconds-of-week of the last data point in the granule. Source: Derived
end_gpsweek	INTEGER(1) -	weeks from 1980-01-06	GPS week number of the last data point in the granule. Source: Derived
end_orbit	INTEGER(1) -	1	The ending orbit number associated with the data contained within this granule. The orbit number increments each time the spacecraft completes a full orbit of the Earth. Source: Derived
end_region	INTEGER(1) -	1	The ending product-specific region number associated with the data contained within this granule. ICESat-2 data products are separated by geographic regions. The data contained within a specific region are the same for ATL01 and ATL02. ATL03 regions differ slightly because of different geolocation segment locations caused by the irregular shape of the Earth. The region indices for other products are completely independent. Source: Derived
end_rgt	INTEGER(1) -	1	The ending reference groundtrack (RGT) number associated with the data contained within this granule. There are 1387 reference groundtrack in the ICESat-2 repeat orbit. The reference groundtrack increments each time the spacecraft completes a full orbit of the Earth and resets to 1 each time the spacecraft completes a full cycle. Source: Derived
granule_end_utc	STRING(1) -	1	Requested end time (in UTC CCSDS-A) of this granule. Source: Derived
granule_start_utc	STRING(1) -	1	Requested start time (in UTC CCSDS-A) of this granule. Source: Derived
release	STRING(1) -	1	Release number of the granule. The release number is incremented when the software or ancillary data used to create the granule has been changed. Source: Operations
start_cycle	INTEGER(1) -	1	The starting cycle number associated with the data contained within this granule. The cycle number is the counter of the number

Name Standard Name	Type(Dims) FillValue	Units	Description
			of 91-day repeat cycles completed by the mission. Source: Derived
start_delta_time time	DOUBLE(1) -	seconds since 2018-01-01	Number of GPS seconds since the ATLAS SDP epoch at the first data point in the file. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: Derived
start_geoseg	INTEGER(1) -	1	The starting geolocation segment number associated with the data contained within this granule. ICESat-2 granule geographic regions are further refined by geolocation segments. During the geolocation process, a geolocation segment is created approximately every 20m from the start of the orbit to the end. The geolocation segments help align the ATLAS strong a weak beams and provide a common segment length for the L2 and higher products. The geolocation segment indices differ slightly from orbit-to-orbit because of the irregular shape of the Earth. The geolocation segment indices on ATL01 and ATL02 are only approximate because beams have not been aligned at the time of their creation. Source: Derived
start_gpssow	DOUBLE(1) -	seconds	GPS seconds-of-week of the first data point in the granule. Source: Derived
start_gpsweek	INTEGER(1) -	weeks from 1980-01-06	GPS week number of the first data point in the granule. Source: Derived
start_orbit	INTEGER(1) -	1	The starting orbit number associated with the data contained within this granule. The orbit number increments each time the spacecraft completes a full orbit of the Earth. Source: Derived
start_region	INTEGER(1) -	1	The starting product-specific region number associated with the data contained within this granule. ICESat-2 data products

Name Standard Name	Type(Dims) FillValue	Units	Description
			are separated by geographic regions. The data contained within a specific region are the same for ATL01 and ATL02. ATL03 regions differ slightly because of different geolocation segment locations caused by the irregular shape of the Earth. The region indices for other products are completely independent. Source: Derived
start_rgt	INTEGER(1) -	1	The starting reference groundtrack (RGT) number associated with the data contained within this granule. There are 1387 reference groundtrack in the ICESat-2 repeat orbit. The reference groundtrack increments each time the spacecraft completes a full orbit of the Earth and resets to 1 each time the spacecraft completes a full cycle. Source: Derived
version	STRING(1) -	1	Version number of this granule within the release. It is a sequential number corresponding to the number of times the granule has been reprocessed for the current release. Source: Operations

1.3 Group: /ancillary_data/beam_selection

These parameters control which laser beam spots from ATL10 are included in the output ATL21.

1.3.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
proc_atl21_spot_1	INTEGER_1(1) -	1	Indicates if spot 1 is processed for the ATL21 product Source: Operations Flags: 0()=not_processed, 1()=processed
proc_atl21_spot_2	INTEGER_1(1) -	1	Indicates if spot 2 is processed for the ATL21 product Source: Operations Flags: 0()=not_processed, 1()=processed
proc_atl21_spot_3	INTEGER_1(1) -	1	Indicates if spot 3 is processed for the ATL21 product Source: Operations Flags: 0()=not_processed, 1()=processed
proc_atl21_spot_4	INTEGER_1(1) -	1	Indicates if spot 4 is processed for the ATL21 product

Name Standard Name	Type(Dims) FillValue	Units	Description
			Source: Operations Flags: 0()=not_processed, 1()=processed
proc_atl21_spot_5	INTEGER_1(1) -	1	Indicates if spot 5 is processed for the ATL21 product Source: Operations Flags: 0()=not_processed, 1()=processed
proc_atl21_spot_6	INTEGER_1(1) -	1	Indicates if spot 6 is processed for the ATL21 product Source: Operations Flags: 0()=not_processed, 1()=processed

1.4 Group: /ancillary_data/refsurf_selection

These parameters control which reference surfaces from ATL10 are included processing for the output ATL21. The selection of reference surface is determined using the beam_refsurf_interp_flag on ATL10 in group /gtx/freeboard_beam_segment/.

1.4.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
process_refsurf_0	INTEGER_1(1) -	1	Indicates if reference surfaces with interpolation flag value of 0 is processed for the ATL21 product. Source: Operations Flags: 0()=not_processed, 1()=processed
process_refsurf_1	INTEGER_1(1) -	1	Indicates if reference surfaces with interpolation flag value of 1 is processed for the ATL21 product. Source: Operations Flags: 0()=not_processed, 1()=processed
process_refsurf_2	INTEGER_1(1) -	1	Indicates if reference surfaces with interpolation flag value of 2 is processed for the ATL21 product. Source: Operations Flags: 0()=not_processed, 1()=processed
process_refsurf_3	INTEGER_1(1) -	1	Indicates if reference surfaces with interpolation flag value of 3 is processed for the ATL21 product. Source: Operations Flags: 0()=not_processed, 1()=processed

1.5 Group: /daily

gridded daily averages

1.6 Group: /daily/dayxx

Gridded daily averages

1.6.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
delta_time_beg time	DOUBLE(1) -	seconds since 2018-01-01	Center time of the first reference surface used in this gridded composite in seconds since the ATLAS SDP GPS Epoch. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: Derived via Time Tagging
delta_time_end time	DOUBLE(1) -	seconds since 2018-01-01	Center time of the last reference surface used in this gridded composite in seconds since the ATLAS SDP GPS Epoch. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: Derived via Time Tagging
mean_ssha	FLOAT(:, :) INVALID_R4B	meters	Daily mean sea surface height anomalies (SSHA) for each daily grid cell. Sea surface height anomalies expressed relative to the mean sea surface (other geophysical corrections also applied, as indicated in the ATBD) using the reference surface heights. Source: Sea Ice ATBD
mean_weighted_earth_free2mean solid earth tide free2mean	FLOAT(:, :) INVALID_R4B	meters	Mean of the solid earth permanent tide correction (height_segment_earth_free2mean in ATL10) sampled at each reference surface height location used in the daily grid cell. Subtract from mean_ssha to remove the solid earth permanent tide. Source: Sea Ice ATBD
mean_weighted_geoid	FLOAT(:, :) INVALID_R4B	meters	Mean of the geoid values (height_segment_geoid in ATL10) sampled at each reference surface height location used in the daily grid cell. Geoid is expressed relative to the WGS-84 reference ellipsoid from EGM2008 and is in a mean-tide system. Source: Sea Ice ATBD

Name Standard Name	Type(Dims) FillValue	Units	Description
mean_weighted_geoid_free2mean geoid free2mean	FLOAT(:, :) INVALID_R4B	meters	Mean of the geoid free-to-mean correction (height_segment_geoid_free2mean in ATL10) sampled at each reference surface height location used in the daily grid cell. Subtract from mean_weighted_mss or mean_weighted_geoid to convert to a tide-free system. Source: Sea Ice ATBD
mean_weighted_mss	FLOAT(:, :) INVALID_R4B	meters	Grid-cell mean of the Mean Sea Surface (MSS) values sampled at each reference surface height location used in the daily grid cell. MSS in ATL10 is expressed relative to the WGS-84 reference ellipsoid from a CryoSat-2/DTU13 merged product (https://doi.org/10. 5281/zenodo.4294047) and is in a tide free system. MSS is converted to mean tide when sampled by ATL21 using the geoid_free2mean correction. Source: Sea Ice ATBD
n_refsurfs	INTEGER(:, :) INVALID_I4B	1	Number of reference surface sections used in each daily grid cell. Source: Sea Ice ATBD
sigma	FLOAT(:, :) INVALID_R4B	meters	Standard deviation of daily gridded mean sea surface height anomaly, computed following ATBD section 6.3. Source: Sea Ice ATBD

1.7 Group: /monthly

Gridded Monthly averages

1.7.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
delta_time_beg time	DOUBLE(1) -	seconds since 2018-01-01	Center time of the first reference surface used in this gridded composite in seconds since the ATLAS SDP GPS Epoch. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can

Name Standard Name	Type(Dims) FillValue	Units	Description
			be computed. Source: Derived via Time Tagging
delta_time_end time	DOUBLE(1) -	seconds since 2018-01-01	Center time of the last reference surface used in this gridded composite in seconds since the ATLAS SDP GPS Epoch. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: Derived via Time Tagging
mean_ssha	FLOAT(:, :) INVALID_R4B	meters	Monthly mean sea surface height anomalies (SSHA) for each monthly grid cell. Sea surface height anomalies expressed relative to the mean sea surface (other geophysical corrections also applied, as indicated in the ATBD) calculated as the mean of all available daily mean_ssha values. Source: Sea Ice ATBD
mean_weighted_earth_free2mean solid earth tide free2mean	FLOAT(:, :) INVALID_R4B	meters	Mean monthly solid earth permanent tide correction calculated from all available daily mean_weighted_earth_free2mean values. Subtract from mean_ssha to remove the solid earth permanent tide. Source: Sea Ice ATBD
mean_weighted_geoid	FLOAT(:, :) INVALID_R4B	meters	Mean monthly geoid calculated from all available daily mean_weighted_geoid values. Geoid is expressed relative to the WGS-84 reference ellipsoid from EGM2008 and is in a mean-tide system. Source: Sea Ice ATBD
mean_weighted_geoid_free2mean geoid free2mean	FLOAT(:, :) INVALID_R4B	meters	Mean monthly geoid free-to-mean correction calculated from all available daily mean_weighted_geoid values. Subtract from mean_weighted_mss or mean_weighted_geoid to covert to a tide-free system. Source: Sea Ice ATBD
mean_weighted_mss	FLOAT(:, :) INVALID_R4B	meters	Mean monthly MSS calculated from all available daily mean_weighted_mss values. MSS is expressed relative to the WGS-84 reference ellipsoid from a DTU/CS-2 merged product (https://doi.org/10.5281/zenodo.4294047) and is in a mean-tide system. Source: Sea Ice ATBD

Name Standard Name	Type(Dims) FillValue	Units	Description
n_refsurfs	INTEGER(:, :) INVALID_I4B	1	Number of reference surface sections used in each monthly grid cell Source: Sea Ice ATBD
sigma	FLOAT(:, :) INVALID_R4B	meters	Standard deviation of monthly gridded mean sea surface height anomaly, computed following ATBD section 6.3. Source: Sea Ice ATBD

1.8 Group: /orbit_info

Contains orbit information.

1.8.1 Attributes

data_rate	Varies. Data are only provided when one of the stored values (besides time) changes.

1.8.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
crossing_time time	DOUBLE(:) -	seconds since 2018-01-01	The time, in seconds since the ATLAS SDP GPS Epoch, at which the ascending node crosses the equator. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: POD/PPD
cycle_number	INTEGER_1(:) -	1	A count of the number of exact repeats of this reference orbit. Source: Operations
lan	DOUBLE(:) -	degrees_east	Longitude at the ascending node crossing. Source: POD/PPD
orbit_number	UINT_2_LE(:) -	1	Unique identifying number for each planned ICESat-2 orbit. Source: Operations
rgt	INTEGER_2(:) -	1	The reference ground track (RGT) is the track on the earth at which a specified unit vector within the observatory is pointed. Under nominal operating conditions, there will be no data collected along the RGT, as the RGT is

Name Standard Name	Type(Dims) FillValue	Units	Description
			spanned by GT3 and GT4. During slews or off-pointing, it is possible that ground tracks may intersect the RGT. The ICESat-2 mission has 1387 RGTs. Source: POD/PPD
sc_orient	INTEGER_1(:) -	1	This parameter tracks the spacecraft orientation between forward, backward and transitional flight modes. ICESat-2 is considered to be flying forward when the weak beams are leading the strong beams; and backward when the strong beams are leading the weak beams. ICESat-2 is considered to be in transition while it is maneuvering between the two orientations. Science quality is potentially degraded while in transition mode. Source: POD/PPD Flags: 0()=backward, 1()=forward, 2()=transition
sc_orient_time time	DOUBLE(:) -	seconds since 2018-01-01	The time of the last spacecraft orientation change between forward, backward and transitional flight modes, expressed in seconds since the ATLAS SDP GPS Epoch. ICESat-2 is considered to be flying forward when the weak beams are leading the strong beams; and backward when the strong beams are leading the weak beams. ICESat-2 is considered to be in transition while it is maneuvering between the two orientations. Science quality is potentially degraded while in transition mode. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the number of GPS seconds between the GPS epoch (1980-01-06T00:00:00.000000Z UTC) and the ATLAS SDP epoch. By adding the offset contained within atlas_sdp_gps_epoch to delta time parameters, the time in gps_seconds relative to the GPS epoch can be computed. Source: POD/PPD

1.9 Group: /quality_assessment

Contains quality assessment data. This may include QA counters, QA along-track data and/or QA summary data.

1.9.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
qa_granule_fail_reason	INTEGER(1) -	1	Flag indicating granule failure reason. 0=no failure; 1=processing error; 2=Insufficient output data was generated; 3=TBD Failure; 4=TBD_Failure; 5=other failure.

Name Standard Name	Type(Dims) FillValue	Units	Description
			Source: Operations Flags: 0()=no_failure, 1()=PROCESS_ERROR, 2()=INSUFFICIENT_OUTPUT, 3()=failure_3, 4()=failure_4, 5()=OTHER_FAILURE
qa_granule_pass_fail	INTEGER(1) -	1	Flag indicating granule quality. 0=granule passes automatic QA. 1=granule fails automatic QA. Source: Operations Flags: 0()=PASS, 1()=FAIL