1.0 DATA DICTIONARY

The following subsections list the data content of ATL08. 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	ATL08
title	SET_BY_META
level	L3A
description	This data set (ATL08) contains along-track heights above the WGS84 ellipsoid (ITRF2014 reference frame) for the ground and canopy surfaces. The canopy and ground surfaces are processed in fixed 100 m data segments, which typically contain more than 100 sig
Conventions	CF-1.6
citation	SET_BY_META
contributor_name	Thomas A Neumann (thomas.neumann@nasa.gov), Thorsten Markus (thorsten.markus@nasa.gov), Suneel Bhardwaj (suneel.bhardwaj@nasa.gov) David W Hancock III (david.w.hancock@nasa.gov)
contributor_role	Instrument Engineer, Investigator, Principle Investigator, Data Producer, Data Producer
creator_name	SET_BY_META
date_created	SET_BY_PGE
date_type	UTC
featureType	trajectory
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	ATL08
hdfversion	SET_BY_PGE
history	SET_BY_PGE
identifier_file_uuid	SET_BY_PGE
identifier_product_doi	10.5067/ATLAS/ATL08.001
identifier_product_doi_authority	http://dx.doi.org
identifier_product_format_version	SET_BY_PGE
identifier_product_type	ATL08
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	L3A
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
ds_geosegments	INTEGER_1(5) -	1	Dimension scale for geosegments within land segments. Source: Dim Scale Flags: 1()=geosegments1, 2()=geosegments2, 3()=geosegments3, 4()=geosegments4, 5()=geosegments5
ds_metrics	INTEGER_1(18) -	1	Dimension scale for metrics. Source: Dim Scale Flags: 1()=metrics1, 2()=metrics2, 3()=metrics3, 4()=metrics4, 5()=metrics5, 6()=metrics6, 7()=metrics7, 8()=metrics8, 9()=metrics9, 10()=metrics10, 11()=metrics11, 12()=metrics12, 13()=metrics13, 14()=metrics14, 15()=metrics15, 16()=metrics16, 17()=metrics17, 18()=metrics18
ds_surf_type	INTEGER(5) -	1	Dimension scale indexing the surface type array. Index=1 corresponds to Land; index = 2 corresponds to Ocean; Index = 3 corresponds to SeaIce; Index=4 corresponds to LandIce; Index=5 corresponds to InlandWater Source: Dim Scale Flags: 1()=land, 2()=ocean, 3()=seaice, 4()=landice, 5()=inland_water

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 Attributes

data_rate	Data within this group pertain to the granule in its entirety.

1.2.2 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
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 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

Name Standard Name	Type(Dims) FillValue	Units	Description
			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
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

Name Standard Name	Type(Dims) FillValue	Units	Description
granule_start_utc	STRING(1) -	1	Requested start time (in UTC CCSDS-A) of this granule. Source: Derived
qa_at_interval	DOUBLE(1) -	1	Statistics time interval for along-track QA data. Source: control
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 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 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
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 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/land

Constants used in the land_vegetation ATBD

1.3.1 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
atl08_region atl08_region	INTEGER(:) -	1	ATL08 region(s) encompassed by ATL03 granule being processed Source: Land ATBD reference summary table
bin_size_h	FLOAT(1) -	1	Histogram bin size for the alternative DRAGANN algorithm. (Default = 1.0) Source: ATBD "Noise filtering via DRAGANN"
bin_size_n	INTEGER(1) -	1	Size of neighbor histogram bins in number of neighbors in DRAGANN. (Default = 1) Source: ATBD "Noise filtering via DRAGANN"
bright_thresh	FLOAT(1) -	1	Threshold to set brightness_flag, average ground photons per shot. (Default = 3.0) Source: ATBD "Brightness flag"
ca_class	INTEGER(1) -	1	Canopy classification flag value. (Default = 2) Source: ATBD "Classifying the Photons"
can_noise_thresh	INTEGER(1) -	1	Threshold, as a number of canopy photons in the CAN_FILT_SEG, used for the reclassification of canopy signal photons. (Default = 75) Source: ATBD "Canopy Photon Filtering"
can_stat_thresh	FLOAT(1) -	1	Minimum percentage of canopy photons to compute statistics upon. (Default =0.05) Source: ATBD segment parameters for canopy products
canopy20m_thresh	INTEGER(1) -	1	Minimum number of photons to compute statistics upon. (Default =3) Source: ATBD "canopy_height GeoSegment"
canopy_flag_switch	INTEGER(1) -	1	Controls entrance to the canopy flag subroutine . (Default = 1) Source: ATBD Find top of canopy
canopy_seg	INTEGER(1) -	1	Segment in number of signal photons for filtering sparse canopy cover. (Default = 500) Source: ATBD segment parameters for canopy products
class_thresh	INTEGER(1) -	1	Threshold flag value for classification of photons as signal via input from ATL03. (Default =3) Source: ATBD section "De-trend Data"
cloud_filter_switch	INTEGER(1) -	1	Controls entrance to the cloud_filter subroutine. (Default = 0) Source: ATBD Cloud based filtering

Name Standard Name	Type(Dims) FillValue	Units	Description
del_amp	FLOAT(1) -	1	Step size for optimizing the amplitude variable of Gaussian function. (Default = 1.0) Source: ATBD "Noise filtering via DRAGANN"
del_mu	FLOAT(1) -	1	Step size for optimizing the mean parameter of Gaussian function. (Default = 0.2) Source: ATBD "Noise filtering via DRAGANN"
del_sigma	FLOAT(1) -	1	Step size for optimizing the standard deviation parameter of Gaussian function. (Default = 0.5) Source: ATBD "Noise filtering via DRAGANN"
dem_filter_switch	INTEGER(1) -	1	Controls filtering based on DEM. (Default = 1) Source: ATBD De-trend Data
dem_removal_percent_limit	FLOAT(1) -	percent	Percent of photons in land segment failing DEM test to set dem_removal_flag. (default = 20.0) Source: ATBD "segment_reference_DEM_removal_flag"
dragann_switch	INTEGER(1) -	1	Controls entrance to the DRAGANN subroutine. (Default =1) Source: ATBD "Noise filtering via DRAGANN"
dseg	INTEGER(1) -	1	DRAGANN segment length in 20m geolocated segments along ground track. (Default=170) Source: ATBD "Noise filtering via DRAGANN"
dseg_buf	INTEGER(1) -	1	DRAGANN segment buffer length in 20m geolocated segments along ground track. (Default=10) Source: ATBD "Noise filtering via DRAGANN"
fnlgnd_filter_switch	INTEGER(1) -	1	Controls filtering based on FINALGROUND. (Default = 1) Source: ATBD "photon classification QA check"
gnd_stat_thresh	FLOAT(1) -	1	Minimum percentage of terrain photons to compute statistics upon. (Default =0.05) Source: ATBD segment parameters for Land Products
gthresh_factor	FLOAT(1) -	1	Controls threshold for Gaussian Elimination. (Default = 0.1) Source: ATBD "Noise filtering via DRAGANN"
h_canopy_perc	FLOAT(1) -	1	Percentile component of h_canopy parameter. (Default =0.95) Source: ATBD segment parameters for Canopy Products
iter_gnd	INTEGER(1) -	1	Iterations of smoothing of interpolated ground surface for refinement. (Default = 10) Source: ATBD Refine Ground Estimates

Name Standard Name	Type(Dims) FillValue	Units	Description
iter_max	INTEGER(1) -	1	Maximum number of iterations for optimizing the Gaussian parameters for fitting of histogram. (Default = 10) Source: ATBD "Noise filtering via DRAGANN"
lseg	INTEGER(1) -	1	Long segment size in number of 20 meter segments along ground track. (Default=500) Source: ATBD Preparing ATL03 data
lseg_buf	INTEGER(1) -	1	Overlapping long segment buffer size in 20m geosegments along ground track. (Default=10) Source: ATBD Preparing ATL03 data
lw_filt_bnd	INTEGER(1) -	1	Lower bound of the filter window size function. (Default = 5) Source: ATBD initial ground estimate
lw_gnd_bnd	FLOAT(1) -	meters	Lower bound restricting the search of a ground surface in canopy cases. (Default = -4.0) Source: ATBD initial ground estimate
lw_toc_bnd	FLOAT(1) -	meters	Lower bound restricting the search of a top of canopy surface. (Default = -4.0) Source: ATBD Find the top of canopy
lw_toc_cut	FLOAT(1) -	meters	Lower cutoff for top of canopy surface. (Default = 2.0) Source: ATBD Find the top of canopy
max_atl03files	INTEGER(1) -	1	Maximum number of input ATL03 files. (Default = 200) Source: Operations
max_atl09files	INTEGER(1) -	1	Maximum number of input ATL09 files. (Default = 200) Source: Operations
max_peaks	INTEGER(1) -	1	Maximum number of Gaussian peaks to fit in the data set in DRAGANN. (Default =10) Source: ATBD "Noise filtering via DRAGANN"
max_try	INTEGER(1) -	1	Maximum number of tries to compute a P value in alternative DRAGANN Source: ATBD "dynamically determing a DRAGANN parameter"
min_nphs	INTEGER(1) -	1	Minimum number of input photons from ATL03 to process. (default=1) Source: Operations
n_dec_mode	INTEGER(1) -	1	Number of decimal places to consider in mode computation. (Default =1) Source: ATBD segment_terrain_height_mode

Name Standard Name	Type(Dims) FillValue	Units	Description
night_thresh	FLOAT(1) -	1	Solar elevation threshold for determining night time conditions. (Default =0.0) Source: ATBD Night_flag
noise_class	INTEGER(1) -	1	Noise classification flag value. (Default = 0) Source: ATBD "Classifying the Photons"
outlier_filter_switch	INTEGER(1) -	1	Controls entrance to the outlier filter subroutine. (Default = 1) Source: ATBD Filter outlier noise
p_static	FLOAT(1) -	1	Parameter for controlling the search radius in nearest neighbor search in DRAGANN. (Default = 20) Source: ATBD "Noise filtering via DRAGANN"
ph_removal_percent_limit	FLOAT(1) -	percent	Percent of photons in land segment removed to set ph_removal_flag. (default = 50.0) Source: ATBD Final photon classification QA
proc_geoseg	INTEGER(1) -	1	Geosegment process interval length. This controls the amount read from ATL03 and ATL09 at a time. (Default = 500000). Source: Operations
psf	FLOAT(1) -	meters	Parameter controlling identification of photons around an interpolated surface. (Default = 0.5) Source: ATBD Refine ground estimates
ref_dem_limit	FLOAT(1) -	meters	Reference DEM limit used to reclassify signal as noise. (default = 120.0) Source: ATBD De-trend Data
ref_finalground_limit	FLOAT(1) -	meters	Reference finalground limit used to reclassify signal as noise. (default = 150.0) Source: ATBD Final photon classification QA
relief_hbot	FLOAT(1) -	meters	The approximate relief of the L-km segment uses the percentile height values, relief_htop and relief_hbot. (Default=0.05) Source: ATBD De-trend Data
relief_htop	FLOAT(1) -	meters	The approximate relief of the L-km segment uses the percentile height values, relief_htop and relief_hbot. (Default=0.95) Source: ATBD De-trend Data
shp_param	FLOAT(1) -	1	Exponential coefficient of the filter window size as a function. (Default = 21.0E-06) Source: ATBD Compute Filtering Window
sig_rsq_search	FLOAT(1) -	meters^2	Top of canopy refinement square search radius. (Default = 10000.0) Source: ATBD Find the top of canopy

Name Standard Name	Type(Dims) FillValue	Units	Description
skill_cldfold_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for cloud fold flag. (Default =10) Source: ATBD Canopy Quality Score
skill_cldfold_can_thrsh	INTEGER(1) -	1	Threshold of cloud fold flag for canopy quality score demerit. (Default =1) Source: ATBD Canopy Quality Score
skill_cldfold_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for cloud fold flag. (Default =10) Source: ATBD Terrain Quality Score
skill_cldfold_te_thrsh	INTEGER(1) -	1	Threshold of cloud fold flag for terrain quality score demerit. (Default =1) Source: ATBD Terrain Quality Score
skill_demremov_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for DEM removal flag. (Default =10) Source: ATBD Canopy Quality Score
skill_demremov_can_thrsh	INTEGER(1) -	1	Threshold of DEM removal flag for canopy quality score demerit. (Default =1) Source: ATBD Canopy Quality Score
skill_demremov_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for DEM removal flag. (Default =10) Source: ATBD Terrain Quality Score
skill_demremov_te_thrsh	INTEGER(1) -	1	Threshold of DEM removal flag for terrain quality score demerit. (Default =1) Source: ATBD Terrain Quality Score
skill_mswflag_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for MSW flag. (Default =10) Source: ATBD Canopy Quality Score
skill_mswflag_can_thrsh	INTEGER(1) -	1	Threshold of MSW flag for canopy quality score demerit. (Default =1) Source: ATBD Canopy Quality Score
skill_mswflag_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for MSW flag. (Default =10) Source: ATBD Terrain Quality Score
skill_mswflag_te_thrsh	INTEGER(1) -	1	Threshold of MSW flag for terrain quality score demerit. (Default =1) Source: ATBD Terrain Quality Score
skill_od_can_penalty_1	INTEGER(1) -	1	First canopy quality score demerit for optical depth. (Default =5) Source: ATBD Canopy Quality Score
skill_od_can_penalty_2	INTEGER(1) -	1	Second canopy quality score demerit for optical depth. (Default =10) Source: ATBD Canopy Quality Score

Name Standard Name	Type(Dims) FillValue	Units	Description
skill_od_te_penalty_1	INTEGER(1) -	1	First terrain quality score demerit for optical depth. (Default =5) Source: ATBD Terrain Quality Score
skill_od_te_penalty_2	INTEGER(1) -	1	Second terrain quality score demerit for optical depth. (Default =10) Source: ATBD Terrain Quality Score
skill_od_thrsh_can_1	FLOAT(1) -	1	First threshold of optical depth for canopy quality score demerit. (Default =0.2) Source: ATBD Canopy Quality Score
skill_od_thrsh_can_2	FLOAT(1) -	1	Second threshold of optical depth for canopy quality score demerit. (Default =0.3) Source: ATBD Canopy Quality Score
skill_od_thrsh_te_1	FLOAT(1) -	1	First threshold of optical depth for terrain quality score demerit. (Default =0.2) Source: ATBD Terrain Quality Score
skill_od_thrsh_te_2	FLOAT(1) -	1	Second threshold of optical depth for terrain quality score demerit. (Default =0.3) Source: ATBD Terrain Quality Score
skill_radmtry_te_penalty_1	INTEGER(1) -	1	First terrain quality score demerit for radiometry. (Default =5) Source: ATBD Terrain Quality Score
skill_radmtry_te_penalty_2	INTEGER(1) -	1	Second terrain quality score demerit for radiometry. (Default =10) Source: ATBD Terrain Quality Score
skill_radmtry_thrsh_te_1	FLOAT(1) -	1	First threshold of radiometry for terrain quality score demerit. (Default =0.2) Source: ATBD Terrain Quality Score
skill_radmtry_thrsh_te_2	FLOAT(1) -	1	Second threshold of radiometry for terrain quality score demerit. (Default =0.5) Source: ATBD Terrain Quality Score
skill_radmtry_thrsh_total_1	FLOAT(1) -	1	First threshold of total radiometry for canopy quality score demerit. (Default =0.7) Source: ATBD Canopy Quality Score
skill_radmtry_thrsh_total_2	FLOAT(1) -	1	Second threshold of total radiometry for canopy quality score demerit. (Default =1.0) Source: ATBD Canopy Quality Score
skill_radmtry_total_penalty_1	INTEGER(1) -	1	First canopy quality score demerit for total radiometry. (Default =5) Source: ATBD Canopy Quality Score
skill_radmtry_total_penalty_2	INTEGER(1) -	1	Second canopy quality score demerit for total radiometry. (Default =10) Source: ATBD Canopy Quality Score

Name Standard Name	Type(Dims) FillValue	Units	Description
skill_snr_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for signal-to-noise ratio. (Default =10) Source: ATBD Canopy Quality Score
skill_snr_can_thrsh	FLOAT(1) -	1	Threshold of signal-to-noise for canopy quality score demerit. (Default =0.5) Source: ATBD Canopy Quality Score
skill_snr_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for signal-to-noise. (Default =10) Source: ATBD Terrain Quality Score
skill_snr_te_thrsh	FLOAT(1) -	1	Threshold of signal-to-noise for terrain quality score demerit. (Default =0.5) Source: ATBD Terrain Quality Score
skill_solarang_can_penalty_1	INTEGER(1) -	1	First canopy quality score demerit for solar elevation angle. (Default =5) Source: ATBD Canopy Quality Score
skill_solarang_can_penalty_2	INTEGER(1) -	1	Second canopy quality score demerit for solar elevation angle. (Default =10) Source: ATBD Canopy Quality Score
skill_solarang_te_penalty_1	INTEGER(1) -	1	First terrain quality score demerit for solar elevation angle. (Default =5) Source: ATBD Terrain Quality Score
skill_solarang_te_penalty_2	INTEGER(1) -	1	Second terrain quality score demerit for solar elevation angle. (Default =10) Source: ATBD Terrain Quality Score
skill_solarang_thrsh_can_1	FLOAT(1) -	degrees	First threshold of solar elevation angle for canopy quality score demerit. (Default =10.0) Source: ATBD Canopy Quality Score
skill_solarang_thrsh_can_2	FLOAT(1) -	degrees	Second threshold of solar elevation angle for canopy quality score demerit. (Default =20.0) Source: ATBD Canopy Quality Score
skill_solarang_thrsh_te_1	FLOAT(1) -	degrees	First threshold of solar elevation angle for terrain quality score demerit. (Default =10.0) Source: ATBD Terrain Quality Score
skill_solarang_thrsh_te_2	FLOAT(1) -	degrees	Second threshold of solar elevation angle for terrain quality score demerit. (Default =20.0) Source: ATBD Terrain Quality Score
skill_telemratio_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for telemetry band ratio. (Default =10) Source: ATBD Canopy Quality Score
skill_telemratio_can_thrsh	FLOAT(1) -	1	Threshold of telemetry band ratio for canopy quality score demerit. (Default =0.4) Source: ATBD Terrain Canopy Score

Name Standard Name	Type(Dims) FillValue	Units	Description
skill_telemratio_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for telemetry band ratio. (Default =10) Source: ATBD Terrain Quality Score
skill_telemratio_te_thrsh	FLOAT(1) -	1	Threshold of telemetry band ratio for terrain quality score demerit. (Default =0.4) Source: ATBD Terrain Quality Score
skill_weakbeam_can_penalty	INTEGER(1) -	1	Canopy quality score demerit for weak beam. (Default =10) Source: ATBD Canopy Quality Score
skill_weakbeam_te_penalty	INTEGER(1) -	1	Terrain quality score demerit for weak beam. (Default =5) Source: ATBD Terrain Quality Score
sseg	FLOAT(1) -	meters	Short segment length in meters. (Default = 100.0) Source: ATBD segment parameters for Land Products
stat20m_thresh	INTEGER(1) -	1	Minimum number of photons to compute statistics upon. (Default =10) Source: ATBD canopy_height GeoSegment
stat_thresh	INTEGER(1) -	1	Minimum number of photons to compute statistics upon. (Default =50) Source: ATBD Segment parameters for land products
tc_thresh	FLOAT(1) -	1	Percentage threshold for average L-km segment tree cover to be considered canopy. (Default = 5.0) Source: ATBD Segment parameters for canopy products
te_class	INTEGER(1) -	1	Terrain classification flag value. (Default = 1) Source: ATBD "Classifying the Photons"
terrain20m_thresh	INTEGER(1) -	1	Minimum number of photons to compute statistics upon. (Default =3) Source: ATBD Terrain Best Fit GeoSegment
toc_class	INTEGER(1) -	1	Top of canopy classification flag value. (Default = 3) Source: ATBD "Classifying the Photons"
up_filt_bnd	INTEGER(1) -	1	Lower bound of the filter window size function. (Default = 46) Source: ATBD initial ground estimate
up_gnd_bnd	FLOAT(1) -	meters	Upper bound restricting the search of a ground surface in canopy cases. (Default = 1.0) Source: ATBD initial ground estimate

Name Standard Name	Type(Dims) FillValue	Units	Description
up_toc_bnd	FLOAT(1) -	meters	Upper bound restricting the search of a top of canopy surface. (Default=1.0) Source: ATBD Find the top of canopy
up_toc_cut	FLOAT(1) -	meters	Upper cutoff for top of canopy surface. (Default = 150.0) Source: ATBD Find the top of canopy
yapc_switch	INTEGER(1) -	1	Controls inclusion of YAPC analysis for ground finding subroutines. (Default =1) Source: ATBD De-trend Data

1.4 Group: /gtx

Each group contains the segments for one Ground Track. As ICESat-2 orbits the earth, sequential transmit pulses illuminate six ground tracks on the surface of the earth. The track width is approximately 14m. Each ground track is numbered, according to the laser spot number that generates a given ground track. Ground tracks are numbered from the left to the right in the direction of spacecraft travel as: 1L, 1R in the left-most pair of beams; 2L, 2R for the center pair of beams; and 3L, 3R for the right-most pair of beams.

1.5 Group: /gtx/land_segments

Contains data categorized as land at 100 meter intervals.

1.5.1 Attributes

data_rate	Data are stored as aggregates of 100 meters.

1.5.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
asr	FLOAT(:) INVALID_R4B	1	Apparent surface reflectance Source: ATL09
atlas_pa	FLOAT(:) INVALID_R4B	radians	Off nadir pointing angle (in radians) of the satellite to increase spatial sampling in the non-polar regions. ATLAS_PA =radians(90degs-beam_coelev). Source: ATL03
beam_azimuth	FLOAT(:) INVALID_R4B	radians	Azimuth(in radians) of the unit pointing vector for the reference photon in the local ENU frame in radians. The angle is measured from north and positive towards East. Source: ATL03

Name Standard Name	Type(Dims) FillValue	Units	Description
beam_coelev	FLOAT(:) INVALID_R4B	radians	Co-elevation (CE) is direction from vertical of the laser beam as seen by an observer located at the laser ground spot. Source: ATL03
brightness_flag	UINT_1_LE(:) -	1	Flag indicating that the ground surface is bright (e.g. snow-covered or other bright surfaces) Source: Land ATBD Brightness_flag Flags: 0()=not_bright_surface, 1()=bright_surface, 255()=Undetermined
cloud_flag_atm	INTEGER_1(:) INVALID_I1B	1	Cloud confidence flag from ATL09 that indicates the number of cloud or aerosol layers identified in each 25Hz atmospheric profile. If the flag is greater than 0, aerosols or clouds could be present. Valid range is 0 - 10. Source: ATL09
cloud_fold_flag	INTEGER_1(:) -	1	Flag that indicates this profile likely contains cloud signal folded down from above 15 km to the last 2-3 km of the profile. See ATL09 ATBD Table 3.9 for detailed flag value meanings. Source: ATL09 Flags: 0()=no_folding, 1()=goes5_indicates, 2()=profile_indicates, 3()=both_indicate, 127()=outside_limits
column_od_asr	FLOAT(:) INVALID_R4B	1	Optical depth of atmosphere column based on apparent surface reflectance and the assumed actual surface reflectance. Source: ATL09
delta_time time	DOUBLE(:) -	seconds since 2018-01-01	Mean time for the segment in number of GPS seconds since the ATLAS SDP 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: Land ATBD segment parameters for Land Products
delta_time_beg	DOUBLE(:) -	seconds since 2018-01-01	Time of the first photon contained within the data segment, 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

Name Standard Name	Type(Dims) FillValue	Units	Description
			computed. Source: Derived (gps_seconds-gps_sec_offset)
delta_time_end	DOUBLE(:) -	seconds since 2018-01-01	Time of the last photon contained within the data segment, in seconds since the ATLAS SDP 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 (gps_seconds-gps_sec_offset)
dem_flag	INTEGER_1(:) -	1	Indicates source of the DEM height. Values: 0=None, 1=Arctic, 2=Global, 3=MSS, 4=Antarctic. Source: Atmosphere ATBD Flags: 0()=none, 1()=arctic, 2()=global, 3()=mss, 4()=antarctic, 127()=Undetermined
dem_h	FLOAT(:) INVALID_R4B	meters	Best available DEM (in priority of Arctic/Antarctic/Global/MSS) value at the geolocation point. Height is in meters above the WGS84 Ellipsoid. Source: Arctic, Antarctic, Global, MSS DEM
dem_removal_flag	UINT_1_LE(:) -	1	Flag indicating more than dem_removal_percent_limit (default 20.0) removed from land segment due to failing DEM-QA tests Source: ATBD Segment reference DEM removal flag Flags: 0()=below_threshold, 1()=above_threshold, 255()=Undetermined
h_dif_ref	FLOAT(:) INVALID_R4B	meters	Difference between h_te_median and ref_DEM Source: Land ATBD segment parameters for Land Products
last_seg_extend last_seg_extend	FLOAT(:) -	kilometers	The distance (km) that the last ATL08 processing segment in a file is either extended or overlapped with the previous ATL08 processing segment. Source: Land ATBD Preparing ATL03 data for input
latitude latitude	FLOAT(:) -	degrees	Latitude of the center-most signal photon within each segment. Source: Land ATBD segment parameters for Land Products
latitude_20m	FLOAT(5, :) INVALID_R4B	degree	Center latitude of 20m geosegments within each 100m land segment. Source: ATBD Geosegment latitude
layer_flag	INTEGER_1(:) -	1	This flag is a combination of multiple flags (cloud_flag_atm, cloud_flag_asr, and bsnow_con) and takes daytime/nighttime into consideration. A value of 1 means clouds or blowing snow are likely present. A value of 0 indicates the likely absence of clouds or

Name Standard Name	Type(Dims) FillValue	Units	Description
			blowing snow. Source: ATL09 Flags: 0()=likely_clear, 1()=likely_cloudy
longitude longitude	FLOAT(:) -	degrees	Longitude of the center-most signal photon within each segment. Source: Land ATBD segment parameters for Land Products
longitude_20m	FLOAT(5, :) INVALID_R4B	degree	Center longitude of 20m geosegments within each 100m land segment. Source: ATBD Geosegment longitude
msw_flag	INTEGER_1(:) -	1	Multiple Scattering Warning flag. If no layers were detected, then msw_flag = 0. If blowing snow is detected and its estimated optical depth is greater than or equal to 0.5, then msw_flag = 5. If the blowing snow optical depth is less than 0.5, then msw_flag = 4. If no blowing snow is detected but there are cloud or aerosol layers detected, the msw_flag assumes values of 1 to 3 based on the height of the bottom of the lowest layer: < 1 km, msw_flag = 3; 1-3 km, msw_flag = 2; > 3km, msw_flag = 1. A value of 127 indicates that the signal to noise of the data was too low to reliably ascertain the presence of cloud or blowing snow. We expect values of 127 to occur only during daylight. Source: ATL09 Flags: 127()=cannot_determine, 0()=no_layers, 1()=layer_gt_3km, 2()=layer_between_1_and_3_km, 3()=layer_lt_1km, 4()=blow_snow_od_lt_0.5, 5()=blow_snow_od_gt_0.5
n_seg_ph	INTEGER(:) -	1	Number of photons within each land segment. Source: Derived
night_flag	UINT_1_LE(:) -	1	Flag indicating the data were acquired in night conditions: 0=day, 1=night. Flag is derived from solar elevation at the geolocated segment. IF solar elevation is above threshold it is day, if not then it is night. Threshold is set in atlas_l3a_const_mod. Source: Land ATBD Night_Flag Flags: 0()=day, 1()=night, 255()=Undetermined
permafrost_alt permafrost_alt	FLOAT(:) INVALID_R4B	meters	Permafrost active layer thickness (m) from ESA CCI 2019 northern hemisphere permafrost dataset Source: ESA CCI, ANC47
permafrost_prob permafrost_prob	INTEGER_1(:) INVALID_I1B	percent	Permafrost probability (0 - 100) derived via percent of permafrost within pixel cell area in ESA CCI 2019 northern hemisphere permafrost dataset Source: ESA CCI, ANC47
ph_ndx_beg	INTEGER_8(:) -	1	Index (1-based) within the photon-rate data (/land_segments/photons) of the first photon within this each land segment. Source: Derived

Name Standard Name	Type(Dims) FillValue	Units	Description
ph_removal_flag	UINT_1_LE(:) -	1	Flag indicating more than ph_removal_percent_limit (default 50.0) removed from land segment due to failing QA tests Source: ATBD Final photon classification QA Flags: 0()=below_threshold, 1()=above_threshold, 255()=Undetermined
psf_flag	UINT_1_LE(:) -	1	Flag is set to 1 if the point spread function (computed as sigma_atlas_land) has exceeded the threshold (1 m) Source: Land/Veg ATBD Refine Ground Estimates Flags: 0()=below_threshold, 1()=above_threshold, 255()=Undetermined
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 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: Operations
sat_flag	INTEGER_1(:) -	1	Flag derived from full_sat_fract on the ATL03 data product, averaged over 5 geosegments in 100m land segment Source: ATL03, Land ATBD Saturation Flag Flags: 0()=no_saturation_detected, 1()=saturation_detected, -1()=not_enough_valid_data, 127()=Undetermined
segment_id_beg	INTEGER(:) -	1	Geolocation segment number of the first photon in the land segment. Source: ATL03
segment_id_end	INTEGER(:) -	1	Geolocation segment number of the last photon in the land segment. Source: ATL03
segment_landcover	UINT_1_LE(:) -	1	UN-FAO Land Cover Surface type classification as reference from Copernicus Land Cover(ANC18) at the 100m resolution. Source: ATL08 ATBD segment_landcover Flags: 0()=No_data, 111()=Closed_forest_evergreen_needle_leaf, 113()=Closed_forest_deciduous_needle_leaf, 112()=Closed_forest_evergreen_broad_leaf, 114()=Closed_forest_deciduous_broad_leaf, 115()=Closed_forest_mixed, 116()=Closed_forest_unknown, 121()=Open_forest_evergreen_needle_leaf, 123()=Open_forest_deciduous_needle_leaf, 122()=Open_forest_evergreen_broad_leaf, 124()=Open_forest_deciduous_broad_leaf, 125()=Open_forest_mixed, 126()=Open_forest_unknown, 20()=Shrubs,

Name Standard Name	Type(Dims) FillValue	Units	Description
			30()=Herbaceous, 90()=Herbaceous_wetleand, 100()=Moss_and_lichen, 60()=Bare_sparse_vegetation, 40()=Cultivated_and_managed_vegetation_agriculture, 50()=Urban_built_up, 70()=Snow_and_ice, 80()=Permanent_water_bodies, 200()=Open_sea, 255()=Undetermined
segment_snowcover	UINT_1_LE(:) -	1	Daily snow/ice cover from ATL09 at the 25 Hz rate(275m) indicating likely presence of snow and ice within each segment. 0=ice free water; 1=snow free land; 2=snow; 3=ice. Source: ATL08 ATBD segment_snowcover Flags: 0()=ice_free_water, 1()=snow_free_land, 2()=snow, 3()=ice, 255()=Undetermined
segment_watermask	UINT_1_LE(:) -	1	Water mask(i.e. flag) indicating inland water as referenced from the Global Raster Water Mask(ANC33) at 250 m spatial resolution. Source: ATL08 ATBD segment_watermask Flags: 0()=no_water, 1()=water, 255()=Undetermined
sigma_across	FLOAT(:) INVALID_R4B	1	Total cross-track uncertainty due to PPD and POD knowledge. Read from ATL03 product gtx/geolocation/sigma_across. Sigma_atlas_y is reported on ATL08 as the uncertainty of the center-most reference photon of the 100m ATL08 segment. Source: ATL03
sigma_along	FLOAT(:) INVALID_R4B	1	Total along-track uncertainty due to PPD and POD knowledge. Read from ATL03 product gtx/geolocation/sigma_along. Sigma_atlas_x is reported on ATL08 as the uncertainty of the center-most reference photon of the 100m ATL08 segment. Source: ATL03
sigma_atlas_land	FLOAT(:) INVALID_R4B	1	Total vertical geolocation error due to ranging and local surface slope. The parameter is computed for ATL08 as described in equation 1.2 ATL08 ATBD. Source: Land ATBD Refine Ground Estimates
sigma_h	FLOAT(:) INVALID_R4B	1	Estimated uncertainty for the reference photon bounce point ellipsoid height: 1- sigma (m) provided at the geolocation segment rate on ATL03. Sigma_h is reported on ATL08 as the uncertainty of the center-most reference photon of the 100m ATL08 segment. Source: ATL03
sigma_topo	FLOAT(:) INVALID_R4B	1	Total uncertainty that include sigma_h plus geolocation uncertainty due to local slope (equation 1.3). The local slope is multiplied by the geolocation uncertainty factor. This will be used to determine the total vertical geolocation error due to ranging and local slope. Source: Land ATBD Refine Ground Estimates

Name Standard Name	Type(Dims) FillValue	Units	Description
snr	FLOAT(:) INVALID_R4B	1	The signal to noise ratio of geolocated photons as determined by the ratio of the superset of ATL03 signal and DRAGANN found signal photons used for processing the ATL08 segments to the background photons (i.e. noise) within the same ATL08 segments. Source: ATBD Noise filtering via DRAGANN
solar_azimuth	FLOAT(:) -	degrees_east	The direction, eastwards from north, of the sun vector as seen by an observer at the laser ground spot. Source: ATL03 ATBD
solar_elevation	FLOAT(:) -	degrees	Solar Angle above or below the plane tangent to the ellipsoid surface at the laser spot. Positive values mean the sun is above the horizon, while negative values mean it is below the horizon. The effect of atmospheric refraction is not included. This is a low precision value, with approximately TBD degree accuracy. Source: ATL03 ATBD
surf_type	INTEGER_1(5, :) -	1	Flags describing which surface types this interval is associated with. 0=not type, 1=is type. Order of array is land, ocean, sea ice, land ice, inland water. Source: ATL03 ATBD Flags: 0()=not_type, 1()=is_type
terrain_flg	UINT_1_LE(:) -	1	Terrain flag quality check to indicate a deviation above a threshold from the reference DEM height reported on the product. Source: Land ATBD Segment_terrain flag Flags: 0()=below_threshold, 1()=above_threshold, 255()=Undetermined
urban_flag	UINT_1_LE(:) -	1	The urban flag indicates that a segment is likely located over an urban area as determined by coincident pixels in the Global Urban Footprint (GUF) 0.4 arcsecond product. Source: Land ATBD Urban_flag Flags: 0()=not_urban, 1()=urban, 255()=Undetermined

1.6 Group: /gtx/land_segments/canopy

Contains height parameters based on the land algorithm.

1.6.1 Attributes

data_rate	Data are stored as aggregates of 100 meters.

1.6.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
can_noise	FLOAT(:) INVALID_R4B	count/meter	Number of noise photons calculated that fall within the canopy height for each 100 m segment based on ATL03 background rate parameters. Source: Land ATBD Vegetation Parameters
can_quality_score	INTEGER_1(:) INVALID_I1B	1	Canopy quality score based on coincident conditions, from ATL08 ATBD section titled "Canopy Quality Score". Source: Land ATBD Vegetation Parameters
canopy_h_metrics	FLOAT(18, :) INVALID_R4B	meters	Height metrics based on the cumulative distribution of relative canopy heights above the interpolated ground surface. The height metrics are calculated at the following percentiles: 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95%. Source: Land ATBD Vegetation Parameters
canopy_h_metrics_abs	FLOAT(18, :) INVALID_R4B	meters	Height metrics based on the cumulative distribution of absolute canopy heights above the WGS84 Ellipsoid. The height metrics are calculated at the following percentiles: 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95%. Source: Land ATBD Vegetation Parameters
canopy_openness	FLOAT(:) INVALID_R4B	1	Standard Deviation of all photons classified as canopy photons within the segment to provide inference of canopy openness. Source: Land ATBD Vegetation Parameters
canopy_rh_conf	INTEGER_1(:) -	1	Canopy relative height confidence flag based on percentage of ground and canopy photons within a segment: 0 (<5% canopy), 1 (>5% canopy, <5% ground), 2 (>5% canopy, >5% ground). Source: Land/Veg ATBD Vegetation Parameters Flags: 0()=<5%_canopy, 1()=>=5%_canopy_<5%_ground, 2()=>=5%_canopy_>=5%_ground
centroid_height	FLOAT(:) INVALID_R4B	meters	Optical centroid of all photons classified as either canopy or ground points within the segment. The heights used in this calculation are absolute heights above the reference ellipsoid. This parameter is equivalent to the centroid height produced ICESat GLA14. Source: Land ATBD Vegetation Parameters
h_canopy	FLOAT(:) INVALID_R4B	meters	98% height of all the individual canopy relative heights for the segment above the estimated terrain surface. Relative canopy heights have been computed by differencing the canopy photon

Name Standard Name	Type(Dims) FillValue	Units	Description
			height from the estimated terrain surface. Source: Land ATBD Vegetation Parameters
h_canopy_20m	FLOAT(5, :) INVALID_R4B	m	Canopy height for each 20m geosegment with each 100m land segment. Source: ATBD Vegetation Parameters
h_canopy_abs	FLOAT(:) INVALID_R4B	meters	The 98% height of all the absolute individual canopy heights referenced above the WGS84 ellipsoid. Source: Land ATBD Vegetation Parameters
h_canopy_quad	FLOAT(:) INVALID_R4B	meters	The quadratic mean height of individual classified relative canopy photon heights above the estimated terrain surface. Source: Land ATBD Vegetation Parameters
h_canopy_uncertainty	FLOAT(:) INVALID_R4B	meters	Uncertainty of the relative canopy heights for the segment. Incorporates all systematic uncertainties as well as uncertainty from errors of identified photons. See section 1 and equations 1.4 and 1.5 of the ATL08 ATBD. Source: Land ATBD Vegetation Parameters
h_dif_canopy	FLOAT(:) INVALID_R4B	meters	Difference between h_canopy and h_median_canopy Source: Land ATBD Vegetation Parameters
h_max_canopy	FLOAT(:) INVALID_R4B	meters	Relative maximum of individual canopy heights within segment. Relative canopy heights have been computed by differencing the canopy photon height from the estimated terrain surface. Should be equivalent to RH100 metric reported in the literature. Source: Land ATBD Vegetation Parameters
h_max_canopy_abs	FLOAT(:) INVALID_R4B	meters	Maximum of individual absolute canopy heights within segment referenced above the WGS84 ellipsoid. Source: Land ATBD Vegetation Parameters
h_mean_canopy	FLOAT(:) INVALID_R4B	meters	Mean of individual relative canopy heights within segment. Relative canopy heights have been computed by differencing the canopy photon height from the estimated terrain surface. Source: Land ATBD Vegetation Parameters
h_mean_canopy_abs	FLOAT(:) INVALID_R4B	meters	Mean of the individual absolute canopy heights within segment referenced above the WGS84 Ellipsoid. Source: Land ATBD Vegetation Parameters
h_median_canopy	FLOAT(:) INVALID_R4B	meters	The median of individual relative canopy heights within segment. Relative canopy heights have been computed by differencing the canopy photon height from the estimated terrain surface. This parameter should be equivalent to RH50 reported

Name Standard Name	Type(Dims) FillValue	Units	Description
			in the literature. Source: Land ATBD Vegetation Parameters
h_median_canopy_abs	FLOAT(:) INVALID_R4B	meters	The median of individual absolute canopy heights within segment referenced above the WGS84 Ellipsoid. Source: Land ATBD Vegetation Parameters
h_min_canopy	FLOAT(:) INVALID_R4B	meters	The minimum of relative individual canopy heights within segment. Relative canopy heights have been computed by differencing the canopy photon height from the estimated terrain surface. Source: Land ATBD Vegetation Parameters
h_min_canopy_abs	FLOAT(:) INVALID_R4B	meters	The minimum of absolute individual canopy heights within segment referenced above the WGS84 Ellipsoid. Source: Land ATBD Vegetation Parameters
n_ca_photons	INTEGER(:) -	1	The number of photons classified as canopy within the segment. Source: Land ATBD Vegetation Parameters
n_toc_photons	INTEGER(:) -	1	The number of photons classified as top of canopy within the segment. Source: Land ATBD Vegetation Parameters
photon_rate_can	FLOAT(:) INVALID_R4B	s^-1	Calculated photon rate of canopy photons within each 100m segment Source: Land ATBD Vegetation Parameters
photon_rate_can_nr	FLOAT(:) INVALID_R4B	s^-1	Noise removed photon canopy rate within each 100 m segment. Source: Land ATBD Vegetation Parameters
segment_cover	INTEGER_2(:) INVALID_I2B	1	Average percentage value of the valid (value <= 100) Copernicus fractional cover product for each 100 m segment. This data is temporally static, and is the summation of forest and shrub land cover fractions. Source data from: https://land.copernicus.eu/en/products/global-dynamic-land-cover/copernicus-global-land-service-land-cover-100m-collection-3-epoch-2019-globe . Source: Land ATBD Vegetation Parameters
subset_can_flag	INTEGER_1(5, :) INVALID_I1B	1	Quality flag indicating the canopy photons populating the 100 m segment statistics are derived from less than 100 m worth of photons and/or less than 5 20m ATL03 segments. Source: Land ATBD Vegetation Parameters Flags: -1()=no_photon_data_within_geosegment, 0()=no_canopy_photons_within_geosegment, 1()=canopy_photons_present_within_geosegment

Name Standard Name	Type(Dims) FillValue	Units	Description
toc_roughness	FLOAT(:) INVALID_R4B	meters	Standard deviation of the relative heights of all photons classified as top of canopy within the segment Source: Land ATBD Vegetation Parameters

1.7 Group: /gtx/land_segments/terrain

Contains terrain parameters at a 100m aggregation.

1.7.1 Attributes

data_rate	Data are stored as aggregates of 100 meters.

1.7.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
h_te_best_fit	FLOAT(:) INVALID_R4B	meters	The best fit terrain elevation at the the mid-point location of each 100m segment. The mid-segment terrain elevation is determined by selecting the best of three fits- linear, 3rd order and 4th order polynomials - to the terrain photons and interpolating the elevation at the mid-point location of the 100 m segment. For the linear fit, a slope correction and weighting is applied to each ground photon based on the distance to the slope height at the center of the segment. Source: Land ATBD Land Parameters
h_te_best_fit_20m	FLOAT(5, :) INVALID_R4B	m	Best fit terrain height to center of each 20m geosegment within each 100m land segment. Source: Land ATBD Land Parameters
h_te_interp	FLOAT(:) INVALID_R4B	meters	Interpolated terrain surface height above the WGS84 Ellipsoid at the midpoint of the segment. Source: Land ATBD Land Parameters
h_te_max	FLOAT(:) INVALID_R4B	meters	The maximum of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_mean	FLOAT(:) INVALID_R4B	meters	The mean of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_median	FLOAT(:) INVALID_R4B	meters	The median of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters

Name Standard Name	Type(Dims) FillValue	Units	Description
h_te_min	FLOAT(:) INVALID_R4B	meters	The minimum of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_mode	FLOAT(:) INVALID_R4B	meters	The mode of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_rh25	FLOAT(:) INVALID_R4B	meters	The terrain elevation from the 25% height. The classified ground photons are sorted into a cumulative distribution and the height associated with the 25% height for that segment is reported. Source: Land ATBD Land Parameters
h_te_skew	FLOAT(:) INVALID_R4B	meters	The skewness of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_std	FLOAT(:) INVALID_R4B	meters	The standard deviation of the photon heights above the WGS84 Ellipsoid, classified as terrain within the segment. Source: Land ATBD Land Parameters
h_te_uncertainty	FLOAT(:) INVALID_R4B	meters	Uncertainty of the mean terrain height for the segment. This uncertainty incorporates all systematic uncertainties(e.g. timing orbits, geolocation,etc.) as well as uncertainty from errors of identified photons. This parameter is described in section 1, equation 1.4 in ATL08 ATBD. Source: Land ATBD Land Parameters
n_te_photons	INTEGER(:) -	1	The number of the photons classified as terrain within the segment. Source: Land ATBD Land Parameters
photon_rate_te	FLOAT(:) INVALID_R4B	s^-1	Calculated photon rate of terrain photons within each 100m segment Source: Land ATBD Land Parameters
subset_te_flag	INTEGER_1(5, :) INVALID_I1B	1	Quality flag indicating the terrain photons populating the 100 m segment statistics are derived from less than 100 m worth of photons and/or less than 5 20m ATL03 segments. Source: Land ATBD Land Parameters Flags: -1()=no_photon_data_within_geosegment, 0()=no_terrain_photons_within_geosegment, 1()=terrain_photons_present_within_geosegment
te_quality_score	INTEGER_1(:) INVALID_I1B	1	Quality score based on coincident conditions, from ATL08 ATBD section titled "Terrain Quality Score". Source: Land ATBD Land Parameters

Name Standard Name	Type(Dims) FillValue	Units	Description
terrain_slope	FLOAT(:) INVALID_R4B	1	The along-track slope of terrain, within each segment;computed by a linear fit of terrain classified photons. Slope is in units of delta height over delta along track distance. Source: Land ATBD Land Parameters

1.8 Group: /gtx/signal_photons

Contains parameters related to individual photons.

1.8.1 Attributes

data_rate	Data are stored at the signal-photon classification rate.

1.8.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
classed_pc_flag	INTEGER_1(:) -	1	Land Vegetation ATBD classification flag for each photon as either noise, ground, canopy, and top of canopy. 0 = noise, 1 = ground, 2 = canopy, or 3 = top of canopy. Source: Land ATBD Subgroup: Photons Flags: 0()=noise, 1()=ground, 2()=canopy, 3()=top_of_canopy
classed_pc_indx	INTEGER(:) -	1	Index (1-based) of the ATL08 classified signal photon from the start of the ATL03 geolocation segment specified on the ATL08 product at the photon rate in the corresponding parameter, ph_segment_id. This index traces back to specific photon within a 20m segment_id on ATL03. The unique identifier for tracing each ATL08 signal photon to the corresponding photon record on ATL03 is the segment_id, orbit, cycle, and classed_pc_indx. Orbit and cycle intervals for the granule are found in the /ancillary_data. The timestamp of each orbit transition is found in the /orbit_info group. Source: Retained from prior a_alt_science_ph packet
d_flag	INTEGER_1(:) -	1	Flag indicating the labeling of DRAGANN noise filtering for a given photon. Source: Land ATBD Subgroup: Photons Flags: 0()=noise, 1()=signal
delta_time time	DOUBLE(:) -	seconds since	Number of GPS seconds since the ATLAS SDP epoch. The ATLAS Standard Data Products (SDP) epoch offset is defined within /ancillary_data/atlas_sdp_gps_epoch as the

Name Standard Name	Type(Dims) FillValue	Units	Description
		2018-01-01	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: ATL03
ph_h height	FLOAT(:) INVALID_R4B	meters	Height of photons above interpolated land surface Source: Land ATBD Subgroup: Photons
ph_segment_id	INTEGER(:) -	1	Segment ID of photons tracing back to specific 20m segment_id on ATL03. The unique identifier for tracing each ATL08 signal photon to the photon on ATL03 is the segment_id, orbit, and classed_pc_indx. The unique identifier for tracing each ATL08 signal photon to the corresponding photon record on ATL03 is the segment_id, orbit, cycle, and classed_pc_indx. Orbit and cycle intervals for the granule are found in the /ancillary_data. The timestamp of each orbit transition is found in the /orbit_info group. Source: Retained from prior a_alt_science_ph packet

1.9 Group: /orbit_info

Contains orbit information.

1.9.1 Attributes

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

1.9.2 Datasets

Name Standard Name	Type(Dims) FillValue	Units	Description
bounding_polygon_lat1	DOUBLE(:) -	degrees_north	Latitude values for the first out of two possible bounding polygons Source: geo_poly
bounding_polygon_lat2	DOUBLE(:) -	degrees_north	Latitude values for the second out of two possible bounding polygons Source: geo_poly
bounding_polygon_lon1	DOUBLE(:) -	degrees_east	Longitude values for the first out of two possible bounding polygons Source: geo_poly

Name Standard Name	Type(Dims) FillValue	Units	Description
bounding_polygon_lon2	DOUBLE(:) -	degrees_east	Longitude values for the second out of two possible bounding polygons Source: geo_poly
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 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

Name Standard Name	Type(Dims) FillValue	Units	Description
			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

1.10 Group: /quality_assessment

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

1.10.1 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. 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