

MABEL L2A Release 010

Standard Data Product

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Introduction

Release 010 MABEL L2A products are created by Version 2.0.1 of the MABEL processing software.

This release note focuses on changes specific to the MABEL L2A products. Please see the **MABEL Release 010 Software Change and Release Note** (located in the MABEL Repository) for information regarding changes/improvements to the Release 010 L2A software.

The format of the Release 010 L2A Products has changed from Release 008. For this reason, the attribute `/identifier_product_format_version` has been updated to `"2.0.1"`. (`"2.0"` was the identifier for the unreleased 009 L2A products.)

There are changes to the structure and content of the L2A product. The major changes include:

- The `"gps_sec_offset"` parameter was renamed to `"granule_gps_epoch"` to more accurately identify that value as a per-granule epoch. For ICESat-2, there will be a single `"ICESat-2 Epoch"` to which all time values within all granules are referenced.
- The `"flight_parameters"` group is now populated with HDF5 compact datasets (rather than attributes). The use of compact datasets allows the `flight_parameters` to be self-describing. This is not possible when using attributes.
- Additional `"flight_parameters"` information was added, including geolocation-related biases and placeholders for TBD laboratory-measured transmit efficiency and pulse shape information. Due to the way the HDF5 file is designed, the channel-associated arrays have dimensions of 50. The datasets `"num_channels_532"` and `"num_channels_1064"` identify the number of values filled within each array.
- Platform information was added under the `"flight_parameters"` to identify the platform (aircraft) to which MABEL is attached. Made the geolocation bias parameters flight-specific and moved the datasets from `"ancillary_data"` to `"flight_parameters."`
- Added a placeholder, within `"flight_parameters"` for a per-channel pulse shape. This is not currently filled with valid information.
- The `"ancillary_data"` group is now populated with HDF5 compact datasets (rather than attributes). The use of compact datasets allows the `ancillary_data` parameters to be self-describing. This is not possible when using attributes.
- Additional `"novatel_ins"` parameters were included to improve geolocation. In addition, since the format of the input Novatel INS file has changed several times over the course of MABEL operations, invalid values are used to indicate when certain data are not available. Check the `"FillValue"` attribute of each parameter to determine the `"invalid value"`.
- All L1B `"novatel_ins"` parameters provided on L1B are now also on L2A.

- The data rate of the altimetry segments (reference_track, channel/altimetry) was increased to every 100 shots.
- The channel data was reorganized into ATL03-like GT groups. Channel-specific data are now grouped under top-level “channelxx” groups. Data are not specific to a channel (range windows, reference track lat/lon, surface type, mean sea surface, etc) are grouped under a “reference track” group since those values are derived from locations on the reference track and are not channel-specific.
- “/reference_track/geophysical /surf_type” was added. This is an array of 5 flags that indicate the type of surface and presence of inland water. These values are derived from the ICESat-2 surface type and inland water masks at each point on the reference track. Latitude and longitude within the “/reference_track” group were renamed to “rt_latitude” and “rt_longitude”. This more clearly indicates that these are the locations of the reference track.
- Latitude, longitude and height within “/channel/photon” groups were renamed to “ph_latitude”, “ph_longitude” and “ph_h”. This more clearly indicates that these are the photon-related.
- ph_class and ph_class_src were added to the “/channel/photon” group. ph_class is the photon classification value from the signal classification algorithm; ph_class_src indicates from which part of the signal classification algorithm the photon was classified highest. The ph_class_src parameter is used for evaluating the signal classification code and will not be present on ATL03.
- “/reference_track/geophysical/emg2008_geoid” was added. This is the EGM2008 geoid value interpolated at each point on the reference track.
- The “/atmosphere/meteorology” group was added. This group contains GEOS5-FP IT meteorological information interpolated to each point on the reference track at the atmosphere histogram data rate (/ancillary_data/segment_sizes/atm_seg_shots). The 48 bottom-most GEOS5-FPIT layers are put on the product. The layers range from the geoid height to about 30km. (L2A)
- ch_latitude and ch_longitude were added to the “/channelxx/altimetry” and “/channelxx/atmosphere/” groups. In prior releases, there was no (easy) way of assigning a geolocated per-channel position to histograms or other segment-based data values.
- The “/met_corr” group was removed. The information within this group has been replaced by the “/reference_track/corrections/atm_delay_xxxx” parameters. In addition the “transtime” parameter was moved to the “/altimetry/corrections” group.
- “bg_mean” and “bg_sdev” were added to the channelxx/atmosphere groups. The values are computed from the atmosphere histograms using the signal removal technique described in the ICESat-2 Global Geolocated Photons ATBD. (Note: These parameters are computed by the same algorithm used in signal classification, but at the atmosphere segment rate.)
- The “signal_finding” group was added to “channelxx/altimetry”. This group contains statistics computed by the signal finding routine. In addition to the statistical values, this group also contains indexes into the photon arrays that identify the indices of the first and last photon used within each segment. This is intended to help match the photon data to the segments more precisely.
- The preliminary relative apparent reflectance calculation and parameters were removed.

- Improved the descriptions of “delta_time_start” and “delta_time_stop” to indicate that the start times are inclusive and stop times are exclusive.
- Added “data_rate” attributes to each group in order to define the data rates of the parameters within each group.
- Descriptions of the several parameters were improved.
- Several metadata values were improved.
- Non-standard “standard_names” were removed.

Input Products

The primary inputs to MABEL L2A data are the Release 010 MABEL L1B products and multiple ancillary files, including DEMs, geoids, masks, and GEOS5-FPIT Meteorological model files. The input MABEL L1B product is described in the document **MABEL Release 010 L1B Standard Data Product** located in the MABEL repository

Repository

The MABEL data, documentation and example code are available at the following URL:

http://icesat.gsfc.nasa.gov/icesat2/data/mabel/mabel_docs.php

Access Constraints

The following access constraint statement was approved by the ICESat-2 Project Office and included in the Metadata of each product file:

“Data may not be reproduced or distributed without including the CitationForExternalPublication 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”

MABEL L2A Data Usage

The L2A Release 010 data product is useful for scientists who wish to learn how to use altimeter photon counting instrument data. It is also useful as an example of HDF5-formatted aircraft data and can serve as a basis for development team comments regarding missing items, ways to improve the groupings, and improving the descriptions.

This product is also an initial prototype of ICESat-2 data and comments are welcome.

MABEL L2A Data Notes

Release 010 products have the following notes/caveats:

1. L2A data files were generated from Release 010 MABEL L1B data files. All errors/caveats applied to the L1B (and L1A) data equally apply to L2A. Please see the corresponding **MABEL Release 010 L1B Standard Data Product** document. This document is located in the MABEL repository.
2. Some L1A products were not created due to errors in the data or errors in the processing code. The corresponding L1B and L2A products are missing as well.

3. Transmit time was not applied to the UTC time in the computation of location. It will be included in future releases
4. The ICESat-2 Project Science Office provided improved calibration values computed by analyzing calibration maneuvers performed during the Greenland/Iceland flights.
5. `photon_id` is implemented as channel number, shot number and a received photon counter which resets to 0 when the `shot_num` increments. (The `photon_id` is assigned before the photons are filtered via the range window, so the numbers will not necessarily be consecutive.) This combination of parameters should be sufficient to identify each photon individually.
6. The Altimeter window for reporting elevations over land is 1 km above and 500 m below the reference DEM. The Altimeter window for reporting elevations over water is 100 m above and 100 m below the reference DEM. The aircraft nadir lat and long from the reference track is used for the DEM measurements for all channels.
7. The L2A data are corrected for aircraft motion and beam angle.
8. Altimeter histograms of 3 meter bin size are for 500 meters above and 100 meters below the DEM computed for every 200 MABEL shots. These have not been fully evaluated.
9. Atmosphere histograms of 30 meter bin size are for 14 km above and 1 km below the DEM computed for every 400 MABEL shots. These have not been fully evaluated.

File Naming/Versioning

The MABEL H5 file naming convention is as follows:

```
mabel_LLL_YYMMDDTHMMSS_RRR_V.h5
```

Where:

LLL=level of product (ie: l1a, l1b)

YYMMDD=year month day of requested granule start time

HHMMSS=hours minutes seconds of requested granule start time

RRR=Release number (further explained below)

V=Version number (further explained below)

Example:

```
mabel_l2a_20101211T004500_010_1.h5
```

The MABEL product versioning scheme uses Release and Version numbers. The Release is an instance of the MABEL product corresponding to a specific version of the MABEL processing software. (For example, the Release 010 MABEL L2A products were created by the v2.0.1 MABEL processing software.) The version field specifies the instance of the Release processed/reprocessed by the same version of software.

Example Code

Example IDL and Fortran code is provided at the MABEL repository.

L2A Product Data Description

The HDF5 file is hierarchically structured with top-level groups of **METADATA**, **ancillary_data**, **quality_assessment**, **flight_parameters**, **meteorology**, **novatel_ins**, **reference_track**, **tof** and multiple **channel** groups. The **channel** groups are further organized into **altimetry**, **atmosphere**, **photon** and **quality_assessment** sub-groups. The sub-groups are described in detail below.

Data rates of individual groups differ, so the delta time (time since the start of the file) is stored within each group to enable time-alignment of data within different groups. Storing different-rate data within separate groups allows us to avoid the issue of fill data and saves significant amounts of storage space (a real issue with large data sets such as this).

The **altimeter** and **atmosphere** groups are summaries of segments of data based on a pre-determined number of shots. Start and End Delta times for each segment are stored within each subgroup.

For each data Group, parameters are stored in individual HDF5 datasets. Using separate datasets allows us to attach parameter-level metadata attributes to each parameter. If the parameters were stored in the same dataset, it would be more difficult to attach the metadata attributes.

The HDF5 file is configured for HDF5 chunking and internal gzip compression.

Data Groups

The HDF5 groups are as follows (derived from `h5ls -r file | grep Group`). METADATA subgroups have been edited for brevity.

```
/ Group
/METADATA Group
/METADATA/COLLECTIONMETADATA Group
/METADATA/INVENTORYMETADATA Group
/ancillary_data Group
/ancillary_data/general Group
/ancillary_data/histograms Group
/ancillary_data/photon_range_window Group
/ancillary_data/segment_sizes Group
/ancillary_data/signal_finding Group
/ancillary_data/streak_removal Group
/channel Group
/channel/altimetry Group
/channel/altimetry/histogram Group
/channel/altimetry/signal_finding Group
/channel/atmosphere Group
/channel/photon Group
/channel/quality_assessment Group
/flight_parameters Group
/meteorology Group
/novatel_ins Group
/novatel_ins/attitude Group
/novatel_ins/covariance Group
/novatel_ins/ecef Group
/novatel_ins/flags Group
/novatel_ins/geolocation Group
/novatel_ins/rms Group
/novatel_ins/solar_angle Group
/novatel_ins/sta Group
/novatel_ins/time Group
/novatel_ins/velocity Group
/quality_assessment Group
/reference_track Group
/reference_track/corrections Group
```

```

/reference_track/geophysical Group
/tof Group
/tof/osc_corr Group

```

Parameter-Level Metadata

The following attributes are attached and filled for each parameter. Some of these attributes may seem redundant but are present for future NetCDF/CF convention compliance.

Name	Description
Coordinates	Field to be used on x-axis for plotting. (Placeholder for future NetCDF/CF compliance.)
Datatype	The HDF5 data type
Description	Description of data parameter
contentType	ISO content type classification
Label	HDF5 label identifying the data element.
Long_name	Descriptive name (useful for plot labels)
Name	Name of data parameter
Rank	Number of array indices (one-dimensional array=rank 1, two-dimensions=rank 2)
Source	Source of data parameter. Includes computational details, if appropriate.
Standard_name	CF-compliant standard name
Units	Physical units of data

Granule-Level Metadata

Granule-level metadata is a mixture of ECHO-style structured metadata and CF-style global attributes. The structured metadata is more complete and computer-friendly; the global attributes are simpler and more human-friendly. Data users are encouraged to use global attributes whenever possible since the structured metadata will be replaced by ISO19115 equivalents in a future release.

Data Dictionary

HTML and PDF versions of the L2A data dictionary are provided at the MABEL repository:

http://icesat.gsfc.nasa.gov/icesat2/data/mabel/mabel_docs.php