ICESat (GLAS) Science Processing Software Document Series

Volume
GLAS Standard Data Products Specification - Level 2
Version 7

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Foreword

This document defines the Level Two GLAS standard data products. This Standard Data Products Specification is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. This document is a roll out of the GLAS ESDIS Software Detailed Design Specification under the Product Specification Volume.

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS ICESat (Ice, Cloud and Land Elevation Satellite). The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document addresses the data flow, interfaces, record and data formats associated with the GLAS Level 2 standard data products. The term "standard data products" refers to those EOS instrument data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the EOSDIS Distributed Active Archive Center (DAAC) or Science Computing Facilities (SCFs). Each data product has a unique Product Identification code assigned by the EOS Senior Project Scientist.

The Level 2 Standard Data Products specifically include those derived geophysical data values (i.e., ice sheet elevation, cloud height, vegetation height, etc.). Additionally, the appropriate correction elements used to transform the Level 1A and Level 1B Data Products into Level 2 Data Products are included. The data are packaged with time tags, precision orbit location coordinates, and data quality and usage flags.

This document was prepared by the Observational Science Branch at NASA GSFC/WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (757) 824-1238, David.W.Hancock@nasa.gov (e-mail), or (757) 824-1036 (FAX).

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Section 1

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 2 Standard Data Products Specification. The unique document identification number within the GLAS Standard Data Software documentation numbering scheme is GLAS-DPS-2641. Progressive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

This document addresses the purpose, usage, and description of the GLAS Level 2 Standard Data Products. The intended audience for this document is the GLAS Science and Instrument Teams, the ESDIS Project and related focus teams, the community of EOS data users and investigators, and the GLAS Standard Data Software Development Team. This document will not address the procedures for obtaining the GLAS Level 2 Standard Data Products from the EOSDIS DAAC.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 2 Standard Data Products Specification is to provide a high-level descriptive document for the data products. This document describes the purpose, usage, content, and format of the GLAS Level 2 Data Products. It describes the representation and definition of the GLAS data elements constituting the data product. It further describes the structure, physical storage, organization, and access characteristics of the GLAS Level 2 Data Products. The document additionally describes file transfer methods to support product access, the data flow associated with the data product, and the data storage and generation characteristics of the data product.

1.4 Document Organization

This document outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Applicable Document 2.3a].

1.5 Document Status and Schedule

This document will be updated and released as required.

1.5.1 Document Change History

Document Name: GLAS Standard Data Products Specification - Level 2		
Version Number	**Date**	**Nature of Change**
Preliminary	December 31, 1995	Original Version
Version 1.2	March 1998	Text, Figures, and Tables updated for Level 2 data updates, for the change to GLAS standard data product generation being performed at the GLAS SCF, and change of the spacecraft name to ICESAT.
Version 2.0	January 1999	Updates to the data product contents.
Version 3.0	November 2000	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V1 release.
Version 4.0	November 2001	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V2 release.
Version 5.0	July 2002	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V2.2 release.
Version 6.0	October 2002	Revised for Version 3.0 software.
Version 7.0	August 2004	Revised Table A-1 (Product Header Elements) and added Table A-2 (Product Specific Elements).

Section 2

Related Documentation

2.1 Parent Documents

The GLAS Level 2 Standard Data Products Specification is considered a "roll-out" from the Product Specification as the parent document or volume. Specific topics pertaining to data descriptions are located in the External Interface sections under the Detailed Design document template.

This document is subordinate to any top-level mission or instrument management plan documents, and as such, recognizes these documents as external parent documents in lineage. The recognized external EOSDIS and GLAS parent documents superior to the GLAS Level 2 Standard Data Products Specification are listed below.

a) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document,* Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.

b) *GLAS Science Software Management Plan*, NASA/TM-1999-208641/Version 3/Volume 1, August 1998, NASA/GSFC Wallops Flight Facility.

2.2 Applicable Documents

The following documents are applicable to, or contain policies or references pertinent to the contents of the GLAS Level 2 Standard Data Products Specification.

a) *Data Production Software, Data Management, and Flight Operations Working Agreement for GLAS*, TBD, NASA Goddard Space Flight Center.

b) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges,* Algorithm Theoretical Basis Document, March 2001, Massachusetts Institute of Technology.

c) *Algorithm Theoretical Basis Document for the GLAS Atmospheric Channel Observations*, Version 0 (Preliminary), December 1995, Goddard Space Flight Center.

d) *Geoscience Laser Altimeter System: Surface Roughness of Ice Sheets*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, University of Wisconsin.

e) *Determination of Sea Ice Surface Roughness from Laser Altimeter Waveform*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1995, The Ohio State University.

f) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 3.0, October 2002, Center for Space Research, The University of Texas at Austin.

g) *Precision Orbit Determination (POD),* Algorithm Theoretical Basis Document, Version 2.2, October 2002, Center for Space Research, The University of Texas at Austin.

h) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, Version 2.2, October 2002, Center for Space Research, The University of Texas at Austin.

i) *GLAS Atmospheric Data Products*, Algorithm Theoretical Basis Document, Version 4.2, June 2001, Goddard Space Flight Center.

2.3 Information Documents

The following documents are provided as sources of information that provide background or supplemental information that may clarify or amplify material in the GLAS Level 2 Standard Data Products Specification.

a) *NASA Software Documentation Standard Software Engineering Program*, NASA-STD-21000-91, July 29, 1991, NASA.

b) *The Geoscience Laser Altimetry/Ranging System*, IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25, No. 5, September 1987.

c) *EOS Altimetry/GLAS Phase-A Study*, November 1995, NASA Goddard Space Flight Center.

d) *Memorandum: GLAS Data Products*, December 23, 1993, Center for Space Research, University of Texas at Austin.

e) *GLAS Science Computing Facility (SCF) Plan*, October 1997, NASA Goddard Space Flight Center, Wallops Flight Facility.

Section 3

Purpose and Description of the Data Products

3.1 Purpose of the Data Products

The purpose of the GLAS Level 2 Standard Data Products is to provide time-ordered, processed GLAS data, acceptable for science applications. This GLAS derived data consists of calibrated laser altimeter data supplemented with precision orbit determination, earth-location and precision attitude data from the ancillary data sources. The GLAS Level 2 Standard Data Products are intended for use by the GLAS Science Team, and by the EOSDIS data user community.

3.2 Description of the Data Product

Table 3-1 identifies the Level 2 Data Products and shows the composition of each. The data products are integer-binary format files containing fixed-length records of data. Each data record consists of several data elements. An element is either an Item or an Array of Items. The elements are measurements and associated correction values obtained from specific GLAS science algorithm sets. The data products will be formatted in scaled integer binary format with both attached and unattached metadata containing identification, processing history, and data descriptive information.

Table 3-1 GLAS Level 2 Standard Data Products

Product ID (Identification)	Product Name	Product Level
GLA08	Boundary Layer and Elevated Aerosol Layer Heights File	2
GLA09	Cloud Height for Multiple Layers File	2
GLA10	Aerosol Vertical Structure File	2
GLA11	Thin Cloud/Aerosol Optical Depth File	2
GLA12	Ice Sheet Products File	2
GLA13	Sea Ice Products File	2
GLA14	Land Products File	2
GLA15	Ocean Products File	2

n/a - Not applicable

The GLAS Level 2 Standard Data Products are generated as product aggregates or files (i.e., nominally a pass, a half orbit) of GLAS derived geophysical data. The data parameters represent derived geophysical data and associated correction values obtained from specific GLAS science algorithms. These data parameter groups include time tags, data use and quality flags, and precision orbit location data. In

addition to the data products, metadata including identification, processing history, and data content descriptive information is produced for archival.

The GLAS Level 2 Standard Data Products are produced by the GLAS science data processing software which is based on the GLAS Algorithm Theoretical Basis Documents [Applicable Documents 2.2b - 2.2h]. These data products are produced by processing the GLAS Level 1 Data Products to form the Level 2 data. Figure 3-1 illustrates the source data products being processed to generate the Level 2 Data Products.

The specific details of the data product structure, content, format, and data element details will be presented in Section 6. Data sizing and burden, and physical media details are provided in Section 5.

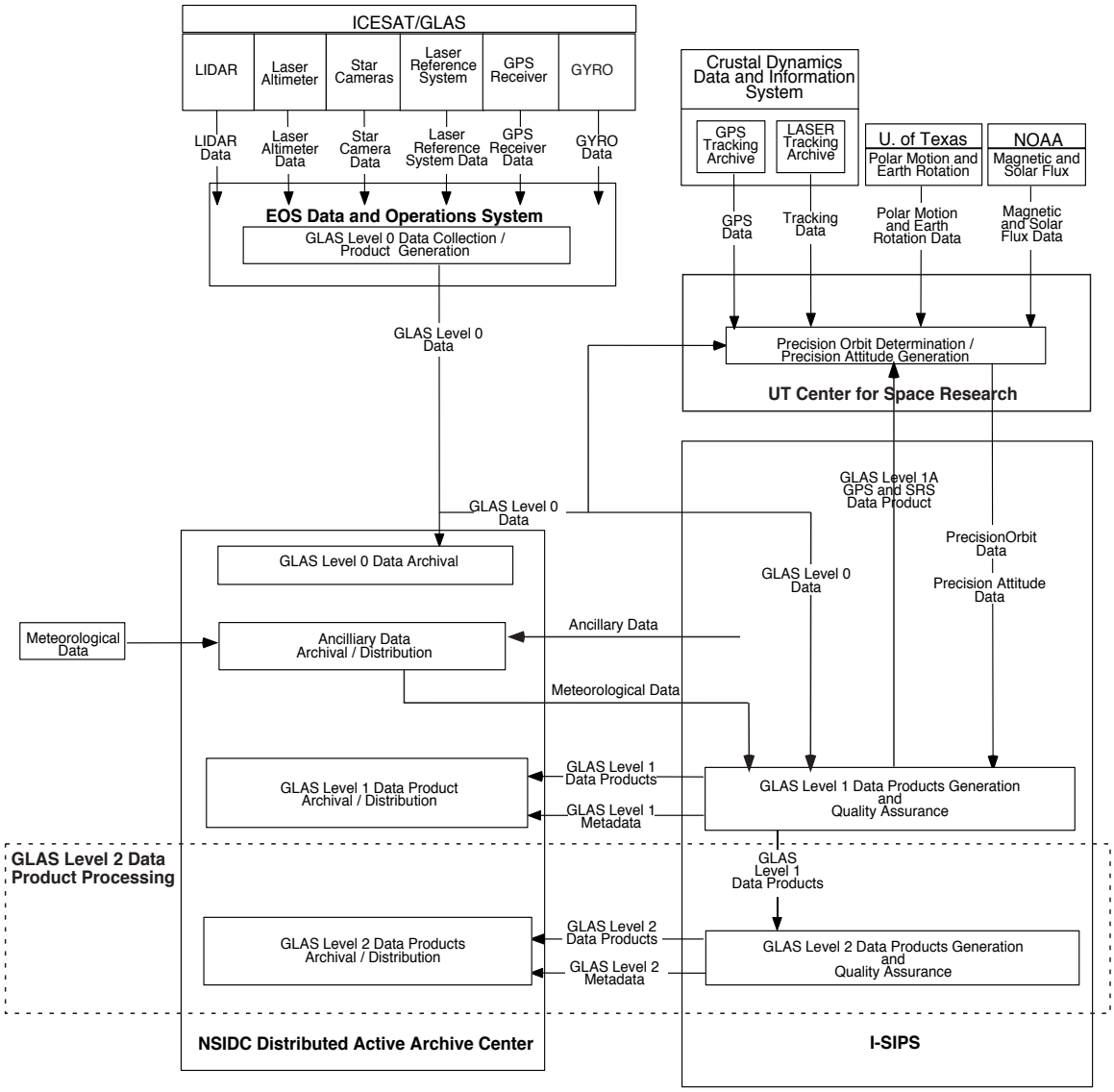

Figure 3-1 GLAS Level 2 Products Within The Data Product Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

The GLAS Level 2 Standard Data Products will be generated on the UNIX host processors within the I-SIPS. The input GLAS Level 1 Data Products and ancillary data reside in the I-SIPS storage facilities. Newly-generated Level 2 Data Products are accessed for quality assurance (QA) monitoring through the I-SIPS.

The I-SIPS consists of distributed UNIX operating system-based computers operating under the standard UNIX environment that support the GLAS Science Team operations including the quality monitoring. The GLAS Level 2 Data Products and their metadata (including the QA monitoring data) are delivered to the EOSDIS DAAC archive. The Level 2 metadata (associated data description and support information) are stored in the EOSDIS DAAC to facilitate EOS client inquiry and retrieval activities. The distribution management function of the EOSDIS DAAC allows clients to perform direct search and access of the Level 2 data or to request preparation of Level 2 Data Products.

4.2 Data Product Medium and Characteristics

The Data Products will be archived within the EOSDIS DAAC. The storage system will contain not only the Level 2 Data Products, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information also called metadata). The Level 2 Data Products and their metadata will be part of the Earth Sciences Data Types collection.

The Earth Science data are implemented in the current EOSDIS system through a hierarchical storage manager interface. Physical media supported by the storage system interface will include the disk storage subsystems, magnetic or optical media subsystems, and tiered archive robotics storage subsystems. EOSDIS clients can directly access the GLAS Level 2 data from the DAAC and can copy the data products to their host processors across the EOSDIS Networks.

The Level 2 Data Products will be available to the GLAS Science Team through the GLAS SCF. See Information Document 2.3e for a detailed description of the GLAS SCF.

4.3 Protocol and Conventions

Specific protocols and convention applying to the GLAS SCF will be specified in the SCF Plan [Information Document 2.3e]. When interfacing to the EOSDIS DAAC, the I-SIPS will comply with procedures, conventions, and protocols as defined by the EOSDIS.

Data definition terminology specific to the GLAS Level 2 Data Products and this document is presented in the Glossary at the end of this document. Figure 4-1 “Data Representation” depicts a schematic of the standard data representations used in GLAS Level 2 Data Products. These data structures will be used in the Section 6.0 generic data description and in the Appendix C detailed data description of the GLAS Level 2 Data Product contents.

Figure 4-1 Data Representation

4.4 Failure Protection, Detection, and Recovery Features

The team supporting operations at the I-SIPS will be responsible for failure protection, detection, and recovery of the generated GLAS Level 2 Data Products stored on the I-SIPS. Initial GLAS Level 2 Data Products error detection is performed during product generation as part of the product and processing quality assurance activity. The GLAS Level 2 Data Products will be “backed up” under the routine operational functions performed at the I-SIPS. In the event of failure or error detection in the active working or archive storage, recovery would be performed from backup media or from the EOSDIS DAAC archive.

The EOSDIS will be responsible for failure protection, detection, and recovery of the GLAS Level 2 Data Products archived at the EOSDIS DAAC.

Section 5

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

The expected daily data burdens for the GLAS Level 2 Standard Data Products are listed in Table 5-1 "GLAS Level 2 Data Product Daily Storage Burden". These estimates are based on the following EOS ICESat (Ice, Cloud, and Land Elevation Satellite) operational assumptions. The spacecraft will orbit the Earth at an inclination of 94 degrees and a nominal altitude of 600 kilometers in a circular orbit. The orbit (groundtrack) repeat cycle is one-half year based on a frozen orbit. The EOS ICESat orbit period will be approximately 100 minutes, with a pass period duration of approximately 50 minutes.

Table 5-1 GLAS Level 2 Data Product Daily Storage Burden

Product ID	Volume (MBytes per Day)
GLA08	7.16
GLA09	82.47
GLA10	289.46
GLA11	13.26
GLA12	104.64
GLA13	107.94
GLA14	209.61
GLA15	279.62

The daily volumes shown in Table 5-1 are assuming 24 hours of global coverage for each product. However, the contents of the GLA12, GLA13, GLA14, and GLA15 products will be edited based on location. Therefore the actual daily volume of these products may vary from what is shown in the table.

5.2 Data Transfer and Transmission

The GLAS Science Team will have access to the GLAS Level 2 Data Products through the GLAS SCF using TCP/IP and standard UNIX command operations. GLAS Level 2 Data Products generated within the I-SIPS will be transferred to the DAAC through the EOS Science Network or off-line via storage media.

Data access procedures to retrieve GLAS Level 2 Standard Data Products from the DAAC will be provided by the EOSDIS DAAC.

5.3 Timing and Sequencing Characteristics

The GLAS Level 2 Standard Data Products are generated as product files consisting of processed GLAS Level 1A and Level 1B Standard Data Products data. The basic aggregation of the GLAS Level 2 Data Products is the descriptive information in the header records and GLAS Data Elements in the data record. All data records within the GLAS Level 2 Data Products will be in ascending time order based on the height vector or aerosol measurement time tag. All parameters contained within the record are synchronous. The GLAS instrument and the EOS ICESat spacecraft are expected to operate for at least three years with a goal of five years.

5.4 Recipients and Utilization

The initial recipients of the GLAS Level 2 Data Products will be the GLAS Science Team and the EOSDIS. At the I-SIPS, the GLAS Level 2 Data Products will be used to produce the metadata quantifying and qualifying the products for EOS community usage. The GLAS Science Team will use the Level 2 Data Products for analysis and research. The subsequent recipients for the GLAS Level 2 Data Products are the scientific, governmental, and educational community sectors which will obtain the data products from the EOSDIS DAAC.

5.5 Access

The GLAS Level 2 Data Products are available to the GLAS Science Team from the GLAS SCF. Access to the GLAS SCF is controlled by the GLAS Science Team.

While EOS is intended to be a globally available and utilized mission program, access to the data is still operated under a security and integrity program to protect the data and data system resources from unauthorized or destructive use. Procedures for data access are provided by the EOSDIS DAAC.

Section 6

Data Products Definitions

6.1 Data Products Structure

The GLAS Level 2 Standard Data Products will be generated as scaled integer binary files. Each file will include appropriate header, labelling, and metadata information.

6.2 Labeling and Identification

Each of the GLAS Level 2 Data Products is uniquely identified by a GLAS standard file name. The form of this file name is

GLAxx_mmm_prkk_ccc_tttt_s_nn_ffff.eee

Specific elements within the file name are described in Table 6-1.

Table 6-1 GLAS File Naming Keys

Key	Description
xx	The GLAS Product ID (01-15)
mmm	release number for process that created the produce (CCB assigned-combination of software and data)
p	repeat ground track phase
r	reference orbit number
kk	instance # incremented every time GLAS enters a different reference orbit
ccc	cycle of reference orbit for this phase
tttt	track within reference orbit
s	segment of orbit. This is 0 on files that contain multiple segments (GLA02, GLA03, GLA04,GLA07-GLA15) and 1,2,3,or 4 on GLA01, GLA05, and GLA06.
nn	granule version number (the number of times this granule is created for a specific release)
ffff	file type (numerical,CCB assigned for multiple files as needed for data of same time period for a specific ANCxx or GLAxx, .i.e. multi-file granule)

The structure and contents of the GLAS Level 2 Data Product headers and labels are contained in Appendix A.

6.3 Data Products Substructure Descriptions

Full data product descriptions are provided in Appendix B and online in a hyper-linked format at the WFF GLAS website. The URL for product descriptions is:

http://glas.wff.nasa.gov/v40_products/

Table 6-2 lists the fields shown in each data product description entry.

Table 6-2 GLAS Data Product Description Fields

Field	Description
ID	GLAS File ID (GLA01, GLA02, etc).
Name	Descriptive name.
Product Type	Product Type (Standard|Ancillary).
Product Level	Product Level (L0,L1A,L1B,L2,L3).
Science Discipline	Primary associated science discipline.
Investigator	Primary investigator.
Temporal Resolution	Nominal time span, in seconds, of each record of data within a file.
Temporal Coverage	Nominal time span, in minutes, of data contained within a file.
Horiz Res Coverage	Horizontal coverage, in meters, over Earth's surface for each instrument measurement.
Vert Res Coverage	Vertical coverage, in meters, over the Earth's surface for each instrument measurement.
Instrument Name	Source instrument for the file (GLAS).
Archive Site	Location at which this file will be permanently archived.
File Disposition	Usage indicator with the following definitions: **Archive** - a file that is permanently archived after it is created. **Interim** - a file that is created for use by a subsequent process, but is not archived. **Permanent** - a file that is assumed to be kept in the processing environment for repeated access by one or more processes. **Temporary** - a file that is created by a process during its execution and is then deleted after termination. **Transfer to SCF** - similar to an Interim file, except the process that uses it is at an SCF.
Root/External Flag	A flag signifying whether this file is: **0**: neither of the following. **1**: the head-of-chain (Level 0 data) of an instrument's data stream. **2**: a file from an external source.
Source	A flag giving source data system of this file.
Frequency (per day)	Number of times processing PGE is executed.
Files per Granule	Number of physical files per each granule.

Table 6-2 GLAS Data Product Description Fields (Continued)

Field	Description
CPU (min)	Number of processing minutes required to produce a granule of this data.
MB per Day	Estimated amount of this data processed each data.
Record Size (bytes, 0=variable)	Size, in bytes, of a single record of data. 0 indicates a variable sized record.
Granule Size (MB)	Size, in megabytes, of a granule.
Granules per Day	Number of granules normally processed per day.
Revs per Granule	Number of earth revolutions contained in one granule.
Description	Text description.
Comment	Text comments.

6.4 Detailed Data Descriptions

Detailed data descriptions are provided at the website listed above. These descriptions provide details for each value within a product file. Table 6-3 lists the fields shown in each detailed data description entry.

Table 6-3 GLAS Detailed Data Description Fields

Field	Description
Product Var Name	Unique identifying name of the product variable.
Short Description	Descriptive name of the product variable.
Offset (bytes)	Offset in bytes from start of data record (start=0).
Prod Data Type	Product (Unscaled) Variable Type and dimensions (in parens). **i1b** = Integer, 1 byte **i2b** = Integer, 2 bytes **i4b** = Integer, 4 bytes **r4b** = Real, 4 bytes **r8b** = Real, 8 bytes etc...
Total Bytes	Total number of bytes used by variable.
Product Units	Units in which variable is stored on product file.
Prod Minimum Variable	Minimum value supported in product variable.
Prod Maximum Variable	Maximum value supported in product variable.
Is Correction Flag	Flag indicating if the variable is a correction flag.

Table 6-3 GLAS Detailed Data Description Fields (Continued)

Field	Description
Is Unsigned?	Flag indicating if variable should be treated as unsigned.
Invalid Value/Flag	Indicates what identifies the filed as being invalid. **None** = variable cannot be invalid. **gd_invalid_*xxx*** = datatype-specific value which indicates the variable is not valid. ***[variable name]*** = name of the flag to check in order to determine validity of the variable.

Appendix A
Level 2 Data Products
Standard Label Contents & Description

GLAS Products begin with ASCII header records containing information regarding the processing which created the Product and the data contained within. These header records are exactly the same size as a Product data record and contain ASCII information in a slightly modified KEYWORD=VALUE format. In order to conserve space on the product, the header entries are not delimited by the record length, but by a semi-colon (;) and linefeed (ASCII 10).

By design, the first two header entries are the record length and number of header records. This allows product readers to verify the record length and jump directly to the first data record, if necessary. Most of the remaining information within the headers is directly applicable to the generation of metadata files for EOS ingest.

The following common fields are defined for GLAS Product Headers:

Table A-1 Product Header Elements

Keyword	Content Description
Additional_Attribute	Product-specific additional attributes.
AutomaticQualityFlagExplan	Automatic Quality flag explanation (per parameter).
Cycle	A count of the number of exact repeats of this reference orbit.
EquatorCrossingDate	Date of the equator crossing.
EquatorCrossingLong	Longitude of equator crossing.
EquatorCrossingTime	Time of the equator crossing.
InputPointer	Name of each input product file used to created this product (one instances of this keyword appears in the product header record for each input product file used in creation of this product).
Instance	The number of times that a specific reference orbit has been returned to during flight.
instrument_short_name	Short name of instrument (GLAS).
Instrument_State	Flag word that indicates which redundant units (laser, detector, oscillator) of the GLAS instrument are in operation.
Instrument_State_Date	The date that corresponds to the Instrument_State. There are a maximum of two per granule.

Table A-1 Product Header Elements (Continued)

Keyword	Content Description
Instrument_State_Time	The time that corresponds to the Instrument_State. There are a maximum of two per granule.
LocalGranuleID	Filename of the granule.
LocalVersionID	Granule version number (auto-incrementing, nn in filenaming convention).
Numhead	Number of header records preceeding product data records.
OperationalQualityFlagExpl	Operational Quality flag explanation (per parameter).
Orbit Number	Orbit number
OrbitQuality	Status word that states what type of orbit was used during processing of the data for the granule. It specifies the models used in the orbit determination program. This provides an indication of the quality of the orbits being applied to the data.
ParameterName	Name of product specific parameters for which additional information follows.
PercentFullRate	Percent of data for this granule that atmospheric parameters are provided at 40 Hz data rate.
PercentGroundHit	Percent of data for this granule that had a detected ground return of the transmitted laser pulse.
PercentHighRate	Percent of data for this granule that atmospheric parameters are provided at 5 Hz data rate.
PercentLowRate	Percent of data for this granule that atmospheric parameters are provided at 0.25 Hz data rate.
PercentMediumRate	Percent of data for this granule that atmospheric parameters are provided at 1 Hz data rate.
Percent1064to532	Percent atmospheric profiles that use the 1064 nm profile data to provide estimated values for the saturated 532nm profiles.
PGEVersion	Version number of the GSAS software that generated this granule.
platform_short_name	Short name of spacecraft (Icesat).
ProductionDateTime	Creation time of granule.
QAPercentMissingData	Percent of missing data (per parameter)
QAPercentOutofBounds	Percent of out-of-bounds data (per parameter)
RangeBeginningDate	Start date of data on the granule.

Table A-1 Product Header Elements (Continued)

Keyword	Content Description
RangeEndingDate	End data of data on the granule.
RangeBeginningTime	Start time of day for data on this granule.
Range_Bias	The additive calibration correction in millimeters to apply to range based on the science team cal/val activities.
Range_Bias_Date	The date that corresponds to the first valid Range_Bias. There are a maximum of two per granule.
Range_Bias_Time	The time that corresponds to the first valid Range_Bias. There are a maximum of two per granule.
RangeEndingTime	End time of day for data on this granule.
Recl	Record length in bytes.
ReferenceOrbit	Assigned number for which exact orbital elements describe the exact repeat orbit pattern.
ReprocessingPlanned	Planned reprocessing status.
ReprocessingActual	Actual reprocessing status.
sensor_short_name	Short name of sensor (LaserALT).
ScienceQualityFlagExplana	Science Quality flag explanation (per parameter).
ShortName	GSAS Filetype.
size_mb_ecs_data_granule	Size (in MB) of the granule.
SP_ICE_GLAS_EndBlock	Integer SPICE block number within GLAS coverage scheme in which granule data ends.
SP_ICE_PATH_NO	Number which represents the GLAS SPICE path number.
SP_ICE_GLAS_StartBlock	Integer SPICE block number within GLAS coverage scheme in which granule data starts.
time_between_contiguous_records	Time between contiguous data records (in seconds).
Timing_Bias	The time tag error determined by the calibration team that was added to the time tags to compute the true time of data as provided on the granule.
Timing_Bias_Date	The date that corresponds to the Timing_Bias. There are a maximum of two per granule.
Timing_Bias_Time	The time of day that corresponds to the Timing_Bias. There are a maximum of two per granule.
Timing_Drift	This is the ratio of the true time for a one second oscillator tick to nominal one.
Timing_Drift_Date	The date that corresponds to the Timing_Drift. There are a maximum of two per granule.

Table A-1 Product Header Elements (Continued)

Keyword	Content Description
Timing_Drift_Time	The time of day that corresponds to the Timing_Drift. There are a maximum of two per granule.
Track	The unique number assigned for each repeat ground track (one orbit) of the reference orbit.
Track_Segment	Number assigned for the specific latitude segment (1 = +50 to +50, 2 = +50 to -50, 3 = -50 to -50, 4 = -50 to +50) of the track for the data.
VersionID	The ESDT version number that is to be used with this product.
Additional product specific information	(see Table A-2)

Each product allows addition information specific to it in the metadata related to the data quality. The parameters and their attitudes are listed in Table A-2.

Table A-2 Product Specific Elements

Product	Parameter Name	Attribute
GLA08	Aerosol Layer Heights	TBD
GLA08	Planetary Boundary Layer	TBD
GLA09	Cloud Layer Heights	TBD
GLA10	Cloud Backscatter Cross Section Profile	TBD
GLA10	Cloud Extinction Cross Section Profile	TBD
GLA10	Aerosol Backscatter Cross Section Profile	TBD
GLA10	Aerosol Extinction Cross Section Profile	TBD
GLA11	Cloud Optical Depth	TBD
GLA11	Aerosol Optical Depth	TBD
GLA11	Planetary Boundary Layer Optical Depth	TBD

Table A-2 Product Specific Elements (Continued)

Product	Parameter Name	Attribute
GLA12	Surface Elevation	Flag
GLA12		Percent Out of Bounds
GLA12	Surface Roughness	Flag
GLA12		Percent Out of Bounds
GLA12	Surface Reflectance	Flag
GLA12		Percent Out of Bounds
GLA12	Surface Slope	Flag
GLA12		Percent Out of Bounds
GLA13	Surface Elevation	Flag
GLA13		Percent Out of Bounds
GLA13	Surface Roughness	Flag
GLA13		Percent Out of Bounds
GLA13	Surface Reflectance	Flag
GLA13		Percent Out of Bounds
GLA14	Surface Elevation	Flag
GLA14		Percent Out of Bounds
GLA14	Surface Roughness	Flag
GLA14		Percent Out of Bounds
GLA14	Surface Reflectance	Flag
GLA14		Percent Out of Bounds
GLA14	Surface Slope	Flag
GLA14		Percent Out of Bounds
GLA15	Surface Elevation	Flag
GLA15		Percent Out of Bounds
GLA15	Surface Roughness	Flag
GLA15		Percent Out of Bounds

Table A-2 Product Specific Elements (Continued)

Product	Parameter Name	Attribute
GLA15	Surface Reflectance	Flag
GLA15		Percent Out of Bounds

Appendix B
Level 2 Data Products
Level 2 Data Products Description

Table B-1 lists the GLAS Data products.

Table B-1 Level-2 Data Products Description

Product ID	Name	Level	Science Discipline	Investigator	Temporal Resolution (sec)	Temporal Coverage (min)	Horiz Res Coverage (m)	Vert Rez Coverage (m)	Instrument Name	Archive Site	Root / External Flag	Source	Frequency (per day)	Files per Granule	CPU (min)	MB per Day	Record Size (0=variable)	Granule Size (MB)	Granules per Day	Revs per Granule
GLA08 (Latest)	Boundary Layer height	2	Atmosphere	Jim Spinhirne	4380	1380	-90 to 90	-180 to 180	GLAS	NSIDC	0	ISIPS	1	1	80.07	7.16857910 2	348	7.16857910 2	1	14
GLA09 (Latest)	Cloud Height	2	Atmosphere	Jim Spinhirne	4	1380	170	76.8	GLAS	Icesat SCF	0	ICESat SCF	1	1	146.57	82.4798584	4004	82.4798584	1	14
GLA10 (Latest)	Aerosol Vertical Structure	2	Atmosphere	Jim Spinhirne	4	1380	170	76.8	GLAS	Icesat SCF	0	Icesat SCF	1	1	214.02	289.462280 3	14052	289.462280 3	1	14
GLA11 (Latest)	Thin Cloud/ OD	2	Atmosphere	Jim Spinhirne	4	1380	170	76.8	GLAS	Icesat SCF	0	ICESat SCF	1	1	115.49	13.2659912 1	644	13.2659912 1	1	14
GLA12 (Latest)	Ice Sheet Elevation	2	Elevations-Ice Sheet	Jay Zwally	1	1380	170	0	GLAS	Icesat SCF	0	ICESat SCF	1	1	3.21	104.644775 4	5080	104.644775 4	1	14
GLA13 (Latest)	Sea Ice Roughness	2	Elevations-Sea Ice	Bob Thomas	1	1380	170	0	GLAS	Icesat SCF	0	ICESat SCF	1	1	2.9	107.940673 8	5240	107.940673 8	1	14
GLA14 (Latest)	Land/Canopy Elevation	2	Elevations-Land	Jack Bufton	1	1380	170	0	GLAS	Icesat SCF	0	ICESat SCF	1	1	3.05	209.619140 6	8480	209.619140 6	1	14
GLA15 (Latest)	Ocean Elevation	2	Elevations-Ocean	N/A	1	1380	170	0	GLAS	Icesat SCF	0	ICESat SCF	1	1	4.72	279.624023 4	4848	279.624023 4	1	14

Appendix C

Level 2 Data Product Formats

C.1 Record Formats

C.1.1 Guidelines

The GLAS Data Product record formats were developed under the following guidelines:

1) Record size a multiple of 8.
2) Start elements on a 4 byte boundary; where not possible use pads or group smaller elements together to get to 4 byte boundary. Pad and move elements so that arrays start on 4 byte boundaries.
3) The output structures to build files should be grouped in descending size order, therefore group elements on file logically and in descending size order.
4) Data that occurs occasionally in the file should be put in the header. Specifically, the orbit number and instrument state are changing at a much lower rate than the record rate on the files, therefore the orbit numbers and instrument states encompassed by a file will be put in the header. These elements will not be shown in the record format. Other data in the same category will be put in the header.
5) Add spares.

C.1.2 GLA08

Each record contains 4 seconds of data. Empty aerosol or planetary boundary layers will contain fill data.

Table C-1 GLA08 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA08_MAIN; % of Granule: 100; Record Duration (seconds):4; Repeats: 1										
Latest : Last Modified : Wed Feb 04 07:25:07 GMT-0500 (EST) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_beam_coelev	Co-elevation	12	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	28	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_pad_angle	PAD Angle	44	i4b (4)	16	microdegrees	0	3600000000	NA	No	i4b
i_spare0	Spares	60	i1b (40)	40	null	0	0	NA	NA	No
i_AttFlg1	Attitude flag	100	i2b (4)	8	NA	null	null	NA	No	no
i_lat	Profile Location, Latitude	108	i4b (4)	16	microdegrees	-90000000	90000000	NA	No	i4b
i_lon	Profile Location, Longitude	124	i4b (4)	16	microdegrees	0	360000000	NA	No	i4b
i_OrbFlg	Orbit flag	140	i1b (2, 4)	8	NA	0	255	NA	No	no
i_spare1	Spares	148	i1b (4)	4	NA	0	0	NA	No	NA
i_LidarQF	Lidar Frame quality flag	152	i2b (4)	8	NA	null	null	NA	No	no
i_atm_dem	DEM value at current location from 1 km x 1 km grid	160	i4b (4)	16	meters	-32768	32768	NA	No	i4b
i4_aer_bot	Below 20 KM Aerosol Layer Bottom	176	i2b (5)	10	deka-meters	-100	2000	NA	No	i4_aer_af
i4_aer_top	Below 20 KM Aerosol Layer Top	186	i2b (5)	10	deka-meters	-100	2000	NA	No	i4_aer_af
i20_aer_bot	20-40 KM Aerosol Layer Bottom	196	i2b (3)	6	deka-meters	1000	4000	NA	No	i20_aer_af
i20_aer_top	20-40 KM Aerosol Layer Top	202	i2b (3)	6	deka-meters	1000	4000	NA	No	i20_aer_af

Table C-1 GLA08 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_LRpbl_ht	Low Resolution PBL Height	208	i2b	2	deka-meters	-100	700	NA	No	i2b
i_LRpbl_grd	Ground Detection for Low Res PBL	210	i2b	2	deka-meters	-100	1000	NA	No	i2b
i_HRpbl_ht	High Resolution PBL Height	212	i2b (20)	40	deka-meters	-100	700	NA	No	i2b
i_HRpbl_grd	Ground Detection for High Res PBL	252	i2b (20)	40	deka-meters	-100	1000	NA	No	i2b
i4_aer_pct	Percentage of Saturated Bins in Below 20 KM Aerosol Layers	292	i1b (5)	5	unitless	0	100	NA	No	i4_aer_af
i20_aer_pct	Percentage of Saturated Bins in 20-40 KM Aerosol Layers	297	i1b (3)	3	unitless	0	100	NA	No	i20_aer_af
i_LRpbl_pct	Percentage of Saturated Bins in Low Resolution PBL Layer	300	i1b	1	unitless	0	100	NA	No	i1b
i_LayHgt_Flag	Layer Height Flag	301	i1b (32)	32	NA	0	15	NA	No	no
i_AttFlg3	Attitude Flag 3	333	i1b	1	NA	null	null	NA	No	null
i_timecorflg	time correction flag	334	i2b	2	N/A	0	32767	No	No	No
i_spare2	Spares	336	i1b (12)	12	NA	null	null	NA	No	NA
Total Bytes		348								

C.1.3 GLA09

Each record contains 4 seconds of data. Empty cloud layers will contain fill data.

Table C-2 GLA09 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA09_MAIN; % of Granule: 100; Record Duration (seconds):4; Repeats: 1										

Table C-2 GLA09 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Latest : Last Modified : Wed Feb 04 07:25:07 GMT-0500 (EST) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_beam_coelev	Co-elevation	12	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	28	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_pad_angle	PAD Angle	44	i4b (4)	16	microdegrees	0	3600000000	NA	No	i4b
i_spare0	Spares	60	i1b (40)	40	null	0	0	NA	NA	No
i_AttFlg1	Attitude flag	100	i2b (4)	8	NA	null	null	NA	No	no
i_lat	Profile Location, Latitude	108	i4b (4)	16	microdegrees	-90000000	90000000	NA	No	i4b
i_lon	Profile Location, Longitude	124	i4b (4)	16	microdegrees	0	360000000	NA	No	i4b
i_OrbFlg	Orbit flag	140	i1b (2, 4)	8	NA	0	255	NA	No	no
i_spare1	Spares	148	i1b (4)	4	NA	0	0	NA	No	NA
i_LidarQF	Lidar Frame quality flag	152	i2b (4)	8	NA	null	null	NA	No	no
i_spare2	Spares	160	i1b (8)	8	NA	null	null	NA	No	NA
i_topo_elev	Topographic elevation of surface above geoid	168	i4b (4)	16	meters	-2500	32000	NA	No	i4b
i_atm_dem	DEM value at current location from 1 km x 1 km grid	184	i4b (4)	16	meters	-32768	32768	NA	No	i4b
i_LRcld_bot	Low Resolution Cloud Bottom	200	i2b (10)	20	deka-meters	-100	2000	NA	No	i_LRC_af
i_LRcld_top	Low Resolution Cloud Top	220	i2b (10)	20	deka-meters	-100	2000	NA	No	i_LRC_af
i_LRcld_grd	Low Resolution Ground Detection	240	i2b	2	deka-meters	-100	1000	NA	No	i2b
i_spare3	Spares	242	i1b (2)	2	NA	null	null	NA	No	NA
i_MRcld_bot	Medium Resolution Cloud Bottom	244	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i_MRC_af

Table C-2 GLA09 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_MRcld_top	Medium Resolution Cloud Top	324	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i_MRC_af
i_MRcld_grd	Medium Resolution Ground Detection	404	i2b (4)	8	deka-meters	-100	1000	NA	No	i2b
i_MRcld_pct	Percentage of Saturated Bins in Medium Resolution Cloud Layers	412	i1b (10, 4)	40	unitless	0	100	NA	No	i_MRC_af
i_HRcld_bot	High Resolution Cloud Bottom	452	i2b (10, 20)	400	deka-meters	-100	2000	NA	No	i_HRC_af
i_HRcld_top	High Resolution Cloud Top	852	i2b (10, 20)	400	deka-meters	-100	2000	NA	No	i_HRC_af
i_HRcld_grd	High Resolution Ground Detection	1252	i2b (20)	40	deka-meters	-100	1000	NA	No	i2b
i_FRcld_bot	Full Resolution Cloud Bottom	1292	i2b (160)	320	deka-meters	-100	400	NA	No	i_FRC_af
i_FRcld_top	Full Resolution Cloud Top	1612	i2b (160)	320	deka-meters	-100	400	NA	No	i_FRC_af
i_FRcld_grd	Full Resolution Cloud Ground Detection	1932	i2b (160)	320	deka-meters	-100	1000	NA	No	i2b
i_FRg_grd_sig	Full Resolution Ground Return Signal at 532 nm	2252	i4b (160)	640	e11/(m-sr)	10000	10000000	NA	No	i4b
i_FRir_grd_sig	Full Resolution Ground Return Signal at 1064 nm	2892	i4b (160)	640	e14/(m-sr)	100000	10000000	NA	No	i4b
i_LRCL_Flag	Low Resolution Cloud Layers Flag	3532	i1b (11)	11	NA	0	15	NA	No	no
i_MRCL_Flag	Medium Resolution Cloud Layers Flag	3543	i1b (37)	37	NA	0	15	NA	No	no
i_HRCL_Flag	High Resolution Cloud Layers Flag	3580	i1b (185)	185	NA	0	15	NA	No	no
i_FRCL_Flag	Full Resolution Cloud Layers Flag	3765	i1b (220)	220	NA	0	15	NA	No	no
i_AttFlg3	Attitude Flag 3	3985	i1b	1	NA	null	null	NA	No	null
i_timecorflg	time correction flag	3986	i2b	2	N/A	0	32767	No	No	No

Table C-2 GLA09 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_spare4	Spares	3988	i1b (16)	16	NA	null	null	NA	No	NA
Total Bytes		4004								

C.1.4 GLA10

Each record contains 4 seconds of data.

Table C-3 GLA10 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA10_MAIN; % of Granule: 100; Record Duration (seconds):4; Repeats: 1										
Latest : Last Modified : Wed Feb 04 07:25:07 GMT-0500 (EST) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_beam_coelev	Co-elevation	12	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	28	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_pad_angle	PAD Angle	44	i4b (4)	16	microdegrees	0	3600000000	NA	No	i4b
i_spare0	Spares	60	i1b (40)	40	null	0	0	NA	NA	No
i_AttFlg1	Attitude flag	100	i2b (4)	8	NA	null	null	NA	No	no
i_lat	Profile Location, Latitude	108	i4b (4)	16	microdegrees	-90000000	90000000	NA	No	i4b
i_lon	Profile Location, Longitude	124	i4b (4)	16	microdegrees	0	360000000	NA	No	i4b
i_OrbFlg	Orbit flag	140	i1b (2, 4)	8	NA	0	255	NA	No	no
i_spare1	Spares	148	i1b (4)	4	NA	0	0	NA	No	NA
i_LidarQF	Lidar Frame quality flag	152	i2b (4)	8	NA	null	null	NA	No	no

Table C-3 GLA10 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_cld1_bs_prof	Cloud Backscatter Cross Section Profile	160	i4b (280, 4)	4480	e10/(m-sr)	-1000000	100000000	NA	No	i4b
i_cld1_ext_prof	Cloud Extinction Cross Section Profile	4640	i4b (280, 4)	4480	e9/m	-10000000	1000000000	NA	No	i4b
i_aer4_bs_prof	Aerosol Backscatter Cross Section Profile	9120	i4b (548)	2192	e10/(m-sr)	-1000000	100000000	NA	No	i4b
i_aer4_ext_prof	Aerosol Extinction Cross Section Profile	11312	i4b (548)	2192	e9/m	-10000000	1000000000	NA	No	i4b
i_cld1_sval1	Cloud true S values from table	13504	i2b (10, 4)	80	100*sr	100	20000	NA	No	i2b
i_cld1_sval2	Cloud true S values from equation calc.	13584	i2b (10, 4)	80	100*sr	100	20000	NA	No	i2b
i_aer4_sval1	Aerosol true S Values from table	13664	i2b (9)	18	100*sr	100	20000	NA	No	i2b
i_aer4_sval2	Aerosol true S Values from equation calc.	13682	i2b (9)	18	100*sr	100	20000	NA	No	i2b
i_cld1_bot	Medium Resolution Cloud Bottom	13700	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i2b
i_cld1_top	Medium Resolution Cloud Top	13780	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i2b
i_cld1_grd_det	Medium Resolution Ground Detection	13860	i2b (4)	8	deka-meters	-100	2000	NA	No	i2b
i_aer4_bot	Low Resolution Aerosol Layer Bottom	13868	i2b (9)	18	deka-meters	-100	4000	NA	No	i2b
i_aer4_top	Low Resolution Aerosol Layer Top	13886	i2b (9)	18	deka-meters	-100	4000	NA	No	i2b
i_pbl4_grd_det	Low Resolution Aerosol Layer Ground Detection	13904	i2b	2	deka-meters	-100	1000	NA	No	i2b
i_spare2	Spares	13906	i1b (2)	2	NA	null	null	NA	No	NA
i_cld1_sval_uf	Cloud true S values use flag	13908	i1b (20)	20	NA	0	15	NA	No	no

Table C-3 GLA10 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_aer4_sval_uf	Aerosol true S Values use flag	13928	i1b (5)	5	NA	0	15	NA	No	no
i_spare3	Spares	13933	i1b (3)	3	NA	null	null	NA	No	NA
i_cld1_bs_flag	Cloud backscatter flag	13936	i1b (40)	40	NA	0	15	NA	No	no
i_cld1_ext_flag	Cloud extinction flag	13976	i1b (40)	40	NA	0	15	NA	No	no
i_aer4_bs_flag	Aerosol backscatter flag	14016	i1b (10)	10	NA	0	15	NA	No	no
i_aer4_ext_flag	Aerosol extinction flag	14026	i1b (10)	10	NA	0	15	NA	No	no
i_spare4	Spares	14036	i1b	1	null	0	0	NA	NA	No
i_AttFlg3	Attitude Flag 3	14037	i1b	1	NA	null	null	NA	No	null
i_timecorflg	time correction flag	14038	i2b	2	N/A	0	32767	No	No	No
i_spare5	Spares	14040	i1b (12)	12	NA	0	0	NA	No	NA
Total Bytes		14052								

C.1.5 GLA11

Each record contains 4 seconds of data.

Table C-4 GLA11 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA11_MAIN; % of Granule: 100; Record Duration (seconds):4; Repeats: 1										
Latest : Last Modified : Fri Jul 16 07:44:31 GMT-0400 (EDT) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no

Table C-4 GLA11 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_beam_coelev	Co-elevation	12	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	28	i4b (4)	16	degrees*100	0	36000	NA	No	i4b
i_pad_angle	PAD Angle	44	i4b (4)	16	microdegrees	0	3600000000	NA	No	i4b
i_spare0	Spares	60	i1b (40)	40	null	0	0	NA	NA	No
i_AttFlg1	Attitude flag	100	i2b (4)	8	NA	null	null	NA	No	no
i_lat	Profile Location, Latitude	108	i4b (4)	16	microdegrees	-90000000	90000000	NA	No	i4b
i_lon	Profile Location, Longitude	124	i4b (4)	16	microdegrees	0	360000000	NA	No	i4b
i_OrbFlg	Orbit flag	140	i1b (2, 4)	8	NA	0	255	NA	No	no
i_spare1	Spares	148	i1b (4)	4	NA	0	0	NA	No	NA
i_LidarQF	Lidar Frame quality flag	152	i2b (4)	8	NA	null	null	NA	No	no
i_cld1_od	Cloud Optical Depth	160	i2b (10, 4)	80	unitless	0	5000	NA	No	i2b
i_aer4_od	Aerosol Optical Depth	240	i2b (8)	16	unitless	0	5000	NA	No	i2b
i_pbl4_od	PBL Optical Depth	256	i2b	2	unitless	0	5000	NA	No	i2b
i_aer4_msf	Aerosol Multiple Scattering Factor	258	i2b (9)	18	unitless	0	1000	NA	No	i2b
i_cld1_msf	Cloud Multiple Scattering Factor	276	i2b (10, 4)	80	unitless	0	1000	NA	No	i2b
i_cld1_bot	Medium Resolution Cloud Bottom	356	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i2b
i_cld1_top	Medium Resolution Cloud Top	436	i2b (10, 4)	80	deka-meters	-100	2000	NA	No	i2b
i_cld1_grd_det	Medium Resolution Ground Detection	516	i2b (4)	8	deka-meters	-100	2000	NA	No	i2b
i_aer4_bot	Low Resolution Aerosol Layer Bottom	524	i2b (8)	16	deka-meters	-100	4000	NA	No	i2b
i_aer4_top	Low Resolution Aerosol Layer Top	540	i2b (8)	16	deka-meters	-100	4000	NA	No	i2b

Table C-4 GLA11 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_aer4_ht	Low Resolution PBL Height	556	i2b	2	deka-meters	-100	700	NA	No	i2b
i_aer4_grd_det	Low Resolution Ground Detection	558	i2b	2	deka-meters	-100	1000	NA	No	i2b
i_erd	Estimated Range Delay	560	i2b (4)	8	millimeters	0	1000	NA	No	i2b
i_pse	Particle Size Estimate	568	i2b (4)	8	microns	0	1000	NA	No	i2b
i_cld1_mswf	Cloud Multiple Scattering Warning Flag	576	i1b (2)	2	NA	0	15	NA	No	no
i_cld1_flag	Cloud optical depth flag	578	i1b (40)	40	NA	0	15	NA	No	no
i_aer4_flag	Aerosol optical depth flag	618	i1b (8)	8	NA	0	15	NA	No	no
i_pbl4_flag	PBL optical depth flag	626	i1b	1	NA	0	15	NA	No	no
i_AttFlg3	Attitude Flag 3	627	i1b	1	NA	null	null	NA	No	null
i_timecorflg	time correction flag	628	i2b	2	N/A	0	32767	No	No	No
i_rdu	Range Delay Uncertainty	630	i2b (4)	8	millimeters	0	10000	NA	No	i2b
i_spare2	Spares	638	i1b (6)	6	NA	null	null	NA	No	NA
Total Bytes		644								

FIX.....The table for GLA11 (table C-4) is incomplete. The definitions for bytes 540 – 644 are missing.

C.1.6 GLA12

Each record contains 1 second of data.

Table C-5 GLA12 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA12_MAIN; % of Granule: 25; Record Duration (seconds):1; Repeats: 1										

Table C-5 GLA12 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Latest : Last Modified : Fri Jul 16 07:45:15 GMT-0400 (EDT) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_transtime	One way transit time	12	i2b	2	microseconds	0	4000	NA	No	i2b
i_Spare1	Spare	14	i1b (2)	2	N/A	null	null	NA	No	No
i_deltagpstmcor	Delta GPS time correction	16	i4b	4	nanoseconds	0	1000000	NA	No	gi_invalid_i4b
i_dShotTime	Laser Shot Time Deltas (shots 2-40)	20	i4b (39)	156	microseconds	0	1200000	NA	No	No
i_lat	Coordinate Data, Latitude, specific to ice sheet range	176	i4b (40)	160	microdeg	-90000000	90000000	NA	No	i4b
i_lon	Coordinate Data, Longitude, specific to ice sheet range	336	i4b (40)	160	microdeg	0	360000000	NA	No	i4b
i_elev	Ice Sheet Surface elevation	496	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_PADPoint	PAD Pointing unit Vector in ICRF	656	i4b (6, 40)	960	Unit-less*1000000	-1000000	1000000	NA	No	i4b
i_PODFixedPos	Position orbit vector in ICRF	1616	i4b (6, 40)	960	m, mm	-7.00E+10	7.00E+10	NA	No	i4b
i_sigmaatt	Attitude Quality Indicator	2576	i2b (40)	80	Unitless	0	6000	NA	No	i2b
i_Azimuth	Local Azimuth	2656	i4b	4	millideg	0	360000	NA	No	i4b
i_SolAng	Solar Incidence Angle	2660	i4b	4	microdeg	-90000000	90000000	NA	No	i4b
i_tpintensity_avg	Transmit Pulse intensity - frame avg	2664	i4b	4	counts	0	25500	NA	No	i4b
i_tpazimuth_avg	Transmit Pulse azimuth - frame avg	2668	i2b	2	degrees*10	0	3600	NA	No	i2b
i_tpeccentricity_avg	Transmit Pulse eccentricity - frame avg	2670	i2b	2	Unitless*1000	0	1000	NA	No	i2b
i_tpmajoraxis_avg	Tramsit Pulse major axis - frame avg	2672	i2b	2	cm	0	10000	NA	No	i2b

Table C-5 GLA12 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_Spare2	Spare	2674	i1b (2)	2	null	null	null	NA	No	null
i_gdHt	Geoid	2676	i2b (2)	4	cm	-20000	20000	NA	No	i2b
i_erElv	Solid Earth Tide Elevation (at first & last shot)	2680	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_spElv	Tide Elevations, Specific	2684	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ldElv	Load Tide Elevation	2692	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ocElv	Ocean Tide Elevation (at first & last shot)	2700	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_wTrop	Range Correction_Wet Troposphere	2704	i2b (2)	4	mm	-1000	0	NA	No	i2b
i_dTrop	Range Correction, Dry Troposphere	2708	i2b (40)	80	mm	-2500	0	NA	No	i2b
i_surfType	Region Type	2788	i1b	1	N/A	1	15	NA	No	No
i_Spare3	Spare	2789	i1b (3)	3	N/A	null	null	NA	No	null
i_DEM_elv	DEM Elevation	2792	i4b (40)	160	cm	-50000	1000000	NA	No	i4b
i_refRng	Reference Range	2952	i4b (40)	160	mm	400000000	1000000000	NA	No	i4b
i_TrshRngOff	Threshold Retracker Range Offset	3112	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_isRngOff	Ice Sheet Range Offset	3272	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_SigEndOff	Signal End Range Offset	3432	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_cntRngOff	Centroid Range Offset	3592	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_reflctUncorr	Reflectivity not corrected for Atmospheric Effects	3752	i4b (40)	160	Unitless*1E06	0	1000000	NA	No	i4b
i_reflCor_atm	Reflectance Correction, Atmosphere	3912	i4b	4	Unitless*1E06	0	1000000	NA	No	i4b
i_maxSmAmp	Peak Amplitude of Smoothed Received Echo	3916	i2b (40)	80	Tenth of millivolts	-300	30000	NA	No	No
i_SigmaElv	Sigma of Elevation	3996	i2b (40)	80	mm	0	32000	NA	No	i2b

Table C-5 GLA12 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_numPk	Number of Peaks found in the Return	4076	i1b (40)	40	N/A	0	6	NA	No	No
i_kurt2	Kurtosis of the Received Echo (standard)	4116	i2b (40)	80	unitless * 100	-1000	1000	NA	No	i2b
i_skew2	Skewness	4196	i2b (40)	80	unitless * 100	-10000	10000	NA	No	i2b
i_IceSheetRuf	Ice Sheet Roughness	4276	i2b (40)	80	cm	0	12000	NA	No	i2b
i_IsSlopeEmp	Ice Sheet Slope - echo	4356	i2b (40)	80	millideg	0	32000	NA	No	i2b
i_IsRngLast	Ice Sheet Range offset using last peak	4436	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_IsRngFst	Ice Sheet Range Offset using first peak	4596	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_IceSVar	Standard Deviation of the ice sheet Gaussian Fit	4756	i2b (40)	80	millivolts	0	25500	NA	No	i2b
i_ElvuseFlg	Elevation use flag	4836	i1b (5)	5	N/A	-127	127	NA	No	No
i_atm_avail	Atmosphere Availability Flag	4841	i1b	1	NA	0	15	NA	No	No
i_erd	Estimated Range Delay	4842	i2b	2	Millimeters	0	1000	NA	No	i2b
i_rdu	Range Delay Uncertainty	4844	i2b	2	Millimeters	0	10000	NA	No	i2b
i_cld1_mswf	Cloud Multiple Scattering Warning Flag	4846	i1b	1	NA	0	15	NA	No	No
i_MRC_af	Medium Resolution Cloud Availability Flag	4847	i1b	1	NA	0	15	NA	No	No
i_SurfRuf_slpQF	Surface Roughness & Slope Quality Flag	4848	i1b (40)	40	N/A	0	127	NA	No	No
i_ElvFlg	Elevation Definition Flag	4888	i1b (40)	40	N/A	0	127	NA	No	No
i_rng_UQF	Range Offset Quality/Use Flag	4928	i2b (40)	80	N/A	0	32767	NA	No	No
i_atmQF	Atmosphere Flag	5008	i1b (10)	10	N/A	0	1	NA	No	No
i_timecorflg	time correction flag	5018	i2b	2	N/A	0	32767	No	No	No

Table C-5 GLA12 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_APID_AvFlg	APID Data Availability Flag	5020	i1b (8)	8	n/a	-127	127	NA	No	No
i_AttFlg2	Attitude Flag 2	5028	i1b (20)	20	NA	0	15	NA	No	no
i_spare5	Spares	5048	i1b	1	NA	0	0	NA	No	NA
i_FrameQF	Altimeter Frame Quality Flag	5049	i1b	1	N/A	0	1	NA	No	No
i_OrbFlg	POD flag (Orbit Flag)	5050	i1b (2)	2	NA	0	32767	NA	No	no
i_rngCorrFlg	Range Correction Flag	5052	i1b (2)	2	N/A	0	32767	NA	No	No
i_CorrStatFlg	Correction Status Flag	5054	i1b (2)	2	NA	0	32767	NA	No	no
i_beam_coelev	Co-elevation	5056	i4b	4	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	5060	i4b	4	degrees*100	0	36000	NA	No	i4b
i_AttFlg1	Attitude Flag 1	5064	i2b	2	N/A	0	32767	NA	No	i_AttFlg1
i_Spare6	Spare	5066	i1b (14)	14	N/A	null	null	NA	No	i_Spare6
Total Bytes		5080								

C.1.7 GLA13

Each record contains 1 second of data.

Table C-6 GLA13 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA13_MAIN; % of Granule: 25; Record Duration (seconds):1; Repeats: 1										
Latest : Last Modified : Fri Jul 16 07:45:15 GMT-0400 (EDT) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no

Table C-6 GLA13 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_transtime	One way transit time	12	i2b	2	microseconds	0	4000	NA	No	i2b
i_Spare1	Spare	14	i1b (2)	2	N/A	null	null	NA	No	No
i_deltagpstmcor	Delta GPS time correction	16	i4b	4	nanoseconds	0	1000000	NA	No	gi_invalid_i4b
i_dShotTime	Laser Shot Time Deltas (shots 2-40)	20	i4b (39)	156	microseconds	0	1200000	NA	No	No
i_lat	Coordinate Data, Latitude, specific to sea ice range	176	i4b (40)	160	microdeg	-90000000	90000000	NA	No	i4b
i_lon	Coordinate Data, Longitude, specific to sea ice range	336	i4b (40)	160	microdeg	0	360000000	NA	No	i4b
i_elev	Sea Ice Surface Elevation	496	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_PADPoint	PAD Pointing unit Vector in ICRF	656	i4b (6, 40)	960	Unit-less*1000000	-1000000	1000000	NA	No	i4b
i_PODFixedPos	Position orbit vector in ICRF	1616	i4b (6, 40)	960	m, mm	-7.00E+10	7.00E+10	NA	No	i4b
i_sigmaatt	Attitude Quality Indicator	2576	i2b (40)	80	Unitless	0	6000	NA	No	i2b
i_Azimuth	Local Azimuth	2656	i4b	4	millideg	0	360000	NA	No	i4b
i_SolAng	Solar Incidence Angle	2660	i4b	4	microdeg	-90000000	90000000	NA	No	i4b
i_tpintensity_avg	Transmit Pulse intensity - frame avg	2664	i4b	4	counts	0	25500	NA	No	i4b
i_tpazimuth_avg	Transmit Pulse azimuth - frame avg	2668	i2b	2	degrees*10	0	3600	NA	No	i2b
i_tpeccentricity_avg	Transmit Pulse eccentricity - frame avg	2670	i2b	2	Unitless*1000	0	1000	NA	No	i2b
i_tpmajoraxis_avg	Tramsit Pulse major axis - frame avg	2672	i2b	2	cm	0	10000	NA	No	i2b
i_Spare2	Spare	2674	i1b (2)	2	N/A	null	null	NA	No	No
i_gdHt	Geoid	2676	i2b (2)	4	cm	-20000	20000	NA	No	i2b

Table C-6 GLA13 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_erElv	Solid Earth Tide Elevation (at first & last shot)	2680	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_spElv	Tide Elevations, Specific	2684	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ldElv	Load Tide Elevation	2692	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ocElv	Ocean Tide Elevation (at first & last shot)	2700	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_wTrop	Range Correction_Wet Troposphere	2704	i2b (2)	4	mm	-1000	0	NA	No	i2b
i_dTrop	Range Correction, Dry Troposphere	2708	i2b (40)	80	mm	-2500	0	NA	No	i2b
i_surfType	Region Type	2788	i1b	1	N/A	1	15	NA	No	No
i_Spare3	Spare	2789	i1b (3)	3	N/A	null	null	NA	No	No
i_DEM_elv	DEM Elevation	2792	i4b (40)	160	cm	-50000	1000000	NA	No	i4b
i_refRng	Reference Range	2952	i4b (40)	160	mm	400000000	1000000000	NA	No	i4b
i_TrshRngOff	Threshold Retracker Range Offset	3112	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_siRngOff	Sea Ice Range Offset	3272	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_SigEndOff	Signal End Range Offset	3432	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_cntRngOff	Centroid Range Offset	3592	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_reflctUncorr	Reflectivity not corrected for Atmospheric Effects	3752	i4b (40)	160	Unitless*1E06	0	1000000	NA	No	i4b
i_reflCor_atm	Reflectance Correction, Atmosphere	3912	i4b	4	Unitless*1E06	0	1000000	NA	No	i4b
i_maxSmAmp	Peak Amplitude of Smoothed Received Echo	3916	i2b (40)	80	Tenth of millivolts	-300	30000	NA	No	No
i_SigmaElv	Sigma of Elevation	3996	i2b (40)	80	mm	0	32000	NA	No	i2b
i_numPk	Number of Peaks found in the Return	4076	i1b (40)	40	N/A	0	6	NA	No	No

Table C-6 GLA13 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_RufSeaIce	Surface Roughness - whole signal	4116	i2b (40)	80	cm	0	12000	NA	No	i2b
i_skew2	Skewness	4196	i2b (40)	80	unitless * 100	-10000	10000	NA	No	i2b
i_SiRufLstPk	Surface Roughness - last peak	4276	i2b (40)	80	cm	0	12400	NA	No	i2b
I_AvgRuf	Avg Roughness	4356	i2b (40)	80	cm	0	12000	NA	No	i4b
i_BergElev	Iceberg Elevation	4436	i4b (40)	160	mm	0	200000	NA	No	i4b
i_AvgElev	Average elevation	4596	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_SiRngFst	Sea ice range increment to first peak	4756	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_SeaIceVar	Standard Deviation of the sea ice Gaussian fit	4916	i2b (40)	80	millivolts	0	25500	NA	No	i2b
i_ElvuseFlg	Elevation use flag	4996	i1b (5)	5	N/A	-127	127	NA	No	No
i_atm_avail	Atmosphere Availability Flag	5001	i1b	1	NA	0	15	NA	No	No
i_erd	Estimated Range Delay	5002	i2b	2	Millimeters	0	1000	NA	No	i2b
i_rdu	Range Delay Uncertainty	5004	i2b	2	Millimeters	0	10000	NA	No	i2b
i_cld1_mswf	Cloud Multiple Scattering Warning Flag	5006	i1b	1	NA	0	15	NA	No	No
i_MRC_af	Medium Resolution Cloud Availability Flag	5007	i1b	1	NA	0	15	NA	No	No
i_SiRufQF	Sea ice Roughness Quality Flag	5008	i1b (40)	40	N/A	0	1	NA	No	No
i_ElvFlg	Elevation Definition Flag	5048	i1b (40)	40	N/A	0	127	NA	No	No
i_rng_UQF	Range Offset Quality/Use Flag	5088	i2b (40)	80	N/A	0	32767	NA	No	No
i_atmQF	Atmosphere Flag	5168	i1b (10)	10	N/A	0	1	NA	No	No
i_timecorflg	time correction flag	5178	i2b	2	N/A	0	32767	No	No	No

Table C-6 GLA13 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_APID_AvFlg	APID Data Availability Flag	5180	i1b (8)	8	n/a	-127	127	NA	No	No
i_AttFlg2	Attitude Flag 2	5188	i1b (20)	20	NA	0	15	NA	No	no
i_spare5	Spares	5208	i1b	1	NA	0	0	NA	No	NA
i_FrameQF	Altimeter Frame Quality Flag	5209	i1b	1	N/A	0	1	NA	No	No
i_OrbFlg	POD flag (Orbit Flag)	5210	i1b (2)	2	NA	0	32767	NA	No	no
i_rngCorrFlg	Range Correction Flag	5212	i1b (2)	2	N/A	0	32767	NA	No	No
i_CorrStatFlg	Correction Status Flag	5214	i1b (2)	2	NA	0	32767	NA	No	no
i_beam_coelev	Co-elevation	5216	i4b	4	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	5220	i4b	4	degrees*100	0	36000	NA	No	i4b
i_AttFlg1	Attitude Flag 1	5224	i2b	2	N/A	0	32767	NA	No	No
i_Spare6	Spares	5226	i1b (14)	14	N/A	null	null	NA	NA	No
Total Bytes		5240								

C.1.8 GLA14

Each record contains 1 second of data.

Table C-7 GLA14 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA14_MAIN; % of Granule: 30; Record Duration (seconds):1; Repeats: 1										
Latest : Last Modified : Fri Jul 16 07:45:15 GMT-0400 (EDT) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no

Table C-7 GLA14 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_transtime	One way transit time	12	i2b	2	microseconds	0	4000	NA	No	i2b
i_Spare1	Spare	14	i1b (2)	2	N/A	null	null	NA	No	No
i_deltagpstmcor	Delta GPS time correction	16	i4b	4	nanoseconds	0	1000000	NA	No	gi_invalid_i4b
i_dShotTime	Laser Shot Time Deltas (shots 2-40)	20	i4b (39)	156	microseconds	0	1200000	NA	No	No
i_lat	Coordinate Data, Latitude, specific to land range	176	i4b (40)	160	microdeg	-90000000	90000000	NA	No	i4b
i_lon	Coordinate Data, Longitude, specific to land range	336	i4b (40)	160	microdeg	0	360000000	NA	No	i4b
i_elev	Land surface Elevation	496	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_PADPoint	PAD Pointing unit Vector in ICRF	656	i4b (6, 40)	960	Unit-less*1000000	-1000000	1000000	NA	No	i4b
i_PODFixedPos	Position orbit vector in ICRF	1616	i4b (6, 40)	960	m, mm	-7.00E+10	7.00E+10	NA	No	i4b
i_sigmaatt	Attitude Quality Indicator	2576	i2b (40)	80	Unitless	0	6000	NA	No	i2b
i_Azimuth	Local Azimuth	2656	i4b	4	millideg	0	360000	NA	No	i4b
i_SolAng	Solar Incidence Angle	2660	i4b	4	microdeg	-90000000	90000000	NA	No	i4b
i_tpintensity_avg	Transmit Pulse intensity - frame avg	2664	i4b	4	counts	0	25500	NA	No	i4b
i_tpazimuth_avg	Transmit Pulse azimuth - frame avg	2668	i2b	2	degrees*10	0	3600	NA	No	i2b
i_tpeccentricity_avg	Transmit Pulse eccentricity - frame avg	2670	i2b	2	Unitless*1000	0	1000	NA	No	i2b
i_tpmajoraxis_avg	Tramsit Pulse major axis - frame avg	2672	i2b	2	cm	0	10000	NA	No	i2b
i_Spare2	Spares	2674	i1b (2)	2	N/A	null	null	NA	No	No
i_gdHt	Geoid	2676	i2b (2)	4	cm	-20000	20000	NA	No	i2b

Table C-7 GLA14 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_erElv	Earth Tide Elevation	2680	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_spElv	Tide Elevations, Specific	2684	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ldElv	Load Tide Elevation	2692	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ocElv	Ocean Tide Elevation (at first & last shot)	2700	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_wTrop	Range Correction, Wet Troposphere	2704	i2b (2)	4	mm	-1000	0	NA	No	i2b
i_dTrop	Range Correction, Dry Troposphere	2708	i2b (40)	80	mm	-2500	0	NA	No	i2b
i_surfType	Region Type	2788	i1b	1	N/A	1	15	NA	No	No
i_Spare3	Spare	2789	i1b (3)	3	N/A	null	null	NA	No	No
i_DEM_elv	DEM Elevation	2792	i4b (40)	160	cm	-50000	1000000	NA	No	i4b
i_refRng	Reference Range	2952	i4b (40)	160	mm	400000000	1000000000	NA	No	i4b
i_SigBegOff	Signal Begin Range Increment	3112	i4b (40)	160	mm	-300000	0	NA	No	i4b
i_ldRngOff	Land Range Offset	3272	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_SigEndOff	Signal End Range Increment	3432	i4b (40)	160	mm	-300000	0	NA	No	i4b
i_gpCntRngOff	Centroid Range Increment for all 6 peaks	3592	i4b (6, 40)	960	mm	-150000	0	NA	No	i4b
i_reflctUncorr	Reflectivity not corrected for Atmospheric Effects	4552	i4b (40)	160	Unitless*1E06	0	1000000	NA	No	i4b
i_reflCor_atm	Reflectance Correction, Atmosphere	4712	i4b	4	Unitless*1E06	0	1000000	NA	No	i4b
i_maxSmAmp	Peak Amplitude of Smoothed Received Echo	4716	i2b (40)	80	Tenth of millivolts	-300	30000	NA	No	No
i_SigmaElv	Sigma of Elevation - TBD	4796	i2b (40)	80	mm	0	32000	NA	No	i2b
i_numPk	Number of Peaks found in the Return	4876	i1b (40)	40	N/A	0	6	NA	No	No

Table C-7 GLA14 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_kurt1	Kurtosis of Received Echo (alternative)	4916	i2b (40)	80	unitless * 100	-1000	1000	NA	No	i2b
i_skew1	Skewness of Received Echo (alternative)	4996	i2b (40)	80	unitless * 100	-1000	1000	NA	No	i2b
i_LdRufLstPk	Land Roughness - last	5076	i2b (40)	80	cm	0	12000	NA	No	i2b
i_LandSlopeLast	Land Slope - echo - last	5156	i2b (40)	80	millideg	0	32000	NA	No	i2b
i_Gamp	Amplitudes of Gaussians	5236	i4b (6, 40)	960	counts	0	6963200	NA	No	i4b
i_Garea	Area under Gaussian	6196	i4b (6, 40)	960	Counts X ns	0	6963200	NA	No	i4b
i_Gsigma	Sigma of Gaussians	7156	i4b (6, 40)	960	mm	0	6963200	NA	No	i4b
i_nPeaks1	Initial Number of Peaks in received echo (alternate)	8116	i1b (40)	40	NA	0	50	NA	No	no
i_LandVar	Standard Deviation of the land Gaussian Fit	8156	i2b (40)	80	millivolts	0	25500	NA	No	i2b
i_ElvuseFlg	Elevation use flag	8236	i1b (5)	5	N/A	-127	127	NA	No	No
i_atm_avail	Atmosphere Availability Flag	8241	i1b	1	NA	0	15	NA	No	No
i_erd	Estimated Range Delay	8242	i2b	2	Millimeters	0	1000	NA	No	i2b
i_rdu	Range Delay Uncertainty	8244	i2b	2	Millimeters	0	10000	NA	No	i2b
i_cld1_mswf	Cloud Multiple Scattering Warning Flag	8246	i1b	1	NA	0	15	NA	No	No
i_MRC_af	Medium Resolution Cloud Availability Flag	8247	i1b	1	NA	0	15	NA	No	No
i_SurfRuf_slpQF	Surface Roughness & Slope Quality Flag	8248	i1b (40)	40	N/A	0	127	NA	No	No
i_ElvFlg	Elevation Definition Flag	8288	i1b (40)	40	N/A	0	127	NA	No	No
i_rng_UQF	Range Offset Quality/Use Flag	8328	i2b (40)	80	N/A	0	32767	NA	No	No
i_atmQF	Atmosphere Flag	8408	i1b (10)	10	N/A	0	1	NA	No	No

Table C-7 GLA14 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_timecorflg	time correction flag	8418	i2b	2	N/A	0	32767	No	No	No
i_APID_AvFlg	APID Data Availability Flag	8420	i1b (8)	8	n/a	-127	127	NA	No	No
i_AttFlg2	Attitude Flag 2	8428	i1b (20)	20	NA	0	15	NA	No	no
i_spare5	Spares	8448	i1b	1	NA	0	0	NA	No	NA
i_FrameQF	Altimeter Frame Quality Flag	8449	i1b	1	N/A	0	1	NA	No	No
i_OrbFlg	POD flag (Orbit Flag)	8450	i1b (2)	2	NA	0	32767	NA	No	no
i_rngCorrFlg	Range Correction Flag	8452	i1b (2)	2	N/A	0	32767	NA	No	No
i_CorrStatFlg	Correction Status Flag	8454	i1b (2)	2	NA	0	32767	NA	No	no
i_beam_coelev	Co-elevation	8456	i4b	4	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	8460	i4b	4	degrees*100	0	36000	NA	No	i4b
i_AttFlg1	Attitude Flag 1	8464	i2b	2	N/A	0	32767	NA	No	No
i_Spare6	Spares	8466	i1b (14)	14	N/A	null	null	NA	No	No
Total Bytes		8480								

C.1.9 GLA15

Each record contains 1 second of data.

Table C-8 GLA15 Record Format

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
Record Type:GLA15_MAIN; % of Granule: 70; Record Duration (seconds):1; Repeats: 1										
Latest : Last Modified : Fri Jul 16 07:45:15 GMT-0400 (EDT) 2004										
i_rec_ndx	GLAS Record Index	0	i4b	4	N/A	0	2147483647	NA	No	no

Table C-8 GLA15 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_UTCTime	Transmit Time of First Shot in frame in J2000	4	i4b (2)	8	seconds, microseconds	0	2147483647	NA	No	no
i_transtime	One way transit time	12	i2b	2	microseconds	0	4000	NA	No	i2b
i_Spare1	Spare	14	i1b (2)	2	N/A	null	null	NA	No	No
i_deltagpstmcor	Delta GPS time correction	16	i4b	4	nanoseconds	0	1000000	NA	No	gi_invalid_i4b
i_dShotTime	Laser Shot Time Deltas (shots 2-40)	20	i4b (39)	156	microseconds	0	1200000	NA	No	No
i_lat	Coordinate Data, Latitude, specific to ocean range	176	i4b (40)	160	microdeg	-90000000	90000000	NA	No	i4b
i_lon	Coordinate Data, Longitude, specific to ocean range	336	i4b (40)	160	microdeg	0	360000000	NA	No	i4b
i_elev	Ocean Surface Elevation	496	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_PADPoint	PAD Pointing unit Vector in ICRF	656	i4b (6, 40)	960	Unit-less*1000000	-1000000	1000000	NA	No	i4b
i_PODFixedPos	Position orbit vector in ICRF	1616	i4b (6, 40)	960	m, mm	-7.00E+10	7.00E+10	NA	No	i4b
i_sigmaatt	Attitude Quality Indicator	2576	i2b (40)	80	Unitless	0	6000	NA	No	i2b
i_Azimuth	Local Azimuth	2656	i4b	4	millideg	0	360000	NA	No	i4b
i_SolAng	Solar Incidence Angle	2660	i4b	4	microdeg	-90000000	90000000	NA	No	i4b
i_tpintensity_avg	Transmit Pulse intensity - frame avg	2664	i4b	4	counts	0	25500	NA	No	i4b
i_tpazimuth_avg	Transmit Pulse azimuth - frame avg	2668	i2b	2	degrees*10	0	3600	NA	No	i2b
i_tpeccentricity_avg	Transmit Pulse eccentricity - frame avg	2670	i2b	2	Unitless*1000	0	1000	NA	No	i2b
i_tpmajoraxis_avg	Tramsit Pulse major axis - frame avg	2672	i2b	2	cm	0	10000	NA	No	i2b
i_Spare2	Spare	2674	i1b (2)	2	N/A	null	null	NA	No	No
i_gdHt	Geoid	2676	i2b (2)	4	cm	-20000	20000	NA	No	i2b

Table C-8 GLA15 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_erElv	Solid Earth Tide Elevation (at first & last shot)	2680	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_spElv	Tide Elevations, Specific	2684	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ldElv	Load Tide Elevation	2692	i2b (4)	8	mm	-10000	10000	NA	No	i2b
i_ocElv	Ocean Tide Elevation (at first & last shot)	2700	i2b (2)	4	mm	-10000	10000	NA	No	i2b
i_wTrop	Range Correction, Wet Tro-posphere	2704	i2b (2)	4	mm	-1000	0	NA	No	i2b
i_dTrop	Range Correction, Dry Tro-posphere	2708	i2b (40)	80	mm	-2500	0	NA	No	i2b
i_surfType	Region Type	2788	i1b	1	N/A	1	15	NA	No	No
i_Spare3	Spares	2789	i1b (3)	3	N/A	null	null	NA	No	No
i_DEM_elv	DEM Elevation	2792	i4b (40)	160	cm	-50000	1000000	NA	No	i4b
i_refRng	Reference Range	2952	i4b (40)	160	mm	400000000	1000000000	NA	No	i4b
i_TrshRngOff	Threshold Retracker Range Offset	3112	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_ocRngOff	Ocean Range Offset	3272	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_SigEndOff	Signal End Range Offset	3432	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_cntRngOff	Centroid Range Offset	3592	i4b (40)	160	mm	-150000	0	NA	No	i4b
i_reflctUncorr	Reflectivity not corrected for Atmospheric Effects	3752	i4b (40)	160	Unitless*1E06	0	1000000	NA	No	i4b
i_reflCor_atm	Reflectance Correction, Atmosphere	3912	i4b	4	Unitless*1E06	0	1000000	NA	No	i4b
i_maxSmAmp	Peak Amplitude of Smoothed Received Echo	3916	i2b (40)	80	Tenth of milli-volts	-300	30000	NA	No	No
i_SigmaElv	Sigma of Elevation	3996	i2b (40)	80	mm	0	32000	NA	No	i2b
i_numPk	Number of Peaks found in the Return	4076	i1b (40)	40	N/A	0	6	NA	No	No

Table C-8 GLA15 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_skew2	Skewness	4116	i2b (40)	80	unitless * 100	-10000	10000	NA	No	i2b
i_OcRufRMS	RMS of elevations used for 1-sec mean elevation	4196	i4b	4	mm	0	120000	NA	No	i4b
i_OcMeanElev	Mean elevation over 1 sec	4200	i4b	4	mm	-500000	10000000	NA	No	i4b
i_lowElev	Lowest Elevation	4204	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_highElev	Highest Elevation	4364	i4b (40)	160	mm	-500000	10000000	NA	No	i4b
i_OceanVar	Standard Deviation of the ocean Gaussian Fit	4524	i2b (40)	80	millivolts	0	25500	NA	No	i2b
i_ElvuseFlg	Elevation use flag	4604	i1b (5)	5	N/A	-127	127	NA	No	No
i_atm_avail	Atmosphere Availability Flag	4609	i1b	1	NA	0	15	NA	No	No
i_erd	Estimated Range Delay	4610	i2b	2	Millimeters	0	1000	NA	No	i2b
i_rdu	Range Delay Uncertainty	4612	i2b	2	Millimeters	0	10000	NA	No	i2b
i_cld1_mswf	Cloud Multiple Scattering Warning Flag	4614	i1b	1	NA	0	15	NA	No	No
i_MRC_af	Medium Resolution Cloud Availability Flag	4615	i1b	1	NA	0	15	NA	No	No
i_OcRMSqf	Ocean RMS Roughness Quality Flag	4616	i1b (40)	40	null	0	1	NA	No	N
i_ElvFlg	Elevation Definition Flag	4656	i1b (40)	40	N/A	0	127	NA	No	No
i_rng_UQF	Range Offset Quality/Use Flag	4696	i2b (40)	80	N/A	0	32767	NA	No	No
i_atmQF	Atmosphere Flag	4776	i1b (10)	10	N/A	0	1	NA	No	No
i_timecorflg	time correction flag	4786	i2b	2	N/A	0	32767	No	No	No
i_APID_AvFlg	APID Data Availability Flag	4788	i1b (8)	8	n/a	-127	127	NA	No	No
i_AttFlg2	Attitude Flag 2	4796	i1b (20)	20	NA	0	15	NA	No	no
i_spare5	Spares	4816	i1b	1	NA	0	0	NA	No	NA

Table C-8 GLA15 Record Format (Continued)

Product Var Name	Short Description	Offset (Bytes)	Product Data Type	Total Bytes	Product Units	Product Minimum	Product Maximum	Is Correction Flag?	Is Unsigned?	Invalid Value/ Flag
i_FrameQF	Altimeter Frame Quality Flag	4817	i1b	1	N/A	0	1	NA	No	No
i_OrbFlg	POD flag (Orbit Flag)	4818	i1b (2)	2	NA	0	32767	NA	No	no
i_rngCorrFlg	Range Correction Flag	4820	i1b (2)	2	N/A	0	32767	NA	No	No
i_CorrStatFlg	Correction Status Flag	4822	i1b (2)	2	NA	0	32767	NA	No	no
i_beam_coelev	Co-elevation	4824	i4b	4	degrees*100	0	36000	NA	No	i4b
i_beam_azimuth	Azimuth	4828	i4b	4	degrees*100	0	36000	NA	No	i4b
i_AttFlg1	Attitude Flag 1	4832	i2b	2	N/A	0	32767	NA	No	No
i_Spare6	spares	4834	i1b (14)	14	N/A	null	null	NA	No	No
Total Bytes		4848								

Abbreviations & Acronyms

A2P	Algorithm-to-Product Conversion
ALT	Altimeter or Altimetry, also designation for the EOS-Altimeter spacecraft series
ANCxx	GLAS Ancillary Data Files
APID	GLAS Level-0 Data file
ATBD	Algorithm Theoretical Basis Document
ATM	Atmosphere
CCB	Change Control Board
ClearCase	GSAS version tracking software
CR	Change Request
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Model
DFD	Data Flow Diagram
DLT	Digital Linear Tape
EDOS	EOS Data and Operations System
EDS	Expedited Data Set
ELEV	Elevation
EOC	EOS Operating Center
EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
GB	Gigabyte
GDS	GLAS Ground Data System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GLAxx	GLAS Science Data Product Files
GLOP	GLAS Level-0 PGE (correctly called GLAS_L0proc)
GPS	Global Positioning System
GSAS	GLAS Science Algorithm Software
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
TBD	to be determined, to be done, or to be developed

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.

Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS ICESat spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the DAAC or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ICESat/GLAS Data Product produced on the DAAC or on the SCF. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.