ICESat (GLAS) Science Processing Software Document Series

Volume

GLAS Standard Data Products Specification - Level 1

Version 3.0

Peggy L. Jester/Raytheon ITSS
Observational Science Branch
Laboratory for Hydrospheric Processes
NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337

Jeffrey Lee/Raytheon ITSS
Observational Science Branch
Laboratory for Hydrospheric Processes
NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337

November 2000

ICESat Contacts:

H. Jay Zwally, ICESat Project Scientist
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Bob E. Schutz, GLAS Science Team Leader
University of Texas Center for Space Research
Austin, Texas 78759-5321

David W. Hancock III, Science Software Development Leader
NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337

Foreword

This preliminary document defines the Level One 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 1 standard data products. GLAS Level 1 standard data products are composed of Level 1A and Level 1B 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.

Level 1A and Level 1B Data Products are composed from those Level 0 data that have been reformatted or reversibly transformed to corrected and calibrated data in physical units at the full instrument rate and resolution.

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, hancock@osb1.wff.nasa.gov (e-mail), or (757) 824-1036 (FAX).

Table of Contents

Foreword iii
Table of Contents v
List of Figures vii
List of Tables ix

Section 1 Introduction

1.1 Identification of Document 1-1
1.2 Scope of Document 1-1
1.3 Purpose and Objectives of Document 1-1
1.4 Document Organization 1-1
1.5 Document Status and Schedule 1-1

Section 2 Related Documentation

2.1 Parent Documents 2-1
2.2 Applicable Documents 2-1
2.3 Information Documents 2-2

Section 3 Purpose and Description of the Data Products

3.1 Purpose of the Data Products 3-1
3.2 Description of the Data Products 3-1

Section 4 Environment

4.1 Hardware Characteristics and Limitations 4-1
4.2 Data Products Medium and Characteristics 4-1
4.3 Protocol and Conventions 4-1
4.4 Failure Protection, Detection, and Recovery Features 4-2

Section 5 Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates 5-1
5.2 Data Transfer and Transmission 5-1
5.3 Timing and Sequencing Characteristics 5-2
5.4 Recipients and Utilization 5-2
5.5 Access 5-2

Section 6 Data Product Definitions

6.1 Data Product Structure 6-1
6.2 Labeling and Identification 6-1
6.3 Data Product Substructure Descriptions 6-2
6.4 Detailed Data Descriptions 6-2

Appendix A Standard Label - Contents & Description

Appendix B Level 1 Data Product Formats

B.1 Record Formats B-1

Appendix C Detailed Data Contents & Description

C.1 GLA01 . . . . . C-2
C.2 GLA02 . . . . . C-7
C.3 GLA03 . . . . . C-14
C.4 GLA05 . . . . . C-31
C.5 GLA06 . . . . . C-39
C.6 GLA07 . . . . . C-45

Appendix D Flag Formats

D.1 GLA01 . . . . . D-1
D.2 GLA02 . . . . . D-1
D.3 GLA03 . . . . . D-6
D.4 GLA05 . . . . . D-7
D.5 GLA06 . . . . . D-10
D.6 GLA07 . . . . . D-12

Abbreviations & Acronyms AB-1

Glossary GL-1

List of Figures

Figure 3-1 Level 1 Data Products Within the Processing Hierarchy 3-2
Figure 4-1 Data Representation 4-2
Figure D-1 i_DEM_flag D-1
Figure D-2 i1_g_lid_qf D-1
Figure D-3 i1_g_lid_uf D-1
Figure D-4 i1_g_sat_f D-2
Figure D-5 i1_ir_lid_qf D-2
Figure D-6 i1_ir_lid_uf D-2
Figure D-7 i40_g_lid_ef D-3
Figure D-8 i40_g_sat_f D-3
Figure D-9 i5_g_sat_f D-4
Figure D-10 i_DEM_flag D-4
Figure D-11 i_g_TxNrg_qf D-5
Figure D-12 i_ir_IntRet_qf D-5
Figure D-13 i_ir_TxNrg_qf D-5
Figure D-14 i_dlaywf_stat D-6
Figure D-15 i_FETSbHS_t D-6
Figure D-16 i_LHtP12_St D-6
Figure D-17 i_OpSenSt D-7
Figure D-18 i_otswf_stat D-7
Figure D-19 i_Register Flags D-7
Figure D-20 iBadFrame_flag D-7
Figure D-21 i_fit_maxiter D-8
Figure D-22 i_fit_nogo D-8
Figure D-23 i_obErr D-8
Figure D-24 i_PODPADQF D-9
Figure D-25 i_satFlag D-9
Figure D-26 i_surfType D-9
Figure D-27 i_WF_qual D-10
Figure D-28 i_metFlg D-10

Figure D-29 i_atmQF D-10
Figure D-30 i_ElvCor_QF. D-11
Figure D-31 i_ElvFlg. D-11
Figure D-32 i_rng_UQF D-11
Figure D-33 i_SurfRufQF D-12
Figure D-34 i_surfType D-12
Figure D-35 i_metFlg D-12
Figure D-36 i_1064AttBS_Flag D-13
Figure D-37 i_532AttBS_Flag D-14
Figure D-38 i_g_TxNrg_qf. D-14
Figure D-39 i_ir_TxNrg_qf D-15
Figure D-40 i_PODPADQF D-15
Figure D-41 i_metFlg D-15

List of Tables

Table 3-1 GLAS Level 1 Standard Data Products 3-1
Table 5-1 GLAS Level 1 Data Product Daily Storage Burden 5-1
Table 6-1 GLAS File Naming Keys 6-1
Table 6-2 GLAS Product Format Terms and Explanations 6-2
Table 6-3 GLAS Product Description Terms and Explanations 6-3
Table B-1 GLA01 Header Record B-2
Table B-2 GLA01 Waveform Long Record B-4
Table B-3 GLA01 Waveform Short Record B-4
Table B-4 GLA02 Record Format B-5
Table B-5 GLA03 Record Format B-8
Table B-6 GLA05 Record Format B-15
Table B-7 GLA06 Record Format B-18
Table B-8 GLA07 Record Format B-20
Table C-1 GLA01: 02/25/2000 . . . . . C-2
Table C-2 GLA02: 09/04/2000 . . . . . C-7
Table C-3 GLA03 : 01/24/2000 . . . . . C-14
Table C-4 GLA05: 07/10/2000 . . . . . C-31
Table C-5 GLA06: 09/06/2000 . . . . . C-39
Table C-6 GLA07: 06/16/2000 . . . . . C-45

Section 1

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 1 Standard Data Products Specification. The unique document identification number within the GLAS Standard Data Software documentation numbering scheme is GLAS-DPS-2621. 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 1 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 does not provide details of the archive and distribution processes at the DAAC.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 1 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 1 Data Products. It describes the structure, physical storage, organization, and access characteristics of the GLAS Level 1 Data Products. The document additionally describes file transfer methods to support product access, the data flow associated with the data products, and the data storage and generation characteristics of the data products.

1.4 Document Organization

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

1.5 Document Status and Schedule

This document will be updated and released as required.

1.5.1 Items To Be Resolved

1) Headers and labels must be defined.

1.5.2 Document Change History

Document Name: GLAS Standard Data Products Specification - Level 1		
Version Number	**Date**	**Nature of Change**
Preliminary	December 31, 1995	Original Version
Version 1.2	March 1998	Text, Figures, and Tables updated for Level 1 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 Data Product Contents
Version 3.0	November 2000	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V1 release.

Section 2

Related Documentation

2.1 Parent Documents

The GLAS Level 1 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 section 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 1 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*, Version 3.0, August 1998, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-SMP-1100.

2.2 Applicable Documents

The following documents are related to, or contain policies or references pertinent to the contents of the GLAS Level 1 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, Version 0.3, December 1996, 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 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

g) *Precision Orbit Determination (POD)*, Algorithm Theoretical Basis Document, Version 0.1, December 1996, Center for Space Research, The University of Texas at Austin.

h) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.

i) *The Algorithm Theoretical Basis Document for Level 1A Processing*, November 1999, Version 0, GSFC/Wallops Flight Facility.

j) *GLAS Atmospheric Data Products*, Algorithm Theoretical Basis Document, Version 4.0, July 2000, 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 1 Standard Data Products Specification.

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

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*, NASA Goddard Space Flight Center, November 1995.

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

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

Section 3

Purpose and Description of the Data Products

3.1 Purpose of the Data Products

The purpose of the GLAS Level 1 Standard Data Products is to provide the initial reduced GLAS instrument data to the GLAS Science Team and to provide input to the Level 2 data product generation. The GLAS Level 1 Data Products are monitored for data quality and instrument performance. The GLAS Level 1 Data Products are available to the EOS data user community for analysis purposes from the EOSDIS DAAC product storage facility.

3.2 Description of the Data Products

Table 3-1 identifies the Level 1 Data Products. The data products are integer-binary format files containing fixed-length records of data with the exception of the GPS data in the GLA04 product. The GPS data is stored in ASCII format. 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 1 Standard Data Products

Product ID (Identification)	Product Name	Product Level
GLA01	Altimetry Data File	1A
GLA02	Atmosphere Data File	1A
GLA03	Engineering Data File	1A
GLA04	SRS and GPS Data File	1A
GLA05	Waveform-based Elevation Corrections File	1B
GLA06	Elevation File	1B
GLA07	Backscatter File	1B

n/a - Not applicable

Figure 3-1 illustrates the source Level 0 data being processed to generate the Level 1 Data Products on the I-SIPS (ICESAT Science Investigator-led Processing System). The GLAS science data processing software transforms the instrument data into the appropriate time-ordered, along-track 1064 nanometer and 532 nanometer Level 1A and Level 1B data parameters and elements. Additional Level 1A science processing algorithms retrieve the GPS receiver data and stellar reference system data and

include in the Level 1A product file records. Instrument engineering monitor data along with derived calibration data items are recorded. The Level 1 Data Products are recorded with sufficient detail so as to allow the recovery of the original input elements. In support of the GLAS Science Team, the GLAS Operations Team performs quality assurance at the I-SIPS and returns data quality and descriptive metadata to EOSDIS for incorporation in the EOS data base system.

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

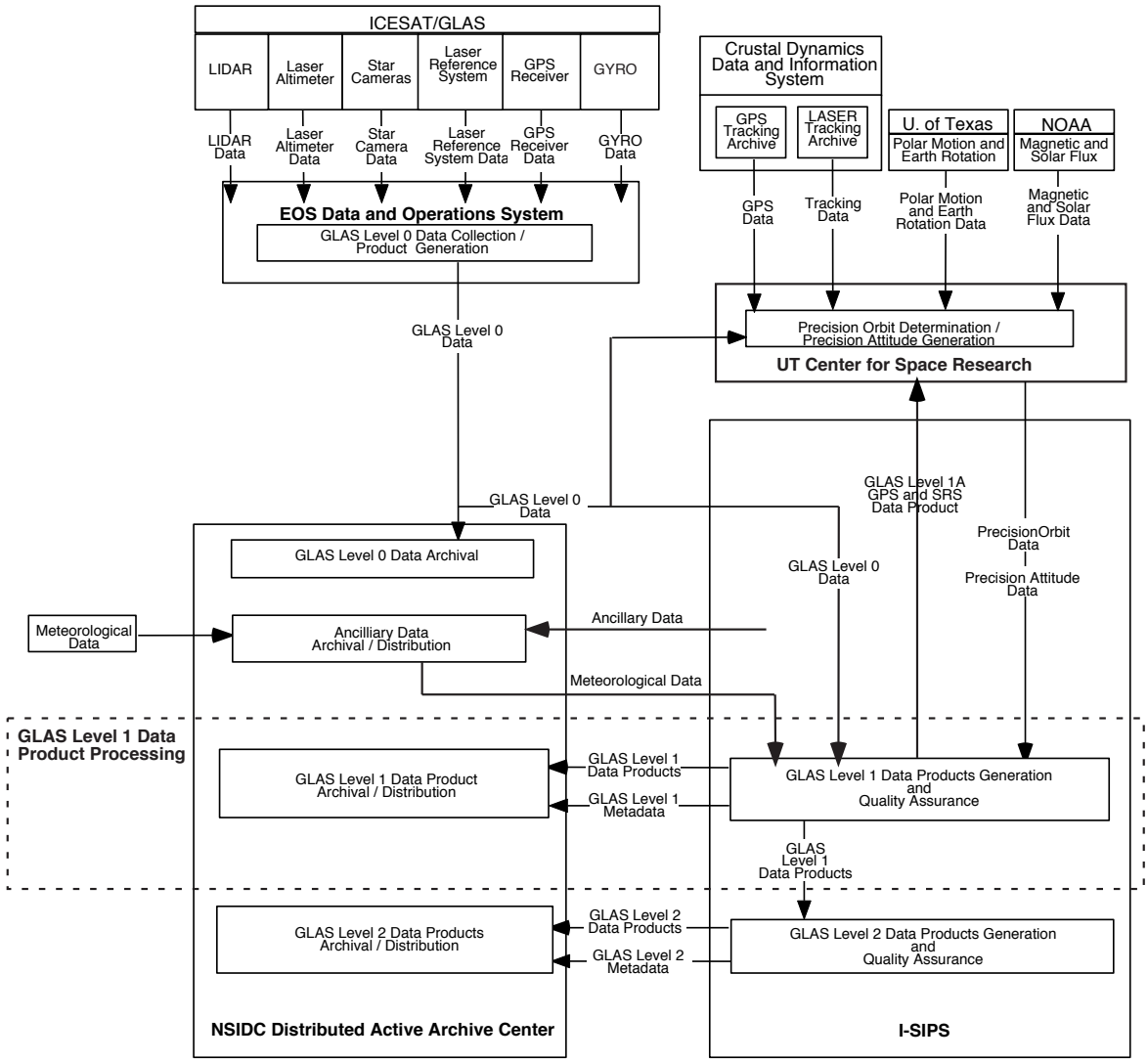

Figure 3-1 Level 1 Data Products Within the Processing Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

The required input to the software that creates the Level 1 Data Products is the GLAS Level 0 instrument and spacecraft telemetry data. The Level 0 data is available from EDOS in Production or Expedited Data Sets. The GLAS Level 1A and Level 1B Standard Data Products will be generated on 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 standard data product generation and quality assurance monitoring. The GLAS Level 1A and Level 1B Data Products and their metadata (including QA data) are archived at the DAAC. The Level 1A and Level 1B associated data description and support information are included in the EOSDIS data base to facilitate EOS client inquiry and retrieval activities. The distribution management function of the DAAC allows clients to perform direct search and access of the Level 1A and Level 1B data or to request preparation of Level 1 Data Products.

4.2 Data Products Medium and Characteristics

The Level 1 Data Products will be delivered to the DAAC and archived under the Earth Sciences data collection within the DAAC's data storage and archival subsystem. The storage system will contain not only the Level 1 Data Products, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information, also called metadata).

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 1A and Level 1B data from the DAAC and can copy the data products to their host processors.

The Level 1 Data Products will be available to the GLAS Science Team through the ICESat SCF. See Information Document 2.3e for a detailed description of the ICESat SCF.

4.3 Protocol and Conventions

Protocols and conventions specific to the GLAS SCF will be developed by the GLAS Science Team and documented in the SCF Plan [Information Document 2.3e]. When interfacing to the DAAC, the I-SIPS will comply with procedures, conventions, and protocols as defined by the EOSDIS.

Data definition terminology specific to the GLAS Level 1 Data Products 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 the GLAS Level 1 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 1 Data Products.

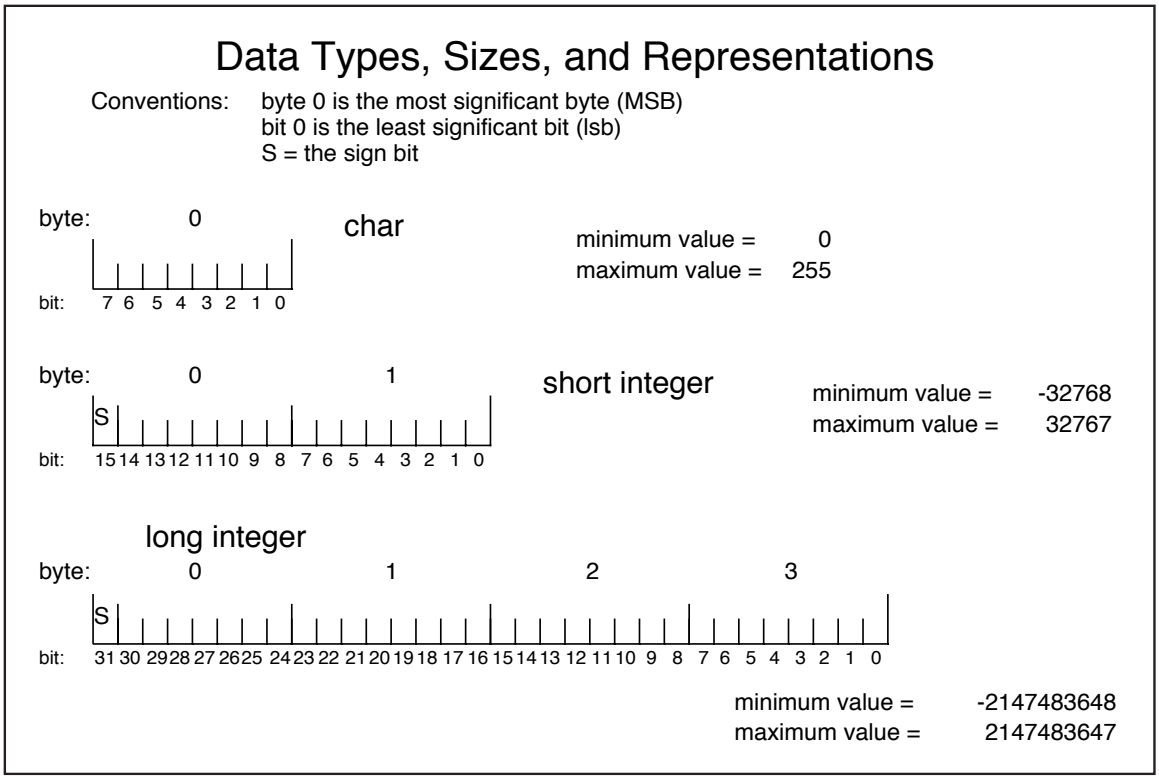

Figure 4-1 Data Representation

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 GLAS Level 1A and Level 1B Data Products stored on the I-SIPS. Initial GLAS Level 1A and Level 1B Data Products error detection is performed during product generation as part of the product and processing quality assurance activity. The GLAS Level 1A and Level 1B 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 1A and Level 1B Data Products archived at the DAAC.

Section 5

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

The expected daily data storage burdens for the GLAS Level 1A and Level 1B Standard Data Products are listed in Table 5-1 "GLAS Level 1 Data Product Daily Storage Burden". This estimate is based on the following EOS ICESat 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.

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

Product ID	Volume (MBytes per Day)
GLA01	2236.399
GLA02	2475.274
GLA03	82.128
GLA04	2410.085
GLA05	819.428
GLA06	446.170
GLA07	5508.626

n/a - Not applicable

5.2 Data Transfer and Transmission

The GLAS Data Products and associated descriptive metadata will be delivered to the EOSDIS DAAC archival facility through the EOS Science Network access arrangement or off-line via storage media. The GLAS Level 1A and Level 1B Data Products delivered to the DAAC processing subsystem will be designated for fail-safe functions. The GLAS Science Team will have access to the GLAS Level 1 Data Products through the GLAS SCF using TCP/IP and standard UNIX command operations.

Data access procedures to retrieve the GLAS Level 1A and Level 1B Standard Data Products from the EOSDIS DAAC will be provided by the EOSDIS DAAC.

5.3 Timing and Sequencing Characteristics

The GLAS Level 1A and Level 1B Standard Data Products are generated as product files consisting of processed Level 0 data. The basic aggregation of the GLAS Level 1 Data Products is the descriptive information in the header records and GLAS Data Elements in the data records. Records consists of one-second of reduced GLAS instrument, GPS receiver and stellar reference system data, and location data. The exception is the Engineering Data File (GLA03) with records that span 16 seconds. The data parameters and elements contained within the records are groups of forty hertz, five hertz, and one hertz rate data.

All data records within the GLAS Level 1 Data Product files will be in ascending time order based on the first pulse time tag or the first sample time tag. All parameters and elements contained within the records are synchronous at either forty hertz, five hertz, or one hertz. The GLAS instrument and the EOS ICESat spacecraft are expected to operate continuously for at least three years with a goal of five years.

5.4 Recipients and Utilization

The GLAS Science Team and the EOSDIS DAAC are the initial recipients of the Level 1 Data Products. At the I-SIPS, the Level 1 Data Products will be used to generate the Level 1 metadata and the Level 2 Data Products. The metadata (delivered to the EOSDIS DAAC) will include data quality evaluation and statistical reporting on the GLAS Level 1 Data Products to quantify and qualify the products for EOS community usage. The GLAS Science Team will use the Level 1 Data Products for research and analysis.

The subsequent audience for the GLAS Level 1 Data Products is the scientific, governmental, and educational community sectors who will obtain the products from the EOSDIS DAAC.

5.5 Access

The GLAS Level 1 Data Products will be 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 defined by the EOSDIS DAAC.

Section 6

Data Product Definitions

6.1 Data Product Structure

The GLAS Level 1 Data Products will be generated as scaled integer binary files. Each file will contain appropriate header, labelling, and metadata information and a collection of one-second records of GLAS instrument, sensor, and time data. Exceptions are the GLA03 product which contains 16-second records and the GLA04 product which contains ASCII GPS data.

6.2 Labeling and Identification

Each of the GLAS Level 1 Data Products is uniquely identified by a GLAS standard file name. The form of this file name is

GLAxx_mmm _pr_ccc_tttt_s _nn_ff.dat

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

Table 6-1 GLAS File Naming Keys

Key	Description
xx	Type ID number (CCB assigned number within a specific HHH)
p	repeat ground track phase
r	reference orbit number
ccc	cycle of reference orbit for this phase
tttt	track within reference orbit
s	segment of orbit
nn	granule version number (the number of times this granule is created for a specific release)
ff	file type (numerical, CCB assigned for multiple files as needed for data of same time period for a specific data product,.i.e. multi-file granule)

The structure and contents of the GLAS Level 1 Data Product headers and labels are contained in Appendix A, GLAS Level 1 Data Product -- Standard Label -- Contents and Description, TBD. The following information may be included in the standard product label.

- Instrument Name
- Product Creation Time
- Generating Algorithm Name
- Generating Algorithm Identification

- EOS ICESat Orbit Number
- EOS ICESat Pass Number
- Equator Crossing Time
- Equator Crossing Longitude
- First Data Point Time (First Laser Pulse or Sample Time)
- Last Data Point Time (Last Laser Pulse or Sample Time)

6.3 Data Product Substructure Descriptions

The data product labels and headers are an aggregate of [TBD] records of string information (TBD bytes in length) describing the GLAS Level 1 Data Products. Appendix A, TBD, provides the format of the standard label and headers, including the keyword/value field contents.

The specific record format of the data portion of the GLAS Level 1 Data Products is provided in Appendix B, GLAS Level 1 Data Products. Table 6-2 is provided as a road map for the formats presented in Appendix B.

Table 6-2 GLAS Product Format Terms and Explanations

Data Detail Field	Explanation
Element Name	the GLAS Data Element name, describes the unique GLAS item, items, or array
Elements/Rec	the number of times the GLAS Data Element is repeated in the record expressed as rate, per second (e.g., 5 for five elements per second)
Bytes/Item	the size of each data item (value) contained in the GLAS Data Element, expressed in bytes
Items/Element	the number of data items (values) or arrays of values contained in the record for the GLAS Data Element (e.g., 2 for two items per element)
Bytes/Rec	the total number of bytes per second of the data item.
Start Byte	starting byte number of the data item with the product record.
Stop Byte	ending byte number of the data item with the product record.

6.4 Detailed Data Descriptions

The detailed information describing the data elements in the GLAS Level 1 Data Products is provided as a data dictionary in Appendix C, GLAS Level 1 Data Products -- Detailed Data Contents and Description. Table 6-3 is provided as a road map for the data descriptions presented in Appendix C.

Table 6-3 GLAS Product Description Terms and Explanations

Data Detail Field	Explanation
Element Name	the GLAS Data Element name, describes the unique GLAS item, items, or array .
Product Variable Name	the variable name used in coding the product element.
Units	the physical or temporal units in which the data are stored.
Scale Factor	scale factor used to convert from stored product units to scientifically usable algorithm units (product = algorithm * scale).
Description	text description of the element.

Appendix A
Level 1 Data Products
Standard Label - Contents & Description

To Be Provided

Appendix B
Level 1 Data Product Formats

B.1 Record Formats

B.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, data that are changing at a much lower rate than the record rate on the files, will be put in the header. These elements will not be shown in the record format.
5) Add spares.

B.1.2 GLA01

Fixed length, variable format records. For each second of data there is a header record and a varying number of waveform records. The number of waveform records depends on whether the telemetry data was sampled over ocean (2) or land (5). The header record contains all altimetry waveform information except the waveform and indicates whether the following records are ocean (short) or land (long) waveforms; the following records contain long or short waveform data until complete. While the waveform will always occur at 40 per second, the on-board flight software determines the number of samples from the on-board surface type. For land surfaces 544 samples are collected; for ocean surfaces 200 samples are collected. The record formats are contained in the following tables.

Table B-1 GLA01 Header Record

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Altimetry Record Index	1	4	1	4	0	3
Time of First Shot - Seconds	1	4	2	8	4	11
GLA01 Record Type	1	2	1	2	12	13
Spares	1	2	1	2	14	15
Delta Shot Times	39	4	1	156	0	155
Predicted Profile Coordinates, Latitude	40	4	1	160	156	315
Predicted Profile Coordinates, Longitude	40	4	1	160	316	475
Spacecraft Height	40	4	1	160	476	635
AD Gain Setting	40	4	1	160	636	795
Filter Number	40	4	1	160	796	955
Ending Time of Range Response	40	4	1	160	956	1115
Last Threshold Crossing Time	40	4	1	160	1116	1275
Next to Last Threshold Crossing	40	4	1	160	1276	1435
Echo Peak Location	40	4	1	160	1436	1595
Echo Peak Value	40	4	1	160	1596	1755
Filter Weight Factors	40	4	1	160	1756	1915
Selected Filter Threshold Value	40	4	1	160	1916	2075
Time of Transmit Pulse Waveform Peak	40	4	1	160	2076	2235
Starting address Transmit Pulse Waveform	40	4	1	160	2236	2395
Transmit Waveform Peak Status Flag	40	4	1	160	2396	2555
1064 nm Laser Transmit Energy	40	4	1	160	2556	2715
Range Window Status Word	40	4	1	160	2716	2875
Spares	1	1	32	32	2876	2907
Waveform Compression Parameters	1	2	2	4	2908	2911
Shot Counter	40	2	1	80	2912	2991
Compression Ratios	1	2	2	4	2992	2995
DEM Grid Number	1	2	1	2	2996	2997

Table B-1 GLA01 Header Record (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Spares	1	1	30	30	2998	3027
Global DEM Bias	1	1	2	2	3028	3029
DEM Flag	1	1	1	1	3030	3030
Filter Numbers Mask	1	1	1	1	3031	3031
Spares	1	1	16	16	3032	3047
Altimeter Digitizer Bias	1	1	2	2	3048	3049
Range Window Start and Stop	1	1	2	2	3050	3051
Sampled Transmit Pulse Waveform	40	1	32	1280	3052	4331
Spares	1	1	244	244	4332	4575
Delta Shot Times	39	4	1	156	0	155
Predicted Profile Coordinates, Latitude	40	4	1	160	156	315
Predicted Profile Coordinates, Longitude	40	4	1	160	316	475
Spacecraft Height	40	4	1	160	476	635
AD Gain Setting	40	4	1	160	636	795
Filter Number	40	4	1	160	796	955
Ending Time of Range Response	40	4	1	160	956	1115
Last Threshold Crossing Time	40	4	1	160	1116	1275
Next to Last Threshold Crossing	40	4	1	160	1276	1435
Echo Peak Location	40	4	1	160	1436	1595
Echo Peak Value	40	4	1	160	1596	1755
Filter Weight Factors	40	4	1	160	1756	1915
Selected Filter Threshold Value	40	4	1	160	1916	2075
Time of Transmit Pulse Waveform Peak	40	4	1	160	2076	2235
Starting address Transmit Pulse Waveform	40	4	1	160	2236	2395
Transmit Waveform Peak Status Flag	40	4	1	160	2396	2555
1064 nm Laser Transmit Energy	40	4	1	160	2556	2715
Range Window Status Word	40	4	1	160	2716	2875

Table B-1 GLA01 Header Record (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Spares	1	1	32	32	2876	2907
Waveform Compression Parameters	1	2	2	4	2908	2911
Shot Counter	40	2	1	80	2912	2991

Table B-2 GLA01 Waveform Long Record

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Altimetry Record Index	1	4	1	4	0	3
Time of First Shot - Seconds	1	4	2	8	4	11
GLA01 Record Type	1	2	1	2	12	13
Spares	1	2	1	2	14	15
Background Mean Value	8	2	6	96	0	95
Background Standard Deviation	8	2	6	96	96	191
1064 nm Range Waveform	8	1	544	4352	192	4543
Spares	1	4	8	32	4544	4575

Table B-3 GLA01 Waveform Short Record

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Altimetry Record Index	1	4	1	4	0	3
Time of First Shot - Seconds	1	4	2	8	4	11
GLA01 Record Type	1	2	1	2	12	13
Spares	1	2	1	2	14	15
Background Mean Value	20	2	6	240	0	239
Background Standard Deviation	20	2	6	240	240	479
1064 nm Range Waveform	20	1	200	4000	480	4479
Spares	1	4	24	96	4480	4575

B.1.3 GLA02

Records are fixed length and format and occur once per second. Table B-4 contains the record format.

Table B-4 GLA02 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Atmosphere Record Index	1	4	1	4	0	3
Time of First Sample - Seconds	1	4	2	8	4	11
Predicted Profile Coordinates, Latitude	1	4	1	4	12	15
Predicted Profile Coordinates, Longitude	1	4	1	4	16	19
Spares	1	1	16	16	20	35
Location of Last Peak	40	2	1	80	36	115
Etalon Filter Temperature	1	2	1	2	116	117
Etalon Filter Feedback Monitor	1	2	1	2	118	119
Etalon Filter Heater Drive Control Point	1	2	1	2	120	121
DEM Grid Number	1	2	1	2	122	123
DEM Flag	1	1	1	1	124	124
532 nm LIDAR Use Flag	1	1	5	5	125	129
532 nm LIDAR Data Quality Flag	1	1	10	10	134	143
Spares	1	1	4	4	130	133
532 nm LIDAR Data from 10 KM to -1 KM	40	4	148	23680	144	23823
532 nm LIDAR Data from 20 KM to 10 KM	5	4	132	2640	23824	26463
532 nm LIDAR Data from 40 KM to 20 KM	1	4	268	1072	26464	27535
532 nm Saturation Flag for 10 to -1 KM Segment	1	1	740	740	27536	28275
532 nm Saturation Flag for 20 to 10 KM Segment	1	1	84	84	28276	28359
532 nm Saturation Flag for 40 to 20 KM Segment	1	1	36	36	28360	28395
532 nm Laser Transmit Energy	40	4	1	160	28396	28555

Table B-4 GLA02 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
532 nm Laser Transmit Energy	5	4	1	20	28556	28575
532 nm Laser Transmit Energy	1	4	1	4	28576	28579
532 nm Integrated Return, 40 to 20 KM	1	4	1	4	28580	28583
Start Range of Backscatter Profile	1	4	1	4	28584	28587
Range from S/C to Return bin	40	4	1	160	28588	28747
Spares	1	1	16	16	28748	28763
Surface elevation - peak of return	40	2	1	80	28764	28843
Surface elevation - threshold of return	40	2	1	80	28844	28923
532 nm Background at 40 Hz	40	4	3	480	28924	29403
532 nm Background at 5 Hz	5	4	3	60	29404	29463
532 nm Background at 1 Hz	1	4	3	12	29464	29475
532 nm Predicted Cloud Top Height	5	2	1	10	29476	29485
532 nm LIDAR Data Shot Counter	1	2	1	2	29486	29487
SPCM Background 2 and LIDAR Delay	1	2	2	4	29488	29491
SPCM Gate and Background 1 Delay	1	2	2	4	29492	29495
Photon Counter Range Delay	1	2	1	2	29496	29497
SPCM Status	1	2	1	2	29498	29499
Spares	1	1	16	16	29500	29515
532 LIDAR Data Error Flag	40	1	1	40	29516	29555
532 nm Laser Transmit Energy, counts	40	1	1	40	29556	29595
532 nm Laser Transmit Energy Quality Flag	1	1	10	10	29596	29605
Photon Counter Range Bias	1	1	1	1	29606	29606
Integrated Return Quality Flag	1	1	1	1	29607	29607
SPCM Raw Counts	1	1	8	8	29608	29615
1064 nm LIDAR Use Flag	1	1	5	5	29616	29620
1064 nm LIDAR Data Quality Flag	1	1	10	10	29621	29630
Spares	1	1	5	5	29631	29635

Table B-4 GLA02 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
1064 nm Laser Transmit Energy	40	4	1	160	29636	29795
1064 nm Laser Transmit Energy	5	4	1	20	29796	29815
Spares	1	1	16	16	29816	29831
1064 nm Background from -5 KM to -3.75 KM at 40 Hz	40	4	3	480	29832	30311
1064 nm Background from -5 KM to -3.75 KM at 5 Hz	5	4	3	60	30312	30371
1064 nm LIDAR Data from 10 KM to -1 KM	40	4	148	23680	30372	54051
1064 nm LIDAR Data from 20 KM to 10 KM	5	4	132	2640	54052	56691
1064 nm Cloud Digitizer Shot Counter	1	2	1	2	56692	56693
Cloud Digitizer Background 2 delay	1	2	1	2	56694	56695
Cloud Digitizer Background 1 Delay	1	2	1	2	56696	56697
Range Gate for Cloud Digitizer	1	2	1	2	56698	56699
Cloud Digitizer Detector Status	1	2	1	2	56700	56701
Spares	1	2	8	16	56702	56717
1064 nm Cloud Digitizer Data Spare	40	1	1	40	56718	56757
Cloud Return Peak Signal	8	1	1	8	56758	56765
A/D Output and Attenuation Setting	1	1	2	2	56766	56767
Cloud Digitizer Range Bias	1	1	1	1	56768	56768
1064 Digitizer Gain Setting	1	1	1	1	56769	56769
Threshold Crossing	40	1	3	120	56770	56889
Ground Return Peak Signal	8	1	1	8	56890	56897
Ground Return Location	8	1	1	8	56898	56905
1064 nm Laser Transmit Energy Quality Flag	1	1	10	10	56906	56915
Spares	1	1	12	12	56916	56927

B.1.4 GLA03

Records occur at once per 16 second rate and are fixed format. Table B-5 contains the record format.

Table B-5 GLA03 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Engineering Record Index	1	4	1	4	0	3
Record Time (Seconds.Microsec-onds)	1	4	2	8	4	11
Primary Header APID 20	4	6	1	24	12	35
Secondary Header APID 20 (time stamp)	4	8	1	32	36	67
532 Energy	4	4	1	16	68	83
Laser Oscillator Temperature	4	2	1	8	84	91
Laser Doubler Temperature	4	2	1	8	92	99
Laser Power Supply Temperature	4	2	1	8	100	107
Laser Preamp Temperature	4	2	1	8	108	115
Laser Osc Current	4	2	1	8	116	123
Laser Amp Current	4	2	1	8	124	131
Laser Dr Pulse Width	4	2	1	8	132	139
Primary Altimeter Detector 550 V	4	2	1	8	140	147
Secondary Altimeter Detector 550 V	4	2	1	8	148	155
SPCM Detector #1 550 V	4	2	1	8	156	163
SPCM Detector #2 550 V	4	2	1	8	164	171
SPCM Detector #3 550 V	4	2	1	8	172	179
SPCM Detector #4 550 V	4	2	1	8	180	187
SPCM Detector #5 550 V	4	2	1	8	188	195
SPCM Detector #6 550 V	4	2	1	8	196	203
SPCM Detector #7 550 V	4	2	1	8	204	211
SPCM Detector #8 550 V	4	2	1	8	212	219
Internal Temp #1	4	2	1	8	220	227
Internal Temp #2	4	2	1	8	228	235
Internal Temp #3	4	2	1	8	236	243

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
VC X Motor Current	4	2	1	8	244	251
VC Y Motor Current	4	2	1	8	252	259
X Position	4	2	1	8	260	267
Y Position	4	2	1	8	268	275
OTS Level 1 readback	4	1	1	4	276	279
OTS Level 2 readback	4	1	1	4	280	283
OTS Level 3 readback	4	1	1	4	284	287
OTS Level 4 readback	4	1	1	4	288	291
OTS Trigger Count 1 (Upper byte) readback	4	2	1	8	292	299
OTS Trigger Count 2 (Upper byte) readback	4	2	1	8	300	307
AD Detector Outgoing Gain readback	4	1	1	4	308	311
AD Detector Return Gain readback	4	1	1	4	312	315
Dual Pin -A	4	1	1	4	316	319
Dual Pin -B	4	1	1	4	320	323
Loop Heat Pipe 1 & 2 Heater Status	4	1	1	4	324	327
Primary Header APID 21	4	6	1	24	328	351
Secondary Header APID 21 (time stamp)	4	8	1	32	352	383
+28V Bus A Instrument	4	2	1	8	384	391
Hybrid Supplies	4	2	1	8	392	399
HVPS Detector Supplies	4	2	1	8	400	407
Operational Heaters	4	2	1	8	408	415
Mechanical System	4	2	1	8	416	423
+28V Bus B Laser 1	4	2	1	8	424	431
+28V Bus B Laser 1	4	2	1	8	432	439
+28V Bus C Laser 2	4	2	1	8	440	447
+28V Bus C Laser 2	4	2	1	8	448	455
+28V Bus D Laser 3	4	2	1	8	456	463
+28V Bus D Laser 3	4	2	1	8	464	471

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
+ 5 V Hybrid # 1	4	2	1	8	472	479
+ 5 V Hybrid # 1	4	2	1	8	480	487
+12 V Hybrid # 2	4	2	1	8	488	495
+ 12 V Hybrid # 2	4	2	1	8	496	503
- 12 V Hybrid # 3	4	2	1	8	504	511
- 12 V Hybrid # 3	4	2	1	8	512	519
+ 5 V Hybrid # 4	4	2	1	8	520	527
+ 5 V Hybrid # 4	4	2	1	8	528	535
- 5 V Hybrid # 5	4	2	1	8	536	543
- 5 V Hybrid # 5	4	2	1	8	544	551
- 5 V Hybrid # 6	4	2	1	8	552	559
- 5 V Hybrid # 6	4	2	1	8	560	567
+ 15 V Boost Post Reg	4	2	1	8	568	575
- 15 V Boost Post Reg	4	2	1	8	576	583
+12 V Prim Osc Thermal Control	4	2	1	8	584	591
+12 V Sec Osc Thermal Control	4	2	1	8	592	599
-2 V Discrete Voltage	4	2	1	8	600	607
Hybrid Heatsink	4	2	1	8	608	615
FET Switch Bank Heatsink	4	2	1	8	616	623
FET Switch Bank	4	2	1	8	624	631
HVPS +0 Volts Reference	4	2	1	8	632	639
HVPS +5 V Reference	4	2	1	8	640	647
Optical Sensor Status	4	2	1	8	648	655
Register Flags	4	2	1	8	656	663
Primary Monitor Calibration	4	1	1	4	664	667
Primary Monitor Calibration	4	1	1	4	668	671
Secondary Monitor Calibration	4	1	1	4	672	675
Secondary Monitor Calibration	4	1	1	4	676	679
Counter info	4	1	1	4	680	683

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Primary Header APID 22	1	6	1	6	684	689
Secondary Header APID 22 (time stamp)	1	8	1	8	690	697
Housekeeping Board Temperature, Ch 0	1	2	1	2	698	699
Instrument Processor System Board Temperature, Ch 1	1	2	1	2	700	701
Photon Counter Board Temperature, Ch 2	1	2	1	2	702	703
Cloud Digitizer/Frequency & Time Board Temperature, Ch 3	1	2	1	2	704	705
Altimeter Digitizer 1 Board Temperature 1, Ch 4	1	2	1	2	706	707
Altimeter Digitizer 1 Board Temperature 2, Ch 5	1	2	1	2	708	709
Altimeter Digitizer 2 Board Temperature 1, Ch 6	1	2	1	2	710	711
Altimeter Digitizer 2 Board Temperature 2, Ch 7	1	2	1	2	712	713
Data Collection & Handling Board Temperature, Ch 8	1	2	1	2	714	715
Laser Monitor Board Temperature, Ch 9	1	2	1	2	716	717
Temperature Controller Monitor Board Temperature, Ch 10	1	2	1	2	718	719
Oven-crystal-controlled Oscillator(OXCO) 1 Board Temperature, Ch 11	1	2	1	2	720	721
Oven-crystal-controlled Oscillator(OXCO) 2 Board Temperature, Ch 12	1	2	1	2	722	723
Oscillator Board Temperature, Ch 13	1	2	1	2	724	725
Optical Test Source (OTS) Board Temperature, Ch 14	1	2	1	2	726	727
Laser Profiler Array (LPA) Temperature 1, Ch 15	1	2	1	2	728	729

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Laser Profiler Array (LPA) Temperature 2, Ch 16	1	2	1	2	730	731
Altimeter Digitizer 1 Board Temperature 3, Ch 17	1	2	1	2	732	733
Altimeter Digitizer 2 Board Temperature 3, Ch 18	1	2	1	2	734	735
Altimeter Digitizer 1 Board Temperature 4, Ch 19	1	2	1	2	736	737
Altimeter Digitizer 2 Board Temperature 4, Ch 20	1	2	1	2	738	739
Altimeter Digitizer 1 Board Temperature 5, Ch 21	1	2	1	2	740	741
Altimeter Digitizer 2 Board Temperature 5, Ch 22	1	2	1	2	742	743
HK Tlm Channel 23- Spare	1	2	1	2	744	745
PRT, Gyro Temperature, Ch 24	1	2	1	2	746	747
PRT, Star Camera Temperature, Ch 25	1	2	1	2	748	749
PRT, Stellar Reference System (SRS) Temperature, Ch 26	1	2	1	2	750	751
PRT, Lidar Detector Pkg? Temperature, Ch 27	1	2	1	2	752	753
PRT, Altimeter Detector 1 Temperature, Ch 28	1	2	1	2	754	755
PRT, Altimeter Detector 2 Temperature, Ch 29	1	2	1	2	756	757
PRT, Spacecraft Interface Temperature, Ch 30	1	2	1	2	758	759
PRT, Telescope Mount Temperature, Ch 31	1	2	1	2	760	761
PRT, Telescope Baffle Temperature, Ch 32	1	2	1	2	762	763
PRT Temperature Region 10, Ch 33, Spare	1	2	1	2	764	765
PRT Temperature Region 11, Ch 34, Spare	1	2	1	2	766	767

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
PRT Cal Low, Ch 35	1	2	1	2	768	769
PRT Cal High, Ch 36	1	2	1	2	770	771
Pin Diode Bias Voltage	1	2	1	2	772	773
Spare	1	2	1	2	774	775
Spare	1	2	1	2	776	777
Spare	1	2	1	2	778	779
Spare	1	2	1	2	780	781
Primary Header APID 23	1	6	1	6	782	787
Secondary Header APID 23 (time stamp)	1	8	1	8	788	795
Telescope Region 0 Primary Mirror	1	2	1	2	796	797
Telescope Region 1 Secondary Mirror	1	2	1	2	798	799
Telescope Region 2 Tower	1	2	1	2	800	801
Etalon Temperature, Ch 37d	1	2	1	2	802	803
Loop Heat Pipe 1 Temperature, Ch 37e	1	2	1	2	804	805
Loop Heat Pipe 2 Temperature, Ch 37f	1	2	1	2	806	807
Telescope Primary Mirror Heater drive current	1	2	1	2	808	809
Telescope Secondary Mirror Heater drive current	1	2	1	2	810	811
Telescope Tower Heater drive current	1	2	1	2	812	813
Etalon Heater Current, Ch 37j	1	2	1	2	814	815
HOP and VC Thermistors - 1	1	2	1	2	816	817
HOP and VC Thermistors - 2	1	2	1	2	818	819
HOP and VC Thermistors - 3	1	2	1	2	820	821
HOP and VC Thermistors - 7	1	2	1	2	822	823
HOP and VC Thermistors - 8	1	2	1	2	824	825
HOP 1 Actuator Current - Heater 1	1	2	1	2	826	827
HOP 2 Actuator Current - Heater 1	1	2	1	2	828	829

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
HOP 3 Actuator Current - Heater 1	1	2	1	2	830	831
HOP 4 Actuator Current - Heater 2	1	2	1	2	832	833
HOP 5 Actuator Current - Heater 2	1	2	1	2	834	835
HOP 6 Actuator Current - Heater 2	1	2	1	2	836	837
Spare	1	2	1	2	838	839
Spare	1	2	1	2	840	841
Spare	1	2	1	2	842	843
Spare	1	2	1	2	844	845
Spare	1	2	1	2	846	847
Spare	1	2	1	2	848	849
Spare	1	2	1	2	850	851
Spare	1	2	1	2	852	853
Spare	1	2	1	2	854	855
Spare	1	2	1	2	856	857
spare	1	2	1	2	858	859
Primary Header APID 12 or 13	64	6	1	384	860	1243
Secondary Header 12 or 13 (time stamp)	64	8	1	512	1244	1755
Primary Header APID 15	16	6	1	96	1756	1851
Secondary Header APID 15 (time stamp)	16	8	1	128	1852	1979
Primary Header APID 17	16	6	1	96	1980	2075
Secondary Header APID 17 (time stamp)	16	8	1	128	2076	2203
Primary Header APID 19	16	6	1	96	2204	2299
Secondary Header APID 19 (time stamp)	16	8	1	128	2300	2427
Shot Counter APID 19	16	2	1	32	2428	2459
Transmit Pulse Search Window Location	16	4	1	64	2460	2523
OTS Pulse Waveform Start Address	16	4	1	64	2524	2587

Table B-5 GLA03 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
OTS Pulse Waveform Status	16	4	1	64	2588	2651
Shot Counter for OTS WF	64	2	1	128	2652	2779
Sampled OTS Pulse Waveform	64	1	32	2048	2780	4827
RMS Noise Calculation Location	16	4	1	64	4828	4891
Post Delay Pulse Waveform Start Address	16	4	1	64	4892	4955
Post Delay Pulse Waveform Status	16	4	1	64	4956	5019
Shot Counter for Post Delay WF	16	2	1	32	5020	5051
Sampled Post Delay Pulse Waveform	16	1	32	512	5052	5563
Spare APID 19	16	2	1	32	5564	5595
Dual Pin A	16	1	40	640	5596	6235
Dual Pin B	16	1	40	640	6236	6875
Spacecraft position Packet Data with VTCW	16	1	50	800	6876	7675
Spares	1	4	33	132	7676	7807

B.1.5 GLA04

GLA04 is a multi-file product. Within each file, records occur at once per second and are fixed format. The record format is TBD.

B.1.6 GLA05

Records are fixed length and format and occur once per second. Table B-6 contains the record format.

Table B-6 GLA05 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Waveform Record Index	1	4	1	4	0	3
Time of First Laser Pulse	1	4	2	8	4	11
One way transit time	1	4	1	4	12	15
Laser Shot Time Deltas (shots 2-40)	39	4	1	156	16	171
Spot Coordinate Data Latitude(uncor-rected)	40	4	1	160	172	331

Table B-6 GLA05 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Spot Coordinate Data Longi-tude(uncorrected)	40	4	1	160	332	491
Spot Surface Elevation (uncorrected)	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611
POD Position	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
Spares	1	1	2	2	2582	2583
On-board Error Flags	40	2	1	80	2584	2663
Frame Use Flag	1	1	1	1	2664	2664
Spares	1	1	3	3	2665	2667
Reference Range	40	4	1	160	2668	2827
Threshold Retracker Range Offset (other than land)	40	4	1	160	2828	2987
Maximum Range Offset (land)	40	4	1	160	2988	3147
Minimum Range Offset (land)	40	4	1	160	3148	3307
Maximum Range Offset (other than land)	40	4	1	160	3308	3467
Minimum Range Offset (other than land)	40	4	1	160	3468	3627
Waveform Quality Flag	40	4	1	160	3628	3787
Preliminary Uncorrected Range Off-set (land)	40	4	1	160	3788	3947
Preliminary Uncorrected Range Off-set (other than land)	40	4	1	160	3948	4107
Area Under Transmitted Pulse	40	4	1	160	4108	4267
Centroid of Transmitted Pulse	40	4	1	160	4268	4427
Amplitude, Peak Location, and Sigma of Transmitted Pulse	40	4	3	480	4428	4907
Skewness of Transmitted Pulse	40	4	1	160	4908	5067
Centroid of Received Pulse	40	4	1	160	5068	5227
Spares	1	4	10	40	5228	5267
Area of Signal Return (land)	40	2	1	80	5268	5347

Table B-6 GLA05 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Area of Signal Return (other than land)	40	2	1	80	5348	5427
Chi Square (land)	40	2	1	80	5428	5507
Chi Square (other than land)	40	2	1	80	5508	5587
Max Amplitude of Received Wave-form	40	2	1	80	5588	5667
Max Amplitude of Smoothed Wave-form	40	2	1	80	5668	5747
Percent of Saturated Signal From Received WF	40	2	1	80	5748	5827
Skewness of Received WF (land)	40	2	1	80	5828	5907
Kurtosis of Received WF (land)	40	2	1	80	5908	5987
Skewness of Received WF (other than land)	40	2	1	80	5988	6067
Kurtosis of Received WF (other than land)	40	2	1	80	6068	6147
Sigmas of fit parameters (land)	40	2	19	1520	6148	7667
Sigmas of Fit Parameters (other than land)	40	2	19	1520	7668	9187
WF Parameters from fit (land)	40	2	19	1520	9188	10707
WF Parameters from fit (other than land)	40	2	19	1520	10708	12227
Gain Value of Transmitted Pulse	40	2	1	80	12228	12307
Gain Value of Received Pulse	40	2	1	80	12308	12387
Maximum Amp of Transmitted Pulse	40	2	1	80	12388	12467
Spares	1	2	4	8	12468	12475
Initial Number of Peaks of the Smooth WF (land)	40	1	1	40	12476	12515
Initial Number of Peaks of the Smooth WF (other than land)	40	1	1	40	12516	12555
Rank of WF Significant Peaks (land)	40	1	6	240	12556	12795
Rank of WF Significant Peaks (other than land)	40	1	6	240	12796	13035
1064 nm Background Signal	40	1	1	40	13036	13075

Table B-6 GLA05 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Saturation Flag (land)	1	1	10	10	13076	13085
Saturation Flag (other than land)	1	1	10	10	13086	13095
WF Fit Success Flag MaxIter(land)	1	1	5	5	13096	13100
WF Fit Success Flag NoGo(land)	1	1	5	5	13101	13105
WF Fit Success Flag MaxIter(other than land)	1	1	5	5	13106	13110
WF Fit Success Flag NoGo(other than land)	1	1	5	5	13111	13115
Spares	1	4	4	16	13116	13131

B.1.7 GLA06

Records are fixed length and format and occur once per second. Table B-7 contains the record format.

Table B-7 GLA06 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Record Index	1	4	1	4	0	3
Time of First Laser Pulse	1	4	2	8	4	11
One Way Transit Time	1	4	1	4	12	15
Laser Shot TIme Deltas, Shots 2-40	39	4	1	156	16	171
Spot 1 Coordinate Data, Latitude Corrected	40	4	1	160	172	331
Spot 1 Coordinate Data, Longitude Corrected	40	4	1	160	332	491
Surface Elevation	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611
POD Fixed Position Vector	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
spares	1	1	14	14	2582	2595
Local Azimuth	1	4	1	4	2596	2599
Solar Incidence Angle	1	4	1	4	2600	2603
Orientation of Pulse	1	4	1	4	2604	2607

Table B-7 GLA06 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Semi-major axis of footprint	40	2	1	80	2596	2675
Semi-minor axis of footprint	40	2	1	80	2676	2755
Geoid	1	2	1	2	2756	2757
Solid Earth Tide Elevation	1	2	1	2	2758	2759
Tide Elevations, Specific	4	2	1	8	2760	2767
Load Tide Elevation	4	2	1	8	2768	2775
Ocean Tide Elevation	1	2	1	2	2776	2777
Range Correction, Wet Troposphere	1	2	1	2	2778	2779
Range Correction, Dry Troposphere	40	2	1	80	2780	2859
Elevation Corrections Quality Flag	1	1	2	2	2860	2861
spares	1	1	10	10	2862	2871
Atmosphere Flag	40	1	1	40	2872	2911
Surface Type	40	1	1	40	2912	2951
Meteorological Data Quality Flag	1	1	1	1	2952	2952
spares	1	1	3	3	2953	2955
DEM Elevation	40	4	1	160	2956	3115
Reference Range	40	4	1	160	3116	3275
Threshold Retracker Range Increment	40	4	1	160	3276	3435
Signal Begin Range Increment	40	4	1	160	3436	3595
Signal End Range Increment	40	4	1	160	3596	3755
Ice Sheet Range Increment	40	4	1	160	3756	3915
Sea Ice Range Increment	40	4	1	160	3916	4075
Land Range Increment	40	4	1	160	4076	4235
Ocean Range Increment	40	4	1	160	4236	4395
Centroid Range Increment	40	4	1	160	4396	4555
Reflectance	40	4	1	160	4556	4715
Reflectance Correction, Laser Pointing	40	4	1	160	4716	4875
Reflectance Correction, Solar Angle	1	4	1	4	4876	4879

Table B-7 GLA06 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Reflectance Correction, Atmosphere	1	4	1	4	4880	4883
spares	1	1	32	32	4884	4915
Peak Amplitude of Smooth WF	40	2	1	80	4916	4995
Sigma of Elevation	40	2	1	80	4996	5075
Elevation Quality	1	1	5	5	5076	5080
	1	1	3	3	5081	5083
Goodness of Fit, Roughness	40	2	1	80	5084	5163
Surface Roughness	40	2	1	80	5164	5243
Surface Slope	40	2	1	80	5244	5323
Surface Roughness Quality Flag	40	1	1	40	5324	5363
Number of Peaks from Waveform Fit	40	1	1	40	5364	5403
Initial Number of Peaks of the Smooth Waveform (land)	40	1	1	40	5404	5443
Range Increment Quality/Use Flag	40	1	1	40	5444	5483
spares	1	1	4	4	5484	5487

B.1.8 GLA07

Records are fixed length and format and occur once per second. Table B-8 contains the record format.

Table B-8 GLA07 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Backscatter Record Index	1	4	1	4	0	3
Time of First Sample - Seconds	1	4	2	8	4	11
PAD Pointing Vector	1	4	6	24	12	35
Profile Coordinate, Latitude	1	4	1	4	36	39
Profile Coordinate, Longitude	1	4	1	4	40	43
Profile Coordinate, Elevation	1	4	1	4	44	47
POD & PAD orbit quality flag	1	1	1	1	48	48
Spares	1	1	7	7	49	55

Table B-8 GLA07 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Solar Angle	1	4	1	4	56	59
Surface elevation - peak of return	40	2	1	80	60	139
Surface elevation - threshold of return	40	2	1	80	140	219
Threshold Crossing	40	1	3	120	220	339
Start Range of Backscatter Profile	1	4	1	4	340	343
532 nm Background	40	4	3	480	344	823
532 nm Background	5	4	3	60	824	883
532 nm Background	1	4	3	12	884	895
1064 nm Background	40	4	3	480	896	1375
1064 nm Background	5	4	3	60	1376	1435
532 nm laser transmitted energy quality flag	1	1	10	10	1436	1445
1064 nm laser transmitted energy quality flag	1	1	10	10	1446	1455
DEM value used by atmosphere processes	1	4	1	4	1456	1459
532 nm Backscatter Calibration Coefficient	1	4	3	12	1460	1471
1064 nm Backscatter Calibration Coefficient	1	4	2	8	1472	1479
532 nm Merged Attenuated Back-scatter Profile 10 to -1 km	40	4	148	23680	1480	25159
532 nm Merged Attenuated Back-scatter Profile 40 to -1 km	5	4	548	10960	25160	36119
1064 nm Merged Attenuated Backscatter Profile 10 to -1 km	40	4	148	23680	36120	59799
1064 nm Merged Attenuated Backscatter Profile 20 to -1 km	5	4	280	5600	59800	65399
532 nm molecular backscatter cross section profile 40 to -1 km	1	2	548	1096	65400	66495

Table B-8 GLA07 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
1064 nm molecular backscatter cross section profile 20 to -1 km	1	2	280	560	66496	67055
532 nm integrated return from 30 to 20 km	1	4	1	4	67056	67059
Met/std atm source/quality flag	1	1	1	1	67060	67060
Spares	1	1	7	7	67061	67067
532 nm Attenuated Backscatter Vertical Profile Flag contains:	1	1	18	18	67068	67085
532 nm calibration coefficient quality flag	1	0.25	1			
532 nm calibration coefficient day/night flag	1	0.25	1			
532 nm backscatter cross section quality flag for 5 Hz profile	1	0.25	1			
532 nm backscatter cross section quality flag for 5 Hz profile	1	0.25	5			
Spares	1	0.125	3			
532 nm backscatter cross section use flag for 5 Hz profile	1	0.125	5			
532 nm backscatter cross section quality flag for 40 Hz profile	1	0.25	40			
532 nm backscatter cross section use flag for 40 Hz profile	1	0.125	40			
1064 nm Attenuated Backscatter Vertical Profile Flag	1	1	18	18	67086	67103
1064 nm calibration coefficient quality flag	1	0.25	1			
Spares	1	0.125	4			
1064 nm backscatter cross section quality flag for 5 Hz profile	1	0.25	5			
Spares	1	0.125	3			

Table B-8 GLA07 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
1064 nm backscatter cross section use flag for 5 Hz profile	1	0.125	5			
1064 nm backscatter cross section quality flag for 40 Hz profile	1	0.25	40			
1064 nm backscatter cross section use flag for 40 Hz profile	1	0.125	40			
spares	1	1	8	8	67104	67111

Appendix C
Level 1 Data Products
Detailed Data Contents & Description

C.1 GLA01

Table C-1 GLA01: 02/25/2000

Element Name	Product Variable Name	Units	Scale Factors	Description
GLA01 Header Contains:				
Altimetry Record Index	i_rec_ndx	n/a	n/a	Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Shot - Seconds	i_UTCTime	seconds, microsec-onds	1	The whole number of seconds from J2000 of the time of the first shot in the 1 second frame.
GLA01 Record Type	i_gla01_rectype			Record type indicating whether data for this second is a long or short wave-form.
End GLA01 Header				
GLA01 Main Contains:				
Delta Shot Times	i_msec	microsec-onds	1.00E-06	The time deltas of the subsequent shots in the 1 second frame to the first shot; in microseconds.
Predicted Profile Coordinates, Lati-tude	i1_pred_lat	microde-grees	1.00E-06	The latitude of the first spot in the 1 second frame; calculated from the pre-dicted orbit.
Predicted Profile Coordinates, Lon-gitude	i1_pred_lon	microde-grees	1.00E-06	The longitude of the first spot in the 1 second frame; calculated from the predicted orbit.
Spacecraft Height	i_pred_scHt	mm	1/1000	The height of the spacecraft above the reference ellipsoid for the first shot ion the 1 second frame; calculated from the predicted orbit.
AD Gain Setting	i_gainSet1064			The receiver gain; results of the gain algorithm.

Table C-1 GLA01: 02/25/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factors	Description
Filter Number	i_filtnum	n/a	n/a	Filter selected; from DSP Telemetry. The filter with the highest weight value; in case of a tie the narrowest filter (in terms of nanoseconds is chosen. Values are 0 for 4 nsec filter; 1 for 8 nsec filter; 2 for 16 nsec filter; 3 for 32 nsec filter; 4 for 64 nsec filter; 5 for 128 nsec filter.
Ending Time of Range Response	i_RespEndTime	nanoseconds	1	Ending address of the range response in nanosecond resolution. Time of last sample (in time) of raw digitizer data.
Last Threshold Crossing Time	i_LastThrXingT	nanoseconds	1	Last threshold crossing location address in nanosecond resolution. Time of trailing edge.
Next to Last Threshold Crossing	i_NextThrXing	nanoseconds	1	Next to last threshold crossing location address in nanosecond resolution. Time of leading edge.
Echo Peak Location	i_EchoPeakLoc	nanoseconds	1	Address (time) of the detected peak value in nanosecond resolution.
Echo Peak Value	i_EchoPeakVal	counts	1	Peak value returned by the FIR engine. Range of value is 0 - 255.
Filter Weight Factors	i_wt_fact_filt	counts	1	Calculated weight factors of all the filters; results of weight formulas for all FIR filters. Not enough bytes for all 6 filters
Selected Filter Threshold Value	i_filtr_thresh	?	1	The threshold crossing value corresponding to the selected filter.
Time of Transmit Pulse Waveform Peak	i_time_txWfPk	nanoseconds	1	The digitizer address of the location of the detected peak of the transmit pulse.
Starting address Transmit Pulse Waveform	i_TxWfStart	nanoseconds	1	Starting address (1st gate) of the transmit pulse waveform.

Table C-1 GLA01: 02/25/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factors	Description
Transmit Waveform Peak Status Flag	i_txWfPk_Flag	n/a	n/a	Transmit waveform peak status word. Bit 0: Peak not found Bit 1: Peak is below threshold. Bit 2 -31: unused. Value of 0 = False, Value of 1 = True.
1064 nm Laser Transmit Energy	i_TxNrg_EU		1.0D-2	The 1064 nm laser pulse energy in energy units, computed from the digitized outgoing pulse and the detector temperature.
Range Window Status Word	i_statflags	n/a	n/a	Range Window Status word: Bit 0: No first crossing found on 4-nsec filter Bit 1: No first crossing found on 8-nsec filter Bit 2: No first crossing found on 16-nsec filter Bit 3: No first crossing found on 32-nsec filter Bit 4: No first crossing found on 64-nsec filter Bit 5: No first crossing found on 128-nsec filter Bit 6: No second crossing found on 4-nsec filter Bit 7: No second crossing found on 8-nsec filter Bit 8: No second crossing found on 6-nsec filter Bit 9: No second crossing found on 32-nsec filter Bit 10: No second crossing found on 64-nsec filter Bit 11: No second crossing found on 128-nsec filter Bit 12: First sample in range greater than or equal to threshold for 4 nsec filter Bit 13: First sample in range >= to threshold for 8 nsec filter Bit 14: First sample in range >= threshold for 16 nsec filter Bit 15: First sample in range >= threshold for 32 nsec filter Bit 16: First sample in range >= threshold for 64 nsec filter Bit 17: First sample in range >= threshold for 128 nsec filter Bit 18: All filters were rejected flag. 0 = FALSE, 1 = TRUE. This flag will be set to true (1) if bits 0 through 5 in Range_Status are set. Bits 19-31 are unused spares.
Waveform Compression Parameters	i_wf_mkup	counts	n/a	Waveform makeup (compress therefore averaged!): Item 1 is number of elements compressed at ratio "p" (uses 15 bits); Item 2 is number of elements compressed at ratio "q" (uses 15 bits).
Shot Counter	i_shot_ctr	counts	n/a	The shot number for each of the 40 shots in this record.
Compression Ratios	i_compRatio	counts	n/a	Averaging values "p" and "q" for hit. The compression ratio. First item is p; second item is q.
DEM Grid Number	i_DEM_grid_num	unitless	n/a	Index into the DEM.

Table C-1 GLA01: 02/25/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factors	Description
Global DEM Bias	i_RwinOff	ns	1	Offsets (DEM uncertainty) added to the range window start and stop: Roffmin, Roffmax.
DEM Flag	i_DEM_flag	n/a	n/a	Flag indicating how DEM grid number was selected -- GPS (=1), spacecraft data (=2) or uplink of min and max (=3). Combination of bits 6 and 7 are the surface indicators. If bit 6 = 0 surface is ocean, if = 1 surface is land. If bit 7 = 0 surface is no ice, if =1 surface is ice.
Filter Numbers Mask	i_FiltNumMask			The low order 6 bits, bits 0 through 5, indicate which filters were selectable for a shot. The definition of complete failure of the filters has been changed to mean the complete failure of all SELECTABLE filters. Bit 0: 4 nsec filter, bit 1: 8 nsec filter, bit 2: 16 nsec filter, bit 3: 32 nsec filter, bit 4: 64 nsec filter, bit 5: 128 nsec filter. In case of the complete failure of all the filters, the result of the last "good" shot shall be used, even if this mask proscribes the filter choice. A bit value = 1 =selectable; bit value = 0 = not selectable.
Altimeter Digitizer Bias	i_RwinRBias	ns	1	Range bias values added to range window start and stop: Rbmin, Rbmax. Used when necessary to correct for off-nadir pointing angles greater than 1 degree.
Range Window Start and Stop	i_RminRmax	ns	1	Range window start and stop in nanoseconds relative to the first sample in the waveform.
Sampled Transmit Pulse Waveform	i_tx_wf	counts	n/a	Transmitted pulse waveform (32 gates).
End GLA01 Main				
GLA01 Long WF Structure contains: (This structure repeats 5 times for 1 second of data)				
Background Mean Value	i_wfnoiseOb	counts	1.0D-2	Background Noise Mean Value for all filters.
Background Standard Deviation	i_bgSDEV	counts	1.0D-2	The standard deviation of the background noise for all filters; calculated from the digitizer.

Table C-1 GLA01: 02/25/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factors	Description
1064 nm Range Waveform	i_rng_wf	counts	n/a	The 1064 nm return waveform digitizer sample output, at 544 samples per shot over land and ice sheet and 200 samples per shot over sea ice and ocean. The surface type is determined by the instrument from the on-board DEM. The digitized data was averaged according to the waveform compression parameters (M,N) and the compression ratio (p,q).
End GLA01 Long WF				
GLA01 Short WF Structure contains: (This structure repeats 2 times for 1 second of data)				
Background Mean Value	i_wfnoiseOb	counts	1.0D-2	Background Noise Mean Value for all filters.
Background Standard Deviation	i_bgSDEV	counts	1.0D-2	The standard deviation of the background noise for all filters; calculated from the digitizer.
1064 nm Range Waveform	i_rng_wf	counts	n/a	The 1064 nm return waveform digitizer sample output, at 544 samples per shot over land and ice sheet and 200 samples per shot over sea ice and ocean. The surface type is determined by the instrument from the on-board DEM. The digitized data was averaged according to the waveform compression parameters (M,N) and the compression ratio (p,q).
End GLA01 Long WF				

C.2 GLA02

Table C-2 GLA02: 09/04/2000

Element Name	Product Variable Name	Units	Scaling Factor	Description
Atmosphere Record Index	i_rec_ndx	n/a	n/a	Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Sample - Seconds	i_UTCTime	Sec, microsec	(/ 1.0D0, 1.0D-6 /)	The seconds portion of the time tag of the first laser pulse in the 1-second data frame, corrected for system and transit delay, in CCSDS day segmented binary form.
Predicted Profile Coordinates, Latitude	i1_pred_lat	microdegrees	1.00E-06	The Latitude of the Profile location; obtained from the predicted orbit.
Predicted Profile Coordinates, Longitude	i1_pred_lon	microdegrees	1.00E-06	The Longitude of the Profile location; obtained from the predicted orbit.
Location of Last Peak	i_loc_last_pk	counts	1	The location of the last peak of the 1064 nm waveform; normally this would be the ground surface return.
Etalon Filter Temperature	i_EtFiltTemp	celsius * 100	0.01	The temperature of the etalon filter.
Etalon Filter Feedback Monitor	i_EtFiltFBMon	amps * 10	0.01	The readout of the pin diode that receives a pick off of outgoing laser light through a fiber and the etalon. The value is used to temperature tune the etalon.
Etalon Filter Heater Drive Control Point	i_EtFiltHtrCP	amps * 10	0.01	Software parameter to control the temperature of the etalon filter.
DEM Grid Number	i_DEM_grid_num	n/a	1	The DEM grid number with sea ice, land ice, land, or ocean indicator.
DEM Flag	i_DEM_flag	n/a		Flag indicating how DEM grid number was selected -- GPS, spacecraft data or uplink used.

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
532 nm LIDAR Use Flag	i1_g_lid_uf	n/a	n/a	532 nm use flag; 1 bit per shot for a total of 40 bits.
532 nm LIDAR Data Quality Flag	i1_g_lid_qf	n/a	n/a	532 nm data quality flag; indicates data quality based on good vs. bad data criteria. 532 nm aerosol data use flag showing discipline and coverage applicability. 2 bits per shot for a total of 80 bits.
Spares	i_spare2	n/a		
532 nm LIDAR Data from 10 KM to -1 KM	i40_g_lid	(pe/ us(km^2)/ mJ)	1.0d3	The normalized lidar signal from the 532 nm photon counting channel for the 10 KM to -1 segment of the atmosphere. Background is subtracted from the raw signal and the dead time correction is applied. NOTES: pe = photons; us = microseconds; mJ = milliJoules.
532 nm LIDAR Data from 20 KM to 10 KM	i5_g_lid	(pe/ us)(km^2/ mJ)	1.0d3	The normalized lidar signal from the 532 nm photon counting channel for the 20 KM to 10 KM segment of the atmosphere. Background is subtracted from the raw signal and the dead time correction is applied. Sums of 8 samples.
532 nm LIDAR Data from 40 KM to 20 KM	i1_g_lid	(pe/ us)(km^2/ mJ)	1.0d3	The normalized lidar signal from the 532 nm photon counting channel for the 40 KM to 20 KM segment of the atmosphere.
532 nm Saturation Flag for 10 to -1 KM Segment	i40_g_sat_f	n/a	1	Bit flag indicating whether the 532 nm signal is saturated or not for the 10 to -1 KM Segment. 1 bit per each shot(40) per bins (148); 0 = not saturated, 1 = saturated.
532 nm Saturation Flag for 20 to 10 KM Segment	i5_g_sat_f	n/a	1	Bit flag indicating whether the 532 nm signal is saturated or not for the 20 to 10 KM Segment. The flag is padded with fill bits at the end to bring it to a byte boundary. 1 bit per each sum of 8 shots per bin; 0 = not saturated, 1 = saturated.

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
532 nm Saturation Flag for 40 to 20 KM Segment	i1_g_sat_f	n/a	1	Bit flag indicating whether the 532 nm signal is saturated or not for the 40 to 20 KM Segment. The flag is padded with fill bits at the end to bring it to a byte boundary. 1 bit per each sum of 40 shots per bin (268); 0 = not saturated, 1 = saturated.
532 nm Laser Transmit Energy	i40_g_TxNrg_EU	milliJoules	0.01	The 532 nm transmitted pulse energy in energy units, converted from the counts from the transmitted energy monitor. Background is subtracted from the raw signal and the dead time correction is applied.
532 nm Laser Transmit Energy	i5_g_TxNrg_EU	milliJoules	0.01	The 532 nm transmitted pulse energy in energy units, converted from the counts from the transmitted energy monitor. Background is subtracted from the raw signal and the dead time correction is applied. Averaged over 8 shots.
532 nm Laser Transmit Energy	i1_g_TxNrg_EU	milliJoules	0.01	The 532 nm transmitted pulse energy in energy units, converted from the counts from the transmitted energy monitor. Background is subtracted from the raw signal and the dead time correction is applied. Averaged over 40 shots.
532 nm Integrated Return, 40 to 20 KM	i_g_IntRet	photons	0.01	Sum of raw photon counts (after background is subtracted) over the 20 to 40 km bins.
Start Range of Backscatter Profile	i_Rng2Prof	Meters	0.001	The range to the start of the backscatter profile - the start of the 40 KM segment of Lidar Data.
Range from S/C to Return bin	i_rngSc2RetBin	Meters	0.001	Used to normalize the lidar signal.
Surface elevation - peak of return	i_SrfEl_PkRt	Meters	0.001	
Surface elevation - threshold of return	i_SrfEl_ThRt	Meters	0.001	

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
532 nm Background at 40 Hz	i40_g_bg	photons/bin	100	The normalized 532 nm background count integration intervals; photons/bin (or photons per 1/2 microsec).
532 nm Background at 5 Hz	i5_g_bg	photons/bin	100	The normalized 532 nm background count integration intervals; photons/bin (or photons per 1/2 microsec). Averaged over 8 shots.
532 nm Background at 1 Hz	i1_g_bg	photons/bin	100	The normalized 532 nm background count integration intervals; photons/bin (or photons per 1/2 microsec). Averaged over 40 shots.
532 nm Predicted Cloud Top Height	i_gPredCldTop	Km	0.01	The predicted height of the first cloud above local ground, predicted from the 532 nm lidar signal.
532 nm LIDAR Data Shot Counter	i1_g_shot_ctr	n/a	1	Corresponds to first value of the 40 -1 km to 10 km aerosol science data.
SPCM Background 2 and LIDAR Delay	i_SpcmBg2LidDel	n/a	1	The delays for the background #2 and the LIDAR as read from the photon counter board.
SPCM Gate and Background 1 Delay	i_SpcmGatBg1Del	n/a	1	The SPCM Gate (1st item) and Background #1 Delay values from the photon counter board.
Photon Counter Range Delay	i_rdel_pc	n/a	1	Range delay value from the photon counter.
SPCM Status	i_spcm_stat	n/a	1	The status of the SPCM as read from the photon counter board. The Photon Counter Bd address 0xXX800004.
532 LIDAR Data Error Flag	i40_g_lid_ef	n/a	1	The error flag returned in the photon counter (aerosol) telemetry data.
532 nm Laser Transmit Energy, counts	i_g_TxNrg_Cts	counts	1	The 532 nm transmitted pulse energy, in raw counts from the transmitted pulse energy monitor.

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
532 nm Laser Transmit Energy Quality Flag	i_g_TxNrg_qf	n/a	n/a	Evaluation of the 532 nm laser transmit energy which is an indication of the laser health; 2 bits per shot; 1 = full laser energy, 2 = marginal laser energy, 3 = deficient laser energy, 0 = not used.
Photon Counter Range Bias	i_pc_rbias	n/a	1	The range bias of the photon counter; always positive.
Integrated Return Quality Flag	i_g_IntRet_qf	n/a	1	Assessment of the integrated return value; indicator of boresight accuracy and signal strength. 0 = unused, 1 = excellent, 2 = good, 3 = marginal, 4 = poor, 5 = bad data.
SPCM Raw Counts	i_spcm_cts	n/a	1	The raw counts for each photon counter (1-8) from the S? Photon Counter Module.
1064 nm LIDAR Use Flag	i1_ir_lid_uf	n/a	1	1064 nm cloud waveform use flag; 1 bit per shot.
1064 nm LIDAR Data Quality Flag	i1_ir_lid_qf	n/a	1	1064 nm cloud waveform data quality flag; 1064 nm cloud waveform data use flag showing discipline and coverage applicability. 2 bits per shot.
Spares	i_spare5	n/a		
1064 nm Laser Transmit Energy	i40_ir_TxNrgEU	milliJoules	0.01	The 1064 nm laser pulse energy in energy units, computed from the digitized outgoing pulse and the detector temperature.
1064 nm Laser Transmit Energy	i5_ir_TxNrgEU	milliJoules	0.01	The 1064 nm laser pulse energy in energy units, computed from the digitized outgoing pulse and the detector temperature. Averaged over 8 shots.
1064 nm Background from -5 KM to -3.75 KM at 40 Hz	i40_ir_bg	photons/bin	100	The normalized below ground background signal for the 1064 nm cloud data from the SiAPD detector.

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
1064 nm Background from -5 KM to -3.75 KM at 5 Hz	i5_ir_bg	photons/bin	100	The normalized below ground background signal for the 1064 nm cloud data from the SiAPD detector. Averaged over 8 shots.
1064 nm LIDAR Data from 10 KM to -1 KM	i40_ir_lid	W(km^2)/ mJ	1.0d-14	The normalized lidar signal from the 1064 nm cloud digitizer data for the 10 KM to -1 KM atmospheric segment. Background is subtracted from the signal and the digital to analog conversion applied.
1064 nm LIDAR Data from 20 KM to 10 KM	i5_ir_lid	W(km^2)/ mJ	1.0d-14	The normalized lidar signal from the 1064 nm cloud digitizer data for the 20 KM to 10 KM atmospheric segment. Background is subtracted from the signal and the digital to analog conversion applied.
1064 nm Cloud Digitizer Shot Counter	i_ir_shot_ctr	n/a	1	Shot number corresponding to first value of the 40 -1 km to 10 km cloud digitizer data.
Cloud Digitizer Background 2 delay	i_CdBg2Lid_Del	n/a	1	The delays for background #2 and the LIDAR from the cloud digitizer board.
Cloud Digitizer Background 1 Delay	i_cd_bg1_del	n/a	1	The delay for background #1 from the cloud digitizer board.
Range Gate for Cloud Digitizer	i_cd_rgate	n/a	1	Range gate value from cloud digitizer board. Last commanded value for start of cloud digitizer data.
Cloud Digitizer Detector Status	i_cd_det_stat	n/a	1	Status of the detector from the cloud digitizer board.
1064 nm Cloud Digitizer Data Spare	i_ir_cd_Spare	n/a	1	Spare byte in the cloud digitizer telemetry stream.

Table C-2 GLA02: 09/04/2000 (Continued)

Element Name	Product Variable Name	Units	Scaling Factor	Description
Cloud Return Peak Signal	i_CldPkSig	counts (photons)	1	Peak photon count in the 532 nm backscatter data within the range for cloud returns. Last 3 bytes are spares.
A/D Output and Attenuation Setting	i_cd_ad_att	n/a	1	The A/D Output (1st item) and the attenuation setting (2nd item) from the cloud digitizer board.
Cloud Digitizer Range Bias	i_cd_rbias	n/a	1	The range bias from the cloud digitizer; always positive.
1064 Digitizer Gain Setting	i_ir_gainSet	counts	1	1064 nm programmable gain amplifier setting, multiplicative factor
Threshold Crossing	i_thres_xing	counts (address)	1	The threshold crossings of the last peak of the 1064 nm altimeter wave-form, estimate of the range to surface. Computed from the offset of the peak time of the last sample.
Ground Return Peak Signal	i_gndret_pksig	counts (photons)	1	Peak photon count in the 532 nm backscatter data. It is assumed that a ground return causes the maximum signal. Last 3 bytes are spares.
Ground Return Location	i_gnd_ret_loc	bin number	1	Bin number (from the end of the profile) of the estimated ground return peak signal. Last 3 bytes are spares.
1064 nm Laser Transmit Energy Quality Flag	i_ir_TxNrg_qf	n/a	1	Evaluation of the 1064 nm laser transmit energy which is an indication of the laser health; 2 bits per shot; 1 = full laser energy, 2 = marginal laser energy, 3 = deficient laser energy, 0 = not used.

C.3 GLA03

Table C-3 GLA03 : 01/24/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Engineering Record Index	i_rec_ndx	N/A		Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Record Time (Seconds.Microseconds)	i_UTCTime	seconds microseconds	(/ 1.0D0, 1.0D-6 /)	
Primary Header APID 20	i_phdr_20	N/A		
Secondary Header APID 20 (time stamp)	i_shdr_20	N/A		
532 Energy	i_g_nrg	Percent X 100	1.0D-2	
Laser Oscillator Temperature	i_LsrOsc_t	Celsius X 100	1.0D-2	
Laser Doubler Temperature	i_LsrDblr_t	Celsius X 100	1.0D-2	
Laser Power Supply Temperature	i_LsrPwrS_t	Celsius X 100	1.0D-2	
Laser Preamp Temperature	i_LsrPAmp_t	Celsius X 100	1.0D-2	
Laser Osc Current	i_LsrOsc_c	Counts	1	
Laser Amp Current	i_LsrAmp_c	Counts	1	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Laser Dr Pulse Width	i_LsrDr_pw	Counts	1	
Primary Altimeter Detector 550 V	i_PrimAD550v	Volts X 100	1.0D-2	
Secondary Altimeter Detector 550 V	i_SecAD550v	Volts X 100	1.0D-2	
SPCM Detector #1 550 V	i_spcm1_550v	Volts X 100	1.0D-2	
SPCM Detector #2 550 V	i_spcm2_550v	Volts X 100	1.0D-2	
SPCM Detector #3 550 V	i_spcm3_550v	Volts X 100	1.0D-2	
SPCM Detector #4 550 V	i_spcm4_550v	Volts X 100	1.0D-2	
SPCM Detector #5 550 V	i_spcm5_550v	Volts X 100	1.0D-2	
SPCM Detector #6 550 V	i_spcm6_550v	Volts X 100	1.0D-2	
SPCM Detector #7 550 V	i_spcm7_550v	Volts X 100	1.0D-2	
SPCM Detector #8 550 V	i_spcm8_550v	Volts X 100	1.0D-2	
Internal Temp #1	i_Int1_t	Counts	1	
Internal Temp #2	i_Int2_t	Counts	1	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Internal Temp #3	i_Int3_t	Counts	1	
VC X Motor Current	i_VCXmtr_c	Counts	1	
VC Y Motor Current	i_VCYmtr_c	Counts	1	
X Position	i_Xpos	Counts	1	
Y Position	i_Ypos	Counts	1	
OTS Level 1 readback	i_OTSL1_rb	Counts	1	
OTS Level 2 readback	i_OTSL2_rb	Counts	1	
OTS Level 3 readback	i_OTSL3_rb	Counts	1	
OTS Level 4 readback	i_OTSL4_rb	Counts	1	
OTS Trigger Count 1 (Upper byte) readback	i_OTS_tc1	Counts	1	
OTS Trigger Count 2 (Upper byte) readback	i_OTS_tc2	Counts	1	
AD Detector Outgoing Gain readback	i_ADdetOutGn	Counts	1	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
AD Detector Return Gain read-back	i_ADdeRetGn	Counts	1	
Dual Pin -A	i_DPinA	Percent X 100	1.0D-2	
Dual Pin -B	i_DPinB	Percent X 100	1.0D-2	
Loop Heat Pipe 1 & 2 Heater Status	i_LHtP12_St	N/A		Pipe 1 -> Bit 0, LSB, Pipe 2 -> Bit 1; 0=OFF, 1=ON; spares -> Bits 2-7
Primary Header APID 21	i_phdr_21	N/A		
Secondary Header APID 21 (time stamp)	i_shdr_21	N/A		
+28V Bus A Instrument	i_BusAInst_28v	Volts X 100	1.0D-2	
Hybrid Supplies	i_HBSupp_c	Amps X 100	1.0D-2	
HVPS Detector Supplies	i_HVPSDetSup_c	Amps X 100	1.0D-2	
Operational Heat-ers	i_OpHtr_c	Amps X 100	1.0D-2	
Mechanical System	i_MechSys_c	Amps X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
+28V Bus B Laser 1	i_BusBL1_v	Volts X 100	1.0D-2	
+28V Bus B Laser 1	i_BusBL1_c	Amps X 100	1.0D-2	
+28V Bus C Laser 2	i_BusCL2_v	Volts X 100	1.0D-2	
+28V Bus C Laser 2	i_BusCL2_c	Amps X 100	1.0D-2	
+28V Bus D Laser 3	i_BusDL3_v	Volts X 100	1.0D-2	
+28V Bus D Laser 3	i_BusDL3_c	Amps X 100	1.0D-2	
+ 5 V Hybrid # 1	i_5VHb1_v	Volts X 100	1.0D-2	
+ 5 V Hybrid # 1	i_5VHb1_c	Amps X 100	1.0D-2	
+12 V Hybrid # 2	i_12VHb2_v	Volts X 100	1.0D-2	
+ 12 V Hybrid # 2	i_12VHb2_c	Amps X 100	1.0D-2	
- 12 V Hybrid # 3	i_n12VHb3_v	Volts X 100	1.0D-2	
- 12 V Hybrid # 3	i_n12VHb3_c	Amps X 100	1.0D-2	
+ 5 V Hybrid # 4	i_5VHb4_v	Volts X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
+ 5 V Hybrid # 4	i_5VHb4_c	Amps X 100	1.0D-2	
- 5 V Hybrid # 5	i_n5VHb5_v	Volts X 100	1.0D-2	
- 5 V Hybrid # 5	i_n5VHb5_c	Amps X 100	1.0D-2	
- 5 V Hybrid # 6	i_n5VHb6_v	Volts X 100	1.0D-2	
- 5 V Hybrid # 6	i_n5VHb6_c	Amps X 100	1.0D-2	
+ 15 V Boost Post Reg	i_15VBPR_v	Volts X 100	1.0D-2	
- 15 V Boost Post Reg	i_n15VBPR_v	Volts X 100	1.0D-2	
+12 V Prim Osc Thermal Control	i_12VPOscTC_c	Amps X 100	1.0D-2	
+12 V Sec Osc Thermal Control	i_12VSOscTC_c	Amps X 100	1.0D-2	
-2 V Discrete Volt-age	i_n2VDV_v	Volts X 100	1.0D-2	
Hybrid Heatsink	i_HbHS_t	Celsius X 100	1.0D-2	
FET Switch Bank Heatsink	i_FETSbHS_t	Celsius X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
FET Switch Bank	i_FETSwBnk	N/A		Each bit position corresponds to the status of a specific subsystem power as 1=On, 0 = Off. 4 of these bit positions are used: Bit 0 = Status of Primary Oscillator; Bit 1 = Status of Secondary Oscillator; Bit 5 = Status of Primary Digitizer; Bit 6 = Status of Secondary Digitizer. Bits 2, 3, 4, 7-15 are spares.
HVPS +0 Volts Reference	i_0VHVPSRef_v	Volts X 100	1.0D-2	
HVPS +5 V Reference	i_5VHVPSRef_v	Volts X 100	1.0D-2	
Optical Sensor Status	i_OptSensSt	N/A		Bit 0 indicates whether read optical sensor is enabled. 0 = disabled, 1 = enabled. Bits 1-15 are spares.
Register Flags	i_RegFlags	N/A		?
Primary Monitor Calibration	i_PDUPMonCal1	N/A		
Primary Monitor Calibration	i_PDUPMonCal2	N/A		
Secondary Monitor Calibration	i_PDUSMonCal1	N/A		
Secondary Monitor Calibration	i_PDUSMonCal2	N/A		
Counter info	i_ctrinfo	Counts	1	
Primary Header APID 22	i_phdr_22	N/A		

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Secondary Header APID 22 (time stamp)	i_shdr_22	N/A		
Housekeeping Board Temperature, Ch 0	i_HkBdC0_t	Celsius X 100	1.0D-2	
Instrument Processor System Board Temperature, Ch 1	i_InPrSBdC1_t	Celsius X 100	1.0D-2	
Photon Counter Board Temperature, Ch 2	i_PCBdC2_t	Celsius X 100	1.0D-2	
Cloud Digitizer/Frequency & Time Board Temperature, Ch 3	i_CDFTBdC3_t	Celsius X 100	1.0D-2	
Altimeter Digitizer 1 Board Temperature 1, Ch 4	i_AD1BdC4_t1	Celsius X 100	1.0D-2	
Altimeter Digitizer 1 Board Temperature 2, Ch 5	i_AD1BdC5_t2	Celsius X 100	1.0D-2	
Altimeter Digitizer 2 Board Temperature 1, Ch 6	i_AD2BdC6_t1	Celsius X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Altimeter Digitizer 2 Board Temperature 2, Ch 7	i_AD2BdC7_t2	Celsius X 100	1.0D-2	
Data Collection & Handling Board Temperature, Ch 8	i_DCHBdC8_t	Celsius X 100	1.0D-2	
Laser Monitor Board Temperature, Ch 9	i_LMBdC9_t	Celsius X 100	1.0D-2	
Temperature Controller Monitor Board Temperature, Ch 10	i_TCMBdC10_t	Celsius X 100	1.0D-2	
Oven-crystal-controlled Oscillator(OXCO) 1 Board Temperature, Ch 11	i_OXCO1BdC11_t	Celsius X 100	1.0D-2	
Oven-crystal-controlled Oscillator(OXCO) 2 Board Temperature, Ch 12	i_OXCO2BdC12_t	Celsius X 100	1.0D-2	
Oscillator Board Temperature, Ch 13	i_OscBdC13_t	Celsius X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Optical Test Source (OTS) Board Temperature, Ch 14	i_OTSBdC14_t	Celsius X 100	1.0D-2	
Laser Profiler Array (LPA) Temperature 1, Ch 15	i_LPAC15_t1	Celsius X 100	1.0D-2	
Laser Profiler Array (LPA) Temperature 2, Ch 16	i_LPAC16_t2	Celsius X 100	1.0D-2	
Altimeter Digitizer 1 Board Temperature 3, Ch 17	i_AD1BdC17_t3	Celsius X 100	1.0D-2	
Altimeter Digitizer 2 Board Temperature 3, Ch 18	i_AD2BdC18_t3	Celsius X 100	1.0D-2	
Altimeter Digitizer 1 Board Temperature 4, Ch 19	i_AD1BdC19_t4	Celsius X 100	1.0D-2	
Altimeter Digitizer 2 Board Temperature 4, Ch 20	i_AD2BdC20_t4	Celsius X 100	1.0D-2	
Altimeter Digitizer 1 Board Temperature 5, Ch 21	i_AD1BdC21_t5	Celsius X 100	1.0D-2	
Altimeter Digitizer 2 Board Temperature 5, Ch 22	i_AD2BdC22_t5	Celsius X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
HK Tlm Channel 23- Spare	i_HKSpareC23	Celsius X 100	1.0D-2	
PRT, Gyro Temperature, Ch 24	i_PRTGyroC24_t	Celsius X 100	1.0D-2	
PRT, Star Camera Temperature, Ch 25	i_PRTStCmC25_t	Celsius X 100	1.0D-2	
PRT, Stellar Reference System (SRS) Temperature, Ch 26	i_PRTSRSC26_t	Celsius X 100	1.0D-2	
PRT, Lidar Detector Pkg? Temperature, Ch 27	i_PRTLiDtC27_t	Celsius X 100	1.0D-2	
PRT, Altimeter Detector 1 Temperature, Ch 28	i_PRTAD1C28_t	Celsius X 100	1.0D-2	
PRT, Altimeter Detector 2 Temperature, Ch 29	i_PRTAD2C29_t	Celsius X 100	1.0D-2	
PRT, Spacecraft Interface Temperature, Ch 30	i_PRTScIfC30_t	Celsius X 100	1.0D-2	
PRT, Telescope Mount Temperature, Ch 31	i_PRTTsMtC31_t	Celsius X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
PRT, Telescope Baffle Tempera-ture, Ch 32	i_PRTTsBfC32_t	Celsius X 100	1.0D-2	
PRT Temperature Region 10, Ch 33, Spare	i_PRTsR10C33_t	Celsius X 100	1.0D-2	
PRT Temperature Region 11, Ch 34, Spare	i_PRTsR11C34_t	Celsius X 100	1.0D-2	
PRT Cal Low, Ch 35	i_PRTCalLC35_t	Celsius X 100	1.0D-2	
PRT Cal High, Ch 36	i_PRTCalHC36_t	Celsius X 100	1.0D-2	
Pin Diode Bias Voltage	i_PDBias_v	Volt X 100	1.0D-2	
Spare	i_spare22_1	Counts	1	
Spare	i_spare22_2	Counts	1	
Spare	i_spare22_3	Counts	1	
Spare	i_spare22_4	Counts	1	
Primary Header APID 23	i_phdr_23	N/A		
Secondary Header APID 23 (time stamp)	i_shdr_23	N/A		

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Telescope Region 0 Primary Mirror	i_TsR0PMir_t	Celsius X 100	1.0D-2	
Telescope Region 1 Secondary Mirror	i_TsR1SMir_t	Celsius X 100	1.0D-2	
Telescope Region 2 Tower	i_TsR2Twr_t	Celsius X 100	1.0D-2	
Etalon Temperature, Ch 37d	i_EtC37i_t	Celsius X 100	1.0D-2	
Loop Heat Pipe 1 Temperature, Ch 37e	i_LHP1C37e_t	Celsius X 100	1.0D-2	
Loop Heat Pipe 2 Temperature, Ch 37f	i_LHP2C37f_t	Celsius X 100	1.0D-2	
Telescope Primary Mirror Heater drive current	i_TsPMirHDr_c	Amps X 100	1.0D-2	
Telescope Secondary Mirror Heater drive current	i_TsSMirHDr_c	Amps X 100	1.0D-2	
Telescope Tower Heater drive current	i_TsTwrHDr_c	Amps X 100	1.0D-2	
Etalon Heater Current, Ch 37j	i_EtHtrC37j_c	Amps X 100	1.0D-2	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
HOP and VC Thermistors - 1	i_HOPVC1_t	Celsius X 100	1.0D-2	
HOP and VC Thermistors - 2	i_HOPVC2_t	Celsius X 100	1.0D-2	
HOP and VC Thermistors - 3	i_HOPVC3_t	Celsius X 100	1.0D-2	
HOP and VC Thermistors - 7	i_HOPVC7_t	Celsius X 100	1.0D-2	
HOP and VC Thermistors - 8	i_HOPVC8_t	Celsius X 100	1.0D-2	
HOP 1 Actuator Current - Heater 1	i_HOP1ActH1_c	Amps X 100	1.0D-2	
HOP 2 Actuator Current - Heater 1	i_HOP2ActH1_c	Amps X 100	1.0D-2	
HOP 3 Actuator Current - Heater 1	i_HOP3ActH1_c	Amps X 100	1.0D-2	
HOP 4 Actuator Current - Heater 2	i_HOP4ActH2_c	Amps X 100	1.0D-2	
HOP 5 Actuator Current - Heater 2	i_HOP5ActH2_c	Amps X 100	1.0D-2	
HOP 6 Actuator Current - Heater 2	i_HOP6ActH2_c	Amps X 100	1.0D-2	
Spare	i_spare23_1	Counts	1	
Spare	i_spare23_2	Counts	1	

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Spare	i_spare23_3	Counts	1	
Spare	i_spare23_4	Counts	1	
Spare	i_spare23_5	Counts	1	
Spare	i_spare23_6	Counts	1	
Spare	i_spare23_7	Counts	1	
Spare	i_spare23_8	Counts	1	
Spare	i_spare23_9	Counts	1	
Spare	i_spare23_10	Counts	1	
spare	i_spare23_11	counts	1	spare added for byte alignment.
Primary Header APID 12 or 13	i_phdr_ad	n/a		
Secondary Header 12 or 13 (time stamp)	i_shdr_ad	n/a		
Primary Header APID 15	i_phdr_15	n/a		
Secondary Header APID 15 (time stamp)	i_shdr_15	n/a		
Primary Header APID 17	i_phdr_17	n/a		

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Secondary Header APID 17 (time stamp)	i_shdr_17	n/a		
Primary Header APID 19	i_phdr_19	n/a		
Secondary Header APID 19 (time stamp)	i_shdr_19	n/a		
Shot Counter APID 19	i_sctr_19	counts	1	
Transmit Pulse Search Window Location	i_Tx_win_loc	ns	1	Reflects commanded value.
OTS Pulse Wave-form Start Address	i_otswf_start	ns	1	
OTS Pulse Wave-form Status	i_otswf_stat	n/a		Status word for OTS pulse operations. Bit 0: Enable(1)/Disable(0) condition for OTS pulse operations. Bits 1-31: Spare.
Shot Counter for OTS WF	i_sctrOTSWf	counts	1	
Sampled OTS Pulse Waveform	i_OTSPWf	counts	1	
RMS Noise Calcu-lation Location	i_RMS_loc	ns	1	Location of RMS noise calculation: starting digitizer element number. RMS location start time.

Table C-3 GLA03 : 01/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Post Delay Pulse Waveform Start Address	i_dlaywf_start	ns		
Post Delay Pulse Waveform Status	i_dlaywf_stat	n/a		Status word for Post delay laser pulse operations. Bit 0: Enable(1)/Disable(0) condition for Post delay laser pulse operations. Bits 1-31: Spare.
Shot Counter for Post Delay WF	i_sctrPDlyWF	counts	1	
Sampled Post Delay Pulse Waveform	i_PDlyWf	counts	1	
Spare APID 19	i_spare19_1	n/a		
Dual Pin A	i_DualPinA	counts	1	From Laser Monitor Board. Each corresponds to one of the 40 shots.
Dual Pin B	i_DualPinB	counts	1	From Laser Monitor Board. Each corresponds to one of the 40 shots.
Spacecraft position Packet Data with VTCW	i_SCPosPkt	counts	1	
Spares	i_spare24	n/a	n/a	

C.4 GLA05

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Waveform Record Index	i_rec_ndx	N/A		Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Laser Pulse (maybe laser ack. time -- Anita David discussion)	i_UTCTime	sec, micro-second	1.0, 1.0E-6	The UTC time tag of the transmitted pulse (fire acknowledge) of the first laser pulse in the 1-second data frame, referenced from J2000. Item 1 is the number of seconds; item 2 is the number of microseconds.
One way transit time	i_transtime	microsec	1.00E-06	One way transit time calculated using the preliminary range offset, used to calculate orbit.
Laser Shot Time Deltas (shots 2-40)	i_dShotTime	microsec	1.00E-06	The time deltas of the 39 remaining laser pulses to the UTC time tag of the first pulse in the 1-second data frame.
Spot Coordinate Data Lati-tude(uncorrected)	i_lat	microdeg	1.00E-06	The geodetic latitude of the forty laser spots in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna coordi-nates, PAD, and preliminary range; in the Inertial Celestial Reference Frame. The coordinates are north latitude. The preliminary range is used with no geodetic corrections applied.
Spot Coordinate Data Longi-tude(uncorrected)	i_lon	microdeg	1.00E-06	The longitude of the forty laser spots in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna coordinates, PAD, and preliminary range; in the Inertial Celestial Reference Frame. The coor-dinates are east longitude. The preliminary range is used with no geodetic corrections applied.
Spot Surface Ele-vation (uncor-rected)	i_elev	mm	0.001	The surface elevation wrt ellipsoid of the forty laser spots in the 1 second time frame, computed from the Precision orbit determined GLAS space-craft coordinates in the Inertial Celestial Reference Frame (ICRF) and atti-tude. The elevation is calculated using the preliminary range correction with no geodetic corrections applied.

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
PAD Pointing Vector	i_PADPoint	N/A	1.00D-6, 1.00D-12	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ICRF (deviations from nadir) of the laser. Each component is composed of 2 4-byte items. To compute, multiply the first byte by 1E-6 and the second by 1E-12 and add the two values.
POD Position	i_PODFixedPos	mm	1.0, 0.001	Time-ordered spacecraft position vector in ICRF x, y, z. Each element is composed of 2 4-byte items. This is the nadir ground location of the laser antenna on the spacecraft.
POD/PAD Quality Flag	i_PODPADQF	N/A		PODP/PAD Quality Flag, 1st 40 bits describe the POD quality, 2nd 40 bits describe the PAD quality; one bit per shot. PAD quality flag will indicate if off-nadir angle is more than specified in ANC07.
Spares	i_Spare1			
On-board Error Flags	i_obErr	N/A		Error flags generated by the instrument on-board the spacecraft. Pass-thru from GLA01
Frame Use Flag	i_badFrame	N/A		Flag indicating whether all data in the record is bad. Set if either no peaks found or no signal found. Frame is bad when bit0 /= 0.
Spares	i_spare2	N/A		
Reference Range	i_refRng	ns	0.01	Range from peak position of transmit pulse (as solved for by the Gaussian fit) to farthest gate telemetered in time (0.01ns precision)
Threshold Retracker Range Offset (other than land)	i_thRtkRngOff	ns	0.01	Offset to be added to the reference range to give the threshold retracker location for other than land parameters.
Maximum Range Offset (land)	i_maxRngOff1	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing farthest from the spacecraft (end of signal)

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Minimum Range Offset (land)	i_minRngOff1	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing closest to the spacecraft (beginning of signal)
Maximum Range Offset (other than land)	i_maxRngOff2	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing farthest from the spacecraft for ice sheet, sea ice, and ocean parameters (preliminary range offset, end of signal)
Minimum Range Offset (other than land)	i_minRngOff2	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing closest to the spacecraft for ice sheet, sea ice, and ocean parameters (beginning of signal).
Waveform Quality Flag	i_WFqual	N/A		Indicator of the quality of the waveform; determined during the waveform assessment process: 1- gwi_mxiterLand: maximum iteration exceeded for land parameters, 2- gwi_mxiterOthr: maximum iteration exceeded for other-than-land parameters, 3- gwi_noLeadEdgL: no leading edge detected for land parameters, 4- gwi_noTrlEdgL: no leading edge detected for land parameters, 5- gwi_noLeadEdgO: no leading edge detected for other-than-land parameters, 6- gwi_noTrlEdgO: no leading edge detected for other-than-land parameters, 7- gwi_land: possible land surface as indicated by regional ID grid, 8- gwi_ocean: possible ocean surface as indicated by regional ID grid, 9- gwi_icesheet: possible icesheet surface as indicated by regional ID grid, 10- gwi_seaice: possible seaice surface as indicated by regional ID grid, 11- gwi_invalidWF: invalid WF (filled/missing data), 12- gwi_noTrPulse: no transmitted pulse, 13- gwi_noFit: fit was not successful ... not set if no signal or invalid, 14- gwi_calcNs1: set if background noise and standard deviation of noise were calculated using land parameters, 15- gwi_calcNs2: set if background noise and standard deviation of noise were calculated using other than land parameters, 16- gwi_noSig: set if invalid WF, or if no signal was found for either set of parameters.
Preliminary Uncorrected Range Offset (land)	i_stdRngOff1	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing farthest from the spacecraft for land parameters

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Preliminary Uncorrected Range Offset (other than land)	i_stdRngOff2	ns	0.01	Offset to be added to the reference range to give the location of the threshold crossing farthest from the spacecraft for ice sheet, sea ice and ocean parameters
Area Under Transmitted Pulse	i_areaTrWF		0.01	Area under the transmitted pulse calculated from 32 gates telemetered
Centroid of Transmitted Pulse	i_locTr	ns	0.01	Time from beginning of digitizer in ns to centroid of transmitted pulse calculated from 32 gates telemetered
Amplitude, Peak Location, and Sigma of Transmitted Pulse	i_parmTr	counts, ns,ns	0.01	Parameters from Gaussian fit to transmitted pulse: item1=amplitude (counts), Item2=peak location (ns), and item 3=sigma (ns).
Skewness of Transmitted Pulse	i_skewTr		1.0d-2	Skewness of transmitted pulse
Centroid of Received Pulse	i_centroid	ns	0.01	Offset to be added to the reference range to give the location of the centroid of the received waveform from signal begin through signal end for land parameters.
Spares	i_Spare3			
Area of Signal Return (land)	i_areaRecWF1	N/A	1	Area of the signal return from the received Waveform.from signal begin to signal end for land parameters
Area of Signal Return (other than land)	i_areaRecWF2	N/A	1	Area of the signal return from the received Waveform.from signal begin to signal end for ice sheet, sea ice, and ocean parameters
Chi Square (land)	i_wfFitSDev_1	N/A	0.01	Chi Square of the received waveform to the waveform fit using land parameters

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Chi Square (other than land)	i_wfFitSDev_2	N/A	0.01	Chi Square of the received waveform to the waveform fit using the ice sheet, ocean, and sea ice parameters
Max Amplitude of Received Waveform	i_maxRecAmp	N/A	0.01	Maximum Amplitude of the Received Waveform.
Max Amplitude of Smoothed Waveform	i_maxSmAmp	N/A	0.01	The maximum amplitude of the smoothed received waveform.
Percent of Saturated Signal From Received WF	i_pcntSat	N/A	0.01	Percent of Saturated Signal above noise level in the received Waveform.
Skewness of Received WF (land)	i_skew1	N/A	0.01	Skewness of the received waveform from signal begin to signal end using land parameters
Kurtosis of Received WF (land)	i_kurt1	N/A	0.01	Kurtosis of the received waveform from signal begin to signal end using land parameters
Skewness of Received WF (other than land)	i_skew2	N/A	0.01	Skewness of the received waveform from signal begin to signal end using ice sheet, sea ice, and ocean parameters
Kurtosis of Received WF (other than land)	i_kurt2	N/A	0.01	Kurtosis of the received waveform from signal begin to signal end using ice sheet, sea ice, and ocean parameters
Sigmas of fit parameters (land)	i_solnSigmas1	same units as corresponding parameters	0.01	standard deviation of each fit parameter from diagonal of final covariance matrix from land parameterization

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Sigmas of Fit Parameters (other than land)	i_solnSigmas2	same units as corre-sponding parameters	0.01	standard deviation of each fit parameter from diagonal of final covariance matrix from ice sheet, sea ice, and ocean parameterization
WF Parameters from fit (land)	i_parm1	N/A	0.01	Parameters (in physical units) determined from the fit of the waveform data.using the land parameterization. In the order of: item1=noise, then 6 sets of Gaussian parameters (subitem1=amplitude (counts), subitem2=peak location (ns), and subitem3=sigma (ns)). Centroid locations are referenced to the reference range.
WF Parameters from fit (other than land)	i_parm2	N/A	0.01	Parameters (in physical units) determined from the fit of the waveform data.using the ice sheet, sea ice, and ocean parameterization. In the order of : item1=noise, then 6 sets of Gaussian parameters (subitem1=amplitude (counts), subitem2=peak location (ns), and subitem3=sigma (ns)). Centroid locations are referenced to the reference range
Gain Value of Transmitted Pulse	i_gval_tx	counts	1	Gain value of transmitted pulse
Gain Value of Received Pulse	i_gval_rcv	counts	1	Gain value of received pulse
Maximum Amp of Transmitted Pulse	i_maxTrAmp	counts	0.01	Maximum amplitude of transmitted pulse calculated from 32 gates teleme-tered
Spares	i_Spare4			
Initial Number of Peaks of the Smooth WF (land)	i_nPeaks1	N/A	1	The initial number of peaks; determined from the smoothed waveform, using land parameters

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Initial Number of Peaks of the Smooth WF (other than land)	i_nPeaks2	N/A	1	The initial number of peaks; determined from the smoothed waveform, using ice sheet, sea ice, and ocean parameters
Rank of WF Significant Peaks (land)	i_rank1	N/A	1	The rank of each peak of the fit to the waveform using land parameters.
Rank of WF Significant Peaks (other than land)	i_rank2	N/A	1	The rank of each peak of the fit to the waveform using ice sheet, sea ice, and ocean parameters.
1064 nm Background Signal	i_wfnoiseOb		1.0d-2	The background noise value used to calculate threshold crossings. Either The 1064 nm background signal or noise energy level sampled in the waveform digitizer noise bins as counts, including solar background, optical, and thermal noise or the background noise calculated from the received waveform for other-than-land parameters.
Saturation Flag (land)	i_satFlag1	N/A	1	Saturation flag from land parameterization : values are as follows– 0 – no saturation found in received signal; 1-saturation found but ignored for processing, 2- significant saturation found, not processed, 3 – significant saturation found waveform processed using special algorithm. Flags are 2 bits each at 40/second.
Saturation Flag (other than land)	i_satFlag2	N/A	1	Saturation flag from ice sheet, sea ice, and ocean parameterization: values are as follows – 0 – no saturation found in received signal; 1-saturation found but ignored for processing, 2- significant saturation found, not processed, 3 – significant saturation found waveform processed using special algorithm. Flags are 2 bits each at 40/second.
WF Fit Success Flag MaxIter(land)	i_fit_maxiter1	N/A	1	Flags indicating success of received waveform fit from land parameterization; 0=success, 1=indicating maximum number of iterations exceeded – fit ended without meeting convergence criteria. Flags are 1 bits each at 40/second

Table C-4 GLA05: 07/10/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
WF Fit Success Flag NoGo(land)	i_fit_nogo1	N/A	1	Flags indicating success of received waveform fit from land parameterization; 0 = success, 1= fit was totally unsuccessful – numerical instabilities occurred. Flags are 1 bit each at 40/second
WF Fit Success Flag MaxIter(other than land)	i_fit_maxiter2	N/A	1	Flags indicating success of received waveform fit from other than land parameterization; 0=success, 1=indicating maximum number of iterations exceeded – fit ended without meeting convergence criteria. Flags are 1 bits each at 40/second
WF Fit Success Flag NoGo(other than land)	i_fit_nogo2	N/A	1	Flags indicating success of received waveform fit from other than land parameterization; 0 = success, 1= fit was totally unsuccessful – numerical instabilities occurred. Flags are 1 bit each at 40/second
Spares	i_Spare5			

C.5 GLA06

Table C-5 GLA06: 09/06/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Record Index	i_rec_ndx	N/A		Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Laser Pulse	i_UTCTime	sec micro-seconds	1.0, 1.0E-6	The UTC time tag of the fire acknowledge of the first laser pulse in the 1-second data frame, referenced from J2000. Item 1 is the number of seconds; item 2 is the number of microseconds.
One Way Transit Time	i_transtime	microsec	1.00E-06	One way transit time calculated using the preliminary range offset, used to calculate orbit.
Laser Shot TIme Deltas, Shots 2-40	i_dShotTime	microsec	1.00E-06	The time deltas of the 39 laser pulses to the UTC time tag of the first pulse in the 1-second data frame, corrected for system and transit delay.
Spot 1 Coordinate Data, Latitude Corrected	i_lat	microdeg	1.00E-06	The coordinates of the first laser spot in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna coordinates, PAD, and range to the centroid of the last peak from the ice sheet fitting procedure after atmospheric delays and tides have been applied. The coordinates are east longitude and geodetic latitude.
Spot 1 Coordinate Data, Longitude Corrected	i_lon	microdeg	1.00E-06	The coordinates of the first laser spot in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna coordinates, PAD, and range to the centroid of the last peak from the ice sheet fitting procedure after atmospheric delays and tides have been applied. The coordinates are east longitude and geodetic latitude.
Surface Elevation	i_elev	mm	1/1000	Surface elevation wrt ellipsoid at the spot location determined by range to the centroid of the last peak from the ice sheet fitting procedure after atmospheric delays and tides have been applied.

Table C-5 GLA06: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
PAD Pointing Vector	i_PADPoint	N/A	1.00D-6, 1.00D-12	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ICRF reference frame (deviations from nadir) of the laser. Each component is composed of 2 4-byte items. This also includes the effect of the pole tide.
POD Fixed Position Vector	i_PODFixedPos	mm	1.0, 0.001	Time-ordered spacecraft position vector in ICRF x, y, z. Each element is composed of 2 4-byte items. This is the nadir ground location of the laser antenna on the spacecraft.
POD/PAD Quality Flag	i_PODPADQF	N/A		POD/PAD Quality Flag, 1st 40 bits describe the POD quality, 2nd 40 bits describe the PAD quality; one bit per shot
spares	i_Spare1	N/A		
Local Azimuth	i_Azimuth	millideg	0.001	Azimuth of the ground track.
Solar Incidence Angle	i_SolAng	millideg	0.001	The solar incidence angle determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Orientation of Pulse	i_PulsOrient	millideg	0.001	Rotation clock angle of the major axis of the footprint; referenced to the ground track path.
Semi-major axis of footprint	i_sMajAxFtPrn	cm	0.01	Semi-major axis of the footprint as measured by the LPA
Semi-minor axis of footprint	i_sMinAxFtPrn	cm	0.01	Semi-minor axis of the footprint as measured by the LPA
Geoid	i_gdHt	cm	0.01	The height of the geoid above the ellipsoid.
Solid Earth Tide Elevation	i_erElv	mm	0.001	The solid earth tide elevation
Tide Elevations, Specific	i_spElv	mm	0.001	Alternate tide models for specific regions

Table C-5 GLA06: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Load Tide Elevation	i_ldElv	mm	0.001	The load tide elevation
Ocean Tide Elevation	i_ocElv	mm	0.001	The ocean tide elevation
Range Correction, Wet Troposphere	i_wTrop	mm	0.001	Atmospheric wet tropospheric delay correction added to the elevation
Range Correction, Dry Troposphere	i_dTrop	mm	0.001	Atmospheric dry tropospheric delay correction added to the elevation
Elevation Corrections Quality Flag	i_ElvCor_QF	N/A		Flag indicating quality of the elevation corrections. 2 bits allocated to each : earth, load, and ocean tides; and wet and dry tropospheric range corrections. 10 bits total, 6 bits spare.
spares	i_Spare2	N/A		
Atmosphere Flag	i_atmQF	N/A		8 bits/measurement indicating presence of cloud layers and some measure of optical depth
Surface Type	i_surfType	N/A		Describes the surface type or types associated with each shot Inland Water, Glacier, Ice Sheet, ocean, sea ice, Unvegetated Land, Urban, or Vegetated Land.
Meteorological Data Quality Flag	i_metFlg	N/A		Flag indicating quality and source of the meteorological data.
spares	i_Spare3	N/A		
DEM Elevation	i_DEM_elv	cm	0.01	Elevation with respect to sea level as interpolated from a Digital Elevation Map (DEM) at each laser pulse location
Reference Range	i_refRng	mm	0.001	Range calculated from the time between the peak of the transmit pulse and the farthest gate from the spacecraft of the received pulse.

Table C-5 GLA06: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Threshold Retracker Range Increment	i_TrshRngOff	mm	0.001	Range increment from reference range to threshold retracker range
Signal Begin Range Increment	i_SigBegOff	mm	0.001	Range increment to be added to reference range to calculate range to signal begin as computed in ground processing
Signal End Range Increment	i_SigEndOff	mm	0.001	Range increment to be added to reference range to signal end as computed in ground processing
Ice Sheet Range Increment	i_isRngOff	mm	0.001	Range increment to be added to reference range to calculate ice sheet specific range
Sea Ice Range Increment	i_siRngOff	mm	0.001	Range increment to be added to reference range to calculate sea ice specific range
Land Range Increment	i_ldRngOff	mm	0.001	Range increment from reference range to calculate land specific range
Ocean Range Increment	i_ocRngOff	mm	0.001	Range increment from reference range to ocean specific range
Centroid Range Increment	i_cntRngOff	mm	0.001	Range increment from reference range to centroid of raw waveform calculated only using gates from signal begin to signal end
Reflectance	i_refl	N/A	1.0d-06	Ratio of the corrected received to the transmitted laser pulse energy, as a measure of the surface reflectance with all corrections applied.
Reflectance Correction, Laser Pointing	i_reflCorLasPt	N/A		Per-pulse energy correction applied to the surface reflectivity value, based on the laser pointing angle at each pulse.
Reflectance Correction, Solar Angle	i_reflCor_SAng	N/A		Solar radiance optical noise contribution correction factor, applied to the 1-second surface reflectivity group.

Table C-5 GLA06: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Reflectance Correction, Atmosphere	i_reflCor_atm	N/A		Atmospheric delay correction factor applied to the surface reflectivity
spares	i_Spare4	N/A		
Peak Amplitude of Smooth WF	i_maxSmAmp	counts	0.01	The peak amplitude from the smoothed waveform.
Sigma of Elevation	i_SigmaElv	mm	0.001	Elevation error estimates, the error from the Gaussian fit associated with the centroid of the last peak
Elevation Quality	i_ElvFlg	N/A		Quality indicator for the elevation. One flag per shot; indicates quality based on good vs. bad criteria.
	i_Spare5			
Goodness of Fit, Roughness	i_gof_ruf	cm	0.01	The error associated with the sigma estimates of the Gaussian for single peaks
Surface Roughness	i_srf_ruf	cm	0.01	The surface roughness over the footprint calculated empirically from the transmitted and received waveforms assuming no slope .
Surface Slope	i_srf_slope	mdeg	1.00E-03	The surface slope over the footprint calculated empirically from the transmitted and received waveforms assuming no roughness
Surface Roughness Quality Flag	i_SurfRufQF	N/A		Per-shot data quality flags for the ice sheet and sea ice surface roughness; indicates quality based on good vs. bad criteria. Bytes 1-20 are ice sheet flags, bytes 21-40 are sea ice flags.
Number of Peaks from Waveform Fit	i_numPk	N/A		The number of peaks in the waveform produced by the Gaussian filtering (from Land), calculated from the number of WF parameters output on GLA05 (up to 6).

Table C-5 GLA06: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Initial Number of Peaks of the Smooth Waveform (land)	i_nPeaks1	N/A		The number of peaks; determined from the smoothed waveform, using land parameters.
Range Increment Quality/Use Flag	i_rng_UQF	N/A		Data quality flag for the range increment group; allows 1 bit per measurement; bit indicates quality based on good vs. bad criteria
spares	i_Spare6			

C.6 GLA07

Table C-6 GLA07: 06/16/2000

Element Name	Product Variable Name	Units	Scale Factor	Description
Backscatter Record Index	i_rec_ndx	n/a	n/a	Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Sample - Seconds	i_UTCTime	sec micro-seconds	(/ 1.0D0, 1.0D-6 /)	The time tag of the first data sample in this record, corrected for system and transit delay, in CCSDS day segmented binary form.
PAD Pointing Vector	i_PADPoint		(/ 1.0D-6, 1.0D-12/)	The controlled pointing vector as determined from the Precision Attitude data. For each item in the vector there are 2 4-byte values.
Profile Coordinate, Latitude	i_lat	Microdegrees	1.0D-6	Profile coordinate in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Profile Coordinate, Longitude	i_lon	Microdegrees	1.0D-6	Profile coordinate in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Profile Coordinate, Elevation	i_elev	Millimeters	0.001_8	Profile coordinate in the IERS Terrestrial Reference Frame: elevation, at the 1 herz rate.
POD & PAD orbit quality flag	i_PODPADqf			POD orbit quality flag
Spares	i_Spare1			
Solar Angle	i_SolAng	Microdegrees	1.0D-6	The solar incidence angle id determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Surface elevation - peak of return	i_SrfEl_PkRt	Millimeters	0.001_8	The surface elevation based on the peak of the ground return. This is from the altimeter channel
Surface elevation - threshold of return	i_SrfEl_ThRt	Millimeters	0.001_8	Surface elevation based on the threshold of the ground return. Altimeter channel.

Table C-6 GLA07: 06/16/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factor	Description
Threshold Crossing	i_thres_xing	bin number	1.0d0	The threshold crossings of the last peak of the 1064 nm altimeter waveform, estimate of the range to surface. Computed from the offset of the peak time of the last sample.
Start Range of Backscatter Profile	i_Rng2Prof		0.001_8	The start range above mean sea level of the backscatter vertical profile.
532 nm Background	i40_g_bg	photons/bin	1.0d0	532 nm radiant energy reflected by the surface/atmosphere in the direction of the instrument receiver, group of 40 per 1 second.
532 nm Background	i5_g_bg		1.0D0	532 nm radiant energy reflected by the surface/atmosphere in the direction of the instrument receiver, group of 5 per 1 second.
532 nm Background	i1_g_bg		1.0D0	532 nm radiant energy reflected by the surface/atmosphere in the direction of the instrument receiver, 1 per 1 second.
1064 nm Background	i40_ir_bg	photons/bin	1.0D0	1064 nm radiant energy reflected by the surface/atmosphere in the direction of the instrument receiver, group of 40 per 1 second.
1064 nm Background	i5_ir_bg		1.0D0	1064 nm radiant energy reflected by the surface/atmosphere in the direction of the instrument receiver, group of 5 per 1 second.
532 nm laser transmitted energy quality flag	i_g_TxNrg_qf	n/a	n/a	532 laser energy quality flag, group of 40 per 1 second
1064 nm laser transmitted energy quality flag	i_ir_TxNrg_qf	n/a	n/a	1064 laser energy quality flag, group of 40 per 1 second
DEM value used by atmosphere processes	i1_atm_dem		1.0D0	DEM value used for vertical alignment of profiles at 1 per second

Table C-6 GLA07: 06/16/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factor	Description
532 nm Backscatter Calibration Coefficient	i_g_cal_cof	(Ph/usec)(km^3/J)sr	1.0d9	The calibration value applied to the 532 nm lidar data to get the backscatter (1=high cal ht, 2=low cal ht, 3=used).
1064 nm Backscatter Calibration Coefficient	i_ir_cal_cof	(Volts)(km^3/J)sr	1.0d9	The calibration value applied to the 1064 nm lidar data to get the backscatter (1=low cal ht, 2=used).
532 nm Merged Attenuated Backscatter Profile 10 to -1 km	i40_g_bscs	e10/(m-sr)	1.0D-11	For the 10 KM to -1 KM vertical segment, the atmosphere 532 nm calibrated, attenuated backscatter profile at the 40 per 1 second rate. When the 532 nm data becomes saturated the 1064 nm data is converted to 532 data and merged into the data set. Bit 0 indicates whether the 532 data was saturated and therefore the value is converted from the 1064 data. The user must modulo the value by 2 to determine saturation.
532 nm Merged Attenuated Backscatter Profile 40 to -1 km	i5_g_bscs	e10/(m-sr)	1.0D-11	For the full vertical atmospheric profile (-1 to 41 km), the atmosphere 532 nm calibrated, attenuated backscatter profile at the rate of 5 per 1 second. When the 532 nm data becomes saturated the 1064 nm data is converted and merged into the data set. The Level 1A data that occurs at 40/second, every 8 shots are averaged and stored in the profile and the 1/second is replicated to get the full 5 Hz rate on this product. Bit 0 indicates whether the 532 data was saturated and therefore the value is converted from the 1064 data. The user must modulo the value by 2 to determine saturation.
1064 nm Merged Attenuated Backscatter Profile 10 to -1 km	i40_ir_bscs	e10/(m-sr)	1.0D-11	Atmosphere 1064 nm calibrated, attenuated backscatter profile (-1 to 10 km) at the rate of 40 per 1 second.
1064 nm Merged Attenuated Backscatter Profile 20 to -1 km	i5_ir_bscs	e10/(m-sr)	1.0D-11	Atmosphere 1064 nm calibrated, attenuated backscatter profile (-1 to 20 km) at the rate of 5 per 1 second. Averages of 8 shots are used for the Level 1A data that occurs at 40/second rate.

Table C-6 GLA07: 06/16/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factor	Description
532 nm molecular backscatter cross section profile 40 to -1 km	i_g_mbscs	e10/(m-sr)	1.0D-9	532 nm molecular backscatter profile computed from MET data interpolated in space and time to profile location.
1064 nm molecular backscatter cross section profile 20 to -1 km	i_ir_mbscs	e11/(m-sr)	1.0D-10	1064 nm molecular backscatter profile computed from MET data interpolated in space and time to profile location.
532 nm integrated return from 30 to 20 km	i1_int_ret	e11/(m-sr)	1.0D-11	The integrated or summed 532 attenuated backscatter profile from 30 to 20 km. When normalized by the sum of the molecular backscatter for the same interval, gives an indication of data quality
Met/std atm source/quality flag	i_metFlg	NA	NA	Flag indicating if met data or standard atmosphere data are used to fill met profiles. Flag is set to 1 if time of first file > 24 hrs, 2 if time of second file > 24 hrs, 2+index of standard atmosphere file if time of both files > 24 hrs.
Spares	i_Spare2			
532 nm Attenuated Backscatter Vertical Profile Flag contains:	i_532AttBS_Flag			532 nm Attenuated Backscatter Vertical Profile Flag
532 nm calibration coefficient quality flag	i_g_cal_qf	NA	NA	532 nm calibration coefficient quality flag. Set to 1 for time gaps or if large percentage of records are bad. Set to 2 if excessive percentage of records are bad or if large percentage of records are cloudy. If flag=2 use last valid calibration coefficients.
532 nm calibration coefficient day/night flag	i_g_cal_dnf	NA	NA	Day/night flag based on average 532 nm background over calibration period. (-1=night, 0=indeterminate, 1=day).

Table C-6 GLA07: 06/16/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factor	Description
532 nm backscatter cross section quality flag for 5 Hz profile	i1_g_bscs_qf	NA	NA	532 nm data quality flag at 1 sec. Set to 1 if 532 nm integrated return is bad or if ratio of integrated return to molecular integrated return is bad.
532 nm backscatter cross section quality flag for 5 Hz profile	i5_g_bscs_df	NA	NA	532 nm data quality flag at 5 Hz. Set to 1 if 532 nm laser energy flag = 3. Set to 2 if 1064 nm quality flag = 1 and 1064 nm backscatter value replaced 532 nm backscatter value.
Spares	i_BSpares1	NA	NA	
532 nm backscatter cross section use flag for 5 Hz profile	i5_g_bscs_uf	NA	NA	
532 nm backscatter cross section quality flag for 40 Hz profile	i40_g_bscs_qf	NA	NA	532 nm data quality flag at 40 Hz. Set to 1 if 532 nm laser energy flag = 3. Set to 2 if 1064 nm quality flag = 1 and 1064 nm backscatter value replaced 532 nm backscatter value.
532 nm backscatter cross section use flag for 40 Hz profile	i40_g_bscs_uf	NA	NA	
1064 nm Attenuated Backscatter Vertical Profile Flag	i_1064AttBS_Flag			
1064 nm calibration coefficient quality flag	i1_ir_cal_qf	NA	NA	1064 nm calibration coefficient quality flag. Set to 1 for time gaps or if large percentage of records are bad. Set to 2 if excessive percentage of records are bad or if large percentage of records are cloudy. If flag=2 use last valid calibration coefficients.

Table C-6 GLA07: 06/16/2000 (Continued)

Element Name	Product Variable Name	Units	Scale Factor	Description
Spares	i_BSpare2	NA	NA	
1064 nm backscatter cross section quality flag for 5 Hz profile	i5_ir_bscs_qf	NA	NA	1064 nm data quality flag at 5 Hz. Set to 1 if 1064 nm laser energy flag = 3.
Spares	i_BSpare3	NA	NA	
1064 nm backscatter cross section use flag for 5 Hz profile	i5_ir_bscs_uf	NA	NA	
1064 nm backscatter cross section quality flag for 40 Hz profile	i40_ir_bscs_qf	NA	NA	1064 nm data quality flag at 40 Hz. Set to 1 if 1064 nm laser energy flag = 3.
1064 nm backscatter cross section use flag for 40 Hz profile	i40_ir_bscs_uf	NA	NA	

Appendix D
Level 1 Data Products
Flag Formats

D.1 GLA01

i_DEM_flag [GLA01, 02]: Flag indicating how DEM grid number was selected -- GPS, spacecraft data or uplink used.

Byte 1							
7							0

Figure D-1 i_DEM_flag

D.2 GLA02

i1_g_lid_qf [GLA02]: 532 nm LIDAR Data Quality Flag - 2 bits per shot

Byte 1							
7							0
shot 40		shot 39		shot 38		shot 37	

— — — — — — — — — — — — — — — —

(shots 40 - 1)

Byte 10							
7							0
shot 4		shot 3		shot 2		shot 1	

Figure D-2 i1_g_lid_qf

i1_g_lid_uf [GLA02]: 1 bit use flag for 532 nm LIDAR

1-bit flags, 40/second

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9

(shots 40-9)

Byte 5							
7							0
8	7	6	5	4	3	2	1

(shots 8-1)

Figure D-3 i1_g_lid_uf

i1_g_sat_f [GLA02]: Bit flag indicating whether the 532 nm signal is saturated or not for the 40 to 20 KM Segment. 1 bit per each sum of 40 shots per bin (268); 0 = not saturated, 1 = saturated.

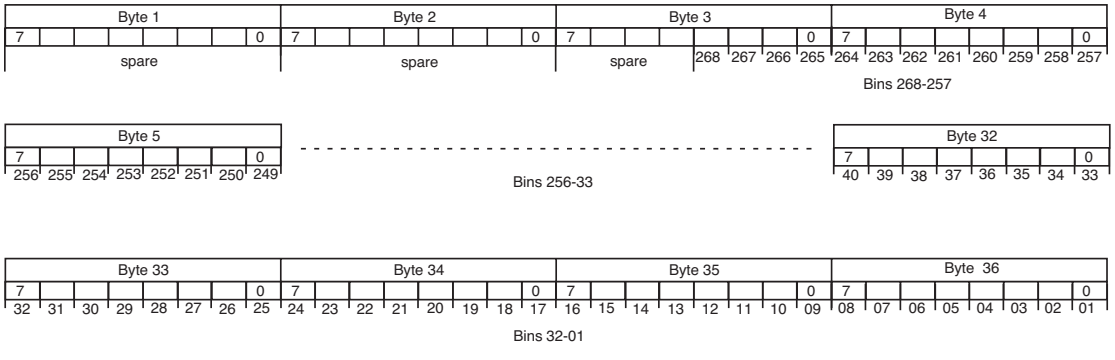

Figure D-4 i1_g_sat_f

i1_ir_lid_qf [GLA02]: 1064 nm LIDAR Data Quality Flag - 2 bits per shot.

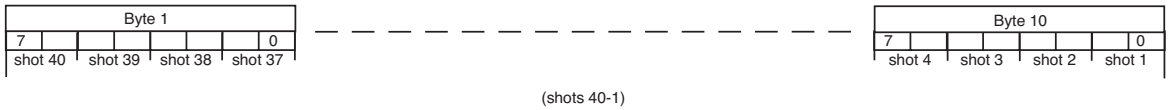

Figure D-5 i1_ir_lid_qf

i1_ir_lid_uf [GLA02]: 1 bit use flag for 1064 nm LIDAR
1-bit flags, 40/second

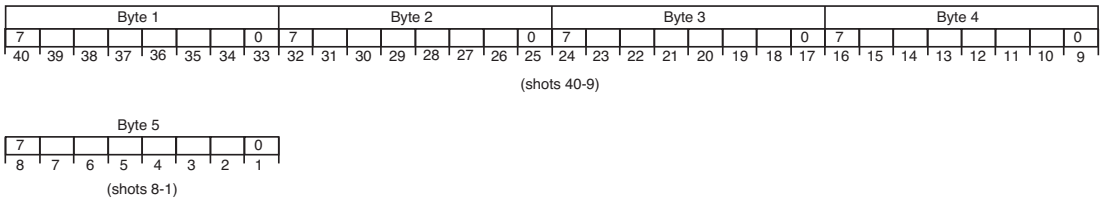

Figure D-6 i1_ir_lid_uf

i40_g_lid_ef [GLA02]: 532 LIDAR Data Error Flag: The error flag returned in the photon counter (aerosol) telemetry data.
1 byte measurement at 40/second.

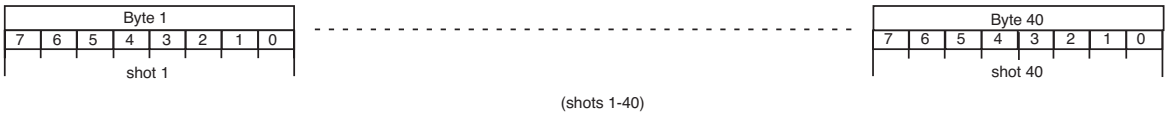

Figure D-7 i40_g_lid_ef

i40_g_sat_f [GLA02]: Bit flag indicating whether the 532 nm signal is saturated or not for the 10 to -1 KM Segment.
1 bit per each shot(40) per bin (148); 0 = not saturated, 1 = saturated.

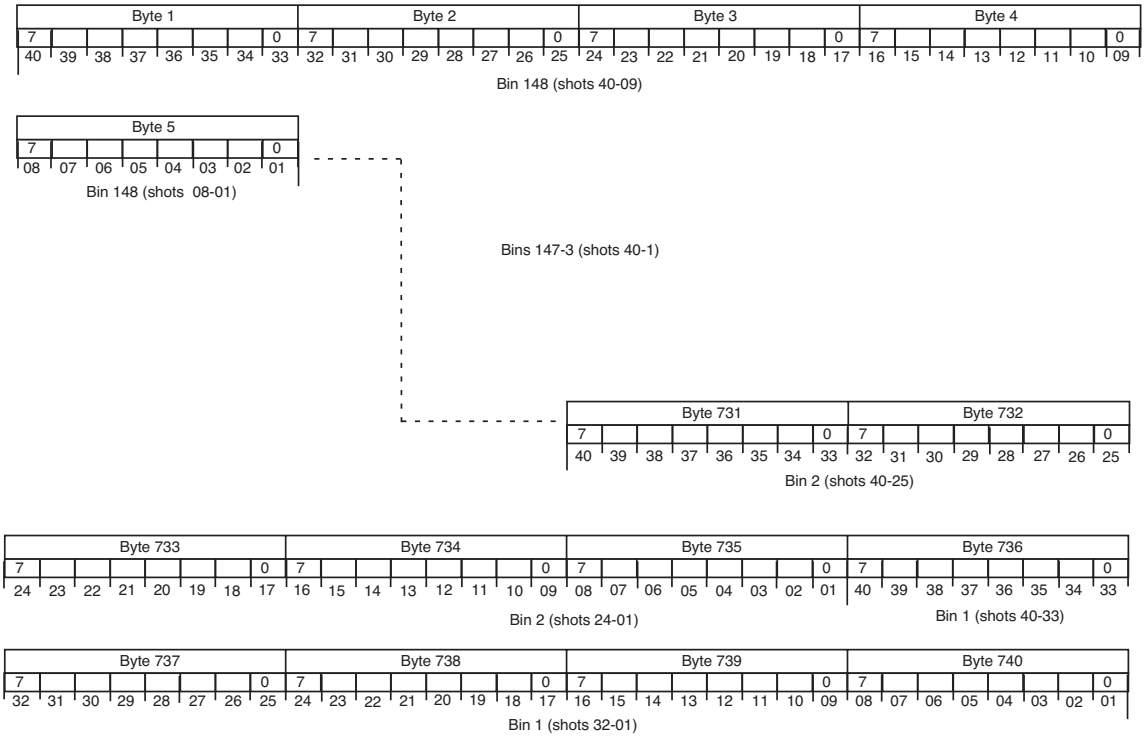

Figure D-8 i40_g_sat_f

i5_g_sat_f [GLA02]: Bit flag indicating whether the 532 nm signal is saturated or not for the 20 to 10 KM Segment.
1 bit per each sum of 8 shot(40) per bin (132); 0 = not saturated, 1 = saturated.

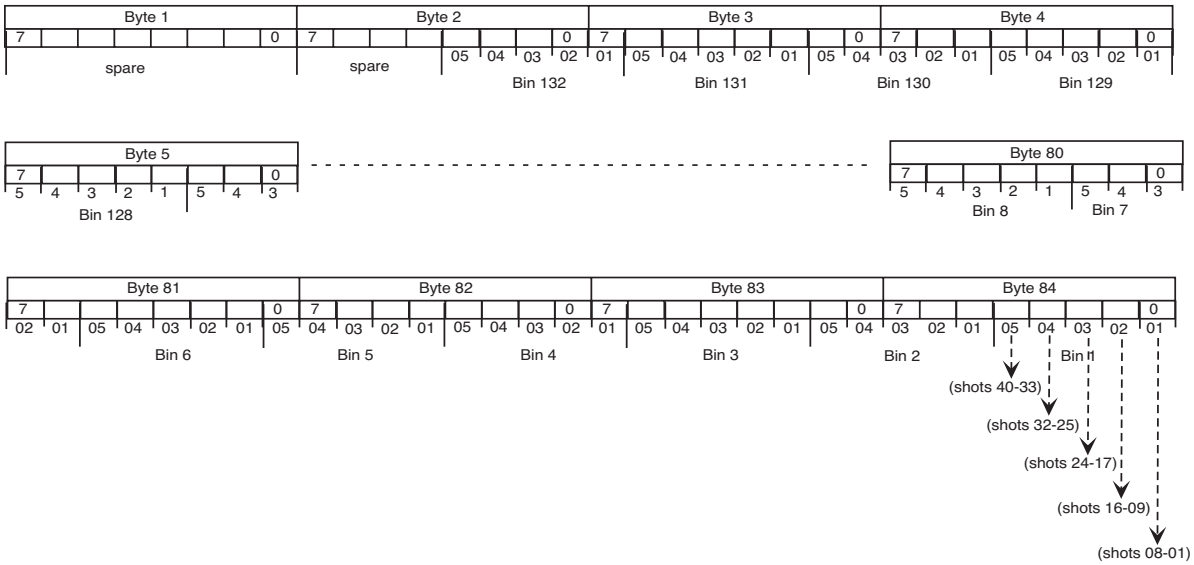

Figure D-9 i5_g_sat_f

i_DEM_flag [GLA01, 02]: Flag indicating how DEM grid number was selected -- GPS, spacecraft data or uplink used.

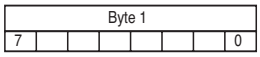

Figure D-10 i_DEM_flag

i_g_TxNrg_qf [GLA02 & 07]: 532 nm Laser Transmitted Energy Quality Flag

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37					36	35	34	33					32	31	30	29					28	27	26	25				

(shots 40 - 25)

Byte 5								Byte 6								Byte 7								Byte 8							
7							0	7							0	7							0	7							0
24	23	22	21					20	19	18	17					16	15	14	13					12	11	10	09				

(shots 24 - 9)

Byte 9								Byte 10							
7							0	7							0
8	7	6	5					4	3	2	1				

(shots 8 - 1)

Figure D-11 i_g_TxNrg_qf

i_ir_IntRet_qf [GLA02]: Assessment of the integrated return value; indicator of boresight accuracy and signal strength.
0 = unused, 1 = excellent, 2 = good, 3 = marginal, 4 = poor, 5 = bad data.

Byte 1							
7	6	5	4	3	2	1	0
spares				i_ir_IntRet_qf			

Figure D-12 i_ir_IntRet_qf

i_ir_TxNrg_qf [GLA02, 07]: 1064 nm Laser Transmitted Energy Quality Flag

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37					36	35	34	33					32	31	30	29					28	27	26	25				

(shots 40 - 25)

Byte 5								Byte 6								Byte 7								Byte 8							
7							0	7							0	7							0	7							0
24	23	22	21					20	19	18	17					16	15	14	13					12	11	10	09				

(shots 24 - 9)

Byte 9								Byte 10							
7							0	7							0
8	7	6	5					4	3	2	1				

(shots 8 - 1)

Figure D-13 i_ir_TxNrg_qf

D.3 GLA03

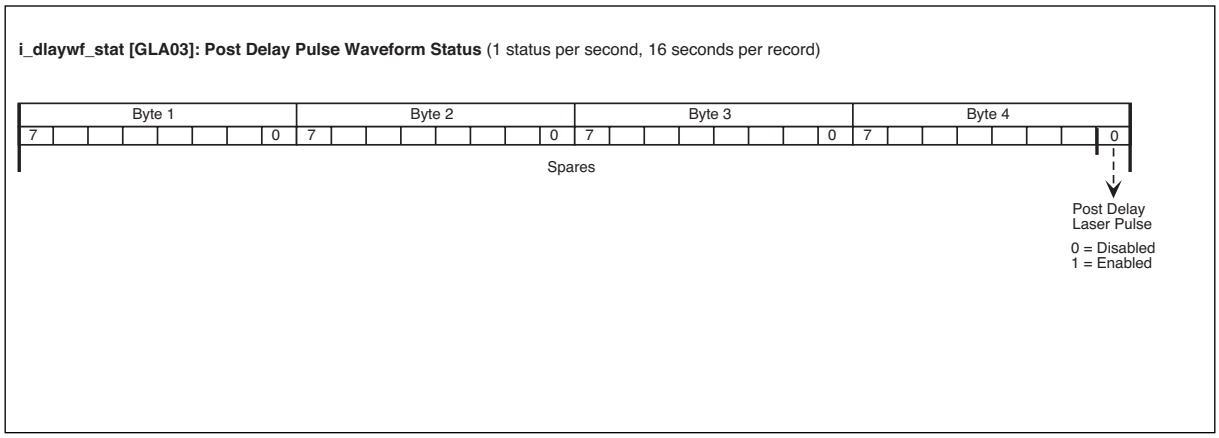

Figure D-14 i_dlaywf_stat

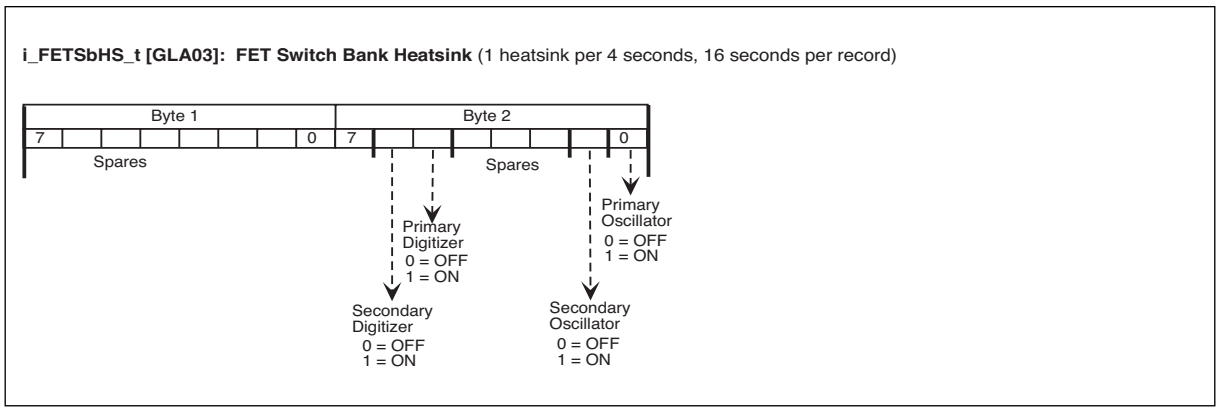

Figure D-15 i_FETSbHS_t

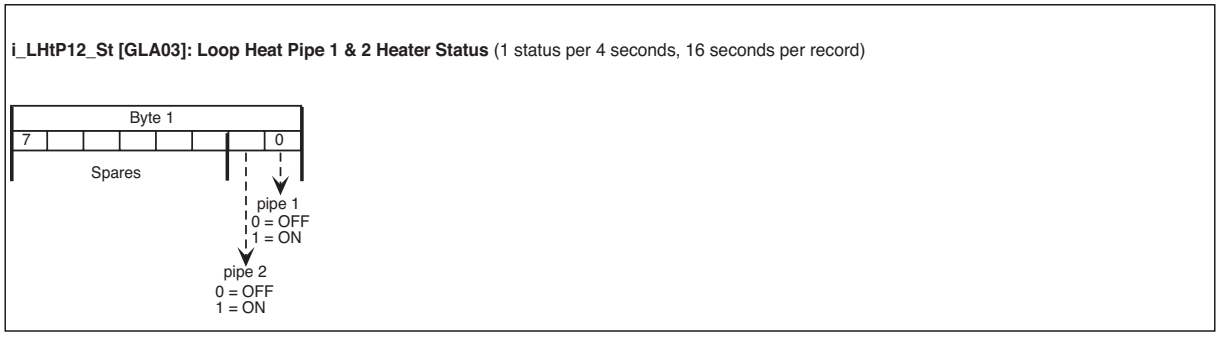

Figure D-16 i_LHtP12_St

i_OptSenSt [GLA03]: Optical Sensor Status (1 status per 4 seconds, 16 seconds per record)

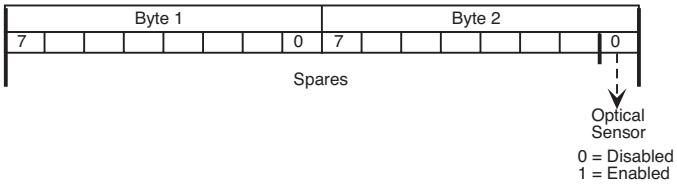

Figure D-17 i_OpSenSt

i_otswf_stat [GLA03]: OTS Pulse Waveform Status (1 status per second, 16 seconds per record)

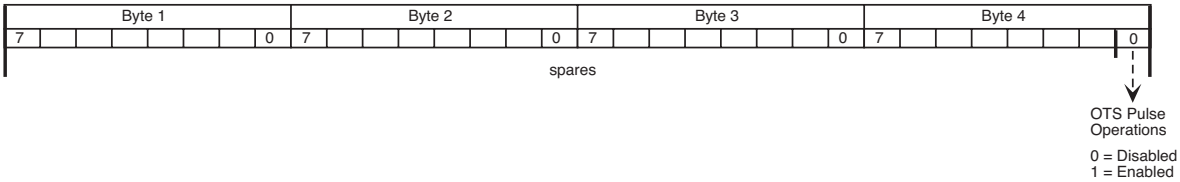

Figure D-18 i_otswf_stat

i_Register Flags [GLA03]: Register Flags (1 register per 4 seconds, 16 seconds per record)

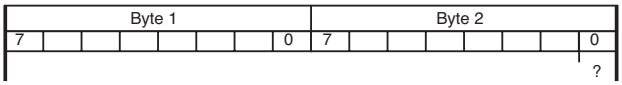

Figure D-19 i_Register Flags

D.4 GLA05

iBadFrame_flag [GLA05]: Flag indicating whether all data in the record is bad. Set if either no peaks found or no signal found.

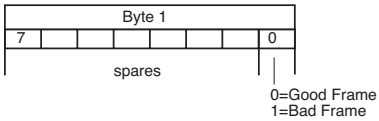

Figure D-20 iBadFrame_flag

i_fit_maxiter [GLA05]: WF Fit Success Flags MaxIter (land and other than land)
1-bit flags, 40/second.

0=success
1=indicating maximum number of iterations exceeded – fit ended without meeting convergence criteria

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09

shots 09-40

Byte 5							
7							0
08	07	06	05	04	03	02	01

shots 01-08

Figure D-21 i_fit_maxiter

i_fit_nogo [GLA05]: WF Fit Success Flags NoGo (land and other than land)
1-bit flags, 40/second, GLA05Flags indicating success of received waveform fit from land parameterization

0=success,
1=fit was totally unsuccessful – numerical instabilities occurred.

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09

shots 09-40

Byte 5							
7							0
08	07	06	05	04	03	02	01

shots 01-08

Figure D-22 i_fit_nogo

i_obErr [GLA05]: onboard Error Flags, not yet fully defined.

2 byte set of 1-bit flags, 40/second.

Byte 1								Byte 2								Byte 3							
7							0	7							0	7							0
tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd								

Shot 1 Shot 2

Byte 78								Byte 79								Byte 80							
7							0	7							0	7							0

Shot 39 Shot 40

Figure D-23 i_obErr

i_PODPADQF [GLA05, 12-15]: PODPAD Quality Flag

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	09
iPODFlg(09-40)																															

Byte 5								Byte 6								Byte 7								Byte 8							
7							0	7							0	7							0	7							0
08	07	06	05	04	03	02	01	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
iPODFlg(01-08)								iPADFlg(17-40)																							

Byte 9								Byte 10							
7							0	7							0
16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
iPADFlg(01-16)															

Figure D-24 i_PODPADQF

i_satFlag [GLA05]: Waveform Saturation Flags

Set of 2-bit flags at 40/second

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
shot40	shot39	shot38	shot37	shot36	shot35	shot34	shot33	shot32	shot31	shot30	shot29	shot28	shot27	shot26	shot25

Values for each 2 bit item are as follows:
0=no saturation found in received signal
1=saturation found but ignored for processing
2=significant saturation found waveform not processed
3=significant saturation found waveform processed using special algorithm.

Byte 07								Byte 08								Byte 09								Byte 10							
7							0	7							0	7							0	7							0
shot16	shot15	shot14	shot13	shot12	shot11	shot10	shot09	shot08	shot07	shot06	shot05	shot04	shot03	shot02	shot01

Figure D-25 i_satFlag

i_surfType [GLA05, 06, 12-15]: 40/second Surface Type Flag

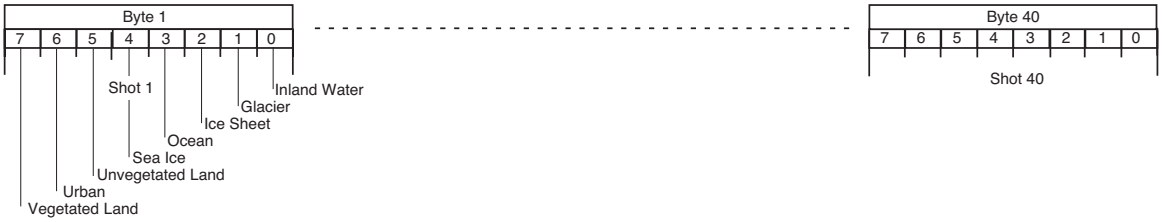

Figure D-26 i_surfType

i_WF_qual [GLA05]: Waveform assessment quality flags, not yet fully defined.

4 byte set of flags, 40/second.

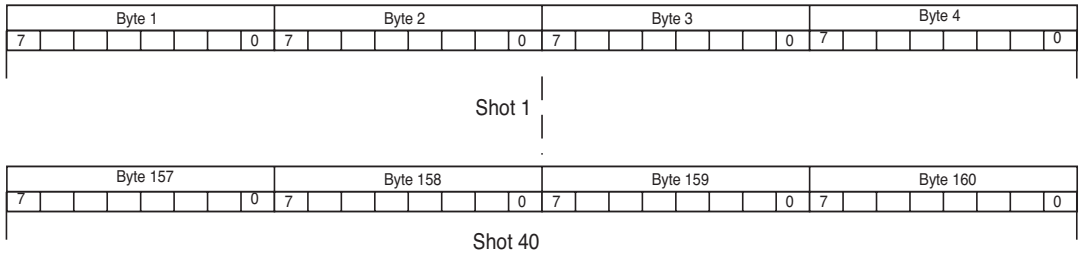

Figure D-27 i_WF_qual

D.5 GLA06

i_metFlg [GLA06, 07, 12-15]: Meteorological Data Quality Flag - Flag indicating quality and source of the meteorological data.
One packed byte

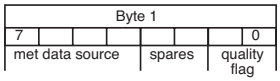

Figure D-28 i_metFlg

i_atmQF [GLA06, 12-15]: Atmosphere Quality Flag
This flag is not yet well understood.

Figure D-29 i_atmQF

i_ElvCor_QF [GLA06, 12-15]: Flag indicating quality of the elevation corrections. 2 bits allocated to each : earth, load, and ocean tides; and wet and dry tropospheric range corrections. 10 bits total, 6 bits spare.

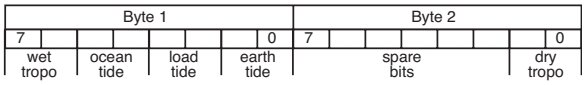

Figure D-30 i_ElvCor_QF

i_ElvFlg [GLA06]: Quality indicator for the elevation. One flag per shot; indicates quality based on good vs. bad criteria.

1-bit flags, 40/second.

This flag is relatively undefined.

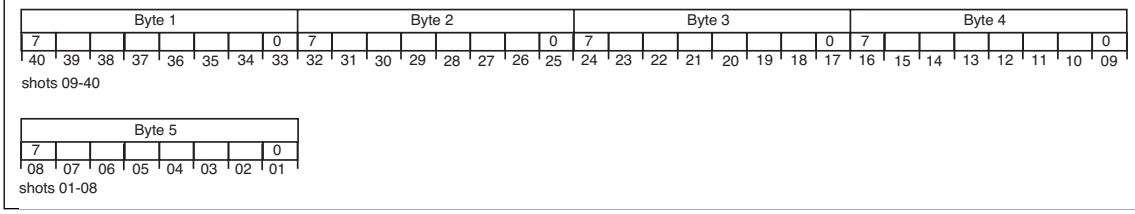

Figure D-31 i_ElvFlg

i_rng_UQF [GLA06, 11-15]: 40/second Data quality flag for the range increment group; allows 1 bit per measurement; bit indicates quality based on good vs. bad criteria

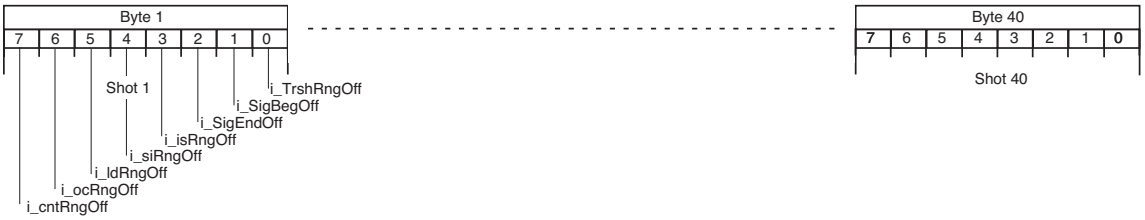

Figure D-32 i_rng_UQF

i_SurfRufQF [GLA06, GLA11-15]: Per-shot data quality flags for the ice sheet and sea ice surface roughness; indicates quality based on good vs. bad criteria. Bytes 0-39 are ice sheet flags, bytes 40-79 are sea ice flags.

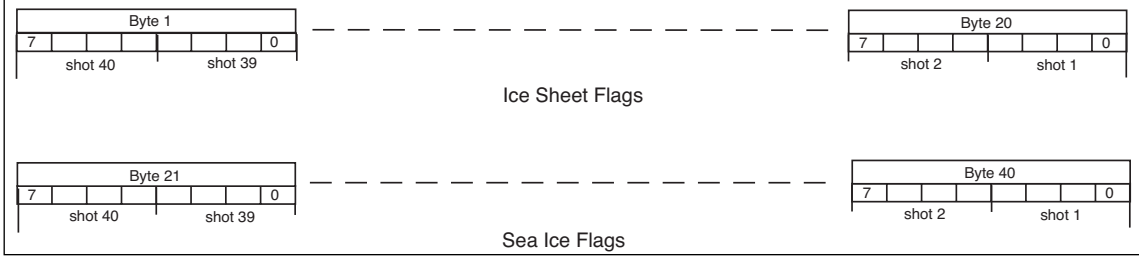

Figure D-33 i_SurfRufQF

i_surfType [GLA05, 06, 12-15]: 40/second Surface Type Flag

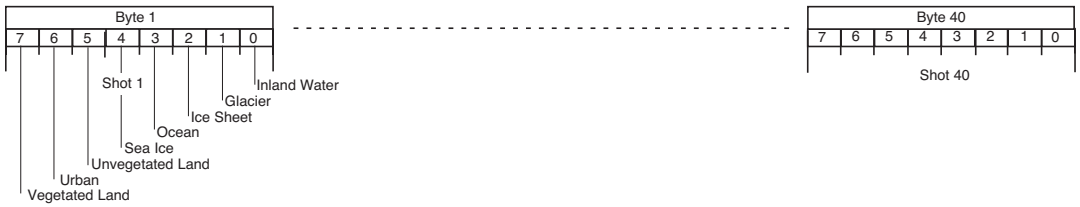

Figure D-34 i_surfType

D.6 GLA07

i_metFlg [GLA06, 07, 12-15]: Meteorological Data Quality Flag - Flag indicating quality and source of the meteorological data. One packed byte

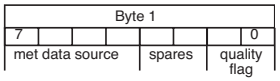

Figure D-35 i_metFlg

i_1064AttBS_Flag [GLA07]: 1064 nm Attenuated Backscatter Vertical Profile Flag

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
						5		4		3		2		1					5	4	3	2	1	40		39		38		37	
i1_ir_cal_qf		spares						i5_ir_bscs_qf								spares				i5_ir_bscs_uf				i40_ir_bscs_qf (shots 40-37)							

Byte 5				Byte 6				Byte 7				Byte 8			
7			0	7			0	7			0	7			0
36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21
i40_ir_bscs_qf (shots 36-21)															

Byte 9				Byte 10				Byte 11				Byte 12			
7			0	7			0	7			0	7			0
20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5
i40_ir_bscs_qf (shots 20-5)															

Byte 13				Byte 14								Byte 15								Byte 16							
7			0	7							0	7							0	7							0
4	3	2	1	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
i40_ir_bscs_qf (shots 4-1)				i40_ir_bscs_uf (shots 40-17)																							

Byte 17								Byte 18							
7							0	7							0
16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
i40_ir_bscs_uf (shots 16-1)															

Figure D-36 i_1064AttBS_Flag

i_532AttBS_Flag [GLA07]: 532 nm Attenuated Backscatter Vertical Profile Flag

Byte 1	Byte 2	Byte 3	Byte 4
7 … 0	7 … 0	7 … 0	7 … 0
i_g_cal_qf, i_g_cal_dnf, i1_g_bscs_qf, 5	4, 3, 2, 1	spare, 5, 4, 3, 2, 1	40, 39, 38, 37
	i5_g_bscs_df	i5_g_bscs_uf	i40_g_bscs_qf (shots 40-37)

Byte 5	Byte 6	Byte 7	Byte 8
7 … 0	7 … 0	7 … 0	7 … 0
36, 35, 34, 33	32, 31, 30, 29	28, 27, 26, 25	24, 23, 22, 21
	i40_g_bscs_qf (shots 36-21)		

Byte 9	Byte 10	Byte 11	Byte 12
7 … 0	7 … 0	7 … 0	7 … 0
20, 19, 18, 17	16, 15, 14, 13	12, 11, 10, 9	8, 7, 6, 5
	i40_g_bscs_qf (shots 20-5)		

Byte 13	Byte 14	Byte 15	Byte 16
7 … 0	7 … 0	7 … 0	7 … 0
4, 3, 2, 1	40, 39, 38, 37, 36, 35, 34, 33	32, 31, 30, 29, 28, 27, 26, 25	24, 23, 22, 21, 20, 19, 18, 17
i40_g_bscs_qf (shots 4-1)		i40_g_bscs_uf (shots 40-17)	

Byte 17	Byte 18
7 … 0	7 … 0
16, 15, 14, 13, 12, 11, 10, 09	08, 07, 06, 05, 04, 03, 02, 01
i40_g_bscs_uf (shots 16-1)	

Figure D-37 i_532AttBS_Flag

i_g_TxNrg_qf [GLA02 & 07]: 532 nm Laser Transmitted Energy Quality Flag

Byte 1	Byte 2	Byte 3	Byte 4
7 … 0	7 … 0	7 … 0	7 … 0
40, 39, 38, 37	36, 35, 34, 33	32, 31, 30, 29	28, 27, 26, 25
	(shots 40 - 25)		

Byte 5	Byte 6	Byte 7	Byte 8
7 … 0	7 … 0	7 … 0	7 … 0
24, 23, 22, 21	20, 19, 18, 17	16, 15, 14, 13	12, 11, 10, 09
	(shots 24 - 9)		

Byte 9	Byte 10
7 … 0	7 … 0
8, 7, 6, 5	4, 3, 2, 1
(shots 8 - 1)	

Figure D-38 i_g_TxNrg_qf

i_ir_TxNrg_qf [GLA02, 07]: 1064 nm Laser Transmitted Energy Quality Flag

Byte 1								Byte 2								Byte 3								Byte 4							
7							0	7							0	7							0	7							0
40	39	38	37					36	35	34	33					32	31	30	29					28	27	26	25				

(shots 40 - 25)

Byte 5								Byte 6								Byte 7								Byte 8							
7							0	7							0	7							0	7							0
24	23	22	21					20	19	18	17					16	15	14	13					12	11	10	09				

(shots 24 - 9)

Byte 9								Byte 10							
7							0	7							0
8	7	6	5					4	3	2	1				

(shots 8 - 1)

Figure D-39 i_ir_TxNrg_qf

i_PODPADQF [GLA07, 09]: PODPAD Quality Flag

Byte 1							
7							0

Figure D-40 i_PODPADQF

i_metFlg [GLA06, 07, 12-15]: Meteorological Data Quality Flag - Flag indicating quality and source of the meteorological data.
One packed byte

Byte 1							
7							0
met data source				spares		quality flag	

Figure D-41 i_metFlg

Abbreviations & Acronyms

ATBD	Algorithm Theoretical Basis Document
DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System Project
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
ICESat	Ice, Cloud, and land Elevation Satellite
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
SCF	Science Computing Facility
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division
WFF	Wallops Flight Facility

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 geo-reference 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.