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ICESat (GLAS) Science Processing Software Document Series

Volume
GLAS Standard Data Products Specification - Level 2
Version 3.0

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Foreword

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

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

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

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

This document was prepared by the Observational Science Branch at NASA GSFC/WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (757) 824-1238, hancock@osb.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 Product 3-1

Section 4 Environment

4.1 Hardware Characteristics and Limitations 4-1
4.2 Data Product 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 Products Definitions

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

Appendix A Standard Label - Contents & Description

Appendix B Level 2 Data Product Formats

B.1 Record Formats B-1

Appendix C Detailed Contents and Description

C.1 GLA08 . . . . . C-2
C.2 GLA09 . . . . . C-6
C.3 GLA10 . . . . . C-12
C.4 GLA11 . . . . . C-15
C.5 GLA12 . . . . . C-18
C.6 GLA13 . . . . . C-23
C.7 GLA14 . . . . . C-28
C.8 GLA15 . . . . . C-34

Appendix D Flag Formats

D.1 GLA08 . . . . . D-1
D.2 GLA09 . . . . . D-2
D.3 GLA10 . . . . . D-4
D.4 GLA11 . . . . . D-7
D.5 GLA12 . . . . . D-9
D.6 GLA13 . . . . . D-12
D.7 GLA14 . . . . . D-15
D.8 GLA15 . . . . . D-18

Abbreviations & Acronyms AB-1

Glossary GL-1

List of Figures

Figure 3-1 GLAS Level 2 Products Within The Data Product Hierarchy . . . 3-3
Figure 4-1 Data Representation 4-2
Figure D-1 i_LayHgt_Flag D-1
Figure D-2 i_FRCL_Flag. D-2
Figure D-3 i_HRCL_Flag D-2
Figure D-4 i_LRCL_Flag D-3
Figure D-5 i_MRCL_Flag D-3
Figure D-6 i_PODPADQF D-4
Figure D-7 i_aer4_bs_flag D-4
Figure D-8 i_aer4_ext_flag. D-4
Figure D-9 i_aer4_sval_uf D-5
Figure D-10 i_cld1_bs_flag D-5
Figure D-11 i_cld1_ext_flag. D-6
Figure D-12 i_cld1_sval_uf D-6
Figure D-13 i_aer4_flag D-7
Figure D-14 i_cld1_flag D-7
Figure D-15 i_cld1_mswf. D-7
Figure D-16 i_pbl4_flag D-8
Figure D-17 i_rng_UQF D-8
Figure D-18 i_SurfRufQF. D-8
Figure D-19 i_IceSheetQF D-9
Figure D-20 i_isRufQF D-9
Figure D-21 i_PODPADQF D-9
Figure D-22 i_surfType D-10
Figure D-23 i_metFlg D-10
Figure D-24 i_atmQF D-10
Figure D-25 i_ElvCor_QF. D-10
Figure D-26 i_rng_UQF D-11
Figure D-27 i_SurfRufQF. D-11
Figure D-28 i_metFlg D-11

Figure D-29 i_SeaIceQF D-12
Figure D-30 i_siRufQF D-12
Figure D-31 i_PODPADQF D-12
Figure D-32 i_surfType D-13
Figure D-33 i_metFlg D-13
Figure D-34 i_atmQF D-13
Figure D-35 i_ElvCor_QF. D-13
Figure D-36 i_rng_UQF D-14
Figure D-37 i_SurfRufQF. D-14
Figure D-38 i_metFlg D-14
Figure D-39 i_LandQF D-15
Figure D-40 i_ldRufQF. D-15
Figure D-41 i_PODPADQF D-15
Figure D-42 i_surfType D-16
Figure D-43 i_metFlg D-16
Figure D-44 i_atmQF D-16
Figure D-45 i_ElvCor_QF. D-16
Figure D-46 i_rng_UQF D-17
Figure D-47 i_SurfRufQF. D-17
Figure D-48 i_metFlg D-17
Figure D-49 i_metFlg D-18
Figure D-50 i_atmQF D-18
Figure D-51 i_ElvCor_QF. D-18
Figure D-52 i_OceanQF D-18
Figure D-53 i_OcRMSqf Flag. D-19
Figure D-54 i_PODPADQF D-19
Figure D-55 i_surfType D-19
Figure D-56 i_rng_UQF D-20
Figure D-57 i_SurfRufQF. D-20

List of Tables

Table 3-1 GLAS Level 2 Standard Data Products 3-1
Table 5-1 GLAS Level 2 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 GLA08 Record Format B-1
Table B-2 GLA09 Record Format B-3
Table B-3 GLA10 Record Format B-6
Table B-4 GLA11 Record Format B-8
Table B-5 GLA12 Record Format B-9
Table B-6 GLA13 Record Format B-11
Table B-7 GLA14 Record Format B-13
Table B-8 GLA15 Record Format B-16
Table C-1 GLA08: 10/24/2000 . . . . . C-2
Table C-2 GLA09: 10/25/2000 . . . . . C-6
Table C-3 GLA10: 06/21/2000 . . . . . C-12
Table C-4 GLA11: 06/21/2000 . . . . . C-15
Table C-5 GLA12: 09/06/2000 . . . . . C-18
Table C-6 GLA13: 09/06/2000 . . . . . C-23
Table C-7 GLA14: 09/06/2000 . . . . . C-28
Table C-8 GLA15: 09/06/2000 . . . . . C-34

Section 1

Introduction

1.1 Identification of Document

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

1.2 Scope of Document

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

1.3 Purpose and Objectives of Document

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

1.4 Document Organization

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

1.5 Document Status and Schedule

This document will be updated and released as required.

1.5.1 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 2		
Version Number	**Date**	**Nature of Change**
Preliminary	December 31, 1995	Original Version
Version 1.2	March 1998	Text, Figures, and Tables updated for Level 2 data updates, for the change to GLAS standard data product generation being performed at the GLAS SCF, and change of the spacecraft name to ICESAT.
Version 2.0	January 1999	Updates to the data product contents.
Version 3.0	November 2000	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V1 release.

Section 2

Related Documentation

2.1 Parent Documents

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

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

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

b) *GLAS Science Software Management Plan*, Version 3.0, August 1998, NASA Goddard Space Flight Center, Wallops Flight Facility

2.2 Applicable Documents

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

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

b) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges*, Algorithm Theoretical Basis Document, 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) *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 2 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 2 Standard Data Products is to provide time-ordered, processed GLAS data, acceptable for science applications. This GLAS derived data consists of calibrated laser altimeter data supplemented with precision orbit determination, earth-location and precision attitude data from the ancillary data sources. The GLAS Level 2 Standard Data Products are intended for use by the GLAS Science Team, and by the EOSDIS data user community.

3.2 Description of the Data Product

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

Table 3-1 GLAS Level 2 Standard Data Products

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

n/a - Not applicable

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

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

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

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

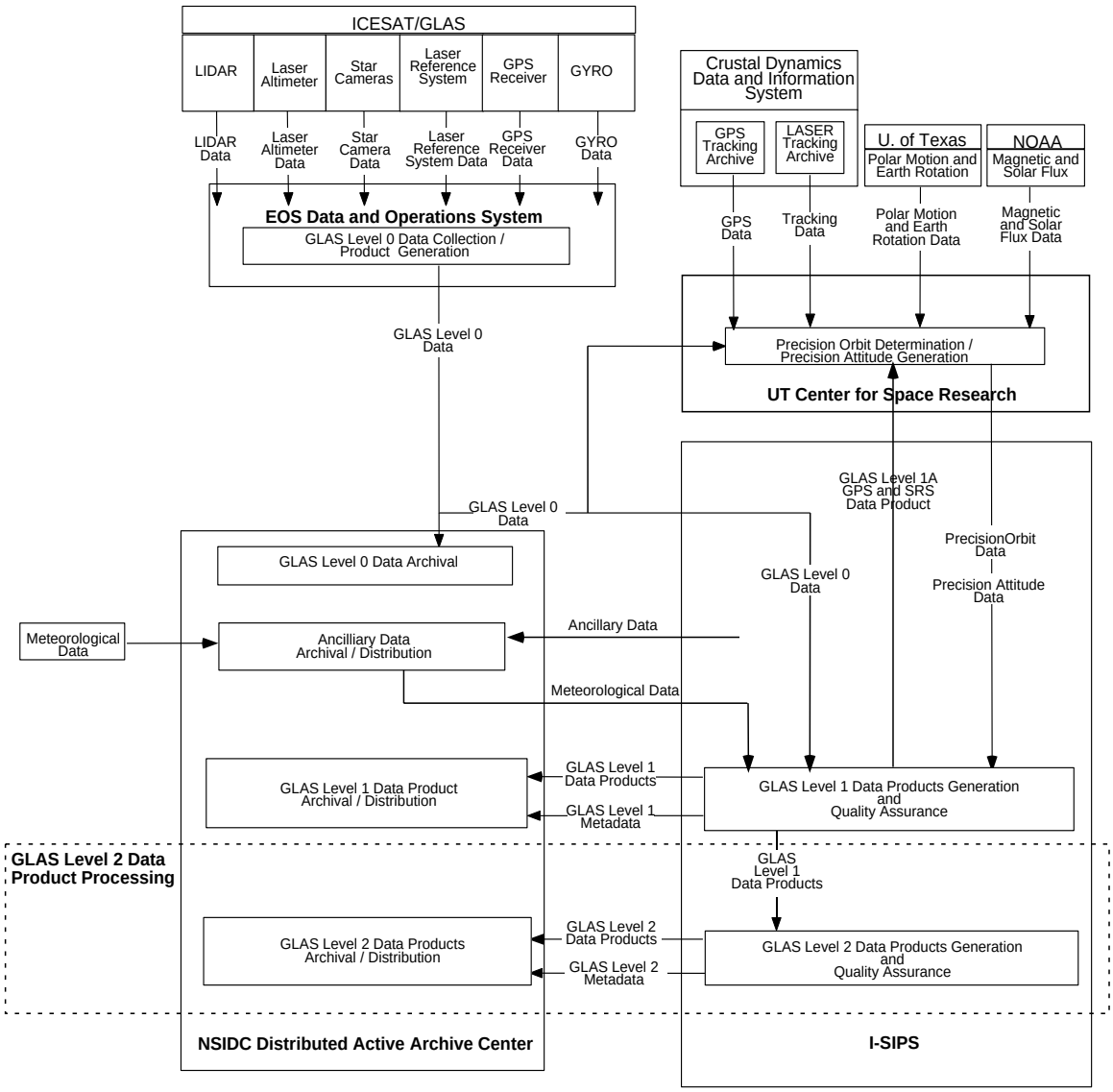

Figure 3-1 GLAS Level 2 Products Within The Data Product Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

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

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

4.2 Data Product Medium and Characteristics

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

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

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

4.3 Protocol and Conventions

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

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

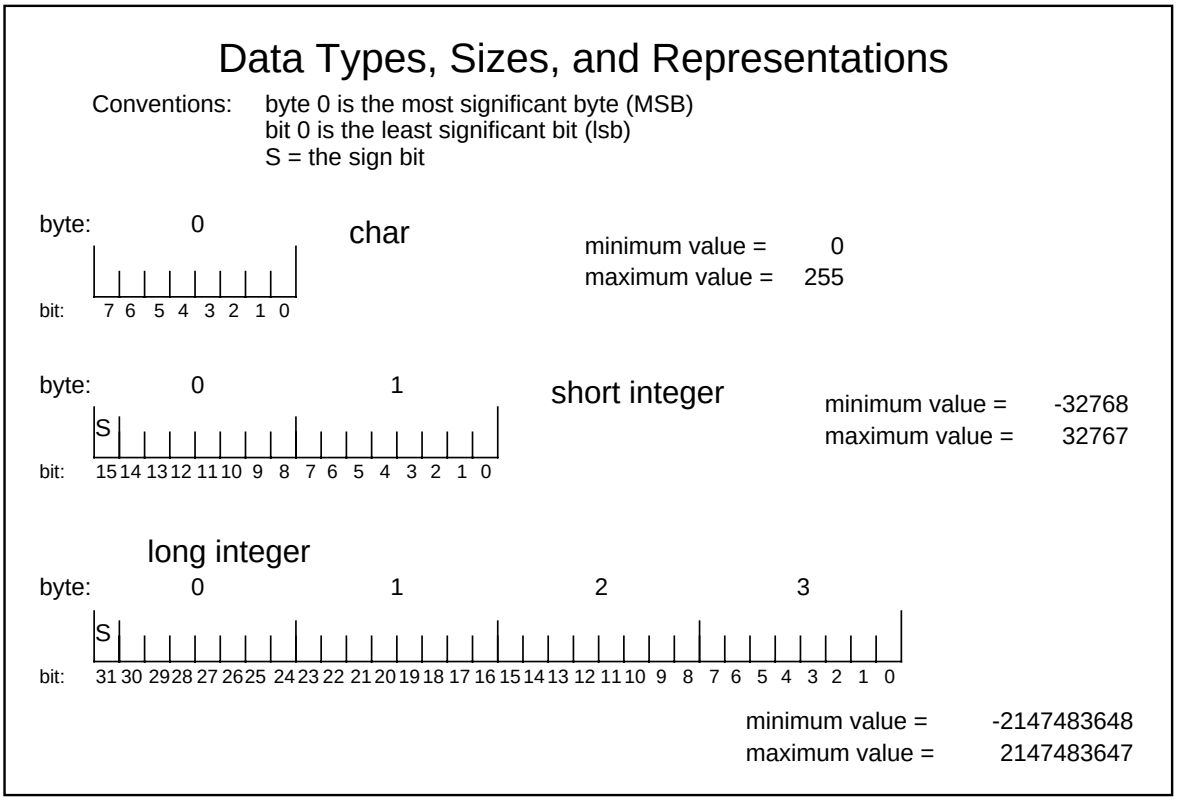

Figure 4-1 Data Representation

4.4 Failure Protection, Detection, and Recovery Features

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

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

Section 5

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

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

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

Product ID	Volume (MBytes per Day)
GLA08	7.713
GLA09	69.809
GLA10	303.834
GLA11	17.785
GLA12	256.435
GLA13	348.019
GLA14	455.846
GLA15	246.067

n/a - Not applicable

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

5.2 Data Transfer and Transmission

The GLAS Science Team will have access to the GLAS Level 2 Data Products through the GLAS SCF using TCP/IP and standard UNIX command operations. GLAS Level

2 Data Products generated within the I-SIPS will be transferred to the DAAC through the EOS Science Network or off-line via storage media.

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

5.3 Timing and Sequencing Characteristics

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

5.4 Recipients and Utilization

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

5.5 Access

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

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

Section 6

Data Products Definitions

6.1 Data Products Structure

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

6.2 Labeling and Identification

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

GLAxx_mmm _pr_ccc_tttt_s _nn_ff.dat

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

Table 6-1 GLAS File Naming Keys

Key	Description
xx	The GLAS Product ID (01-15)
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 GLAxx,.i.e. multi-file granule)

The structure and contents of the GLAS Level 2 Data Product labels are contained in Appendix A, GLAS Level 2 Data Products -- Standard Label -- Contents and Description. The following information may be included within 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 Products Substructure Descriptions

The data product label and headers contain an aggregate of [TBD] fixed length (=TBD bytes) records of string information describing the GLAS Level 2 Data Products. Appendix A 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 2 Data Products is provided in Appendix B, GLAS Level 2 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 as a member of the GLAS Data Parameter collection
Elements/Record	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 2 Data Products is provided as a data dictionary in Appendix C, GLAS Level 2 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 2 Data Products
Standard Label
Contents & Description

To Be Provided

Appendix B

Level 2 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, the orbit number and instrument state are changing at a much lower rate than the record rate on the files, therefore the orbit numbers and instrument states encompassed by a file will be put in the header. These elements will not be shown in the record format. Other data in the same category will be put in the header.
5) Add spares.

B.1.2 GLA08

Each record contains 20 seconds of data. Empty aerosol or planetary boundary layers will contain fill data. Record format is in Table B-1.

Table B-1 GLA08 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Aerosol Height Record Index of First Record	1	4	1	4	0	3
Time of First Record - Seconds	1	4	2	8	4	11
PAD Pointing Vector of First Record	1	4	6	24	12	35
Latitude	1	4	1	4	36	39
Longitude	1	4	1	4	40	43
Latitude Deltas (referenced to profile location)	3	4	1	12	44	55

Table B-1 GLA08 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Longitude Deltas (referenced to profile location)	3	4	1	12	56	67
Delta PAD Pointing Vectors	3	4	6	72	68	139
POD & PAD orbit quality flag	1	1	1	1	140	140
Spares	1	1	7	7	141	147
Below 20 KM Aerosol Layer Bottom	1	2	5	10	148	157
Below 20 KM Aerosol Layer Top	1	2	5	10	158	167
20-40 KM Aerosol Layer Bottom	1	2	3	6	168	173
20-40 KM Aerosol Layer Top	1	2	3	6	174	179
Low Resolution PBL Height	1	2	1	2	180	181
Ground Detection for Low Res PBL	1	2	1	2	182	183
High Resolution PBL Height	20	2	1	40	184	223
Ground Detection for High Res PBL	20	2	1	40	224	263
Layer Height Flag contains:	1	1	32	32	264	295
Spares	1	0.125	1			
Low res PBL clear/cloudy flag	1	0.125	1			
Low res PBL use flag	1	0.25	1			
Low res PBL quality level flag	1	0.5	1			
Spares	1	0.125	4			
High res PBL clear/cloudy flag	1	0.125	20			
High res PBL use flag	1	0.25	20			
High res PBL quality level flag	1	0.5	20			
Spares	1	0.125	6			
Below 20 km aerosol layer use flag	1	0.25	3			
Spares	1	0.125	4			
Below 20 km aerosol layer quality level flag	1	0.5	5			
Spares	1	0.125	2			
20-40 km aerosol layer use flag	1	0.25	3			
Spares	1	0.125	4			

Table B-1 GLA08 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
20-40 km aerosol layer quality level flag	1	0.5	3			
Spares	1	0.25	12			
Polar Stratospheric Cloud (PSC) flag	1	0.25	8			
Number of bytes		296				
Packed product elements						
Low Resolution PBL Flags	1	1	1			
High Resolution PBL Flags	1	4	4			
Below 20 km aerosol layer flag	1	4	1			
20-40 km aerosol layer flag	1	2	1			

B.1.3 GLA09

Each record contains 4 seconds of data. Empty cloud layers will contain fill data. Record format is in Table B-2.

Table B-2 GLA09 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Cloud Height Record Index of First Record	1	4	1	4	0	3
Time of First Record - Seconds	1	4	2	8	4	11
PAD Pointing Vector of First Record	1	4	6	24	12	35
Latitude	1	4	1	4	36	39
Longitude	1	4	1	4	40	43
Latitude Deltas (referenced to profile location)	3	4	1	12	44	55
Longitude Deltas (referenced to profile location)	3	4	1	12	56	67
Delta PAD Pointing Vectors	3	4	6	72	68	139

Table B-2 GLA09 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
POD & PAD orbit quality flag	1	1	1	1	140	140
Spares	1	1	7	7	141	147
Surface elevation - peak of return	160	2	1	320	148	467
Surface elevation - threshold of return	160	2	1	320	468	787
Threshold Crossing	160	1	3	480	788	1267
Low Resolution Cloud Bottom	1	2	10	20	1268	1287
Low Resolution Cloud Top	1	2	10	20	1288	1307
Low Resolution Ground Detection	1	2	1	2	1308	1309
Spares	1	1	6	6	1310	1315
Medium Resolution Cloud Bottom	4	2	10	80	1316	1395
Medium Resolution Cloud Top	4	2	10	80	1396	1475
Medium Resolution Ground Detection	4	2	1	8	1476	1483
High Resolution Cloud Bottom	20	2	10	400	1484	1883
High Resolution Cloud Top	20	2	10	400	1884	2283
High Resolution Ground Detection	20	2	1	40	2284	2323
Full Resolution Cloud Bottom	160	2	1	320	2324	2643
Full Resolution Cloud Top	160	2	1	320	2644	2963
Full Resolution Cloud Ground Detection	160	2	1	320	2964	3283
Low Res Cloud Layer Flag contains:	1	1	11	11	3284	3294
Bspares	1	0.5	1			
Low res cloud layer availability flag	1	0.5	1			
Low res cloud layer quality flag	1	0.5	10			
BSpares	1	0.25	2			
Low res cloud layer use flag	1	0.25	10			
Bspares	1	0.125	6			
Low Resolution Diurnal flag	1	0.125	10			
Spares	1	1	1	1	3295	3295
Medium Res Cloud Layer Flag contains:	1	1	37	37	3296	3332
Medium res cloud layer availability flag	4	0.5	1			

Table B-2 GLA09 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Medium res cloud layer quality flag	4	0.5	10			
Medium res cloud layer use flag	4	0.25	10			
Medium Resolution Diurnal Flag	4	0.125	10			
Spares	1	1	3	3	3333	3335
High Res Cloud Layer Flag contains:	1	1	185	185	3336	3520
High res cloud layer availability flag	20	0.5	1			
High res cloud layer quality flag	20	0.5	10			
High res cloud layer use flag	20	0.25	10			
High Resolution Diurnal Flag	20	0.125	10			
Spares	1	1	3	3	3521	3523
Full Res Cloud Layer Flag contains:	1	1	220	220	3524	3743
Full res cloud layer availability flag	160	0.5	1			
Full res cloud layer quality flag	160	0.5	1			
Full res cloud layer use flag	160	0.25	1			
Full Resolution Diurnal Flag	160	0.125	1			
Number of Bytes		**3744**				
Packed product elements						
Low Resolution Cloud Layers Flag	1	4	2			
Medium Resolution Cloud Layers Flag	1	4	8			
High Resolution Cloud Layers Flag	1	4	40			
Full Resolution Cloud Layers Flag	1	4	50			

B.1.4 GLA10

Each record contains 4 seconds of data. Record format is in Table B-3.

Table B-3 GLA10 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Cross Section Record Index	1	4	1	4	0	3
Time of First Sample	1	4	2	8	4	11
PAD Pointing Vector	1	4	6	24	12	35
Latitude	1	4	1	4	36	39
Longitude	1	4	1	4	40	43
Spares	1	4	8	32	44	75
Cloud backscatter flag	1	1	40	40	76	115
Cloud backscatter quality flag	1	0.5	10			
Cloud backscatter use flag	1	0.5	10			
Cloud extinction flag	1	1	40	40	116	155
Cloud extinction quality flag	1	0.5	10			
Cloud extinction use flag	1	0.5	10			
Aerosol backscatter flag	1	1	10	10	156	165
BSpares	1	0.125	4			
Aerosol backscatter quality flag	1	0.5	9			
BSpares	1	0.125	4			
Aerosol backscatter use flag	1	0.5	9			
Aerosol extinction flag	1	1	10	10	166	175
BSpares	1	0.125	4			
Aerosol extinction quality flag	1	0.5	9			
BSpares	1	0.125	4			
Aerosol extinction use flag	1	0.5	9			
Spares	1	1	4	4	176	179
Cloud Backscatter Cross Section Profile	4	4	280	4480	180	4659
Cloud Extinction Cross Section Profile	4	4	280	4480	4660	9139
Aerosol Backscatter Cross Section Profile	1	4	548	2192	9140	11331

Table B-3 GLA10 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Aerosol Extinction Cross Section Profile	1	4	548	2192	11332	13523
Cloud true S values from table	4	2	10	80	13524	13603
Cloud true S values from equation calc.	4	2	10	80	13604	13683
Cloud true S values use flag	1	0.5	40	20	13684	13703
Spares	1	1	1	1	13704	13704
Aerosol true S Values use flag	1	0.5	10	5	13705	13709
Aerosol true S Values from equation calc.	1	2	10	20	13710	13729
Aerosol true S Values from table	1	2	10	20	13730	13749
Medium Resolution Cloud Bottom	4	2	10	80	13750	13829
Medium Resolution Cloud Top	4	2	10	80	13830	13909
Medium Resolution Ground Detection	4	2	1	8	13910	13917
Low Resolution Aerosol Layer Bottom	1	2	9	18	13918	13935
Low Resolution Aerosol Layer Top	1	2	9	18	13936	13953
Low Resolution Aerosol Layer Ground Detection	1	2	1	2	13954	13955
Spares	1	1	12	12	13956	13967
Number of bytes				13968		

B.1.5 GLA11

Each record contains 4 seconds of data. Record format is in Table B-4.

Table B-4 GLA11 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Optical Depth Record Index	1	4	1	4	0	3
Time of First Sample	1	4	2	8	4	11
PAD Pointing Vector	1	4	6	24	12	35
Latitude	1	4	1	4	36	39
Longitude	1	4	1	4	40	43
Spares	1	1	10	10	44	53
Multiple Scattering Warning Flag	1	1	2	2	54	55
Cloud optical depth flag	1	1	40	40	56	95
Cloud optical depth quality flag	4	0.5	20			
Cloud optical depth use flag	4	0.5	20			
Aerosol optical depth flag	1	1	8	8	96	103
Aerosol optical depth quality flag	1	0.5	4			
Aerosol optical depth use flag	1	0.5	1			
PBL optical depth flag	1	1	1	1	104	104
PBL optical depth quality flag	1	0.5	1			
PBL optical depth use flag	1	0.5	1			
Spares	1	1	7	7	105	111
Cloud Optical Depth	4	2	10	80	112	191
Aerosol Optical Depth	1	2	8	16	192	207
PBL Optical Depth	1	2	1	2	208	209
Aerosol Multiple Scattering Factor	1	2	9	18	210	227
Cloud Multiple Scattering Factor	4	2	10	80	228	307
Medium Resolution Cloud Bottom	4	2	10	80	308	387
Medium Resolution Cloud Top	4	2	10	80	388	467
Medium Resolution Ground Detection	4	2	1	8	468	475
Low Resolution Aerosol Layer Bottom	1	2	8	16	476	491
Low Resolution Aerosol Layer Top	1	2	8	16	492	507

Table B-4 GLA11 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Low Resolution PBL Height	1	2	1	2	508	509
Ground Detection for Low Res PBL	1	2	1	2	510	511
Spares	1	2	22	44	512	555
Number of items		29				
				556		

B.1.6 GLA12

Each record contains 1 second of data. Record format is in Table B-5.

Table B-5 GLA12 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 for shots 2 - 40	39	4	1	156	16	171
Coordinate Data, Latitude, specific to ice sheet range	40	4	1	160	172	331
Coordinate Data, Longitude, specific to ice sheet range	40	4	1	160	332	491
Ice Sheet Surface elevation	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611
POD nadir position	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
Spare	1	2	7	14	2582	2595
Solar Incidence Angle	1	4	1	4	2596	2599
Orientation of Pulse	1	4	1	4	2600	2603
Local Azimuth	1	4	1	4	2604	2607
Semi-major axis of footprint	40	2	1	80	2608	2687
Semi-minor axis of footprint	40	2	1	80	2688	2767
Geoid	1	2	1	2	2768	2769

Table B-5 GLA12 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Earth Tide Elevation	1	2	1	2	2770	2771
Load Tide Elevation	4	2	1	8	2772	2779
Tide Elevations, Specific regions	4	2	1	8	2780	2787
Ocean Tide Elevation	1	2	1	2	2788	2789
Elevation Corrections Quality Flag	1	1	2	2	2790	2791
Range Correction, Dry Troposphere	40	2	1	80	2792	2871
Range Correction, Wet Troposphere	1	2	1	2	2872	2873
Spare	1	2	7	14	2874	2887
Atmosphere flag	40	1	1	40	2888	2927
Meteorological Data Quality Flag	1	1	1	1	2928	2928
Spare	1	1	7	7	2929	2935
DEM Elevation	40	4	1	160	2936	3095
Reference Range	40	4	1	160	3096	3255
Threshold Retracker range increment	40	4	1	160	3256	3415
Ice Sheet Range increment using last peak	40	4	1	160	3416	3575
Ice Sheet Range increment using first peak	40	4	1	160	3576	3735
Signal Begin range increment	40	4	1	160	3736	3895
Signal end range increment	40	4	1	160	3896	4055
Centroid Range increment	40	4	1	160	4056	4215
Reflectance	40	4	1	160	4216	4375
Kurtosis	40	2	1	80	4376	4455
Skewness	40	2	1	80	4456	4535
Spare	1	4	8	32	4536	4567
Error Estimate of Ice Sheet Range Increment	40	2	1	80	4568	4647
Variance of the Ice Sheet Gaussian fit	40	2	1	80	4648	4727
Peak Amplitude of Smooth WF	40	2	1	80	4728	4807
Ice Sheet Roughness	40	2	1	80	4808	4887
Ice Sheet Slope - wf	40	2	1	80	4888	4967

Table B-5 GLA12 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Ice Sheet Slope - elev	1	2	1	2	4968	4969
Ice Sheet Elevation Quality Flag	1	1	5	5	4970	4974
Spare	1	1	5	5	4975	4979
Ice Sheet Roughness/slope Quality Flag	1	1	40	40	4980	5019
Surface Type	40	1	1	40	5020	5059
Number of peaks from Waveform Fit	40	1	1	40	5060	5099
Spare	1	1	8	8	5100	5107
			Total bytes/ rec		5108	
			total mbyte s/day		441.3 312	

B.1.7 GLA13

Each record contains 1 second of data. Record format is in Table B-6.

Table B-6 GLA13 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 for shots 2 - 40	39	4	1	156	16	171
Coordinate Data, Latitude, specific to sea ice range	40	4	1	160	172	331
Coordinate Data, Longitude, specific to sea ice range	40	4	1	160	332	491
Sea Ice Surface Elevation	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611
POD nadir position	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
Spare	1	2	7	14	2582	2595

Table B-6 GLA13 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Solar Incidence Angle	1	4	1	4	2596	2599
Orientation of Pulse	1	4	1	4	2600	2603
Local Azimuth	1	4	1	4	2604	2607
Semi-major axis of footprint	40	2	1	80	2608	2687
Semi-minor axis of footprint	40	2	1	80	2688	2767
Geoid	1	2	1	2	2768	2769
Earth Tide Elevation	1	2	1	2	2770	2771
Load Tide Elevation	4	2	1	8	2772	2779
Tide Elevations, Specific regions	4	2	1	8	2780	2787
Ocean Tide Elevation	1	2	1	2	2788	2789
Elevation Corrections Quality Flag	1	1	2	2	2790	2791
Range Correction, Dry Troposphere	40	2	1	80	2792	2871
Range Correction, Wet Troposphere	1	2	1	2	2872	2873
Spare	1	2	7	14	2874	2887
Atmosphere flag	40	1	1	40	2888	2927
Meteorological Data Quality Flag	1	1	1	1	2928	2928
Spare	1	1	7	7	2929	2935
DEM Elevation	40	4	1	160	2936	3095
Reference Range	40	4	1	160	3096	3255
Threshold Retracker range increment	40	4	1	160	3256	3415
Sea ice range increment to first peak	40	4	1	160	3416	3575
Average elevation	40	4	1	160	3576	3735
Signal Begin range increment	40	4	1	160	3736	3895
Signal end range increment	40	4	1	160	3896	4055
Centroid Range increment	40	4	1	160	4056	4215
Reflectance	40	4	1	160	4216	4375
Skewness	40	2	1	80	4376	4455
Spare	1	4	8	32	4456	4487
Error Estimate of Sea Ice Range Increment	40	2	1	80	4488	4567

Table B-6 GLA13 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Variance of the sea ice Gaussian fit	40	2	1	80	4568	4647
Peak Amplitude of Smooth WF	40	2	1	80	4648	4727
Surface Roughness – last peak	40	2	1	80	4728	4807
Surface Roughness – whole signal	40	2	1	80	4808	4887
Sea ice Elevation Quality Flag	1	1	5	5	4888	4892
Spare	1	1	7	7	4893	4899
Sea ice Roughness Quality Flag	1	1	40	40	4900	4939
Surface Type	40	1	1	40	4940	4979
Number of Peaks from Waveform Fit	40	1	1	40	4980	5019
Spare	1	1	8	8	5020	5027
	Total Bytes per Record	5028				
	mbytes/day	434.4192				

B.1.8 GLA14

Each record contains 1 second of data. Record format is in Table B-7.

Table B-7 GLA14 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 for shots 2 - 40	39	4	1	156	16	171
Coordinate Data, Latitude, specific to land range	40	4	1	160	172	331
Coordinate Data, Longitude, specific to land range	40	4	1	160	332	491
Land surface Elevation	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611

Table B-7 GLA14 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
POD nadir position	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
Spare	1	2	7	14	2582	2595
Solar Incidence Angle	1	4	1	4	2596	2599
Orientation of Pulse	1	4	1	4	2600	2603
Local Azimuth	1	4	1	4	2604	2607
Semi-major axis of footprint	40	2	1	80	2608	2687
Semi-minor axis of footprint	40	2	1	80	2688	2767
Geoid	1	2	1	2	2768	2769
Earth Tide Elevation	1	2	1	2	2770	2771
Load Tide Elevation	4	2	1	8	2772	2779
Tide Elevations, Specific regions	4	2	1	8	2780	2787
Ocean Tide Elevation	1	2	1	2	2788	2789
Elevation Corrections Quality Flag	1	1	2	2	2790	2791
Range Correction, Dry Troposphere	40	2	1	80	2792	2871
Range Correction, Wet Troposphere	1	2	1	2	2872	2873
Spare	1	2	7	14	2874	2887
Atmosphere flag	40	1	1	40	2888	2927
Meteorological Data Quality Flag	1	1	1	1	2928	2928
Spare	1	1	7	7	2929	2935
DEM Elevation	40	4	1	160	2936	3095
Reference Range	40	4	1	160	3096	3255
Threshold Retracker range increment	40	4	1	160	3256	3415
Land Range increment	40	4	1	160	3416	3575
Signal Begin range increment	40	4	1	160	3576	3735
Signal end range increment	40	4	1	160	3736	3895
Amplitudes of Gaussians	40	4	6	960	3896	4855
Area under Gaussian	40	4	6	960	4856	5815
Sigma of Gaussians	40	4	6	960	5816	6775

Table B-7 GLA14 Record Format

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Centroid Range increments	40	4	6	960	6776	7735
Reflectance	40	4	1	160	7736	7895
Kurtosis	40	2	1	80	7896	7975
Skewness	40	2	1	80	7976	8055
Spare	1	4	8	32	8056	8087
Error Estimate of land Range Increment	40	2	1	80	8088	8167
Variance of the Land Gaussian fit	40	2	1	80	8168	8247
Peak Amplitude of Smooth WF	40	2	1	80	8248	8327
Land Roughness - last	40	2	1	80	8328	8407
Land Roughness - all	40	2	1	80	8408	8487
Land Slope – wf - all	40	2	1	80	8488	8567
Land Slope – wf - last	40	2	1	80	8568	8647
Land Slope - elev	40	2	1	80	8648	8727
Land Elevation Quality Flag	1	1	5	5	8728	8732
Spare	1	1	7	7	8733	8739
Land Roughness/slope Quality Flag	1	1	40	40	8740	8779
Surface Type	40	1	1	40	8780	8819
Number of Peaks from Waveform Fit	40	1	1	40	8820	8859
Initial Number of Peaks of the Smooth WF (land)	40	1	1	40	8860	8899
Spare	1	1	8	8	8900	8907
	Total Bytes per Record	8908				
	mbytes/ day	769.65 12				

B.1.9 GLA15

Each record contains 1 second of data. Record format is in Table B-8.

Table B-8 GLA15 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 for shots 2 - 40	39	4	1	156	16	171
Coordinate Data, Latitude, specific to ocean range	40	4	1	160	172	331
Coordinate Data, Longitude, specific to ocean range	40	4	1	160	332	491
Ocean Surface Elevation	40	4	1	160	492	651
PAD Pointing Vector	40	4	6	960	652	1611
POD nadir position	40	4	6	960	1612	2571
POD/PAD Quality Flag	1	1	10	10	2572	2581
Spare	1	1	14	14	2582	2595
Solar Incidence Angle	1	4	1	4	2596	2599
Orientation of Pulse	1	4	1	4	2600	2603
Local Azimuth	1	4	1	4	2604	2607
Semi-major axis of footprint	40	2	1	80	2608	2687
Semi-minor axis of footprint	40	2	1	80	2688	2767
Geoid	1	2	1	2	2768	2769
Earth Tide Elevation	1	2	1	2	2770	2771
Load Tide Elevation	4	2	1	8	2772	2779
Tide Elevations, Specific regions	4	2	1	8	2780	2787
Ocean Tide Elevation	1	2	1	2	2788	2789
Elevation Corrections Quality Flag	1	1	2	2	2790	2791
Range Correction, Dry Troposphere	40	2	1	80	2792	2871
Range Correction, Wet Troposphere	1	2	1	2	2872	2873
Spare	1	1	14	14	2874	2887
Atmosphere flag	40	1	1	40	2888	2927

Table B-8 GLA15 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
Meteorological Data Quality Flag	1	1	1	1	2928	2928
Spare	1	1	7	7	2929	2935
DEM Elevation	40	4	1	160	2936	3095
Reference Range	40	4	1	160	3096	3255
Threshold Retracker range increment	40	4	1	160	3256	3415
Ocean range increment to first peak	40	4	1	160	3416	3575
Ocean range increment to last peak	40	4	1	160	3576	3735
Signal Begin range increment	40	4	1	160	3736	3895
Signal end range increment	40	4	1	160	3896	4055
Centroid Range increment	40	4	1	160	4056	4215
Reflectance	40	4	1	160	4216	4375
Average range increment	40	4	1	160	4376	4535
Skewness	40	2	1	80	4536	4615
Spare	1	1	32	32	4616	4647
Error Estimate of Ocean Range Increment	40	2	1	80	4648	4727
Variance of the ocean Gaussian fit	40	2	1	80	4728	4807
Peak Amplitude of Smooth WF	40	2	1	80	4808	4887
RMS Roughness – 1 sec	40	2	1	80	4888	4967
Mean elevation – 1 sec	40	2	1	80	4968	5047
Spare	1	1	16	16	5048	5063
Ocean Elevation Quality Flag	1	1	5	5	5064	5068
Spare	1	1	7	7	5069	5075
Ocean RMS Roughness Quality Flag	1	1	40	40	5076	5115
Surface Type	40	1	1	40	5116	5155
Number of Peaks from Waveform Fit	40	1	1	40	5156	5195
Spare	1	1	8	8	5196	5203
	Total Bytes per Record	5204				

Table B-8 GLA15 Record Format (Continued)

Element Name	Elem/ Rec	Bytes/ Item	Items/ Elem	Bytes/ Rec	Start Byte	Stop Byte
	mbytes/ day	449.62 56				

Appendix C
Level 2 Data Products
Detailed Contents and Description

C.1 GLA08

Table C-1 GLA08: 10/24/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Aerosol Height Record Index of First Record	i_rec_ndx			Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Record - Seconds	i_UTCTime	Seconds	1	The time tag of the first sample, in this record, corrected for system and transit delay, in CCSDS day segmented binary form.
PAD Pointing Vector of First Record	i_PADPoint			The controlled pointing vector as determined from the Precision Attitude data. For each item in the vector there are 2 4-byte values.
Latitude	i_lat	Microde-grees	1.0D-6	Profile location in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Longitude	i_lon	Microde-grees	1.0D-6	Profile location in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Latitude Deltas (referenced to profile location)	i_lat_deltas	Microde-grees	1.0D-6	Will be removed for V2.
Longitude Deltas (referenced to profile location)	i_lon_deltas	Microde-grees	1.0D-6	Will be removed for V2.
Delta PAD Pointing Vectors	i_pad_deltas			Will be removed for V2.
POD & PAD orbit quality flag	i_PODPADqf	n/a	n/a	POD orbit quality flag
Spares	i_Spare1			

Table C-1 GLA08: 10/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Below 20 KM Aerosol Layer Bottom	i4_aer_bot	deka-m	10.0D0	The aerosol layer bottoms (below 20 KM in atmosphere) for up to 5 layers at 1 per 4 sec.
Below 20 KM Aerosol Layer Top	i4_aer_top	deka-m	10.0D0	The aerosol layer tops (below 20 KM in atmosphere) for up to 5 layers at 1 per 4 sec.
20-40 KM Aerosol Layer Bottom	i20_aer_bot	deka-m	10.0D0	The aerosol layer bottoms (20 - 40 KM in atmosphere) for up to 3 layers at 1 per 4 sec.
20-40 KM Aerosol Layer Top	i20_aer_top	deka-m	10.0D0	The aerosol layer tops (20 - 40 KM in atmosphere) for up to 3 layers at 1 per 4 sec.
Low Resolution PBL Height	i_LRpbl_ht	deka-m	10.0D0	Low resolution height of the planetary boundary layer, as derived from the aerosol structure; the low resolution data is averaged over 4 seconds.
Ground Detection for Low Res PBL	i_LRpbl_grd	deka-m	10.0D0	The height above the reference ellipsoid of the ground used by the low res PBL processing algorithms.
High Resolution PBL Height	i_HRpbl_ht	deka-m	10.0D0	High resolution height of the planetary boundary layer, as derived from the aerosol structure; the high resolution data occurs at the rate of 5 per second.
Ground Detection for High Res PBL	i_HRpbl_grd	deka-m	10.0D0	The height above the reference ellipsoid of the ground used by the high res PBL processing algorithms.
Layer Height Flag contains:	i_LayHgt_Flag			
Spares	i_BPsare1			
Low res PBL clear/ cloudy flag	i_LRpbl_ccf	NA	NA	Flag indicating whether the PBL found at low resolution is clear or cloudy based upon ground detection (0=clear,1=cloudy).
Low res PBL use flag	i_LRpbl_uf	NA	NA	PBL use flag at 1 per 4 sec. Value of 2 indicates that PBL was not searched for, 0 indicates that PBL was searched for, but not detected.

Table C-1 GLA08: 10/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Low res PBL quality level flag	i_LRpbl_qf	NA	NA	PBL quality flag at 1 per 4 sec based upon ratio of PBL signal to troposphere signal. Values 1 to 13 indicate increasing goodness. 14 indicates bad, 15 indicates PBL not searched for, 0 indicates that PBL was searched for, but not detected.
Spares	I_BSpare2			
High res PBL clear/ cloudy flag	i_HRpbl_ccf	NA	NA	Flag indicating whether the PBL found at high resolution is clear or cloudy based upon ground detection (0=clear,1=cloudy).
High res PBL use flag	i_HRpbl_uf	NA	NA	PBL use flag at 5 Hz. Value of 2 indicates that PBL was not searched for, 0 indicates that PBL was searched for, but not detected.
High res PBL quality level flag	i_HRpbl_qf	NA	NA	PBL quality flag at 5 Hz based upon ratio of PBL signal to troposphere signal. Values 1 to 13 indicate increasing goodness. 14 indicates bad, 15 indicates PBL not searched for, 0 indicates that PBL was searched for, but not detected.
Spares	i_BSpare3			
Below 20 km aerosol layer use flag	i4_aer_uf	NA	NA	Aerosol use flag at 1 per 4 sec. Value of 2 indicates that lower (< 20 km) aerosol layers were not searched for, 0 indicates that they were searched for, but not detected.
Spares	I_BSpare4			
Below 20 km aerosol layer quality level flag	i4_aer_qf	NA	NA	Aerosol quality flag at 1 per 4 sec based upon ratio of average signal to above signal. Values 1 to 13 indicate increasing goodness. 14 indicates bad, 15 indicates that lower (< 20 km) aerosol layers were not searched for, 0 indicates that they were searched for, but not detected.
Spares	i_BSpare5			

Table C-1 GLA08: 10/24/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
20-40 km aerosol layer use flag	i20_aer_uf	NA	NA	Aerosol use flag at 1 per 20 sec. Value of 2 indicates that upper (> 20 km) aerosol layers were not searched for, 0 indicates that they were searched for, but not detected.
Spares	i_BSpare6			
20-40 km aerosol layer quality level flag	i20_aer_qf	NA	NA	Aerosol quality flag at 1 per 20 sec based upon ratio of average signal to threshold signal. Values 1 to 13 indicate increasing goodness. 14 indicates bad, 15 indicates that upper (< 20 km) aerosol layers were not searched for, 0 indicates that they were searched for, but not detected.
Spares	i_BSpare7			
Polar Stratospheric Cloud (PSC) flag	i_pscf	NA	NA	Polar Stratospheric Cloud (PSC) flag based upon latitude and temperature (1=low likely,2=med likely,3=high likely).

C.2 GLA09

Table C-2 GLA09: 10/25/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Cloud Height Record Index of First Record	i_rec_ndx			Unique index that relates this record to the corresponding record(s) in the other GLAS data products.
Time of First Record - Seconds	i_UTCTime	Seconds	(/ 1.0D0, 1.0D-6 /)	The time tag of the first sample, in this record, corrected for system and transit delay, in CCSDS day segmented binary form.
PAD Pointing Vector of First Record	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.
Latitude	i_lat	Microdegrees	1.0D-6	Profile location in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Longitude	i_lon	Microdegrees	1.0D-6	Profile location in the IERS Terrestrial Reference Frame: east longitude and latitude, at the 1 herz rate.
Latitude Deltas (referenced to profile location)	i_lat_deltas	Microdegrees	1.0D-6	Will be removed for V2.
Longitude Deltas (referenced to profile location)	i_lon_deltas	Microdegrees	1.0D-6	Will be removed for V2.
Delta PAD Pointing Vectors	i_pad_deltas		(/ 1.0D-6, 1.0D-12 /)	Will be removed for V2.
POD & PAD orbit quality flag	i_PODPADqf			POD orbit quality flag
Spares	i_Spare1			

Table C-2 GLA09: 10/25/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Surface elevation - peak of return	i_SrfEl_PkRt	Millimeters	0.001_8	The surface elevation based on the peak of the ground return.
Surface elevation - threshold of return	i_SrfEl_ThRt	Millimeters	0.001_8	The surface elevation based on the threshold of the ground return.
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.
Low Resolution Cloud Bottom	i_LRcld_bot	deka-m	10.0D0	Low resolution height above the reference ellipsoid of the bottom of a cirrus, thin, or dense cloud layer in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The low resolution data occurs at the rate of once per 4 seconds.
Low Resolution Cloud Top	i_LRcld_top	deka-m	10.0D0	Low resolution height above the reference ellipsoid of the top of a cirrus, thin, or dense cloud layer in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The low resolution data occurs at the rate of once per 4 seconds.
Low Resolution Ground Detection	i_LRcld_grd	deka-m	10.0D0	The height from the reference ellipsoid of the ground as detected by the low res cloud processing algorithms. A value of -880 indicates that the ground was searched for, but not detected.
Spares	i_Spare2			
Medium Resolution Cloud Bottom	i_MRcld_bot	deka-m	10.0D0	Medium resolution height above the reference ellipsoid of the bottom of a cirrus, thin, or dense cloud layer in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The medium resolution data occurs at the rate of once per second.

Table C-2 GLA09: 10/25/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Medium Resolution Cloud Top	i_MRcld_top	deka-m	10.0D0	Medium resolution height above the reference ellipsoid of the top of a cirrus, thin, or dense cloud layer in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The medium resolution data occurs at the rate of once per second.
Medium Resolution Ground Detection	i_MRcld_grd	deka-m	10.0D0	The height above the reference ellipsoid of the ground as detected by the med res cloud processing algorithms. A value of -880 indicates that the ground was searched for, but not detected.
High Resolution Cloud Bottom	i_HRcld_bot	deka-m	10.0D0	High resolution height above the reference ellipsoid of the bottom of a cirrus, thin, or dense cloud layer below 10KM in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The high resolution data occurs at the rate of 5 per second.
High Resolution Cloud Top	i_HRcld_top	deka-m	10.0D0	High resolution height above the reference ellipsoid of the top of a cirrus, thin, or dense cloud layer below 10 KM in the atmosphere. There can be up to 10 cloud layers in an atmospheric profile. The high resolution data occurs at the rate of 5 per second.
High Resolution Ground Detection	i_HRcld_grd	deka-m	10.0D0	The height above the reference ellipsoid of the ground as detected by the high res cloud processing algorithms. A value of -880 indicates that the ground was searched for, but not detected.
Full Resolution Cloud Bottom	i_FRcld_bot	deka-m	10.0D0	The height above the reference ellipsoid to the bottom of the full resolution cloud layer. The full resolution data occurs at the rate of 40 per second, however, the full resolution cloud layer will only be processed from high resolution layers found below 4 KM. If there are no high resolution layers below 4 KM then the full resolution data will be marked as invalid on the product.

Table C-2 GLA09: 10/25/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Full Resolution Cloud Top	i_FRcld_top	deka-m	10.0D0	The height above the reference ellipsoid to the top of the full resolution cloud layer. The full resolution data occurs at the rate of 40 per second, however, the full resolution cloud layer will only be processed from high resolution layers found below 4 KM. If there are no high resolution layers below 4 KM then the full resolution data will be marked as invalid on the product.
Full Resolution Cloud Ground Detection	i_FRcld_grd	deka-m	10.0D0	The height above the reference ellipsoid of the ground as detected by the full resolution cloud processing algorithms. A value of -880 indicates that the ground was searched for, but not detected.
Low Res Cloud Layer Flag contains:	i_LRCL_Flag			
Bspares	i_BSpare1			
Low res cloud layer availability flag	i_LRC_af			Flag indicating number of low resolution cloud layers present on the product. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Low res cloud layer quality flag	i_LRC_qf			Cloud quality flag at 1 per 4 sec. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected. If value is 14 then cloud bottom is questionable.
BSpares	i_BSpare2			
Low res cloud layer use flag	i_LRC_uf			Cloud use flag at 1 per 4 sec. Value of 2 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Bspares	i_BSpare3			
Low Resolution Diurnal flag	i_LRC_df			Flag indicating that cloud would have been detected using nocturnal algorithm; 1 = detection, 0 = no detection.

Table C-2 GLA09: 10/25/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Spares	i_Spares3			
Medium Res Cloud Layer Flag contains:	i_MRCL_Flag			
Medium res cloud layer availability flag	i_MRC_af			Flag indicating number of medium resolution cloud layers present on the product. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Medium res cloud layer quality flag	i_MRC_qf			Cloud quality flag at 1 per sec. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected. If value is 14 then cloud bottom is questionable.
Medium res cloud layer use flag	i_MRC_uf			Cloud use flag at 1 per sec. Value of 2 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Medium Resolution Diurnal Flag	i_MRC_df			Flag indicating that cloud would have been detected using nocturnal algorithm; 1 = detection, 0 = no detection.
Spares	i_Spares4			
High Res Cloud Layer Flag contains:	i_HRCL_Flag			
High res cloud layer availability flag	i_HRC_af			Flag indicating number of high resolution cloud layers present on the product. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
High res cloud layer quality flag	i_HRC_qf			Cloud quality flag at 5 Hz. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected. If value is 14 then cloud bottom is questionable.

Table C-2 GLA09: 10/25/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
High res cloud layer use flag	i_HRC_uf			Cloud use flag at 5 Hz. Value of 2 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
HIgh Resolution Diurnal Flag	i_HRC_df			Flag indicating that cloud would have been detected using nocturnal algorithm; 1 = detection, 0 = no detection.
Spares	i_Spares5			
Full Res Cloud Layer Flag contains:	i_FRCL_Flag			
Full res cloud layer availability flag	i_FRC_af			Flag indicating number of full resolution cloud layers present on the product. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Full res cloud layer quality flag	i_FRC_qf			Cloud quality flag at 40 Hz. Value of 15 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected. If value is 14 then cloud bottom is questionable.
Full res cloud layer use flag	i_FRC_uf			Cloud use flag at 40 Hz. Value of 2 indicates that cloud layers were not searched for, 0 indicates that they were searched for, but not detected.
Full Resolution Diurnal Flag	i_FRC_df			Flag indicating that cloud would have been detected using nocturnal algorithm; 1 = detection, 0 = no detection.

C.3 GLA10

Table C-3 GLA10: 06/21/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Cross Section Record Index	i_rec_ndx			
Time of First Sample	i_UTCTime		(/ 1.0, 1.0D-6 /)	
PAD Pointing Vector	i_PADPoint		(/ 1.00D-6, 1.00D-12 /)	
Latitude	i_lat		1.0D-06	
Longitude	i_lon		1.0D-06	
Spares	i_Spare1			
Cloud backscatter flag	i_cld1_bs_flag			
Cloud backscatter quality flag	i_cld1_bs_qf	NA		4 sec/records, up to 10 layers/sec, (40 4-bit flags)
Cloud backscatter use flag	i_cld1_bs_uf	NA		4 sec/records, up to 10 layers/sec (40 4-bit flags total)
Cloud extinction flag	i_cld1_ext_flag			
Cloud extinction quality flag	i_cld1_ext_qf	NA		4 sec/records, up to 10 layers/sec, (40 4-bit flags)
Cloud extinction use flag	i_cld1_ext_uf	NA		4 sec/records, up to 10 layers/sec (40 4-bit flags total)
Aerosol backscatter flag	i_aer4_bs_flag			
BSpares	i_BSpare1			
Aerosol backscatter quality flag	i_aer4_bs_qf	NA		once per 4 sec, up to 9 layers/record (9 4-bit flags)

Table C-3 GLA10: 06/21/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
BSpares	i_BSpare2			
Aerosol backscatter use flag	i_aer4_bs_uf	NA		once per 4 sec, up to 9 layers/record (9 4-bit flags)
Aerosol extinction flag	i_aer4_ext_flag			
BSpares	i_BSpare3			
Aerosol extinction quality flag	i_aer4_ext_qf	NA		once per 4 sec, up to 9 layers/record (9 4-bit flags)
BSpares	i_BSpare4			
Aerosol extinction use flag	i_aer4_ext_uf	NA		once per 4 sec, up to 9 layers/record (9 4-bit flags)
Spares	i_Spare2			
Cloud Backscatter Cross Section Profile	i_cld1_bs_prof	e10/(m-sr)	1.0d-10	280 bins
Cloud Extinction Cross Section Profile	i_cld1_ext_prof	e9/m	1.0d-9	280 bins
Aerosol Backscatter Cross Section Profile	i_aer4_bs_prof	e10/(m-sr)	1.0d-10	548 bins
Aerosol Extinction Cross Section Profile	i_aer4_ext_prof	e9/m	1.0d-9	548 bins
Cloud true S values from table	i_cld1_sval1	100*sr	1.0d-2	4 sec/records, up to 10 layers/sec
Cloud true S values from equation calc.	i_cld1_sval2	100*sr	1.0d-2	4 sec/records, up to 10 layers/sec

Table C-3 GLA10: 06/21/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Cloud true S values use flag	i_cld1_sval_uf	NA		4 sec/records, up to 10 layers/sec
Spares	i_Spare3			
Aerosol true S Values use flag	i_aer4_sval_uf	NA		once per 4 sec, up to 9 layers/record
Aerosol true S Values from equation calc.	i_aer4_sval2	100*sr	1.0d-2	once per 4 sec, up to 9 layers/record
Aerosol true S Values from table	i_aer4_sval1		1.0d-2	once per 4 sec, up to 9 layers/record
Medium Resolution Cloud Bottom	i_cld1_bot	deka-m	10.0d0	4 sec/records, up to 10 layers/sec
Medium Resolution Cloud Top	i_cld1_top	deka-m	10.0d0	4 sec/records, up to 10 layers/sec
Medium Resolution Ground Detection	i_cld1_grd_det	deka-m	10.0d0	4 sec/records
Low Resolution Aerosol Layer Bottom	i_aer4_bot	deka-m	10.0d0	once per 4 sec, up to 9 layers/record
Low Resolution Aerosol Layer Top	i_aer4_top	deka-m	10.0d0	once per 4 sec, up to 9 layers/record
Low Resolution Aerosol Layer Ground Detection	i_pbl4_grd_det	deka-m	10.0d0	1 / record
Spares	i_Spare4			

C.4 GLA11

Table C-4 GLA11: 06/21/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Optical Depth Record Index	i_rec_ndx			
Time of First Sample	i_UTCTime		(/ 1.0D0, 1.0D-6 /)	
PAD Pointing Vector	i_PADPoint		(/1.0D-6,1.0D-12 /)	invalid
Latitude	i_lat		1.0D-6	invalid
Longitude	i_lon		1.0D-6	invalid
Spares	i_spare1			
Multiple Scattering Warning Flag	i_cld1_mswf	NA		
Cloud optical depth flag	i_cld1_flag	NA		
Cloud optical depth quality flag	i_cld1_qf	NA		
Cloud optical depth use flag	i_cld1_uf	NA		
Aerosol optical depth flag	i_aer4_flag	NA		
Aerosol optical depth quality flag	i_aer4_qf	NA		
Aerosol optical depth use flag	i_aer4_uf	NA		
PBL optical depth flag	i_pbl4_flag	NA		

Table C-4 GLA11: 06/21/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
PBL optical depth quality flag	i_pbl4_qf	NA		
PBL optical depth use flag	i_pbl4_uf	NA		
Spares	i_spare2			
Cloud Optical Depth	i_cld1_od	unitless	1.0D-3	invalid
Aerosol Optical Depth	i_aer4_od	unitless	1.0D-3	invalid
PBL Optical Depth	i_pbl4_od	unitless	1.0D-3	invalid
Aerosol Multiple Scattering Factor	i_aer4_msf	unitless	1.0D-3	invalid
Cloud Multiple Scattering Factor	i_cld1_msf	unitless	1.0D-3	invalid
Medium Resolution Cloud Bottom	i_cld1_bot	deka-m	10.0d0	invalid
Medium Resolution Cloud Top	i_cld1_top	deka-m	10.0d0	invalid
Medium Resolution Ground Detection	i_cld1_grd_det	deka-m	10.0d0	invalid
Low Resolution Aerosol Layer Bottom	i_aer4_bot	deka-m	10.0d0	invalid
Low Resolution Aerosol Layer Top	i_aer4_top	deka-m	10.0d0	invalid
Low Resolution PBL Height	i_aer4_ht	deka-m	10.0d0	invalid

Table C-4 GLA11: 06/21/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Ground Detection for Low Res PBL	i_aer4_grd_det	deka-m	10.0d0	invalid
Spares	i_spare3			

C.5 GLA12

Table C-5 GLA12: 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, microsec	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 correction, used to calculate orbit.
Laser Shot Time Deltas for 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.
Coordinate Data, Latitude, specific to ice sheet range	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 ground nadir coordinates, PAD, and ice sheet-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude and geodetic latitude.
Coordinate Data, Longitude, specific to ice sheet range	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 ground nadir coordinates, PAD, and ice sheet-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude and geodetic latitude.
Ice Sheet Surface elevation	i_elev	mm	1.00E-03	Surface elevation wrt ellipsoid at the spot location determined by range to the ice sheet specific fitting procedure after atmospheric delays and tides have been applied.
PAD Pointing Vector	i_PADPoint	N/A	1.00E-06	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ICRF reference frame. Each component is composed of 2 4-byte items. This also includes the effect of the pole tide.

Table C-5 GLA12: 09/06/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
POD nadir position	i_PODFixed Pos	mm	1.00E-03	Time-ordered spacecraft position vector in ICRF x, y, z. Each element is composed of 2 4-byte items. The first is m and the second is micrometers. This is the nadir ground location of the laser antenna on the spacecraft.
POD/PAD Quality Flag	i_PODPADQ F	N/A		POD/PAD Quality Flag, 1st 40 bits describe the POD quality, 2nd 40 bits describe the PAD quality; one bit per shot
Spare	i_Spare1			
Solar Incidence Angle	i_SolAng	millideg	1.00E-03	The solar incidence angle determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Orientation of Pulse	i_PulsOrient	millideg	1.00E-03	Rotation clock angle of the major axis of the footprint; referenced to the ground track path. HAS BOB (UTCSR) Been asked for this?
Local Azimuth	i_Azimuth	millideg	1.00E-03	Azimuth of the ground track.
Semi-major axis of footprint	i_sMajAxFtPr n	cm	1.00E-02	Semi-major axis of the footprint as measured by the LPA
Semi-minor axis of footprint	i_sMinAxFtPr n	cm	1.00E-02	Semi-minor axis of the footprint as measured by the LPA
Geoid	i_gdHt	cm	1.00E-02	The height of the geoid above the ellipsoid.
Earth Tide Elevation	i_erElv	mm	1.00E-03	Solid earth tide elevation
Load Tide Elevation	i_ldElv	mm	1.00E-03	Load tide elevation
Tide Elevations, Specific regions	i_spElv	mm	1.00E-03	Alternate tide models for specific regions
Ocean Tide Elevation	i_ocElv	mm	1.00E-03	Ocean tide elevation

Table C-5 GLA12: 09/06/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
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.
Range Correction, Dry Troposphere	i_dTrop	mm	1.00E-03	Atmospheric dry tropospheric delay correction added to the elevation
Range Correction, Wet Troposphere	i_wTrop	mm	1.00E-03	Atmospheric wet tropospheric delay correction added to the elevation
Spare	i_Spare2			
Atmosphere flag	i_atmQF	N/A		8 bits/measurement indicating presence of cloud layers and some measure of optical depth as detected by the onboard GLAS lidar
Meteorological Data Quality Flag	i_metFlg	N/A		Flag indicating quality and source of the meteorological data
Spare	i_Spare3			
DEM Elevation	i_DEM_elv	mm	1.00E-03	Elevation with respect to sea level as interpolated from a Digital Elevation Map (DEM) at each laser pulse location
Reference Range	i_refRng	mm	1.00E-03	Use GLA06 def. -Range calculated from the time between the peak of the transmit and the gate of the received pulse transmitted farthest from the spacecraft
Threshold Retracker range increment	i_TrshRngOff	mm	1.00E-03	Range increment from reference range to threshold retracker range
Ice Sheet Range increment using last peak	i_IsRngLast	mm	1.00E-03	Range increment to be added to reference range to calculate ice sheet specific range from centroid of last peak in ice sheet Gaussian fit

Table C-5 GLA12: 09/06/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Ice Sheet Range increment using first peak	i_IsRngFst	mm	1.00E-03	Range increment to be added to reference range to calculate ice sheet specific range from centroid of first peak in ice sheet Gaussian fit
Signal Begin range increment	i_SigBegOff	mm	1.00E-03	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	1.00E-03	Range increment to be added to reference range to signal end as computed in ground processing
Centroid Range increment	i_cntRngOff	mm	1.00E-03	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	1.00E-06	Ratio of the corrected received to the transmitted laser pulse energy, as a measure of the surface reflectance with all corrections applied.
Kurtosis	i_kurt2		0.01	The kurtosis of the raw waveform using gates from signal begin to signal end using ice sheet, sea ice, and ocean parameters.
Skewness	i_skew2		0.01	The skewness of the raw waveform using gates from signal begin to signal end using ice sheet, sea ice, and ocean parameters.
Spare	i_Spare4			
Error Estimate of Ice Sheet Range Increment	i_IsRngOffErr	cm	1.00E-02	Error estimate on the centroid of Gaussian fit to last peak.
Variance of the Ice Sheet Gaussian fit	i_IceSVar	cm	1.00E-02	The variance of the raw waveform to the Gaussian ice sheet fit.
Peak Amplitude of Smooth WF	i_maxSmAmp	counts	0.01	The peak amplitude from the smoothed waveform.

Table C-5 GLA12: 09/06/2000

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Ice Sheet Rough-ness	i_IceSheetRuf	cm	1.00E-02	The surface roughness over the footprint calculated empirically from the transmitted and received waveforms assuming no slope .
Ice Sheet Slope - wf	i_IsSlopeEmp	cdeg	1.00E-02	The surface slope over the footprint calculated empirically from the trans-mitted and received waveforms assuming no roughness
Ice Sheet Slope - elev	i_IsSlopeElev	cdeg	1.00E-02	The surface slope over the footprint calculated from DEM or GLAS eleva-tion results
Ice Sheet Elevation Quality Flag	i_IceSheetQF	N/A		Data quality flag for the ice sheet elevation group; 1 bit indicates quality based on good vs. bad criteria.
Spare	i_Spare5			
Ice Sheet Rough-ness/slope Quality Flag	i_IsRufQF	N/A		Data quality flag for the ice sheet roughness and slope indicates quality based on good vs. bad criteria.
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.
Number of peaks from Waveform Fit	i_numPk	N/A		The number of peaks in the waveform produced by the Gaussian filtering (from other than land algorithm), calculated from the number of WF parameters output on GLA05 (up to 6).
Spare	i_Spare6			

C.6 GLA13

Table C-6 GLA13: 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, microsec	1.00E-06	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 correction, used to calculate orbit.
Laser Shot Time Deltas for 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.
Coordinate Data, Latitude, specific to sea ice range	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 ground nadir coordinates, PAD, and sea ice specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude, geodetic latitude.
Coordinate Data, Longitude, specific to sea ice range	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 ground nadir coordinates, PAD, and sea ice specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude, geodetic latitude.
Sea Ice Surface Elevation	i_elev	mm	1.0d-03	Surface elevation wrt ellipsoid at the spot location determined by range using the sea ice specific fitting procedure after atmospheric delays and tides have been applied.
PAD Pointing Vector	i_PADPoint	N/A	1.0d-6	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ITRF reference frame. Each component is composed of 2 4-byte items. This also includes the effect of the pole tide.

Table C-6 GLA13: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
POD nadir position	i_PODFixedPos	mm	1.00E-03	Time-ordered spacecraft position vector in ITRF x, y, z. Each element is composed of 2 4-byte items. The first is m and the second is micrometers. 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
Spare	i_Spare1			
Solar Incidence Angle	i_SolAng	Millideg	1.00E-03	The solar incidence angle determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Orientation of Pulse	i_PulsOrient	Millideg	1.00E-03	Rotation clock angle of the major axis of the footprint; referenced to the ground track path. HAS BOB (UTCSR) Been asked for this?
Local Azimuth	i_Azimuth	Millideg	1.00E-03	Azimuth of the ground track.
Semi-major axis of footprint	i_sMajAxFtPrn	cm	1.00E-02	Semi-major axis of the footprint as measured by the LPA
Semi-minor axis of footprint	i_sMinAxFtPrn	cm	1.00E-02	Semi-minor axis of the footprint as measured by the LPA
Geoid	i_gdHt	cm	1.00E-02	The height of the geoid above the ellipsoid.
Earth Tide Elevation	i_erElv	mm	1.00E-03	Solid earth tide elevation
Load Tide Elevation	i_ldElv	mm	1.00E-03	Load tide elevation
Tide Elevations, Specific regions	i_spElv	mm	1.00E-03	Alternate tide models for specific regions
Ocean Tide Elevation	i_ocElv	mm	1.00E-03	Ocean tide elevation

Table C-6 GLA13: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
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.
Range Correction, Dry Troposphere	i_dTrop	mm	1.00E-03	Atmospheric dry tropospheric delay correction added to the elevation
Range Correction, Wet Troposphere	i_wTrop	mm	1.00E-03	Atmospheric wet tropospheric delay correction added to the elevation
Spare	i_Spare2			
Atmosphere flag	i_atmQF	N/A		8 bits/measurement indicating presence of cloud layers and some measure of optical depth
Meteorological Data Quality Flag	i_metFlg	N/A		Flag indicating quality and source of the meteorological data
Spare	i_Spare3			
DEM Elevation	i_DEM_elv	cm	1.00E-02	Elevation with respect to sea level as interpolated from a Digital Elevation Map (DEM) at each laser pulse location
Reference Range	i_refRng	mm	1.00E-03	Use GLA06 definition-Range calculated from the time between the peak of the transmit and the gate of the received pulse transmitted farthest from the spacecraft
Threshold Retracker range increment	i_TrshRngOff	mm	1.00E-03	Range increment from reference range to threshold retracker range
Sea ice range increment to first peak	i_SiRngFst	mm	1.00E-03	Range increment to be added to reference range to compute the sea ice specific range. This was determined from centroid of first peak in sea ice Gaussian fit
Average elevation	i_AvgElev	mm	1.00E-03	Average elevation of all surfaces in the footprint from the centroid of the raw waveform with all corrections applied.

Table C-6 GLA13: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Signal Begin range increment	i_SigBegOff	mm	1.00E-03	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	1.00E-03	Range increment to be added to reference range to signal end as computed in ground processing
Centroid Range increment	i_cntRngOff	mm	1.00E-03	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	1.00D-6	Ratio of the corrected received to the transmitted laser pulse energy, as a measure of the surface reflectance with all corrections applied.
Skewness	i_skew2		0.01	The skewness of the raw waveform using gates from signal begin to signal end using ice sheet, sea ice, and ocean parameters.
Spare	i_Spare4			
Error Estimate of Sea Ice Range Increment	i_SiRngOffErr	cm	1.00E-02	Error estimate on the centroid of Gaussian fit to last peak.
Variance of the sea ice Gaussian fit	i_SeaIceVar	cm	1.00E-02	The variance of the raw waveform to the Gaussian sea ice fit.
Peak Amplitude of Smooth WF	i_maxSmAmp	counts	0.01	The peak amplitude from the smoothed waveform.
Surface Roughness – last peak	i_SiRufLstPk	mm	1.00E-02	The surface roughness over the footprint calculated empirically from the transmitted and received waveforms using the RMS width of the last peak.
Surface Roughness – whole signal	i_RufSeaIce	mm	1.00E-02	The surface slope over the footprint calculated empirically from the transmitted and received waveforms using the RMS width of the entire waveform
Sea ice Elevation Quality Flag	i_SeaIceQF	N/A		Data quality flag for the sea ice elevation -allows 4 bits per elevation measurement; 1 bit indicates quality based on good vs. bad criteria.

Table C-6 GLA13: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Spare	i_Spare5			
Sea ice Roughness Quality Flag	i_SiRufQF	N/A		Data quality flag for the sea ice roughness indicates quality based on good vs. bad criteria.
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.
Number of Peaks from Waveform Fit	i_numPk	N/A		The number of peaks in the waveform produced by the Gaussian filtering (from other than land algorithm), calculated from the number of WF parameters output on GLA05 (up to 6).
Spare	1_Spare6			

C.7 GLA14

Table C-7 GLA14: 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, microsec	1.00E-06	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 correction, used to calculate orbit.
Laser Shot Time Deltas for 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.
Coordinate Data, Latitude, specific to land range	i_lat	microdeg	1.00E-06	The coordinates of the each laser spot in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna ground nadir coordinates, PAD, and land-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude and geodetic latitude.
Coordinate Data, Longitude, specific to land range	i_lon	microdeg	1.00E-06	The coordinates of the each laser spot in the 1 second time frame, computed from the Precision orbit determined GLAS laser antenna ground nadir coordinates, PAD, and land-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude and geodetic latitude.
Land surface Elevation	i_elev	mm	1.00E-03	Surface elevation wrt ellipsoid at the spot location determined by range using the land specific fitting procedure after atmospheric delays and tides have been applied.
PAD Pointing Vector	i_PADPoint	N/A	1.00E-06	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ITRF reference frame. Each component is composed of 2 4-byte items. This also includes the effect of the pole tide.

Table C-7 GLA14: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
POD nadir position	i_PODFixedPos	mm	1.00E-03	Time-ordered spacecraft position vector in ITRF x, y, z. Each element is composed of 2 4-byte items. The first is m and the second is micrometers. 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
Spare	i_Spare1			
Solar Incidence Angle	i_SolAng	millideg	1.00E-03	The solar incidence angle determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Orientation of Pulse	i_PulsOrient	Millideg	1.00E-03	Rotation clock angle of the major axis of the footprint; referenced to the ground track path. HAS BOB (UTCSR) Been asked for this?
Local Azimuth	i_Azimuth	millideg	1.00E-03	Azimuth of the ground track.
Semi-major axis of footprint	i_sMajAxFtPrn	cm	1.00E-02	Semi-major axis of the footprint as measured by the LPA
Semi-minor axis of footprint	i_sMinAxFtPrn	cm	1.00E-02	Semi-minor axis of the footprint as measured by the LPA
Geoid	i_gdHt	cm	1.00E-02	The height of the geoid above the ellipsoid.
Earth Tide Elevation	i_erElv	mm	1.00E-03	Solid earth tide elevation
Load Tide Elevation	i_ldElv	mm	1.00E-03	Load tide elevation
Tide Elevations, Specific regions	i_spElv	mm	1.00E-03	Alternate tide models for specific regions
Ocean Tide Elevation	i_ocElv	mm	1.00E-03	Ocean tide elevation

Table C-7 GLA14: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
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.
Range Correction, Dry Troposphere	i_dTrop	mm	1.00E-03	Atmospheric dry tropospheric delay correction added to the elevation
Range Correction, Wet Troposphere	i_wTrop	mm	1.00E-03	Atmospheric wet tropospheric delay correction added to the elevation
Spare	i_Spare2			
Atmosphere flag	i_atmQF	N/A		8 bits/measurement indicating presence of cloud layers and some measure of optical depth
Meteorological Data Quality Flag	i_metFlg	N/A		Flag indicating quality and source of the meteorological data
Spare	i_Spare3			
DEM Elevation	i_DEM_elv	cm	1.00E-02	Elevation with respect to sea level as interpolated from a Digital Elevation Map (DEM) at each laser pulse location
Reference Range	i_refRng	mm	1.00E-03	Use GLA06 def- Range calculated from the time between the peak of the transmit and the gate of the received pulse transmitted farthest from the spacecraft
Threshold Retracker range increment	i_TrshRngOff	mm	1.00E-03	Range increment from reference range to threshold retracker range
Land Range increment	i_LdRngOff	mm	1.00E-03	Range increment to be added to reference range to calculate land specific range
Signal Begin range increment	i_SigBegOff	mm	1.00E-03	Range increment to be added to reference range to calculate range to signal begin as computed in ground processing

Table C-7 GLA14: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Signal end range increment	i_SigEndOff	mm	1.00E-03	Range increment to be added to reference range to signal end as computed in ground processing
Amplitudes of Gauss-ians	i_Gamp	counts	0.01	Amplitude of each Gaussian solved for (up to six)
Area under Gaussian	i_Garea	Counts X ns	0.01	Area under each of the Gaussians solved for (up to six)
Sigma of Gaussians	i_Gsigma	mm	1.00E-03	Width (sigma) of each Gaussian solved for (up to six)
Centroid Range increments	i_cntRngOff	mm	1.00E-03	Range increment from reference range to centroid of each Gaussian in the fit (up to six)
Reflectance	i_refl	N/A	1.0D-6	Ratio of the corrected received to the transmitted laser pulse energy, as a measure of the surface reflectance with all corrections applied.
Kurtosis	i_kurt1		0.01	The kurtosis of the raw waveform using gates from signal begin to signal endusing land parameters.
Skewness	i_skew1		0.01	The skewness of the raw waveform using gates from signal begin to signal end using land parameters.
Spare	i_Spare4			
Error Estimate of land Range Increment	i_LdRngOffErr	cm	1.00E-02	Error estimate on the centroid of Gaussian fit to last peak.
Variance of the Land Gaussian fit	i_LandVar	cm	0.01d0	The variance of the raw waveform to the Gaussian land fit.
Peak Amplitude of Smooth WF	i_maxSmAmp	counts	0.01	The peak amplitude from the smoothed waveform.
Land Roughness - last	i_LdRufLstPk	cm	1.0d-2	The surface roughness over the footprint calculated empirically from the transmitted and received waveforms assuming no slope using RMS of last Gaussian .

Table C-7 GLA14: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Land Roughness - all	i_RufLand	cm	1.0d-2	The surface roughness over the footprint calculated empirically from the transmitted and received waveforms assuming no slope using RMS of full fit.
Land Slope – wf - all	i_LandSlope	cdeg	1.0d-2	The surface slope over the footprint calculated empirically from the transmitted and received waveforms assuming no roughness using RMS of full fit
Land Slope – wf - last	i_LandSlopeLast	cdeg	1.0d-2	The surface slope over the footprint calculated empirically from the transmitted and received waveforms assuming no roughness using RMS of last Gaussian
Land Slope - elev	i_LandSlopeElev	cdeg	1.0d-2	The surface slope over the footprint calculated from DEM or GLAS elevation results
Land Elevation Quality Flag	i_LandQF	N/A		Data quality flag for the land elevation group; allows 4 bits per elevation measurement; 1 bit indicates quality based on good vs. bad criteria.
Spare	i_Spare5			
Land Roughness/ slope Quality Flag	i_LdRufQF	N/A		Data quality flag for the land roughness and slope indicates quality based on good vs. bad criteria.
Surface Type	i_surfType	N/A		Describes the surface type or types associated with each shot Inland Water, Glacier, , ocean, sea ice, Unvegetated Land, Urban, or Vegetated Land.
Number of Peaks from Waveform Fit	i_numPk	N/A		The number of Peaks in the waveform produced by the Gaussian filtering (from land algorithm), calculated from the number of WF parameters output on GLA05 (up to 6).
Initial Number of Peaks of the Smooth WF (land)	i_nPeaks1	N/A		The number of peaks in the smooth waveform produced by the Gaussian filtering

Table C-7 GLA14: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Spare	i_Spare6			

C.8 GLA15

Table C-8 GLA15: 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, microsec	1.00E-06	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 correction, used to calculate orbit.
Laser Shot Time Deltas for 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.
Coordinate Data, Latitude, specific to ocean range	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 ground nadir coordinates, PAD, and ocean-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude, geodetic latitude
Coordinate Data, Longitude, specific to ocean range	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 ground nadir coordinates, PAD, and ocean-specific range after all atmospheric corrections and tides have been applied. The coordinates are east longitude, geodetic latitude
Ocean Surface Elevation	i_elev	mm	1.00E-03	Surface elevation wrt ellipsoid at the spot location determined by range using the ocean specific fitting procedure after atmospheric delays and tides have been applied.

Table C-8 GLA15: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
PAD Pointing Vector	i_PADPoint	N/A	1.00E-06	Time-ordered unit vectors giving the laser pointing direction wrt the laser antenna in ICRF reference frame. Each component is composed of 2 4-byte items. This also includes the effect of the pole tide.
POD nadir position	i_PODFixedPos	mm	1.00E-03	Time-ordered spacecraft position vector in ICRF x, y, z. Each element is composed of 2 4-byte items. The first is m and the second is micrometers. 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
Spare	i_Spare1			
Solar Incidence Angle	i_SolAng	millideg	1.00E-03	The solar incidence angle determined during Precision Orbit Determination processing; it provides the operational sun angle estimate.
Orientation of Pulse	i_PulsOrient	Millideg	1.00E-03	Rotation clock angle of the major axis of the footprint; referenced to the ground track path. HAS BOB (UTCSR) Been asked for this?
Local Azimuth	i_Azimuth	millideg	1.00E-03	Azimuth of the ground track.
Semi-major axis of footprint	i_sMajAxFtPrn	cm	1.00E-02	Semi-major axis of the footprint as measured by the LPA
Semi-minor axis of footprint	i_sMinAxFtPrn	cm	1.00E-02	Semi-minor axis of the footprint as measured by the LPA
Geoid	i_gdHt	cm	1.00E-02	The height of the geoid above the ellipsoid.
Earth Tide Elevation	i_erElv	mm	1.00E-03	Solid earth tide elevation
Load Tide Elevation	i_ldElv	mm	1.00E-03	Load tide elevation

Table C-8 GLA15: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Tide Elevations, Specific regions	i_spElv	mm	1.00E-03	Alternate tide models for specific regions
Ocean Tide Elevation	i_ocElv	mm	1.00E-03	Ocean tide 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.
Range Correction, Dry Troposphere	i_dTrop	mm	1.00E-03	Atmospheric dry tropospheric delay correction added to the elevation
Range Correction, Wet Troposphere	i_wTrop	mm	1.00E-03	Atmospheric wet tropospheric delay correction added to the elevation
Spare	i_Spare2			
Atmosphere flag	i_atmQF	N/A		8 bits/measurement indicating presence of cloud layers and some measure of optical depth
Meteorological Data Quality Flag	i_metFlg	N/A		Flag indicating quality and source of the meteorological data
Spare	i_Spare3			
DEM Elevation	i_DEM_elv	cm	1.00E-02	Elevation with respect to sea level as interpolated from a Digital Elevation Map (DEM) of the mean sea surface at each laser pulse location
Reference Range	i_refRng	mm	1.00E-03	Range calculated from the time between the peak of the transmit and the gate of the received pulse transmitted farthest from the spacecraft
Threshold Retracker range increment	i_TrshRngOff	mm	1.00E-03	Range increment from reference range to threshold retracker range

Table C-8 GLA15: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Ocean range increment to first peak	i_OcRngFst	mm	1.00E-03	Range increment to be added to reference range to compute ocean specific range from centroid of first peak in ocean Gaussian fit
Ocean range increment to last peak	i_OcRngLast	mm	1.00E-03	Range increment to be added to reference range to compute ocean specific range from centroid of last peak in ocean Gaussian fit
Signal Begin range increment	i_SigBegOff	mm	1.00E-03	Range increment to be added to reference range to calculate range to signal begin – highest elevation within the footprint as computed in ground processing
Signal end range increment	i_SigEndOff	mm	1.00E-03	Range increment to be added to reference range to signal end – lowest elevation within the footprint as computed in ground processing
Centroid Range increment	i_cntRngOff	mm	1.00E-03	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-6	Ratio of the corrected received to the transmitted laser pulse energy, as a measure of the surface reflectance with all corrections applied.
Average range increment	i_AvgRngOff	mm	1.00E-03	Range increment to the centroid of the raw waveform from signal begin to signal end with all corrections applied.
Skewness	i_skew2	N/A	0.01	The skewness of the raw waveform using gates from signal begin to signal end using ice sheet, sea ice, and ocean parameters.
Spare	i_Spare4			
Error Estimate of Ocean Range Increment	i_OcRngErr	cm	1.00E-02	Error estimate on the centroid of Gaussian fit to last peak.

Table C-8 GLA15: 09/06/2000 (Continued)

Element Name	Product Variable Name	Product Units	Scale Factor	Description
Variance of the ocean Gaussian fit	i_OceanVar	cm	1.00E-02	The variance of the raw waveform to the Gaussian ocean fit.
Peak Amplitude of Smooth WF	i_maxSmAmp	counts	0.01	The peak amplitude from the smoothed waveform.
RMS Roughness – 1 sec	i_OcRufRMS	cm	1.00E-02	RMS roughness within the 1 sec segment
Mean elevation – 1 sec	i_OcMeanElev	mm	1.00E-03	1 –sec mean elevation
Spare	i_Spare5			
Ocean Elevation Quality Flag	i_OceanQF	N/A		Data quality flag for the ocean elevation -allows 4 bits per elevation measurement; 1 bit indicates quality based on good vs. bad criteria.
Spare	i_Spare6			
Ocean RMS Roughness Quality Flag	i_OcRMSqf	N/A		Data quality flag for the ocean roughness indicates quality based on good vs. bad criteria.
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.
Number of Peaks from Waveform Fit	i_numPk	N/A		The number of peaks in the waveform produced by the Gaussian filtering (from other than land algorithm), calculated from the number of WF parameters output on GLA05 (up to 6).
Spare	i_Spare7			

Appendix D
Level 2 Data Products
Flag Formats

D.1 GLA08

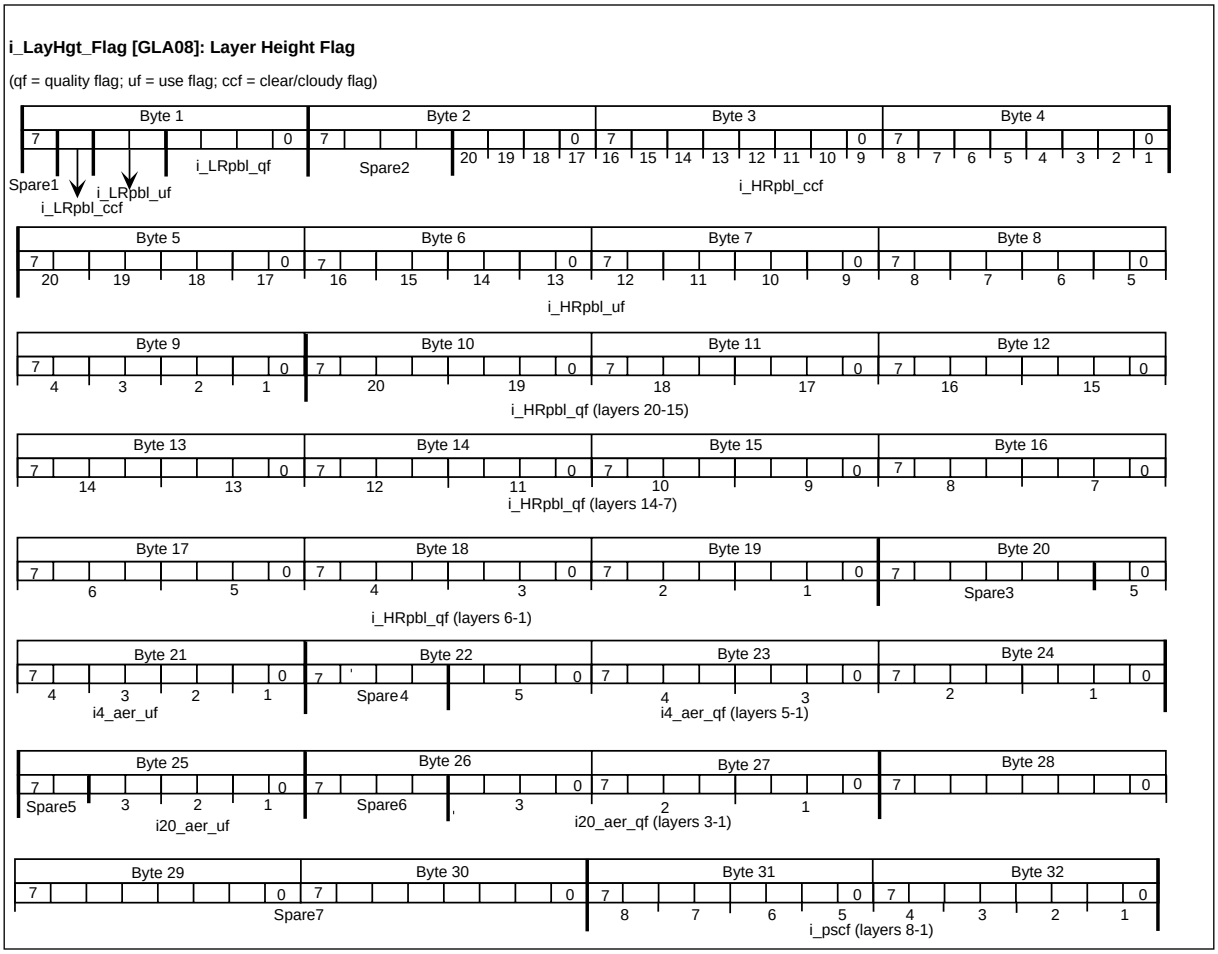

Figure D-1 i_LayHgt_Flag

D.2 GLA09

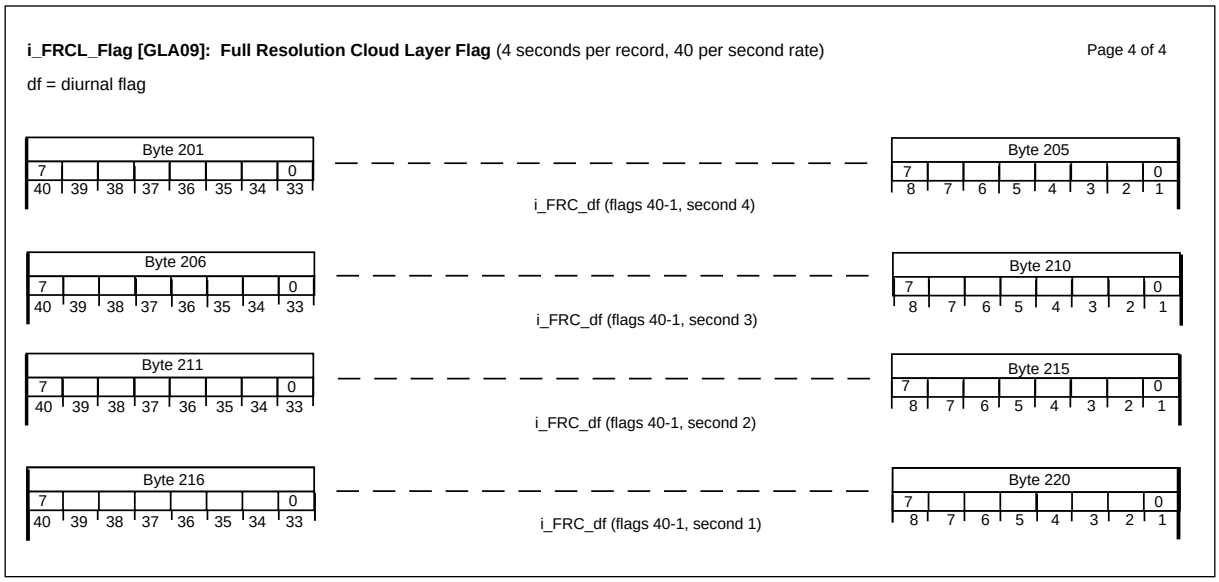

Figure D-2 i_FRCL_Flag

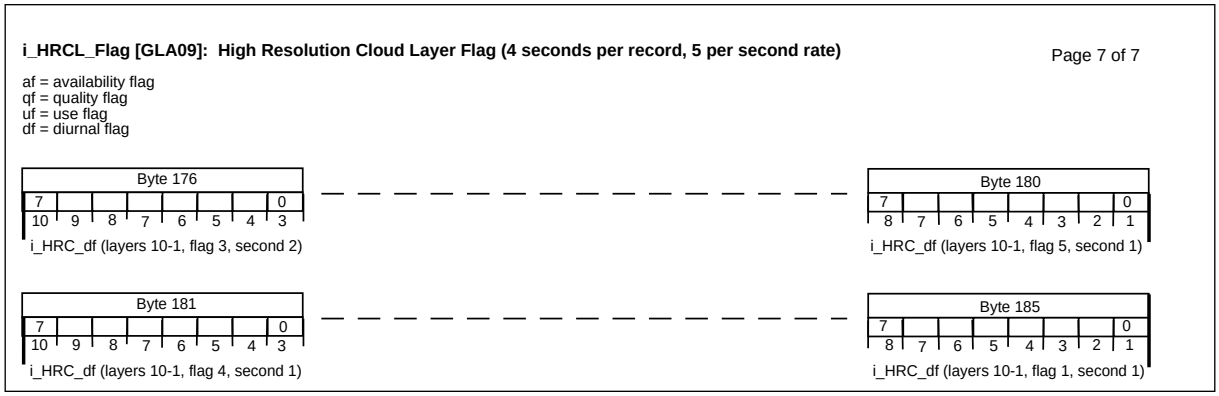

Figure D-3 i_HRCL_Flag

i_LRCL_Flag [GLA09]: Low Resolution Cloud Layer Flag (4 seconds per record, at once per 4 second rate)

af = availability flag
qf = quality flag
uf = use flag
df = diurnal flag

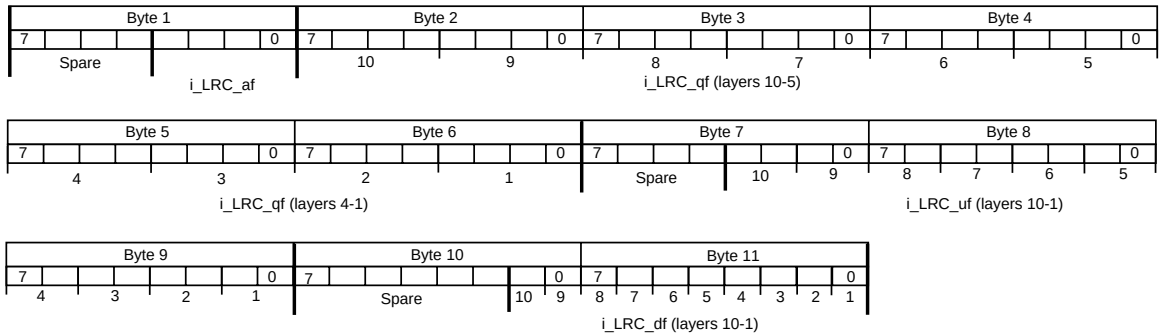

Figure D-4 i_LRCL_Flag

i_MRCL_Flag [GLA09]: Medium Resolution Cloud Layer Flag (4 seconds per record, at once per second rate)

Page 2 of 2

af = availability flag
qf = quality flag
uf = use flag
df = diurnal flag

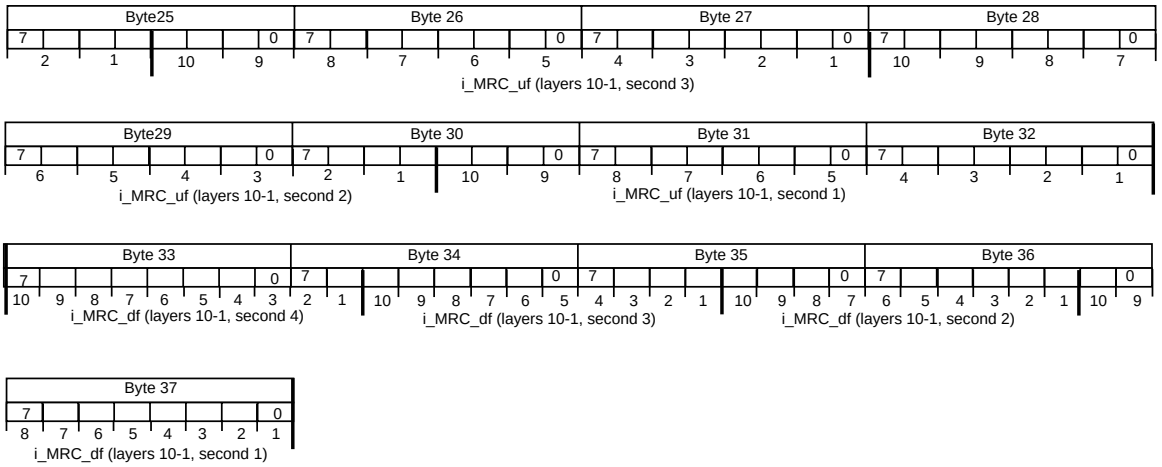

Figure D-5 i_MRCL_Flag

i_PODPADQF [GLA07, 09]: PODPAD Quality Flag

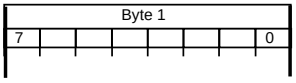

Figure D-6 i_PODPADQF

D.3 GLA10

i_aer4_bs_flag [GLA10]: Aerosol Backscatter Flag (once per 4 sec., up to 9 layers/record)

(QF = Quality Flag; UF = Use Flag)

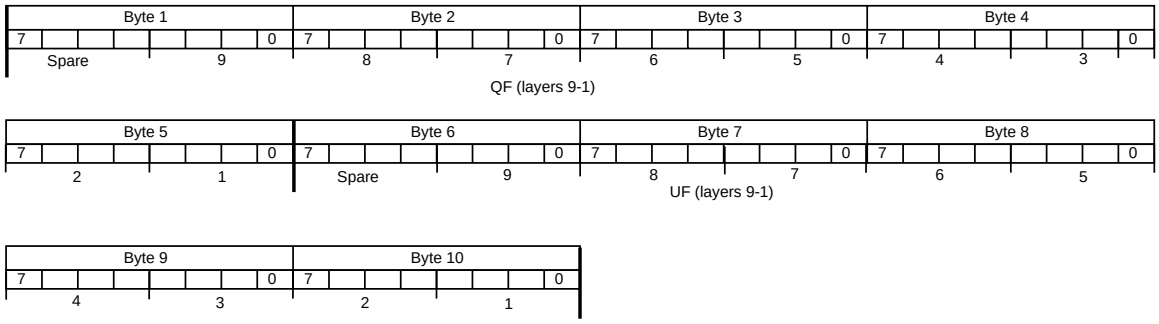

Figure D-7 i_aer4_bs_flag

i_aer4_ext_flag [GLA10]: Aerosol Extinction Flag (once per 4 sec., up to 9 layers/record)

(QF = Quality Flag; UF = Use Flag)

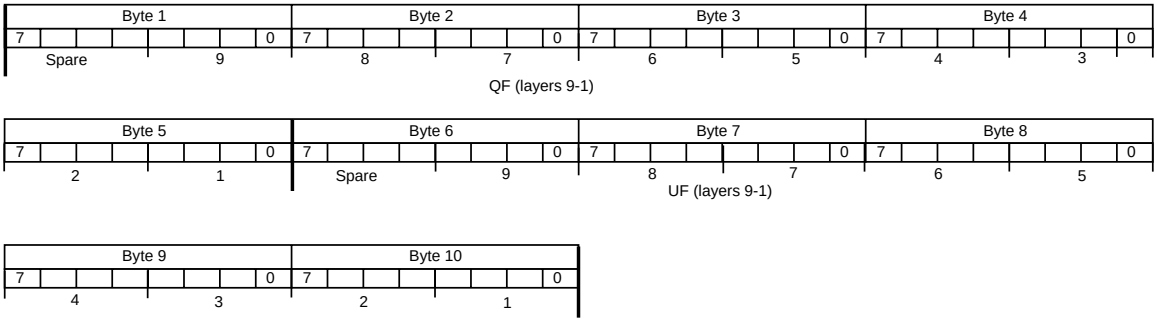

Figure D-8 i_aer4_ext_flag

i_aer4_sval_uf [GLA10]: Aerosol True S Values Use Flag (once per 4 sec., up to 9 layers/record)

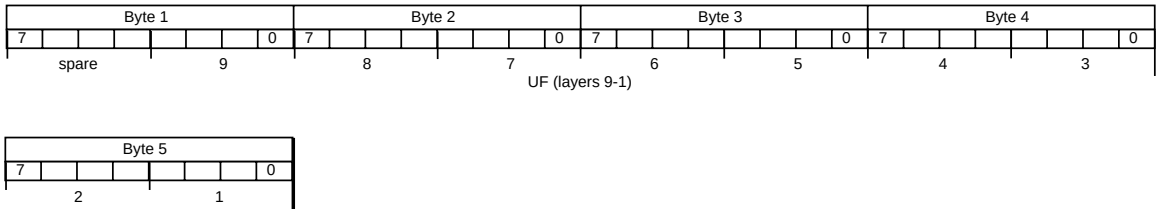

Figure D-9 i_aer4_sval_uf

i_cld1_bs_flag [GLA10]: Cloud Backscatter Flag (4 sec/records, up to 10 layers/sec.) Page 2 of 2

(QF = Quality Flag; UF = Use Flag)

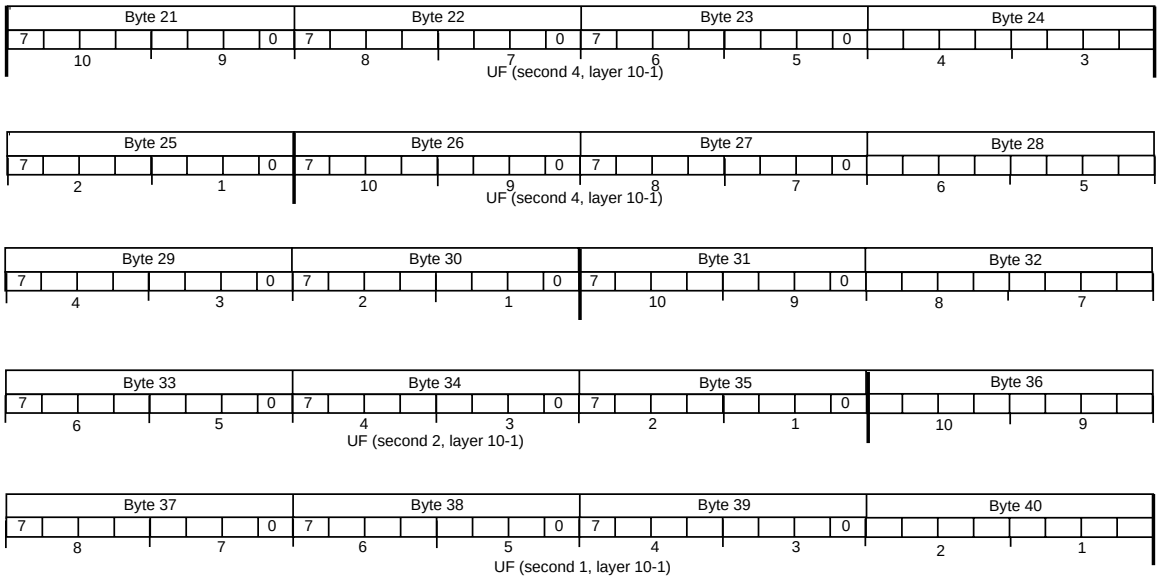

Figure D-10 i_cld1_bs_flag

i_cld1_ext_flag [GLA10]: Cloud Extinction Flag (4 sec/records, up to 10 layers/sec.) Page 2 of 2

(QF = Quality Flag; UF = Use Flag)

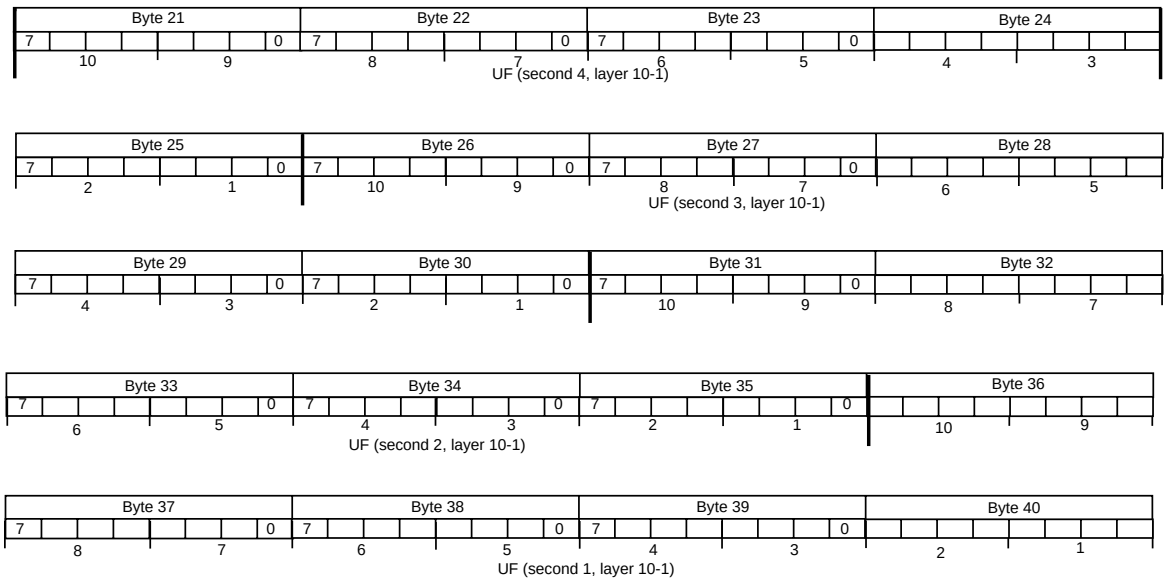

Figure D-11 i_cld1_ext_flag

i_cld1_sval_uf [GLA10]: Cloud True S Values Use Flag (4 sec/records, up to 10 layers/sec.)

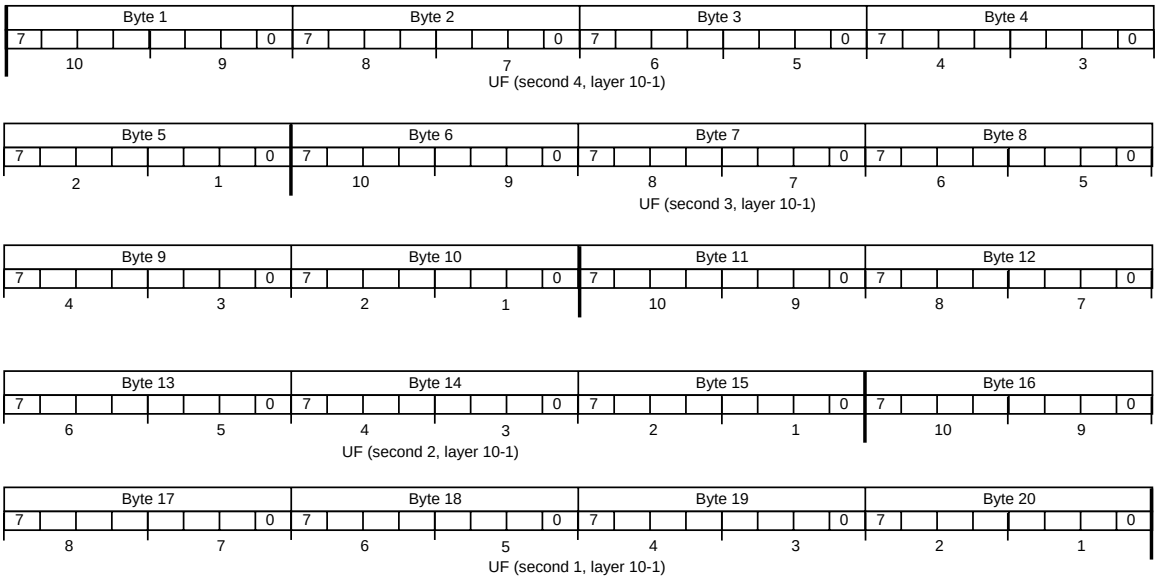

Figure D-12 i_cld1_sval_uf

D.4 GLA11

i_aer4_flag [GLA11]: Aerosol Optical Depth (4 sec. per record, at once per 4 second rate)

(QF = Quality Flag; UF = Use Flag)

Byte 1	Byte 2	Byte 3	Byte 4
7 … 0	7 … 0	7 … 0	7 … 0
QF (layer 8) QF (layer 7)	QF (layer 6) QF (layer 5)	QF (layer 4) QF (layer 3)	QF (layer 2) QF (layer 1)

Byte 5	Byte 6	Byte 7	Byte 8
7 … 0	7 … 0	7 … 0	7 … 0
UF (layer 8) UF (layer 7)	UF (layer 6) UF (layer 5)	UF (layer 4) UF (layer 3)	UF (layer 2) UF (layer 1)

Figure D-13 i_aer4_flag

i_cld1_flag [GLA11]: Cloud Optical Depth (4 sec. per record, at once per second rate) Page 2 of 2

(QF = Quality Flag; UF = Use Flag)

Byte 21	Byte 22	Byte 23	Byte 24
7 … 0	7 … 0	7 … 0	
10 9	8 7	6 5	4 3
	UF (second 4, layer 10-1)		

Byte 25	Byte 26	Byte 27	Byte 28
7 … 0	7 … 0	7 … 0	
2 1	10 9	8 7	6 5
	UF (second 4, layer 10-1)		

Byte 29	Byte 30	Byte 31	Byte 32
7 … 0	7 … 0	7 … 0	
4 3	2 1	10 9	8 7

Byte 33	Byte 34	Byte 35	Byte 36
7 … 0	7 … 0	7 … 0	
6 5	4 3	2 1	10 9
	UF (second 2, layer 10-1)		

Byte 37	Byte 38	Byte 39	Byte 40
7 … 0	7 … 0	7 … 0	
8 7	6 5	4 3	2 1
	UF (second 1, layer 10-1)		

Figure D-14 i_cld1_flag

i_cld1_mswf [GLA11]: Multiple Scattering Warning Flag (4 sec. per record, at once per second rate)

Byte 1	Byte 2
7 … 0	7 … 0
second 4 second 3	second 2 second 1

Figure D-15 i_cld1_mswf

i_pbl4_flag [GLA11]: PBL Optical Depth (4 sec. per record, at once per 4 second rate)

(QF = Quality Flag; UF = Use Flag)

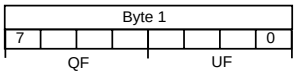

Figure D-16 i_pbl4_flag

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

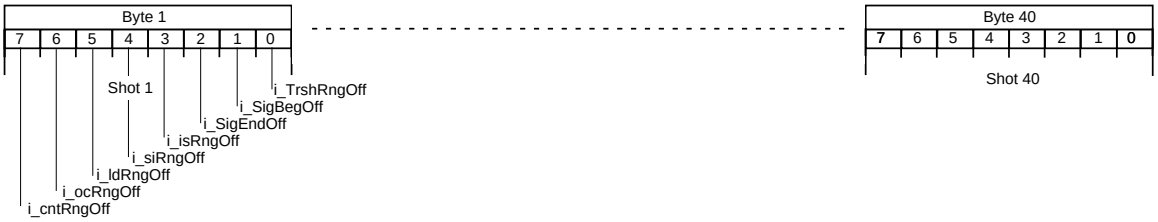

Figure D-17 i_rng_UQF

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.

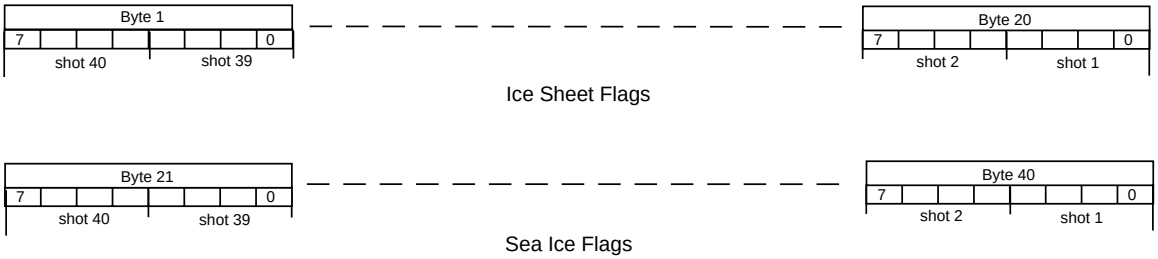

Figure D-18 i_SurfRufQF

D.5 GLA12

i_IceSheetQF [GLA12]: 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.

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-19 i_IceSheetQF

i_isRufQF [GLA12]: Per-shot data quality flags for the ice sheet roughness and slope;
indicates quality based on good vs. bad criteria. Bytes 0-39 are roughness flags, bytes 40-79 are slope flags.

Byte 1							
7							0
shot 40				shot 39			

— — — — — — — — — — — — — — — —

Byte 20							
7							0
shot 2				shot 1			

Roughness Flags

Byte 21							
7							0
shot 40				shot 39			

— — — — — — — — — — — — — — — —

Byte 40							
7							0
shot 2				shot 1			

Slope Flags

Figure D-20 i_isRufQF

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-21 i_PODPADQF

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

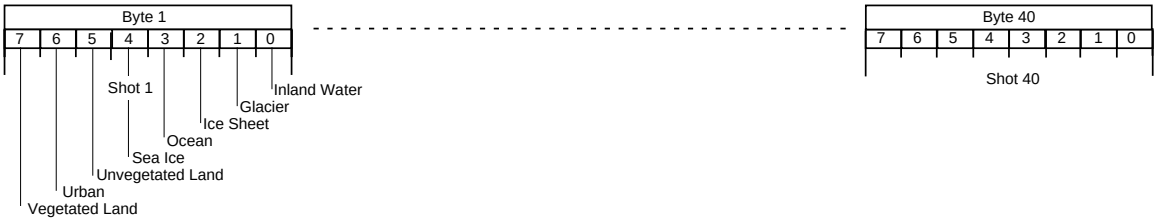

Figure D-22 i_surfType

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

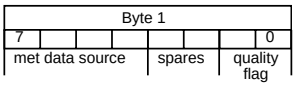

Figure D-23 i_metFlg

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

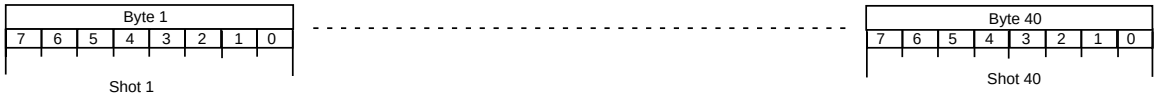

Figure D-24 i_atmQF

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.

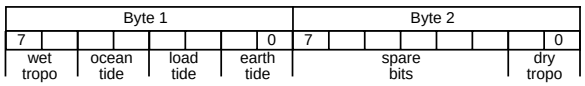

Figure D-25 i_ElvCor_QF

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

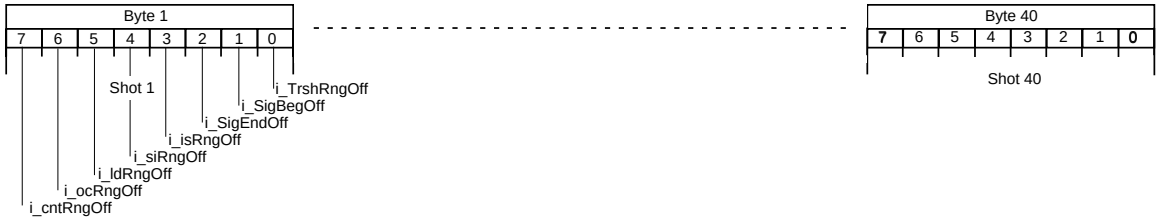

Figure D-26 i_rng_UQF

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.

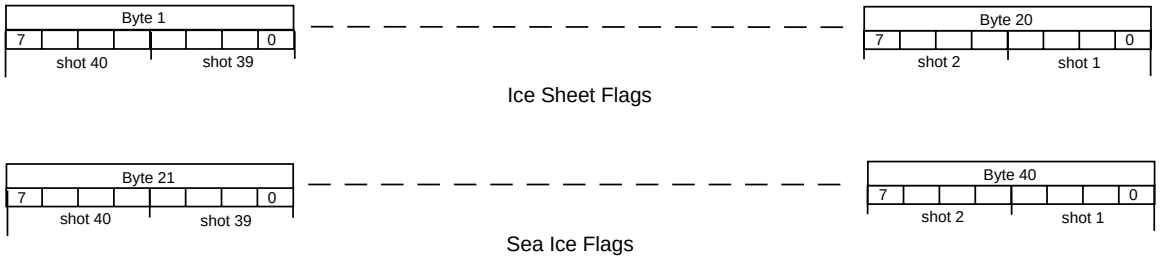

Figure D-27 i_SurfRufQF

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

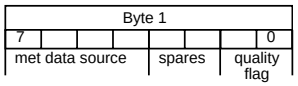

Figure D-28 i_metFlg

D.6 GLA13

i_SealceQF [GLA13]: 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.

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-29 i_SealceQF

i_siRufQF [GLA13]: Per-shot data quality flags for the sea ice roughness and slope;
indicates quality based on good vs. bad criteria. Bytes 0-39 are roughness flags, bytes 40-79 are slope flags.

Byte 1							
7							0
shot 40				shot 39			

— — — — — — — — — — — — — — — —

Byte 20							
7							0
shot 2				shot 1			

Roughness Flags

Byte 21							
7							0
shot 40				shot 39			

— — — — — — — — — — — — — — — —

Byte 40							
7							0
shot 2				shot 1			

Slope Flags

Figure D-30 i_siRufQF

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-31 i_PODPADQF

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

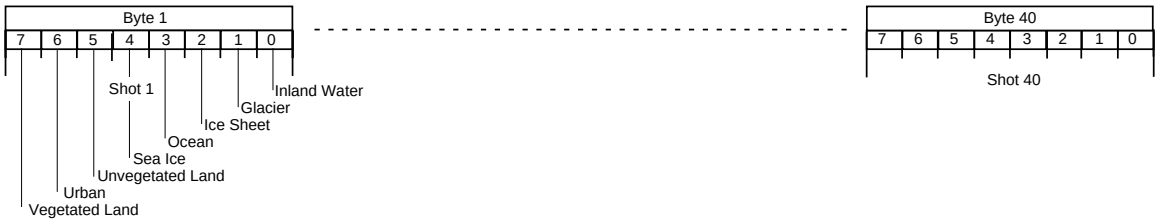

Figure D-32 i_surfType

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

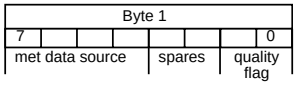

Figure D-33 i_metFlg

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

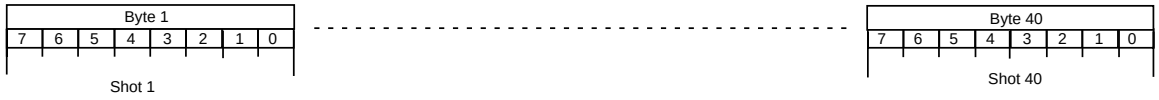

Figure D-34 i_atmQF

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.

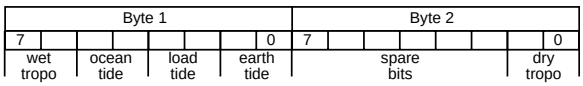

Figure D-35 i_ElvCor_QF

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

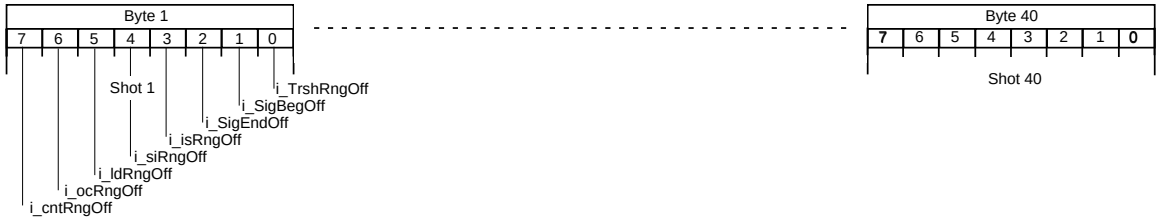

Figure D-36 i_rng_UQF

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.

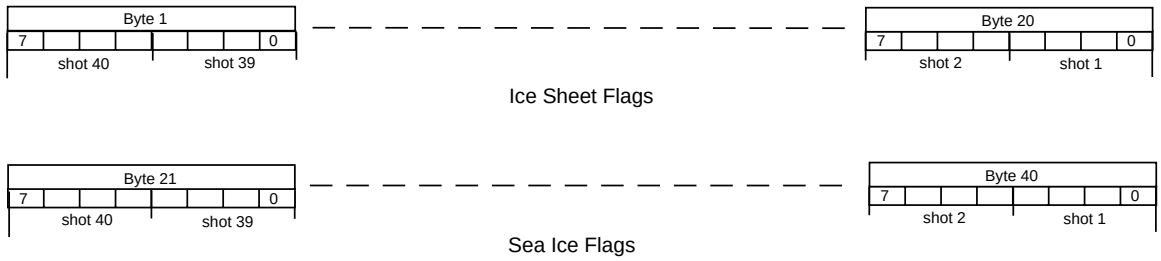

Figure D-37 i_SurfRufQF

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

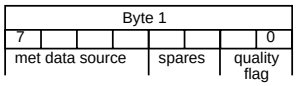

Figure D-38 i_metFlg

D.7 GLA14

i_LandQF [GLA14]: 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.

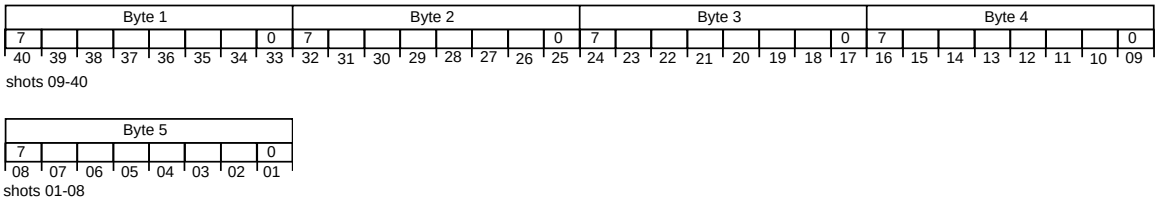

Figure D-39 i_LandQF

i_ldRufQF [GLA14]: Per-shot data quality flags for the land roughness and slope;
indicates quality based on good vs. bad criteria. Bytes 0-39 are roughness flags, bytes 40-79 are slope flags.

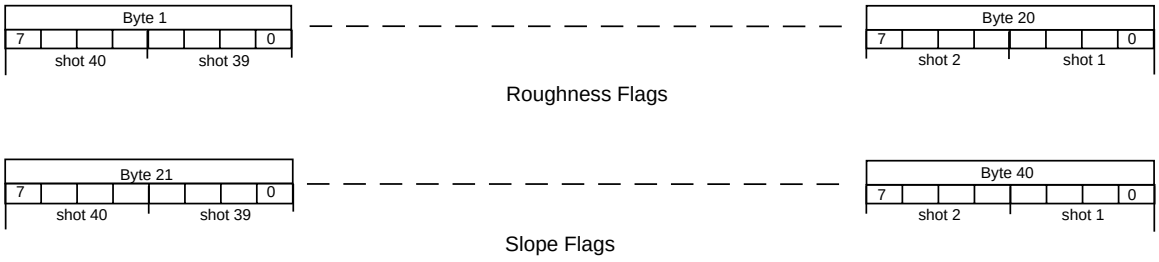

Figure D-40 i_ldRufQF

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

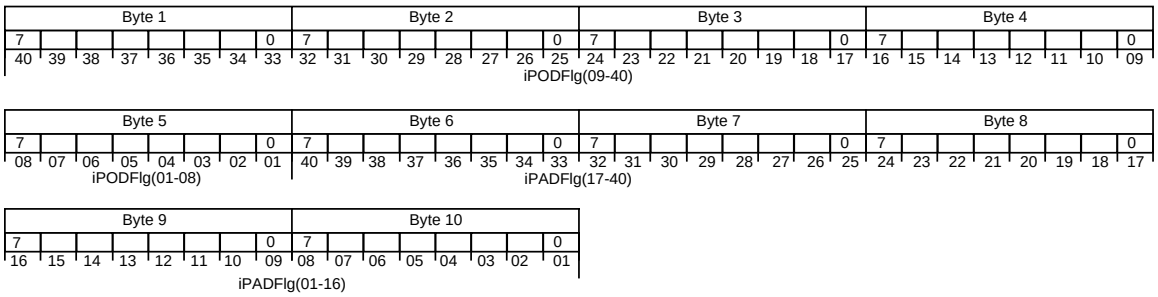

Figure D-41 i_PODPADQF

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

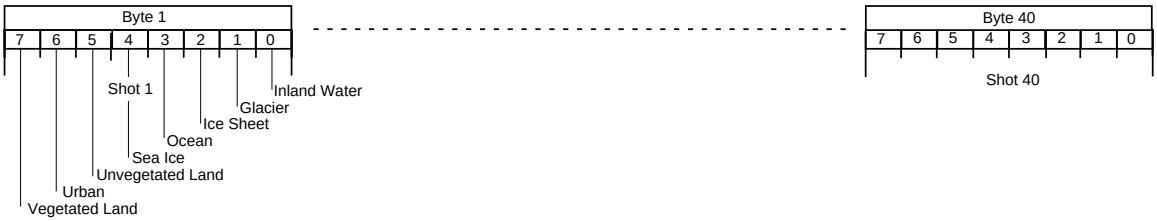

Figure D-42 i_surfType

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

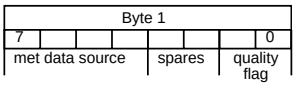

Figure D-43 i_metFlg

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

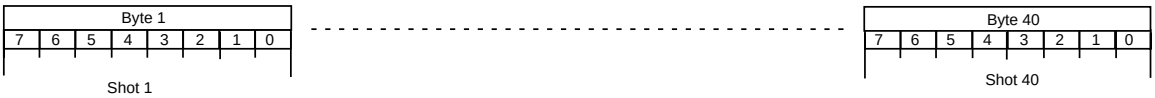

Figure D-44 i_atmQF

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.

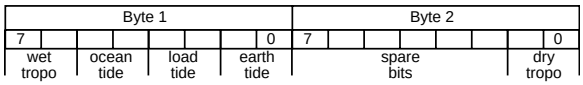

Figure D-45 i_ElvCor_QF

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

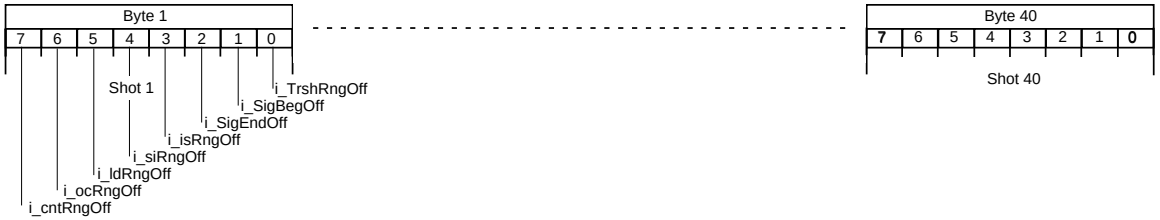

Figure D-46 i_rng_UQF

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.

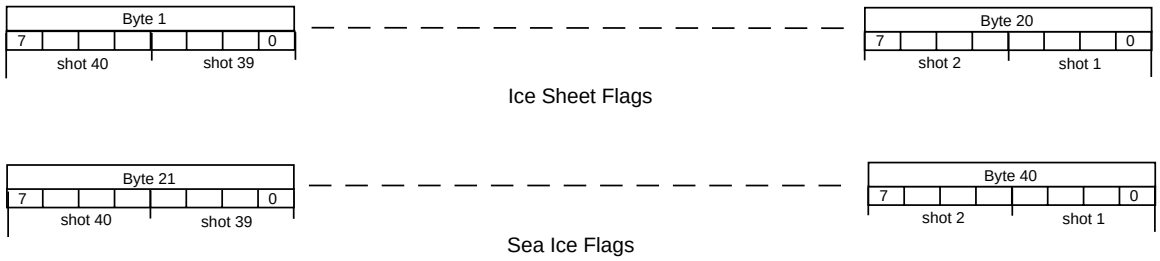

Figure D-47 i_SurfRufQF

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

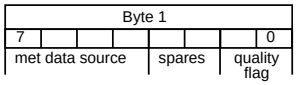

Figure D-48 i_metFlg

D.8 GLA15

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-49 i_metFlg

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

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

- -

Byte 40							
7	6	5	4	3	2	1	0
Shot 40							

Figure D-50 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.

Byte 1								Byte 2							
7							0	7							0
wet tropo		ocean tide		load tide		earth tide		spare bits							dry tropo

Figure D-51 i_ElvCor_QF

i_OceanQF [GLA15]: 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.

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-52 i_OceanQF

i_OcRMSqf Flag [GLA15]: Per-shot data quality flags for the ocean roughness and slope; indicates quality based on good vs. bad criteria. Bytes 0-39 are roughness flags, bytes 40-79 are slope flags. used in GLA12

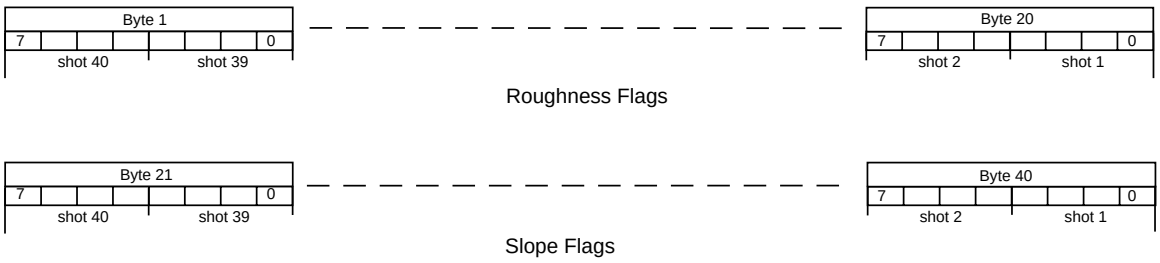

Figure D-53 i_OcRMSqf Flag

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

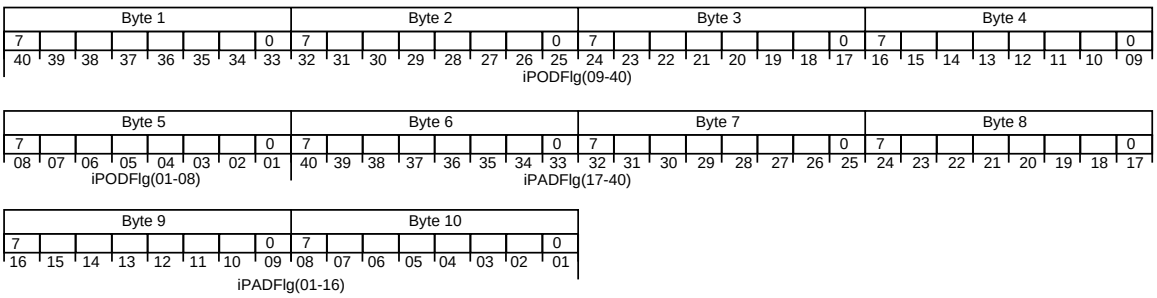

Figure D-54 i_PODPADQF

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

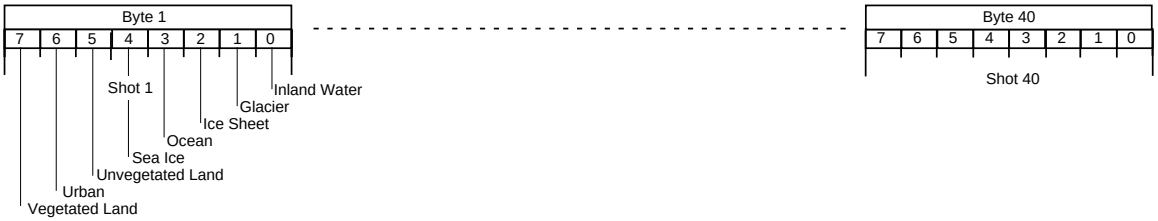

Figure D-55 i_surfType

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

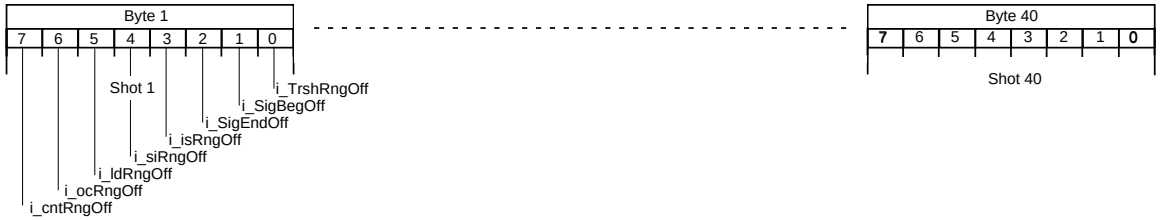

Figure D-56 i_rng_UQF

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.

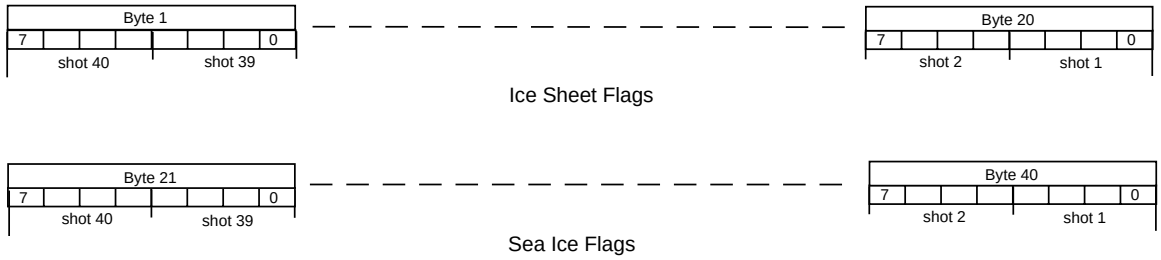

Figure D-57 i_SurfRufQF

Abbreviations & Acronyms

DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
GDS	GLAS Ground Data System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
HDF	Hierarchical Data Format
ICESat	Ice, Cloud, and Land Elevation Satellite
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
IST	GLAS Instrument Support Terminal
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
QA	Quality Assurance
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
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 georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS ICESat spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the DAAC or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ICESat/GLAS Data Product produced on the DAAC or on the SCF. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.