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PRODUCT DEFINITION AND USERS' GUIDE (PUG)

VOLUME 4: GOES-R REBROADCAST (GRB)

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PRODUCT DEFINITION AND USERS' GUIDE (PUG)

VOLUME 4: GOES-R REBROADCAST (GRB)

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01/30/13
Date

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PRODUCT DEFINITION AND USERS' GUIDE (PUG)

VOLUME 4: GOES-R REBROADCAST (GRB)

FOR

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE
R SERIES (GOES-R) CORE GROUND SEGMENT
CONTRACT NO: DG133E-09-CN-0094
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PRODUCT DEFINITION AND USERS' GUIDE (PUG)

VOLUME 4: GRB

FOR
GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE R SERIES (GOES-R) CORE GROUND SEGMENT

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NON-Export Controlled Information

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 NON-Export Controlled Information

1.0 SCOPE

The Product Definition and Users' Guide (PUG) document provides a product description and format user guide for all data and products produced by the Geostationary Operational Environmental Satellite R Series (GOES-R) Core Ground Segment (GS), developed under contract DG133E-09-CN-0094. This includes the GOES-R Rebroadcast (GRB), Level 0 data, Level 1b products and all Level 2+ end-products as well as calibration data, ancillary data, algorithm packages, and metadata related information.

The PUG is divided into five volumes. This current volume, Volume 1: Main, contains reference material, overview information and non-product data. The remaining volumes are divided by product in the following manner: Volume 2: L0, Volume 3: L1b, Volume 4: GRB, and Volume 5: L2+.

1.1 GRB Purpose and Usage

GOES Rebroadcast (GRB) is the primary space relay of Level 1b product data and metadata, GLM Level 2+ product data and metadata, and other information from the GOES-R Ground Segment (GS). Level 1b products consist of instrument data with radiometric and geometric correction applied to produce parameters in physical units. GRB data is available to all users with GRB receivers in view of a GOES-R series satellite at the East or West operational longitudes.

GRB replaces the legacy GOES VARiable (GVAR) service. GRB provides full resolution, calibrated, navigated, near real-time direct broadcast data.

The content of the data distributed via GRB service includes a full set of Level 1b products from all instruments onboard the GOES-R series spacecraft. This concept for GRB is based on analysis that a dual-pole circularly polarized L-band link of 12 MHz bandwidth may support up to a 31 Mbps data rate – enough to include all Advanced Baseline Imager (ABI) channels in a lossless compressed format, as well as data from Geostationary Lightning Mapper (GLM), Solar Ultraviolet Imager (SUVI), Extreme Ultra-Violet and X-Ray Irradiance Sensors (EXIS), Space Environment In-Situ Suite (SEISS), and Magnetometer.

1.2 GOES-R Instrument Overview

The six instruments on the Geostationary Operational Environmental Satellite-R series (GOES-R) offer unique observations of the environment and consist of the ABI, GLM, EXIS, SUVI, SEISS, and Magnetometer. The six GOES-R satellite instruments each generate Level 0 science and telemetry for transport to the GS by the GOES-R spacecraft. The GS processes the Level 0 data for GRB rebroadcast. An elemental knowledge of the GOES-R instruments provides a context for understanding GS processing, including GRB data content and formatting.

The ABI instrument is a multi-spectral channel, two-axis scanning radiometer designed to provide variable area imagery and radiometric information of the Earth's surface and atmosphere as well as the capability for star sensing. The ABI measures emitted and solar reflected radiance simultaneously in all spectral channels, but channels 1-6 sense primarily solar reflected radiance, and channels 7-16 sense primarily emitted radiance. Data availability, radiometric quality, simultaneous data collection, coverage rates, scan flexibility, and minimizing data loss due to the sun, are prime capability requirements of the ABI system. The ABI scans the Earth with three different geographic coverage areas: Full Disk, Continental United States (CONUS), and Mesoscale. The ABI utilizes the concepts of scenes and timelines in defining its scanner operations. For ABI timeline details, reference Volume 2, Section 2.2 Level 0 ABI. Correspondingly, the L1b algorithm generates L1b data product from L0 product for the three coverages. Consequently, Level 2+ (L2+) output products are generated at these same coverage areas.

The ABI Full Disk is defined as a circle, with a 17.4 degree angular diameter, centered at nadir, plus any additional over scan required for uncompensated non ideal orbit and image motion compensation; CONUS is defined as a nadir-viewed rectangle 8.0215 x 4.8129 degrees, 5000 East/West x 3000 North/South kilometers, approximately in the geographic area of 10N-60N latitude and 60W-125W longitude; Mesoscale is defined as the equivalent of a 1.6043 x 1.6043 degree, 1000 x 1000 kilometer nadir-viewed area. Full Disk images are generated in ABI scanning mode 3 and 4, while Mesoscale and CONUS images are only generated in ABI scan mode 3. Regional products such as Hawaii, Puerto Rico and Alaska are derived from Full Disk. CONUS L2+ products are produced in mode 4 by extracting L1b data from the L1b Full Disk that is within the CONUS bounding box.

The X-ray Sensor (XRS) and the Extreme Ultraviolet Sensor (EUVS) are packaged together in one instrument called the EXIS. EXIS is designed to be pointed at the sun and acquiring space weather data at all times except for brief calibration and maintenance activities.

EUVS consists of three spherical grating spectrometer channels. The three channels, denoted A, B and C, give coverage in the bands of 16-37nm (1.4nm resolution), 115-135nm (1.3nm resolution) and 275-285nm (0.2nm resolution). From these, a reconstruction of the full spectrum between 5nm and 127nm will be possible. Post-dispersion photon detection is done via custom arrays of discrete silicon photodiodes for the A and B channels, and a linear 512-element photodiode array for the C channel.

XRS: X-ray Sensor consists of three photodiode-based photometer channels, two active (A and B) and one inactive. Channel A covers 0.05-0.4nm and channel B covers 0.1-0.8nm. The "dark" diode channel allows background subtraction. All active channels view the sun through two Be filters. Each XRS channel consists of a low-sensitivity and a high-sensitivity detector whose responses overlap in order to span the required total dynamic range. The low-sensitivity detectors are quadrant photodiodes which view the sun through a small aperture, allowing X and Y position information to be extracted for bright, localized events such as solar flares.

The GLM instrument is a single-channel, near-infrared optical detector, used to detect, locate and measure the optical pulses associated with lightning over the Full Disk Earth. The instrument has sufficient spatial and temporal resolution to allow tracking of each lightning flash within a specific storm cell and calculation of the cell's optical center over time.

The MAG instrument provides three orthogonal measurements of the geomagnetic field in space at a refresh rate of at least 0.5 seconds and shall have a dynamic range of ±512 nT in each of the three orthogonal axes and shall measure the field with a resolution of at least 0.016 nT per axis. The sampling rate of the product data is 10 Hz. This measurement data is used to map the space environment that controls charged particle dynamics in the outer region of the magnetosphere and provide information on the general level of geomagnetic activity, monitor current systems in space, and permit detection of magnetopause crossings, sudden storm commencements, and sub storms.

The SEISS instrument consists of a suite of sensors that monitors the proton, electron, and heavy ion fluxes at geosynchronous orbit. The information provided by the SEISS is critical for assessing the radiation hazard to astronauts and satellites. In addition to hazard assessment, the information from the SEISS can be used to warn of high flux events, mitigating any damage to radio communication. The SEISS instrument suite consists of the Energetic Heavy Ion Sensor (EHIS), the Magnetospheric Particle Sensor -High and Low (MPS-HI and MPS-LO), and the Solar and Galactic Proton Sensor (SGPS). There are two SGPSs in each suite, one looking east and one looking west.

The SUVI instrument is designed to provide a view of the solar corona, taking the Full Disk solar images at high cadence around the clock, except for brief periods during an eclipse, in the soft XUV to EUV wavelength range. Available combinations of exposures and filters allows the coverage of the entire dynamic range of solar XUV features, from coronal holes to X-class flares, as well as the estimate of temperature and solare emissions.

1.3 GRB Consultative Committee for Space Data Systems (CCSDS) & DVB-S2 Protocols

GRB data is generated and uplinked at the Ground Segment (GS) Wallops Command and Data Acquisition Station (WCDAS) or Remote Backup (RBU) Facility. WCDAS, designated as primary, nominally uplinks GRB. RBU, designated as backup, only uplinks GRB under some failover and handover scenarios. Within these sites the GS Product Generation (PG) and Mission Management (MM) elements produce GRB for uplink. GRB is used to transport Level 1b product data and metadata for all 6 instruments, GLM L2+ product data and metadata, and other limited information to WCDAS, RBU, NOAA Satellite Operations Facility (NSOF) and GOES-R Direct Readout Terminal users. The GS GRB production path is shown in Figure 1.3-1.

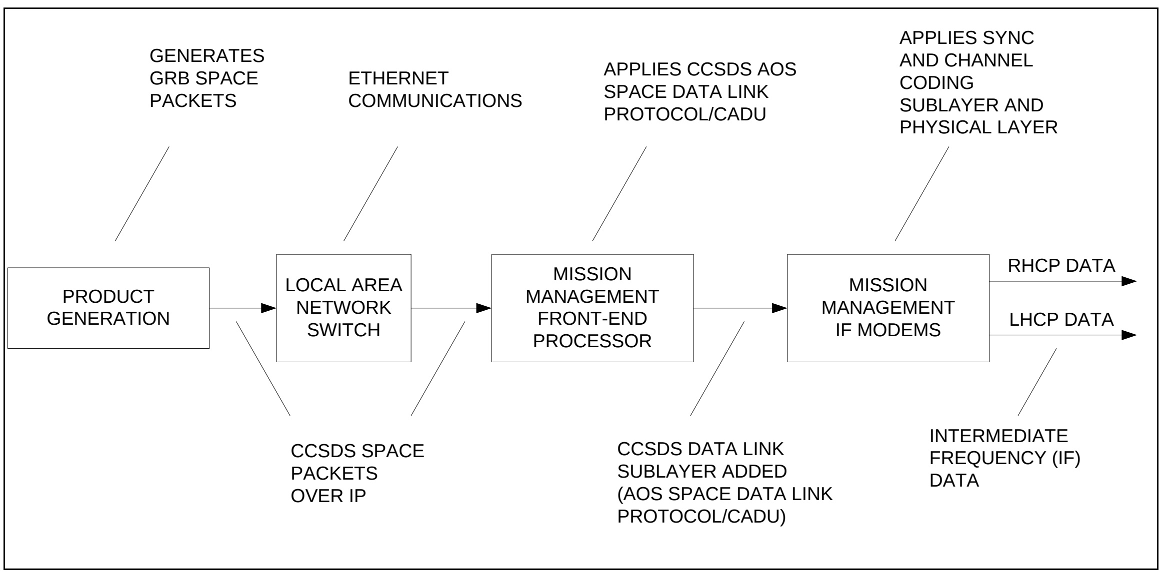

Figure 1.3-1 GOES-R GS GRB Production Path

The operational GOES-R GS utilizes Consultative Committee for Space Data Systems (CCSDS) protocols over Digital Video Broadcasting - Satellite - Second Generation (DVB-S2) to broadcast L1b GLM L2+ product data and metadata, plus other limited information from WCDAS or RBU, to all three GS sites and GRB Direct Readout Terminal (DRT) users.

The GRB communications models and protocols are depicted in Figure 1.3-2. The GRB communications data stream aligns with the bottom three layers of the industry-standard OSI model and bottom four layers of the CCSDS model. Note that CCSDS model divides the OSI Data Link Layer into two sub-layers: (1) Data Link Protocol Sublayer and (2) Synchronization and Channel Coding Sublayer.

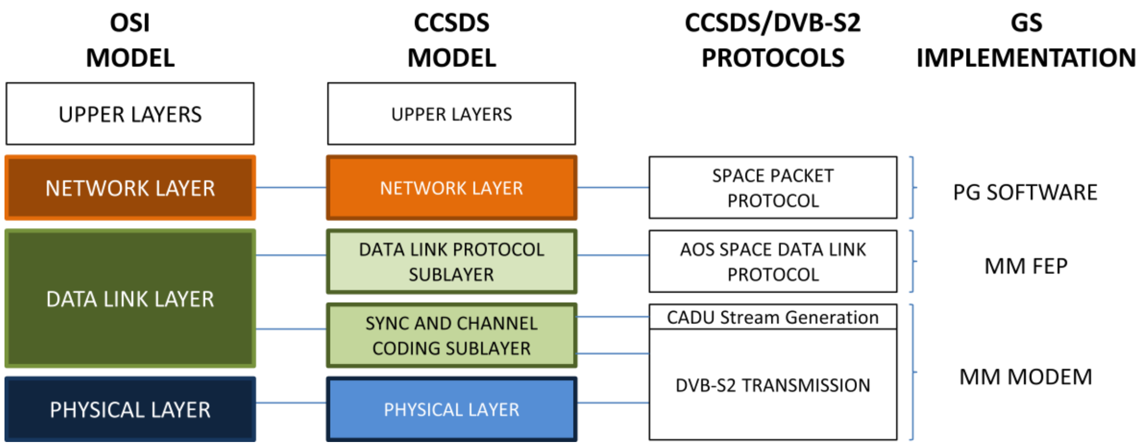

Figure 1.3-2 GOES-R GRB Communications Protocols

As product algorithms generate product data and metadata, they are published to the data fabric. Using subscriptions, GRB processing retrieves the published data and formats it into CCSDS space packets. The packets are transmitted to the MM Front-end Processor (FEP), which encapsulates packets into CCSDS Transfer Frames encapsulated as Channel Access Data Units (CADU). CADUs are forwarded to the MM modem for DVB-S2 processing. As noted before, the reverse process is done as GRB is received at the three GS sites. The GRB Direct Readout Terminals will implement a similar capability compatible with GRB transmission.

2.0 GRB FORMAT AND TYPES

The GRB is a set of products consisting of Level 1b (L1b), Level L2+ (L2+) GLM and associated metadata, and GRB Information (INFO) Packets containing satellite operations schedules, status information and orbit state vectors. GRB INFO packets also include semi-static L1b algorithm calibration parameter tables which are transmitted after an update. GRB is sent to the GOES-R satellites from the Wallops Command and Data Acquisition Station (WCDAS) for rebroadcast to the GOES-R sites and GRB users. Back-up GRB transmission capability is available at the Remote Backup Facility (RBU) site.

The raw sensor data are received by the WCDAS from the GOES-R spacecraft. L0 packets are then generated by MM function, which is processed by the PG function to create L1b and L2+ GLM products. Those products plus associated metadata, satellite operations schedules, status information and orbit state vectors are formatted into GRB and then is uplinked from the WCDAS to the GOES-R spacecraft and rebroadcasted through the GOES-R spacecraft GRB transponder to end users in the western hemisphere, including the NSOF. The GRB is received at the NSOF, from which L1b, L2+ GLM and GRB INFO Packets products (including L1b algorithm calibration parameter tables addressed in Volume 1) are recovered, and the remainder of the L2+ products are created, as well as sectorized Cloud and Moisture Imagery (CMI) products.

The following subparagraphs provide the following information:

- Formats associated with GRB CCSDS Space Packets
- Identification of GRB content types
    - Information
    - Imagery
    - Generic
- Formats associated with CCSDS AOS Space Data Link protocol processing
- Formats associated with DVB-S2 protocol processing

2.1 GRB Space Packet Protocol Processing

This paragraph addresses the CCSDS Space Packet Protocol, as highlighted in Figure 2.1-1 and implemented by the GS PG element.

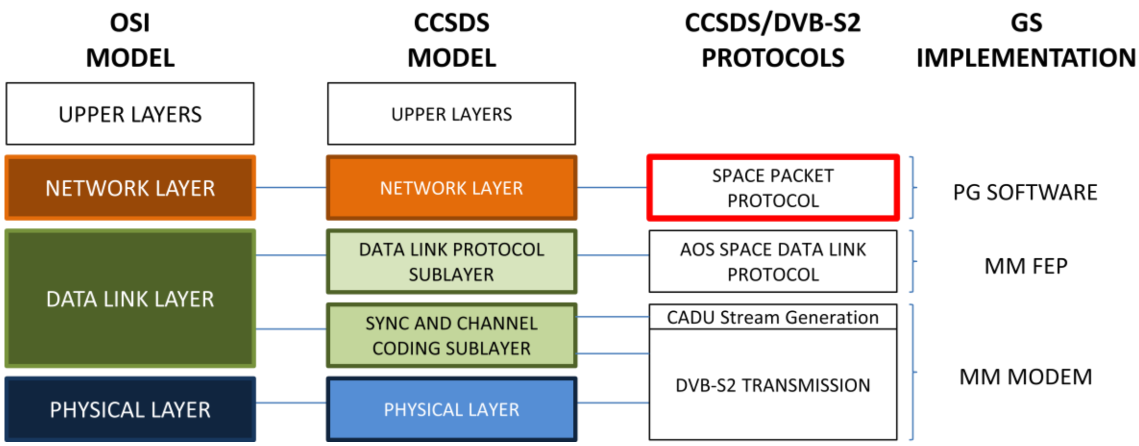

Figure 2.1-1 GOES-R GRB Space Packet Protocol

GRB data is encapsulated within CCSDS packets as defined Consultative Committee for Space Data Systems (CCSDS) 133.0-B-1 Section 4.1. Each CCSDS packet consists of a primary header, a secondary header, a GRB Payload, and 4-byte checksum as shown in Table 2.1 GRB CCSDS packets have this structure. The GRB epoch is January 1, 2000 12:00:00 UTC.

The product data (ABI, GLM, SEISS, etc) are contained within the GRB Payload, as described in Table 2.1. The GRB Payload will have one of two possible formats for GRB product data: Image Data format (Section 2.2) or Generic Data format (Section 2.3). ABI and SUVI imagery are stored in the Image Data format. All other product data and metadata are stored in the Generic Data Format. Section 3 provides detailed information, describing how to interpret the GRB Payload for each sensor type.

Table 2.1 CCSDS Structure of the GRB Data

	Bits	Field	Description
Standard Primary Header	3	Packet Version Number	CCSDS Protocol Version
	1	Packet Type	Indicates whether this is a telecommand or telemetry packet
	1	Secondary Header Flag	Indicates whether this packet has a secondary header (Set to 1 for all GRB Packets)
	11	APID	Application Process Identifier
	2	Sequence Flags	Flags for data segmentation
	14	Packet Sequence Count	Sequence Count
	16	Packet Data Length	Data Length
GRB Secondary Header	16	Days Since the Epoch	Number of full days since the GOES-R epoch date of January 1, 2000 12:00:00 UTC
	32	Milliseconds of the Day	Milliseconds of the Day
	3	GRB Version	GRB Version Number
	5	GRB Payload Variant	Describes the underlying payload

	Bits	Field	Description
	4	Assembler ID	Identifies the assembler by location, string, and whether it is primary or backup
	4	Operational Environment	Identifies the Operational Environment
User Data	130976	GRB Data Payload	GRB Data Payload
	32	Checksum	Packet Checksum

The CCSDS standard requires that each of the fields in the primary and secondary header of the CCSDS packet be in Big Endian format. This convention is illustrated in Figure 2.1-2, below. The first bit in the field to be transmitted via the GRB link is defined as ‘Bit 0’. The last bit to be transmitted is ‘Bit *N*–1’. ‘Bit 0’ is designated at the Most Significant Bit (MSB) for the data field.

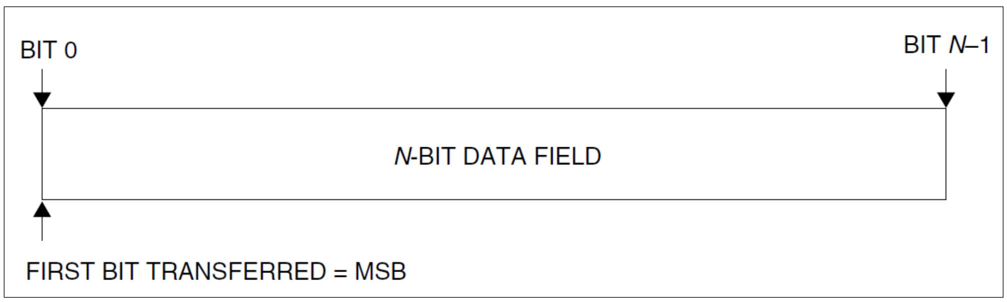

Figure 2.1-2 Bit Numbering Convention

Data fields are often grouped into eight-bit ‘words’ which conform to the above convention. Throughout this document, these eight-bit words are referred to as bytes. By the CCSDS convention, all ‘spare’ bits shall be permanently set to ‘0’.

The Checksum field in the CCSDS packet will be in Big Endian Format. The format of the GRB Payload is described in Section 2.2 for Image Data and Section 2.3 for Generic Data. The data fields in the GRB Payload structures will contain a mixture of Big Endian and Little Endian fields as described in Sections 2.2 and 2.3.

2.1.1 Packet Version Number

Bits 0–2 contain the (binary encoded) Packet Version Number. This 3-bit field is set to ‘000’ and is used to identify this data unit as a CCSDS Space Packet. The packet version number field provides the capability for introducing other packet structures in the future. Setting this field to ‘000’ indicates that version 1 of the CCSDS Packet structure is being used.

2.1.2 Packet Type

Bit 3 contains the Packet Type bit. This bit is used to distinguish between packets used for telemetry (or reporting) from packets that are used for telecommand (or requesting). This bit is set to ‘0’ for all GRB packets, indicating that the GRB data is telemetry.

2.1.3 Secondary Header Flag

Bit 4 contains the Secondary Header Flag. This flag is used to indicate the presence or absence of the Packet Secondary Header within the Space Packet. This bit shall be set to '1' for all GRB data packets. All GRB data packets contain the secondary header shown in Table 2.1.

2.1.4 Application Process Identifier

Bits 5–15 contain the Application Process Identifier (APID) for the GRB packet. GRB APID values are used to identify the product data type contained within the space packet. The APIDs are used to uniquely identify the products and metadata that is included in the GRB data stream. A summary of the APID assignments is provided in Table 2.1.4. The full details showing how the individual APID values are mapped to the product data is described in Section 3 of this document. Note that APID values 0x7F8 through 0x7FF are not used by GRB, as these values are reserved for use by the CCSDS standard.

Table 2.1.4 Overview of the GRB APIDs

Instrument	Data Type	APID (Hex)
ABI	Full Disk Metadata (Mode 3)	100 - 10F
	Full Disk Radiance Image (Mode 3)	110 - 11F
	Continental United States Metadata (Mode 3)	120 - 12F
	Continental United States Radiance Image (Mode 3)	130 - 13F
	Mesoscale #1 Metadata (Mode 3)	140 - 14F
	Mesoscale #1 Radiance Image (Mode 3)	150 - 15F
	Mesoscale #2 Metadata (Mode 3)	160 - 16F
	Mesoscale #2 Radiance Image (Mode 3)	170 - 17F
	Full Disk Metadata (Mode 4)	180 - 18F
	Full Disk Radiance Image (Mode 4)	190 - 19F
	Spare	1A0 - 2FF
GLM	GLM Metadata	300
	GLM Product Data	301 - 303
	Spare	304 - 37F
EXIS	EUV Metadata	380
	EUV Product Data	381
	Spare	382 - 38F
	X-Ray Metadata	390
	X-Ray Product Data	391
	Spare	392 - 3FF
SEISS	EHIS Metadata	400
	EHIS Product Data	401

Instrument	Data Type	APID (Hex)
	Spare	402 - 40F
	MPS-LO Metadata	410
	MPS-LO Product Data	411
	Spare	412 - 41F
	MPS-HI Metadata	420
	MPS_HI Product Data	421
	Spare	422 - 42F
	SGPS Metadata	430
	SGPS Product Data	431
	Spare	432 - 47F
SUVI	SUVI Metadata	480 - 48D
	SUVI Product Data	48E - 49B
	Spare	49C - 4FF
MAG	MAG Metadata	500
	MAG Product Data	501
	Spare	502 - 57F
INFO	GRB INFO File	580
	Spare	581 - 6FF
Reserved	Reserved for GS	700 - 7F7
	Reserved by CCSDS Standard	7F8 - 7FF

2.1.5 Sequence Flags

Bits 16–17 contain the packet's sequence flags. The Sequence Flags are set in the following manner:

'00' if the Space Packet contains a continuation of a GRB Payload segment.

'01' if the Space Packet contains the first segment of a GRB Payload.

'10' if the Space Packet contains the last segment of a GRB Payload.

'11' if the Space Packet contains an unsegmented GRB Payload.

2.1.6 Packet Sequence Count

Bits 18–31 contain the Packet Sequence Count for the GRB data. The Packet Sequence Count provides a sequential binary count of each Space Packet generated for the identified APID. The Packet Sequence Count is continuous (modulo-16384) provided there isn't a failover/handover situation at the ground station that generated the GRB data packet. During failover/handover, there may by a discontinuity in the Packet Sequence Count values. The Assembler Identifier in the GRB Secondary Header can be used to determine if failover/handover has occurred.

2.1.7 Packet Data Length

Bits 32–47 contain the Packet Data Length. This 16-bit field contains a length count, *C,* that equals the length of the Packet Data Field (in bytes) minus one. The Packet Data Field is defined as the data contained in the space packet other than that which is in the Primary Header. Therefore, the Packet Data Field contains the data from the Secondary Header, GRB Payload, and the Packet Checksum.

2.1.8 Days Since the Epoch

Bits 48-63 indicate the number of days since the GOES-R epoch date of January 1, 2000 12:00:00 UTC. This time represents the creation time of the GRB CCSDS packet.

2.1.9 Milliseconds of the Day

Bits 64-95 indicate the number of milliseconds since the start of the current day at 12:00 PM, UTC. This time represents the creation time of the GRB CCSDS packet.

2.1.10 GRB Version

Bits 96-98 indicates the GRB version. This is currently set to 0 and only changes if a new GRB version is needed.

2.1.11 GRB Payload Variant

Bits 99-103 indicate the format of the data contained within the GRB Payload of the given GRB packet. Valid bit combinations are given by:

0x00: Generic Data (Described in Section 2.3)

0x01: Reserved

0x02: Imagery Data (Described in Section 2.2)

0x03: Imagery Data with Data Quality Flags (Section 2.2)

Bits 101-103 are currently not used. They are reserved for future use.

2.1.12 Assembler Identifier

Bits 104-107 uniquely identify the server on which the packet was assembled. Valid values include:

WCDAS_PRIMARY = 0,

WCDAS_BACKUP = 1,

RBU_PRIMARY = 2,

RBU_BACKUP = 3

2.1.13 Operational Environment

Bits 108-111 uniquely identify the operational environment in which the packet was assembled. Valid values include:

DEVELOPMENT = 0,

INTEGRATION = 1,

OPERATIONAL = 2

2.1.14 GRB Payload

The GRB Data Payload begins at bit 112. It has a variable length, containing up to 130,976 bits. The size of the GRB Data Payload, in bytes, is calculated by subtracting 11 from the Packet Data Length field in the CCSDS Primary Header. The format of the GRB Data Payload depends upon the product data type that it contains. There are two distinct GRB data types: GRB Image Data and GRB Generic Data. The format of the GRB Payload for Image Data is described in Section 2.2. The format of the GRB Payload for Generic Data is decribed in Section 2.3. All of the product data, imagery, metadata, and GRB Information files that are included in the GRB data stream will be encapsulated within one of these two data structures.

2.1.15 Checksum

The final 32 bits of the GRB Packet contain a checksum field for the packet. The checksum is Cyclic Redundancy Check (CRC)-32 as defined by International Organization for Standardization (ISO) 3309.

2.2 GRB Image Data

Image Products are produced for both the ABI and SUVI sensors. The image products for these sensors are stored within GRB Image Data Packets. Each GRB Image Data packet contains the information needed to build a small portion of the full image product, which includes both the image data and the associated Data Quality Flags (DQFs) for each of the pixels.

Each GRB packet has a maximum size of 16.4 kB. Therefore, it is necessary to subdivide each image into smaller portions that can be packaged within the GRB packets. The Product Generation Element of the GOES-R ground station subdivides each image into a collection of smaller 'blocks'. For the ABI sensor, this block represents a subset of a full swath of ABI image data. Each block is too large to fit within a single GRB packet. Therefore, the GOES-R ground station further subdivides each block into a series of smaller image fragments. This is illustrated in Figure 2.2, below. Each image fragment consists of a whole number of rows within an image block. The fragments are sized so that, generally, one image data fragment and one image DQF fragment fit within a single GRB packet. However, since lossless compression is used to compress this data, there may be cases where it is necessary to split the image data across multiple GRB packets. The procedure described in Section 2.2.1 describes the method for assembling the information from one or more GRB packets to reconstruct image data blocks and image DQF blocks.

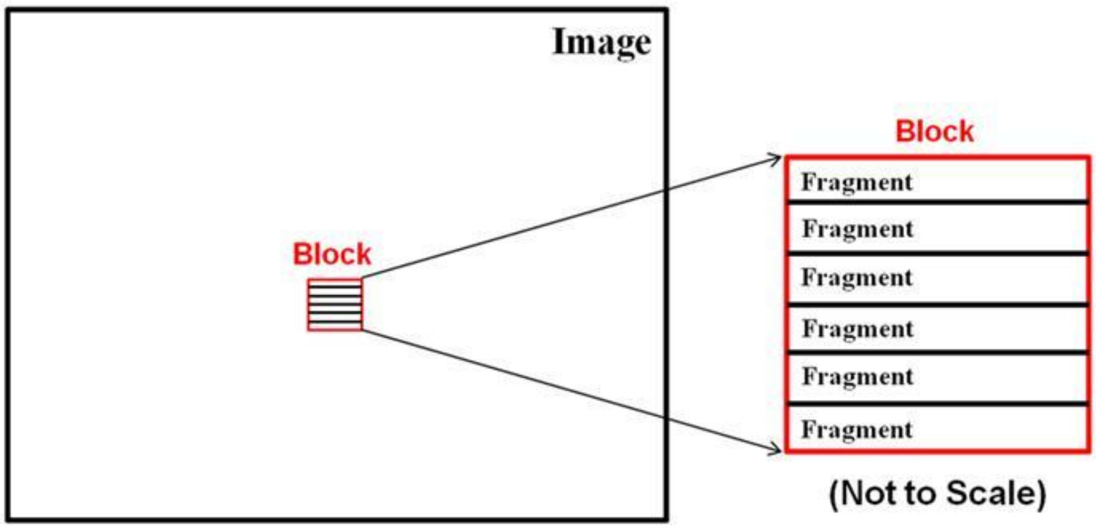

Figure 2.2 GRB Image Structure

The information provided in Section 2.2.1 describes the general procedure for extracting image blocks from the GRB data stream. This is a generic procedure that is independent of the sensor that produced the products. Furthermore, Section 2.2.2 provides format information that can be used for all image products. Specific information describing the procedure for building the final ABI image product from individual ABI image blocks is provided in Section 3.1.2. Specific information describing the procedure for building the final SUVI image product from individual SUVI image blocks is provided in Section 3.5.2.

It is important to note the metadata associated with both the ABI and SUVI imagery are stored using the GRB Generic Data format. This format is described in detail in Section 2.3.

2.2.1 Extracting Image Fragments From GRB

The following steps are needed to extract Image Payload data structure from GRB CCSDS packets. These steps are intended to process the data for a single APID. This process would be repeated for each of the APIDs containing image data. Figure 2.2.1-1 shows the process for combining multiple packets, if necessary, to reconstruct the Image Payload Data structure, which is described in Section 2.2.2. The process for extracting image fragments from the Image Payload data structure and reconstructing image blocks is shown in Figure 2.2.1-2. An important step in this process is the initialization of each image block. The blocks are initialized with values consistent with missing data (negative radiance values and appropriate DQF values). This ensures that the image block contains reasonable values even if a GRB packet is lost. Default image block values for ABI are described in Section 3.1.2. Default image block values from SUVI are described in Section 3.5.2.

In general, the GRB data packets are constructed so that a single image fragment fits within a single GRB CCSDS packet. However, occasionally it will prove necessary to split the image fragment across more than one packet. The collection of packets that make up a single image fragment is referred to as a sequence. The sequence flags, described in Table 2.1, can be used to verify that all packets in a sequence have been received. If one of the packets from the sequence is missing, then the entire sequence (image fragment) must be discarded.

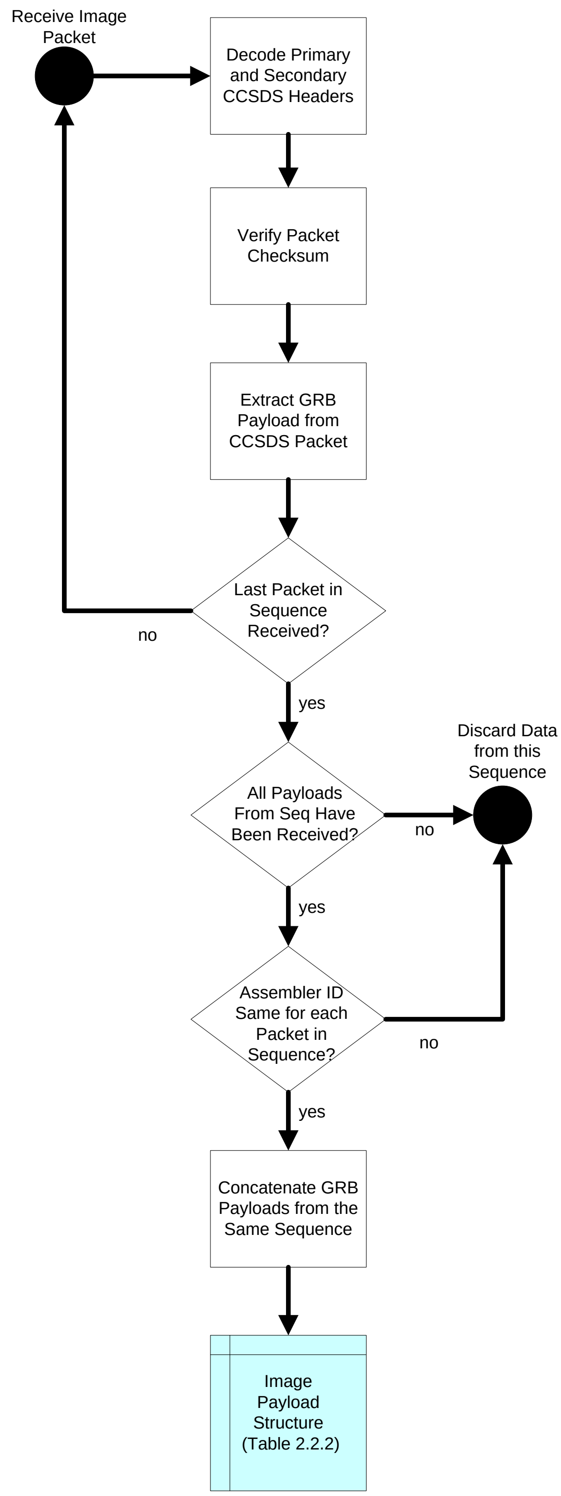

Figure 2.2.1-1 Extracting the Image Payload

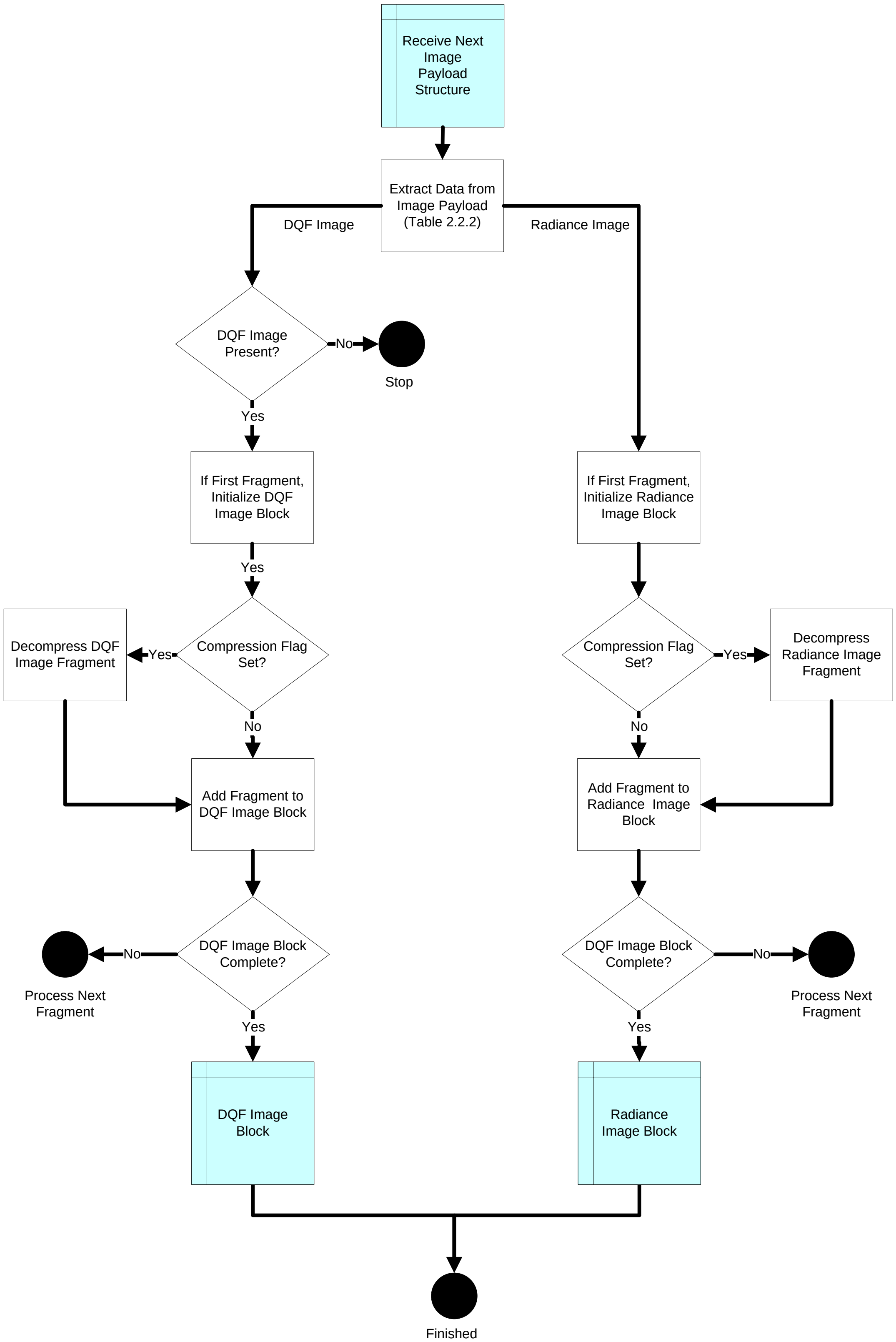

Figure 2.2.1-2 Extracting the Image Fragments

2.2.2 Image Payload Format

The Image Payload contains the data for a single Image Fragment. The format for the Image Payload is summarized in Table 2.2.2 and is described in detail below.

Table 2.2.2 Image Payload Structure

Bits	Field
8	Compression
32	Product Time Seconds Value
32	Product Time microseconds of Second
16	Image Block Identifier
24	Row Offset of Fragment within Image Block
32	Upper Left (UL) X: Pixel Coordinate of Image Block
32	Upper Left (UL) Y: Pixel Coordinate of Image Block
32	Image Block Height (pixels)
32	Image Block Width (pixels)
32	Offset to DQF Data (if present)
Varies	Image Payload

All of the fields in this data structure, except for Product Data, use Big Endian byte ordering. Product Data uses Little Endian byte ordering for all of the sensor product data and product metadata. Specific information describing how to interpret the Product Data field for the imaging sensors is described later in this document: ABI (Section 3.1) and SUVI (Section 3.5).

2.2.2.1 Compression Algorithm

Bits 0-7 of the Image Payload indicate how the underlying data was compressed. The following are the current valid values for this field:

0x00: No Compression was used

0x01: JPEG 2000

0x02: SZIP

2.2.2.2 Product Time Seconds

The GRB Image Payload provides a unique Product Time for the product. All of the image fragments that belong to the same Image Product have the same Product Time. This time represents the spacecraft time for the first packet of data collected by the satellite.

Bits 8-39 are the seconds since the GOES-R epoch of January 1, 2000 12:00:00 UTC.

Bits 40-71 are the number of microseconds since the start of that second.

2.2.2.3 Image Block Identifier

Bits 72-87 indicate the current L1b Image Block Identifier. This L1b Image Block Identifier is incremented with each L1b image block. GRB processing breaks each L1b image block up over multiple transfers, but every transfer for a given L1b image block will have the same L1b Image Block Identifier.

2.2.2.4 Row Offset of Fragment

Bits 88-111 indicate the row offset of the current transfer. This is the number of rows that were sent in previous transfers of the current L1b image block. To determine the Y-Coordinate of the first row in a transfer, add the Row Offset to the Upper Left Y-Coordinate.

2.2.2.5 Upper Left (UL) X Coordinate

Bits 112-143 of the Image Payload provide the X-Coordinate of the upper left-most pixel of the image fragment. This value tells the user where to place the fragment within the final image product. Section 3 provides detailed information about how this information is used to construct complete image products. This field should be interpreted as an unsigned integer.

2.2.2.6 Upper Left (UL) Y Coordinate

Bits 144-175 of the Image Payload provide the Y-Coordinate of the upper left-most pixel of the image fragment. This value tells the user where to place the fragment within the final image product. Section 3 provides detailed information about how this information is used to construct complete image products. This field should be interpreted as an unsigned integer.

2.2.2.7 Image Block Height

Bits 176-207 of the Image Payload provide the height of the entire image in pixels. This field should be interpreted as an unsigned integer.

2.2.2.8 Image Block Width

Bits 208-239 of the Image Payload provide the width of the entire image in pixels. Only whole rows can be transmitted by GRB, so this is also the width of the image fragment being received. This field should be interpreted as an unsigned integer.

2.2.2.9 (Optional) Offset to DQF

Bits 240-271 of the Image Payload contain the offset, in bytes, to the DQF data, if it exists. If the Payload Variant indicates that DQ Flags are included, then bits 240-271 should be interpreted as an unsigned integer, ***N***. The value ***N*** can be used to locate the DQF in the Data Field. The first ***N-1*** bytes of the Data field contain the actual image data. The remaining information in the Data field, starting at byte ***N***, contains the DQF information. DQFs are compressed separately from the image data but with the same algorithm. DQFs always have the same dimensions as the corresponding image data.

2.2.2.10 Image Payload

The remainder of the bits in the GRB Payload is the Data Field. If the Payload Variant field indicates that the Image Payload contains DQF Flags, then this field contains both image information and DQFs. Section 2.2.1 describes the method for extracting product data from Data Field.

2.3 GRB Generic Data

Generic Products are the non-image based products produced by the GLM (Section 3.2.2), EXIS (Sections 3.3.2 and 3.3.4), SEISS (Sections 3.4.2, 3.4.4, 3.4.6, and 3.4.8), and MAG (Section 3.6.2) instruments. There is a three step process for reconstructing products that are in the GRB Generic Data format. First, the Data Payload structure must be built from multiple GRB CCSDS packets (see Section 2.3.1). Second, the information contained within the Data Payload must be extracted. This process is described in Section 2.3.2.

2.3.1 Extracting GRB Generic Product Data

The following steps are needed to extract and reconstruct the GRB Generic Data Payload from the GRB CCSDS packets. This format is used for all non-image products. These steps are intended to process the data from a single APID. This process would be repeated for each of the APIDs containing generic data.

Usually, each data product is fully contained within a single GRB packet. Occasionally, the product will be segmented across more than one packet. The process in Figure 2.3.1-1 shows the methods for combining multiple packets (if needed) to construct the Generic Data Payload structure. The format for the Generic Data Payload structure is provided in Section 2.3.2. The process for extracting product data from the Generic Data Payload structure is shown in Figure 2.3.1-2.

In general, the GRB data packets are constructed so that a single product data structure is contained within a single GRB CCSDS packet. However, occasionally it will prove necessary to split the product data across more than one packet. The collection of packets needed to create a single product data structure is referred to as a sequence. The sequence flags, described in Table 2.1-2, can be used to verify that all packets in a sequence have been received. If one of the packets from the sequence is missing, then the entire sequence must be discarded.

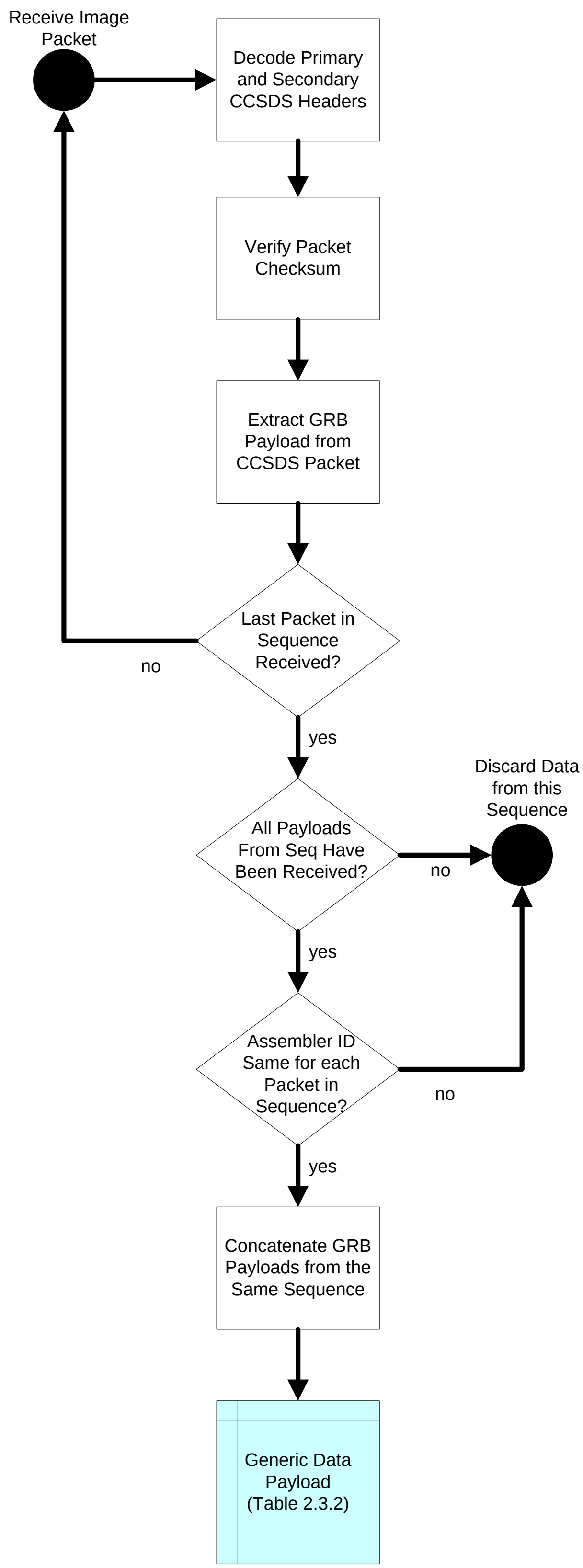

Figure 2.3.1-1 Extracting the Generic Data Payload

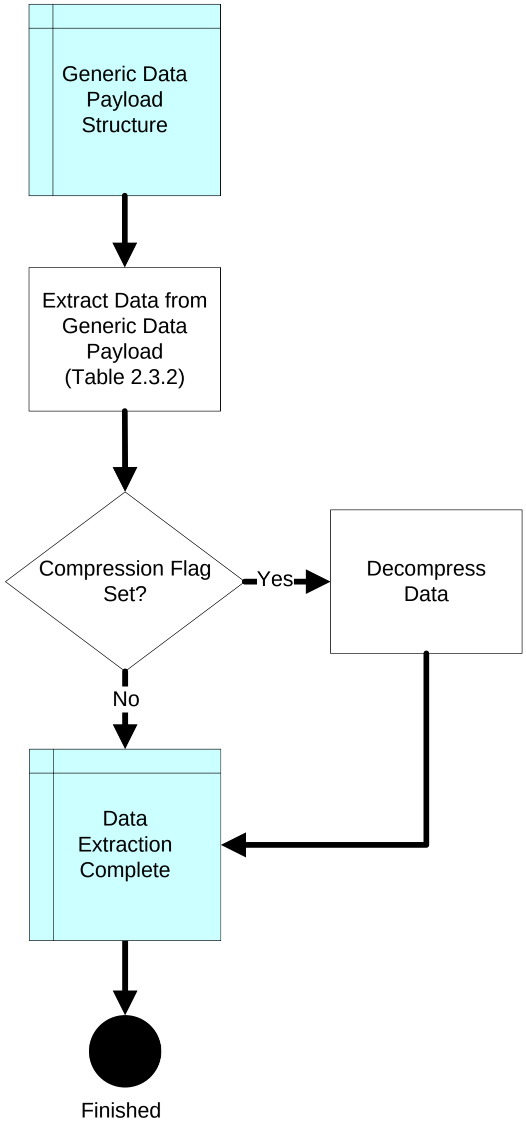

Figure 2.3.1-2 Extracting Non-Image Product Data

2.3.2 GRB Generic Data Payload Format

The GRB Generic Data Payload contains the data for a single Generic Data Product Fragment. The format for the GRB Generic Data Payload is summarized in Table 2.3.2 and is described in detail below.

Table 2.3.2 GRB Generic Data Payload Structure

Bits	Field
8	Compression Algorithm
32	Product Time Seconds Value
32	Product Time microseconds of second

Bits	Field
64	Reserved
32	Block ID
32	Reserved
Varies	Product Data

All of the fields in this data structure, except for Product Data, use Big Endian byte ordering. The Product Data field uses Little Endian byte ordering. The structure of the Product Data will vary depending upon the data type contained within this particular packet. The structure of the Product Data field for the non-imaging sensors is described later in this document: GLM (Section 3.2), EXIS (Section 3.3), SEISS (Section 3.4), SUVI (Section 3.5) and Magnetometer (Section 3.6). GRB INFO data packets also used the Generic Data Payload structure. The details describing how to interpret the Product Data field for GRB INFO packets is given in Section 4.0.

2.3.2.1 Compression Algorithm

Bits 0–7 of the GRB Generic Data Payload indicate how the underlying data was compressed. The following are the current valid values for this field:

0x00: No Compression was used

0x01: JPEG2000

0x02: SZIP

2.3.2.2 Product Time

The GRB Generic Data format provides a unique Product Time for the products. This time represents the spacecraft time for the first packet of data collected by the satellite for this product. Section 3 describes how this field is used to extract product data for each sensor.

Bits 8-39 are the seconds since the GOES-R epoch of January 1, 2000 12:00:00 UTC.

Bits 40-71 are the number of microseconds since the start of that second.

2.3.2.3 Reserved

2.3.2.4 Block Identifier

Bits 136-167 an unsigned integer that are used to enumerate individual product blocks. This field is not used for all of the sensors. The instructions provided in Section 3 will describe how to use this field if it is needed.

2.3.2.5 Reserved

2.3.2.6 Product Data

The remainder of the bits in the GRB Payload is the Generic Data. Section 2.3.1 describes the method for extracting product data from Generic Data field.

2.4 GRB AOS Space Data Link Protocol Processing

This paragraph addresses the CCSDS AOS Space Data Link Protocol, as highlighted in Figure 2.4 and implemented by the GS MM element. Two Data Link sub-layers are defined for CCSDS Data Link protocols. The AOS Space Data Link protocol corresponds to the Data Link Protocol Sublayer and provides functions for transferring data using the protocol data unit called the Transfer Frame.

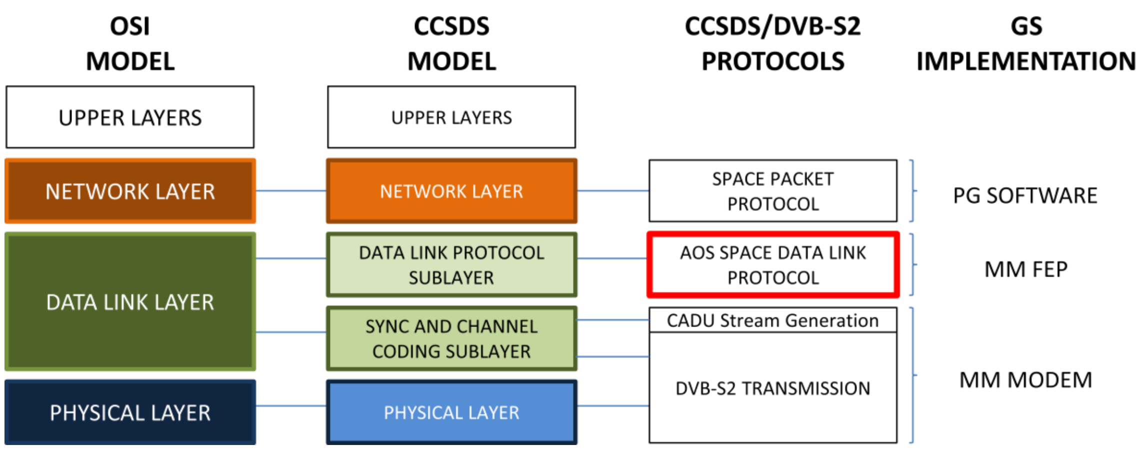

Figure 2.4 GOES-R GRB AOS Space Data Link Protocol

The AOS Space Data Link Protocol is a Data Link Layer protocol used by space missions. This protocol is designed to meet the requirements of space missions for efficient transfer of space application data of various types and characteristics over space-to-ground, ground-to-space, or space-to-space communications links. For GRB it is used for ground-to-space transfer (WCDAS or RBU to satellite transponder) and space-to-ground transfer (satellite transponder to WCDAS, RBU, NSOF and GRB Direct Readout Terminal users.

2.4.1 AOS Transfer Frame for GRB

The AOS Space Data Link Protocol facilitates simple, reliable, and robust synchronization procedures, fixed-length protocol data units are used to transfer data through the weak-signal, noisy space links. As shown in Figure 2.4.1, its protocol data units are known as AOS Transfer Frames. Each Transfer Frame contains a header which provides protocol control information and a fixed-length data field within which higher-layer service data units are carried.

AOS TRANSFER FRAME FOR GRB

TRANSFER FRAME PRIMARY HEADER	TRANSFER FRAME DATA FIELD	FRAME ERROR CONTROL FIELD
6 OCTETS	2036 OCTETS	2 OCTETS
2044 OCTETS		

Figure 2.4.1 AOS Transfer Frame

2.4.2 AOS Transfer Frame - Primary Header

The Transfer Frame Primary Header is mandatory and consists of four fields, positioned contiguously, in the following sequence:

a) Master Channel Identifier (10 bits; mandatory);

b) Virtual Channel Identifier (6 bits; mandatory);

c) Virtual Channel Frame Count (3 octets; mandatory);

d) Signaling Field (1 octet; mandatory).

The optional 2-octet Frame Header Control field is not used for GRB.

TRANSFER FRAME PRIMARY HEADER							
MASTER CHANNEL ID		VIRTUAL CHANNEL ID	VIRTUAL CHANNEL FRAME COUNT	SIGNALING FIELD			
TRANSFER FRAME VERSION NUMBER 01 = VERSION	SPACECRAFT ID			REPLAY FLAG	VIRTUAL CHANNEL FRAME COUNT USAGE FLAG	RSVD SPARE	VIRTUAL CHANNEL COUNT CYCLE
2 BITS	8 BITS	6 BITS	24 BITS	1 BIT	1 BIT	2 BITS	4 BITS
2 OCTETs			3 OCTETs	1 BYTE			
6 OCTETs							

Figure 2.4.2 AOS Transfer Frame - Primary Header

2.4.2.1 Master Channel ID – Transfer Frame Version Number

Bits 0–9 of the Transfer Frame Primary Header shall contain the Master Channel Identifier (MCID).

0b01 = "AOS" = VERSION Per CCSDS 732.0-B-2:

2.4.2.2 Master Channel ID – Spacecraft ID

Bits 2–9 of the Transfer Frame Primary Header shall contain the Spacecraft Identifier (SCID). The Spacecraft Identifier is assigned by CCSDS and provides the identification of the spacecraft supported by the data contained in the Transfer Frame. The Secretariat of the CCSDS assigns Spacecraft Identifiers.

2.4.2.3 Virtual Channel ID

Bits 10–15 of the Transfer Frame Primary Header shall contain the Virtual Channel Identifier (VCID). The 31 Mbps GRB bandwidth is divided in half (15.5 Mbps) for two polarizations.

0b000101 = 5 = GRB Polarization 1

0b000110 = 6 = GRB Polarization 2

0b111111 = 63 = IDLE Frames

2.4.2.4 Virtual Channel Frame Count

The purpose of this field is to provide individual accountability for each Virtual Channel, primarily to enable systematic Packet extraction from the Transfer Frame Data Field. If the Virtual Channel Frame Count is reset because of an unavoidable re-initialization, the completeness of a sequence of Transfer Frames in the related Virtual Channel cannot be determined.

2.4.2.5 Signaling Field – Replay Flag

Bits 40–47 of the Transfer Frame Primary Header shall contain the Signaling Field. The Signaling Field shall be used to alert the receiver of the Transfer Frames with respect to functions that: (a) may change more rapidly than can be handled by management, or; (b) provide a significant cross-check against manual or automated setups for fault detection and isolation purposes.

This 8-bit field shall be subdivided into four sub-fields as follows:

a) Replay Flag (1 bit, mandatory);

b) Virtual Channel (VC) Frame Count Cycle Use Flag (1 bit, mandatory);

c) Reserved Spares (2 bits, mandatory);

d) Virtual Channel Frame Count Cycle (4 bits, mandatory).

Bit 40 of the Transfer Frame Primary Header shall contain the Replay Flag. Some satellites store Transfer Frames during periods when the space link is unavailable, and to retrieve them for subsequent replay when the link is restored, this flag shall alert the receiver of the Transfer Frames with respect to its 'real-time' or 'replay' status. Its main purpose is to discriminate between real-time and replay Transfer Frames when they both may use the same Virtual Channel. GOES-R only support real-time transfer, therefore the flag is set as follows:

0b0 = Real-time Transfer Frame (GOES-R has no on-board storage, all data is real-time)

2.4.2.6 Signaling Field – Virtual Channel Frame Count Use Flag

Bit 41 of the Transfer Frame Primary Header shall contain the VC Frame Count Cycle Use Flag.

1 = VC Frame Count Cycle field is used and shall be interpreted by the receiver.

2.4.2.7 Signaling Field – Reserved Spare

Bits 42-43 of the Transfer Frame Primary Header shall contain the reserved spare.

0b00 = Spares always set to 0

2.4.2.8 Signaling Field – Virtual Channel Count Cycle

Bits 44-47 of the Transfer Frame Primary Header shall contain the Virtual Channel Frame Count Cycle field. Each time the Virtual Channel Frame Count returns to zero, the VC Frame Count Cycle shall be incremented. The VC Frame Count Cycle effectively extends the Virtual Channel Frame Count from 24 to 28 bits.

2.4.3 Transfer Frame Data Field used for GRB Uplinks and Downlinks

The Transfer Frame Data Field contains one Multiplexing Protocol Data Unit (M_PDU), and one M_PDU Packet Zone.

TRANSFER FRAME DATA FIELD – For GRB				
M_PDU_HEADER		M_PDU PACKET ZONE		
RSVD SPARE	FIRST HEADER POINTER	END of SOURCE PKT (N)	SOURCE PACKET (N+1)	START of SOURCE PACKET (N+2)
5 BITS	11 BITS	2034 OCTETS		
2036 OCTETS				

Figure 2.4.3 Transfer Frame Data Field

2.4.3.1 M_PDU Definition: Multiplexing Protocol Data Unit = M_PDU

2.4.3.2 M_PDU Header – Reserved (RSVD) Spare

0b00000 = Reserved Spare always 0

2.4.3.3 M_PDU Header – First Header Pointer

The locations of the octets in the M_PDU Packet Zone shall be numbered in ascending order. The first octet in this zone is assigned the number 0. The First Header Pointer shall contain the binary representation of the location of the first octet of the first Packet that starts in the M_PDU Packet Zone.

The purpose of the First Header Pointer is to facilitate delimiting of variable-length Packets contained within the M_PDU Packet Zone, by pointing directly to the location of the first Packet from which its length may be determined.

0b1111 1111 111 = If no Packet starts in the M_PDU Packet Zone, the First Header Pointer shall be set to 'all ones'.

2.4.3.4 M_PDU Packet Zone

From CSSDS 732.0-B-2: The M_PDU Packet Zone shall contain either Packets or Idle Data.

In the case where no valid Transfer Frame Data Field is available for transmission at release time for a Transfer Frame, a Transfer Frame with a Data Field containing only Idle Data is transmitted. Such a Transfer Frame is called an Idle Transfer Frame. The Virtual Channel ID of an Idle Transfer Frame is set to the value of 'all ones' and a project-specified 'idle' pattern is inserted into the Transfer Frame Data Field.

2.4.4 AOS Transfer Frame – Frame Error Control Field

The Frame Error Control Field is 2 Octets long and is created as detailed in CCSDS AOS Blue Book (CCSDS 732.0-B-2) reference Section 4.1.6

2.5 GRB CADU and DBV-S2 Protocol Processing

This paragraph addresses the CCSDS CADU stream generation and DVB-S2 transmission, as highlighted in Figure 2.5-1 and implemented by the GS MM element. The CCSDS Synchronization and Channel Coding Sublayer provides methods of synchronization and channel coding for transferring AOS Transfer Frames, as generated by the AOS Space Data Link Protocol, over a space link while the Physical Layer provides the RF and modulation methods for transferring a stream of bits over a space link in a single direction. Since DVB-S2 allows continuous Generic Stream input, the transmission of CCSDS CADU over DVB-S2 is supported.

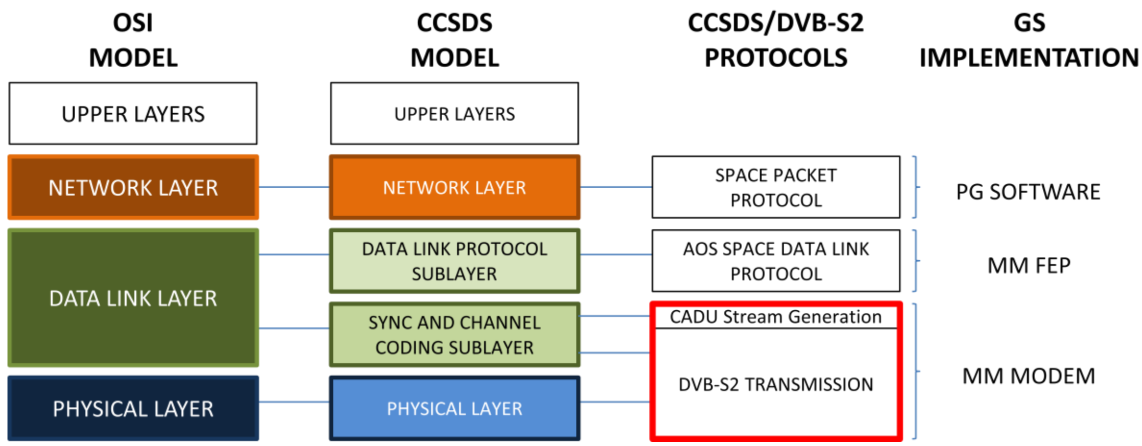

Figure 2.5-1 GOES-R GRB CADU Stream Generation and DVB-S2 Transmission

CCSDS Transfer Frame synchronization is necessary at the receiver. Consequently a 32-bit Attached Sync Marker (ASM) is introduced before transmission.

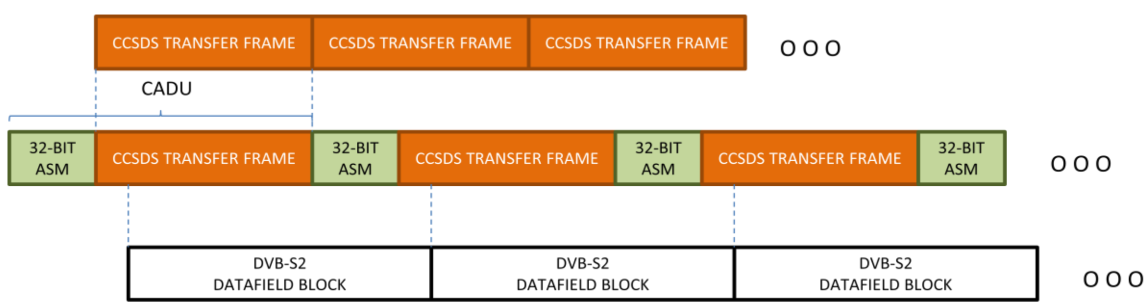

Figure 2.5-2 GOES-R GRB Stream Format to Transmit Transfer Frames over DVB-S2

2.5.1 CADU Stream Generation

CCSDS Transfer Frame synchronization is necessary to support receiver processing. Consequently, for each Transfer Frame produced via the AOS Space Data Link Protocol, a Channel Access Data Unit (CADU) containing the Attached Sync Marker (ASM) and the Transfer Frame is constructed. The ASM is a 32 bits (4 octets) marker with value 1ACFFC1D in Hex.

2.5.2 DVB-S2 Transmission

The ETSI Digital Video Broadcasting-Second Generation (DVB-S2) Link Protocol is described herein as used for GRB. The lowest level input to this protocol is the CCSDS Telemetry Source Channel Access Data Unit (CADU) as described in paragraph 2.4. The source CADU user data field contains the actual telemetry data. The GOES-R GRB DVB-S2 service is transported in the single continuous generic stream format. It utilizes the Constant Coding and Modulation mode.

Two types of modulations are used on GOES-R for the GRB Link, QPSK with a rate 9/10 forward error correction (FEC) coding and 8PSK with a rate 2/3 forward error correction coding. The FEC block length used for GRB is 64800 bits in length and uses Low Density Parity Check (LDPC) error correcting coding, Bose Chaudhuri Hocquenghem (BCH) error correction coding and randomization provided by the transport layer.

The same GRB Link Protocol is used for both polarizations and the input rate to the DVB-S2 processing is 15.5 Megabits per second (Mbps) for each polarization.

For implementation details refer to the ETSI EN 302 307 V1.2.1 document.

2.5.3 Definitions

(1) OCTET = (1) 8-BIT WORD

(1) SYMBOL = 1 BIT for BPSK, 2 BITS for QPSK, 3 BITS for 8PSK

2.5.4 Physical Layer Frame (PLFRAME) used for GRB Uplinks and Downlinks

The Physical Layer Frame for GRB is shown in Figure 2.5.4.

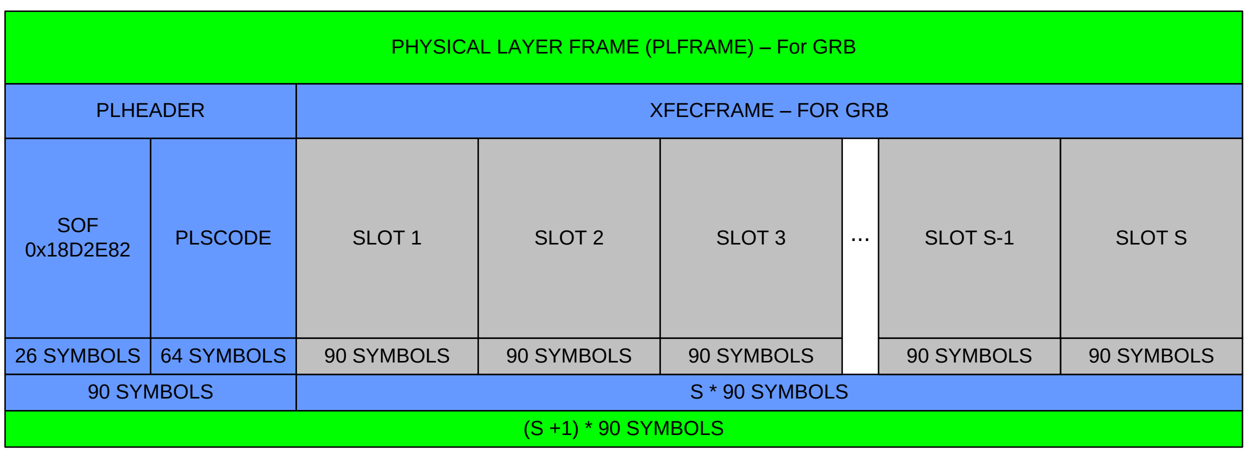

Figure 2.5.4 Physical Layer Frame (PLFRAME) – For GRB Uplinks and Downlinks

The number of XFEC frame (XFECFRAME) data slots (S) is

S = 360 for QPSK and

S = 240 for 8PSK

which results in 360 * 90 * 2 = 240 * 90 * 3 = 64800 bits.

2.5.4.1 Physical Layer Header (PLHEADER)

The PLHEADER consists of 90 Symbols of $\pi/2$ BPSK modulation regardless of the modulation type for the data. This field consists of the 26 symbol SOF and the 64 symbol PLSCODE.

2.5.4.2 Start Of Frame (SOF)

0x18D2E82 = SOF

2.5.4.3 Physical Layer Signaling Code (PLSCODE)

The PLSCODE field is a 7 bit value that is encoded into a 64 bit block using a first order Reed-Muller under permutation error correction code as detailed in ETSI EN 302 307 section 5.5.2.4. The 7bits are formed from a 5 bit modulation code (MODCOD) and a 2 bit type field (TYPE).

MODCODE = 0x0B for QPSK 9/10, 0x0D for 8PSK 2/3

TYPE = 0x0 for normal 64800 bits and no pilots

2.5.4.4 Physical Layer Scrambling (PLSCRAMBLING)

Prior to modulation, each PLFRAME, excluding the PLHEADER shall be scrambled as detailed in ETSI EN 302 307 Section 5.5.4.

2.5.4.5 Baseband Shaping

After scrambling the signals shall be square root raised cosine filtered with a roll-off factor of $\alpha = 0.25$ as detailed in ETSI EN 302 307 Section 5.5.4.

2.5.5 XFEC Frame used for GRB Uplinks and Downlinks

Frames are per the ETSI EN 302 307 reference Section 5.3.

XFEC FRAME (XFECFRAME) – For GRB QPSK 9/10		
Baseband Frame (BBFRAME)	BCH FEC BITS (BCHFEC)	LDPC FEC BITS (LDPCFEC)
BBFRAME	BCHFEC	LDPCFEC
	128 BITS	6480 BITS
58192 BITS	6608 BITS	
64800 BITS		

XFEC FRAME (XFECFRAME) – For GRB 8PSK 2/3		
Baseband Frame (BBFRAME)	BCH FEC BITS (BCHFEC)	LDPC FEC BITS (LDPCFEC)
BBFRAME	BCHFEC	LDPCFEC
	160 BITS	21600 BITS
43040 BITS	21760 BITS	
64800 BITS		

Figure 2.5.5 XFEC Frame (XFECFRAME) – For GRB Uplinks and Downlinks

2.5.5.1 Bit Interleaver

For the 8PSK modulation format the output of the LDPC encoder shall be bit interleaved as detailed in ETSI EN 302 307 section 5.3.3.

2.5.5.2 LDPC FEC inner encoding (LDPCFEC)

The BBFRAME and BCHFEC fields will be LDPC encoded as detailed in ETSI EN 302 307 Section 5.3.2.

2.5.5.3 BCH FEC outer encoding (BCHFEC)

The BBFRAME field will be BCH encoded as detailed in ETSI EN 302 307 section 5.3.1.

2.5.5.4 2.6.5.4 Baseband Frame Scrambling (BBFRAME)

The entire BBFRAME field shall be scrambled as detailed in ETSI EN 302 307 section 5.2.2.

2.5.6 Baseband Frame (BBFRAME) used for GRB Uplinks and Downlinks

BASEBAND FRAME (BBFRAME) – For GRB QPSK 9/10	
Baseband Header (BBHEADER)	DATA FIELD (DFL)
BBHEADER	DFL
80 BITS	58112 BITS
58192 BITS	

BASEBAND FRAME (BBFRAME) – For GRB 8PSK 2/3	
Baseband Header (BBHEADER)	DATA FIELD (DFL)
BBHEADER	DFL
80 BITS	42960 BITS
43040 BITS	

Figure 2.5.6 Baseband Frame (BBFRAME) – For GRB Uplinks and Downlinks

The Baseband Frame (BBFRAME) will consist of a 10 octet Baseband Header (BBHEADER) and the user data field (DFL). The user data field shall be filled by asynchronously slicing the incoming continuous generic stream coming from the Front End Processor (FEP). If there is insufficient data to completely fill the DFL the modem will append zero bits to the end of the data to completely fill the DFL field as detailed in ETSI EN 302 307 section 5.2.

2.5.6.1 Baseband Header (BBHEADER)

BASEBAND HEADER (BBHEADER) – For GRB					
MATYPE	UPL	DFL	SYNC	SYNCD	CRC-8
16 BITS	16 BITS	16 BITS	8 BITS	16 BITS	8 BITS
80 BITS					

Figure 2.5.6.1 Baseband header (BBHEADER) – For GRB Uplinks and Downlinks

The Baseband Header (BBHEADER) consists of 6 subfields as shown in Figure 1-4 and detailed in ETSI EN 302 307 section 5.1.6.

2.5.6.1.1 MATYPE

The MATYPE subfield (2 octets) consists of the following:

First octet (MATYPE-1)

TS/GS field (2 bits) = 0b01, generic continuous

SIS/MIS field (1 bit) = 0b1, single

CCM/ACM field (1 bit) = 0b1, CCM

ISSY field (1 bit) = 0b0, not active

NPD field (1 bit) = 0b0, not active

RO field (2 bits) = 0b01, rolloff = 0.25

Second octet (MATYPE-2)

Reserved = 0x0

2.5.6.1.2 UPL

The UPL subfield (2 octets) consists of the user packet length in bits = 0x0 continuous stream.

2.5.6.1.3 DFL

The DFL subfield (2 octets) consists of the user packet length in bits 0 to 58112.

2.5.6.1.4 SYNC

The SYNC subfield (1 octet) is reserved for transport layer signaling.

2.6.6.1.5 SYNCD

The SYNCD subfield (2 octets) is reserved for future use.

2.5.6.1.5 CRC-8

The CRC-8 subfield (1 octet) is for error detection code applied to first 9 bytes of the BBHEADER.

3.0 GRB PRODUCT DATA DESCRIPTION

3.1 ABI L1b Radiances Products

The following sections describe the ABI L1b Radiances Products that are present in the GRB data stream. There are several characteristics that define the ABI L1b Radiance Products. First, there are four distinct geometric regions (scenes) that are imaged by the ABI instrument during normal operations. These include Full Disk, Continental United States (CONUS), and two Mesoscale scenes. The mesoscale imagery is unique in that ABI has the ability to center this product anywhere within the Field of View of the ABI sensor. Second, each product contains data from only one of 16 spectral bands. The spectral bands and their assocated spatial resolutions are described in detail in Section 3.1.2. Finally, each product contains three distinct data items: ABI L1b Radiance Metadata, ABI L1b Radiance Image, and ABI L1b Radiance Data Quality Flag Image

Each of the products that are produced by the GOES-R system has a Product Time that uniquely identifies that product. Each of the data items listed above (metadata, radiance image, and DQF image) will have the same product time. The Product Time can be extracted from the data structures within the GRB data packets. This is described in Table 2.2.2 for image products and Table 2.3.2 for the metadata.

3.1.1 ABI L1b Radiances Metadata

The ABI L1b Radiance Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.1.1-1, below, lists the GRB APIDs that have been assigned to each ABI metadata file. All of this metadata is provided within a single NcML file. However, for clarity, it has been subdivided into several separate tables in this document. Product Dimension information is provided in Table 3.1.1-2. NcML global variables are described in Table 3.1.1-3. NcML global attributes are described in Table 3.1.1-4, and Keywords information is described in Table 3.1.1-5. It is important to note that the metadata contained within Tables 3.1.1-2 through 3.1.1-5 contain representative values only. The intent of these tables is to describe the general content of the metadata NcML files that will be received throughout the GRB data stream.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its associated radiance and data quality flag images will all have the same product time.

Table 3.1.1-1 ABI Radiances Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
100	ABI-L1b-RADF_M3C01	ABI L1b 1.0-km Band 1 Metadata, Full Disk (Mode 3)
101	ABI-L1b-RADF_M3C02	ABI L1b 0.5-km Band 2 Metadata, Full Disk (Mode 3)
102	ABI-L1b-RADF_M3C03	ABI L1b 1.0-km Band 3 Metadata, Full Disk (Mode 3)
103	ABI-L1b-RADF_M3C04	ABI L1b 2.0-km Band 4 Metadata, Full Disk (Mode 3)
104	ABI-L1b-RADF_M3C05	ABI L1b 1.0-km Band 5 Metadata, Full Disk (Mode 3)

GRB APID (Hex)	Product Data Name	Description
105	ABI-L1b-RADF_M3C06	ABI L1b 2.0-km Band 6 Metadata, Full Disk (Mode 3)
106	ABI-L1b-RADF_M3C07	ABI L1b 2.0-km Band 7 Metadata, Full Disk (Mode 3)
107	ABI-L1b-RADF_M3C08	ABI L1b 2.0-km Band 8 Metadata, Full Disk (Mode 3)
108	ABI-L1b-RADF_M3C09	ABI L1b 2.0-km Band 9 Metadata, Full Disk (Mode 3)
109	ABI-L1b-RADF_M3C10	ABI L1b 2.0-km Band 10 Metadata, Full Disk (Mode 3)
10A	ABI-L1b-RADF_M3C11	ABI L1b 2.0-km Band 11 Metadata, Full Disk (Mode 3)
10B	ABI-L1b-RADF_M3C12	ABI L1b 2.0-km Band 12 Metadata, Full Disk (Mode 3)
10C	ABI-L1b-RADF_M3C13	ABI L1b 2.0-km Band 13 Metadata, Full Disk (Mode 3)
10D	ABI-L1b-RADF_M3C14	ABI L1b 2.0-km Band 14 Metadata, Full Disk (Mode 3)
10E	ABI-L1b-RADF_M3C15	ABI L1b 2.0-km Band 15 Metadata, Full Disk (Mode 3)
10F	ABI-L1b-RADF_M3C16	ABI L1b 2.0-km Band 16 Metadata, Full Disk (Mode 3)
120	ABI-L1b-RADC_M3C01	ABI L1b 1.0-km Band 1 Metadata, CONUS (Mode 3)
121	ABI-L1b-RADC_M3C02	ABI L1b 0.5-km Band 2 Metadata, CONUS (Mode 3)
122	ABI-L1b-RADC_M3C03	ABI L1b 1.0-km Band 3 Metadata, CONUS (Mode 3)
123	ABI-L1b-RADC_M3C04	ABI L1b 2.0-km Band 4 Metadata, CONUS (Mode 3)
124	ABI-L1b-RADC_M3C05	ABI L1b 1.0-km Band 5 Metadata, CONUS (Mode 3)
125	ABI-L1b-RADC_M3C06	ABI L1b 2.0-km Band 6 Metadata, CONUS (Mode 3)
126	ABI-L1b-RADC_M3C07	ABI L1b 2.0-km Band 7 Metadata, CONUS (Mode 3)
127	ABI-L1b-RADC_M3C08	ABI L1b 2.0-km Band 8 Metadata, CONUS (Mode 3)
128	ABI-L1b-RADC_M3C09	ABI L1b 2.0-km Band 9 Metadata, CONUS (Mode 3)
129	ABI-L1b-RADC_M3C10	ABI L1b 2.0-km Band 10 Metadata, CONUS (Mode 3)
12A	ABI-L1b-RADC_M3C11	ABI L1b 2.0-km Band 11 Metadata, CONUS (Mode 3)
12B	ABI-L1b-RADC_M3C12	ABI L1b 2.0-km Band 12 Metadata, CONUS (Mode 3)
12C	ABI-L1b-RADC_M3C13	ABI L1b 2.0-km Band 13 Metadata, CONUS (Mode 3)
12D	ABI-L1b-RADC_M3C14	ABI L1b 2.0-km Band 14 Metadata, CONUS (Mode 3)
12E	ABI-L1b-RADC_M3C15	ABI L1b 2.0-km Band 15 Metadata, CONUS (Mode 3)
12F	ABI-L1b-RADC_M3C16	ABI L1b 2.0-km Band 16 Metadata, CONUS (Mode 3)
140	ABI-L1b-RADM1_M3C01	ABI L1b 1.0-km Band 1 Metadata, Mesoscale #1 (Mode 3)
141	ABI-L1b-RADM1_M3C02	ABI L1b 0.5-km Band 2 Metadata, Mesoscale #1 (Mode 3)
142	ABI-L1b-RADM1_M3C03	ABI L1b 1.0-km Band 3 Metadata, Mesoscale #1 (Mode 3)
143	ABI-L1b-RADM1_M3C04	ABI L1b 2.0-km Band 4 Metadata, Mesoscale #1 (Mode 3)
144	ABI-L1b-RADM1_M3C05	ABI L1b 1.0-km Band 5 Metadata, Mesoscale #1 (Mode 3)
145	ABI-L1b-RADM1_M3C06	ABI L1b 2.0-km Band 6 Metadata, Mesoscale #1 (Mode 3)
146	ABI-L1b-RADM1_M3C07	ABI L1b 2.0-km Band 7 Metadata, Mesoscale #1 (Mode 3)
147	ABI-L1b-RADM1_M3C08	ABI L1b 2.0-km Band 8 Metadata, Mesoscale #1 (Mode 3)

GRB APID (Hex)	Product Data Name	Description
148	ABI-L1b-RADM1_M3C09	ABI L1b 2.0-km Band 9 Metadata, Mesoscale #1 (Mode 3)
149	ABI-L1b-RADM1_M3C10	ABI L1b 2.0-km Band 10 Metadata, Mesoscale #1 (Mode 3)
14A	ABI-L1b-RADM1_M3C11	ABI L1b 2.0-km Band 11 Metadata, Mesoscale #1 (Mode 3)
14B	ABI-L1b-RADM1_M3C12	ABI L1b 2.0-km Band 12 Metadata, Mesoscale #1 (Mode 3)
14C	ABI-L1b-RADM1_M3C13	ABI L1b 2.0-km Band 13 Metadata, Mesoscale #1 (Mode 3)
14D	ABI-L1b-RADM1_M3C14	ABI L1b 2.0-km Band 14 Metadata, Mesoscale #1 (Mode 3)
14E	ABI-L1b-RADM1_M3C15	ABI L1b 2.0-km Band 15 Metadata, Mesoscale #1 (Mode 3)
14F	ABI-L1b-RADM1_M3C16	ABI L1b 2.0-km Band 16 Metadata, Mesoscale #1 (Mode 3)
160	ABI-L1b-RADM2_M3C01	ABI L1b 1.0-km Band 1 Metadata, Mesoscale #2 (Mode 3)
161	ABI-L1b-RADM2_M3C02	ABI L1b 0.5-km Band 2 Metadata, Mesoscale #2 (Mode 3)
162	ABI-L1b-RADM2_M3C03	ABI L1b 1.0-km Band 3 Metadata, Mesoscale #2 (Mode 3)
163	ABI-L1b-RADM2_M3C04	ABI L1b 2.0-km Band 4 Metadata, Mesoscale #2 (Mode 3)
164	ABI-L1b-RADM2_M3C05	ABI L1b 1.0-km Band 5 Metadata, Mesoscale #2 (Mode 3)
165	ABI-L1b-RADM2_M3C06	ABI L1b 2.0-km Band 6 Metadata, Mesoscale #2 (Mode 3)
166	ABI-L1b-RADM2_M3C07	ABI L1b 2.0-km Band 7 Metadata, Mesoscale #2 (Mode 3)
167	ABI-L1b-RADM2_M3C08	ABI L1b 2.0-km Band 8 Metadata, Mesoscale #2 (Mode 3)
168	ABI-L1b-RADM2_M3C09	ABI L1b 2.0-km Band 9 Metadata, Mesoscale #2 (Mode 3)
169	ABI-L1b-RADM2_M3C10	ABI L1b 2.0-km Band 10 Metadata, Mesoscale #2 (Mode 3)
16A	ABI-L1b-RADM2_M3C11	ABI L1b 2.0-km Band 11 Metadata, Mesoscale #2 (Mode 3)
16B	ABI-L1b-RADM2_M3C12	ABI L1b 2.0-km Band 12 Metadata, Mesoscale #2 (Mode 3)
16C	ABI-L1b-RADM2_M3C13	ABI L1b 2.0-km Band 13 Metadata, Mesoscale #2 (Mode 3)
16D	ABI-L1b-RADM2_M3C14	ABI L1b 2.0-km Band 14 Metadata, Mesoscale #2 (Mode 3)
16E	ABI-L1b-RADM2_M3C15	ABI L1b 2.0-km Band 15 Metadata, Mesoscale #2 (Mode 3)
16F	ABI-L1b-RADM2_M3C16	ABI L1b 2.0-km Band 16 Metadata, Mesoscale #2 (Mode 3)
180	ABI-L1b-RADF_M4C01	ABI L1b 1.0-km Band 1 Metadata, Full Disk (Mode 4)
181	ABI-L1b-RADF_M4C02	ABI L1b 0.5-km Band 2 Metadata, Full Disk (Mode 4)
182	ABI-L1b-RADF_M4C03	ABI L1b 1.0-km Band 3 Metadata, Full Disk (Mode 4)
183	ABI-L1b-RADF_M4C04	ABI L1b 2.0-km Band 4 Metadata, Full Disk (Mode 4)
184	ABI-L1b-RADF_M4C05	ABI L1b 1.0-km Band 5 Metadata, Full Disk (Mode 4)
185	ABI-L1b-RADF_M4C06	ABI L1b 2.0-km Band 6 Metadata, Full Disk (Mode 4)
186	ABI-L1b-RADF_M4C07	ABI L1b 2.0-km Band 7 Metadata, Full Disk (Mode 4)
187	ABI-L1b-RADF_M4C08	ABI L1b 2.0-km Band 8 Metadata, Full Disk (Mode 4)
188	ABI-L1b-RADF_M4C09	ABI L1b 2.0-km Band 9 Metadata, Full Disk (Mode 4)
189	ABI-L1b-RADF_M4C10	ABI L1b 2.0-km Band 10 Metadata, Full Disk (Mode 4)
18A	ABI-L1b-RADF_M4C11	ABI L1b 2.0-km Band 11 Metadata, Full Disk (Mode 4)

GRB APID (Hex)	Product Data Name	Description
18B	ABI-L1b-RADF_M4C12	ABI L1b 2.0-km Band 12 Metadata, Full Disk (Mode 4)
18C	ABI-L1b-RADF_M4C13	ABI L1b 2.0-km Band 13 Metadata, Full Disk (Mode 4)
18D	ABI-L1b-RADF_M4C14	ABI L1b 2.0-km Band 14 Metadata, Full Disk (Mode 4)
18E	ABI-L1b-RADF_M4C15	ABI L1b 2.0-km Band 15 Metadata, Full Disk (Mode 4)
18F	ABI-L1b-RADF_M4C16	ABI L1b 2.0-km Band 16 Metadata, Full Disk (Mode 4)

Table 3.1.1-2 Sample ABI NcML: Product Dimensions

Dimension Name	Length
x	500
y	500
t	1
number_of_time_bounds	2

Table 3.1.1-3 Sample ABI NcML: Product Variables

Variable Name: y, Type: float, Dimension: y			
Attributes:	*Name*	*Value*	*Type*
	scale_factor	0.000056	float
	add_offset	-0.013972	float
	units	radians	string
	axis	Y	string
	long_name	GOES Projection y-Coordinate	string
	standard_name	projection_y_coordinate	string
Variable Name: x, Type: float, Dimension: x			
Attributes:	*Name*	*Value*	*Type*
	scale_factor	-0.000056	float
	add_offset	0.013972	float
	units	radians	string
	axis	X	string
	long_name	GOES Projection x-Coordinate	string
	standard_name	projection_x_coordinate	string

Variable Name: t, Type: long, Dimension: t

Attributes:	Name	Value	Type
	long_name	time variable (t) is the mid-point between the start and end image scan	string
	units	seconds since 2000-01-01 00:00:00	string
	axis	T	string
	bounds	time_bounds	string

Variable Name: goes_imager_projection, Type: int, Dimension: 0

Attributes:	Name	Value	Type
	grid_mapping_name	geostationary	string
	long_name	GOES ABI Fixed Grid	string
	perspective_point_height	35786023	float
	semi_major_axis	6378137	float
	semi_minor_axis	6356752.314	float
	latitude_of_projection_origin	0	float
	longitude_of_projection_origin	-137	float
	sweep_angle_axis	x	string
	long_name	GOES Imager Projection	string
	units	radians	string
	coordinates	y x	string

Variable Name: time_bounds, Type: long, Dimension: time number_of_time_bounds

Attributes:	Name	Value	Type
	long_name	Scan start and end times	string
	units	seconds since 2000-01-01 00:00:00	string

Variable Name: Rad, Type: short, Dimension: t y x

Attributes:	Name	Value	Type
	_Unsigned	TRUE	string
	_FillValue	-999	short
	scale_factor	0.1	float
	add_offset	0	float
	coverage_type	physicalMeasurement	string
	description	Radiance measurements grid	string
	units	mW/(m^2•sr•cm^-1)	string
	long_name	ABI L1b Radiances per pixel	string

	standard_name	radiances_brightness_temperatures	string
	grid_mapping	goes_imager_projection	string
	coordinates	t y x	string
	ancillary_variables	DQF	string
Variable Name: DQF, Type: short, Dimension: t y x			
Attributes:	*Name*	*Value*	*Type*
	_Unsigned	TRUE	string
	coverage_type	qualityInformation	string
	long_name	ABI L1b data quality flags per pixel	string
	standard_name	radiances_quality_flag	string
	flag_masks	3b 3b 3b 3b	string
	flag_values	0 1 2 3	string
	flag_names	good_pixel conditionally_usable_pixel out_of_range_pixel no_value_pixel	string
	flag_meanings	good_pixel conditionally_usable_pixel out_of_range_pixel no_value_pixel	string
	grid_mapping	goes_imager_projection	string
	coordinates	t y x	string
Variable Name: nominal_satellite_subpoint_lat, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	degrees_north	string
	long_name	nominal satellite subpoint latitude	string
Values: 0.00			
Variable Name: nominal_satellite_subpoint_long, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	degrees_east	string
	long_name	nominal satellite subpoint longitude	string
Values: 75.00			
Variable Name: nominal_satellite_height, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	km	string
	long_name	nominal satellite subpoint longitude	string
Values: 42164.16			

Variable Name: geospatial_lat_lon, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
geospatial_westbound_longitude	0	float
geospatial_northbound_latitude	0	float
geospatial_eastbound_longitude	0	float
geospatial_southbound_latitude	0	float
geospatial_lat_center	0	float
geospatial_lon_center	0	float
geospatial_lat_nadir	0	float
geospatial_lon_nadir	137	float
geospatial_lat_nadir_resolution	2	float
geospatial_lon_nadir_resolution	2	float
geospatial_lat_units	degrees_north	string
geospatial_lon_units	degrees_east	string
long_name	geospatial latitude and longitude references for this Radiances product	string

Variable Name: valid_pixel_count, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	count	string
long_name	number of valid pixels	string

Values: 19000000

Variable Name: min_radiance_value_of_valid_pixels, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	mW/(m^2•sr•cm^-1)	string
long_name	minimum radiance value of valid pixels	string

Values: 19

Variable Name: max_radiance_value_of_valid_pixels, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	mW/(m^2•sr•cm^-1)	string
long_name	maximum radiance value of valid pixels	string

Values: 265

Variable Name: mean_radiance_value_of_valid_pixels, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	mW/(m^2•sr•cm^-1)	string
long_name	mean radiance value of valid pixels	string

Values: 85

Variable Name: std_dev_radiance_value_of_valid_pixels, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	mW/(m^2•sr•cm^-1)	string
long_name	standard deviation of radiance value of valid pixels	string

Values: 2.65

Variable Name: missing_detector_sample_count, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	count	string
long_name	count of missing detector samples	string

Values: 26500

Variable Name: pixel_count_exceeding_saturation_limit, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	count	string
long_name	count of pixels that exceed saturation limit	string

Values: 2400

Variable Name: pixel_count_below_undersaturation_limit, Type: int, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	count	string
long_name	count of pixels below undersaturation limit	string

Values: 800

Variable Name: percent_uncorrectable_L0_errors, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of uncorrectable L0 errors	string

Values: 1.55

Variable Name: percent_good_pixels, Type: float, Dimension: 0

Attributes:

Name	**Value**	**Type**
units	percent	string
long_name	percent of pixels with data quality flag = 00 (good_pixel)	string

Values: 78.0

Variable Name: percent_conditionally_usable_pixels, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of pixels with data quality flag = 01 (conditionally_usable_pixel)	string

Values: 12.0

Variable Name: percent_out_of_range_pixels, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of pixels with data quality flag = 10 (out_of_range_pixel)	string

Values: 5.5

Variable Name: percent_no_value_pixels, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of pixels with data quality flag = 11 (no_value_pixel)	string

Values: 4.5

Variable Name: earth_sun_distance_anomaly_in_AU, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	AU	string

Values: 45.4

Variable Name: calibration_table_version, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	processing_parameters_table_version	OR_ANC_ABI_L1b_PARM_CalTable_v01r01.nc	string
	L1b_abi_sct_gains_version	OR_ANC_ABI_L1b_PARM_SctGainsTable_v01r01.nc	string
	L1b_abi_fte_coeff_version	OR_ANC_ABI_L1b_PARM_FteCoefTable_v01r01.nc	string
Variable Name: algorithm_version_id, Type: string, Dimension: 0,			
Attributes:	*Name*	*Value*	*Type*
	calibration_algorithm_version	OR_ALG_ABI_L1b_Cal_v01r01.tgz	string
	kalman_filter_algorithm_version	OR_ALG_ABI_L1b_Kalman_v01r01.tgz	string
	resampling_algorithm_version	OR_ALG_ABI_L1b_Resampling_v01r01.tgz	string
	star_nav_algorithm_version	OR_ALG_ABI_L1b_StarNav_v01r01.tgz	string

Table 3.1.1-4 Sample ABI NcML: Global Attributes

Attribute Name	Value	Type
id	ef175830-cc1c-11e0-bfd6-0800200c9a66	string
dataset_name	OR-ABI-L1b-RADF-M4C09_G16_s2011177060530_e2011177062030_c2011177080607.nc	string
naming_authority	gov.nesdis.noaa, SE-21_GS_8021130_Metadata_Model_Rev-C_Final.docx	string
iso_series_metadata_id	a70be540-c38b-11e0-962b-0800200c9a66	string
Conventions	CF-1.6, Unidata Dataset Discovery v1.0	string
Metadata_Conventions	Unidata Dataset Discovery v1.0, CF-1.6	string
standard_name	ABI_Level_1B_Spectral_Radiances	string
standard_name_vocabulary	CF Standard Name Table (v18, 22 July 2011)	string
title	ABI L1b Radiances (Full Disk) Mode 3 Band 9 Wavelength 6.95 Micron	string
summary	The GOES-R ABI instrument measures radiances at high spatial and temporal resolutions in sixteen spectral bands distributed across the visible, near-infrared and long-wave infrared regions of the electromagnetic spectrum.	string
star_id_047	1225	int
star_id_064	4225	int

Attribute Name	Value	Type
star_id_086	7766	int
star_id_138	37798	int
star_id_161	7843	int
star_id_225	5765	int
star_id_390	1801	int
platform	GOES-17	string
sensor	GOES 17 Imager	string
license	Unclassified data. Access is restricted to approved users only.	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
date_created	2016-09-09T14:45:00Z	string
processing_site	WCDAS	string
satellite_position_flag	G17	string
spatial_resolution	2km at nadir	string
scene_id	Full Disk	string
cdm_data_type	Image	string
project	GOES	string
time_coverage_start	2016-09-09T14:30:00Z	string
time_coverage_end	2016-09-09T14:35:00Z	string
timeline_id	ABI Mode 3	string
platform_ID	G17	string
instrument_ID	ABI-1	string
L0_processing_site	WCDAS	string
band_id	9	int
band_wavelength	6.95 µm	string
yaw_flip_flag	N	string
nominal_spatial_resolution	2	float
kappa0	1.0, 1.1, 1.4, 1.5, 1.6, 1.8	string
esun	1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0	string
planck_coeff	fk1, fk2, bc1, bc2	string

Table 3.1.1-5 Sample ABI NcML: Keywords

Variable Name: keywords_GCMD_Science_Keywords, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	keywords	SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > VISIBLE RADIANCE	string
	keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 6.0	string
Variable Name: keywords_GCMD_Project_Keywords, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	keywords	GOES > Geostationary Operational Environmental Satellites	string
	keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 6.0	string
Variable Name: keywords_GCMD_Platform_Keywords, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	keywords	GOES-R > Geostationary Operational Environmental Satellite R	string
	keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 6.0	string
Variable Name: keywords_GCMD_Instrument_Keywords, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	keywords	ABI > Advanced Baseline Imager	string
	keywords_vocabulary	to be added - NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 6.0	string

Variable Name: keywords_goes, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	keywords	Mode 3	string
	keywords_vocabulary	N/A	string

3.1.2 ABI L1b Radiance Image General Characteristics

All of the ABI image fragments are encapsulated within the GRB Data Packets that use the GRB Image Data format structure. Section 2.2 describes the algorithm for extracting and decompressing the data to extract these image fragments. The instructions in this section describe how to combine the image fragments to create the final ABI L1b image product. Each of the GRB data packets that contain ABI image data actually contains two image fragments, an ABI L1b Radiance image fragment and an ABI L1b Data Quality Flag image fragment. In addition, each GRB Image Packet data contains the pixel coordinates associated with the upper left (UL) corner of the image fragment. This coordinate defines the precise positioning of the image fragments within the full image product that is being constructed. The pixel coordinate system for the final image product places the origin, pixel (0, 0), in the upper left corner of the full image as shown in Figure 3.1.2-1.

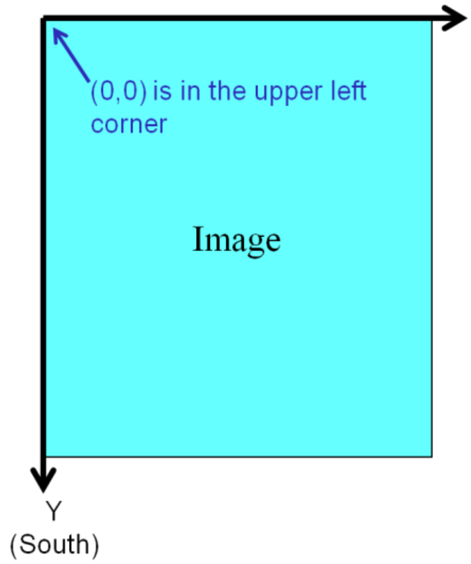

Figure 3.1.2-1 Image Coordinate System

Each pixel in the final image can be directly mapped to an ABI Fixed Grid coordinate. The ABI Fixed Grid differs from the pixel index coordinate system in that the origin of the coordinate system is fixed at the nominal subpoint for the GOES-R satellite. For the Full Disk product, this places the origin of the coordinate system in the center of the Full Disk image as shown in Figure 3.1.2-2. The pixels represent a fixed angular spacing on the Fixed Grid and will have values of 56, 28, and 14 μrad, depending upon the spectral band of the image. The positive "horizontal" axis for the image is in the easterly direction. The positive "vertical" axis for the Fixed Grid is northerly direction. The Product Metadata provides information that can be used to transform from pixel index space, Image Coordinate System, into ABI Fixed Grid coordinate space.

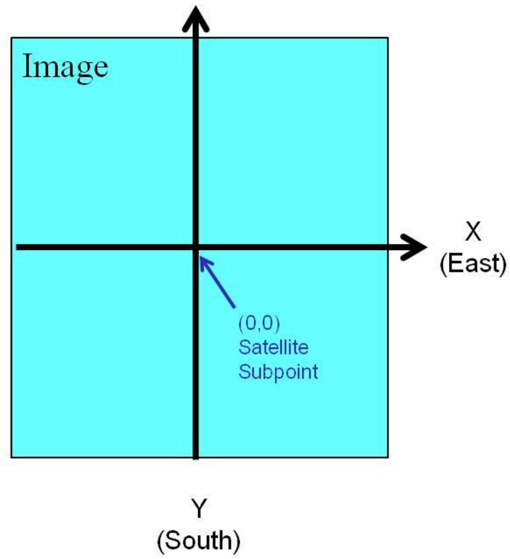

Figure 3.1.2-2 Fixed Grid Coordinate System

The ABI sensor collects data in 16 distinct spectral bands. There are three spatial resolutions for the ABI data, including 0.5km, 1.0km, and 2.0km depending upon the spectral band. These resolutions correspond to angular resolutions of 14 µrad, 28 µrad, and 56 µrad respectively. The spectral and spatial characteristics of each band are provided in Table 3.1.2-1. The relationship between the Fixed Grid coordinate system and each of the pixel resolutions is shown graphically in Figures 3.1.2-3 through 3.1.2-5. Note that each pixel is square in the sense that it has the same angular resolution in both dimensions. The location of each pixel is specified by the column and row values, in the Image Coordinate System, of its upper left corner. The upper left corner corresponds to the appropriate latitude and longitude of the pixel. The spatial resolutions are arranged such that exactly four 28 µrad pixels fit within each 56 µrad pixel, and exactly four 14 µrad pixels fit within each 28 µrad pixel. The pixel coordinates are non-negative integer values, where the Fixed Grid coordinates are signed floating point values. The mapping of pixel coordinates to Fixed Grid coordinates is different for each scene (Full Disk, CONUS, and Mesoscale) and the Product Metadata provides the desired transformation information.

Table 3.1.2-1 Characteristics of ABI Radiance Images

Band	Wavelength (µm)	Angular Resolution (µrad)	Units for Radiance Values
1	0.47	28	W/(m^2•sr• µm)
2	0.64	14	W/(m^2•sr• µm)
3	0.865	28	W/(m^2•sr• µm)
4	1.378	56	W/(m^2•sr• µm)
5	1.61	28	W/(m^2•sr• µm)
6	2.25	56	W/(m^2•sr• µm)
7	3.90	56	mW/(m^2•sr•cm^-1)

Band	Wavelength (µm)	Angular Resolution (µrad)	Units for Radiance Values
8	6.185	56	mW/(m^2•sr•cm^
9	6.95	56	mW/(m^2•sr•cm^
10	7.34	56	mW/(m^2•sr•cm^
11	8.5	56	mW/(m^2•sr•cm^
12	9.61	56	mW/(m^2•sr•cm^
13	10.35	56	mW/(m^2•sr•cm^
14	11.2	56	mW/(m^2•sr•cm^
15	12.3	56	mW/(m^2•sr•cm^
16	13.3	56	mW/(m^2•sr•cm^

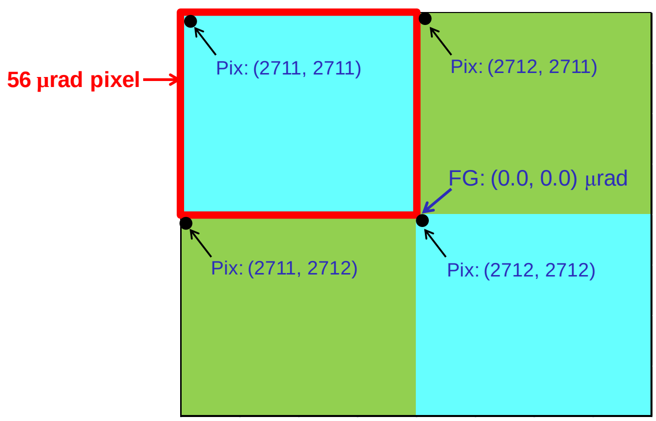

Figure 3.1.2-3 Relationship between 56 µrad pixel and the center of the Fixed Grid

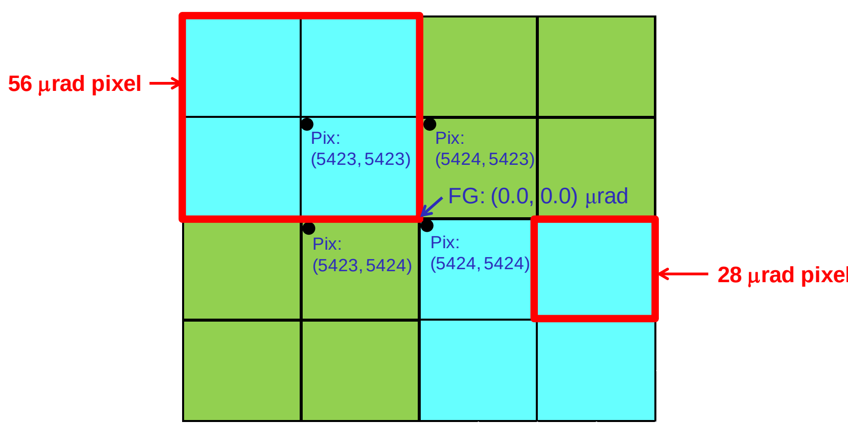

Figure 3.1.2-4 Relationship between 28 µrad and 56 µrad pixels

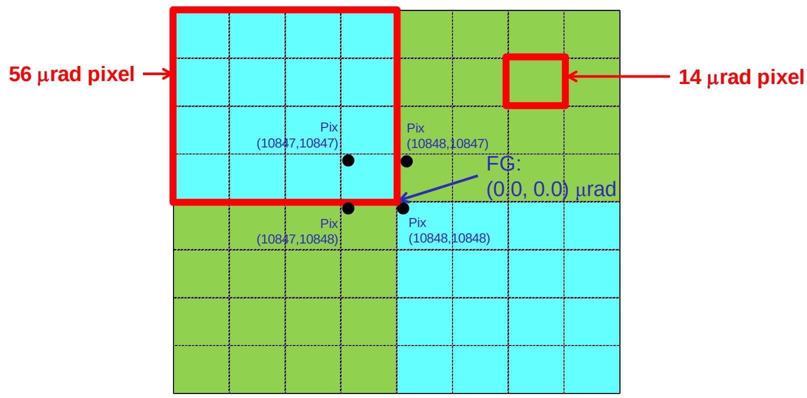

Figure 3.1.2-5 Relationship between 14 µrad and 56 µrad pixels

The Product Metadata for the image provides the information needed to transform from pixel or image coordinate space to ABI Fixed Grid Coordinates. The variable, ***X***, contains the East/West ABI Fixed Grid coordinates in radians for the image. The variable, ***Y***, contains the North/South ABI Fixed Grid coordinates in radians for the image. This is illustrated graphically in Figure 3.1.2-6.

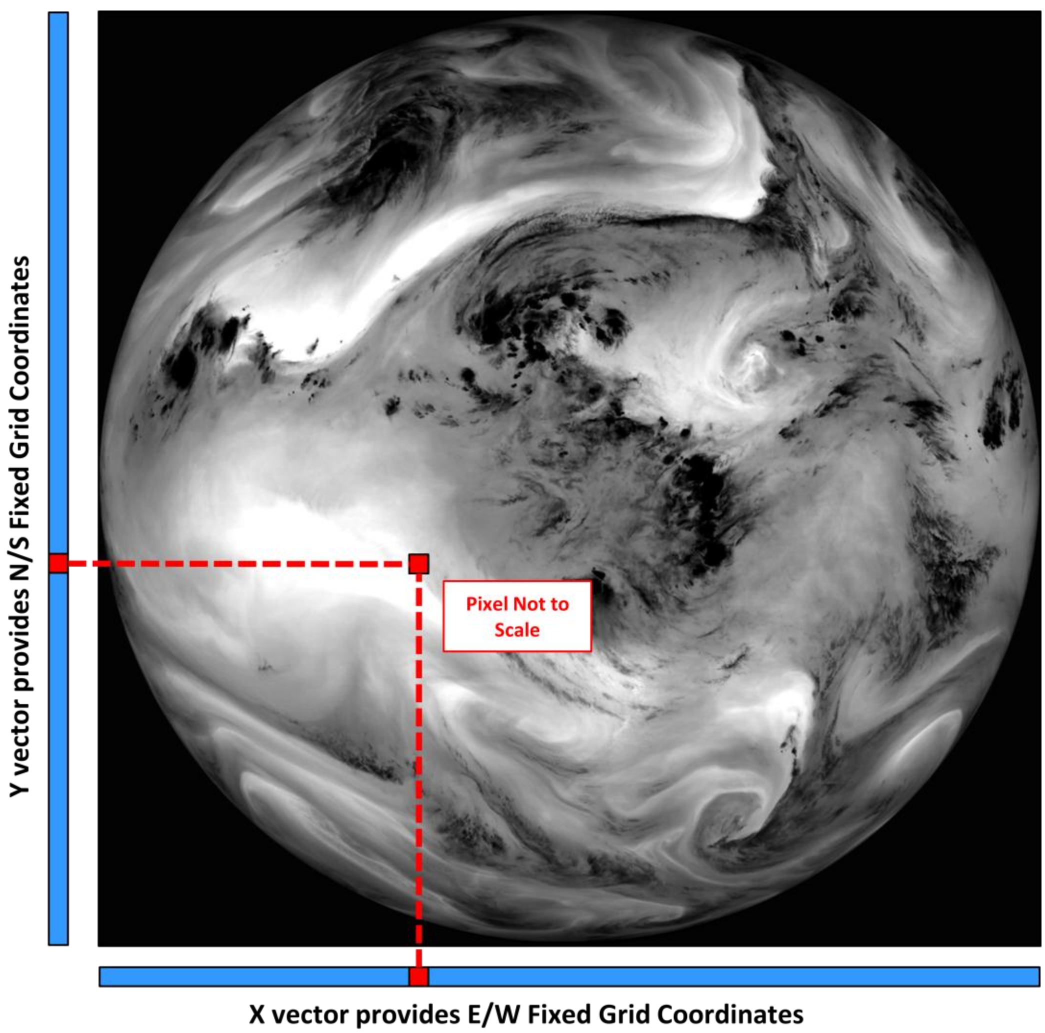

Figure 3.1.2-6 ABI Fixed Grid Coordinate Transformation

The units for the the radiance values in the ABI L1b imagery depends upon whether the image is in the VNIR or IR spectral regime. This information provided in Table 3.1.2-1. It is important to note that the radiance values for the ABI L1b imagery are stored within signed 16-bit integers (SHORTS). These values must be scaled by the parameters, scale_factor and add_offset, which are provided in the NcML metadata associated with the image. The radiance value is obtained by first multiplying the 16-bit integer value by the scale_factor. The result is then added to add_offset. This transforms the 16-bit integers into floating point values with the units described in Table 3.1.2-1.

Each of the ABI L1b Radiance images has a corresponding ABI L1b Radiance Data Quality Flag image. Each of the pixels within the Data Quality Flag product contains an 8-bit quality flag. The values for this quality flag are defined as follows:

Value = 0: Good Data

Value = 1: Conditional Use

Value = 2: Out of Range

Value = 3: Missing Data

The process for constructing full ABI L1b Image Products from the individual image fragments is shown in Figure 3.1.2-7. This is designed to be a continuous process that reconstructs the full image products as they are received via the GRB data stream. There are three key components to this process. First, the Radiance and DQF images are packed within the same GRB Data Packets. Therefore, the process shown in Figure 3.1.2-7 simultaneously constructs both the full Radiance Image and its corresponding DQF Image product. Second, each image product (radiance and DQF) is initialized with a set of fill values. This ensures that the final image products contain meaningful values even if the receipt of GRB Data Packets is interrupted. ABI L1b Radiance images should be initialized with a fill value of -1. ABI L1b Radiance Data Quality Flag images should be initialized with a fill value of 3 (missing data). Finally, the process monitors the Product Times that are extracted from the GRB Data Packets. The image product construction process continues to build image products as long as it receives image fragments with the same Product Time. When a new Product Time is found in the data stream the current set of images are closed out and the next set of images is initialized. It is important to note that multiple products will be interleaved within the GRB data stream. Therefore, users should expect to see unique Product Times for each scene (Full Disk, CONUS, Mesoscale #1, and Mesoscale #2) and spectral band combination.

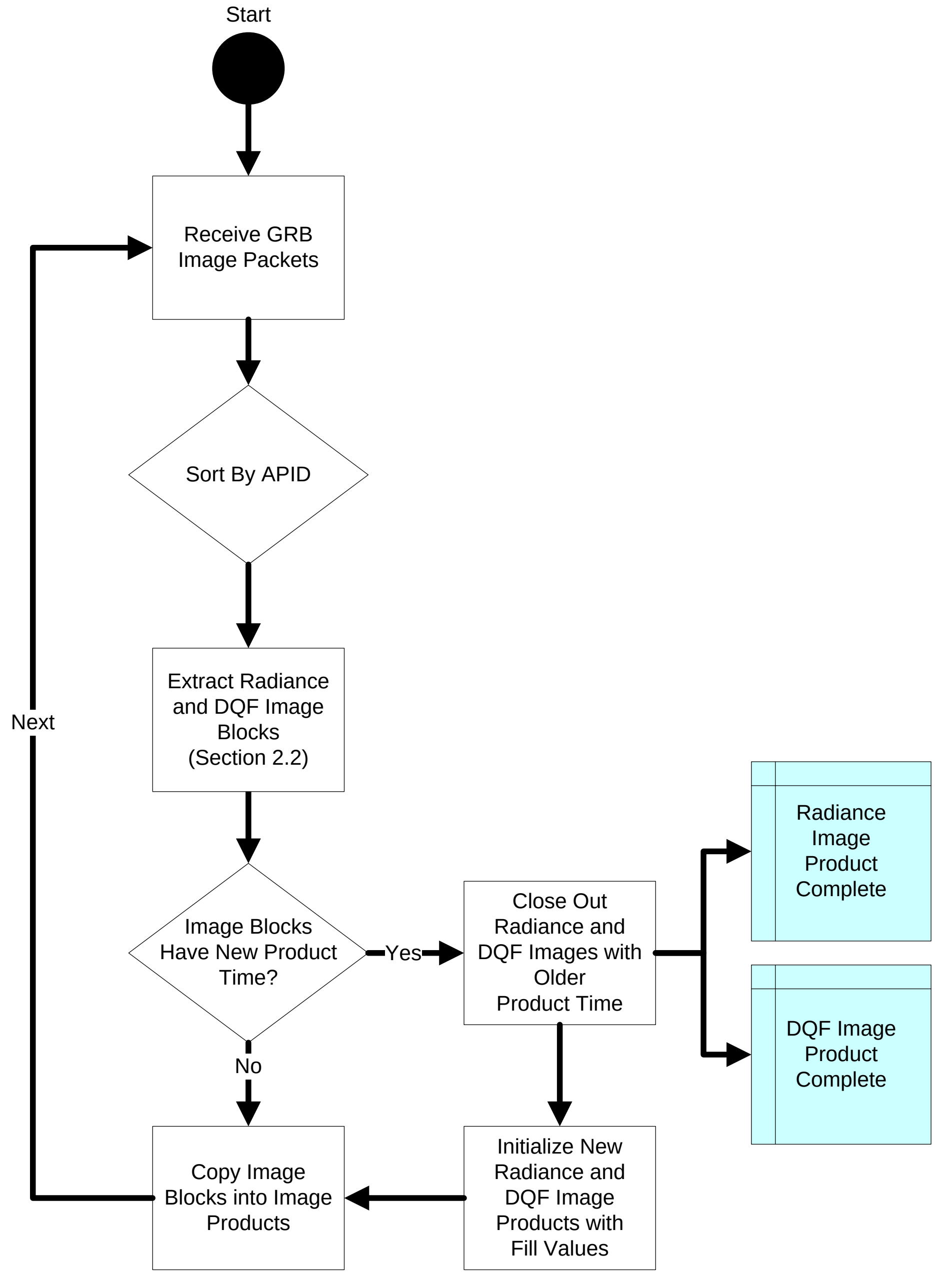

Figure 3.1.2-7 Process for Constructing ABI L1b Image Products

3.1.3 ABI L1b Radiances Full Disk Image

Table 3.1.3-1 lists the APIDs that contain ABI Radiances and Data Quality Image Fragments for the Full Disk Product. Full Disk products are produced whenever the ABI sensor is in Mode 3 or Mode 4. The refresh rate for the Full Disk product will vary with ABI mode. When ABI is in Mode 3, Full Disk images will be produced every 15 minutes. When ABI is in Mode 4, Full Disk images will be produced every 5 minutes. The Radiance and DQF image products are to be assembled according to the instructions given in Section 3.1.2.

The GOES-R ground system will avoid sending image fragments that contain only space-look data. Therefore, image fragments for the corners of the Full Disk image will not be sent to GRB terminal users. The image construction process described in Section 3.1.2 accounts for this by initializing these pixels with reasonable fill values: 0 for radiance images, and 3 (missing data) for DQF images.

Table 3.1.3-1 ABI Radiances Full Disk Products

Mode 3 GRB APID (Hex)	Mode 4 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
110	190	ABI 1.0-km Band 1 Radiances	SHORT	16
		ABI 1.0-km Band 1 DQF	BYTE	8
111	191	ABI 0.5-km Band 2 Radiances	SHORT	16
		ABI 0.5-km Band 2 DQF	BYTE	8
112	192	ABI 1.0-km Band 3 Radiances	SHORT	16
		ABI 1.0-km Band 3 DQF	BYTE	8
113	193	ABI 2.0-km Band 4 Radiances	SHORT	16
		ABI 2.0-km Band 4 DQF	BYTE	8
114	194	ABI 1.0-km Band 5 Radiances	SHORT	16
		ABI 1.0-km Band 5 DQF	BYTE	8
115	195	ABI 2.0-km Band 6 Radiances	SHORT	16
		ABI 2.0-km Band 6 DQF	BYTE	8
116	196	ABI 2.0-km Band 7 Radiances	SHORT	16
		ABI 2.0-km Band 7 DQF	BYTE	8
117	197	ABI 2.0-km Band 8 Radiances	SHORT	16
		ABI 2.0-km Band 8 DQF	BYTE	8
118	198	ABI 2.0-km Band 9 Radiances	SHORT	16
		ABI 2.0-km Band 9 DQF	BYTE	8
119	199	ABI 2.0-km Band 10 Radiances	SHORT	16
		ABI 2.0-km Band 10 DQF	BYTE	8
11A	19A	ABI 2.0-km Band 11 Radiances	SHORT	16
		ABI 2.0-km Band 11 DQF	BYTE	8
11B	19B	ABI 2.0-km Band 12 Radiances	SHORT	16
		ABI 2.0-km Band 12 DQF	BYTE	8
11C	19C	ABI 2.0-km Band 13 Radiances	SHORT	16
		ABI 2.0-km Band 13 DQF	BYTE	8
11D	19D	ABI 2.0-km Band 14 Radiances	SHORT	16
		ABI 2.0-km Band 14 DQF	BYTE	8
11E	19E	ABI 2.0-km Band 15 Radiances	SHORT	16

Mode 3 GRB APID (Hex)	Mode 4 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
		ABI 2.0-km Band 15 DQF	BYTE	8
11F	19F	ABI 2.0-km Band 16 Radiances	SHORT	16
		ABI 2.0-km Band 16 DQF	BYTE	8

3.1.4 ABI L1b Radiances CONUS Image

Table 3.1.4-1 lists the APIDs that contain ABI Radiances and Data Quality Image Fragments for the CONUS Product. CONUS products are produced whenever the ABI sensor is in Mode 3. This product is not produced when ABI is in Mode 4. The refresh rate for the CONUS product is approximately 5 minutes. The Radiance and DQF CONUS image products are to be assembled according to the instructions givein in Section 3.1.2.

Table 3.1.4-1 ABI Radiances CONUS Products

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
130	ABI 1.0-km Band 1 Radiances	SHORT	16
	ABI 1.0-km Band 1 DQF	BYTE	8
131	ABI 0.5-km Band 2 Radiances	SHORT	16
	ABI 0.5-km Band 2 DQF	BYTE	8
132	ABI 1.0-km Band 3 Radiances	SHORT	16
	ABI 1.0-km Band 3 DQF	BYTE	8
133	ABI 2.0-km Band 4 Radiances	SHORT	16
	ABI 2.0-km Band 4 DQF	BYTE	8
134	ABI 1.0-km Band 5 Radiances	SHORT	16
	ABI 1.0-km Band 5 DQF	BYTE	8
135	ABI 2.0-km Band 6 Radiances	SHORT	16
	ABI 2.0-km Band 6 DQF	BYTE	8
136	ABI 2.0-km Band 7 Radiances	SHORT	16
	ABI 2.0-km Band 7 DQF	BYTE	8
137	ABI 2.0-km Band 8 Radiances	SHORT	16
	ABI 2.0-km Band 8 DQF	BYTE	8
138	ABI 2.0-km Band 9 Radiances	SHORT	16
	ABI 2.0-km Band 9 DQF	BYTE	8
139	ABI 2.0-km Band 10 Radiances	SHORT	16
	ABI 2.0-km Band 10 DQF	BYTE	8
13A	ABI 2.0-km Band 11 Radiances	SHORT	16

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
	ABI 2.0-km Band 11 DQF	BYTE	8
13B	ABI 2.0-km Band 12 Radiances	SHORT	16
	ABI 2.0-km Band 12 DQF	BYTE	8
13C	ABI 2.0-km Band 13 Radiances	SHORT	16
	ABI 2.0-km Band 13 DQF	BYTE	8
13D	ABI 2.0-km Band 14 Radiances	SHORT	16
	ABI 2.0-km Band 14 DQF	BYTE	8
13E	ABI 2.0-km Band 15 Radiances	SHORT	16
	ABI 2.0-km Band 15 DQF	BYTE	8
13F	ABI 2.0-km Band 16 Radiances	SHORT	16
	ABI 2.0-km Band 16 DQF	BYTE	8

3.1.5 ABI L1b Radiances Mesoscale #1 Image

Table 3.1.5-1 lists the APIDs that contain ABI Radiances and Data Quality Image Fragments for the Mesoscale #1 Product. Mesoscale products are produced whenever the ABI sensor is in Mode 3. This product is not produced when ABI is in Mode 4. The refresh rate for the Mesoscale product is approximately 30 seconds. However, this will vary depending upon how the satellite is configured, as it can be commanded to collect either Mesoscale #1 or Mesoscale #2 imagery. The Radiance and DQF Mesoscale image products are to be assembled according to the instructions givein in Section 3.1.2.

Table 3.1.5-1 ABI Radiances Mesoscale #1 Products

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
150	ABI 1.0-km Band 1 Radiances	SHORT	16
	ABI 1.0-km Band 1 DQF	BYTE	8
151	ABI 0.5-km Band 2 Radiances	SHORT	16
	ABI 0.5-km Band 2 DQF	BYTE	8
152	ABI 1.0-km Band 3 Radiances	SHORT	16
	ABI 1.0-km Band 3 DQF	BYTE	8
153	ABI 2.0-km Band 4 Radiances	SHORT	16
	ABI 2.0-km Band 4 DQF	BYTE	8
154	ABI 1.0-km Band 5 Radiances	SHORT	16
	ABI 1.0-km Band 5 DQF	BYTE	8
155	ABI 2.0-km Band 6 Radiances	SHORT	16
	ABI 2.0-km Band 6 DQF	BYTE	8
156	ABI 2.0-km Band 7 Radiances	SHORT	16

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
	ABI 2.0-km Band 7 DQF	BYTE	8
157	ABI 2.0-km Band 8 Radiances	SHORT	16
	ABI 2.0-km Band 8 DQF	BYTE	8
158	ABI 2.0-km Band 9 Radiances	SHORT	16
	ABI 2.0-km Band 9 DQF	BYTE	8
159	ABI 2.0-km Band 10 Radiances	SHORT	16
	ABI 2.0-km Band 10 DQF	BYTE	8
15A	ABI 2.0-km Band 11 Radiances	SHORT	16
	ABI 2.0-km Band 11 DQF	BYTE	8
15B	ABI 2.0-km Band 12 Radiances	SHORT	16
	ABI 2.0-km Band 12 DQF	BYTE	8
15C	ABI 2.0-km Band 13 Radiances	SHORT	16
	ABI 2.0-km Band 13 DQF	BYTE	8
15D	ABI 2.0-km Band 14 Radiances	SHORT	16
	ABI 2.0-km Band 14 DQF	BYTE	8
15E	ABI 2.0-km Band 15 Radiances	SHORT	16
	ABI 2.0-km Band 15 DQF	BYTE	8
15F	ABI 2.0-km Band 16 Radiances	SHORT	16
	ABI 2.0-km Band 16 DQF	BYTE	8

3.1.6 ABI L1b Radiances Mesoscale #2 Image

Table 3.1.6-1 lists the APIDs that contain ABI Radiances and Data Quality Image Fragments for the Mesoscale #2 Product. Mesoscale products are produced whenever the ABI sensor is in Mode 3. This product is not produced when ABI is in Mode 4. The refresh rate for the Mesoscale product is approximately 30 seconds. However, this will vary depending upon how the satellite is configured, as it can be commanded to collect either Mesoscale #1 or Mesoscale #2 imagery. The Radiance and DQF Mesoscale image products are to be assembled according to the instructions givein in Section 3.1.2.

Table 3.1.6-1 ABI Radiances Mesoscale #2 Products

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
170	ABI 1.0-km Band 1 Radiances	SHORT	16
	ABI 1.0-km Band 1 DQF	BYTE	8
171	ABI 0.5-km Band 2 Radiances	SHORT	16
	ABI 0.5-km Band 2 DQF	BYTE	8
172	ABI 1.0-km Band 3 Radiances	SHORT	16

Mode 3 GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
	ABI 1.0-km Band 3 DQF	BYTE	8
173	ABI 2.0-km Band 4 Radiances	SHORT	16
	ABI 2.0-km Band 4 DQF	BYTE	8
174	ABI 1.0-km Band 5 Radiances	SHORT	16
	ABI 1.0-km Band 5 DQF	BYTE	8
175	ABI 2.0-km Band 6 Radiances	SHORT	16
	ABI 2.0-km Band 6 DQF	BYTE	8
176	ABI 2.0-km Band 7 Radiances	SHORT	16
	ABI 2.0-km Band 7 DQF	BYTE	8
177	ABI 2.0-km Band 8 Radiances	SHORT	16
	ABI 2.0-km Band 8 DQF	BYTE	8
178	ABI 2.0-km Band 9 Radiances	SHORT	16
	ABI 2.0-km Band 9 DQF	BYTE	8
179	ABI 2.0-km Band 10 Radiances	SHORT	16
	ABI 2.0-km Band 10 DQF	BYTE	8
17A	ABI 2.0-km Band 11 Radiances	SHORT	16
	ABI 2.0-km Band 11 DQF	BYTE	8
17B	ABI 2.0-km Band 12 Radiances	SHORT	16
	ABI 2.0-km Band 12 DQF	BYTE	8
17C	ABI 2.0-km Band 13 Radiances	SHORT	16
	ABI 2.0-km Band 13 DQF	BYTE	8
17D	ABI 2.0-km Band 14 Radiances	SHORT	16
	ABI 2.0-km Band 14 DQF	BYTE	8
17E	ABI 2.0-km Band 15 Radiances	SHORT	16
	ABI 2.0-km Band 15 DQF	BYTE	8
17F	ABI 2.0-km Band 16 Radiances	SHORT	16
	ABI 2.0-km Band 16 DQF	BYTE	8

3.2 GLM Products

The following describes the GLM product data that is present in the GRB data stream. The GLM L2+ lightning detection product is composed of three data objects that have inter-relationships: flashes, groups, and events. Flashes are associated with one or more groups, and groups are associated with one or more events. See Figure 3.2, GLM L2+ Lightning Detection Product Data Object Relationships. Unique identifiers within the GLM data structure are used to identify all of the groups associated with each flash and all of the events associated with each group. The GLM L2+ product data and metadata both use the GRB Generic Data format described in Section 2.3.

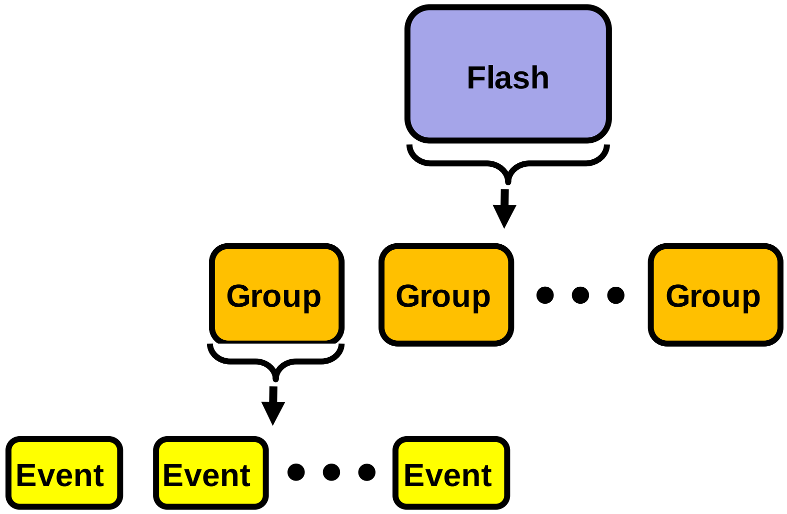

Figure 3.2 GLM L2+ Product Data Relationships

The GOES-R ground station produces the GLM L2+ product every 20 seconds. This product is subdivided into 1 second blocks for broadcast though the GRB data stream. Each 20 second GLM L2+ product will have a unique Product Time associated with it. The Product Time can be extracted from the GLM data packet and is described in Table 2.2.2. Each of the 1 second blocks of data also has a block identifier, which ranges in value from 0 – 19. The block indentifier can also be found in GLM data packet as described in Table 2.2.2. Every 20 seconds, the GOES-R system updates the Product Time and resets the Block Identifier to 0. The data blocks sent after this will keep the same Product Time but will increment the Block Identifier by 1. This process starts again with the next 20 second product. This structure enables the GOES-R ground system to send smaller, more frequent GRB data blocks through the GRB link, while providing a mechanism for determining how to combine the data blocks to recreate the 20 second products that are delivered by the GOES-R ground station to CLASS and PDA. A metadata file will be transmitted once every 20 seconds. The metadata file will have the same Product Time as its corresponding product data.

3.2.1 GLM L2+ Metadata

The GLM Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.2.1-1, below, lists the GRB APIDs that have been assigned to the GLM metadata file. All of this metadata is provided within a single NcML file. However, for clarity, it has been subdivided into several separate tables in this document. Product Dimension information is provided in Table 3.2.1-2. Flash Product Metadata is provided in Table 3.2.1-3. Group Product Metadata is provided in Table 3.2.1-4. Event Product Metadata is provided in Table 3.2.1-5. General GLM Metadata is provided in Table 3.2.1-5, and GLM attributes are provided in Table 3.2.1-6. It is important to note that the metadata contained within Tables 3.2.1-2 through 3.2.1-6 contain representative values only. The intent of these tables is to describe the general content of the metadata NcML files that will be received throughout the GRB data stream.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.2.1-1 GLM Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
300	GLM-L2-LCFA	GLM L2+ Lightning Detection Product Metadata

Table 3.2.1-2 GLM Product Dimension Metadata

Dimension Name	Length
number_of_flashes	unlimited
number_of_groups	unlimited
number_of_events	unlimited
number_of_time_bounds	2

Table 3.2.1-3 Flash Product Metadata

Variable Name: flash_lat, Type: float, Dimension: number_of_flashes			
Attributes:	*Name*	*Value*	*Type*
	units	degrees_north	string
	long_name	latitude of the flash centroid	string
	standard_name	latitude	string
Variable Name: flash_lon, Type: float, Dimension: number_of_flashes			
Attributes:	*Name*	*Value*	*Type*
	units	degrees_east	string
	long_name	longitude of the flash centroid	string
	standard_name	longitude	string
Variable Name: flash_time, Type: double, Dimension: number_of_flashes			
Attributes:	*Name*	*Value*	*Type*
	long_name	mid-point between the start and end event associated with the flash	string
	units	seconds since 2000-01-01 00:00:00	string
	bounds	flash_time_bounds	string

Variable Name: flash_time_bounds, Type: double, Dimension: number_of_flashes number_of_time_bounds			
Attributes:	*Name*	*Value*	*Type*
	long_name	start and end time associated with the flash	string
	units	seconds since 2000-01-01 00:00:00	string
Variable Name: flash_energy, Type: float, Dimension: number_of_flashes			
Attributes:	*Name*	*Value*	*Type*
	coverage_type	modelResult	string
	description	optical energy associated with the flash	string
	units	(micro) Joules per square meter per micron	string
	standard_name	flash_optical_energy	string
	coordinates	flash_time flash_lat flash_lon	string
	cell_measures	area: flash_area	string
	ancillary_variables	flash_quality_flag	string
	associations	flash_energy flash_group_association group_energy	string
Variable Name: flash_area, Type: float, Dimension: number_of_flashes			
Attributes:	*Name*	*Value*	*Type*
	standard_name	area	string
	units	km2	string
Variable Name: flash_quality_flag, Type: short, Dimension: t y x			
Attributes:	*Name*	*Value*	*Type*
	_Unsigned	TRUE	string
	coverage_type	qualityInformation	string
	long_name	glm_flash_quality_flags	string
	standard_name	flash_optical_energy status_flag	string
	flag_masks	1b 1b 2b 2b 4b 4b 8b 8b 16b 16b 32b 32b 64b 64b 128b 128b 256b 256b 512b 512b 1024b 1024b 6144b 6144b 6144b 6144b	string
	flag_values	0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 2 3 4	string

	flag_meanings	flash_ok flash_terminated flash_ok too_many_children flash_ok flash_reached_time_limit flash_ok flash_buffer_overflow flash_ok group_buffer_overflow flash_ok event_buffer_overflow flash_ok processing_capacity_exceeded flash_ok flash_location_may_be_in_error_due_to_parallax_issues flash_ok flash_location_may_be_in_error_due_to_ephemeris_problems flash_ok time_of_flash_may_be_in_error_due_to_problems_with_event_times flash_ok flash_rejected_by_the_non-lightning_flash_detection_filter 0_percent 33_percent 67_percent 100_percent	string
	coordinates	flash_time flash_lat flash_lon	string

Variable Name: flash_count, Type: int, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	km	string
	long_name	number of lightning flashes	string

Values: 4

Variable Name: flash_termination_bit0_qf_ok, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 88.0

Variable Name: flash_termination_bit0_qf_terminated, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag = Flash terminated	string

Values: 12.0

Variable Name: flash_termination_reason_bit1_qf_ok, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string

	long_name	percent of flash termination Quality Flag = Flash is OK	string
Values: 12.0			
Variable Name: flash_termination_reason_bit1_qf, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag with reason = Too many children	string
Values: 6.0			
Variable Name: flash_termination_reason_bit2_qf_ok, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag = Flash is OK	string
Values: 12.0			
Variable Name: flash_termination_reason_bit2_qf, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag with reason = Flash reached time limit	string
Values: 6.0			
Variable Name: flash_termination_reason_bit3_qf_ok, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag = Flash is OK	string
Values: 12.0			
Variable Name: flash_termination_reason_bit3_qf, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flash termination Quality Flag with reason = Flash buffer overflow	string
Values: 6.0			

Variable Name: flash_termination_reason_bit4_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit4_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Group buffer overflow	string

Values: 6.0

Variable Name: flash_termination_reason_bit5_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit5_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Event buffer overflow	string

Values: 6.0

Variable Name: flash_termination_reason_bit6_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit6_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Processing capacity exceeded	string

Values: 6.0

Variable Name: flash_termination_reason_bit7_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit7_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Flash location may be in error due to parallax issues	string

Values: 6.0

Variable Name: flash_termination_reason_bit8_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit8_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Flash location may be in error due to ephemeris problems	string

Values: 6.0

Variable Name: flash_termination_reason_bit9_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit9_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Time of flash may be in error due to problems with the event times	string

Values: 6.0

Variable Name: flash_termination_reason_bit10_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag = Flash is OK	string

Values: 12.0

Variable Name: flash_termination_reason_bit10_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flash termination Quality Flag with reason = Flash rejected by the non-lightning flash detection filter	string

Values: 6.0

Variable Name: flash_termination_reason_bit11_12_qf_0, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of flashes with probability flash is not due to lightning = 0%	string

Values: 12.0

Variable Name: flash_termination_reason_bit11_12_qf_33, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flashes with probability flash is not due to lightning = 33%	string

Values: 6.0

Variable Name: flash_termination_reason_bit11_12_qf_67, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	ppercent of flashes with probability flash is not due to lightning = 67%	string

Values: 12.0

Variable Name: flash_termination_reason_bit11_12_qf_100, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of flashes with probability flash is not due to lightning = 100%	string

Values: 6.0

Table 3.2.1-4 Group Product Metadata

Variable Name: group_lat, Type: float, Dimension: number_of_groups

Attributes:	*Name*	*Value*	*Type*
	units	degrees_north	string
	long_name	latitude of the group centroid	string
	standard_name	latitude	string

Variable Name: group_lon, Type: float, Dimension: number_of_groups

Attributes:	*Name*	*Value*	*Type*
	units	degrees_east	string
	long_name	longitude of the group centroid	string
	standard_name	longitude	string

Variable Name: group_time, Type: double, Dimension: number_of_groups

Attributes:	*Name*	*Value*	*Type*
	long_name	mid-point between the start and end event associated with the group	string

	units	seconds since 2000-01-01 00:00:00	string
	bounds	group_time_bounds	string
Variable Name: group_time_bounds, Type: double, Dimension: number_of_groups number_of_time_bounds			
Attributes:	*Name*	*Value*	*Type*
	long_name	start and end time associated with the group	string
	units	seconds since 2000-01-01 00:00:00	string
Variable Name: group_energy, Type: float, Dimension: number_of_groups			
Attributes:	*Name*	*Value*	*Type*
	coverage_type	modelResult	string
	description	optical energy associated with the group	string
	units	(micro) Joules per square meter per micron	string
	standard_name	group_optical_energy	string
	coordinates	group_time group_lat group_lon	string
	cell_measures	area: group_area	string
	ancillary_variables	group_quality_flag	string
	associations	flash_energy flash_group_association group_energy, group_energy group_event_association event_energy	string
Variable Name: group_area, Type: float, Dimension: number_of_groups			
Attributes:	*Name*	*Value*	*Type*
	standard_name	area	string
	units	km2	string
Variable Name: group_quality_flag, Type: short, Dimension: t y x			
Attributes:	*Name*	*Value*	*Type*
	_Unsigned	TRUE	string
	coverage_type	qualityInformation	string
	long_name	glm_group_quality_flags	string
	standard_name	group_optical_energy status_flag	string
	flag_masks	1b 1b 2b 2b 4b 4b 8b 8b 16b 16b 32b 32b 192b 192b 192b 192b	string
	flag_values	0 1 0 1 0 1 0 1 0 1 0 1 0 1 2 3	string

	flag_meanings	group_ok group_terminated group_ok too_many_children group_ok group_reached_time_limit group_ok group_buffer_overflow group_ok group_buffer_overflow group_ok event_buffer_overflow group_ok group_rejected_by_the_non-lightning_probability_filter 0_percent 33_percent 67_percent 100_percent	string
	coordinates	group_time group_lat group_lon	string
Variable Name: group_energy_association, Type: long, Dimension: number_of_events			
Attributes:	*Name*	*Value*	*Type*
	association	group_energy event_energy	string
Variable Name: group_count, Type: int, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	km	string
	long_name	number of lightning groups	string
Values: 16			
Variable Name: group_termination_bit0_qf_ok, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of group termination Quality Flag = group is OK	string
Values: 88.0			
Variable Name: group_termination_bit0_qf_terminated, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of group termination Quality Flag = group terminated	string
Values: 12.0			
Variable Name: group_termination_reason_bit1_qf_ok, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string

	long_name	percent of group termination Quality Flag = group is OK	string

Values: 12.0

Variable Name: group_termination_reason_bit1_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag with reason = too many children	string

Values: 6.0

Variable Name: group_termination_reason_bit2_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag = group is OK	string

Values: 12.0

Variable Name: group_termination_reason_bit2_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag with reason = group reached time limit	string

Values: 6.0

Variable Name: group_termination_reason_bit3_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag = group is OK	string

Values: 12.0

Variable Name: group_termination_reason_bit3_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag with reason = group buffer overflow	string

Values: 6.0

Variable Name: group_termination_reason_bit4_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag = group is OK	string

Values: 12.0

Variable Name: group_termination_reason_bit4_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag with reason = event buffer overflow	string

Values: 6.0

Variable Name: group_termination_reason_bit5_qf_ok, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag = group is OK	string

Values: 12.0

Variable Name: group_termination_reason_bit5_qf, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of group termination Quality Flag with reason = group rejected by the non-lightning probability filter	string

Values: 6.0

Variable Name: group_termination_reason_bits6_7_qf_0, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of groups with probability group is not due to lightning = 0%	string

Values: 12.0

Variable Name: group_termination_reason_bits6_7_qf_33, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of groups with probability group is not due to lightning = 33%	string

Values: 6.0

Variable Name: group_termination_reason_bits6_7_qf_67, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	ppercent of groups with probability group is not due to lightning = 67%	string

Values: 12.0

Variable Name: group_termination_reason_bits6_7_qf_100, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of groups with probability group is not due to lightning = 100%	string

Values: 6.0

Table 3.2.1-5 Event Product Metadata

Variable Name: event_lat, Type: float, Dimension: number_of_events

Attributes:

Name	*Value*	*Type*
units	degrees_north	string
standard_name	latitude	string

Variable Name: event_lon, Type: float, Dimension: number_of_events

Attributes:	*Name*	*Value*	*Type*
	units	degrees_east	string
	standard_name	longitude	string

Variable Name: event_time, Type: double, Dimension: number_of_events

Attributes:	*Name*	*Value*	*Type*
	long_name	time of the occurrence of the event	string
	units	seconds since 2000-01-01 00:00:00	string

Variable Name: event_energy, Type: float, Dimension: number_of_events

Attributes:	*Name*	*Value*	*Type*
	coverage_type	physicalMeasurement	string
	description	optical energy associated with the event	string
	units	(micro) Joules per square meter per micron	string
	standard_name	event_optical_energy	string
	coordinates	event_time event_lat event_lon	string
	ancillary_variables	event_quality_flag	string
	associations	group_energy group_event_association event_energy	string

Variable Name: event_quality_flag, Type: short, Dimension: t y x

Attributes:	*Name*	*Value*	*Type*
	_Unsigned	TRUE	string
	coverage_type	qualityInformation	string
	long_name	glm_event_quality_flags	string
	standard_name	group_optical_energy status_flag	string
	flag_masks	1b 1b 3b 3b 3b 3b	string
	flag_values	0 1 0 1 2 3	string
	flag_meanings	event_ok event_rejected_by_the_non-lightning_probability_filter 0_percent 33_percent 67_percent 100_percent	string
	coordinates	event_time event_lat event_lon	string

Variable Name: event_count, Type: int, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	km	string
	long_name	number of lightning events	string

Values: 48

Variable Name: event_termination_reason_bit0_qf_ok, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of event termination Quality Flag = event is OK	string

Values: 12.0

Variable Name: event_termination_reason_bit0_qf, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of event termination Quality Flag with reason = event rejected by the non-lightning probability filter	string

Values: 6.0

Variable Name: event_termination_reason_bits1_2_qf_0, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of events with probability event is not due to lightning = 0%	string

Values: 12.0

Variable Name: event_termination_reason_bits1_2_qf_33, Type: float, Dimension: 0

Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent of events with probability event is not due to lightning = 33%	string

Values: 6.0

Variable Name: event_termination_reason_bits1_2_qf_67, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of events with probability event is not due to lightning = 67%	string

Values: 12.0

Variable Name: event_termination_reason_bits1_2_qf_100, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	percent	string
long_name	percent of events with probability event is not due to lightning = 100%	string

Values: 6.0

Table 3.2.1-5 Additional GLM Metadata

Variable Name: nominal_satellite_subpoint_lat, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	degrees_north	string
long_name	nominal satellite subpoint latitude	string

Values: 0.00

Variable Name: nominal_satellite_subpoint_long, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	degrees_east	string
long_name	nominal satellite subpoint longitude	string

Values: 75.00

Variable Name: nominal_satellite_height, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
units	km	string
long_name	nominal satellite subpoint longitude	string

Values: 42164.16

Variable Name: geospatial_lat_lon, Type: float, Dimension: 0

Attributes:

Name	*Value*	*Type*
geospatial_westbound_longitude	0	float
geospatial_northbound_latitude	0	float

	geospatial_eastbound_longitude	0	float
	geospatial_southbound_latitude	0	float
	geospatial_lat_center	0	float
	geospatial_lon_center	0	float
	geospatial_lat_nadir	0	float
	geospatial_lon_nadir	137	float
	geospatial_lat_nadir_resolution	2	float
	geospatial_lon_nadir_resolution	2	float
	geospatial_lat_units	degrees_north	string
	geospatial_lon_units	degrees_east	string
	long_name	geospatial latitude and longitude references for this volcanic ash product	string
Variable Name: percent_uncorrectable_L0_errors, Type: float, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	units	percent	string
	long_name	percent uncorrectable L0 errors	string
Values: 3.55			
Variable Name: lineage, Type: string, Dimension: 0			
Attributes:	*Name*	*Value*	*Type*
	glm_pixel_data_lut_file_version	OE_ANC-L2-PARM_GLMPixelDataLUT_v01r01.nc	string
	algorithm_version	ALG-GLM-L2_Lightning_LigDet_v01r01.tgz	string
	algorithm_date	41777	string

Table 3.2.1-6 GLM Metadata Attributes

Attribute Name	Value	Type
featureType	point	string
id	ef175830-cc1c-11e0-bfd6-0800200c9a66	string
dataset_name	OR_ABI-L2-VAAF-M3_G16_s2011177060530_e2011177062030_c2011177080607.nc	string
naming_authority	gov.noaa.goes-r, SE-21_GS_8021130_Metadata_Model_Rev-A_Final.docx	string
iso_series_metadata_id	a70be540-c38b-11e0-962b-0800200c9a66	string
Conventions	CF-1.6	string

Attribute Name	Value	Type
Metadata_Conventions	Unidata Dataset Discovery v1.0, CF-1.6	string
standard_name	lightning_detection	string
standard_name_vocabulary	CF Standard Name Table (v18, 22 July 2011)	string
title	Lightning Detection: Events, Groups and Flashes	string
summary	TThe Lightning Cluster-Filter Algorithm (LCFA) is responsible for clustering optically detected lightning event data into groups and flashes to map lightning activity. Events are pixels in which potential lightning signals are detected by the GLM within a single GLM Charge-Couple Device (CCD) integration time. Though events are output by the LCFA as Lightning L2+ products, they are initially detected on the GLM by Real-Time Event Processors, filtered on the ground into Level 1b (L1b) data, and input to the LCFA. Events, groups and flashes are related in a tree structure with each group comprised of one or more events and each flash comprised of one or more groups.	string
keywords	ATMOSPHERE > ATMOSPHERIC ELECTRICITY > LIGHTNING	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 6.0	string
platform	GOES-17	string
sensor	GOES 17 Lightning Mapperr	string
license	Unclassified data. Access is restricted to approved users only.	string
processing_level	National Aeronautics and Space Administration (NASA) L2	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
date_created	2016-09-09T14:45:00Z	string
processing_site	WCDAS	string
satellite_position_flag	G17	string
spatial_resolution	10km at nadir	string
scene_id	Full Disk	string
cdm_data_type	point	string
project	GOES	string
time_coverage_start	2016-09-09T14:30:00Z	string
time_coverage_end	2016-09-09T14:35:00Z	string
platform_ID	G17	string
instrument_ID	GLM-1	string

3.2.2 GLM L2+ Product Data

Table 3.2.2-1 lists the APIDs that contain GLM product data. Each of these packets containing GLM product data is in the GRB Generic Data format that is described in Section 2.2. The GLM event, group, and flash Product Data has been separated into separate APIDS.

The process for extracting the product data from these GRB packets is shown Figure 3.2.2. This process results in three binary data structures for each 1 second product: event data, group data, and flash data. The format of these data structures is described in Tables 3.2.2-1 through 3.2.2.-6, below. Note that the Data Quality Flags for the GLM L2+ product are embedded within the event, group, and flash data structures.

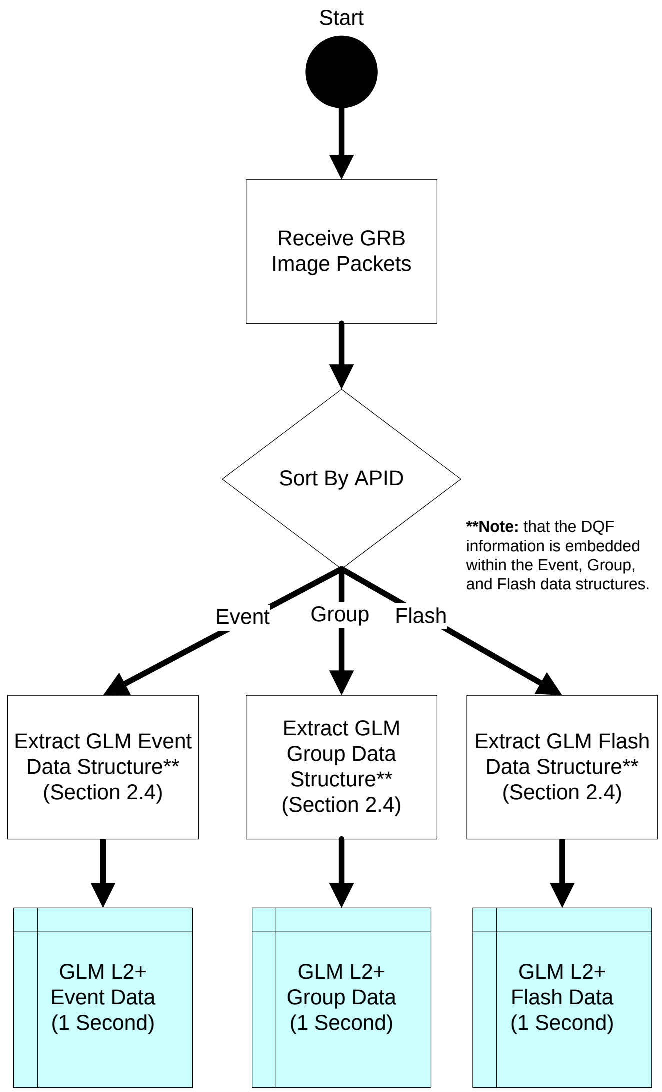

Figure 3.2.2 Process for extracting GLM L2+ product data

Table 3.2.2-1 GLM Event Data Description

Item #	Data Name	Description	Units
1	Event_Num	Number of events in Event Table	Unitless
2	Event_ID	Event ID assigned by L2+ processing	Unitless
3	Event_Time	Event time	Seconds
4	Event_Lat	Latitude of the event	Degrees
5	Event_Lon	Longitude of the event	Degrees
6	Event_Energy	Energy of the event	µJ m^(-2) µm^(-1)
7	Event_ParentGroupID	The ID number of the Parent Group for this event	Unitless
8	Event_DQF	Event Data Quality Flags	Unitless

Table 3.2.2-2 GLM Event Data Structure

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	Event_Num	UINT	32	(scalar)	32
2	Event_ID	UINT[N]	32	Event_Num	32 * N
3	Event_Time	DOUBLE[N]	64	Event_Num	64 * N
4	Event_Lat	FLOAT[N]	32	Event_Num	32 * N
5	Event_Lon	FLOAT[N]	32	Event_Num	32 * N
6	Event_Energy	FLOAT[N]	32	Event_Num	32 * N
7	Event_ParentGroupID	UINT[N]	32	Event_Num	32 * N
8	Event_DQF	BYTE[N]	8	Event_Num	8 * N

Table 3.2.2-3 GLM Group Data Description

Item #	Data Name	Description	Units
1	Group_Num	Number of Groups in Group Table	Unitless
2	Group_ID	Group ID assigned by L2+ processing	Unitless
3	Group_FirstEventTime	Time of first event in group	Seconds
4	Group_LastEventTime	Time of last event in group	Seconds
5	Group_Lat	Centroid latitude of group	Degrees
6	Group_Lon	Centroid longitude of group	Degrees
7	Group_Footprint	Areal coverage of group.	km^2
8	Group_Energy	Group energy	µJ m^(-2) µm^(-1)
9	Group_ParentFlashID	The ID number of the Parent Flash for this group	Unitless

Item #	Data Name	Description	Units
10	Group_NumEventsInGroup	Number of events associated with this group	Unitless
11	Group_FirstEventID	The ID number of the first event in this group	Unitless
12	Group_DQF	Group Data Quality Flags	Unitless

Table 3.2.2-4 GLM Group Data Structure

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	Group_Num	UINT	32	(scalar)	32
2	Group_ID	UINT[M]	32	Group_Num	32 * N
3	Group_FirstEventTime	DOUBLE[M]	64	Group_Num	64 * N
4	Group_LastEventTime	DOUBLE[M]	64	Group_Num	64 * N
5	Group_Lat	FLOAT[M]	32	Group_Num	32 * N
6	Group_Lon	FLOAT[M]	32	Group_Num	32 * N
7	Group_Footprint	FLOAT[M]	32	Group_Num	32 * N
8	Group_Energy	FLOAT[M]	32	Group_Num	32 * N
9	Group_ParentFlashID	UINT[M]	32	Group_Num	32 * N
10	Group_NumEventsInGroup	UINT[M]	32	Group_Num	32 * N
11	Group_FirstEventID	UINT[M]	32	Group_Num	32 * N
12	Group_DQF	BYTE[M]	8	Group_Num	8 * N

Table 3.2.2-5 GLM Flash Data Description

Item #	Data Name	Description	Units
1	Flash_Num	Number of Flashes in Flash Table	Unitless
2	Flash_ID	Flash ID assigned by L2+ processing	Unitless
3	Flash_FirstEventTime	Time of first event in flash	Seconds
4	Flash_LastEventTime	Time of last event in flash	Seconds
5	Flash_Lat	Centroid latitude of flash	Degrees
6	Flash_Lon	Centroid longitude of flash	Degrees
7	Flash_Footprint	Areal coverage of flash	km^2
8	Flash_Energy	Flash energy	µJ m^(-2) µm^(-1)
9	Flash_NumGroupsInFlash	Number of grouops associated with this flash	Unitless
10	Flash_FirstGroupID	The ID number of the first group in this flash	Unitless
11	Flash_DQF	Flash Data Quality Flags	Unitless

Table 3.2.2-6 GLM Flash Data Structure

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	Flash_Num	UINT	32	(scalar)	32
2	Flash_ID	UINT[Q]	32	Flash_Num	32 * N
3	Flash_FirstEventTime	DOUBLE[Q]	64	Flash_Num	64 * N
4	Flash_LastEventTime	DOUBLE[Q]	64	Flash_Num	64 * N
5	Flash_Lat	FLOAT[Q]	32	Flash_Num	32 * N
6	Flash_Lon	FLOAT[Q]	32	Flash_Num	32 * N
7	Flash_Footprint	FLOAT[Q]	32	Flash_Num	32 * N
8	Flash_Energy	FLOAT[Q]	32	Flash_Num	32 * N
9	Flash_NumGroupsInFlash	UINT[Q]	32	Flash_Num	32 * N
10	Flash_FirstGroupID	UINT[Q]	32	Flash_Num	32 * N
11	Flash_DQF	BYTE[Q]	8	Flash_Num	8 * N

3.3 EXIS Products

The following sections describe the EXIS product data that is present in the GRB data stream. Both the product data and the metadata use the GRB Generic Data format described in Section 2.3.

3.3.1 Solar Flux: EUV Irradiances Metadata

The EXIS/EUVS Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.3.1, below, lists the GRB APIDs that have been assigned to the EXIS/EUVS metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.3.1 EXIS EUVS Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
380	EXIS-L1b-SFEU	EXIS L1b Solar Flux: EUVS Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.3.2 Solar Flux: EUV Irradiances Product Data

Table 3.3.2 lists the APIDs that contain the Solar Flux: EUV Irradiances data product.

Table 3.3.2-1 Solar Flux: EUV Irradiances Product Description

Item #	Data Name	Description	Units
1	irradianceSpectrum	1-D array containing the EUV irradiance values from the proxy spectrum model for each of the 5-nm wavelength bins.	W m^{-2}
2	proxyFlags	1-D array containing a packed data word indicating the set of sensor proxies used to generate the EUV irradiance for each 5-nm wavelength bin	N/A
3	productQuality	1-D array containing a 2-bit flag specifying whether the best set, a reduced set, or no set of sensor proxies were used by the proxy spectrum model	N/A
4	avgIrradianceXRSA	The average value of the XRS-A primary irradiances over the 30-second processing interval	W m^{-2}
5	avgProxyXRSA	The average value of the XRS-A primary irradiance proxies over the 30-second processing interval	N/A
6	avgIrradianceXRSB	The average value of the XRS-B primary irradiances over the 30-second processing interval	W m^{-2}
7	avgProxyXRSB	The average value of the XRS-B primary irradiance proxies over the 30-second processing interval	N/A
8	avgIrradiance256	The average value of the EUVS-A 25.6-nm irradiances over the 30-second processing interval	W m^{-2}
9	avgProxy256	The average value of the EUVS-A 25.6-nm irradiance proxies over the 30-second processing interval	N/A
10	avgIrradiance284	The average value of the EUVS-A 28.4-nm irradiances over the 30-second processing interval	W m^{-2}
11	avgProxy284	The average value of the EUVS-A 28.4-nm irradiance proxies over the 30-second processing interval	N/A
12	avgIrradiance304	The average value of the EUVS-A 30.4-nm irradiances over the 30-second processing interval	W m^{-2}
13	avgProxy304	The average value of the EUVS-A 30.4-nm irradiance proxies over the 30-second processing interval	N/A
14	avgIrradiance1175	The average value of the EUVS-B 117.5-nm irradiances over the 30-second processing interval	W m^{-2}
15	avgProxy1175	The average value of the EUVS-B 117.5-nm irradiance proxies over the 30-second processing interval	N/A
16	avgIrradiance1216	The average value of the EUVS-B 121.6-nm irradiances over the 30-second processing interval	W m^{-2}

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Item #	Data Name	Description	Units
17	avgProxy1216	The average value of the EUVS-B 121.6-nm irradiance proxies over the 30-second processing interval	N/A
18	avgIrradiance1335	The average value of the EUVS-B 133.5-nm irradiances over the 30-second processing interval	W m^{-2}
19	avgProxy1335	The average value of the EUVS-B 133.5-nm irradiance proxies over the 30-second processing interval	N/A
20	avgIrradiance1405	The average value of the EUVS-B 140.5-nm irradiances over the 30-second processing interval	W m^{-2}
21	avgProxy1405	The average value of the EUVS-B 140.5-nm primary irradiance proxies over the 30-second processing interval	N/A
22	avgRatioMgExis	The average value of the EUVS-C EXIS Mg II core-to-wing ratios over the 30-second processing interval	N/A
23	avgRatioMgNoaa	The average value of the EUVS-C NOAA Mg II core-to-wing ratios over the 30-second processing interval	N/A
24	avgProxyMg	The average value of the EUVS-C NOAA Mg II core-to-wing ratio proxies over the 30-second processing interval	N/A
25	dailyIrradianceXRSA	The average value of the XRS-A primary irradiances over the previous day	W m^{-2}
26	trailingProxyXRSA	The average value of the XRS-A primary irradiance proxies over the trailing processing interval	N/A
27	dailyIrradianceXRSA	The average value of the XRS-A primary irradiances over the previous day	W m^{-2}
28	trailingProxyXRSB	The average value of the XRS-B primary irradiance proxies over the trailing processing interval	N/A
29	dailyIrradiance256	The average value of the EUVS-A 25.6-nm irradiances over the previous day	W m^{-2}
30	trailingProxy256	The average value of the EUVS-A 25.6-nm irradiance proxies over the trailing processing interval	N/A
31	dailyIrradiance284	The average value of the EUVS-A 28.4-nm irradiances over the previous day	W m^{-2}
32	trailingProxy284	The average value of the EUVS-A 28.4-nm irradiance proxies over the trailing processing interval	N/A
33	dailyIrradiance304	The average value of the EUVS-A 30.4-nm irradiances over the previous day	W m^{-2}
34	trailingProxy304	The average value of the EUVS-A 30.4-nm irradiance proxies	N/A

Item #	Data Name	Description	Units
		over the trailing processing interval	
35	dailyIrradiance1175	The average value of the EUVS-B 117.5-nm irradiances over the previous day	W m^{-2}
36	trailingProxy1175	The average value of the EUVS-B 117.5-nm irradiance proxies over the trailing processing interval	N/A
37	dailyIrradiance1216	The average value of the EUVS-B 121.6-nm irradiances over the previous day	W m^{-2}
38	trailingProxy1216	The average value of the EUVS-B 121.6-nm irradiance proxies over the trailing processing interval	N/A
39	dailyIrradiance1335	The average value of the EUVS-B 133.5-nm irradiances over the previous day	W m^{-2}
40	trailingProxy1335	The average value of the EUVS-B 133.5-nm irradiance proxies over the trailing processing interval	N/A
41	dailyIrradiance1405	The average value of the EUVS-B 140.5-nm irradiances over the previous day	W m^{-2}
42	trailingProxy1405	The average value of the EUVS-B 140.5-nm primary irradiance proxies over the trailing processing interval	N/A
43	dailyRatioMgNoaa	The average value of the EUVS-C NOAA Mg II core-to-wing ratios over the previous day	N/A
44	trailingProxyMgII	The average value of the EUVS-C NOAA Mg II core-to-wing ratio proxies over the trailing processing interval	N/A
45	Average SPS dispersion angle	Average of the 30 1-second dispersion angles produced by the SPS processing functional block and supplied in the XRS L1b data object.	deg.
46	Average SPS cross-dispersion angle	Average of the 30 1-second cross-dispersion angles produced by the SPS processing functional block and supplied in the XRS L1b data object.	deg.

Table 3.3.2-2 Solar Flux: EUV Irradiances Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	irradianceSpectrum	FLOAT[23]	32	wavelength_bin	736
2	proxyFlags	UNIT[23]	32	wavelength_bin	736
3	productQuality	UNIT[23]	32	wavelength_bin	736

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
4	avgIrradianceXRSA	FLOAT	32	(scalar)	32
5	avgProxyXRSA	FLOAT	32	(scalar)	32
6	avgIrradianceXRSB	FLOAT	32	(scalar)	32
7	avgProxyXRSB	FLOAT	32	(scalar)	32
8	avgIrradiance256	FLOAT	32	(scalar)	32
9	avgProxy256	FLOAT	32	(scalar)	32
10	avgIrradiance284	FLOAT	32	(scalar)	32
11	avgProxy284	FLOAT	32	(scalar)	32
12	avgIrradiance304	FLOAT	32	(scalar)	32
13	avgProxy304	FLOAT	32	(scalar)	32
14	avgIrradiance1175	FLOAT	32	(scalar)	32
15	avgProxy1175	FLOAT	32	(scalar)	32
16	avgIrradiance1216	FLOAT	32	(scalar)	32
17	avgProxy1216	FLOAT	32	(scalar)	32
18	avgIrradiance1335	FLOAT	32	(scalar)	32
19	avgProxy1335	FLOAT	32	(scalar)	32
20	avgIrradiance1405	FLOAT	32	(scalar)	32
21	avgProxy1405	FLOAT	32	(scalar)	32
22	avgRatioMgExis	FLOAT	32	(scalar)	32
23	avgRatioMgNoaa	FLOAT	32	(scalar)	32
24	avgProxyMg	FLOAT	32	(scalar)	32
25	dailyIrradianceXRSA	FLOAT	32	(scalar)	32
26	trailingProxyXRSA	FLOAT	32	(scalar)	32
27	dailyIrradianceXRSA	FLOAT	32	(scalar)	32
28	trailingProxyXRSB	FLOAT	32	(scalar)	32
29	dailyIrradiance256	FLOAT	32	(scalar)	32
30	trailingProxy256	FLOAT	32	(scalar)	32

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
31	dailyIrradiance284	FLOAT	32	(scalar)	32
32	trailingProxy284	FLOAT	32	(scalar)	32
33	dailyIrradiance304	FLOAT	32	(scalar)	32
34	trailingProxy304	FLOAT	32	(scalar)	32
35	dailyIrradiance1175	FLOAT	32	(scalar)	32
36	trailingProxy1175	FLOAT	32	(scalar)	32
37	dailyIrradiance1216	FLOAT	32	(scalar)	32
38	trailingProxy1216	FLOAT	32	(scalar)	32
39	dailyIrradiance1335	FLOAT	32	(scalar)	32
40	trailingProxy1335	FLOAT	32	(scalar)	32
41	dailyIrradiance1405	FLOAT	32	(scalar)	32
42	trailingProxy1405	FLOAT	32	(scalar)	32
43	dailyRatioMgNoaa	FLOAT	32	(scalar)	32
44	trailingProxyMgII	FLOAT	32	(scalar)	32
45	Average SPS dispersion angle	FLOAT	32	(scalar)	32
46	Average SPS cross-dispersion angle	FLOAT	32	(scalar)	32

3.3.3 Solar Flux: X-Ray Irradiances Metadata

The EXIS/XRay Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.3.3, below, lists the GRB APIDs that have been assigned to the EXIS/XRay metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time. There is only one 30-second product metadata object per 30 1-second block-level product data sent through GRB.

Table 3.3.3 Solar Flux: EUV X-Ray Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
390	EXIS-L1b-SFXR	EXIS L1b Solar Flux: X-Ray Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.3.4 Solar Flux: X-Ray Irradiances Product Data

Table 3.3.4 lists the APIDs that contain the Solar Flux: X-Ray Irradiances data product.

Table 3.3.4-1 Solar Flux: X-Ray Irradiances Product Description

Item #	Data Name	Description	Units
1	E_A1	Irradiance from XRS-A solar minimum diode	W/m^2
2	E_A2	Irradiance from XRS-A solar maximum diode (quad sum)	W/m^2
3	EA_Primary	1 = channel A2 (quad) is primary 0 = channel A1 (solar min) is primary	N/A
4	E_B1	Irradiance from XRS-B solar minimum diode	W/m^2
5	E_B2	Irradiance from XRS-B solar maximum diode (quad sum)	W/m^2
6	EB_Primary	1 = channel B2 (quad) is primary 0 = channel B1 (solar min) is primary	N/A
7	XRS Ratio	The primary XRS-A irradiance divided by the primary XRS-B irradiance.	N/A
8	ProxyXrsA	The XRS-A primary irradiance proxy.	N/A
9	ProxyXrsB	The XRS-A primary irradiance proxy.	N/A
10	C_A1	XRS-A quad 1 corrected current	Amps
11	C_A2	XRS-A quad 2 corrected current	Amps
12	C_A3	XRS-A quad 3 corrected current	Amps
13	CA4	XRS-A quad 4 corrected current	Amps
14	C_B1	XRS-B quad 1 corrected current	Amps
15	C_B2	XRS-B quad 2 corrected current	Amps
16	C_B3	XRS-B quad 3 corrected current	Amps

Item #	Data Name	Description	Units
17	C_B4	XRS-B quad 4 corrected current	Amps
18	alpha	Averaged dispersion direction pointing angle from SPS	degrees
19	geta	Averaged cross-dispersion direction pointing angle from SPS	degrees
20	alpha_GT	Averaged SUVI Guide Telescope angle along SPS alpha direction (yaw)	degrees
21	beta_GT	Averaged SUVI Guide Telescope angle along SPS beta direction (pitch).	degrees
22	SC_Quaternion	Spacecraft derived normalized quaternion for EXIS based on GOES-OT-10-0069 convection	N/A
23	SC_Quat_Target	Solar target quaternion, based on ephemeris.	N/A
24	scPowerSide	0=B, 1=A (exs_px_pb_stat)	N/A
25	exisMode	0=failsafe, 1=normal, 2=diag, 3=safe (exs_px_exs_md)	N/A
26	exisFlightModel	1=FM1, 2=FM2, 3=FM3, 4=FM4 (exs_px_mdl_num)	N/A
27	exisConfigId	Configuration ID (exs_px_exs_cfg)	N/A
28	checksum	Checksum (exs_px_pkt_cksm)	N/A
29	xrsDiodeCounts	12 raw diodes measurements: (xrs_1_cnt_ch0-5 and xrs_2_cnt_ch0-5)	DN
30	xrsIdacOffsets	IDAC offset registers: (xrs_1_idac_ch0-5 and xrs_2_idac_ch0-5)	N/A
31	xrsCal	Internal gain calibration circuit indicator, 1=science, 2=cal (xrs_runctrlmd)	N/A
32	asic2Powe	0=off, 1=on (xrs_2_pwr)	N/A
33	asic1Power	0=off, 1=on (xrs_1_pwr)	N/A
34	intTime	Integration time in quarter second increments, 0=0.25 sec, 1=0.5 sec, 2=0.75 sec, 3=1.0 sec, … (xrs_integ_tm)	N/A
35	LED_select	LED selection, 0=EUVSC-Backup, 1=EUVSBBackup, 2=EUVSA-Backup, 3=XRS-Backup, 4=EUVSC-Pri, 5=EUVSB-Pri, 6=EUVSA-Pri, 7=XRS-Pri (exs_sl_sel)	N/A
36	LED_power	LED power, 0=off, 1=on (exs_sl_pwr_ena)	N/A
37	LED_level	LED level setting, 12 bits used, (exs_sl_lvl)	N/A
38	IfBoardTemp	Interface board temperature (exs_ifb_tmp_dn)	DN

Item #	Data Name	Description	Units
39	ProcFpgaTemp	Microprocessor board FPGA temperature (Exs_mb_fp_tmp_dn)	DN
40	PowerSupplyTemp	Power board temperature (exs_pb_tmp_dn)	DN
41	CaseHeaterTemp	Case heater temperature(exs_cs_oh_tmp_dn)	DN
42	ASIC1Temperature	ASIC 1 temperature (converted xrs_1_bd_tmp_dn)	^{0}C
43	ASIC2Temperature	ASIC 2 temperature (converted xrs_2_bd_tmp_dn)	^{0}C
44	FilterTemp	Filter holder temperature (xrs_flt_tmp_dn)	DN
45	MagnetTemp	Magnet assembly temperature (xrs_mag_tmp_dn)	DN
46	DetChangeCount	Detector change counter, counts from 0 to 65535 whenever cal circuit is enabled or disabled, or xrs is powered on, sticks at 65535 (xrs_det_chg)	N/A
47	LEDChangeCount	Counts quarter seconds elapsed since LED was powered on or off, sticks at 65535 (exs_sl_chg)	N/A
48	asicSciVDAC	Science voltage DAC last input (xrs_sci_v_lst)	N/A
49	asicCalVmin	Min voltage for the cal ramp (xrs_cal_v_min)	N/A
50	asicCalVmax	Max voltage for the cal ramp (xrs_cal_v_max)	N/A
51	asicCalVstepUp	Voltage step size during ramp up (xrs_cal_v_sup)	N/A
52	asicCalTstepUp	Time step size during ramp up (10 microsec), (xrs_cal_t_sup)	N/A
53	asicCalVstepDown	Voltage step size during ramp down (xrs_cal_v_sdn)	N/A
54	asicCalTstepDown	Time step size during ramp down (10 microsec), (xrs_cal_t_sdn)	N/A
55	XrsMode	XRS detector mode, 0=normal, 1=cal, 2=diagnostic, 3=safe, these do not affect XRS and normal should not be used to filter any science data, XRS can generate good measurements for all values of XrsMode (xrs_md)	N/A
56	EuvsMode	EUVS detector mode with same states as XRS, also has no effect on data collection (euvs_md)	N/A
57	spsTime	Seconds of UT day converted from the secondary header exs_ps_tm_ms of the last SPS packet used to determine pointing angles	seconds

Item #	Data Name	Description	Units
58	spsDiodeCounts	SPS diode data numbers for the diodes and precision resistors (sps_cnt_ch0-5)	DN
59	spsIdacOffsets	SPS IDAC offsets commanded (sps_idac_ch0-5)	DN
60	spsCal	Internal gain calibration circuit indicator, 1=science, 2=cal (sps_runctrlmd)	N/A
61	spsPower	SPS power good indicator, 0=off, 1=on (sps_pwr)	N/A
62	spsIntTime	SPS integration time in quarter seconds, 0=0.25 sec, (sps_integ_tm)	DN
63	spsTemperature	SPS detector temperature (sps_dt_tmp)	^{0}C
64	spsDetChangeCount	SPS detector change counter (sps_det_chg)	N/A
65	spsAsicSciVDAC	Science voltage DAC last input (sps_sci_v_lst)	N/A
66	spsAsicCalVmin	Min voltage for the cal ramp (sps_cal_v_min)	N/A
67	spsAsicCalVmax	Max voltage for the cal ramp (sps_cal_v_max)	N/A
68	spsAsicCalVstepUp	Voltage step size during ramp up (sps_cal_v_sup)	N/A
69	spsAsicCalTstepUp	Time step size during ramp up (10 microsec), (sps_cal_t_sup)	N/A
70	spsAsicCalVstepDown	Voltage step size during ramp down (sps_cal_v_sdn)	N/A
71	spsAsicCalTstepDown	Time step size during ramp down (10 microsec), (sps_cal_t_sdn)	N/A

Table 3.3.4-2 Solar Flux: X-Ray Irradiances Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	E_A1	FLOAT	32	(scalar)	32
2	E_A2	FLOAT	32	(scalar)	32
3	EA_Primary	BYTE	8	(scalar)	8
4	E_B1	FLOAT	32	(scalar)	32

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
5	E_B2	FLOAT	32	(scalar)	32
6	EB_Primary	BYTE	8	(scalar)	8
7	XRS Ratio	FLOAT	32	(scalar)	32
8	ProxyXrsA	FLOAT	32	(scalar)	32
9	ProxyXrsB	FLOAT	32	(scalar)	32
10	C_A1	FLOAT	32	(scalar)	32
11	C_A2	FLOAT	32	(scalar)	32
12	C_A3	FLOAT	32	(scalar)	32
13	CA4	FLOAT	32	(scalar)	32
14	C_B1	FLOAT	32	(scalar)	32
15	C_B2	FLOAT	32	(scalar)	32
16	C_B3	FLOAT	32	(scalar)	32
17	C_B4	FLOAT	32	(scalar)	32
18	alpha	FLOAT	32	(scalar)	32
19	geta	FLOAT	32	(scalar)	32
20	alpha_GT	FLOAT	32	(scalar)	32
21	beta_GT	FLOAT	32	(scalar)	32
22	SC_Quaternion	FLOAT[4]	32	quaternion	128
23	SC_Quat_Target	FLOAT[4]	32	quaternion	128
24	scPowerSide	BYTE	8	(scalar)	8
25	exisMode	BYTE	8	(scalar)	8
26	exisFlightModel	BYTE	8	(scalar)	8
27	exisConfigId	UINT	16	(scalar)	16
28	checksum	BYTE	8	(scalar)	8
29	xrsDiodeCounts	UINT[12]	32	diode	384
30	xrsIdacOffsets	UINT[12]	32	register	384
31	xrsCal	BYTE	8	(scalar)	8

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
32	asic2Powe	BYTE	8	(scalar)	8
33	asic1Power	BYTE	8	(scalar)	8
34	intTime	BYTE	8	(scalar)	8
35	LED_select	BYTE	8	(scalar)	8
36	LED_power	BYTE	8	(scalar)	8
37	LED_level	UINT	32	(scalar)	32
38	IfBoardTemp	UINT	32	(scalar)	32
39	ProcFpgaTemp	UINT	32	(scalar)	32
40	PowerSupplyTemp	UINT	32	(scalar)	32
41	CaseHeaterTemp	UINT	32	(scalar)	32
42	ASIC1Temperature	FLOAT	32	(scalar)	32
43	ASIC2Temperature	FLOAT	32	(scalar)	32
44	FilterTemp	UINT	32	(scalar)	32
45	MagnetTemp	UINT	32	(scalar)	32
46	DetChangeCount	UINT	32	(scalar)	32
47	LEDChangeCount	UINT	32	(scalar)	32
48	asicSciVDAC	UINT	32	(scalar)	32
49	asicCalVmin	UINT	32	(scalar)	32
50	asicCalVmax	UINT	32	(scalar)	32
51	asicCalVstepUp	BYTE	8	(scalar)	8
52	asicCalTstepUp	BYTE	8	(scalar)	8
53	asicCalVstepDown	BYTE	8	(scalar)	8
54	asicCalTstepDown	BYTE	8	(scalar)	8
55	XrsMode	BYTE	8	(scalar)	8
56	EuvsMode	BYTE	8	(scalar)	8
57	spsTime	FLOAT	32	(scalar)	32
58	spsDiodeCounts	UINT[6]	32	diode	192

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
59	spsIdacOffsets	UINT[6]	32	register	192
60	spsCal	BYTE	8	(scalar)	8
61	spsPower	BYTE	8	(scalar)	8
62	spsIntTime	BYTE	8	(scalar)	8
63	spsTemperature	UINT	32	(scalar)	32
64	spsDetChangeCount	UINT	32	(scalar)	32
65	spsAsicSciVDAC	UINT	32	(scalar)	32
66	spsAsicCalVmin	UINT	32	(scalar)	32
67	spsAsicCalVmax	UINT	32	(scalar)	32
68	spsAsicCalVstepUp	BYTE	8	(scalar)	8
69	spsAsicCalTstepUp	BYTE	8	(scalar)	8
70	spsAsicCalVstepDown	BYTE	8	(scalar)	8
71	spsAsicCalTstepDown	BYTE	8	(scalar)	8

3.4 SEISS Products

The following sections describe the SEISS product data that is present in the GRB data stream. Both the product data and the metadata use the GRB Generic Data format described in Section 2.3.

3.4.1 Energetic Heavy Ions L1b Metadata

The SEISS/EHIS Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.4.1, below, lists the GRB APIDs that have been assigned to the SEISS/EHIS metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.4.1 SEISS EHIS Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
400	SEIS-L1b-EHIS	SEISS L1b Energetic Heavy Ions Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.4.2 Energetic Heavy Ions L1b Product Data

Table 3.4.2-1 and 3.4.2-2 lists the APIDs that contain Energetic Heavy Ions product data.

Table 3.4.2-1 SEISS EHIS Product Data

Item #	Data Name	Description	Units
1	H_diff_flux	H differential fluxes (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
2	H_error	H differential flux statistical errors (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
3	H_energy_bounds	H differential flux dynamic energy bounds (5 min.)	MeV
4	H_DQF	H differential flux DQFs (5 min.)	N/A
5	He_diff_flux	He differential fluxes (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
6	He_error	He differential flux statistical errors (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
7	He_energy_bounds	He differential flux dynamic energy bounds (5 min.)	MeV/nuc
8	He_DQF	He differential flux DQFs (5 min.)	N/A
9	CNO_diff_flux	CNO group differential fluxes (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
10	CNO_error	CNO group differential flux statistical error bounds (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
11	CNO_energy_bounds	CNO group differential flux dynamic energy bounds (5 min.)	MeV/nuc
12	CNO_DQF	CNO group differential flux DQFs (5 min.)	N/A
13	Ne-S_diff_flux	Ne-S group differential fluxes (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$

Item #	Data Name	Description	Units
14	Ne-S_error	Ne-S group differential flux statistical error bounds (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
15	Ne-S_energy_bounds	Ne-S group differential flux dynamic energy bounds (5 min.)	MeV/nuc
16	Ne-S_DQF	Ne-S group differential flux DQFs (5 min.)	N/A
17	Cl-Ni_diff_flux	Cl-Ni group differential fluxes (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
18	Cl-Ni_error	Cl-Ni group differential flux statistical error bounds (5 min.)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
19	Cl-Ni_energy_bounds	Cl-Ni group differential flux dynamic energy bounds (5 min.)	MeV/nuc
20	Cl-Ni_DQF	Cl-Ni group differential flux DQFs (5 min.)	N/A
21	Be-Cu_diff_flux	Differential ion fluxes for elements Be-Cu (5-min)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
22	Be-Cu_error	Differential ion flux statistical error bounds for elements Be-Cu (5-min)	cm^{-2} sr^{-1} sec^{-1} $(MeV/nuc)^{-1}$
23	Be-Cu_energy_bounds	Differential ion flux dynamic energy bounds for elements Be-Cu (5-min)	MeV/nuc
24	Be-Cu_DQF	Differential ion flux DQFs for elements Be-Cu (5-min)	N/A

Table 3.4.2-2 SEISS EHIS Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	H_diff_flux	FLOAT[5]	32	energy	160
2	H_error	FLOAT[5]	32	energy	160
3	H_energy_bounds	FLOAT[5,2]	32	energy x bound	320
4	H_DQF	BYTE[5]	8	energy	40
5	He_diff_flux	FLOAT[5]	32	energy	160
6	He_error	FLOAT[5]	32	energy	160
7	He_energy_bounds	FLOAT[5,2]	32	energy x bound	320
8	He_DQF	BYTE[5]	8	energy	40

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
9	CNO_diff_flux	FLOAT[5]	32	energy	160
10	CNO_error	FLOAT[5,2]	32	energy x bound	320
11	CNO_energy_bounds	FLOAT[5,2]	32	energy x bound	320
12	CNO_DQF	BYTE[5]	8	energy	40
13	Ne-S_diff_flux	FLOAT[5]	32	energy	160
14	Ne-S_error	FLOAT[5,2]	32	energy x bound	320
15	Ne-S_energy_bounds	FLOAT[5,2]	32	energy x bound	320
16	Ne-S_DQF	BYTE[5]	8	energy	40
17	Cl-Ni_diff_flux	FLOAT[5]	32	energy	160
18	Cl-Ni_error	FLOAT[5,2]	32	energy x bound	320
19	Cl-Ni_energy_bounds	FLOAT[5,2]	32	energy x bound	320
20	Cl-Ni_DQF	BYTE[5]	8	energy	40
21	Be-Cu_diff_flux	FLOAT[5,26]	32	energy x element	4160
22	Be-Cu_error	FLOAT[5,26,2]	32	energy x element x bound	8320
23	Be-Cu_energy_bounds	FLOAT[5,26,2]	32	energy x element x bound	8320
24	Be-Cu_DQF	FLOAT[5,26]	8	energy x element	1040

3.4.3 Magnetospheric Electrons and Protons: Low Energy L1b Metadata

The SEISS/MPS-LO Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.4.3, below, lists the GRB APIDs that have been assigned to the SEISS/MPS-LO metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.4.3 SEISS MPS-LO Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
410	SEIS-L1b-MPSL	SEISS L1b Magnetospheric Electrons and Protons: Low Energy Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.4.4 Magnetospheric Electrons and Protons: Low Energy L1b Product Data

Tables 3.4.4-1 and 3.4.4-2 lists the APIDs that contain Magnetospheric Electrons and Protons: Low Energy product data.

Table 3.4.4-1 Magnetospheric Electrons and Protons: Low Energy Product Description

Item #	Data Name	Description	Units
1	e_diff_flux	Electron differential fluxes	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
2	e_diff_flux_error	Electron differential flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
3	e_diff_flux_DQF	Electron differential flux DQFs	N/A
4	p_diff_flux	Ion differential fluxes	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
5	p_diff_flux_error	Ion differential flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
6	p_diff_flux_DQF	Ion differential flux DQFs	N/A

Table 3.4.4-2 Magnetospheric Electrons and Protons: Low Energy Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	e_diff_flux	FLOAT[14,15]	32	direction x energy	6720
2	e_diff_flux_error	FLOAT[14,15]	32	direction x energy	6720
3	e_diff_flux_DQF	BYTE[14,15]	8	direction x energy	1680
4	p_diff_flux	FLOAT[14,15]	32	direction x energy	6720
5	p_diff_flux_error	FLOAT[14,15]	32	direction x energy	6720
6	p_diff_flux_DQF	BYTE[14,15]	8	direction x energy	1680

3.4.5 Magnetospheric Electrons and Protons: Medium and High Energy L1b Metadata

The SEISS/MPS-HI Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.4.5, below, lists the GRB APIDs that have been assigned to the SEISS/MPS-HI metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product time data will all have the same product time.

Table 3.4.5 SEISS MPS-HI Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
420	SEIS-L1b-MPSH	SEISS L1b Magnetospheric Electrons and Protons: High Energy Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.4.6 Magnetospheric Electrons and Protons: Medium and High Energy L1b Product Data

Table 3.4.6 lists the APIDs that contain Magnetospheric Electrons and Protons: Medium and High Energy product data.

Table 3.4.6-1 Magnetospheric Electrons and Protons: High Energy Product Description

Item #	Data Name	Description	Units
1	e_diff_flux	Electron differential fluxes	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
2	e_diff_flux_error	Electron differential flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
3	e_diff_flux_DQF	Electron differential flux DQFs	N/A
4	e_int_flux	Electron integral fluxes	cm^{-2} sr^{-1} sec^{-1}
5	e_int_flux_error	Electron integral flux uncertainties	cm^{-2} sr^{-1} sec^{-1}
6	e_int_flux_DQF	Electron integral flux DQFs	N/A
7	p_diff_flux	Proton differential fluxes	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
8	p_diff_flux_error	Proton differential flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
9	p_diff_flux_DQF	Proton differential flux DQFs	N/A

Table 3.4.6-2 Magnetospheric Electrons and Protons: High Energy Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	e_diff_flux	FLOAT[5,10]	32	direction x energy	1600
2	e_diff_flux_error	FLOAT[5,10]	32	direction x energy	1600
3	e_diff_flux_DQF	BYTE[5,10]	8	direction x energy	400
4	e_int_flux	FLOAT[5]	32	direction	160
5	e_int_flux_error	FLOAT[5]	32	direction	160
6	e_int_flux_DQF	BYTE[5]	8	direction	40

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
7	p_diff_flux	FLOAT[5,11]	32	direction x energy	1760
8	p_diff_flux_error	FLOAT[5,11]	32	direction x energy	1760
9	p_diff_flux_DQF	BYTE[5,11]	8	direction x energy	440

3.4.7 Solar and Galactic Protons L1b Metadata

The SEISS/SGPS Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.4.7, below, lists the GRB APIDs that have been assigned to the SEISS/SGPS metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.4.7 Solar and Galactic Protons Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
430	SEIS-L1b-SGPS	SEISS L1b Solar and Galactic Protons Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.4.8 Solar and Galactic Protons L1b Product Data

Tables 3.4.8-1 and 3.4.8-2 lists the APIDs that contain Solar and Galactic Protons product data.

Table 3.4.8-1 Solar and Galactic Protons Product Description

Item #	Data Name	Description	Units
1	SGPS-X_T1_diff_flux	SGPS-X T1 differential proton fluxes for channels P1, P2A, P2B, P3, P4 and P5	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
2	SGPS-X_T1_diff_error	SGPS-X T1 differential proton flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
3	SGPS-X_T1_diff_DQF	SGPS-X T1 differential proton flux DQFs	N/A
4	SGPS-X_T2_diff_flux	SGPS-X T2 differential proton fluxes for channels P6 and P7	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
5	SGPS-X_T2_diff_error	SGPS-X T2 differential proton flux	cm^{-2} sr^{-1} sec^{-1} keV^{-1}

Item #	Data Name	Description	Units
		uncertainties	
6	SGPS-X_T2_diff_DQF	SGPS-X T2 differential proton flux DQFs	N/A
7	SGPS-X_T3_diff_flux	SGPS-X T3 differential proton fluxes for channels P8AF, P8BF, P8CF, P9F and P10	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
8	SGPS-X_T3_diff_error	SGPS-X T3 differential proton flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
9	SGPS-X_T3_diff_DQF	SGPS-X T3 differential proton flux DQFs	N/A
10	SGPS-X_T3_int_flux	SGPS-X T3 integral proton flux for channel P11	cm^{-2} sr^{-1} sec^{-1}
11	SGPS-X_T3_int_error	SGPS-X T3 integral proton flux uncertainty for channel P11	cm^{-2} sr^{-1} sec^{-1}
12	SGPS-X_T3_int_DQF	SGPS-X T3 integral proton flux DQF	N/A
13	SGPS+X_T1_diff_flux	SGPS+X T1 differential proton fluxes for channels P1, P2A, P2B, P3, P4 and P5	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
14	SGPS+X_T1_diff_error	SGPS+X T1 differential proton flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
15	SGPS+X_T1_diff_DQF	SGPS+X T1 differential proton flux DQFs	N/A
16	SGPS+X_T2_diff_flux	SGPS+X T2 differential proton fluxes for channels P6 and P7	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
17	SGPS+X_T2_diff_error	SGPS+X T2 differential proton flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
18	SGPS+X_T2_diff_DQF	SGPS+X T2 differential proton flux DQFs	N/A
19	SGPS+X_T3_diff_flux	SGPS+X T3 differential proton fluxes for channels P8AF, P8BF, P8CF, P9F and P10	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
20	SGPS+X_T3_diff_error	SGPS+X T3 differential proton flux uncertainties	cm^{-2} sr^{-1} sec^{-1} keV^{-1}
21	SGPS+X_T3_diff_DQF	SGPS+X T3 differential proton flux DQFs	N/A
22	SGPS+X_T3_int_flux	SGPS+X T3 integral proton flux for channel P11	cm^{-2} sr^{-1} sec^{-1}
23	SGPS+X_T3_int_error	SGPS+X T3 integral proton flux uncertainty for channel P11	cm^{-2} sr^{-1} sec^{-1}
24	SGPS+X_T3_int_DQF	SGPS+X T3 integral proton flux DQF	N/A

Table 3.4.8-2 Solar and Galactic Protons Product Data

Item #	Data Name	Data Type / Array Size	Bit Depth	Dimension Description	Data Size (Bits)
1	SGPS-X_T1_diff_flux	FLOAT[6]	32	energy	192
2	SGPS-X_T1_diff_error	FLOAT[6]	32	energy	192
3	SGPS-X_T1_diff_DQF	BYTE[6]	8	energy	48
4	SGPS-X_T2_diff_flux	FLOAT[2]	32	energy	64
5	SGPS-X_T2_diff_error	FLOAT[2]	32	energy	64
6	SGPS-X_T2_diff_DQF	BYTE[2]	8	energy	16
7	SGPS-X_T3_diff_flux	FLOAT[5]	32	energy	160
8	SGPS-X_T3_diff_error	FLOAT[5]	32	energy	160
9	SGPS-X_T3_diff_DQF	BYTE[5]	8	energy	40
10	SGPS-X_T3_int_flux	FLOAT	32	(scalar)	32
11	SGPS-X_T3_int_error	FLOAT	32	(scalar)	32
12	SGPS-X_T3_int_DQF	BYTE	8	(scalar)	8
13	SGPS+X_T1_diff_flux	FLOAT[6]	32	energy	192
14	SGPS+X_T1_diff_error	FLOAT[6]	32	energy	192
15	SGPS+X_T1_diff_DQF	BYTE[6]	8	energy	48
16	SGPS+X_T2_diff_flux	FLOAT[2]	32	energy	64
17	SGPS+X_T2_diff_error	FLOAT[2]	32	energy	64
18	SGPS+X_T2_diff_DQF	BYTE[2]	8	energy	16
19	SGPS+X_T3_diff_flux	FLOAT[5]	32	energy	160
20	SGPS+X_T3_diff_error	FLOAT[5]	32	energy	160
21	SGPS+X_T3_diff_DQF	BYTE[5]	8	energy	40
22	SGPS+X_T3_int_flux	FLOAT	32	(scalar)	32
23	SGPS+X_T3_int_error	FLOAT	32	(scalar)	32
24	SGPS+X_T3_int_DQF	BYTE	8	(scalar)	8

3.5 SUVI Products

The following sections describe the SUVI product data that is present in the GRB data stream. The product data uses the GRB Image Product format described in Section 2.2. The SUVI metadata uses the GRB Generic Data format described in Section 2.3 of this document. The JPEG 2000 lossless compression scheme is used for all GRB SUVI product data packets. JPEG 2000 is an image coding system that uses state-of-the-art compression techniques based on wavelet technology. For more information on JPEG 2000 refer to www.jpeg.org/jpeg2000/.

3.5.1 Solar Imagery: X-Ray L1b Metadata

The SUVI Metadata is captured within ASCII NcML files. These files are transmitted through the GRB data stream via the GRB Generic Data mechanism that is described in Section 2.3. Section 2.3 describes how to extract, and if necessary, decompress each NcML metadata file. Table 3.5.1, below, lists the GRB APIDs that have been assigned to the SUVI metadata file. All of this metadata is provided within a single NcML file.

Each metadata file has been assigned a unique product time. This time can be found inside the GRB Payload for the GRB Data packets containing the metadata (as described in Table 2.3.2). The metadata and its product data will all have the same product time.

Table 3.5.1 Solar Imagery: X-Ray Metadata APIDs

GRB APID (Hex)	Product Data Name	Description
480	SUVI-L1b-Fe93	SUVI Fe XVIII [93.9 A] 10-msec flare exposure Metadata
483	SUVI-L1b-Fe131	SUVI Fe XX [131.8 A] 10-msec flare exposure Metadata
486	SUVI-L1b-Fe171	SUVI Fe IX [171.1 A] 10-msec flare exposure Metadata
488	SUVI-L1b-Fe195	SUVI Fe XII [195.1 A] 10-msec flare exposure Metadata
48A	SUVI-L1b-Fe284	SUVI Fe XV [284.3 A] 10-msec flare exposure Metadata
48C	SUVI-L1b-He303	SUVI He II [303.8 A] 10-msec flare exposure Metadata

Detailed information on the content of the NcML metadata will be provided in a future release of this document.

3.5.2 Solar Imagery: X-Ray L1b Product Data

Table 3.5.2 lists the APIDs that contain Solar Imagery: X-Ray product data.

Table 3.5.2 Solar Imagery: X-Ray Product Data

GRB APID (Hex)	Product Data Name	Element Data Type	Element Bit Depth
48E	Fe XVIII [93.9 A] 10-msec flare exposure	SHORT	16
	Fe XVIII [93.9 A] 10-msec flare exposure DQF	BYTE	8
491	Fe XX [132.8 A] 10-msec flare exposure	SHORT	16
	Fe XX [132.8 A] 10-msec flare exposure DQF	BYTE	8
494	Fe IX [171.1 A] 10-msec flare exposure	SHORT	16
	Fe IX [171.1 A] 10-msec flare exposure DQF	BYTE	8
496	Fe XII [195.1 A] 10-msec flare exposure	SHORT	16
	Fe XII [195.1 A] 10-msec flare exposure DQF	BYTE	8
498	Fe XV [284.3 A] 10-msec flare exposure	SHORT	16
	Fe XV [284.3 A] 10-msec flare exposure DQF	BYTE	8
49A	He II [303.8 A] 10-msec flare exposure	SHORT	16
	He II [303.8 A] 10-msec flare exposure DQF	BYTE	8

The procedure for assembling the final SUVI radiance and DQF image products will be described in a future release of this document.

3.6 Magnetometer (MAG) Products

The following sections describe the Magnetometer (MAG) product data that is present in the GRB data stream. Both the product data and the metadata use the GRB Generic Data format described in Section 2.3. The MAG product data is not compressed.

3.6.1 Geomagnetic Field Metadata

The Magnetometer metadata will be described in a future release of this document.

3.6.2 Geomagnetic Field Product Data

The Magnetometer product data including any applicable DQFs will be described in a future release of this document.

4.0 GRB INFORMATION

GRB Information (INFO) Packets contain files which provide operations schedules, periodic status information, orbit state vectors, and algorithm input parameters. GRB INFO files are transmitted every 5 minutes by the GOES ground station. All GRB INFO packets have the APID value of 0x580. All GRB INFO packets use the Generic Data format that is described in Section 2.3. Section 4.2 describes the format of the Product Data that is contained within the Generic Data structure.

4.1 GRB INFO Packets Naming Conventions

File naming conventions for GOES-R reference data transmitted to external interfaces (algorithms, reference data and ancillary) and associated metadata**.** The Naming Convention (FNC) for GRB INFO packets is shown in Table 4.1-1 and adheres to the following rules.

1. All filenames are case-sensitive and shall be less than or equal to a maximum of 255 characters with no spaces.
2. Only alphanumeric characters, underscores, dashes (hyphens), and dots (periods) shall be used within each field.
3. All fields are delimited by a single underscore except for the delimiter for the File Extension field that uses none. (A period (.), the standard delimiter for the file extension, is included as part of the File Extension field.) Underscore delimiters are included in the maximum field lengths.
4. Portions of the mandatory fields (i.e. subfields) may be optional and, when applicable, optional subfields are enclosed in **[brackets]** for easy identification.
5. "Quoted" text within the Valid Values & Format column shall be used literally. Variable values, such as those that can be different for each product file, are enclosed in ***<bold, italic, greater than & less than symbols>***.

GRB INFO packets include the following mandatory fields as identified in Table 4.1-1.

<Env>_<DSN>_<PID>_<Start>.<Ext>

Table 4.1-1 GRB INFO Packets File Name Convention

	Field Name	Description	Valid Values & Format	Max. Length	Mandatory?
0	Env-Environment	Identifies the GS Environment from which the GRB INFO files are being provided and type of data in the file. The single character environment and source identifiers are concatenated without any delimiter.	"OR" = OE Real-Time Data "OT" = OE Test Data "IR" = ITE Real-Time Data "IT" = ITE Test Data "IP" = ITE Playback Data "IS" = ITE Simulated Data	2	M
1	DSN-Data Short Name	Data Short Name uniquely identifies every type of GRB Info file.	"_GRB-INFO-ACQ" = State, Position, & Velocity Vectors "_GRB-INFO-NPRF" = INR Performance "_GRB-INFO-SCH" = Schedule & Operations "_GRB-INFO-STAT" = Health & Status	25	M
2	PID-Platform ID	GOES-R Satellite Platform ID. Starts with an underscore "_".	"_G16" = GOES-16 "_G17" = GOES-17	4	M (except for "STAT" packets)
3	Start-Data Start Date	Identifies Start Date and Time. Starts with an underscore "_" followed by a letter "s" followed by a variable sub-field for the UTC Date and Time.	"_s"<***YYYYDDDhhmmss***> The variable subfield format for the date includes: YYYY = Year (4 characters: 0001-9999) DDD = Day of the year (3 characters: 001-366) hh = Hours (2 characters: 00-23) mm = Minutes (2 characters: 00-59) ss = Seconds (2 characters: 00-59)	16	M
6	Ext-Extension	Identifies the file extension.	".xml" = XML	4	M

Table 4.1-2 provides the "Data Short Name" portion of the file naming convention list in the table above for GRB INFO Packets.

Table 4.1-2 GRB INFO Packets Naming Conventions

Acronym	Data Short Name	Description
ACQ	GRB-INFO-ACQ	GRB INFO State, Position, & Velocity Vectors
NPRF	GRB-INFO-NPRF	GRB INFO INR Performance
SCH	GRB-INFO-SCH	GRB INFO Schedule & Operations
STAT	GRB-INFO-STAT	GRB INFO Health & Status

The following are example file names for GRB INFO:

OR_GRB-INFO-ACQ_G16_s2020200091212.xml
OR_GRB-INFO-NPRF_G17_s2016100100512.xml
OR_GRB-INFO-SCH_G16_s2017100120522.xml
OR_GRB-INFO-STAT_s2018222061159.xml

4.2 Extracting GRB INFO Files

The techniques described in Section 2.3.1 should be used to extract the Product Data from the GRB INFO packets. The resulting data will have the structure shown in Table 4.2. The GRB INFO file data should be written to disk with the file name that is supplied in the Product Data structure.

Table 4.2 GRB INFO Product Data Structure

Size (Bytes)	Name	Description	Type
1	N	Number of ASCII Characters in the filename	BYTE
N	INFO File Name	The filename for this GRB INFO object	N CHARS
Varies	INFO File Data	The remainder of the data in this structure is the GRB_INFO file data	Varies

All of the data in the GRB INFO Product Data structure should be interpreted as Little Endian data.

4.3 File Descriptions

There are a number of different GRB INFO files that are transmitted through the GRB data stream. Table 4.3 provides a brief summary of these files.

Table 4.3 Summary of the GRB INFO File Types

Category	GRB INFO File Type	Description
Algorithm Parameters	ABI_PARAMETERS	Semi-static L1b algorithm input parameters

Category	GRB INFO File Type	Description
Algorithm Parameters	EXIS-EUVS_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	EXIS-XRAY_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	GLM_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	MAGNETOMETER_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	SEISS_EHIS_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	SEISS_MPSHI_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	SEISS_MPSLO_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	SEISS_SGPS_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	SUVI_PARAMETERS	Semi-static L1b algorithm input parameters
Algorithm Parameters	INSTRUMENT_FOV	Look direction (direction cosines) for each instrument's telescope.
Operational Schedules	OPER_SCHEDULE_EAST	The operational schedule for the GOES-East satellite
Operational Schedules	OPER_SCHEDULE_WEST	The operational schedule for the GOES-West satellite
Process Performance	INR_PERF_DATA_EAST	Periodic INR Status informing users of process performance
Process Performance	INR_PERF_DATA_WEST	Periodic INR Status informing users of process performance
Process Performance	PERIODIC_STATUS_DATA	Health & Status information for the GOES satellites.
State Vectors	ACQUISITION_DATA_EAST	Satellite State Position & Velocity Vectors for the GOES-East satellite
State Vectors	ACQUISITION_DATA_WEST	Satellite State Position & Velocity Vectors for the GOES-West satellite

4.4 GRB INFO Data Fields

[Note: This section is a placeholder for the data GRB INFO data fields to be added in the 2013.]