GOES R SERIES PRODUCT DEFINITION AND USERS' GUIDE

(PUG)

VOLUME 1: MAIN

VOLUME 2: L0 PRODUCTS

VOLUME 3: LEVEL 1B PRODUCTS

VOLUME 4: GOES-R REBROADCAST (GRB)

VOLUME 5: LEVEL 2+ PRODUCTS

APPENDIX X: ISO SERIES METADATA

04/11/2018

REVISION 1.2

U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite and Information Service (NESDIS)
National Aeronautics and Space Administration (NASA)

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Signature on File **11/20/2017**
Jim Valenti Date
NOAA
GOES-R Ground Segment Project Manager

CHANGE RECORD

ISSUE	CCR #	DATE	PAGES AFFECTED	DESCRIPTION
Rev. 1.0	CCR-03240	03/02/2017	All	CDRL SE-16 under Government Control. Harris DCN 7035538 PUG L1B Vol 3 Rev E has been placed under Gov. GS control as GOES-R Series 416-R-PUG-L1B 0347 Vol 3 Rev 1.0.
Rev. 1.1	CCR-03332	10/27/2017	All	CDRL SE-16 under Government Control. Harris DCN 7035538 PUG L1B Vol 3 Rev F has been placed under Gov. GS control as GOES-R Series 416-R-PUG-L1B 0347 Vol 3 Rev 1.1.
Rev. 1.2	CCR-03412	04/11/2018	All	CDRL SE-16 under Government Control. Harris DCN 7035538 PUG L1B Vol 3 Rev F.1 has been placed under Gov. GS control as GOES-R Series 416-R-PUG-L1B 0347 Vol 3 Rev 1.2.

PRODUCT DEFINITION AND USER'S GUIDE (PUG)

VOLUME 3: LEVEL 1B PRODUCTS

FOR

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE
R SERIES (GOES-R) CORE GROUND SEGMENT
CONTRACT NO: DG133E-09-CN-0094
DOCUMENT CONTROL NUMBER: 7035538
CDRL SE-16
REVISION F.1
29 NOVEMBER 2017

PREPARED FOR
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NOAA LIAISON OFFICE/NASA GSFC
GOES-R SERIES CODE 417
BLDG. 6, RM. C100
GREENBELT, MD 20771

PREPARED BY:
HARRIS CORPORATION
P.O. BOX 9800
MELBOURNE, FLORIDA 32902-9800
CAGE NUMBER: 91417

PRODUCT DEFINITION AND USER'S GUIDE (PUG)

VOLUME 3: LEVEL 1B PRODUCTS

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

Prepared By:

Michael Carlomusto
GOES-R SEIT Systems Engineering

Reviewed By:

Bob Esposito
GOES-R Security Manager

Frank Lombardo
GOES-R Mission Assurance Manager

Jeannie Recob
GOES-R Configuration Manager

Anita Hudson
GOES-R Chief Software Engineer

Robert Basta
GOES-R Chief Systems Engineer

Mike Blanton
GOES-R Mission Readiness IPT Lead

Debbie Robeson
GOES-R Project Manager

Approved By:

Kevin Hurd
GOES-R Enterprise Ground Solutions Business Area Lead

RECORD OF CHANGE

REVISION	DATE	DESCRIPTION
-	08 February 2011	Initial Release Pre-ECP5
-.1	25 August 2011	Interim Release, including ECP5 PTR-2871 Incorporate GSP comments & organize document structure into volumes PTR-2872 Update content for TBDs/Action Items PTR-2874 Incorporate monthly work-in-progress comments
A	06 February 2012	Pre-CDR Release PTR 3226 Update per BCN_046 ATP for BCR 049 Metadata Delivery PTR-3525 Incorporate GSP Comments (from Interim Release) PTR-3525 Incorporate GSP Comments (CDR Release) PTR-3526 Update Content for TBDs/Action Items (CDR Release)
B	26 July 2012	CDR+90 Release PTR-3239 SE-16 PUG – Update External File Naming Convention for New Static Metadata Files from Metadata BCR PTR-4138 Remove ITAR from Volume 4, GRB PTR-3576 Remove Reference to AWG Ancillary Data PTR-3409 Update Content for TBD-11, TBD-17 and TBD-20 PTR-4039 Update Content for TBDs/Action Items PTR-4203 PUG Update for SUVI Image Refresh and Snow Ice Metadata PTR-4298 GSP Comments Rev A PTR-4204 SE-16 PUG Feedback on PUG for L1b Volume 3

REVISION	DATE	DESCRIPTION
		PTR-4845 SE-16 PUG Incorporate Peer Review Comments Deferred from Rev A (Note: Updated NcML files are from 6/12 for CMI and 6/11 for all others)
B.1	17 December 2012	Post-CDR Interim Release PTR-4841 SE-16 PUG - Deferred Comments from Release A PTR-4946 SE-16 PUG - Deferred Comments from PostCDR+90 Peer Review PTR-5318 SE-16 PUG: BCN_067 ATP for ECP007 RFP Amend 4 PTR-5373 SE-16 PUG - Update PUG Vol 5 Product Algorithm Output Tables PTR-5403 Incorporate customer comments against Rev. B
B.2	20 May 2013	Post-CDR Interim Release PTR-6419 SE-16_Product Definition and User's Guide (PUG) Release Update Rev B.2 Update due to BCR75 PTR-6158 UMB_Delivery_SE-16_Product Definition and User's Guide (PUG) Release Update Rev B.2 PTR-6159 SE-16 PUG - Deferred Comments from Rev. B.1 Peer Review PTR-6837 SE-16 PUG Incorporate Customer Comments Against Rev B.1 PTR-6877 SE-16 Product Definition and User's Guide (PUG) - BCN_085 ATP for MAG SEISS L1b Changes
C	06 December 2013	Post-CDR Interim Release PTR-9218 Delivery_SE-16_Product Definition and User's Guide (PUG) Release Update Rev C 1) ITAR content and markings removed from this volume. 2) Other than the instrument overview and the ABI Fixed Grid paragraph, paragraphs 1 through the end of paragraph 5.3 have been completely revised with new and updated content. A Standard Coordinate data paragraph has been added to the ABI Fixed Grid paragraph. 3) Paragraphs 5.4 through the end of paragraph 5.11.7 have not been revised for this version of the PUG. 4) New appendices for the filename conventions, product refresh rates and latencies, and instrument telemetry parameters have been included.

REVISION	DATE	DESCRIPTION
		5) The subsequent version is identified where new content will be inserted into paragraphs that currently have headings and no content. PTR-7556 SE-16 PUG - Deferred GSP Comments from Rev. B.2 Review A subset of the deferred comments addressed related to the Radiances product, ABI instrument calibration data, filename conventions, and several miscellaneous topics. PTR-9027 SE-16 PUG - Evaluate Customer Comments Against Rev B.2 A subset of the deferred comments addressed related to the Radiances product, ABI instrument calibration data, filename conventions, and several miscellaneous topics.
C.1	05 December 2014	Post-CDR Interim Release Vol 1, Main: • Added FITS format section (SUVI) Vol 2, L0: • Minor editorial changes Vol 3, L1b: • Revised Space Weather and Solar instrument sections • Co-located Instrument Calibration Data with instrument section Vol 4, GRB: • Revised Space Weather and Solar instrument sections • Corrected APID list Vol 5, L2+: • Combined Volumes 5A and 5B • Added section for Latitude/Longitude grid (Radiation products) • Added Appendix for dynamic source data • Miscellaneous changes to CMI product Appendix X, ISO Series Metadata: • Revised L1b, L2+, Instrument Calibration Data sections PTR-12388 UMB_Delivery_SE-16_ Product Definition and User's Guide (PUG) Release Update Rev C.1

REVISION	DATE	DESCRIPTION
		• Incorporates PTR-7028, PTR-7556, PTR-7557, PTR-7553, PTR-8055, PTR-8742, PTR-9027, PTR-9518, PTR-11701 • Combined Vol 5A and Vol 5B into a single volume • Rearranged major sections of the document (consolidated File Naming conventions, consolidated APID lists, etc.), for usability PTR-7028 Update Cumulative ERB/PCRB Changes in Next Rev of Document • ERB: delete the Rainfall Rate Coefficient Algorithm • PCRB: change GLM Lightning Event Peak L1b/GRB update • PCRB: change Radiation Grid from ABI Grid to Latitude/Longitude PTR-7556 Deferred Comments from Rev. B.2 Peer Review • Incorporate comments deferred from Revision B.2 Peer Review PTR-7753 SE-16: Updates to PUG Rev C for next Release • Fixed MAG L1b OMAS/GRB/PD periodicity PTR-8055 SE-16 PUG BCR # 127 + BCR #129 + BCR 124 + BCN_120 ATP for NcML/Product Definition for non-ABI Sensors + BCN_149, BCR 115 Update GLM L2 NcML + BCR 119 + BCR #127 and 129 (IPS and Product Set 1 NcML Corrections) • BCR#127: incorporated IPS Product NcML corrections • BCR#129: incorporated IPS and Product Set 1 NcML corrections • BCR#124: changed SUVI, SEISS, MAG NcML • BCN_120: NcML/product definition for non-ABI instruments • BCN_149 / BCR#115: updated GLM L2+ NcML definition • BCR#119: changed SUVI GLM INR report design • ECP-9a: added aggregation criteria for Geomagnetic Field, Solar Flux: X-Ray products • BCR#212: incorporated Product Set 2 NcML corrections PTR-8742 SE-16 PUG - Scheduled Science Instrument Products definitions

<table>
<tr><th>REVISION</th><th>DATE</th><th>DESCRIPTION</th></tr>
<tr><td></td><td></td><td>Updated SUVI, EXIS, SEISS, MAG, GLM product definitions
PTR-9027
SE-16 PUG - Evaluate Customer Comments Against Rev B.2
Incorporated customer comments not previously addressed in PUG Rev C
PTR-9518
SE-16 PUG, Evaluate Customer Comments from Rev C
Incorporated customer comments against PUG Rev C
PTR-11701
SE-16 PUG - Update for BCR # 227, Non-ABI product Corrections
Incorporated non-ABI Product NcML corrections</td></tr>
<tr><td>D</td><td>13 May 2015</td><td>PTR-7557
UMB_Delivery_SE-16_Product Definition and User's Guide (PUG) Release Update Rev D
Incorporate customer comments against PUG Rev C.1
PTR-13600
SE-16 PUG - Miscellaneous Corrections
Appendix X
New content – L0 and GRB Info ISO Series Metadata
Vol 2, L0
Restructured to be consistent with other volumes
Vol 3, L1b
New content – dynamic and semi-static processing parameters.
Vol 4, GRB
New content – GRB Information
Vol 5, L2+
New content – dynamic and semi-static processing parameters.</td></tr>
<tr><td>D.1</td><td>11 August 2015</td><td>PTR-14093
Change 132.8 Angstroms wavelength to 131.2 Angstroms in SUVI documentation
PTR-14107
Update various L2 product lineage issues</td></tr>
</table>

<table>
<tr><th>REVISION</th><th>DATE</th><th>DESCRIPTION</th></tr>
<tr><td></td><td></td><td>PTR-13638
Update document for ECP-023 new CONUS center points
PTR-14388
WR 757: SE-16: CMI - Update PUG to change scaling of band 7 to a max brightness temp of 400K</td></tr>
<tr><td>D.2</td><td>24 March 2016</td><td>PUG release aligned with PC DO.03.00.00 software baseline.

PTR-14663
SE-16 PUG, Evaluate Customer Comments from Rev D
PTR-15294
SE-16 PUG, Add GRB-INFO-STATIC description
PTR-15324
SE-16 PUG - Misc. Updates to Sync with GS File Naming Conventions
Additionally, the following changes have been made, in preparation for PC D0.04.00.00 (WR 813 / PTR-15605):
Changed yaw_flip_flag to allow 3 states (upright, neither, inverted)
Changed EXIS num_angle_pairs long_name</td></tr>
<tr><td>E</td><td>15 June 2016</td><td>PUG release aligned with PC DO.04.00.00 software baseline.

PTR-16585
SE-16 PUG - Miscellaneous Corrections
PTR-16442
WR 1949: GLM appears to have Timing Artifacts (PUG Update)
PTR-15605
WR 813: Space Weather products' enhancements requested by NCEI (SE-16 PUG)
Add SEISS MPS-LO energy bounds/levels to differential_flux_energy_band_label variable value
PTR-15580
WR 1697: SE-16 PUG - Rainfall Rate Product DQF Valid Range is Incorrect
PTR-15194</td></tr>
</table>

REVISION	DATE	DESCRIPTION
		• WR 1177: SE-16 Modify Product Definition User's Guide for expanded ABI L1b Radiance Limits
E.1	4 November 2016	PUG release aligned with PC DO.04.02.00 software baseline, except where otherwise noted. PTRDOC-15878 DO.05.00.00 • WR 1552: SE-16 PUG - ABI L1b Instrument Calibration Data - Number of detector rows discrepancy PTRDOC-16363 • WR 2261: SE-16 PUG - Provide documentation for CAL INR data file structures PTRDOC-16387 DO.05.00.00 • WR 2218: SE-16 PUG - There are no ABI CCR results in the PM Generated ABI INR Report PTRDOC-16397 DO.05.00.00 • WR 1937: SE-16 PUG - GLM L2+ product metadata errors PTRDOC-16639 DO.05.00.00 • WR 1698: SE-16 PUG - Sea Surface Temperature Fill Value incorrect PTRDOC-16911 DO.05.00.00 • WR 2961: SE-16 Update PUG to clarify Rainfall Rate metadata PTRDOC-16936 • WR 2566: SE-16 PUG - Add Derived Motion Winds PQI and Diagnostic Intermediate Products to the PUG PTRDOC-17008 • WR 2749: SE-16 PUG - Update PUG to reflect 2 minute EXIS L0 LZSS file aggregation time PTRDOC-17088 • WR 2874: SE-16 PUG - Correct File Names of Instrument Calibration Files Produced PTRDOC-17123 • WR 1739: SE-16 PUG - SUVI Instrument Calibration File Names PTRDOC-17254 • WR 2962: SE-16 PUG - CMI Coefficients update-ADR 143

REVISION	DATE	DESCRIPTION
		PTRDOC-17416 • WR 3058: SE-16 PUG - SUVI scale factors in products do not match scale factors in the PUG PTRDOC-17661 • WR 3274: SE-16 PUG - Update to Align with XTCE Database v6.3.005A PTRDOC-17818 DO.06.00.00 • WR 2260: SE-16 PUG - Derived Motion Winds (DMW) Wind Direction: Incorrect Direction
E.2	30 March 2017	PUG release aligned with GOES-R Ground Segment Product Capabilities (PG, PD, PM) software baselines, as follows: DO.04.04.00: April 2017 DO.05.00.00: July 2017 DO.06.00.00: September 2017 (TBR) PTRDOC-17880 DO.05.00.00 Vol 5, Table 5.1.6.4-1. • WR 3383: SE-16 PUG - Changes for Expansion of CMI range to match DO.04 Rad-ADR 154 PTRDOC-17887 DO.04.04.00 Vol 3, Section 5.0.1; Vol 4, Section 7.0.1; Vol 5, Section 5.0.1 • WR 3483: SE-16 PUG - add explanation/instructions for converting 'seconds since epoch' to standard date/time PTRDOC-17995 DO.06.00.00 Vol 3, Table 5.3.2.5.1-11; Vol 4, Table 7.4.2.5.1-11. • WR 3438: SE-16 PUG - Fix Incorrect Flag Definition in EXIS Files - ADR 159 PTRDOC-18023 DO.06.00.00 Vol 5, Table 4.3.7-2. • WR 2291: SE-16 PUG - GRIP is not showing full SRB image on GOES WEST PTRDOC-18057 DO.05.00.00 Vol 3, Sections D.7, D.8 and D.9. • WR 3554: SE-16 PUG - Provide documentation for [CAL] INR data file structures (ABI, GLM, SUVI) PTRDOC-18090 DO.06.00.00 Vol 3, Section 5.1.4.1. • WR 3433: SE-16 PUG - Include pixels with under-saturated sample contributors in ABI Sample Outlier files PTRDOC-18144 DO.06.00.00 Vol 5, Table 5.1.7.6-2. • WR 3076: SE-16 PUG: DMW Output File is not CF Compliant-ADR 139 (PUG Changes)

REVISION	DATE	DESCRIPTION
		PTRDOC-18158 DO.06.00.00 Vol 3, Table 5.3.1.5-2; Vol 4, Table 7.4.1.5.2. • WR 3078: SE-16 PUG: EXIS - Add total number of valid SPS measurements used - ADR 148 PTRDOC-18191 DO.05.00.00 Vol 3, Table 5.3.1.5-2; Vol 4, Tables 7.4.1.5.1 and 7.4.1.5.2. • WR 3568: SE-16 PUG: Revise EXIS EUVS-C Cadence - ADR 183 (PUG Updates) PTRDOC-18225 DO.05.00.00 Vol 3, Sections D.4 and D.5. • WR 3324, 2989: SE-16 PUG - Update Documentation for MAG, SEISS CAL INR data file structures PTRDOC-18228 DO.06.00.00 Vol 3, Table 5.3.2.5-2; Vol 4, Table 7.4.2.5.2. • WR 3571: SE-16 PUG: Add SUVI roll angle to EXIS XRS - ADR 147 (PUG Changes) PTRDOC-18259 DO.06.00.00 Vol 5, Table 5.21.6-2. • WR 3222: SE-16 PUG - Land L2: FSC Metadata Issues-ADR 167 PTRDOC-18406 DO.06.00.00 Vol 3, Table 5.5.1.5-2; Vol 4, Tables 7.6.1.5.1 and 7.6.1.5.2. • WR 3429: SE-16 PUG - MAG Add IB and OB measurements in 4 coord frames-ADR 145 PTRDOC-18441 DO.04.04.00 Vol 3, Table 5.1.3.6.3-2; Vol 4, Table 7.1.3.6.1.1-2. • WR 3804: SE-16 PUG: Bad Radiance-to-Brightness-Temp Conversion Coeffs PTRDOC-18608 DO.04.04.00 Vol 5, Table A.2-1, Section E.1. • WR 1264: SE-16 PUG: Change DMW Intermediate Product Filename (Data Short Name) PTRDOC-18646 DO.05.00.00 Vol 3, Tables 5.3.1.5-2, 5.4.4.5-1, 5.4.4.5-2, 5.4.4.5.2-4 and 5.4.6.2-1; Vol 4, Tables 7.4.1.5.1, 7.4.1.5.2, 7.5.4.5.1, 7.5.4.5.1.2-4 and 7.5.4.5.2. • WR 3918: SE-16 PUG: Removing Hyphens in EXIS and SEIS Vars and Attrs-ADR 207

REVISION	DATE	DESCRIPTION
F	16 June 2017	PTRDOC-18154 DO.06.00.00 Vol 3, section 5.0.2; Vol 4, section 7.0.2; Vol 5, section 5.0.2 • WR 3725: SE-16 PUG - Add description of unsigned integer processing PTRDOC-18519 DO.06.00.00 Vol 3, Table 5.3.1.5-2, Table 5.4.4.5-2; Vol 5, Table 5.10.6-2 • WR 3897: SE-16 PUG: Variable missing from XRS and SGPS files- ADR 211 PTRDOC-18813 DO.06.00.00 Vol 3, Table 5.2.1.5.1-2, section 5.2.1.5.2, Table 5.2.1.5.4-5, Table 5.3.1.5-2, Table 5.3.1.5.2-7, Table 5.3.2.5-2, Table 5.3.2.5.1-15, Table 5.4.1.5-2, Table 5.4.1.5.2-9, Table 5.4.2.5-2, Table 5.4.2.5.2-5, Table 5.4.3.5-2, Table 5.4.3.5.2-6, Table 5.4.4.5-2, Table 5.4.4.5.2-6, Table 5.5.1.5-2, Table 5.5.1.5.2-3; Vol 4, Table 7.3.1.5.1.2-8, Table 7.3.1.5.2, Table 7.4.1.5.1.2-7, Table 7.4.1.5.2, Table 7.4.2.5.1.1-15, Table 7.4.2.5.2, Table 7.5.1.5.1.2-9, Table 7.5.1.5.2, Table 7.5.2.5.1.2-5, Table 7.5.2.5.2, Table 7.5.3.5.1.2-6, Table 7.5.3.5.2, Table 7.5.4.5.1.2-6, Table 7.5.4.5.2, Table 7.6.1.5.1.2-3, Table 7.6.1.5.2 • WR 4164: SE-16 PUG: Space weather eclipse_flag flags do not capture all possible states PTRDOC-18819 DO.06.00.00 Vol 4, section 4.1, section 4.3 • WR 4139: SE-16 PUG: GRB Default Modem Configuration - QPSK PTRDOC-18879 DO.06.00.00 Vol 4, section 2.0, section 5.0, section 6.0, section 6.2.6.3, section 7.1.3.6, section 7.3.1.5 • WR 4179: SE-16 PUG: ABI L1b metadata sent prior to end of scene in GRB PTRDOC-18890 DO.06.00.00 Vol 4, Table A • WR 3511: SE-16 PUG: Add statement on CCSDS reserved APIDs to the PUG PTRDOC-18907 DO.06.00.00 Vol 3, section 5.3.1.1; Vol 4, section 7.4.1.1 • WR 3257: SE-16 PUG: Resolve Time Stamp Error in EXIS Files-ADR 158 PTRDOC-18910 DO.06.00.00 Vol 3, Table 5.3.1.5-2; Vol 4, Table 7.4.1.5.1, Table 7.4.1.5.2

REVISION	DATE	DESCRIPTION
		• WR 4205: SE-16 PUG: EXIS EUVS long name corrections-ADR278 PTRDOC-18951 DO.06.00.00 Vol 3, Table 5.6.2.2-1 • WR 3407: SE-16 PUG: GLM Background Image Metadata Differences from PUG PTRDOC-18955 DO.06.00.00 Vol 1 – 5, Appendix X, several sections and tables • WR 4263: BCR_591 ATP for ECP-029, SE-16: ECP-029 - Update Product Users Guide (PUG) for Mode 6 functionality PTRDOC-19131 DO.07.00.00 Vol 3, Table 5.2.1.1-1, Table 5.2.1.5.3-1, Table 5.2.1.5.4-2, Table A.1; Vol 4, Table 7.3.1.1-1, Table 7.3.1.5.1.1-1, Table 7.3.1.5.1.2-2 • WR 4023: SE-16 PUG: SUVI short exposure time - Long term fix - ADR 199 PTRDOC-19350 DO.06.00.00 Vol 3, Table 5.3.1.5.2-3, Table 5.3.2.5.1-3; Vol 4, Table 7.4.1.5.1.2-3, Table 7.4.2.5.1.1-3 • WR 4540: SE-16 PUG: EUVS and EXIS Processing and Data Quality Flag Meanings
F.1	29 November 2017	PTRDOC-19542 DO.06.00.00 Vol 5, Table 4.3.6, Table 4.3.7-2, Table 4.3.7-3 • WR 4182: SE-16 PUG: Displaced full disk Radiation data, Displaced CONUS radiation data - ADR 241, 242 PTRDOC-18158 DO.06.00.00 Vol 3, Table 5.3.1.5-2; Vol 4, Table 7.4.1.5.1; Vol 4, Table 7.4.1.5.2 • WR 3078: SE-16 PUG: EXIS - Add total number of valid SPS measurements used - ADR 148 PTRDOC-19760 DO.06.00.00 Vol 3, Table D.6-1 • WR 4709: SE-16 PUG: Incorporate GLM CalINR Tech Memo Rev A Changes (GLM CDRL-79 Rev H) PTRDOC-20567 DO.06.00.00 Vol 3, Table D.2-1 • WR 3812: SE-16 PUG: Incorporate SUVI CalINR Tech Memo Changes - SUVI CDRL-80 Rev G PTRDOC-18521 DO.06.00.00 Vol 4, Section 4.4.2.1; Vol 4, Figure 4.4.2.1 • WR 3904: SE-16 PUG: GRB primary header SCID mismatch with SANA registry and PUG

REVISION	DATE	DESCRIPTION
		PTRDOC-19877 DO.06.00.00 Vol 4, Table 7.2.1.6.2; Vol 5, Table 5.26.6-2 • WR 2691: SE-16 PUG: Abnormally large group areas in GLM L2+ products PTRDOC-19295 DO.06.00.00 Vol 5, Table 5.1.6.3-2 • WR 4466: SE-16 PUG: No downscaling method given in multiband CMI files - ADR 262

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1.0 INTRODUCTION

1.1 Scope

The Product Definition and User's Guide (PUG) document provides product descriptions and formats for all data and products produced and made available to users by the Geostationary Operational Environmental Satellite R Series (GOES-R) Core Ground Segment (GS), developed under contract DG133E-09-CN-0094. This includes the Level 0 products, Level 1b products, GOES-R Rebroadcast (GRB), and Level 2+ products. This also includes ISO series metadata, instrument calibration data, and semi-static source data and algorithm packages.

The PUG is divided into five volumes. This volume, Volume 3: Level 1B Products, contains Level 1b product and data descriptions, and content and format information. Note that there is a separate standalone Appendix X containing detailed descriptions of the ISO series metadata associated with Level 1b products and data.

1.2 Document Overview

The purpose of this volume is to describe the functional characteristics, and content and format of GOES-R Level 1b products and data made available to users. The intent of providing this information is to allow users to exploit the products and data. This document also supports Government remote tele-training and public outreach requirements.

This Level 1b PUG volume includes the following sections:

- Instrument Overview
- Level 1b Products and Data Overview
- Common Level 1b Product and Data Characteristics
- Level 1b Product and Data Descriptions
- Level 1b Filename Conventions
- Level 1b Product Refresh Rates and Latencies
- Instrument Engineering Telemetry Parameters and Units

2.0 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 Advanced Baseline Imager (ABI), Geostationary Lightning Mapper (GLM), Extreme Ultra-Violet and X-Ray Irradiance Sensors (EXIS), Solar Ultraviolet Imager (SUVI), Space Environment In-Situ Suite (SEISS), and Magnetometer.

The ABI instrument is a multi-spectral channel, two-axis scanning radiometer designed to provide radiometrically calibrated and geolocated observations of the Earth. ABI bands 1-6 measure solar reflected radiance at visible and near-infrared wavelengths, and bands 7-16 measure emitted radiance from the sources at infrared wavelengths. 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 using three standard geographic coverage regions: Full Disk, Continental United States (CONUS), and Mesoscale. The ABI utilizes the concepts of scenes and timelines in defining its scanner operations.

The Full Disk is defined as a circle, with a 17.4 degree angular diameter from the perspective of the ABI centered at the instrument's nadir that reaches the Earth's limb. Overscan is required to deal with the non-ideal orbit and image motion compensation. CONUS is defined as a nadir-viewed rectangle 8.0215 x 4.8129 degrees, approximately 5000 E/W x 3000 North/South kilometers, 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, approximately 1000 x 1000 kilometer region. Full Disk images are generated in ABI scanning Mode 3, Mode 6 and Mode 4, while Mesoscale and CONUS images are only generated in ABI scanning Mode 3 and Mode 6. Note that CONUS images are extracted from Full Disk images in Mode 4 for distribution to PDA.

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 to acquire 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 16-37 nm (1.4 nm resolution), 115-135 nm (1.3 nm resolution) and 275-285 nm (0.2 nm resolution). From these, a reconstruction of the full spectrum between 5 and 127 nm will be possible.

XRS: X-ray Sensor consists of three photodiode-based photometer channels, two active (A and B) and one inactive. Channel A covers 0.05-0.4 nm and channel B covers 0.1-0.8 nm. The "dark" diode channel allows background subtraction. All active channels view the sun through two Beryllium (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 Magnetometer instrument provides three orthogonal measurements of the geomagnetic field in space at a refresh rate of at least 0.5 seconds, a dynamic range of ±512 nT in each of the three orthogonal axes, and field measurements 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 solar emissions.

3.0 LEVEL 1B PRODUCTS AND DATA OVERVIEW

All Level 1b products represent calibrated measurements expressed in terms of physical units that are generated from L0 observation data during ground processing. The Level 1b products contain the information that locate their constituent data in space and time.

The ABI Level 1b Radiance product is computed from Level 0 instrument detector samples that are resampled to pixels on the ABI fixed grid. The ABI fixed grid is a projection relative to the ideal location of a satellite in geostationary orbit. This is a change from the previous generation GOES Level 1 earth imagery enabling the product's image data to be geospatially normalized.

Instances of an ABI Level 1b Radiances product contain different areas of earth coverage. The standard coverage regions are defined in Table 3.0, Radiances Product Standard Coverage Regions.

Table 3.0 Radiances Product Standard Coverage Regions

Coverage Region	Description
Full Disk	Near hemispheric earth region centered at the longitude of the sensing satellite.
CONUS	An approximately 3000 km x 5000 km region intended to cover the continental United States within the constraints of viewing angle from the sensing satellite.
Mesoscale	An approximately 1000 km x 1000 km dynamically centered region in the instrument's field of regard. The particular coverage region associated with a mesoscale product is operator- selected to support high-rate temporal analysis of environmental conditions in regions of interest.

The GLM Level 1b product, which is composed of valid radiometrically corrected and navigated high energy lightning events is not distributed to users standalone. Only the GLM Level 2+ product that contains the Level 1b high energy lightning events, and the derived lightning detection product data is made available to users.

All the Level 1b products contain product-level metadata that is useful in interpreting the processed observation data, and verifying its integrity and that of the sensing instrument. The Level 1b products also contain product-level metadata that can be used for cataloguing, such as formal product name, geographic coverage area in the case of the Radiances product, sensing period, resolution, data source related information, and search keywords, and error information.

The Level 1b products are in two forms using two different distribution mechanisms. netCDF-4 formatted products for all the Level 1b product are available from the NOAA Product Distribution and Access (PDA) system. In addition, a FITS formatted Level 1b SUVI Solar Imagery: EUV product file is also available. In addition, a CCSDS space packet form of the Level 1b products is broadcast via GRB.

ABI sample outlier data files are generated as part of Level 1b processing. These data files contain the pixel and the source ABI sample identity and values for pixels whose values are not in the valid range.

Instrument calibration data files are generated. These data files contain one or more of downlinked science telemetry obtained from instrument-specific calibration targets, instrument engineering telemetry, parameters used to radiometrically correct Level 0 data, and ephemeris and attitude data received from the satellite. Some calibration targets are integrated into an instrument, such as an internal calibrated black body, a solar reflectance target or an intrinsic light source. Other calibration targets are external sources that are within the field of regard of an instrument, such as the sun, moon, stars or space. Data files containing instrument engineering telemetry are generated for all the instruments.

The GOES-R imagers, ABI and SUVI, perform independent calibration tasks interleaved with operational observations as part of their nominal sensing cadence. In the case of the ABI, there are four types of calibration data generated: Infrared Calibration Target (ICT) looks, space looks, Solar Calibration Target (SCT) looks, and lunar scans. ICT and associated space look observation data are used to compute detector gain coefficients for each of the ABI emissive bands. SCT and associated space look observation data are used to compute detector gain coefficients for ABI reflective bands. Lunar scans are collected as part of an ABI Mode 3 or Mode 6 timeline when the moon is in the field of regard of the instrument. The coverage area is equivalent to a mesoscale scene, and consists of two swaths.

Similarly, there are unique instrument calibration data files associated with the other instruments. In the case of the SUVI, dark frames, which are observations made with the shutter closed, measure the thermal energy of the imaging CCD, and are interleaved with the operational observations. Additionally, there are several other types of calibration frames collected when the SUVI is on-line and off-line. Examples include flat-field, bias, leak test, and focus calibration images. For the SEISS, there are parameters calculated during Level 1b processing to radiometrically correct the Level 0 data. In addition, for the Magnetometer, there are raw magnetic field measurements collected during calibration maneuvers. Furthermore, the GLM generates a background image periodically, interleaved with the detection of events in support of detecting false events, and instrument calibration.

Level 1b semi-static source data and algorithm package files are made available. These are the data processing and instrument-specific configuration parameters, and source software code, that are used during the generation of Level 1b products.

For each Level 1b product, ABI sample outlier data, instrument calibration data, Level 1b semi-static source data, and Level 1b algorithm packages, metadata is provided in an ISO-compliant XML product series (i.e., collection) level file. This metadata is in addition to the embedded native metadata existing in the GOES-R product and data files that is used to discover, display, exploit and further process the data. The ISO series metadata contains a set of "quasi-static" metadata elements that describe a collection of instances of a product or data. Their format, content, and citations to documents and points of contact are provided. Note that a complete ISO metadata record is produced by combining the series metadata with metadata in the product and data files using the ncISO functionality available at the NOAA Data Centers.

The detailed descriptions of the ISO series metadata for GOES-R Level 1b products and data are located in Appendix X, GOES-R ISO Series Metadata. This is a special standalone appendix to the PUG. This appendix includes a table of contents with a paragraph reference to each ISO series metadata file.

4.0 LEVEL 1B PRODUCT AND DATA CHARACTERISTICS

The Level 1b products and data other than the related ISO series metadata and semi-static source data are output using the Network Common Data Format version 4 (netCDF-4) file format. In addition, the Level 1b SUVI Solar Imagery: EUV is also output using the Flexible Image Transport System (FITS) file format.

The netCDF Level 1b products and data conform to Unidata's Attribute Conventions for Data Discovery (ACDD). Unidata's ACDD are identified and described in the main volume of the PUG. Conforming to this set of conventions facilitates cataloguing product files with information contained in the product files.

The netCDF ABI Level 1b product, Radiances, conforms to the Climate and Forecast (CF) Metadata Conventions. The CF Metadata Conventions, and how these conventions are applied to the Radiances product are described in the main volume of the PUG. Conforming to the CF Metadata Conventions allow the product file to be self-describing.

The Level 1b SUVI Solar Imagery: EUV product file conforms to the FITS standard. The FITS standard is a file format, and also includes application keyword and keyword value conventions for the metadata required to fully interpret the product data.

The Level 1b products other than Radiances make use of flag variables. These products conform to the CF Metadata Conventions for flag variables. These flag variable conventions are described in the main volume of the PUG.

5.0 LEVEL 1B PRODUCT AND DATA DESCRIPTIONS

This section of the document describes, and defines the detailed content and format of the GOES-R Level 1b product and data files.

The Level 1b products include a metadata field identifying the percentage of product data lost due to uncorrectable Level 0 data errors. This metadata field is not specifically discussed in the product description paragraphs.

There are two variable attributes that denote versions – product_version and algorithm_version. These attributes are independent of each other. Algorithm version will always increment when a new algorithm version is installed. Product version will also increment for a new algorithm, but may also increment due to a change to a product that is not an algorithm update.

Tables are used to communicate the detailed content. For each type of netCDF product and data file, one table defines their global attributes. Another table defines their variables and their variables' attributes. By default, in the product tables included in the volume, the values of the variables are dynamic and the values of the attributes are static. However, there are situations when an attribute value is selected from a list of valid values, has a fixed format, or is a dynamic value. Furthermore, there are situations where a variable or attribute value contains spatial coordinates, dimensioning information related to coverage areas and resolution, band dependent values, or flag values. For all these cases, ***bold italic text*** is used to convey how to properly interpret what the value of the variable or attribute should be.

5.0.1 Time Representation and Conversion

Products and data files described in this volume contain time and time-related variables that represent the seconds since J2000 (J2K) epoch (2000-01-01 12:00:00 UTC). Below are three methods that can be used to convert the "seconds since J2000 epoch" value into a standard calendar date and time. The following URL contains numerous other methods that are used in various computer languages (e.g., C, Perl, Python):

http://www.epochconverter.com.

Let "SSE" represent the value of "seconds since J2000 epoch".

Microsoft Excel conversion:

1. Enter into cell A1: =DATE(2000,1,1) + TIME(12,0,0)
2. Enter into cell A2: =SSE/24/3600
3. Enter into cell A3: =A2+A1
4. Change the format of cell A3 as desired (e.g., Format Cells > Number > Category:Date, Type:choose format)

IDL conversion:

1. epoch = julday(1,1,2000,12,0,0)
2. CALDAT, epoch + SSE, month, day, year, hour, minute, second
3. time_format = '(I04,"-",I02,"-",I02,"T",I02,":",I02,":",I02,"Z")'
4. print, year, month, day, hour, minute, second, FORMAT=time_format

Linux workstation conversion:

1. Add 946,728,000 to SSE (946,728,000 is the difference in seconds between J2000 epoch and the UNIX epoch (1/1/1970):

a. SUM=$((946728000 + SSE))

2. Enter on the command line:

a. date -u -d @${SUM}

Note: this method may not work after January 19, 2038, which is the largest date the linux "date" command can support on some machines.

5.0.2 Unsigned Integer Processing

The classic model for netCDF (used by the GS) does not support unsigned integers larger than 8 bits. Many of the variables in GOES-R netCDF files are unsigned integers of 16-bit or 32-bit length. The following process is recommended to convert these unsigned integers:

1. Retrieve the variable data from the netCDF file.
2. For this variable, retrieve the attribute "_Unsigned".
3. If the "_Unsigned" attribute is set to "true" or "True", then cast the variable data to be unsigned.

The steps above must be completed before applying the scale_factor and add_offset values to convert from scaled integer to science units. Also, the valid_range and _FillValue attribute values are to be governed by the "_Unsigned" attribute.

5.1 ABI Level 1b Product and Data

5.1.1 ABI Modes

There are three standard scanning modes for the ABI instrument: Mode 3, Mode 6 and Mode 4. Mode 4 consists of the observation of the Full Disk scene every five minutes. Mode 3 consists of one observation of the Full Disk scene of the earth, three observations of the continental United States (CONUS) scene, and thirty observations for each of two distinct mesoscale scenes every fifteen minutes during nominal operations. Mode 6 consists of one observation of the Full Disk scene of the earth, two observations of the continental United States (CONUS) scene, and twenty observations for each of two distinct mesoscale scenes every ten minutes, during nominal operations. The CONUS scene coverage area is approximately 5000 km in the east-west direction by 3000 km in the north-south direction. The coverage area of a mesoscale scene is approximately 1000 km by 1000 km. In all of these modes, there are interleaved space, blackbody, and star looks to support radiometric and navigation accuracy requirements.

The detailed sensing timelines for the ABI in Mode 3, 4, and 6 are defined in Figures 5.1.1-1, 5.1.1-2 and Figure 5.1.1-3, respectively. Space Looks needed for data calibration may occur after a Full Disk swath rather than before it depending on whether the Space Look occurs on the East or West side of the earth. Observations of the Full Disk (pink), CONUS (blue), and mesoscale (green) scenes, and the calibration looks (yellow: visible stars, red: infrared stars) are shown.

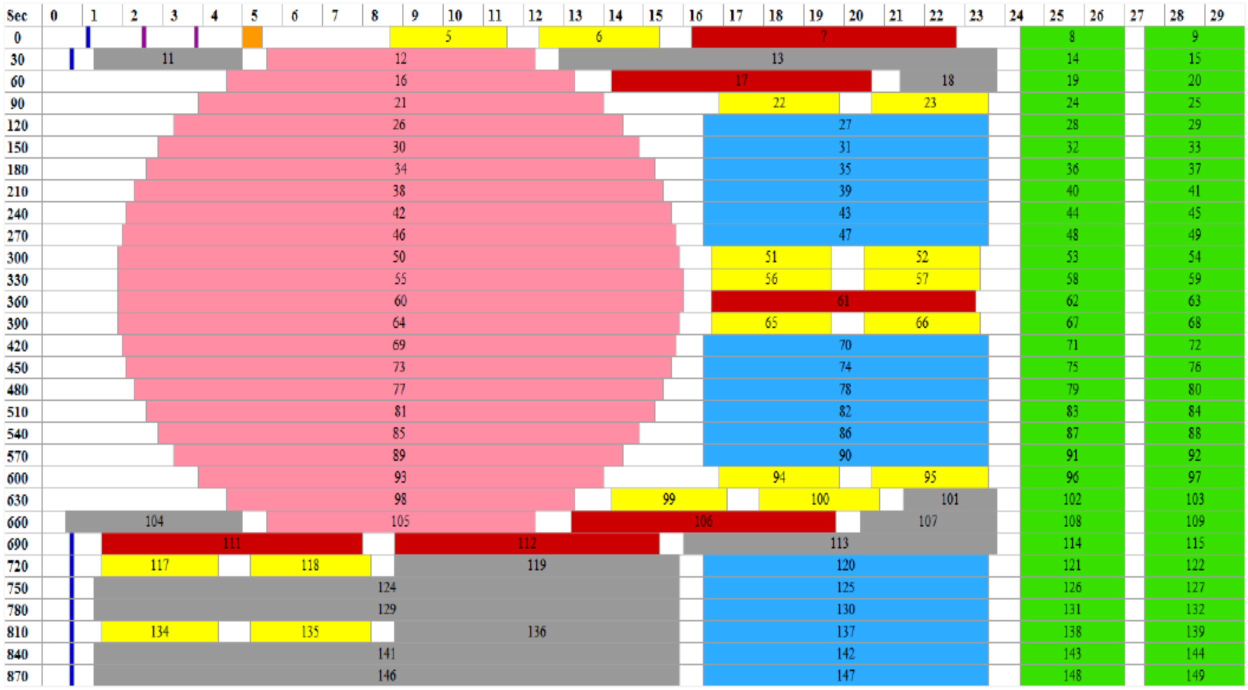

Figure 5.1.1-1 ABI Mode 3 Timeline

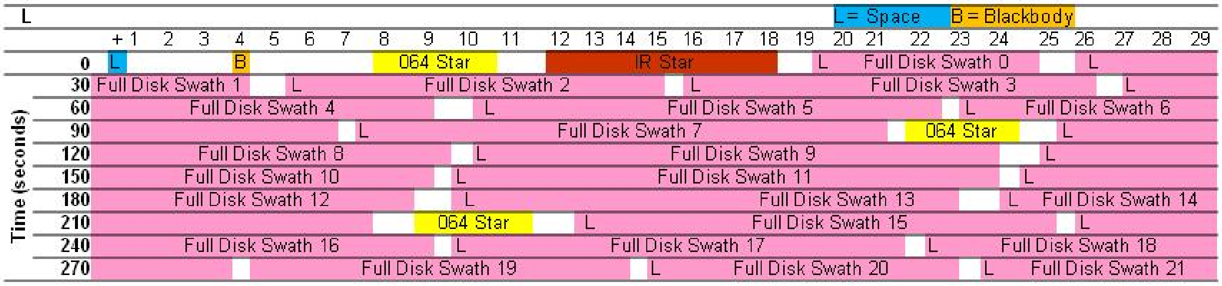

Figure 5.1.1-2 ABI Mode 4 Timeline

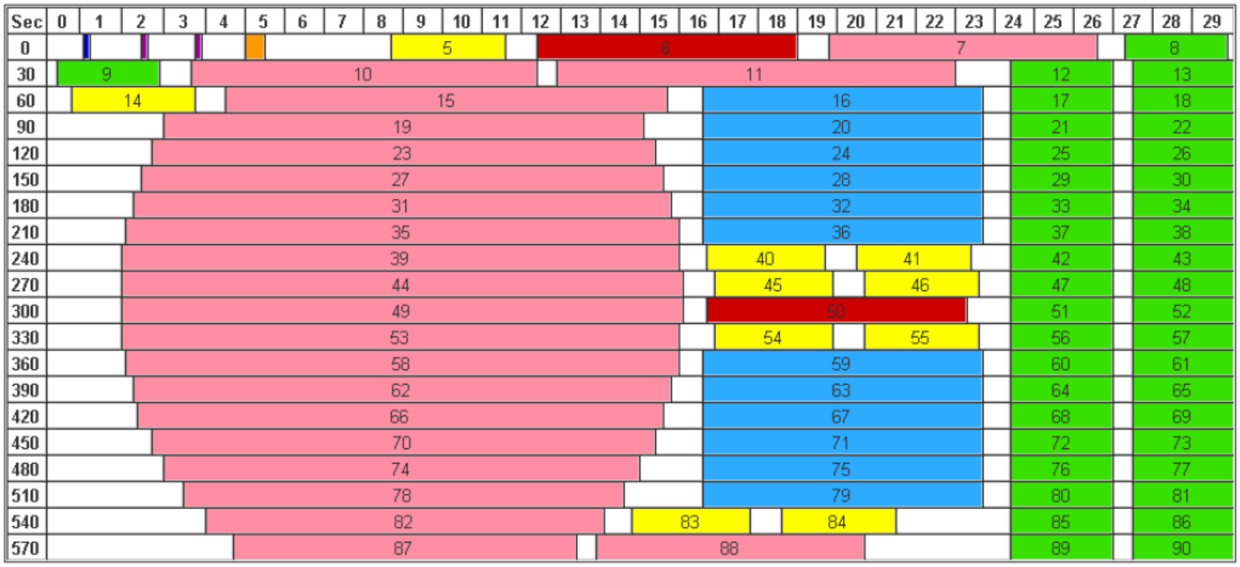

Figure 5.1.1-3 ABI Mode 6 Timeline

The Mode 3 fifteen minute timeline consists of 22 swaths to cover the Full Disk, 3 sets of 6 swaths to cover the CONUS 3 times, and 30 sets of 2 swaths to cover the Mesoscale regions 30 times. White space in the diagram represents periods of time when the instrument is not actively scanning or making calibration measurements. During Mode 4, the Full Disk is covered once with 22 swaths with the instrument actively scanning or making calibration measurements much of the time. The Mode 6 ten minute timeline consists of 22 swaths to cover the Full Disk, 2 sets of 6 swaths to cover the CONUS 2 times, and 20 sets of 2 swaths to cover the Mesoscale regions 20 times.

5.1.2 ABI Fixed Grid

The ABI fixed grid is the projection associated with the data in the ABI Level 1b Radiances products, and all the ABI Level 2+ products except for the Derived Motion Winds, Hurricane Intensity, Downward Shortwave Radiation: Surface, and Reflected Shortwave Radiation: Top-Of-Atmosphere products.

This paragraph includes the following subordinate paragraphs:

- Description
- Coordinate System
- Coverage Area Associated with the Full Disk, CONUS, and Mesoscale Images
- Horizontal Spatial Resolutions
- Data Point Coordinates
- Product Data Structures
- Standard Coordinate Data
- Navigation of Image Data

- Overlaying Data from Different Image Types

5.1.2.1 Description

The data points in the GOES-R ABI Level 1b and the ABI Level 2+ imagery products are on the ABI fixed grid. The ABI fixed grid is a projection based on the viewing perspective of the idealized location of a satellite in geosynchronous orbit. This allows the same data points in every product to be at the same location on the earth. All of the dynamics associated with an orbiting satellite are removed from the data to accomplish this. GOES-R ground system product processing functionality receives raw data from the ABI instrument and performs the processing required to place the data points on the ABI fixed grid.

The fixed grid is rectified to a GRS80 ellipsoid viewed from the idealized geostationary position. This defines the ellipsoid parameters to use when geo-referencing data points on the fixed grid. Data points are defined out to the edge of the earth's limb as defined by the GRS80 ellipsoid.

Data points at a particular horizontal spatial resolution on the fixed grid have the same angular separation from the satellite's viewing perspective in both east to west and north to south directions. Refer to Figure 5.1.2.1.

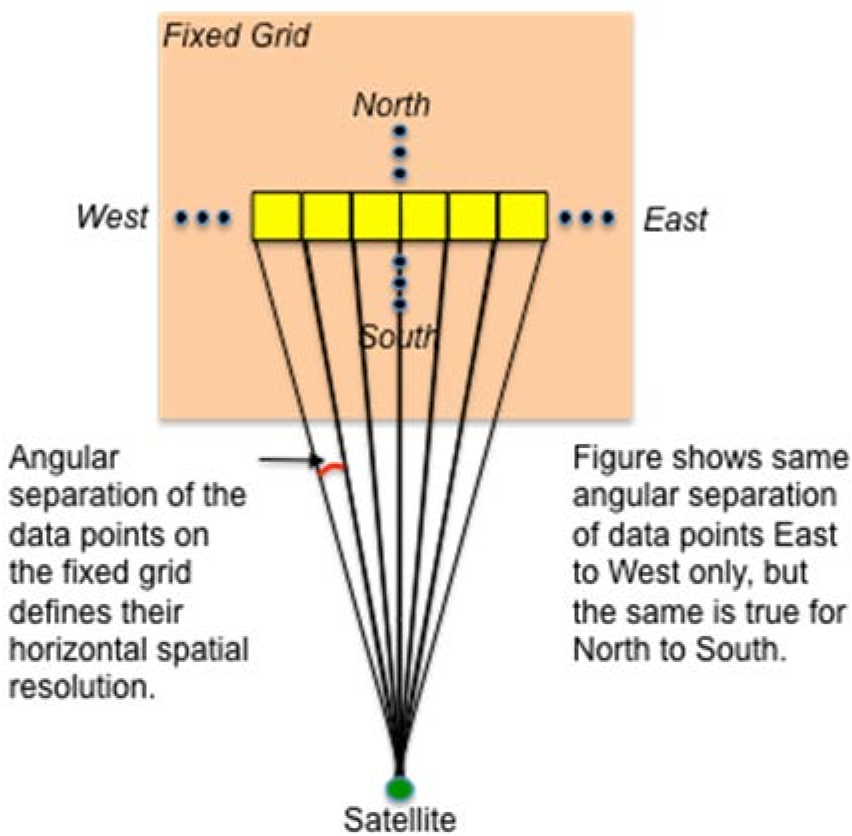

Figure 5.1.2.1Data Points Have The Same Angular Separation On The Fixed Grid

The angular separation of the data points on the fixed grid provides the basis for the spatial resolution of the imagery data points, and is used to determine their coordinates. From the viewpoint of a right-hand coordinate system of the idealized geostationary satellite with the x-axis in the direction of the satellite velocity and the z-axis pointed at nadir, the north to south angle (i.e., N/S elevation angle) is determined by a rotation about the x-axis. The east to west angle (i.e., E/W scanning angle) is determined by a rotation about the rotated y-axis. Note that the earth surface area covered by a data point at a specific horizontal spatial resolution increases as the distance from the satellite's nadir increases.

5.1.2.2 Coordinate System

The ABI fixed grid is expressed in terms of the Cartesian coordinate system. The x axis represents the ABI E/W scan angle, i.e., the east-to-west direction. The y axis represents the ABI N/S scan angle, i.e., the north-to-south direction. The origin of the fixed grid represents the satellite sub-point which, by definition, is at the coordinate, (y = 0, x = 0). Refer to Figure 5.1.2.2-1, ABI Fixed Grid Coordinate System.

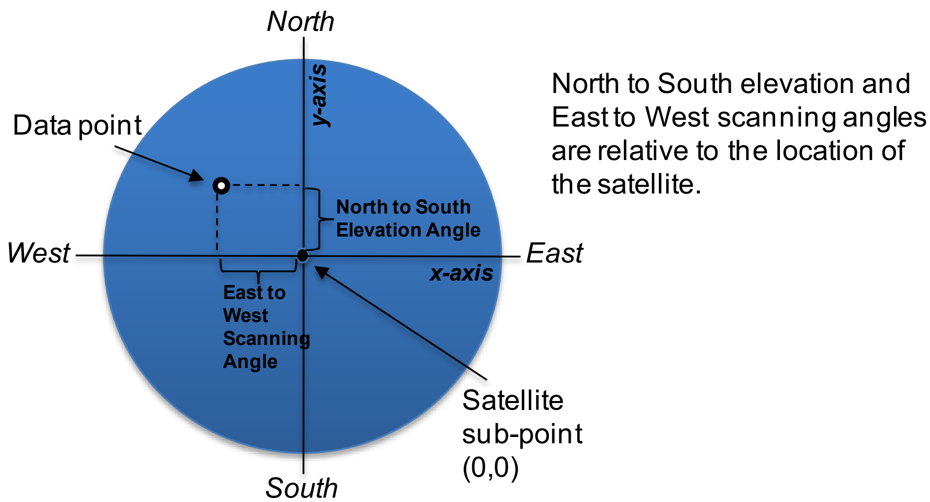

Figure 5.1.2.2-1 ABI Fixed Grid Coordinate System

The ABI native spatial resolutions are 0.5, 1.0, and 2.0 km at nadir. The radian is the standard unit of measure of the fixed grid. It is used to express the angular separation between imagery data points, which are 14, 28, and 56 microradians. For the ABI L2+ products that have reduced resolution (i.e., coarser distance between data points), the analogous spatial resolutions and angular separations apply. For example, ABI L2+ products with a spatial resolution of 10 km at nadir have data points with an angular separation of 280 microradians.

The ABI fixed grid coordinate system dictates that the ideal satellite sub-point is located at the corner of four imagery data points for the ABI native resolutions. Refer to Figure 5.1.2.2-2.

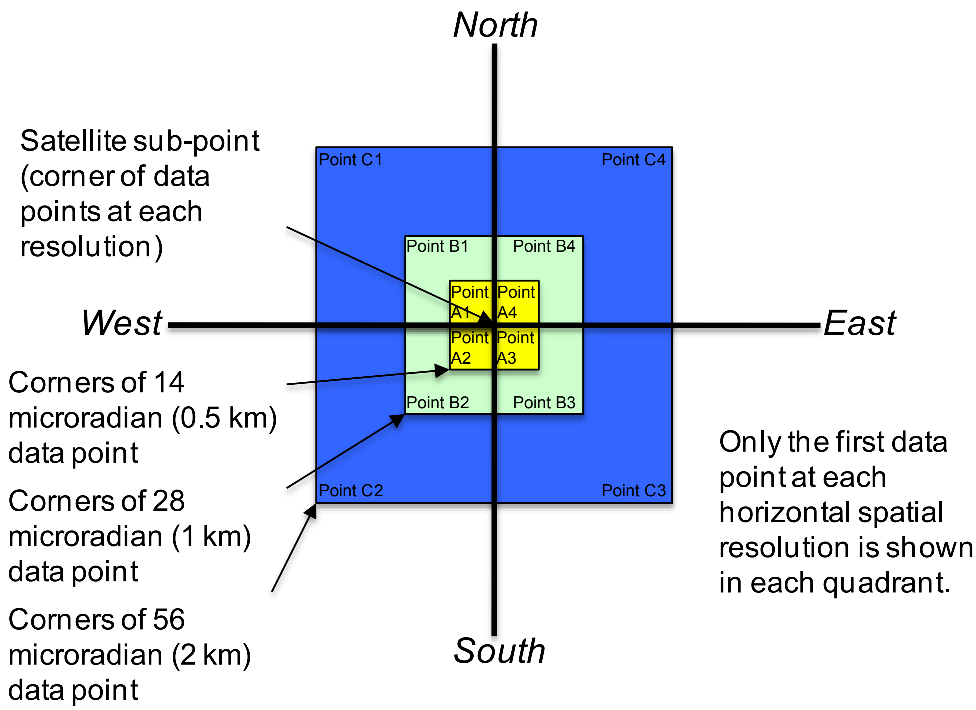

Figure 5.1.2.2-2 Fixed Grid Data Point Locations Relative to the Satellite Sub-Point

A 2 km data point subsumes four 1 km data points exactly. A 1 km data point subsumes four 0.5 km data points exactly. Refer to Figure 5.1.2.2-3. Note that for each of the Full Disk, CONUS, and mesoscale products, this relationship holds true when the lower resolution data is a multiple of the higher resolution data.

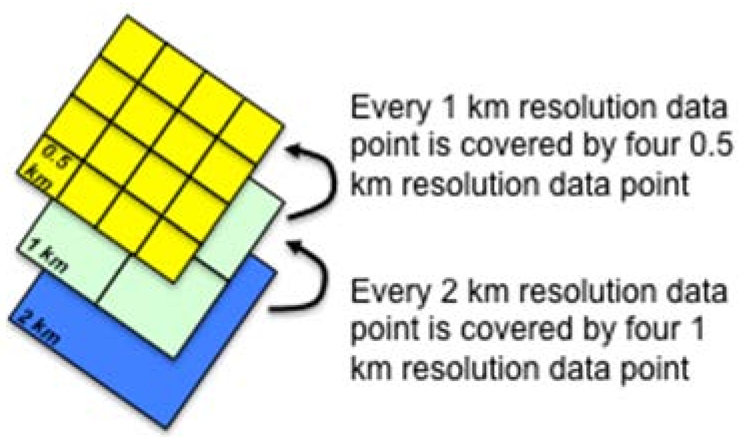

Figure 5.1.2.2-3 Relationship Between Data Points at Different Resolutions

ABI fixed grid imagery data points can be located on the earth. Knowing the (1) satellite sub-point longitude, (2) horizontal spatial resolution of the imagery data, (3) distance of the ideal geostationary satellite location from the earth, and (4) the selected earth model (GRS80) allows the location on the earth of each data point on the fixed grid to be determined.

5.1.2.3 Coverage Regions Associated with the Full Disk, CONUS, and Mesoscale Images

The coverage associated with the ABI images is defined in terms of the viewing angle of the earth from the satellite perspective. Note that the term "scene" is used to communicate what the ABI instrument observes. The term, "image," is used to communicate the product data resulting from the scene. Refer to Figure 5.1.2.3.

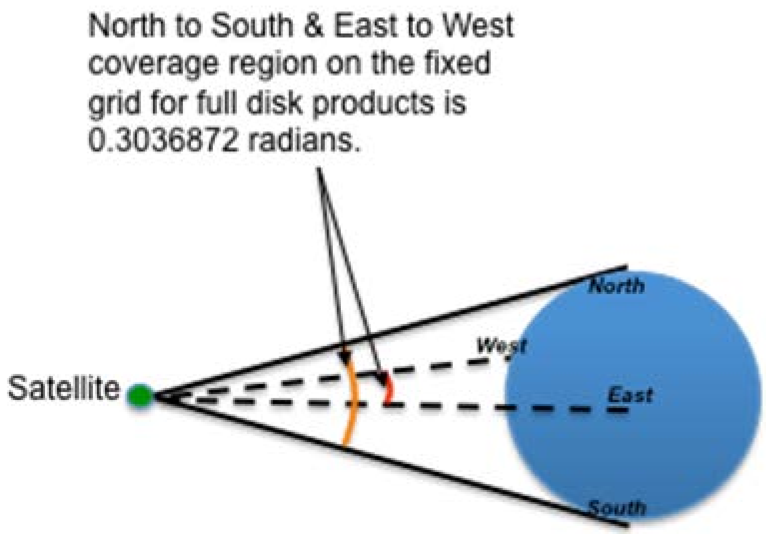

Figure 5.1.2.3 ABI Coverage Regions are Defined In Terms of Viewing Angle From The Satellite's Perspective

The coverage of the Full Disk L1b product consists of those pixels whose centers fall within the GRS80 Earth Ellipse. The maximum East to West and North to South extent of the GRS80 ellipse is shown in Table 5.1.2.3-1. Note that the center of the Full Disk image is the satellite sub-point.

Table 5.1.2.3-1 Full Disk Image Coverage Region

East to West Coverage Extent	0.303704160 radians
North to South Coverage Extent	0.302701402 radians

Table 5.1.2.3-2 defines the coverage region for a CONUS image.

Table 5.1.2.3-2 CONUS Image Coverage Region

East to West Coverage Extent	0.14 radians
North to South Coverage Extent	0.084 radians

Table 5.1.2.3-3, Table 5.1.2.3-4 and Table 5.1.2.3-5 define the precise location of the center of the CONUS regions sensed by the ABI for the GOES-R East, West and Test satellite orbital slots at 75 degrees, 137 degrees and 89.5 degrees west longitude. Note that a negative fixed grid coordinate indicates a data point that is either west or south of the satellite sub-point.

Table 5.1.2.3-3 GOES-R East CONUS Image Center

East to West Image Offset from Satellite Sub-point	-0.031360 radians
North to South Image Offset from Satellite Sub-point	0.086240 radians

Table 5.1.2.3-4 GOES-R West CONUS Image Center

East to West Image Offset from Satellite Sub-point	0.000000 radians
North to South Image Offset from Satellite Sub-point	0.086240 radians

Table 5.1.2.3-5 GOES-R Test CONUS Image Center

East to West Image Offset from Satellite Sub-point	-0.005040 radians
North to South Image Offset from Satellite Sub-point	0.084560 radians

Table 5.1.2.3-6 defines the coverage region for a mesoscale image. The mesoscale coverage region extents are relative to the center of the mesoscale image. The center of a mesoscale image is selected during operations based on weather conditions in the ABI's field of regard.

Table 5.1.2.3-6 Mesoscale Image Coverage Region

East to West Coverage Extent	0.028 radians
North to South Coverage Extent	0.028 radians

Note that the center of each CONUS image and mesoscale image is adjusted to the image corner that is nearest to the fixed grid data point.

5.1.2.4 Horizontal Spatial Resolutions

The GOES-R ground system outputs ABI Level 1b and ABI Level 2+ imagery products on the ABI fixed grid at several horizontal spatial resolutions. Table 5.1.2.4 identifies the set of horizontal spatial resolutions associated with the different types of products. Note that the horizontal spatial resolutions are specified in terms of resolution in kilometers at nadir, and angular resolution as defined above.

Table 5.1.2.4 Horizontal Spatial Resolution

ABI L1b/GRB	ABI L2+	Horizontal Spatial Resolution	
		At Nadir	Angular
applicable	*applicable*	0.5 km	14 µrad
		1.0 km	28 µrad
		2.0 km	56 µrad
not applicable		4.0 km	112 µrad
		10.0 km	280 µrad

5.1.2.5 Data Point Coordinates

An imagery data point on the ABI fixed grid is associated with an area on or above the surface of the earth. For example, a data point with a horizontal spatial resolution of 2 km at nadir is associated with a 4 square kilometer area. By convention, a data point is located at the center of this area with its coordinates expressed in terms of its angular resolution. For example, the center of a 2 km data point, which has an angular resolution of 56 microradians in both N/S elevation angle and E/W scanning angle, is 28 microradians from its edges. Refer to Figure 5.1.2.5.

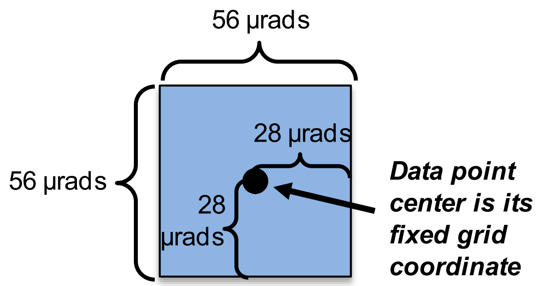

Figure 5.1.2.5 Example: Center of 2 km Data Point

A data point is populated with observed data if its center is on-earth and in the ABI's field of regard. In the case of the lower resolution, non-native resolutions, 4 and 10 km, a data point is populated with observed data if the center of at least one constituent 2 km pixel is on-earth and in the ABI's field of regard.

5.1.2.6 Product Data Structures

In the preceding paragraphs that discussed the ABI fixed grid, the specification of its coordinate system, and the size and location of its data points have been defined. This paragraph defines how this information is captured in the ABI Level 1b and ABI Level 2+ imagery products.

The ABI Level 1b and ABI Level 2+ products are stored in netCDF version 4 product files. netCDF includes constructs to define scalar and multi-dimensional data, along with the associated metadata. netCDF variables are used to store scalar and multi-dimensional data. Metadata can be stored using either netCDF variables or attributes. The Climate and Forecast (CF) Metadata Conventions are applied to make the ABI Level 1b and ABI Level 2+ products self-describing. This standard includes requirements that allow the data to be located in space and time, as well as the semantics of the data to be captured in the product file.

For Full Disk products, the netCDF variables used to house the values for data points on the fixed grid define a rectangular region that encompasses the elliptical earth. Note that fill values are used for off-earth and missing data points. Refer to Figure 5.1.2.6-1.

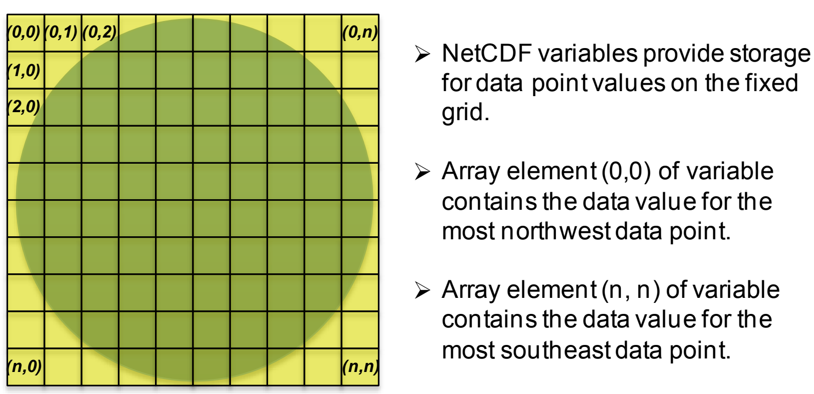

Figure 5.1.2.6-1 Storing Data Point Values For Full Disk Image in a Variable

CONUS and mesoscale images are stored in a similar manner.

When netCDF values for data points are reported for single levels in the atmosphere, the variable has two dimensions, with array element (0, 0) being the most northwest data point and array element (n,n) being the most southeast data point. Note that the first element of an array element represents the fixed grid y-axis, while the second element represents the fixed grid x-axis, i.e., (n_y,n_x).

When netCDF data values are reported for multiple levels in the atmosphere, the data variable has three dimensions. The data variable subscripting is in the form (y, x, z) where z provides the dimension to store multiple values at the same location on the fixed grid.

In addition to the netCDF variables containing the data, there are coordinate variables in the product file. Coordinate variables, which are a CF metadata convention construct, provide the means to locate the data in space and time. Coordinate variables are required for the time, and the location along the y and x axes. The CF metadata conventions dictate that the coordinate variable names be the same as the corresponding dimension names. The values of data elements in the y and x coordinate variables are the ABI fixed grid coordinates - the N/S elevation angle and the E/W scanning elevation angle, respectively. Note that scaled integers as defined in the netCDF Users Guide are used for the y and x axis coordinate variables. The coordinate variable value in the product file is multiplied by the attached attribute scale_factor and then summed with the add_offset to obtain the ABI fixed grid coordinate in radians. The y and x coordinate variables are one-dimensional. The dimension of the y coordinate variable is the same as the y dimension in the data variable. The same is true for the x coordinate variable. This allows specific data points in the data variable to be associated with their ABI fixed grid coordinates. Refer to Figure 5.1.2.6-2.

In the GRB form of the ABI Level 1b Radiances product, the y- and x-coordinate variables, which are included in the Generic Payload containing the product metadata, are not populated. In this case, the y- and x-coordinate variables can be determined using the upper left y- and x-coordinates of the data points in the image, along with the image block height field and the image block width field contained in the Image Payload Header.

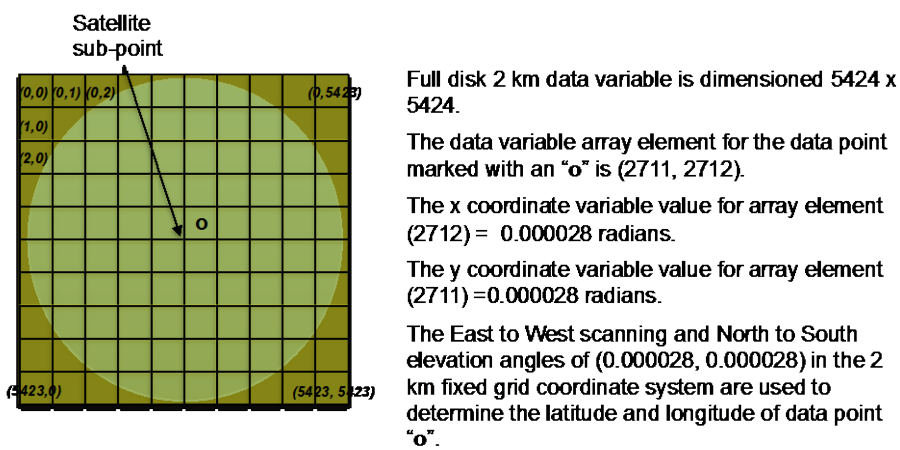

Figure 5.1.2.6-2 Relating a Data Point to Its ABI Fixed Grid Coordinates

Determining the latitude and longitude of data points using their ABI fixed grid coordinates is defined in paragraph 5.1.2.8, Navigation of Image Data that follows.

The dimensions of the data variables for ABI Level 1b and 2+ Full Disk, CONUS, and mesoscale products are defined in Table 5.1.2.6.

Table 5.1.2.6 ABI Product Data Variable Dimensions

Horizontal Spatial Resolution		Full Disk		CONUS Extraction from Full Disk		CONUS		Mesoscale	
km (nadir)	micro-radians	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)
0.5	14	21696	21696	6000	10000	6000	10000	2000	2000
1.0	28	10848	10848	3000	5000	3000	5000	1000	1000
2.0	56	5424	5424	1500	2500	1500	2500	500	500

Horizontal Spatial Resolution		Full Disk		CONUS Extraction from Full Disk		CONUS		Mesoscale	
km (nadir)	micro-radians	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)	N/S (y-axis)	E/W (x-axis)
4.0	112	2712	2712	*not applicable*				250	250
10.0	280	1086	1086	300	500	300	500	100	100

There are two conventions associated with the dimensioning of variables for image data on the fixed grid. The first convention requires the dimensioning of the lowest native resolution data variables (2 km at nadir) completely covers the Full Disk, CONUS, and mesoscale images defined above. The second convention requires the higher native resolution data variables (i.e., 0.5, 1, and 2 km at nadir) and the lower non-native resolution data variables (i.e., 4 and 10 km at nadir) fully cover the region included in the native 2 km at nadir resolution data variables.

The selection of CONUS and mesoscale center points has an effect on the location of these region's pixels on the ABI fixed grid. For example, if the center point of a native CONUS image is not on the corner of a Full Disk 10 km pixel, the locations of its 10 km pixels are not the same as that in a CONUS image extracted from a mode 4 Full Disk image. It is advantageous to end users and their applications to select CONUS and mesoscale center points where pixels at the provided resolutions are at the same locations regardless of image type. This is accomplished by selecting CONUS and mesoscale center points using the least common denominator among the horizontal spatial resolutions (0.5, 1.0, 2.0. 4.0, and 10.0 km) for ABI fixed grid products. This constraint requires CONUS and mesoscale center points to be on the corner of Full Disk 20 km (i.e., 0.00056 radian) pixels.

5.1.2.7 Standard Coordinate Data

There are several netCDF variables and attributes in the ABI Level 1b and ABI Level 2+ products on the fixed grid that contain coordinate related information required to geo-locate data points and geo-reference metadata in the product, and provide support for data discovery. The standard coverage areas associated with Full Disk and CONUS products result in coordinate data values that do not change for a satellite operating at a particular slot. These standard and fixed coordinate data are identified and described in this paragraph.

Table 5.1.2.7-1 defines the variables and attributes that contain standard coordinate data.

Table 5.1.2.7-1 Variables and Attributes Containing Standard Coordinate Data

Variable / Attribute	Description
y -> add_offset x -> add_offset	Attribute add_offset of coordinate variables "y" and "x" contains the N/S elevation and E/W scanning angles for center, respectively, of the upper left (i.e., most northwest) data point in the image. This value varies with the location of the image for mesoscale.
y -> scale_factor x -> scale_factor	Attribute scale_factor of coordinate variables "x" and "y" contains the horizontal spatial resolution of the image.
y_image_center x_image_center	The y_image_center and x_image_center coordinate variables contain the N/S elevation and E/W scanning angles, respectively, of the center the image. These values vary with the location of the image for mesoscale.
y_image_bounds x_image_bounds	The y_image_bounds and x_image_bounds boundary variables contain the N/S elevation and E/W scanning angles of the north and south, and west and east, extents, respectively, of the image. These values vary with the location of the image for mesoscale.

Variable / Attribute	Description
geospatial_lat_lon_extent -> geospatial_lat_nadir geospatial_lat_lon_extent -> geospatial_lon_nadir geospatial_lat_lon_extent -> geospatial_lat_center geospatial_lat_lon_extent -> geospatial_lon_center geospatial_lat_lon_extent -> geospatial_northbound_latitude geospatial_lat_lon_extent -> geospatial_southbound_latitude geospatial_lat_lon_extent -> geospatial_westbound_longitude geospatial_lat_lon_extent -> geospatial_eastbound_longitude	This variable and its attributes contain the latitude and longitude of the satellite's nadir, center of the image, and north, south, west, and east extents of the image. Except for the satellite's nadir, these values vary with the location of the image for mesoscale.

Table 5.1.2.7-2 identifies the N/S elevation and E/W scanning angles of the center of the most northwest pixel in Full Disk and CONUS images (i.e., y and x coordinate variables' add_offsets), and the y and x coordinate variables' scale_factors.

Table 5.1.2.7-2 ABI Image Standard Upper Left Coordinates

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="5">Horizontal Spatial Resolution</th></tr>
<tr><th>0.5 km (0.000014 radians)</th><th>1.0 km (0.000028 radians)</th><th>2.0 km (0.000056 radians)</th><th>4.0 km (0.000112 radians)</th><th>10.0 km (0.000280 radians)</th></tr>
<tr><td rowspan="2">Full Disk (all slots)</td><td>add offset for y</td><td>0.151865</td><td>0.151858</td><td>0.151844</td><td>0.151816</td><td>0.151900</td></tr>
<tr><td>add offset for x</td><td>-0.151865</td><td>-0.151858</td><td>-0.151844</td><td>-0.151816</td><td>-0.151900</td></tr>
<tr><td rowspan="2">CONUS (GOES-R East at -75 degrees east longitude)</td><td>add offset for y</td><td>0.128233</td><td>0.128226</td><td>0.128212</td><td rowspan="5">not applicable</td><td>0.128100</td></tr>
<tr><td>add offset for x</td><td>-0.101353</td><td>-0.101346</td><td>-0.101332</td><td>-0.101220</td></tr>
<tr><td rowspan="2">CONUS (GOES-R West at -137 degrees east longitude)</td><td>add offset for y</td><td>0.128233</td><td>0.128226</td><td>0.128212</td><td>0.128100</td></tr>
<tr><td>add offset for x</td><td>-0.069993</td><td>-0.069986</td><td>-0.069972</td><td>-0.069860</td></tr>
<tr><td>CONUS (Test Slot</td><td>add offset for y</td><td>0.126553</td><td>0.126546</td><td>0.126532</td><td>0.126420</td></tr>
</table>

		Horizontal Spatial Resolution				
		0.5 km (0.000014 radians)	1.0 km (0.000028 radians)	2.0 km (0.000056 radians)	4.0 km (0.000112 radians)	10.0 km (0.000280 radians)
at -89.5 degrees east longitude)	add offset for x	-0.075033	-0.075026	-0.075012		-0.074900
Scale Factors for All Image Types	scale factor for y	-0.000014	-0.000028	-0.000056	-0.000112	-0.000280
	scale factor for x	0.000014	0.000028	0.000056	0.000112	0.000280

Table 5.1.2.7-3 ABI Image Center (Fixed Grid Coordinates) identifies the N/S elevation and E/W scanning angles of the center of Full Disk and CONUS images (i.e., y_image_center and x_image_center coordinate variables).

Table 5.1.2.7-3 ABI Image Center (Fixed Grid Coordinates)

	y image center (N/S)	x image center (E/W)
Full Disk (all slots)	0.0	0.0
CONUS (GOES-R East at -75 degrees east longitude)	0.086240	-0.031360
CONUS (GOES-R West at -137 degrees east longitude)	0.086240	0.000000
CONUS (Test Slot at -89.5 degrees east longitude)	0.084560	-0.005040

Table 5.1.2.7-4 identifies the N/S elevation angles of the N/S extents and E/W scanning angles of the E/W extents of Full Disk and CONUS images (i.e., y_image_bounds and x_image_bounds boundary variables).

Table 5.1.2.7-4 ABI Image N/S and E/W Extents (Fixed Grid Coordinates)

	y image bounds		x image bounds	
	North	South	West	East
Full Disk (all slots)	0.151872	-0.151872	-0.151872	0.151872
CONUS (GOES-R East at -75 degrees east longitude)	0.128240	0.044240	-0.101360	0.038640
CONUS (GOES-R West at -137 degrees east longitude)	0.128240	0.044240	-0.070000	0.070000
CONUS (Test Slot at -89.5 degrees east longitude)	0.126560	0.042560	-0.075040	0.064960

Table 5.1.2.7-5 identifies the latitude and longitude of the center and extents of Full Disk and CONUS images (i.e., geospatial_lat_lon_extent variable attributes).

Table 5.1.2.7-5 ABI Image Center and Extents (Lat/Lon Coordinates)

Latitude is degrees north Longitude is degrees east	Full Disk (GOES-R East at -75 degrees east longitude)	Full Disk (GOES-R West at -137 degrees east longitude)	Full Disk (GOES-R Test at -89.5 degrees east longitude)	CONUS (GOES-R East at -75 degrees east longitude)	CONUS (GOES-R West at -137 degrees east longitude)	CONUS (GOES-R Test Slot at -89.5 degrees east longitude)
geospatial_lat_nadir	0.0	0.0	0.0	0.0	0.0	0.0
geospatial_lon_nadir	-75.0	-137.0	-89.5	-75.0	-137.0	-89.5
geospatial_lat_center	0.0	0.0	0.0	30.083003	29.967	29.294
geospatial_lon_center	-75.0	-137.0	-89.5	-87.096958	-137.000	-91.406
geospatial_northbound_latitude	81.3282	81.3282	81.3282	56.761450	53.500062	52.767707
geospatial_southbound_latitude	-81.3282	-81.3282	-81.3282	14.571340	14.571340	14.000162
geospatial_westbound_longitude	-156.2995	141.7005	-170.7995	-152.109282	175.623576	-140.616268
geospatial_eastbound_longitude	6.2995	-55.7005	-8.2005	-52.946879	-89.623576	-49.179291

5.1.2.8 Navigation of Image Data

This paragraph provides the equations needed to navigate data points on the ABI fixed grid to and from latitude and longitude. ABI fixed grid coordinates, N/S elevation angle and E/W scanning angle, coupled with the location of the satellite and the parameters associated with the selected earth model (GRS80) are used to determine the geodetic latitude/longitude coordinates. This paragraph also provides equations to determine the ABI fixed grid coordinates from the geodetic latitude/longitude coordinates.

All of the equations are based on the International System of Units (SI). These equations assume data points are lying on the GRS80 ellipsoid, and the location of data points on the ABI fixed grid is based on a geostationary satellite at the equator in an idealized orbit.

Table 5.1.2.8 defines the parameters required to navigate data points on the ABI fixed grid. The parameters are used in the equations in the following sections.

Table 5.1.2.8 Parameters Required to Navigate Data Points on ABI Fixed Grid

Parameter	netCDF Product File Attributes for the "goes_imager_projection" Variable	Attribute Value	Definition
r_{eq}	semi_major_axis	6378137 m	GRS80 semi-major axis of earth
$1/f$	inverse_flattening	298.257222096	Reciprocal of GRS80 flattening factor
r_{pol}	semi_minor_axis	6356752.31414 m	GRS80 semi-minor axis of earth = $(1-f)r_{eq}$
e	n/a	0.0818191910435	1st eccentricity = sqrt(f(2-f)) =sqrt((r_{eq}^2-r_{pol}^2)/r_{eq}^2)
n/a	perspective_point_height	35786023 m	Satellite height above ellipsoid
H	perspective_point_height + semi_major_axis	42164160 m	Satellite height from center of earth (m)

Parameter	netCDF Product File Attributes for the "goes_imager_projection" Variable	Attribute Value	Definition
x	x	Input or Output Value rad	Fixed Grid E/W scanning angle (rad)
y	y	Input or Output Value rad	Fixed Grid N/S elevation angle (rad)
ϕ		Input or Output Value deg/rad	GRS80 geodetic latitude (deg/rad)
λ		Input or Output Value deg/rad	GRS80 longitude (deg/rad)
n/a	latitude_of_projection_origin	0 deg 0 rad	Satellite East latitude North
		0 deg 0 rad	Satellite West latitude North
		0 deg 0 rad	Satellite Test latitude North
λ_0	longitude_of_projection_origin	-75 deg -1.308996939 rad	Satellite East longitude East
		-137 deg -2.39110107523 rad	Satellite West longitude East
		-89.5 deg -1.56206968053 rad	Satellite Test longitude East

Figure 5.1.2.8 provides an illustration of the coordinate frames and their relationships required for navigation. The equations in the following paragraphs are based on this figure.

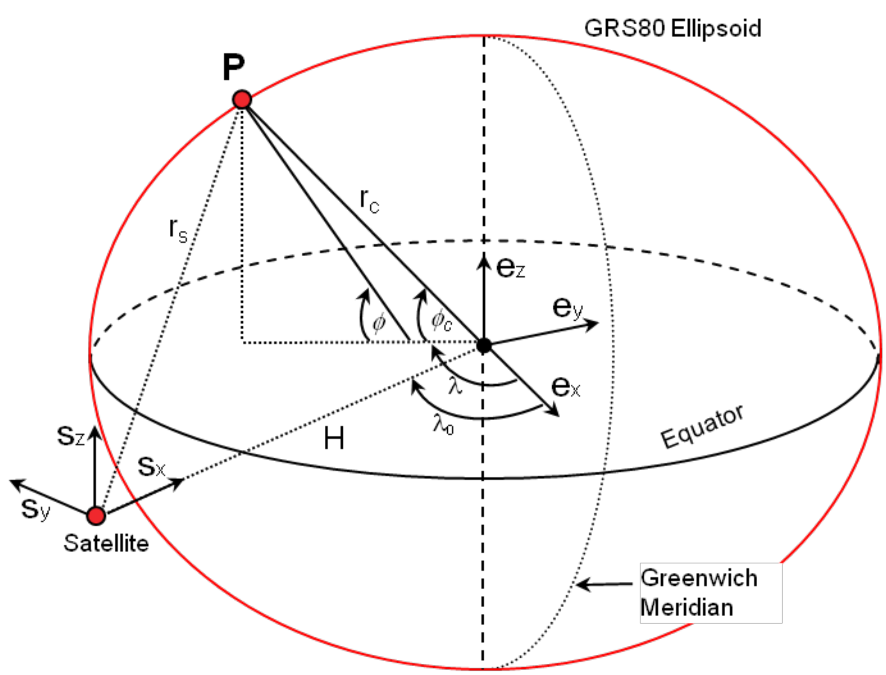

Figure 5.1.2.8 Coordinate Frames for ABI Fixed Grid Navigation

Two coordinate frames are described. The Earth Centered Fixed (ECF) coordinate frame rotates with the Earth. The origin is located at the center of the earth. The x-axis (e_x) passes through the Greenwich Meridian and the equator. The z-axis (e_z) passes through the North Pole. The y-axis (e_y) is defined as the cross product of the z-axis (e_z) with the x-axis (e_x) completing the right-handed coordinate system. The satellite coordinate frame has its origin located at the center of mass of the satellite. Its x-axis (s_x) is defined along the line from the satellite to the center of the earth and the z-axis (s_z) is parallel to the ECF z-axis (e_z) and points up. Again the y-axis (s_y) completes the right-handed coordinate system and is aligned with the equatorial axis. Two representations are shown for the latitude. The ϕ represents the geodetic latitude, and ϕ_C represents the geocentric latitude. Note that the geodetic latitude is measured at the equator, where the line is perpendicular or normal to the GRS80 ellipsoid at point P. The geodetic and geocentric longitudes λ are the same. Longitude is measured from the Greenwich meridian and is positive East and negative West. Note that the geostationary positions of the GOES-R satellites are both west of the Greenwich Meridian and therefore have negative longitudes as shown in the table immediately above.

Note that the open-source Unidata Geolocation Projection and Proj.4 Cartographic Projections software to perform these navigation functions will be available on the web at:

- http://www.unidata.ucar.edu/software/thredds/v4.3/netcdf-java/v4.2/javadoc/ucar/unidata/geoloc/Projection.html
- http://trac.osgeo.org/proj/wiki/proj%3Dgeos

5.1.2.8.1 Navigating from N/S Elevation Angle (*y*) and E/W Scanning Angle (*x*) to Geodetic Latitude (ϕ) and Longitude (λ)

Given a point P on the GRS80 ellipsoid with fixed grid coordinates (y,x) find the geodetic coordinates, (ϕ, λ).

The geodetic latitude (ϕ) and longitude (λ) are computed by the following equations

$$\begin{pmatrix}\phi \\ \lambda\end{pmatrix} = \begin{pmatrix}\arctan\left(\dfrac{r_{eq}^2}{r_{pol}^2}\dfrac{s_z}{\sqrt{(H-s_x)^2+s_y^2}}\right) \\ \lambda_0 - \arctan\left(\dfrac{s_y}{H-s_x}\right)\end{pmatrix}$$

For:

$x =$ Fixed Grid E/W scan angle in radians

$y =$ Fixed Grid N/S scan angle in radians

One computes S_x, S_y, S_z as follows:

$$a = \sin^2(x) + \cos^2(x)\left(\cos^2(y) + \frac{r_{eq}^2}{r_{pol}^2}\sin^2(y)\right)$$

$$b = -2H\cos(x)\cos(y)$$

$$c = H^2 - r_{eq}^2$$

$$r_s = \frac{-b-\sqrt{b^2-4ac}}{2a} \quad \text{distance from the satellite to point P}$$

$$s_x = r_s \cos(x)\cos(y)$$

$$s_y = -r_s \sin(x)$$

$$s_z = r_s \cos(x)\sin(y)$$

Example

This example is based on the GOES-R east satellite for a point, P, in a 2 km CONUS product with fixed grid coordinates given by

$y(558) = 0.095340$ rad

$x(1539) = -0.024052$ rad

Note the variables and their subscripts used here are as defined in paragraph 5.1.2.6, Product Data Structures, above.

Values for the parameters used in the equations and their netCDF Product File Attribute Names described in the table immediately above are as follows:

r_{eq} = goes_imagery_projection:semi_major_axis = *6378137 (meters)*

1/f= goes_imagery_projection:inverse_flattening = *298.257222096*

r_{pol} = goes_imagery_projection:semi_minor_axis = *6356752.31414 (meters)*

e = 0.0818191910435

goes_imagery_projection:perspective_point_height = *35786023 (meters)*

H = goes_imagery_projection:perspective_point_height +
goes_imagery_projection:semi_major_axis = *42164160 (meters)*

$x = x(1539) = -0.024052$

$y = y(558) = 0.095340$

λ_0 = goes_imagery_projection: longitude_of_projection_origin
= -1.308996939

Based on these input values, the intermediate calculations in the above equations yield the following:

$a = 1.000061039$

$b = -83921070.03$

$c = 1.73714E+15$

$r_s = 37116295.87$

$s_x = 36937048.73$

$s_y = 892635.0779$

$s_z = 3532287.213$

Now using the values specified above and substituting into the equations for ϕ and λ, we obtain the following for the geodetic latitude and longitude:

$\phi = 0.590726971$ rad $= 33.846162$ deg

$\lambda = -1.478135612$ rad $= -84.690932$ deg

corresponding to the GOES-R east satellite fixed grid coordinates of

$y(558) = 0.095340$ rad

$x(1539) = -0.024052$ rad

5.1.2.8.2 Navigating from Geodetic Latitude (ϕ) and Longitude (λ) to N/S Elevation Angle (y) and E/W Scanning Angle (x)

Given a point P on the GRS80 ellipsoid with geodetic (ϕ, λ) coordinates find the fixed grid (y, x) coordinates.

Note that if the following inequality is true, then the (ϕ, λ) location is not visible from the satellite and the elevation and scanning angles should not be computed.

$$H\left(H - s_x\right) < s_y^2 + \frac{r_{eq}^2}{r_{pol}^2} s_z^2$$

The N/S Elevation Angle (y) and E/W Scanning Angle (x) are computed by the following equations

$$\begin{pmatrix} y \\ x \end{pmatrix} = \begin{pmatrix} \arctan\left(\dfrac{s_z}{s_x}\right) \\ \arcsin\left(\dfrac{-s_y}{\sqrt{s_x^2 + s_y^2 + s_z^2}}\right) \end{pmatrix}$$

Where,

ϕ = GRS80 geodetic latitude in radians

λ = GRS80 longitude in radians

$$\phi_C = \arctan\left(\frac{r_{pol}^2}{r_{eq}^2}\tan(\phi)\right) \quad \text{geocentric latitude}$$

$$r_C = \frac{r_{pol}}{\sqrt{1 - e^2 \cos^2(\phi_C)}} \quad \text{geocentric distance to the point on the ellipsoid}$$

$$\begin{pmatrix} s_x \\ s_y \\ s_z \end{pmatrix} = \begin{pmatrix} H - r_C \cos(\phi_C) \cdot \cos(\lambda - \lambda_0) \\ -r_C \cos(\phi_C) \cdot \sin(\lambda - \lambda_0) \\ r_C \sin(\phi_C) \end{pmatrix}$$

Example

This example verifies that the algorithm defined in paragraph 5.1.2.8.1 has an inverse. This example is based on the GOES-R east satellite for a point, P, in a 2 km CONUS product with geodetic latitude and longitude given by

ϕ = 33.846162 deg = 0.590726966 rad

λ = -84.690932 deg = -1.47813561 rad

Values for the parameters used in the equations and their netCDF Product File Attribute Names described in the table immediately above are as follows:

r_{eq} = goes_imagery_projection:semi_major_axis = *6378137 (meters)*

$1/f$ = goes_imagery_projection:inverse_flattening = *298.257222096*

r_{pol} = goes_imagery_projection:semi_minor_axis = *6356752.31414 (meters)*

$e = 0.0818191910435$

goes_imagery_projection:perspective_point_height = *35786023 (meters)*

H = goes_imagery_projection:perspective_point_height + goes_imagery_projection:semi_major_axis = *42164160 (meters)*

$\phi = 0.590726966$

$\lambda = -1.47813561$

λ_0 = goes_imagery_projection: longitude_of_projection_origin = -1.308996939

Based on these input values, the intermediate calculations in the above equations yield the following:

$\phi_C = 0.587623849$

$r_c = 6371541.614$

$s_x = 36937048.71$

$s_y = 892635.07$

$s_z = 3532287.186$

Now using the values specified above and substituting into the equations for y and x, we obtain the following for the fixed grid coordinates

$y = 0.095340$ rad

$x = -0.024052$ rad

corresponding to the GOES-R east satellite geodetic latitude and longitude of

$\phi = 33.846162$ deg

$\lambda = -84.690932$ deg

5.1.2.9 Overlaying Data from Different Image Types

GOES-R ABI Level 1b and ABI Level 2+ product data users will need to overlay Full Disk, CONUS, and mesoscale products for data processing and display purposes.

The netCDF coordinate variables contain the ABI fixed grid coordinates, E/W scanning angle and N/S elevation angle that correspond to each point in the data variable. The ABI fixed grid coordinate values are relative to the origin of the fixed grid, which is the satellite sub-point. However, the array subscripts for a netCDF product image data variable are relative to the most northwest data point in the image.

When the resolutions of the products are the same, the following equation allows one to map the data variable array subscripts from the product containing the geographically smaller region to the product containing the geographically larger region. Note that the data variable array element (0,0) corresponds to the most northwest data point in the image data.

$^{\wedge}Y_L = ({}^{FG}Y_L - {}^{FG}Y_S) / \alpha$

$^{\wedge}X_L = ({}^{FG}X_S - {}^{FG}X_L) / \alpha$

where,

$^{FG}Y_S$ *fixed grid N/S elevation angle in radians for smaller region's northwest data point*

$^{FG}X_S$ *fixed grid E/W scanning angle in radians for smaller region's northwest data point*

$^{FG}Y_L$ *fixed grid N/S elevation angle in radians for larger region's northwest data point*

$^{FG}X_L$ *fixed grid E/W scanning angle in radians for larger region's northwest data point*

α *horizontal spatial resolution of the data in radians*

$^{\wedge}X_L$ *larger region's data variable x-axis subscript for smaller region's northwest data point*

$^{\wedge}Y_L$ *larger region's data variable y-axis subscript for smaller region's northwest data point*

In the case where the resolution of the products being overlaid is not the same, the same general thinking applies, except "α" needs to be the horizontal spatial resolution of the data in radians for the geographically larger product, and the application will need to deal with incongruities caused by the differing resolutions of the products.

Example

This example shows how a 2 km CONUS product can be overlaid on a 2 km Full Disk product from the GOES-R East satellite at -75 degrees east longitude.

Table 5.1.2.9 captures the parameters required.

Table 5.1.2.9 Parameters for 2 km CONUS Product Overlay on 2 km Full Disk Product

Parameter Name	netCDF Product Variable / Attribute Name	Value (radians)
$^{FG}Y_{CONUS}$	CONUS coordinate variable y(0)	0.126588
$^{FG}X_{CONUS}$	CONUS coordinate variable x(0)	-0.110236
$^{FG}Y_{FullDisk}$	Full Disk coordinate variable y(0)	0.151844
$^{FG}X_{FullDisk}$	Full Disk coordinate variable x(0)	-0.151844
α	CONUS product file <*primary data variable*>:resolution	0.000056

Using the equations defined above:

$^{\wedge}Y_{FullDisk} = (^{FG}Y_{FullDisk} - {}^{FG}Y_{CONUS}) / \alpha$ = (0.151844 - 0.126588) / 0.000056 = 451

$^{\wedge}X_{FullDisk} = (^{FG}X_{CONUS} - {}^{FG}X_{FullDisk}) / \alpha$ = (-0.110236 - -0.151844) / 0.000056 = 743

Therefore:

(1) Full Disk location for coordinate variable y(422) and x(902) is same location as CONUS coordinate variable y(0) and x(0)

(2) <DataVariable> Full Disk (422,743) is the same location as <DataVariable> CONUS (0,0)

5.1.3 Radiances Product

5.1.3.1 Description

The Radiances product contains an Earth-view radiometrically corrected and navigated image with pixel values identifying the radiance. The product includes data quality information that provides an assessment of the radiance data values for on-earth pixels, including an indication of good or degraded quality, or invalid, and the rationale.

Radiances product files are generated for each of the ABI's six reflective and ten emissive bands. Radiances product data is radiometrically corrected and navigated with image pixels being resampled to the ABI fixed grid.

The units of measure for the reflective band image pixel radiance values are "watts per square meter per steradian per micron". The units of measure for the emissive band image pixel radiance values are "milliwatts per square meter per steradian per reciprocal centimeter".

The reflective bands support the characterization of clouds, vegetation, snow/ice, and aerosols. The emissive bands supports the characterization of the surface, clouds, water vapor, ozone, volcanic ash and dust based on emissive properties. Table 5.1.3.1-1, Applications of the Radiances Product, identifies the ABI bands and their central wavelength, native horizontal spatial resolution, and application for the product.

Table 5.1.3.1-1 Applications of the Radiances Product

ABI Band	Central Wavelength (um)	Native Resolution (km)	Primary Use
1	0.47	1	Daytime aerosol over land, coastal water mapping.
2	0.64	0.5	Daytime clouds, fog, insolation, winds.
3	0.865	1	Daytime vegetation, burn scar, aerosol over water, winds.
4	1.378	2	Daytime cirrus cloud.
5	1.61	1	Daytime cloud-top phase and particle size, snow.
6	2.25	2	Daytime land, cloud properties, particle size, vegetation, snow.
7	3.9	2	Surface and cloud, fog at night, fire, winds.

ABI Band	Central Wavelength (um)	Native Resolution (km)	Primary Use
8	6.185	2	High-level atmospheric water vapor, winds, rainfall.
9	6.95	2	Midlevel atmospheric water vapor, winds, rainfall.
10	7.34	2	Lower-level water vapor, winds, and SO_2.
11	8.5	2	Total water for stability, cloud phase, dust SO_2, rainfall.
12	9.61	2	Total ozone, turbulence, winds.
13	10.35	2	Surface and clouds.
14	11.2	2	Imagery, sea surface temperature, clouds, rainfall.
15	12.3	2	Total water, volcanic ash, sea surface temperature.
16	13.3	2	Air temperature, cloud heights.

The Radiances product image is produced on the ABI fixed grid for Full Disk, CONUS, and Mesoscale coverage regions. The Radiances performance requirements are summarized in Table 5.1.3.1-2, Radiances Performance Requirements.

Table 5.1.3.1-2 Radiances Performance Requirements

	Measurement				Mapping
Region	**Range**	**Accuracy [1]**	**Precision [1]**	**Performance Conditions**	**Accuracy**
Full Disk, CONUS, & Mesoscale	180 to 320 K in brightness temperature units	(1) Bands 1, 2, 3, 5, 6: +/- 3% (one sigma) (2) Band 4: +/- 4% (one sigma) (3) All emissive bands (7-16): +/- 1 K (one-sigma)	(1) Bands 1, 2, 3, 5, 6: SNR = 300:1 (2) Band 4: SNR = 600:1 (3) Bands 7-15: NEDT = 0.1 K (4) Band 16: NEDT = 0.3 K	LZA ≤ 70 degrees [2] clear sky above clouds	1 km

[1] Specified accuracy and precision performance for reflective bands is for earth albedo measurements in scene of 100% albedo and, for emissive bands, is at a reference temperature of 300 K.
[2] Conditions for good quality prescribed by the algorithm do not include Local Zenith Angle (LZA) ≤ 70 degrees.

Metadata in the Radiances product provides statistical and other properties of the product image and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start, midpoint, and end time of the product image observation period.
- Solar radiance and irradiance values that vary as a function of the Earth-Sun distance, and planck constants used in support of cloud and moisture imagery generation.
- Number of good and conditionally usable, and missing pixels.
- Number of saturated and undersaturated pixels.
- Minimum, maximum, mean, and standard deviation of the radiance values in the product image.
- Star tracking information.
- Satellite's yaw flip configuration.

The minimum, maximum, mean, and standard deviation values are calculated using good and conditionally usable quality pixels. The percentages of pixels assigned to each data quality flag (DQF) value are also included in the product.

The Radiances product can be converted from radiances to reflectance factor or brightness temperature using information provided in the product. For the reflective bands, conversion from radiance L_ν to reflectance factor ρf_υ is computed as:

$$\rho f_{\upsilon} = \kappa L_{\upsilon}$$

where κ is the 'kappa factor'. The kappa factor $\kappa = ((\pi \cdot d^2)/E_{sun})$ represents the incident Lambertian-equivalent radiance, where d is the instantaneous Earth-Sun distance (in Astronomical Units) and E_{sun} is the solar irradiance in the respective bandpass (in $W/(m^2\ \mu m)$). The kappa factor is included in the product metadata as the variable "kappa0". The solar irradiance and Earth-Sun distance are also represented as variables "esun" and "earth_sun_distance_anomaly_in_AU", respectively.

Conversion from radiance to brightness temperature (*T*) is achieved for the emissive bands by applying the Planck function and the spectral bandpass correction:

$$T = [\ \mathrm{fk2} / (\mathrm{alog}((\mathrm{fk1} / L_{\nu}) + 1)) - \mathrm{bc1}\ ] / \mathrm{bc2}$$

where fk1 and fk2 are coefficients of the Planck function derived from physical constants (i.e., the speed of light, the Boltzmann constant, and the Planck constant) and the bandpass central wavenumber, and bc1 and bc2 are the spectral response function offset and scale correction terms. These four coefficients are included in the product metadata as variables: "planck_fk1", "planck_fk2", "planck_bc1", and "planck_bc2".

The detailed description of the ISO series metadata for the Radiances product is located in the standalone Appendix X, ISO Series Metadata.

5.1.3.2 Dynamic Source Data

The Radiances product is derived using ABI Level 0 raw science telemetry, ABI engineering telemetry, and satellite ephemeris related telemetry. This data includes the sixteen bands, ABI bands 1 to 16, of observed scenes and instrument calibration data.

The primary sensor data used by the Radiances algorithm is identified in Table 5.1.3.6.1-2, Radiances Product for Reflective Bands: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_ABI_L0_data".

5.1.3.3 Semi-Static Source Data

There are six categories of semi-static source data employed in the ABI Level 1b ground processing algorithm:

- Coverage calibration parameters
- Radiometric calibration parameters
- Calibration target parameters
- Geometric calibration parameters
- Kalman filter calibration parameters
- Algorithm processing parameters

Semi-static source data files from the six categories above are contained in a single zip file. Some files fit into more than one category. The filename conventions for the Level 1b semi-static source data files are located in Appendix A.

Coverage calibration parameters are those associated with the location of the ABI in geostationary orbit, global reference ellipsoid used to geolocate raw and resampled ABI imagery, ABI's field of regard, and instrument sensing rate. Specific types include:

- Earth polar and equatorial radius, and flattening.

- Extent and other physical and performance characteristics of the instrument's field of regard and field of view.

Following are the file names of coverage parameters within the ABI semi-static source data zip file. In this case the file names describe the content.

- ABI_FD_2km_LatLonPosition.bin
- ABI_FD_2km_LocalAzimuth.bin
- ABI_FD_2km_LocalZenith.bin
- ABI_FD_2km_SemiStaticMasks_GM.bin
- Auxiliary_Params.bin
- Imagery_Params.bin
- L2ServicesSharedLibrary_Params.bin

Radiometric calibration parameters are those associated with the instrument's radiometric observing characteristics, or its raw outputs. Specific types include:

- Band-specific lower and upper bounds of the radiances observed.
- East-west Line-of-Sight (LOS) offset of each band from field of view center.
- North-south and east-west mirror resistance factors, mirror temperature weights, and mirror reflectivity coefficients.
- Infrared observation data to engineering telemetry time synchronization parameters.
- Band-specific and detector-specific "Q" coefficients (i.e., quadratic term coefficients) used in the calculation of radiances.
- Emissive band-specific radiances as a function of brightness temperature.
- Reflective band normal scan start and end time intervals.

Following are the file names of radiometric calibration parameters within the zip file. XML and HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- ABI_BandSaturationLimits.h5
- FTEParameters.xml
- ABI_ICM_ConversionConsts.h5
- ABI_ICM_SensorCoefficients.h5
- ABI_Mirror_Record.h5
- Q_TableBand1.h5 (Quadratic coefficients in detector response model)
- Q_TableBand2.h5
- Q_TableBand3.h5
- Q_TableBand4.h5
- Q_TableBand5.h5
- Q_TableBand6.h5
- Q_TableBand7.h5
- Q_TableBand8.h5
- Q_TableBand9.h5
- Q_TableBand10.h5
- Q_TableBand11.h5
- Q_TableBand12.h5
- Q_TableBand13.h5

- Q_TableBand14.h5
- Q_TableBand15.h5
- Q_TableBand16.h5

Calibration target parameters are those associated with the calibration performed by the instrument during operations including the infrared calibration (i.e., blackbody), and space, solar, and star looks. Specific types include:

- Band-specific initial and minimum number of space look samples to use for processing.
- Band-specific and detector-specific valid ranges of space look sample values used to calculate the mean count.
- Parameters used to determine space look outliers.
- Emissive band-specific initial and minimum number of Infrared Calibration Target (ICT) samples to use for processing.
- Emissive band-specific and detector-specific valid range of ICT sample values used to calculate the mean count.
- Parameters used to determine the ICT outliers.
- Platinum Resistance Thermometer (PRT) specific fixed low and high resistance values, and "A" and "B" coefficients used when calculating infrared calibration target temperatures.
- PRT specific temperature weight values used to determine the ICT weighted average temperature.
- Emissive band-specific emissivity values used to compute the effective ICT radiances.
- Reflective band-specific initial and minimum number of Solar Calibration Target (SCT) samples to use for processing.
- Reflective band-specific and detector-specific valid range of SCT sample values used to calculate the mean count.
- Parameters used to determine SCT outliers.
- Reflective band-specific and detector-specific coefficients used to relate to the Bi-directional Reflectance Distribution Function (BRDF).
- Instrument alignment angles and coefficients used to compute the solar incidence angle to the SCT.
- Parameters used to calculate the obliquity of the ecliptic, solar ephemerides, and geocentric apparent ecliptic latitude and longitude of the sun needed in support of SCT.
- Band-specific 100 percent albedo Lambertian scene, band-average spectral radiances with the sun at 1 Astronomical Unit (AU) from the earth needed in support of SCT.
- Parameters used to calculate the SCT effective radiances.
- Time interval parameters for space look, ICT, and SCT.
- Number of star look samples to use, and star look time interval parameters.

Following are the file names of calibration target parameters within the zip file. The XML files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- CalTargetTimeIntervals.h5
- ABI_ICT_Record.h5
- IR_RetrievalParameters.h5
- ABI_SCT_Record.h5
- ABI_SolarSpaceLookParams.h5
- ABI_SpaceLookParams.h5
- StarLookParameters.h5

- VNIR_RetrievalParameters.h5
- ABI_DeadRowListParams.h5

Geometric calibration parameters are those associated with resampling, and the related geolocating of raw and resampled instrument data. Specific types include:

- Band-specific detector stack characteristic parameters, and detector selection map.
- Band-specific sample angular separation and timing parameters.
- Fixed grid pixel spacing parameters.
- Band-specific east-west and north-south swath characteristic parameters.
- Full disk, CONUS, and mesoscale scene dimensions.
- Band-specific and detector-specific valid range of space look sample values used to calculate the mean count.
- Scan and cross scene direction, which is roughly east-west and north-south direction, resampling kernel weighting functions.
- Band-specific eastward and northward LOS alignment offsets.
- Band-specific radiances valid range.
- Missing, saturated, under-saturated, minimum, and maximum pixel fill values.
- Valid pixel's contributing sample characteristic parameters.
- Band-dependent navigation sparseness parameters.
- Band-specific pixel bit depth, gain and bias values used when calculating scaled pixel values.
- Resampling threshold parameters.

Following are the file names of geometric calibration parameters within the zip file. XML and csv files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- ABI_NavigationRDP_Band7.xml
- BlockReleaseRegions.csv
- ResamplingScaledConversion.xml
- ResamplingParams.bin
- StarDetectionParams.xml

Kalman filter calibration parameters are those associated with the Kalman filter used to support geolocation of raw samples and resampled pixels. Specific types include:

- Astronomical constants for earth-sun distance, earth, moon, and sun gravitation, earth reference ellipsoid parameters, earth rotation rate, and solar flux.
- Kalman filter control parameters.
- Orbit, attitude, and star look tolerance parameters.
- Angular rate, orbit, and star look threshold parameters.
- Star catalog parameters.

Following are the file names of Kalman filter calibration parameters within the zip file. XML and HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- LeapSecondOffsets.xml
- ft24Simulation.bin
- JplEphem_2000-2060_Kalman.dat

- IERS_BullA_ser7.txt (International Earth Rotation and Reference Systems Service, Bulletin A: Contains rapid determinations for earth orientation parameters, 12 date versions)
- abiRefData_137.dat
- AstroConsts.bin
- filterControls.dat
- MeasMaxSensibles.bin
- PreprocessorControls.bin
- StarCatalogs.bin

Algorithm processing parameters are those used during service initiation, the processing of science data and to format data in preparation for producing an end product. Specific types include:

- netCDF product templates
- Service configurations
- Look up tables

Following are the file names of algorithm processing parameters within the zip file. XML, csv and HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- BlockReleaseRegions.csv
- RadianceLUT_Band7.h5
- RadianceLUT_Band8.h5
- RadianceLUT_Band9.h5
- RadianceLUT_Band10.h5
- RadianceLUT_Band11.h5
- RadianceLUT_Band12.h5
- RadianceLUT_Band13.h5
- RadianceLUT_Band14.h5
- RadianceLUT_Band15.h5
- RadianceLUT_Band16.h5
- DMI_ABI_Params.bin
- L2ServicesSharedLibrary_Params.bin
- CMI_metadata_config.xml
- Geo_metadata_config.xml
- Geo_SOF_metadata_config.xml
- Header_metadata_config.xml
- MCMI_metadata_config.xml
- Morph_metadata_config.xml
- Morph_SOF_metadata_config.xml
- Product_metadata_config.xml
- SampleOutlier_metadata_config.xml
- ABI-L1b-PARM_ALG-RAD.template
- ABI-L1b-PARM_ALG-SOF.template
- ABI-L1bSOF-PARM_GEO-C-E.template
- ABI-L1bSOF-PARM_GEO-C-W.template
- ABI-L1bSOF-PARM_GEO-F-E.template
- ABI-L1bSOF-PARM_GEO-F-W.template
- ABI-L1bSOF-PARM_GEO-M-E.template
- ABI-L1bSOF-PARM_GEO-M-W.template

- ABI-L1bSOF-PARM_MOR-05-Mm.template
- ABI-L1bSOF-PARM_MOR-10-Mm.template
- ABI-L1bSOF-PARM_MOR-20-Mm.template
- ABI-L1b-PARM_PRO-RAD-C01.template (16 templates, C01 through C16)
- ABI-L1bSOF-PARM_PRO-C01P01
- ABI-L1bSOF-PARM_PRO-C02P01
- ABI-L1bSOF-PARM_PRO-C02P02
- ABI-L1bSOF-PARM_PRO-C02P03
- ABI-L1bSOF-PARM_PRO-C02P04
- ABI-L1bSOF-PARM_PRO-C02P05
- ABI-L1bSOF-PARM_PRO-C03P01 (13 additional templates, C04 through C16)

5.1.3.4 Coordinates

The coordinates associated with data variables in the Radiances product are identified in Table 5.1.3.4, Radiances Product Coordinates.

Table 5.1.3.4 Radiances Product Coordinates

Radiances Product Data Quantity	Coordinates
radiances data radiances data quality flags	• Observation time period • N/S elevation and E/W scanning angles for pixel geo-location • Central wavelength and identifier of the ABI band
radiances pixel counts radiances minimum, maximum, mean, and standard deviation values	• Observation time period • N/S elevation and E/W scanning angle extents for image geo-location • Central wavelength and identifier of the ABI band
star look data solar irradiance (esun) inverse of the incoming top of atmosphere radiance (kappa0)	• Observation time period • Central wavelength and identifier of the ABI band
planck constants	• Central wavelength and identifier of the ABI band
Earth – sun distance anomaly	• Observation time period
data transmission error percentages	• Observation time period • N/S elevation and E/W scanning angle extents for image geo-location

5.1.3.5 Production Notes

The Radiances product is generated by ABI Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm decompresses and extracts the raw detector observation and calibration sample data from the CCSDS packets. The Level 1b algorithm radiometrically corrects the sample data, and navigates and resamples the radiometrically corrected sample data to the ABI fixed grid.

There are separate radiometric correction flows for the reflective and emissive bands. In both cases, the gains of the detectors are computed. The detector gain values are applied to the raw detector samples obtained during Earth scenes, star scenes, and lunar scans.

The image navigation and registration algorithms are responsible for generating target star selection lists for uplink to the instrument, determining instrument line-of-sight, correcting the registration between focal plane module fields of view, and navigating and resampling sample data to the ABI fixed grid.

Resampling of the ABI Level 0 data to the fixed grid is driven by a "state" output by a Kalman Filter. This state contains all of the information needed to determine the orientation of the line-of-sight for the ABI. In addition, the position of the spacecraft is needed to determine the Earth locations of the detector samples to allow resampling to the ABI fixed grid. The Kalman Filter state is updated whenever the ABI performs a star look and is propagated using spacecraft position and attitude rate telemetry from the spacecraft.

Resampling is an interpolation process that calculates the value of a pixel from a weighted sum of detector samples that are within ± 2 angular separation distances of the pixel location. The weight assigned to each detector sample is determined by its proximity to the selected pixel and the resampler kernel values. The proximity of a sample to a pixel is determined from the coordinates assigned during the navigation portion of the ground processing. Refer to Figure 5.1.3.5, ABI Level 1b Resampling Process.

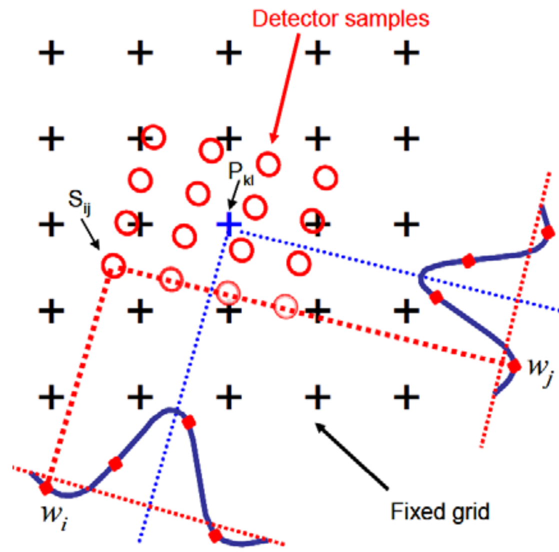

Figure 5.1.3.5 ABI Level 1b Resampling Process

The bit depth of the Radiances product, 10 to 14 bits, is band dependent, and is based on the bit depth of the downlinked samples from the ABI coupled with optimization considerations for GRB transmission. The bit depth for each of the sixteen bands is identified in Table 5.1.3.6.3-1, Radiances Product Quantity Characteristics.

A conditionally usable pixel is one where significantly less than the typical complement of sixteen radiometrically corrected data samples were present when calculating the pixel radiance value. If the number of contributing samples is greater than zero but less than the minimum contributing sample threshold of twelve, and if there are no saturated or undersaturated sample contributors, then the pixel is considered available for conditional use. Pixels can be either over-saturated or under-saturated. The valid range of pixel values are identified in in Table 5.1.3.6.3-1, Radiances Product Quantity Characteristics. Saturated pixels are assigned the minimum or maximum value in the valid range. The resampling algorithm identifies pixels affected by saturation, and outputs the radiometrically corrected sample data for the surrounding area in a sample outlier file for further analysis.

The ABI Level 1b data is processed in near real-time and transmitted over GRB before being assembled into a netCDF-4 product file that is distributed to PDA.

The Radiances algorithm intermediate data and diagnostic product files, which includes presampled radiometrically corrected and navigated radiance data, are available in the GOES-R ground system's Mission Management seven-day short term storage to support anomaly resolution and algorithm analysis. The final product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

The Radiances product is generated for each observation performed by the instrument. For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.1.3.6 Data Fields

The Radiances product is delivered using the netCDF-4 file format. The Radiances product data, specifically the radiances image data is scaled, making use of an unsigned 16 bit integer to store the data. The conventions used to specify the scaling information, specifically the data variable attributes scale_factor and add_offset, conform to the netCDF Users Guide (NUG) recommendations defined in the main volume of the PUG. In addition, the radiances image data and the data quality flags are losslessly compressed using a built-in netCDF API compression feature. Applications that use the netCDF API, do not have to explicitly decompress the data. If the algorithm generates a data value less than or greater than the valid range, the scaled value is assigned to be the minimum or maximum value in the valid range, respectively.

The Radiances product global attributes and the variables are defined in the tables that follow. The specifications for the reflective and emissive bands are different. As a result, separate tables are used to convey their content. In addition, there are metadata fields in the product related to the physical quantities that vary as a function of the band. Following the product specification tables are paragraphs containing tables that describe the physical quantity characteristics that vary as a function of the bands, and values and meanings for the flag variables in the product.

The filename conventions for the Radiances product are located in Appendix A.

5.1.3.6.1 Reflective Bands Data Fields

Table 5.1.3.6.1-1 Radiances Product for Reflective Bands: Global Attributes

Global Attribute Name	Value	Type
id	***universally unique identifier (UUID) for the instance of the product.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	a70be540-c38b-11e0-962b-0800200c9a66	string
Conventions	CF-1.7	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
standard_name_vocabulary	CF Standard Name Table (v25, 05 July 2013)	string
title	ABI L1b Radiances	string
summary	Single reflective band ABI L1b Radiances Products are digital maps of outgoing radiance values at the top of the atmosphere for visible and near-IR bands.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > VISIBLE RADIANCE	string
cdm_data_type	Image	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string

Global Attribute Name	Value	Type
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
timeline_id	***possible values are ABI Mode 3, ABI Mode 4 and ABI Mode 6. Default value is n/a***	string
scene_id	***possible values are Full Disk, CONUS, and Mesoscale.***	string
spatial_resolution	***possible values are 0.5km at nadir, 1km at nadir, and 2km at nadir.***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.3.6.1-2 Radiances Product for Reflective Bands: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
y	short	***y = see note[1]***	long_name	GOES-R fixed grid projection y-coordinate	string
			standard_name	projection_y_coordinate	string
			scale_factor	***see note [1]***	float
			add_offset	***see note [1]***	float
			units	rad	string
			axis	Y	string
x	short	***x = see note [1]***	long_name	GOES-R fixed grid projection x-coordinate	string
			standard_name	projection_x_coordinate	string
			scale_factor	***see note [1]***	float
			add_offset	***see note [1]***	float
			units	rad	string
			axis	X	string
t ***default value = -999.0***	double	n/a	long_name	J2000 epoch mid-point between the start and end image scan in seconds since 2000-01-01 12:00:00	string
			standard_name	time	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	seconds since 2000-01-01 12:00:00	string
			axis	T	string
			bounds	time_bounds	string
time_bounds ***default value = -999.0, -999.0***	double	number_of_time_bounds = 2	long_name	Scan start and end times in seconds since epoch (2000-01-01 12:00:00)	string
band_wavelength ***value = see note [2]***	float	band = 1	long_name	ABI band central wavelength	string
			standard_name	sensor_band_central_radiation_wavelength	string
			units	um	string
band_id ***value = see note [2]***	byte	band = 1	long_name	ABI band number	string
			standard_name	sensor_band_identifier	string
			units	1	string
y_image value = ***see note [1]***	float	n/a	long_name	GOES-R fixed grid projection y-coordinate center of image	string
			standard_name	projection_y_coordinate	string
			units	rad	string
			axis	Y	string
			bounds	y_image_bounds	string
y_image_bounds value = ***see note [1]***	float	number_of_image_bounds = 2	long_name	GOES-R fixed grid projection y-coordinate north/south extent of image	string
x_image value = ***see note [1]***	float	n/a	long_name	GOES-R fixed grid projection x-coordinate center of image	string
			standard_name	projection_x_coordinate	string
			units	rad	string
			axis	X	string
			bounds	x_image_bounds	string
x_image_bounds value = ***see note [1]***	float	number_of_image_bounds = 2	long_name	GOES-R fixed grid projection x-coordinate west/east extent of image	string
	int	n/a	long_name	GOES-R ABI fixed grid projection	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
goes_imager_projection			grid_mapping_name	geostationary	string
			perspective_point_height	35786023	double
			semi_major_axis	6378137	double
			semi_minor_axis	6356752.314	double
			inverse_flattening	298.2572221	double
			latitude_of_projection_origin	0	double
			longitude_of_projection_origin	***see note [1]***	double
			sweep_angle_axis	x	string
Rad	short	***y = see note[1]*** ***x = see note [1]***	long_name	ABI L1b Radiances	string
			standard_name	toa_outgoing_radiance_per_unit_wavelength	string
			_Unsigned	TRUE	string
			_FillValue	***see note [2]***	short
			sensor_band_bit_depth	***see note [2]***	byte
			valid_range	***see note [2]***	short
			scale_factor	***see note [2]***	float
			add_offset	***see note [2]***	float
			units	W m-2 sr-1 um-1	string
			resolution	y: see note [2] rad x: see note [2] rad	string
			coordinates	band_id band_wavelength t y x	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: point area: point	string
			ancillary_variables	DQF	string
DQF	byte	***y = see note[1]*** ***x = see note [1]***	long_name	ABI L1b Radiances data quality flags	string
			standard_name	status_flag	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			coordinates	band_id band_wavelength t y x	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: point area: point	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
			number_of_qf_values	4	byte
			percent_good_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_conditionally_usable_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_out_of_range_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_no_value_pixel_qf	***dynamic value. Default value = -999.0***	float
valid_pixel_count	int	n/a	long_name	number of good and conditionally usable pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
missing_pixel_count	int	n/a	long_name	number of missing pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: missing ABI fixed grid pixels only)	string
saturated_pixel_count	int	n/a	long_name	number of saturated pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: radiometrically saturated geolocated/not missing pixels only)	string
undersaturated_pixel_count	int	n/a	long_name	number of undersaturated pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: radiometrically undersaturated geolocated/not missing pixels only)	string
min_radiance_value_of_valid_pixels	float	n/a	long_name	minimum radiance value of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavelength	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	W m-2 sr-1 um-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: minimum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
max_radiance_value_of_valid_pixels	float	n/a	long_name	maximum radiance value of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavelength	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	W m-2 sr-1 um-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: maximum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
mean_radiance_value_of_valid_pixels	float	n/a	long_name	mean radiance value of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavelength	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	W m-2 sr-1 um-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: mean (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
std_dev_radiance_value_of_valid_pixels	float	n/a	long_name	standard deviation of radiance values of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavelength	string
			_FillValue	-999.0	float
			units	W m-2 sr-1 um-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: standard_deviation (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
t_star_look	double	num_star_looks = 24	long_name	J2000 epoch time of star observed in seconds since 2000-01-01 12:00:00	string
			standard_name	time	string
			units	seconds since 2000-01-01 12:00:00	string
			axis	T	string
band_wavelength_star_look	float	num_star_looks = 24	long_name	ABI band central wavelength associated with observed star	string
			standard_name	sensor_band_central_radiation_wavelength	string
			units	um	string
star_id	short	num_star_looks = 24	long_name	ABI star catalog identifier associated with observed star	string
			_Unsigned	TRUE	

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			_FillValue	65535	short
			coordinates	band_id band_wavelength_star_look t_star_look	string
yaw_flip_flag	byte	n/a	long_name	Flag indicating the spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			coordinates	T	string
			flag_values	0, 1, 2	byte
			flag_meanings	upright, neither, inverted	string
esun	float	n/a	long_name	bandpass-weighted solar irradiance at the mean Earth-Sun distance	string
			standard_name	toa_shortwave_irradiance_per_unit_wavelength	string
			_FillValue	-999.0	float
			units	W m-2 um-1	string
			coordinates	band_id band_wavelength t	string
			cell_methods	t: mean	string
kappa0	float	n/a	long_name	Inverse of the incoming top of atmosphere radiance at current earth-sun distance (PI d2 esun-1)-1, where d is the ratio of instantaneous Earth-Sun distance divided by the mean Earth-Sun distance, esun is the bandpass-weighted solar irradiance and PI is a standard constant used to convert ABI L1b radiance to reflectance	string
			_FillValue	-999.0	float
			units	(W m-2 um-1)-1	string
			coordinates	band_id band_wavelength t	string
			cell_methods	t: mean	string
planck_fk1	float	n/a	long_name	wavenumber-dependent coefficient (2 h c2/ nu3) used in the ABI emissive band monochromatic brightness temperature computation, where nu =central wavenumber and h and c are standard constants	string
			_FillValue	-999.0	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	W m-1	string
			coordinates	band_id band_wavelength	string
planck_fk2	float	n/a	long_name	wavenumber-dependent coefficient (h c nu/b) used in the ABI emissive band monochromatic brightness temperature computation, where nu = central wavenumber and h, c, and b are standard constants	string
			_FillValue	-999.0	float
			units	K	string
			coordinates	band_id band_wavelength	string
planck_bc1	float	n/a	long_name	spectral bandpass correction offset for brightness temperature (B(nu) – bc_1)/bc_2 where B()=planck_function() and nu=wavenumber	string
			_FillValue	-999.0	float
			units	K	string
			coordinates	band_id band_wavelength	string
planck_bc2	float	n/a	long_name	spectral bandpass correction scale factor for brightness temperature (B(nu) – bc_1)/bc_2 where B()=planck_function() and nu=wavenumber	string
			_FillValue	-999.0	float
			units	1	string
			coordinates	band_id band_wavelength	string
earth_sun_distance_anomaly_in_AU	float	n/a	long_name	earth sun distance anomaly in astronomical units	string
			_FillValue	-999.0	float
			units	ua	string
			coordinates	t	string
			cell_methods	t: mean	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999.0	float
			valid_range	0.0, 1.0	float
			units	percent	string
			coordinates	t y_image x_image	string
			grid_mapping	goes_imager_projection	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			cell_methods	t: sum area: sum (uncorrectable L0 errors only)	string
nominal_satellite_subpoint_lat ***value = 0.00***	float	n/a	long_name	nominal satellite subpoint latitude (platform latitude)	string
			standard_name	latitude	string
			_FillValue	-999.0	float
			units	degrees_north	string
nominal_satellite_subpoint_lon value = ***see note [1]***	float	n/a	long_name	nominal satellite subpoint longitude (platform longitude)	string
			standard_name	longitude	string
			_FillValue	-999.0	float
			units	degrees_east	string
nominal_satellite_height ***value = 35786.023***	float	n/a	long_name	nominal satellite height above GRS 80 ellipsoid (platform altitude)	string
			standard_name	height_above_reference_ellipsoid	string
			_FillValue	-999.0	float
			units	km	string
geospatial_lat_lon_extent	float	n/a	long_name	geospatial latitude and longitude references	string
			geospatial_westbound_longitude	***see note [1]***	float
			geospatial_northbound_latitude	***see note [1]***	float
			geospatial_eastbound_longitude	***see note [1]***	float
			geospatial_southbound_latitude	***see note [1]***	float
			geospatial_lat_center	***see note [1]***	float
			geospatial_lon_center	***see note [1]***	float
			geospatial_lat_nadir	0	float
			geospatial_lon_nadir	***see note [1]***	float
			geospatial_lat_units	degrees_north	string
			geospatial_lon_units	degrees_east	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_ABI_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string
processing_parm_version_container	int	n/a	long_name	container for processing parameter filenames	string
			L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters I Appendix A.***	string
algorithm_product_version_container	int	n/a	long_name	container for algorithm package filename and product version	string
			algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A.***	string
			product_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: Coverage region and horizontal spatial resolution related sizing and extent variable and attribute values are located in paragraph 5.1.2.6, Product Data Structures, and paragraph 5.1.2.7, Standard Coordinate Data, in the ABI Fixed Grid section.

Note 2: Radiances quantity characteristics are located in paragraph 5.1.3.6.3, Radiances Product Quantity Characteristics.

Note "flags and meanings": Flag values and meanings are located in paragraph 5.1.3.6.4, Radiances Product Data Quality Flag Values and Meanings.

5.1.3.6.2 Emissive Bands Data Fields

Table 5.1.3.6.2-1 Radiances Product for Emissive Bands: Global Attributes

Global Attribute Name	Value	Type
id	***universally unique identifier (UUID) for the instance of the product.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	a70be540-c38b-11e0-962b-0800200c9a66	string
Conventions	CF-1.7	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string

Global Attribute Name	Value	Type
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
standard_name_vocabulary	CF Standard Name Table (v25, 05 July 2013)	string
title	ABI L1b Radiances	string
summary	Single emissive channel ABI L1b Radiances Products are digital maps of outgoing radiance values at the top of the atmosphere for IR bands.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > INFRARED RADIANCE	string
cdm_data_type	Image	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
timeline_id	***possible values are ABI Mode 3, ABI Mode 4 and ABI Mode 6. Default value is n/a***	string
scene_id	***possible values are Full Disk, CONUS, and Mesoscale.***	string
spatial_resolution	***possible values are 0.5km at nadir, 1km at nadir, and 2km at nadir.***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.3.6.2-2 Radiances Product for Emissive Bands: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
y	short	***y = see note[1]***	long_name	GOES-R fixed grid projection y-coordinate	string
			standard_name	projection_y_coordinate	string
			scale_factor	***see note [1]***	float
			add_offset	***see note [1]***	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	rad	string
			axis	Y	string
x	short	***x = see note [1]***	long_name	GOES-R fixed grid projection x-coordinate	string
			standard_name	projection_x_coordinate	string
			scale_factor	***see note [1]***	float
			add_offset	***see note [1]***	float
			units	rad	string
			axis	X	string
t ***Default value = -999.0***	double	n/a	long_name	J2000 epoch mid-point between the start and end image scan in seconds since 2000-01-01 12:00:00	string
			standard_name	time	string
			units	seconds since 2000-01-01 12:00:00	string
			axis	T	string
			bounds	time_bounds	string
time_bounds ***Default value = -999.0, -999.0***	double	number_of_time_ bounds = 2	long_name	Scan start and end times in seconds since epoch (2000-01-01 12:00:00)	string
band_wavelength ***value = see note [2]***	float	band = 1	long_name	ABI band central wavelength	string
			standard_name	sensor_band_central_radiation_wavelength	string
			units	um	string
band_id ***value = see note [2]***	byte	band = 1	long_name	ABI channel number	string
			standard_name	sensor_band_identifier	string
			units	1	string
y_image value = ***see note [1]***	float	n/a	long_name	GOES-R fixed grid projection y-coordinate center of image	string
			standard_name	projection_y_coordinate	string
			units	rad	string
			axis	Y	string
			bounds	y_image_bounds	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
y_image_bounds value = ***see note [1]***	float	number_of_image_ bounds = 2	long_name	GOES-R fixed grid projection y-coordinate north/south extent of image	string
x_image value = ***see note [1]***	float	n/a	long_name	GOES-R fixed grid projection x-coordinate center of image	string
			standard_name	projection_x_coordinate	string
			units	rad	string
			axis	X	string
			bounds	x_image_bounds	string
x_image_bounds value = ***see note [1]***	float	number_of_image_ bounds = 2	long_name	GOES-R fixed grid projection x-coordinate west/east extent of image	string
goes_imager_proje ction	int	n/a	long_name	GOES-R ABI fixed grid projection	string
			grid_mapping_name	geostationary	string
			perspective_point_height	35786023	double
			semi_major_axis	6378137	double
			semi_minor_axis	6356752.314	double
			inverse_flattening	298.2572221	double
			latitude_of_projection_ origin	0	double
			longitude_of_projection_ origin	***see note [1]***	double
			sweep_angle_axis	x	string
Rad	short	***y = see note[1]*** ***x = see note [1]***	long_name	ABI L1b Radiances	string
			standard_name	toa_outgoing_radiance_per_unit_wavenumber	string
			_Unsigned	TRUE	string
			_FillValue	***see note [2]***	short
			sensor_band_bit_depth	***see note [2]***	byte
			valid_range	***see note [2]***	short
			scale_factor	***see note [2]***	float
			add_offset	***see note [2]***	float
			units	mW m-2 sr-1 (cm-1)-1	string
			resolution	y: see note [2] rad x: see note [2] rad	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			coordinates	band_id band_wavelength t y x	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: point area: point	string
			ancillary_variables	DQF	string
DQF	byte	***y = see note[1]*** ***x = see note [1]***	long_name	ABI L1b Radiances data quality flags	string
			standard_name	status_flag	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			coordinates	band_id band_wavelength t y x	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: point area: point	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
			number_of_qf_values	4	byte
			percent_good_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_conditionally_usable_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_out_of_range_pixel_qf	***dynamic value. Default value = -999.0***	float
			percent_no_value_pixel_qf	***dynamic value. Default value = -999.0***	float
valid_pixel_count	int	n/a	long_name	number of good and conditionally usable pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
missing_pixel_count	int	n/a	long_name	number of missing pixels	string
			_FillValue	-1	int

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: missing ABI fixed grid pixels only)	string
saturated_pixel_count	int	n/a	long_name	number of saturated pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: radiometrically saturated geolocated/not missing pixels only)	string
undersaturated_pixel_count	int	n/a	long_name	number of undersaturated pixels	string
			_FillValue	-1	int
			units	count	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (interval: see note [2] rad comment: radiometrically undersaturated geolocated/not missing pixels only)	string
min_radiance_value_of_valid_ pixels	float	n/a	long_name	minimum radiance value of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavenumber	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	mW m-2 sr-1 (cm-1)-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: minimum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
	float	n/a	long_name	maximum radiance value of pixels	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
max_radiance_value_of_valid_pixels			standard_name	toa_outgoing_radiance_per_unit_wavenumber	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	mW m-2 sr-1 (cm-1)-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: maximum (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
mean_radiance_value_of_valid_pixels	float	n/a	long_name	mean radiance value of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavenumber	string
			_FillValue	-999.0	float
			valid_range	***see note [2]***	float
			units	mW m-2 sr-1 (cm-1)-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: mean (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
std_dev_radiance_value_of_valid_pixels	float	n/a	long_name	standard deviation of radiance values of pixels	string
			standard_name	toa_outgoing_radiance_per_unit_wavenumber	string
			_FillValue	-999.0	float
			units	mW m-2 sr-1 (cm-1)-1	string
			coordinates	band_id band_wavelength t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: standard_deviation (interval: see note [2] rad comment: good and conditionally usable quality pixels only)	string
t_star_look	double	num_star_looks = 24	long_name	J2000 epoch time of star observed in seconds since 2000-01-01 12:00:00	string
			standard_name	time	string
			units	seconds since 2000-01-01 12:00:00	string
			axis	T	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
band_wavelength_star_look	float	num_star_looks = 24	long_name	ABI channel central wavelength associated with observed star	string
			standard_name	sensor_band_central_radiation_wavelength	string
			units	um	string
star_id	short	num_star_looks = 24	long_name	ABI star catalog identifier associated with observed star	string
			_Unsigned	TRUE	string
			_FillValue	65535	string
			coordinates	band_id band_wavelength_star_look t_star_look	string
yaw_flip_flag	byte	n/a	long_name	Flag indicating the spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			coordinates	t	string
			flag_values	0, 1, 2	byte
			flag_meanings	upright, neither, inverted	string
esun	float	n/a	long_name	bandpass-weighted solar irradiance at the mean Earth-Sun distance	string
			standard_name	toa_shortwave_irradiance_per_unit_ wavelength	string
			_FillValue	-999.0	float
			units	W m-2 um-1	string
			coordinates	band_id band_wavelength t	string
			cell_methods	t: mean	string
kappa0	float	n/a	long_name	Inverse of the incoming top of atmosphere radiance at current earth-sun distance (PI d2 esun-1)-1, where d is the ratio of instantaneous Earth-Sun distance divided by the mean Earth-Sun distance, esun is the bandpass-weighted solar irradiance and PI is a standard constant used to convert ABI L1b radiance to reflectance	string
			_FillValue	-999.0	float
			units	(W m-2 um-1)-1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			coordinates	band_id band_wavelength t	string
			cell_methods	t: mean	string
planck_fk1 *value =* ***see note [2]***	float	n/a	long_name	wavenumber-dependent coefficient (2 h c2/ nu3) used in the ABI emissive band monochromatic brightness temperature computation, where nu =central wavenumber and h and c are standard constants	string
			_FillValue	-999.0	float
			units	W m-1	string
			coordinates	band_id band_wavelength	string
planck_fk2 *value =* ***see note [2]***	float	n/a	long_name	wavenumber-dependent coefficient (h c nu/b) used in the ABI emissive band monochromatic brightness temperature computation, where nu = central wavenumber and h, c, and b are standard constants	string
			_FillValue	-999.0	float
			units	K	string
			coordinates	band_id band_wavelength	string
planck_bc1 *value =* ***see note [2]***	float	n/a	long_name	spectral bandpass correction offset for brightness temperature (B(nu) – bc_1)/bc_2 where B()=planck_function() and nu=wavenumber	string
			_FillValue	-999.0	float
			units	K	string
			coordinates	band_id band_wavelength	string
planck_bc2 *value =* ***see note [2]***	float	n/a	long_name	spectral bandpass correction scale factor for brightness temperature (B(nu) – bc_1)/bc_2 where B()=planck_function() and nu=wavenumber	string
			_FillValue	-999.0	float
			units	1	string
			coordinates	band_id band_wavelength	string
earth_sun_distance _anomaly_in_AU	float	n/a	long_name	earth sun distance anomaly in astronomical units	string
			_FillValue	-999.0	float
			units	ua	string
			coordinates	t	string
			cell_methods	t: mean	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999.0	float
			valid_range	0.0, 1.0	float
			units	percent	string
			coordinates	t y_image x_image	string
			grid_mapping	goes_imager_projection	string
			cell_methods	t: sum area: sum (uncorrectable L0 errors only)	string
nominal_satellite_subpoint_lat ***value = 0.00***	float	n/a	long_name	nominal satellite subpoint latitude (platform latitude)	string
			standard_name	latitude	string
			_FillValue	-999.0	float
			units	degrees_north	string
nominal_satellite_subpoint_lon value = ***see note [1]***	float	n/a	long_name	nominal satellite subpoint longitude (platform longitude)	string
			standard_name	longitude	string
			_FillValue	-999.0	float
			units	degrees_east	string
nominal_satellite_height ***value = 35786.023***	float	n/a	long_name	nominal satellite height above GRS 80 ellipsoid (platform altitude)	string
			standard_name	height_above_reference_ellipsoid	string
			_FillValue	-999.0	float
			units	km	string
geospatial_lat_lon_extent	float	n/a	long_name	geospatial latitude and longitude references	string
			geospatial_westbound_longitude	***see note [1]***	float
			geospatial_northbound_latitude	***see note [1]***	float
			geospatial_eastbound_longitude	***see note [1]***	float
			geospatial_southbound_latitude	***see note [1]***	float
			geospatial_lat_center	***see note [1]***	float
			geospatial_lon_center	***see note [1]***	float
			geospatial_lat_nadir	0	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			geospatial_lon_nadir	***see note [1]***	float
			geospatial_lat_units	degrees_north	string
			geospatial_lon_units	degrees_east	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_ABI_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string
processing_parm_version_container	int	n/a	long_name	container for processing parameter filenames	string
			L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters I Appendix A.***	string
algorithm_product_version_container	int	n/a	long_name	container for algorithm package filename and product version	string
			algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A.***	string
			product_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: Coverage region and horizontal spatial resolution related sizing and extent variable and attribute values are located in paragraph 5.1.2.6, Product Data Structures, and paragraph 5.1.2.7, Standard Coordinate Data, in the ABI Fixed Grid section.
Note 2: Radiances quantity characteristics are located in paragraph 5.1.3.6.3, Radiances Product Quantity Characteristics.
Note "flags and meanings": Flag values and meanings are located in paragraph 5.1.3.6.4, Radiances Product Data Quality Flag Values and Meanings.

5.1.3.6.3 Radiances Product Quantity Characteristics

Table 5.1.3.6.3-1 Radiances Product Quantity Characteristics

						Scaled Integer to Physical Quantity Conversion		Valid Range (packed - scaled integer form)		Valid Range (in units of physical quantity)	
ABI Channel (Band)	**Central Wave-length (in µm)**	**Horizontal Spatial Resolution (in km at nadir)**	**Horizontal Spatial Resolution (in radians)**	**Fill Value (packed - scaled integer form)**	**Bit Depth**	**Scale Factor**	**Add Offset**	**Mini-mum**	**Maxi-mum**	**Minimum**	**Maximum**
1	0.47	1.0	0.000028	1023	10	0.812106364	-25.93664701	0	1022	-25.93664701	804.03605737
2	0.64	0.5	0.000014	4095	12	0.158592367	-20.28991094	0	4094	-20.28991094	628.98723908
3	0.865	1.0	0.000028	1023	10	0.376912525	-12.03764377	0	1022	-12.03764377	373.16695681

						Scaled Integer to Physical Quantity Conversion		Valid Range (packed - scaled integer form)		Valid Range (in units of physical quantity)	
ABI Channel (Band)	Central Wave-length (in µm)	Horizontal Spatial Resolution (in km at nadir)	Horizontal Spatial Resolution (in radians)	Fill Value (packed - scaled integer form)	Bit Depth	Scale Factor	Add Offset	Mini-mum	Maxi-mum	Minimum	Maximum
4	1.378	2.0	0.000056	2047	11	0.070731082	-4.52236858	0	2046	-4.52236858	140.19342584
5	1.61	1.0	0.000028	1023	10	0.095800040	-3.05961376	0	1022	-3.05961376	94.84802665
6	2.25	2.0	0.000056	1023	10	0.030088475	-0.96095066	0	1022	-0.96095066	29.78947040
7	3.9	2.0	0.000056	16383	14	0.001564351	-0.03760000	0	16382	-0.03760000	25.58960000
8	6.185	2.0	0.000056	4095	12	0.007104763	-0.55860000	0	4094	-0.55860000	28.52830000
9	6.95	2.0	0.000056	2047	11	0.022539101	-0.82360000	0	2046	-0.82360000	45.29140000
10	7.34	2.0	0.000056	4095	12	0.020041280	-0.95610000	0	4094	-0.95610000	81.09290000
11	8.5	2.0	0.000056	4095	12	0.033357792	-1.30220000	0	4094	-1.30220000	135.26460000
12	9.61	2.0	0.000056	2047	11	0.054439980	-1.53940000	0	2046	-1.53940000	109.84480000
13	10.35	2.0	0.000056	4095	12	0.045728920	-1.64430000	0	4094	-1.64430000	185.56990000
14	11.2	2.0	0.000056	4095	12	0.049492208	-1.71870000	0	4094	-1.71870000	200.90240000
15	12.3	2.0	0.000056	4095	12	0.052774108	-1.75580000	0	4094	-1.75580000	214.30140000
16	13.3	2.0	0.000056	1023	10	0.176058513	-5.23920000	0	1022	-5.23920000	174.69260000

For the emissive channel radiances product, the planck constants required to convert the radiances to brightness temperature (*T*) are defined in Table 5.1.3.6.3-2, Radiances to Brightness Temperature Planck Constants.

Scale factors are chosen in order to handle the minimum and maximum allowable values. Note that the values in this table reflect pre-launch nominal values.

Table 5.1.3.6.3-2 Radiances to Brightness Temperature Planck Constants[1]

	Variable Names			
ABI Channel (Band)	planck_fk1	planck_fk2	planck_bc1	planck_bc2
7	2.02263e+05	3.69819e+03	0.43361	0.99939
8	5.06871e+04	2.33158e+03	1.55228	0.99667
9	3.58283e+04	2.07695e+03	0.34427	0.99918
10	3.01740e+04	1.96138e+03	0.05651	0.99986
11	1.97799e+04	1.70383e+03	0.18733	0.99948
12	1.34321e+04	1.49761e+03	0.09102	0.99971

	Variable Names			
ABI Channel (Band)	**planck_fk1**	**planck_fk2**	**planck_bc1**	**planck_bc2**
13	1.08033e+04	1.39274e+03	0.07550	0.99975
14	8.51022e+03	1.28627e+03	0.22516	0.99920
15	6.45462e+03	1.17303e+03	0.21702	0.99916
16	5.10127e+03	1.08453e+03	0.06266	0.99974

[1] The Planck constants in this table are example values, based on the ABI FM-1 instrument (on GOES-16). User applications should use the values in the product files because these values vary with each instance of the ABI instrument.

5.1.3.6.4 Radiances Product Data Quality Flag Values and Meanings

Table 5.1.3.6.4 Radiances Product Data Quality Flag Values and Meanings

Data Quality Flags (DQF)	
Flag Value	**Flag Meaning**
0	good_pixel_qf
1	conditionally_usable_pixel_qf
2	out_of_range_pixel_qf
3	no_value_pixel_qf

5.1.4 ABI Sample Outlier Data

5.1.4.1 Description

An outlier is an ABI fixed grid pixel in a specific band whose ABI L1b radiance value is outside of the product's measurement range because some of its constituent detector samples have radiance values indicating over-saturation, under-saturation or both. An ABI Sample Outlier Data file is a netCDF-4 file created for each ABI Radiances product image containing at least one outlier. A separate file is created for each band, and in the case of band 2, a separate file is created for each of the five data paths. The band 2 data paths provide a partitioning of the high data volume associated with its 0.000014 radian horizontal spatial resolution to support concurrent processing in the instrument and ground system.

An ABI Sample Outlier Data File contains resampled outlier radiance values, their corresponding Data Quality Flag, and the ABI fixed grid location of the resampled outlier. It also contains the source sample data received from the ABI, an ABI image chip (4 x 4 samples) for each resampled outlier pixel, along with a Data Quality Flag and the ABI fixed grid location for each of the 16 samples. This file is used to assess the impact of resampling saturated samples on product quality.

The detailed description of the ISO series metadata for ABI Sample Outlier Data is located in the standalone Appendix X, ISO Series Metadata document.

5.1.4.2 Data Fields

The ABI Sample Outlier Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables is a subordinate paragraph containing tables that describes the values and meanings for the flag variables in the data file.

The filename conventions for the ABI Sample Outlier Data file are located in Appendix A.

Table 5.1.4.2-1 ABI Sample Outlier Data File: Global Attributes

Name	Value	Type
id	***universally unique identifier (UUID) for the instance of the product.***	string
dataset_name	***refer to filename conventions for sample outlier data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	21798500-3a7a-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	ABI Sample Outlier Data	string
summary	ABI sample outlier data identifies outlier resampled pixels on the fixed grid, and their 4x4 source sample chips. These chips and their geo-location information are collected and stored for saturated resampled ABI pixels on the fixed grid.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > VISIBLE RADIANCE, SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > SENSOR COUNTS, SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > INFRARED RADIANCE, SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > SENSOR COUNTS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
timeline_id	***possible values are ABI Mode 3, ABI Mode 4 and ABI Mode 6. Default value is n/a***	string
scene_id	***possible values are Full Disk, CONUS, and Mesoscale.***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Name	Value	Type
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.4.2-2 ABI Sample Outlier Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
Band_ID	int	n/a	long_name	ABI band number associated with the sample outlier data in this dataset	string
			units	1	string
Band_Wavelength	float	n/a	long_name	ABI band central wavelength	string
			units	um	string
Path_ID	int	n/a	long_name	Path number (1-5) associated with channel 2 only	string
			_FillValue	-1	int
			units	1	string
Start_Time	double	n/a	long_name	start time of the scene in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
End_Time	double	n/a	long_name	end time of the scene in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
nominal_satellite_subpoint_lat ***value = 0.0***	float	n/a	long_name	nominal satellite subpoint latitude (platform latitude)	string
			_FillValue	-999.0	float
			units	degrees_north	string
nominal_satellite_subpoint_lon ***value = see note [1]***	float	n/a	long_name	nominal satellite subpoint longitude (platform longitude)	string
			_FillValue	-999.0	float
			units	degrees_east	string
nominal_satellite_height ***value = 35786.023***	float	n/a	long_name	nominal satellite height above GRS 80 ellipsoid (platform altitude)	string
			_FillValue	-999.0	float
			units	km	string
OutlierSampleFGEWAngles	double	n/a	long_name	OutlierSamples E/W fixed grid location	string
			units	urad	string
OutlierSampleFGNSAngles	double	n/a	long_name	OutlierSamples N/S fixed grid location	string
			units	urad	string
OutlierFGEWIndex	int	outlierPixelNumber = unlimited	long_name	OutlierPixel E/W pixel index where (0,0) is NW corner in fixed grid image (resolution dependent)	string
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
OutlierFGNSIndex	int	outlierPixelNumber = unlimited	long_name	OutlierPixel N/S pixel index where (0,0) is NW corner in fixed grid image (resolution dependent)	string
			units	1	string
outlierPixelNumber	int	n/a	long_name	number of outlier pixels in this file	string
			units	count	string
OutlierPixel	float	outlierPixelNumber = unlimited	long_name	Resampled pixel radiance value	string
			_FillValue	-999.0	float
			units	***possible values are "W m-2 sr-1 um-1" for reflective bands and "mW m-2 sr-1 (cm-1)-1" for emissive bands.***	string
OutlierPixelDQF	byte	outlierPixelNumber = unlimited	long_name	resampled outlier pixel data quality flag per pixel (0-good, 1-conditionally usable, 2-out of range, 3-no value)	string
			units	1	string
			_FillValue	-1	byte
			flag_values	***see note [flags and meanings]***	string
			flag_meanings	***see note [flags and meanings]***	string
numOutlierSamples	int	outlierPixelNumber = unlimited	long_name	number of samples contributing to each outlier pixel	string
			units	count	string
OutlierSamples	float	outlierPixelNumber = unlimited numOutlierSamples = 16	long_name	The samples - 4x4 pixels - contributing to OutlierPixel. At least one is an outlier	string
			_FillValue	-999.0	float
			units	***possible values are "W m-2 sr-1 um-1" for reflective bands and "mW m-2 sr-1 (cm-1)-1" for emissive bands.***	string
OutlierSampleDQFs	byte	outlierPixelNumber = unlimited numOutlierSamples = 16	long_name	outlier sample radiance value data quality flags	string
			_FillValue	-1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	string
			flag_meanings	***see note [flags and meanings]***	string
data_file_version_container	int	n/a	long_name	container for version of sample outlier data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: Longitude of satellite subpoint are located in paragraph 5.1.2.7, Standard Coordinate Data, in the ABI Fixed Grid section.

Note "flags and meanings": Flag values and meanings are located in paragraph 5.1.4.2.1, ABI Sample Outlier Data Quality Flag Values and Meanings.

5.1.4.2.1 ABI Sample Outlier Data Quality Flag Values and Meanings

Table 5.1.4.2.1-1 ABI Sample Outlier Pixel Data Quality Flag Values and Meanings

ABI Sample Outlier Pixel Data Quality Flags (OutlierPixelDQF)	
Flag Value	**Flag Meaning**
0	good_pixel_qf
1	conditionally_usable_pixel_qf
2	out_of_range_pixel_qf
3	no_value_pixel_qf

Table 5.1.4.2.1-2 ABI Sample Outlier Sample Data Quality Flag Values and Meanings

ABI Sample Outlier Sample Data Quality Flags (OutlierSampleDQFs)	
Flag Value	**Flag Meaning**
0	acceptable
1	undersaturated
2	saturated
3	unusable

5.1.5 Instrument Calibration Data: ABI Engineering Telemetry

5.1.5.1 Description

The ABI Instrument Engineering Telemetry Data file contains data used to support the generation of ABI Level 1b products, and monitor and evaluate the health and performance of the instrument. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. Most of the data pertains to the temperature of components in the instrument. This includes the ABI Infrared Calibration Target (ICT), the North-South and East-West scan mirrors, the three focal plane modules (i.e., VNIR, MWIR, LWIR), and the ABI optical bench. Temperatures are expressed in units of kelvin. The only exception to this is the data for the twelve platinum resistance thermometers (PRTs) associated with the ICT. These data PRT data are expressed in counts. Table C.1, ABI Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter. Elements of the instrument telemetry support the generation of the ABI Level 1b Radiances product data. The North-South scan mirror, the East-West scan mirror, and the PRT counts contribute to the computation of gain coefficients for detectors in the ABI emissive channels during observations of the ICT and the Space Look. Additionally, the scan mirror temperatures are used in support of determining the Earth scene radiances for the emissive bands.

A netCDF-4 file containing this ABI engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the ABI Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.1.5.2 Data Fields

The ABI Engineering Telemetry Data is delivered using the netCDF-4 file format. Its global attributes and variables are defined in the tables that follow.

The filename conventions for the ABI Engineering Telemetry Data file are located in Appendix A.

Table 5.1.5.2-1 ABI Engineering Telemetry Data File: Global Attributes

Name	Value	Type
dataset_name	***refer to filename conventions for instrument telemetry data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	ABI Instrument Science and Engineering Telemetry Data	string
summary	ABI instrument science and engineering telemetry for a one hour period.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.5.2-2 ABI Engineering Telemetry Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
Name	char	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item engineering data name	string
Units	char	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item units of measure	string
t	double	t = unlimited	long_name	time associated with the telemetry item in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
SU_Telemetry	float	t = unlimited numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item value	string
			_FillValue	-999.0	float
Min	float	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item minimum value over dataset's time period	string
			_FillValue	-999.0	float
Max	float	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item maximum value over dataset's time period	string
			_FillValue	-999.0	float
Mean	float	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item average value over dataset's time period	string
			_FillValue	-999.0	float
standard_deviation	float	numberOfDataTypes = unlimited	long_name	ABI instrument telemetry item standard deviation over dataset's time period	string
			_FillValue	-999.0	float
data_file_version_container	int	n/a	long_name	container for version of instrument telemetry data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Refer to Table C.1 for the specific ABI telemetry parameter names and their units of measure included in the data file.

5.1.6 Instrument Calibration Data: ABI Space, Blackbody, Star, and Solar Look Data

5.1.6.1 Description

The ABI Instrument Calibration Data files contain data resulting from the observation of the ABI Space Look, Infrared Calibration Target (ICT) (i.e., blackbody), Star Look Target, and Solar Calibration Target (SCT) (i.e., solar look target). These observations are dependent on the ABI band and the individual detectors.

There are two types of Space Look observations; one of which occurs in Mode 3, Mode 4 and Mode 6, and; the other occurs when the ABI is in a diagnostic mode, to support calibration of the SCT observation. Refer to Figure 5.1.1-1, ABI Mode 3 Timeline, Figure 5.1.1-2, ABI Mode 4 Timeline and Figure 5.1.1-3, ABI Mode 6 Timeline for details as to when in the Mode 3, Mode 4 and Mode 6 timelines the calibration observations occur. Note that the Space Looks needed for data calibration may occur after a Full Disk swath rather than before it depending on whether the Space Look occurs on the East or West side of the earth.

The SCT and corresponding Space Look observations are used to determine the detector gain coefficients for each reflective band. The distinguishing aspect of a SCT Space Look is that it contains more detector samples than a normal mode Space Look.

These files are in netCDF-4 format. An ABI instrument calibration data file contains ICT, Space Look, and Star Look data, or Space Look and SCT data. Separate files are created for each band and each occurrence of an ABI Mode 3, Mode 4 or Mode 6 timeline, which corresponds to fifteen, five and ten minutes, respectively. In the case of band 2, five different files are created, one for each of the data paths. The band 2 data paths provide a partitioning of the high data volume associated with its 0.000014 radian horizontal spatial resolution to support concurrent processing in the instrument and ground system.

ICT data is collected at the beginning of an ABI Mode 3, Mode 4 and Mode 6 timeline. This is followed by a Space Look observation. Such pairs of observations, taking into account the ABI scan mirror radiometric properties obtained at these times, leads to the computation of detector gain coefficient values. The remaining Space Look observations during a Mode 3, Mode 4 or Mode 6 sequence always precede a swath scan of the Earth. Star Look observations are interspersed in the Mode 3, Mode 4 and Mode 6 timelines as well in support of navigating the product data as depicted in the figures in the ABI Modes paragraph above.

The ABI instrument calibration data file containing SCT data is generated and populated during ABI diagnostic mode. Such observations occur daily or weekly during post launch test and early operations for a satellite, gradually tapering off in frequency to several times a year as the end of mission life of the satellite approaches. Each SCT observation is accompanied by an SCT Space Look, which is an extended duration version of the Space Look observation obtained during ABI Mode 3, Mode 4 and Mode 6 operations. A file is created each time the ABI enters this diagnostic mode.

The data in these ABI instrument calibration data files are the discrete measurement values received from the ABI, and several derived statistical measures. Both the reflective and emissive band raw counts data are collected for the Space Look observations. Reflective band raw counts data is collected for the SCT observations. Emissive band raw counts data is collected for the ICT observations.

The ICT statistical measures are the minimum, maximum, mean and standard deviation of the ICT observation samples for each detector of every ABI emissive band. In addition, the noise equivalent change in radiance (NEdN) and noise equivalent differential temperature (NEdT) for detectors of the emissive bands over single calibration sampling periods are included.

The Space Look statistical data is the minimum, maximum, mean and standard deviation of the Space Look observation samples for each detector of every ABI band. In addition, the NEdN for detectors of every ABI band over single calibration sampling period are included in the data file. NEdT is also included, but only for the emissive bands.

The SCT statistical data is the minimum, maximum, mean and standard deviation of the SCT observation samples for each detector of the ABI reflective bands. In addition, the NEdN and signal to noise ratio for detectors of the ABI reflective bands over single calibration sampling period are included.

There are no statistical measures included for Star Look observation data.

Star Look observations for the ABI reflective bands occur during Mode 3, Mode 4 and Mode 6. There is a total of seven ABI star scene ID types. Star scene ID values of 4 through 9 represent one star scene for each reflective band. Star scene ID 10 is reserved for a star scene observation associated with an emissive band. The Star Look observation data is represented in the data file in terms of calibrated radiances. Data Quality Flags, and computed gain coefficients are also included.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the ABI Instrument Calibration Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.1.6.2 Data Fields

The ABI Instrument Calibration Data is delivered using the netCDF-4 file format. There is one netCDF file specification used for the two types of ABI instrument calibration data files identified in the Description paragraph immediately above. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables are subordinate paragraphs containing tables that describe the number of detectors for each ABI band, and the values and meanings for the flag variable in the product.

The filename conventions for the ABI Instrument Calibration Data file are located in Appendix A.

Table 5.1.6.2-1 ABI Instrument Calibration Data File: Global Attributes

Name	Value	Type
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	ABI Instrument Calibration Data	string
summary	ABI instrument calibration space, solar, star, and internal target data, and calculated gain and offset coefficients for each detector for a single mode 3, 4 or 6 timeline (epoch).	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > SENSOR COUNTS, SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > SENSOR COUNTS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
timeline_id	***possible values are ABI Mode 3, ABI Mode 4 and ABI Mode 6. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.6.2-2 ABI Instrument Calibration Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
band_id	int	n/a	long_name	ABI band number associated with all the calibration data in this dataset	string
			units	1	string
band_wavelength	float	n/a	long_name	ABI band central wavelength	string
			units	um	string
data_path	int	n/a	long_name	Path number (1-5) associated with channel 2 only	string
			units	1	string
ict_times	double	ict_times = unlimited	long_name	time of the ict observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
sct_times	double	sct_times = unlimited	long_name	time of the act observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
spacelook_times	double	spacelook_times = unlimited	long_name	time of the space look observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
starlook_times	double	starlook_times = unlimited	long_name	time of the star look observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
gain_times	double	gain_times = unlimited	long_name	valid time of the calculated gain in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
offset_times	double	offset_times = unlimited	long_name	valid time of the offset times in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
nominal_satellite_subpoint_lat ***value = 0.0***	float	n/a	long_name	nominal satellite subpoint latitude (platform latitude)	string
			_FillValue	-999.0	float
			units	degrees_north	string
nominal_satellite_subpoint_lon ***value = see note [2]***	float	n/a	long_name	nominal satellite subpoint longitude (platform longitude)	string
			_FillValue	-999.0	float
			units	degrees_east	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
nominal_satellite_height ***value = 35786.023***	float	n/a	long_name	nominal satellite height above GRS 80 ellipsoid (platform altitude)	string
			_FillValue	-999.0	float
			units	km	string
ict	short	ict_times = unlimited ***num_detectors = see note[1]*** num_ict_samples = 256	long_name	internal calibration target data digital numbers for emissive bands	string
			_FillValue	-999.0	short
			units	count	string
ict_min	short	ict_times = unlimited ***num_detectors = see note[1]***	long_name	minimum internal calibration target data digital number for detectors of emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
ict_max	short	ict_times = unlimited ***num_detectors = see note[1]***	long_name	maximum internal calibration target data digital number for detectors of emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
ict_mean	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	average internal calibration target data digital number for detectors of emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string
ict_stddev	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	standard deviation of internal calibration target data digital numbers for detectors of emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string
ict_nedn	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	internal calibration target calculated noise equivalent change in radiance (NEdN) for detectors of emissive bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	mW m-2 sr-1 (cm-1)-1	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
ict_nedt	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	internal calibration target calculated noise equivalent differential temperature (NEdT) for detectors of emissive bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	K	string
sct	short	sct_times = unlimited ***num_detectors = see note[1]*** num_sct_samples = 256	long_name	solar calibration target data digital numbers for reflective bands	string
			_FillValue	-999.0	short
			units	count	string
sct_min	short	sct_times = unlimited ***num_detectors = see note[1]***	long_name	minimum solar calibration target data digital number for detectors of reflective bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
sct_max	short	sct_times = unlimited ***num_detectors = see note[1]***	long_name	maximum solar calibration target data digital number for detectors of reflective bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
sct_mean	float	sct_times = unlimited ***num_detectors = see note[1]***	long_name	average solar calibration target data digital number for detectors of reflective bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string
sct_stddev	float	sct_times = unlimited ***num_detectors = see note[1]***	long_name	standard deviation of solar calibration target data digital numbers for detectors of reflective bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
sct_nedn	float	sct_times = unlimited ***num_detectors = see note[1]***	long_name	solar calibration target calculated noise equivalent change in radiance (NEdN) for detectors of reflective bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	W m-2 sr-1 um-1	string
sct_signal_to_noise	float	sct_times = unlimited ***num_detectors = see note[1]***	long_name	solar calibration target calculated signal to noise ratio for detectors of reflective bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	1	string
spacelook	short	spacelook_times = unlimited ***num_detectors = see note[1]*** num_spacelook_samples = 16	long_name	space look calibration data digital numbers for reflective and emissive bands	string
			_FillValue	-999.0	short
			units	count	string
spacelook_min	short	spacelook_times = unlimited ***num_detectors = see note[1]***	long_name	minimum space look calibration data digital number for detectors of reflective and emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
spacelook_max	short	spacelook_times = unlimited ***num_detectors = see note[1]***	long_name	maximum space look calibration data digital number for detectors of reflective and emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	short
			units	count	string
spacelook_mean	float	spacelook_times = unlimited ***num_detectors = see note[1]***	long_name	average space look calibration data digital number for detectors of reflective and emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
spacelook_stddev	float	spacelook_times = unlimited ***num_detectors = see note[1]***	long_name	standard deviation of space look calibration data digital numbers for detectors of reflective and emissive bands over single calibration sampling period excluding outliers	string
			_FillValue	-999.0	float
			units	count	string
spacelook_nedn	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	space look calibration calculated noise equivalent change in radiance (NEdN) for detectors of reflective and emissive bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	***possible values are "W m-2 sr-1 um-1" for reflective bands and "mW m-2 sr-1 (cm-1)-1" for emissive bands.***	string
spacelook_nedt	float	ict_times = unlimited ***num_detectors = see note[1]***	long_name	space look calibration calculated noise equivalent differential temperature (NEdT) for detectors of emissive bands over single calibration sampling period	string
			_FillValue	-999.0	float
			units	K	string
starlook	float	starlook_times = unlimited ***num_detectors = see note[1]*** num_starlook_samples = unlimited	long_name	calibrated star look radiance for detectors over single calibration sampling period for applicable bands	string
			_FillValue	-999.0	short
			units	W m-2 sr-1 um-1	string
starlook_dqf	byte	starlook_times = unlimited ***num_detectors = see note[1]*** num_starlook_samples = unlimited	long_name	calibrated detector star look radiance data quality flags for applicable bands	string
			_FillValue	-1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	string
			flag_meanings	***see note [flags and meanings]***	string
gain	float	gain_times = unlimited ***num_detectors = see note[1]***	long_name	calculated gain coefficient for each detector of reflective and emissive bands	string
			_FillValue	-999.0	float
			units	1	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
offset	float	offset_times = unlimited ***num_detectors = see note[1]***	long_name	calculated offset coefficient for each detector of reflective and emissive bands	string
			_FillValue	-999.0	float
			units	1	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: Dimension value for num_detectors varies as a function of the band. Number of detectors for each band are located in paragraph 5.1.6.2.1 ABI Instrument Calibration Data Quantity Characteristics.
Note 2: Longitude of satellite subpoint are located in paragraph 5.1.2.7, Standard Coordinate Data, in the ABI Fixed Grid section.
Note "flags and meanings": Flag values and meanings are located in paragraph 5.1.6.2.2, ABI Instrument Calibration Star Look Data Quality Flag Values and Meanings.

5.1.6.2.1 ABI Instrument Calibration Data Quantity Characteristics

Table 5.1.6.2.1 ABI Number of Detectors

Channel (Band)	Central Wavelength	Number of Detectors
1	0.47	676
2	0.64	292 for each of 5 data paths
3	0.865	676
4	1.378	372
5	1.61	676
6	2.25	372
7	3.9	332
8	6.185	332
9	6.95	332
10	7.34	332
11	8.5	332
12	9.61	332
13	10.35	408
14	11.2	408
15	12.3	408
16	13.3	408

5.1.6.2.2 ABI Instrument Calibration Star Look Data Quality Flags

Table 5.1.6.2.2 ABI Instrument Calibration Data Quality Flag Values and Meanings

ABI Instrument Calibration Star Look Data Quality Flags (starlook_dqf)	
Flag Value	**Flag Meaning**
0	acceptable
1	undersaturated
2	saturated
3	unusable

5.1.7 Instrument Calibration Data: ABI Lunar Scan

5.1.7.1 Description

The ABI Lunar Scan Data file contains an off-earth mesoscale scene, and is collected as part of an ABI mode 3 or mode 6 timeline when the moon is in the field of regard of the ABI instrument. The apparent size of the moon in the field of regard of the ABI subtends a size suitable for coverage using the ABI mesoscale scene type, which consists of two swaths. This data is collected for all ABI bands. Lunar scan data samples are radiometrically calibrated. The moon is observed in support of off-line ABI calibration activities.

Separate files are created for each band and each occurrence of an ABI Mode 3 or Mode 6 timeline, which corresponds to fifteen minutes or ten minutes, respectively. In the case of band 2, five different files are created, one for each of the data paths. The band 2 data paths provide a partitioning of the high data volume associated with its 0.000014 radian horizontal spatial resolution to support concurrent processing in the instrument and ground system.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the ABI Lunar Scan Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.1.7.2 Data Fields

The ABI Lunar Scan Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables is a subordinate paragraph containing a table that describes the values and meanings for the flag variable in the data file.

The filename conventions for the ABI Lunar Scan Data file are located in Appendix A.

Table 5.1.7.2-1 ABI Lunar Scan Data File: Global Attributes

Name	Value	Type
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	ABI Lunar Scan Calibrated Sample Data	string
summary	ABI lunar scan calibrated sample data in a mode 3 or mode 6 timeline (epoch).	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > VISIBLE WAVELENGTHS > SENSOR COUNTS, SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > SENSOR COUNTS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES R Series Advanced Baseline Imager	string
instrument_ID	***serial number of the instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
timeline_id	***possible values are ABI Mode 3, ABI Mode 4 and ABI Mode 6. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.1.7.2-2 ABI Lunar Scan Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
band_id	int	n/a	long_name	ABI band number associated with the calibration data in this dataset	string
			units	1	string
band_wavelength	float	n/a	long_name	ABI band central wavelength	string
			units	um	string
data_path	int	n/a	long_name	Path number (1-5) associated with channel 2 only	string
			units	1	string
t	double	t = unlimited	long_name	start time of the lunar scan observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
nominal_satellite_subpoint_lat ***value = 0.0***	float	n/a	long_name	nominal satellite subpoint latitude (platform latitude)	string
			_FillValue	-999.0	float
			units	degrees_north	string
nominal_satellite_subpoint_lon ***value = see note [2]***	float	n/a	long_name	nominal satellite subpoint longitude (platform longitude)	string
			_FillValue	-999.0	float
			units	degrees_east	string
nominal_satellite_height ***value = 35786.023***	float	n/a	long_name	nominal satellite height above GRS 80 ellipsoid (platform altitude)	string
			_FillValue	-999.0	float
			units	km	string
center_y	float	n/a	long_name	ABI fixed grid N/S elevation angle (y) coordinate for the center of the scene	string
			units	rad	string
center_x	float	n/a	long_name	ABI fixed grid E/W scanning angle (x) coordinate for the center of the scene	string
			units	rad	string
radiance	float	t = unlimited	long_name	lunar scan calibrated sample radiance values	string
			_FillValue	-999.0	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
		num_swaths = unlimited ***num_detectors = see note[1]*** num_lunar_samples = unlimited	units	***possible values are "W m-2 sr-1 um-1" for reflective bands and "mW m-2 sr-1 (cm-1)-1" for emissive bands.***	string
radiance_dqf	byte	t = unlimited num_swaths = unlimited ***num_detectors = see note[1]*** num_lunar_samples = unlimited	long_name	lunar scan calibrated sample radiance value data quality flags	string
			_FillValue	-1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	string
			flag_meanings	***see note [flags and meanings]***	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: Number of detectors for each band are located in Table 5.1.6.2.1.
Note 2: Longitude of satellite subpoint are located in paragraph 5.1.2.7, Standard Coordinate Data, in the ABI Fixed Grid section.
Note "flags and meanings": Flag values and meanings are located in paragraph 5.1.7.2.1, ABI Lunar Scan Data Quality Flag Values and Meanings.

5.1.7.2.1 ABI Lunar Scan Data Quality Flags

Table 5.1.7.2.1 ABI Lunar Scan Data Quality Flag Values and Meanings

ABI Lunar Scan Data Quality Flags (radiance_dqf)	
Flag Value	Flag Meaning
0	acceptable
1	undersaturated
2	saturated
3	unusable

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5.2 SUVI Level 1b Product and Data

5.2.1 Level 1b SUVI Solar Imagery: Extreme Ultraviolet Product

5.2.1.1 Description

The Level 1b SUVI Solar Imagery: EUV product contains a radiometrically corrected 1280 x 1280 image of the sun with pixel values identifying the radiance. Pixels have a bit depth of sixteen bits: a fifteen bit image with ½ Digital Number (DN) resolution and; one bit for sign, which is needed to support radiometric correction, specifically dark frame current subtraction. The product includes data quality information that provides an assessment of the radiance data values for pixel in the SUVI's field of view, including an indication of good or degraded quality, or invalid, and the rationale.

Imaging of the sun is performed at six wavelengths. The solar features observed for each of the six wavelengths are identified in Table 5.2.1.1-1, Observed Solar Features.

Table 5.2.1.1-1 Observed Solar Features

	Wavelength (in Angstroms)					
Solar Feature	**93.9**	**131.2**	**171.1**	**195.1**	**284.2**	**303.8**
Filament						x
Coronal Hole					x	
Active Region Complexity			x	x		
Coronal Mass Ejection			x	x		
Flare Location and Morphology	x	x				
Quiet Region			x	x		x

Solar imagery product files are generated for fourteen types of solar images. Combinations of the six wavelengths, two exposure periods, and two types of exposures are the basis for the fourteen types of solar imagery. The science objective mnemonic and wavelengths enumerated in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics, define the fourteen solar imagery types.

The units of measure for the image pixel radiance values are "watts per square meter per steradian".

The Level 1b SUVI Solar Imagery: EUV product image is produced at 2.5 arcsecond resolution on a gnomonic azimuthal projection that uses helioprojective-cartesian coordinates. This projection is from the perspective of the observer.

The precise look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are available from the Product Distribution and Access system.

The Level 1b SUVI Solar Imagery: EUV performance requirements are summarized in Table 5.2.1.1-2, Level 1b SUVI Solar Imagery: EUV Performance Requirements.

Table 5.2.1.1-2 Level 1b SUVI Solar Imagery: EUV Performance Requirements

	Measurement			Mapping
Region	**Range**	**Accuracy**	**Precision**	**Accuracy**
solar disk	0.3 to 10^6 photons/cm^2/arcsec/s	+/- 40%	+/- 40%	+/- 2.5 arcsec

Metadata in the Level 1b SUVI Solar Imagery: EUV product provides statistical properties of the product image and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the product image observation period.
- Pixel location of center of sun, and diameter of the sun in pixels.

- Number of good quality pixels.
- Number of corrected, saturated, and missing pixels.
- Sum of radiance and irradiance pixel values in the product image.
- Minimum, maximum, mean, and standard deviation of the radiance values in the product image.

The sum, minimum, maximum, mean, and standard deviation values are calculated using good and degraded quality pixels.

Metadata in the Level 1b SUVI Solar Imagery: EUV product provides instrument configuration and other information required for the generation of level 2 products, including:

- Type of solar imagery product.
- Satellite location and earth to sun distance.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Product image orientation.
- Angular offset of the solar north rotational pole and the solar equatorial plane.
- Uncertainty in pixels due to systematic errors.
- Wavelength-dependent telescope effective area and aperture selector setting.
- Forward and aft filter wheel settings and corresponding mnemonics.
- SUVI CCD readout configuration.
- SUVI CCD detector plate scale.
- Product image projection information.

Metadata in the Level 1b SUVI Solar Imagery: EUV product provides calibration processing and instrument performance information, including:

- Contamination correction state parameters, and estimated contamination thickness used to correct the product image.
- CCD signal to noise ratio, background noise, and temperature.
- Dark frames used for calibration.

The detailed description of the ISO series metadata for the Level 1b SUVI Solar Imagery: EUV product is located in the standalone Appendix X, ISO Series Metadata.

5.2.1.2 Dynamic Source Data

The Level 1b SUVI Solar Imagery: EUV product is derived using the SUVI Level 0 raw science telemetry, SUVI engineering telemetry, and satellite ephemeris related telemetry. This data includes fourteen types of images, as identified in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics.

The primary sensor data used by the Level 1b SUVI Solar Imagery: EUV algorithm is named in Table 5.2.1.5.1-2, Level 1b SUVI Solar Imagery: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_SUVI_L0_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.2.1.3 Level 1b Semi-Static Source Data

There are three categories of semi-static source data employed in the SUVI Level 1b ground processing algorithm:

- Radiometric calibration parameters and images.
- Geometric calibration parameters.

- Algorithm processing parameters.

Semi-static source data files from the three categories above are contained in a single zip file. Some files fit into more than one category. The filename conventions for the Level 1b semi-static source data files are located in Appendix A.

Radiometric calibration parameters and images are those associated with the instrument's radiometric observing characteristics, or its raw outputs. Specific types include:

- Entrance and focal plane filter transmission factors.
- Data collection surface area.
- Wavelength-specific mirror reflectances.
- Wavelength-specific electron to photon and photon to energy conversion factors.
- Wavelength-specific quantum efficiencies.
- Wavelength-specific flat field images used to correct vignetting effects and variation in pixel response.
- Wavelength-specific coefficients used to determine signal loss.
- Contamination thickness coefficients and weights for the 284 and 304 Angstrom wavelengths.
- Solid angle at the SUVI detector pixel subtended by the telescope aperture.
- Per-pixel signal chain non-linearity correction tables as a function of Digital Number.
- Per-pixel electron to Digital Number gain table as a function of CCD temperature for readout amplifiers.
- Weighting factors and coefficients used to compute SUVI CCD temperatures.
- Temperature to gain mapping table.
- Signal to noise ratio, and Digital Number saturation threshold.
- Dark frame CCD temperature validation threshold.
- Bad CCD pixels and columns, and counts thereof.

Following are the file names of radiometric calibration parameters within the zip file. The HDF5 file is internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- PD_L1alpha_SUVI_Corrected_Dark_Image_Predecessor.bin
- PD_L1alpha_SUVI_ Dark_Image_Id_Data_Predecessor.bin
- PD_L1alpha_SUVI_ Median_Dark_Image_Predecessor.bin
- SUVI_CalibrationParameters.h5
-

Geometric calibration parameters are those associated with the precise look angle and size of the instrument's field of view. Specific types include:

- Roll angle offset between the SUVI feet attached to the Sun Pointing Platform (SPP) and SUVI boresight.
- Guide telescope to SUVI telescope offsets in x and y axis directions.
- Wavelength-specific image shift in x and y axis directions caused by offset in corresponding mirror location.
- Correlation between the GT diode x and y axis readings to the sun center pixel location.
- Scale factor for converting pixels to arcseconds (i.e., plate scale).

Following is the file name of geometric calibration parameters within the zip file. The XML file is internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- SUVI_NavigationParameters.xml

Algorithm processing parameters are those associated with configurable decision-making logic in the algorithm related to data identification, data, time, and position thresholds, and conversion factors. Specific types include:

- CCSDS packet Application Process Identifiers (APIDs) for SUVI image data.
- Expected (i.e., commanded) image exposure times.
- Aperture selector encoder valid range.
- Exposure time conversion scale factors.
- Dark frame expiration threshold.
- Number of previous daily EUVS irradiances required for the SUVI-EXIS cross-calibration analysis.
- Exposure time threshold used when correcting image for dark current and bias.
- Filter wheel angle encoder limits and coefficients to convert encoder angle from Digital Number to engineering units.
- Number of rows and columns in leading and trailing edge overscan regions, and final image.
- Pixel buffer to avoid edge effects when calculating bias.
- Service configuration information
- netCDF product template

Following is the file name of geometric calibration parameters within the zip file. The XML and csv files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- SUVI-L1b-PARM_All_v00r00.xml
- suvi-metadata-config.xml
- scaled_conversion.csv

5.2.1.4 Production Notes

The Level 1b SUVI Solar Imagery: EUV product is generated by SUVI Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm decompresses and extracts the raw detector observation and calibration CCD sample data from the CCSDS packets. The Level 1b algorithm removes the overscan region, radiometrically corrects the CCD sample data, performs additional corrections to resolve CCD imperfections and degradations, and the effects of vignetting, and orients the image.

The fourteen types of solar images and dark frame calibration images are observed sequentially by the SUVI in the context of an imaging epoch.

The L1b algorithm executes and product data is generated only when the instrument is in the operational mode. The product is available in netCDF and FITS file formats. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.2.1.5 Data Fields

The Level 1b SUVI Solar Imagery: EUV product is delivered using the netCDF-4 and FITS file formats. This product is the only GOES-R product delivered using the FITS format. A summary level description of the FITS standard and how it is applied for this product is in the main volume of the PUG. The specifications for the netCDF-4 and FITS formatted product files are different. As a result, separate tables are used to convey their content. In addition, there are metadata fields in the Level 1b SUVI Solar Imagery: EUV product related to the physical quantity that varies as a function of the type of solar image. The subordinate paragraphs that follow also include tables for the product characteristics that vary as a function of the type of solar image, and that describe the values and meanings for the flag variables in the product.

The filename conventions for the Level 1b SUVI Solar Imagery: EUV product are located in Appendix A.

5.2.1.5.1 Data Fields for netCDF Format

Table 5.2.1.5.1-1 Level 1b SUVI Solar Imagery: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f5816f57-fd6d-11e3-a3ac-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SUVI L1b Solar Imagery: EUV	string
summary	SUVI L1b Solar Imagery: EUV Products are images of the sun at six wavelengths and multiple radiance level ranges spanning many orders of magnitude in support of viewing the sun during different types of solar activity. Different combinations of aperture positions, mirror coating, filters and exposure periods are used when imaging the sun. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR IMAGERY, ATMOSPHERE > ATMOSPHERIC RADIATION > SOLAR RADIATION, SPECTRAL/ENGINEERING > ULTRAVIOLET WAVELENGTHS > ULTRAVIOLET RADIANCE, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONA, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONA HOLES, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONAL MASS EJECTIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR ACTIVE REGIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR FLARES, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR	string

Global Attribute Name	Value	Type
	PROMINENCES/SOLAR FILAMENTS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR ULTRAVIOLET EMISSIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SUNSPOTS	
cdm_data_type	Image	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Solar Ultraviolet Imager	string
instrument_ID	***serial number of the instrument.***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
spatial_resolution	2.5 arcsec	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.2.1.5.1-2 Level 1b SUVI Solar Imagery: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
CRPIX1	float	n/a	long_name	center of sun pixel, potentially fractional, in image along x-axis (1st axis). center of 1st pixel location = 1.0. provides alignment of image in solar projection	string
			comment	center of sun pixel in image along 1st axis	string
			_FillValue	-999	float
			valid_range	0.5 1280.5	float
			units	1	string
CRPIX2	float	n/a	long_name	center of sun pixel, potentially fractional, in image along y-axis (2nd axis). center of 1st pixel location = 1.0. provides alignment of image in solar projection	string
			comment	center of sun pixel in image along 2nd axis	string
			_FillValue	-999	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			valid_range	0.5 1280.5	float
			units	1	string
CDELT1 ***value = 2.5***	float	n/a	long_name	x-axis (1st axis) detector plate scale at the reference pixel in image	string
			comment	1st axis detector plate scale @ref pix	string
			_FillValue	-999	float
			valid_range	2.5 2.5	float
			units	arcsec	string
CDELT2 ***value = 2.5***	float	n/a	long_name	y-axis (2nd axis) detector plate scale at the reference pixel in image	string
			comment	2nd axis detector plate scale @ref pix	string
			_FillValue	-999	float
			valid_range	2.5 2.5	float
			units	arcsec	string
DIAM_SUN	float	n/a	long_name	sun diameter, potentially fractional, in pixels	string
			comment	sun diameter in pixels	string
			_FillValue	-999	float
			valid_range	752.0 780.0	float
			units	count	string
CUNIT1 ***value = arcsec***	char	detector_plate_scale_units_str_len = 6	long_name	x-axis (1st axis) detector plate scale units	string
			comment	1st axis detector plate scale units	string
CUNIT2 ***value = arcsec***	char	detector_plate_scale_units_str_len = 6	long_name	y-axis (2nd axis) detector plate scale units	string
			comment	2nd axis detector plate scale units	string
ORIENT ***value = SESW***	char	orientation_str_len = 4	long_name	orientation of image in array defined by string indicating side of sun corresponding to array origin corner (0,0) and that defined by x-axis (1st axis) maximum coordinate corner pixel. string contains 4 characters from set N, S, E, W and is a concatenation of the corner for (0,0) pixel and corner for the (0, x-axis maximum coordinate) pixel. solar direction is relative to an observer on earth	string
			comment	orientation of image	string
CROTA	float	n/a	long_name	angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	solar north pole angular offset	string
			_FillValue	-999	float
			valid_range	0.0 359.99999	float
			units	degree	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
SOLAR_B0	float	n/a	long_name	angular offset of the solar equatorial plane relative to center of sun in image (positive values indicate solar equator is in lower half of image)	string
			comment	solar equator angular offset	string
			_FillValue	-999	float
			valid_range	-7.23 7.23	float
			units	degree	string
PC1_1	float	n/a	long_name	1st row, 1st col term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	1st row, 1st col 2D transformation matrix	string
			_FillValue	-999	float
			valid_range	-1.0 1.0	float
			units	1	string
PC1_2	float	n/a	long_name	1st row, 2nd column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	1st row, 2nd col 2D transformation matrix	string
			_FillValue	-999	float
			valid_range	-1.0 1.0	float
			units	1	string
PC2_1	float	n/a	long_name	2nd row, 1st column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	2nd row, 1st col 2D transformation matrix	string
			_FillValue	-999	float
			valid_range	-1.0 1.0	float
			units	1	string
PC2_2	float	n/a	long_name	2nd row, 2nd column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	2nd row, 2nd col 2D transformation matrix	string
			_FillValue	-999	float
			valid_range	-1.0 1.0	float
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
CSYER1	float	n/a	long_name	uncertainty in coordinates due to systematic errors, specifically average guide telescope error signal reading in x-axis (1st axis) over image exposure time	string
			comment	1st axis systematic errors	string
			_FillValue	-999	float
			valid_range	0.0 100.0	float
			units	arcsec	string
CSYER2	float	n/a	long_name	uncertainty in coordinates due to systematic errors, specifically average guide telescope error signal reading in y-axis (2nd axis) over image exposure time	string
			comment	2nd axis systematic errors	string
			_FillValue	-999	float
			valid_range	0.0 100.0	float
			units	arcsec	string
WCSNAME ***value = Helioprojective-cartesian***	char	coord_ref_sys_str_len = 25	long_name	solar image coordinate system type	string
			comment	solar image coordinate system type	string
CTYPE1 ***value = HPLN-TAN***	char	coded_coord_ref_sys_str_len = 8	long_name	HPLN is a helioprojective-cartesian coordinate system centered on observation location. LN indicates longitude varies as function of x-axis (1st axis). TAN is a gnomonic azimuthal projection used for CCD camera from observer perspective	string
			comment	1st axis coordinate system name	string
CTYPE2 ***value = HPLT-TAN***	char	coded_coord_ref_sys_str_len = 8	long_name	HPLT is a helioprojective-cartesian coordinate system centered on observation location. LT indicates latitude varies as function of y-axis (2nd axis). TAN is a gnomonic azimuthal projection used for CCD camera from observer perspective	string
			comment	2nd axis coordinate system name	string
CRVAL1 ***value = 0.0***	float	n/a	long_name	longitude at center of sun in image for projection HPLN-TAN	string
			comment	longitude of sun center for HPLN-TAN	string
			_FillValue	-999	float
			valid_range	0.0 0.0	float
			units	degree	string
CRVAL2 ***value = 0.0***	float	n/a	long_name	latitude at center of sun in image for projection HPLT-TAN	string
			comment	latitude of sun center for HPLT-TAN	string
			_FillValue	-999	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			valid_range	0.0 0.0	float
			units	degree	string
LONPOLE ***value = 180.0***	float	n/a	long_name	native longitude of celestial north pole for sun projection	string
			comment	longitude of celestial north pole	string
			_FillValue	-999	float
			valid_range	180.0 180.0	float
			units	degree	string
TIMESYS ***value = UTC***	char	time_sys_str_len = 3	long_name	principal time system for time related keywords and data	string
			comment	principal time system	string
DATE-OBS	double	n/a	long_name	J2000 epoch start time of observing sun at spacecraft in seconds since 2000-01-01 12:00:00	string
			comment	sun observation start time on sat	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-END	double	n/a	long_name	J2000 epoch end time of observing sun at spacecraft in seconds since 2000-01-01 12:00:00	string
			comment	sun observation end time on sat	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
CMD_EXP	float	n/a	long_name	commanded imaging exposure time	string
			comment	commanded imaging exposure time	string
			_FillValue	-999	float
			valid_range	0.01 1.0	float
			units	s	string
EXPTIME	float	n/a	long_name	actual imaging exposure time	string
			comment	actual imaging exposure time	string
			_FillValue	-999	float
			valid_range	0.008 1.02	float
			units	s	string
OBSGEO-X	float	n/a	long_name	observing platform ECEF X coordinate	string
			comment	observing platform ECEF X coordinate	string
			_FillValue	-99999999	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
OBSGEO-Y	float	n/a	long_name	observing platform ECEF Y coordinate	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			comment	observing platform ECEF Y coordinate	string
			_FillValue	-99999999	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
OBSGEO-Z	float	n/a	long_name	observing platform ECEF Z coordinate	string
			comment	observing platform ECEF Z coordinate	string
			_FillValue	-99999999	float
			valid_range	-7360.0 7360.0	float
			units	m	string
DSUN_OBS	double	n/a	long_name	distance to center of sun from observation location	string
			comment	distance to center of sun	string
			_FillValue	-999	double
			valid_range	146000000000.0 152100000000.0	double
			units	m	string
OBJECT ***value = SUN***	char	object_str_len = 3	long_name	name of object being viewed	string
			comment	object being viewed	string
SCI_OBJ value = ***see note [1]*** ***Default value = "EE_NNNNN_wwwA_NULL_NULL"***	char	science_objective_str_len = 38	long_name	science objective of observation: image wavelength, exposure time and solar activity type	string
			comment	science objective of observation	string
WAVELNTH ***value = see note [1]***	float	n/a	long_name	solar image wavelength	string
			comment	solar image wavelength	string
			_FillValue	-999	float
			valid_range	93.9 303.8	float
			units	angstrom	string
WAVEUNIT ***value = Angstrom***	char	wavelength_unit_str_len = 8	long_name	solar image wavelength units	string
			comment	solar image wavelength units	string
RAD	short	NAXIS2 = 1280 NAXIS1 = 1280	long_name	SUVI L1b Solar Imagery	string
			_FillValue	-32768	short
			sensor_bit_depth	16	byte
			valid_range	***see note [1]***	short
			scale_factor	***see note [1]***	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			add_offset	***see note [1]***	float
			units	W m-2 sr-1	string
DQF	byte	NAXIS2 = 1280 NAXIS1 = 1280	long_name	SUVI L1b Solar Imagery data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			FITS_flag_values	0 1 2 3	string
			flag_meanings	***see note [flags and meanings]***	string
GOOD_PIX	int	n/a	long_name	number of good quality pixels in L1b solar image	string
			comment	number of good quality pixels in image	string
			_FillValue	-1	int
			units	count	string
FIX_PIX	int	n/a	long_name	number of pixels corrected in L1b solar image	string
			comment	number of corrected pixels in image	string
			_FillValue	-1	int
			units	count	string
SAT_PIX	int	n/a	long_name	number of saturated pixels in L1b solar image	string
			comment	number of saturated pixels in image	string
			_FillValue	-1	int
			units	count	string
MISS_PIX	int	n/a	long_name	number of missing pixels in L1b solar image	string
			comment	number of missing pixels in image	string
			_FillValue	-1	int
			units	count	string
IMGTII	float	n/a	long_name	sum of irradiance values of pixels in L1b solar image	string
			comment	total irradiance of image	string
			_FillValue	-999	float
			units	W m-2	string
IMGTIR	float	n/a	long_name	sum of radiance values of pixels in L1b solar image	string
			comment	total radiance of image	string
			_FillValue	-999	float
			units	W m-2 sr-1	string
IMG_MIN	float	n/a	long_name	minimum radiance value of pixels in L1b solar image	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			comment	minimum radiance in image	string
			_FillValue	-999	float
			valid_range	%float_valid_range_min% %float_valid_range_max%	float
			units	W m-2 sr-1	string
IMG_MAX	float	n/a	long_name	maximum radiance value of pixels in L1b solar image	string
			comment	maximum radiance in image	string
			_FillValue	-999	float
			valid_range	%float_valid_range_min% %float_valid_range_max%	float
			units	W m-2 sr-1	string
IMG_MEAN	float	n/a	long_name	mean radiance value of pixels in L1b solar image	string
			comment	mean radiance in image	string
			_FillValue	-999	float
			valid_range	%float_valid_range_min% %float_valid_range_max%	float
			units	W m-2 sr-1	string
IMG_SDEV	float	n/a	long_name	standard deviation of radiance values of pixels in L1b solar image	string
			comment	std dev of radiance in image	string
			_FillValue	-999	float
			units	W m-2 sr-1	string
EFF_AREA	float	n/a	long_name	effective area of telescope (wavelength dependent)	string
			comment	effective telescope area	string
			_FillValue	-999	float
			valid_range	0.0002 0.00045	float
			units	m2	string
APSELPOS	int	n/a	long_name	aperture selector setting (wavelength dependent)	string
			comment	aperture selector setting	string
			_FillValue	-1	int
			valid_range	0 5	int
			units	1	string
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
FILTPOS1	int	n/a	long_name	forward filter wheel setting	string
			comment	forward filter wheel setting	string
			_FillValue	-1	int
			valid_range	0 4	int
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
FILTPOS2	int	n/a	long_name	aft filter wheel setting	string
			comment	aft filter wheel setting	string
			_FillValue	-1	int
			valid_range	0 4	int
			units	1	string
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
FILTER1 value = ***see note [2]***	char	filter_mnemonic_str_len = 14	long_name	forward filter setting mnemonic	string
			comment	forward filter setting mnemonic	string
FILTER2 value = ***see note [2]***	char	filter_mnemonic_str_len = 14	long_name	aft filter setting mnemonic	string
			comment	aft filter setting mnemonic	string
YAW_FLIP	byte	n/a	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			comment	0=upright 1=neither 2=inverted	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
CCD_READ	byte	n/a	long_name	flags indicating the CCD readout configuration	string
			comment	CCD cnfg: 0=no cnfg 1=left amp 2=right amp	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
ECLIPSE	byte	n/a	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			comment	sun eclipse state	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
CONTAMIN	float	n/a	long_name	estimated contamination thickness value in angstroms used to correct image	string
			comment	contamination thickness in angstroms	string
			_FillValue	-999	float
			valid_range	0.0 999.0	float
			units	angstrom	string
CONT_FLG	byte	n/a	long_name	flags indicating whether contamination correction applied	string
			comment	contamination correction: 0=false 1=true	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
CONT_QF	byte	n/a	long_name	flags indicating whether standard contamination correction applied or non-standard or no contamination correction applied between bake-out end and midnight UTC	string
			comment	none, nonstd contam correct: 0=false 1=true	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
DATE-BKE	double	n/a	long_name	J2000 epoch time stamp of when last contamination bake-out ended, in seconds since 2000-01-01 12:00:00	string
			comment	last contamination bake-out end time	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
DER_SNR	float	n/a	long_name	CCD signal to noise ratio for equivalent of 10 photons (wavelength dependent)	string
			comment	CCD signal to noise ratio	string
			_FillValue	-999	float
			valid_range	0.0 999.0	float
			units	W m-2 sr-1	string
SAT_THR	float	n/a	long_name	CCD saturation point (wavelength dependent)	string
			comment	CCD saturation point	string
			_FillValue	-999	float
			valid_range	2.0 40000.0	float
			units	W m-2 sr-1	string
CCD_BIAS	float	n/a	long_name	CCD background electronic noise estimated using mean value of digital numbers in overscan region	string
			comment	CCD background electronic noise	string
			_FillValue	-999	float
			valid_range	0.0 16383.0	float
			units	count	string
CCD_TMP1	float	n/a	long_name	camera temperature during exposure from one of two temperature sensors on the instrument	string
			comment	sensor 1 camera temperature	string
			_FillValue	-999	float
			valid_range	-85.0 50.0	float
			units	degrees_C	string
CCD_TMP2	float	n/a	long_name	camera temperature during exposure from one of two temperature sensors on the instrument	string
			comment	sensor 2 camera temperature	string
			_FillValue	-999	float
			valid_range	-85.0 50.0	float
			units	degrees_C	string
DATE-DFM	double	n/a	long_name	J2000 epoch time stamp of calculated median value dark frame used to calibrate image in seconds since 2000-01-01 12:00:00	string
			comment	median value dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
NDFRAMES	int	n/a	long_name	number of source dark frames used to generate median value dark frame	string
			comment	number of source dark frames	string
			_FillValue	-1	int
			valid_range	1 10	float
			units	count	string
DATE-DF0	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	1st observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF1	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	2nd observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF2	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	3rd observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF3	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	4th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF4	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	5th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF5	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	6th observed dark frame time stamp	string
			_FillValue	-999	double

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF6	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	7th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF7	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	8th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF8	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	9th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
DATE-DF9	double	n/a	long_name	J2000 epoch time stamp of dark frame used to calculate median dark frame: 0-oldest 9-most recent in seconds since 2000-01-01 12:00:00	string
			comment	10th observed dark frame time stamp	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
SOLCURR1	short	n/a	long_name	solar array current in DN for channels 1-4	string
			comment	solar array current chan 1-4 in DN	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
SOLCURR2	short	n/a	long_name	solar array current in DN for channels 5-8	string
			comment	solar array current chan 5-8 in DN	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
SOLCURR3	short	n/a	long_name	solar array current in DN for channels 9-12	string
			comment	solar array current chan 9-12 in DN	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
SOLCURR4	short	n/a	long_name	solar array current in DN for channels 13-16	string
			comment	solar array current chan 13-16 in DN	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
PCTL0ERR	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			comment	uncorrectable L0 error pct	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_SUVI_L0_data	***refer to filename conventions for L0 products in Appendix A***	string

Note 1: Science objective mnemonics, wavelengths, valid range, scale factor, and add offset for the fourteen solar image types are located in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics.
Scale factor and add offset are used together to provide simple data compression to store floating-point data as small integers in a product data file. When these attributes are present, the data is first scaled (i.e., multiplied) before the offset is added. In GOES-R netCDF product files, when scale factor and add offset are used for packing, the associated variable (containing the packed data) is of type short, whereas the unpacked values are intended to be of type float or double. The attributes scale_factor and add_offset are of the type intended for the unpacked data.

Note 2: Forward and after filter setting mnemonics are located in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics.

Note "flags and meanings": Flag values and meanings are located in paragraph 5.2.1.5.4, Level 1b SUVI Solar Imagery: EUV Product Flag Values and Meanings.

5.2.1.5.2 Data Fields for FITS Format

Table 5.2.1.5.2-1 Level 1b SUVI Solar Imagery: FITS Data Fields

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
SIMPLE	T		required first keyword in primary header
BITPIX	16		number of bits in solar image pixels
NAXIS	2		number of axes in solar image
NAXIS1	1280		number of columns in solar image
NAXIS2	1280		number of rows in solar image
EXTEND	T		indication that product file may contain an extension
EXTNAME	DATA		name of the primary header and data unit
EXTVER	1		integer identifier of the primary header and data unit
UUID	***dynamic value***		universally unique identifier for product file instance (same value as NetCDF version of product file instance)
CRPIX1	***dynamic value***	solar image pixels	center of sun pixel, potentially fractional, in image along x-axis (1st axis). center of 1st pixel location = 1.0. provides alignment of image in solar projection
CRPIX2	***dynamic value***	solar image pixels	center of sun pixel, potentially fractional, in image along y-axis (2nd axis). center of 1st pixel location = 1.0. provides alignment of image in solar projection
CDELT1	2.5	arcsec	x-axis (1st axis) detector plate scale at the reference pixel in image
CDELT2	2.5	arcsec	y-axis (2nd axis) detector plate scale at the reference pixel in image
DIAM_SUN	***dynamic value***	solar image pixels	sun diameter, potentially fractional, in pixels
CUNIT1	arcsec		x-axis (1st axis) detector plate scale units
CUNIT2	arcsec		y-axis (2nd axis) detector plate scale units
ORIENT	SESW		orientation of image in array defined by string indicating side of sun corresponding to array origin corner (0,0) and that defined by x-axis (1st axis) maximum coordinate corner pixel. string contains 4 characters from set N, S, E, and W and is a concatenation of the corner for (0,0) pixel and corner for the (0, x-axis maximum coordinate) pixel. solar direction is relative to an observer on earth
CROTA	***dynamic value***	degrees	angular offset of the solar north rotational pole in image with positive values measured clockwise
SOLAR_B0	***dynamic value***	degrees	angular offset of the solar equatorial plane relative to center of sun in image (positive values indicate solar equator is in lower half of image)

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
PC1_1	***dynamic value***		1st row, 1st col term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise
PC1_2	***dynamic value***		1st row, 2nd column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise
PC2_1	***dynamic value***		2nd row, 1st column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise
PC2_2	***dynamic value***		2nd row, 2nd column term in generalized 2x2 linear transformation matrix defining angular offset of the solar north rotational pole in image with positive values measured clockwise
CSYER1	***dynamic value***	arcsec	uncertainty in coordinates due to systematic errors, specifically average guide telescope error signal reading in x-axis (1st axis) over image exposure time
CSYER2	***dynamic value***	arcsec	uncertainty in coordinates due to systematic errors, specifically average guide telescope error signal reading in y-axis (2nd axis) over image exposure time
WCSNAME	Helioprojective-cartesian		solar image coordinate system type
CTYPE1	HPLN-TAN		HPLN is a helioprojective-cartesian coordinate system centered on observation location. LN indicates longitude varies as function of x-axis (1st axis). TAN is a gnomonic azimuthal projection used for CCD camera from observer perspective
CTYPE2	HPLT-TAN		HPLT is a helioprojective-cartesian coordinate system centered on observation location. LT indicates latitude varies as function of y-axis (2nd axis). TAN is a gnomonic azimuthal projection used for CCD camera from observer perspective
CRVAL1	0.0	degrees	longitude at center of sun in image for projection HPLN-TAN
CRVAL2	0.0	degrees	latitude at center of sun in image for projection HPLT-TAN
LONPOLE	180.0	degrees	native longitude of celestial north pole for sun projection
TIMESYS	UTC		principal time system for time related keywords and data
DATE-OBS	***dynamic value***		start time of observing sun at spacecraft
DATE-END	***dynamic value***		end time of observing sun at spacecraft
CMD_EXP	***dynamic value***		commanded imaging exposure time
EXPTIME	***dynamic value***		actual imaging exposure time
OBSGEO-X	***dynamic value***	meters	observing platform ECEF X coordinate
OBSGEO-Y	***dynamic value***	meters	observing platform ECEF Y coordinate

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
OBSGEO-Z	***dynamic value***	meters	observing platform ECEF Z coordinate
DSUN_OBS	***dynamic value***	meters	distance to center of sun from observation location
OBJECT	SUN		name of object being viewed
SCI_OBJ	***see note [1]***		science objective mnemonic of observation: image wavelength, exposure time and solar activity type
WAVELNTH	***see note [1]***	Angstrom	solar image wavelength
WAVEUNIT	Angstrom		solar image wavelength units
GOOD_PIX	***dynamic value***		number of good quality pixels in L1b solar image
FIX_PIX	***dynamic value***		number of pixels corrected in L1b solar image
SAT_PIX	***dynamic value***		number of saturated pixels in L1b solar image
MISS_PIX	***dynamic value***		number of missing pixels in L1b solar image
IMGTII	***dynamic value***	watts per square meter	sum of irradiance values of pixels in L1b solar image
IMGTIR	***dynamic value***	watts per square meter per steradian	sum of radiance values of pixels in L1b solar image
IMG_MIN	***dynamic value***	watts per square meter per steradian	minimum radiance value of pixels in L1b solar image
IMG_MAX	***dynamic value***	watts per square meter per steradian	maximum radiance value of pixels in L1b solar image
IMG_MEAN	***dynamic value***	watts per square meter per steradian	mean radiance value of pixels in L1b solar image
IMG_SDEV	***dynamic value***	watts per square meter per steradian	standard deviation of radiance values of pixels in L1b solar image
EFF_AREA	***configured value***	square meters	effective area of telescope (wavelength dependent)
APSELPOS	***see note [flags and meanings]***		aperture selector setting (wavelength dependent)
FILTPOS1	***see note [flags and meanings]***		forward filter wheel setting
FILTPOS2	***see note [flags and meanings]***		aft filter wheel setting
FILTER1	***see note [2]***		forward filter setting mnemonic
FILTER2	***see note [2]***		aft filter setting mnemonic
YAW_FLIP	***dynamic value***		flags indicating whether spacecraft is operating in yaw flip configuration: 0=upright 1=neither 2=inverted
CCD_READ	***see note [flags and meanings]***		flags indicating the CCD readout configuration: 0=no cnfg 1=left amp 2=right amp
ECLIPSE	***dynamic value***		flags indicating whether sun is obscured by earth as provided by spacecraft: 0= no eclipse 1=penumbra, preceding full eclipse 2 = umbra, full eclipse 3 = penumbra, following full eclipse
CONTAMIN	***dynamic value***	Angstrom	estimated contamination thickness value in angstroms used to correct image

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
CONT_FLG	***dynamic value***		flags indicating whether contamination correction applied: 0=false 1=true
CONT_QF	***see note [flags and meanings]***		flags indicating whether standard contamination correction applied or non-standard or no contamination correction applied between bake-out end and midnight UTC: 0=false 1=true
DATE-BKE	***dynamic value***		time stamp of when last contamination bake-out ended
DER_SNR	***configured value***	watts per square meter per steradian	CCD signal to noise ratio for equivalent of 10 photons (wavelength dependent
SAT_THR	***configured value***	watts per square meter per steradian	CCD saturation point (wavelength dependent)
CCD_BIAS	***dynamic value***		CCD background electronic noise estimated using mean value of digital numbers in overscan region
CCD_TMP1	***dynamic value***	degrees Celsius	camera temperature during exposure from one of two temperature sensors on the instrument
CCD_TMP2	***dynamic value***	degrees Celsius	camera temperature during exposure from one of two temperature sensors on the instrument
DATE-DFM	***dynamic value***		time stamp of calculated median value dark frame used to calibrate image
NDFRAMES	***dynamic value***		number of source dark frames (1-10) used to generate median value dark frame
DATE-DF0	***dynamic value***		time stamp of dark frame used to calculate median dark frame 0: 0-oldest 9-most recent
DATE-DF1	***dynamic value***		time stamp of dark frame used to calculate median dark frame 1: 0-oldest 9-most recent
DATE-DF2	***dynamic value***		time stamp of dark frame used to calculate median dark frame 2: 0-oldest 9-most recent
DATE-DF3	***dynamic value***		time stamp of dark frame used to calculate median dark frame 3: 0-oldest 9-most recent
DATE-DF4	***dynamic value***		time stamp of dark frame used to calculate median dark frame 4: 0-oldest 9-most recent
DATE-DF5	***dynamic value***		time stamp of dark frame used to calculate median dark frame 5: 0-oldest 9-most recent
DATE-DF6	***dynamic value***		time stamp of dark frame used to calculate median dark frame 6: 0-oldest 9-most recent
DATE-DF7	***dynamic value***		time stamp of dark frame used to calculate median dark frame 7: 0-oldest 9-most recent

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
DATE-DF8	***dynamic value***		time stamp of dark frame used to calculate median dark frame 8: 0-oldest 9-most recent
DATE-DF9	***dynamic value***		time stamp of dark frame used to calculate median dark frame 9: 0-oldest 9-most recent
SOLCURR1	***dynamic value***	digital numbers	solar array current in DN for channel 1
SOLCURR2	***dynamic value***	digital numbers	solar array current in DN for channel 2
SOLCURR3	***dynamic value***	digital numbers	solar array current in DN for channel 3
SOLCURR4	***dynamic value***	digital numbers	solar array current in DN for channel 4
PCTL0ERR	***dynamic value***	percent	percent data lost due to uncorrectable L0 errors
FILENAME	***dynamic value***		refer to filename conventions for L1b products in Appendix A
NAMEAUTH	gov.nesdis.noaa		naming authority for product
LONGSTRN	OGIP 1.0		OGIP Long String Keyword Convention may be used in product file
ORIGIN	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services		institution responsible for product
PROJECT	GOES		project controlling data access and distribution restrictions
ISO_META	f5816f57-fd6d-11e3-a3ac-0800200c9a66		ISO series metadata identifier for product
KEYVOCAB	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0		keywords vocabulary used for KEYWORDS value
TITLE	SUVI L1b Solar Imagery: EUV		title of product
SUMMARY	SUVI L1b Solar Imagery: EUV Products are images of the sun at six wavelengths and multiple radiance level ranges spanning many orders of magnitude in support of viewing the sun during different types of solar activity. Different combinations of aperture positions, mirror		summary description of product

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
	coating, filters and exposure periods are used when imaging the sun. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.		
LICENSE	Unclassified data. Access is restricted to approved users only.		data access and distribution restrictions for product file
KEYWORDS	SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR IMAGERY, ATMOSPHERE > ATMOSPHERIC RADIATION > SOLAR RADIATION, SPECTRAL/ENGINEERING > ULTRAVIOLET WAVELENGTHS > ULTRAVIOLET RADIANCE, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONA, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONA HOLES, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > CORONAL MASS EJECTIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR ACTIVE REGIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR FLARES, SUN-EARTH		keywords for retrieval/query purposes

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
	INTERACTIONS > SOLAR ACTIVITY > SOLAR PROMINENCES/SOLAR FILAMENTS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR ULTRAVIOLET EMISSIONS, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SUNSPOTS		
TELESCOP	***configured value***		possible values are G16 and G17
INSTRUME	GOES-R Series Solar Ultraviolet Imager		type of instrument
INST_ID	***dynamic value***		serial number of the instrument
LEVEL	National Aeronautics and Space Administration (NASA) L1b		processing level associated with product
DATE	***dynamic value***		time stamp for product file creation
PRODSITE	***configured value***		production site (WCDAS or RBU)
PROD_ENV	***configured value***		production environment (OE, ITE, or DE)
DATA_SRC	***configured value***		production data source (Realtime, Simulated, Playback, or Test)
BLANK	-32768		solar image pixel fill value
BSCALE	***see note [1]***		scale factor to multiply the solar image pixel value by to convert to physical measurement units
BZERO	***see note [1]***		once scale factor has been applied, add this value to convert to physical measurement units
END			required last keyword in primary header
Primary Data Unit (1,138 2880-byte blocks)			
The solar image whose dimensions are defined by the values of the NAXIS1 and NAXIS2 keywords in the primary header is stored here. The size of each pixel in bits is defined by the value of the BITPIX keyword in the primary header. The relationship between the order of the image columns (axis 1), which varies most frequently, and image rows (axis 2), and solar north, south, west, and east is defined by the value of the ORIENT keyword. The solar image pixels in the primary data unit are scaled integers. The values associated with keywords BSCALE and BZERO are used to convert to physical measurement units. The units of the solar imagery are watts per square meter per steradian.			
Extension Header (1 2880-byte block)			
Keyword	**Value**	**Units (where applicable)**	**Description**
XTENSION	IMAGE		required first keyword in extension header identifying the type of data in the extension data unit

Primary Header (3 2880-byte blocks)			
Keyword	**Value**	**Units (where applicable)**	**Description**
BITPIX	8		number of bits in solar image data quality flag values
NAXIS	2		number of axes in solar data quality flag array (a.k.a. image)
NAXIS1	1280		number of columns in solar data quality flag array (a.k.a. image)
NAXIS2	1280		number of rows in solar data quality flag array (a.k.a. image)
PCOUNT	0		value used to support calculation of the size of the extension data unit (refer to paragraph 4.4.1.2 in the FITS standard)
GCOUNT	1		value used to support calculation of the size of the extension data unit (refer to paragraph 4.4.1.2 in the FITS standard)
EXTNAME	DQF		name of the extension header and data unit
EXTVER	1		integer identifier of the extension header and data unit
FLAGVAL	***see note [flags and meanings]***		string consisting of blank separated list of possible solar image data quality flag values
LONGSTRN	OGIP 1.0		OGIP Long String Keyword Convention may be used in product file
FLAGMEAN	***see note [flags and meanings]***		string consisting of blank separated list of possible solar image data quality flag meaning in order corresponding to FLAGVAL string immediately above
END			required last keyword in extension header
Extension Data Unit (569 2880-byte blocks)			
Each solar image pixel has a corresponding data quality flag value. This data quality flag array (a.k.a. image) is stored here and its organization mirrors the solar image in the primary data unit.			

Note 1: Science objective mnemonics, wavelengths, valid range, scale factor, and add offset for the fourteen solar image types are located in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics.
Note 2: Forward and after filter setting mnemonics are located in paragraph 5.2.1.5.3, Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics.
Note "flags and meanings": Flag values and meanings are located in paragraph 5.2.1.5.4, Level 1b SUVI Solar Imagery: EUV Product Flag Values and Meanings.

CONTINUE, COMMENT, and LONGSTRN keywords are used but not shown. The fill values for all keyword values except the "DATE-" keywords are located in the netCDF definition of the product in Table 5.2.1.5.1-2, Level 1b SUVI Solar Imagery: Variables. The "DATE-" keyword fill value is "2000-01-01T11:43:21.000".

5.2.1.5.3 Level 1b SUVI Solar Imagery: EUV Product Quantity Characteristics

The following table allows users to convert the integer-based SUVI L1b Solar Imagery data into physical units. These data are stored in the RAD variable. The conversion is accomplished by multiplying the value of the RAD variable by the appropriate Scale Factor then adding the Add Offset.

Table 5.2.1.5.3-1 Level 1b SUVI Solar Imagery: EUV Product Characteristics

		Scaled Integer to Physical Quantity Conversion		Valid Range (packed - scaled integer form)		Valid Range (in units of physical quantity)	
Science Objective Mnemonic	Wavelength (in angstrom)	Scale Factor	Add Offset	Minimum	Maximum	Minimum	Maximum
Fe_XVIII_93.9A_short_flare_exposure	93.9	7.3244424	0.0	-5	32767	-5.0	40000.0
Fe_XVIII_93.9A_short_exposure	93.9	0.18311106	0.0	-410	32767	-5.0	400.0
Fe_XVIII_93.9A_long_exposure	93.9	0.002288888	0.0	-8192	32767	-1.0	4
Fe_XX_131.2A_short_flare_exposure	131.2	2.3499253	0.0	-6	32767	-5.0	30000.0
Fe_XX_131.2A_short_exposure	131.2	0.12512589	0.0	-103	32767	-5.0	400.0
Fe_XX_131.2A_long_exposure	131.2	0.001678518	0.0	-8192	32767	-1.0	4.0
Fe_IX_171.1A_short_flare_exposure	171.1	0.024414808	0.0	-205	32767	-5.0	800.0
Fe_IX_171.1A_long_exposure	171.1	0.00061037	0.0	-8192	32767	-1.0	4.0
Fe_XII_195.1A_short_flare_exposure	195.1	0.012207404	0.0	-205	32767	-5.0	800.0
Fe_XII_195.1A_long_exposure	195.1	0.000762963	0.0	-8192	32767	-1.0	4.0
Fe_XV_284.2A_short_flare_exposure	284.2	0.06408887	0.0	-137	32767	-5.0	1200.0
Fe_XV_284.2A_long_exposure	284.2	0.002136296	0.0	-8192	32767	-1.0	4.0
He_II_303.8A_short_flare_exposure	303.8	0.5676443	0.0	-127	32767	-5.0	1300.0
He_II_303.8A_long_exposure	303.8	0.005188147	0.0	-8192	32767	-1.0	4.0

Note that the values in this table were extrapolated from the SUVI vendor Critical Design Review package, which contained the anticipated radiometric range of each of the image types in units of photons/sec/pixel, and leveraging the accuracy provided by a 16 bit signed integer. Note that the values in this table reflect pre-launch nominal values.

Note: changes to the Science Objective Mnemonic are effective with build DO.07.00.00.

Table 5.2.1.5.3-2 Level 1b SUVI Solar Imagery: Filter Setting Mnemonics

Forward Filter Variable/Keyword Value (FILTPOS1)	Forward Filter Variable/Keyword Meaning (FILTER1)	Aft Filter Variable/Keyword Value (FILTPOS2)	Aft Filter Variable/Keyword Meaning (FILTER2)
0	thick_aluminum	0	thick_aluminum
1	open	1	fused_silica

Forward Filter Variable/Keyword Value (FILTPOS1)	Forward Filter Variable/Keyword Meaning (FILTER1)	Aft Filter Variable/Keyword Value (FILTPOS2)	Aft Filter Variable/Keyword Meaning (FILTER2)
2	thin_aluminum	2	open
3	thin_zirconium	3	thin_aluminum
4	thick_zirconium	4	thin_zirconium

5.2.1.5.4 Level 1b SUVI Solar Imagery: EUV Product Flag Values and Meanings

Table 5.2.1.5.4-1 Level 1b SUVI Solar Imagery: EUV Product Data Quality Flag Values and Meanings

Data Quality Flags (DQF)	
Flag Value	**Flag Meaning**
0	good_quality_qf
1	degraded_due_to_bad_pixel_correction_qf
2	degraded_due_to_bad_column_correction_qf
3	invalid_due_to_missing_L0_data_qf

Table 5.2.1.5.4-2 Level 1b SUVI Solar Imagery: EUV Product Aperture Selector Position Flag Values and Meanings

Aperture Selector Settings (APSELPOS)	
Flag Value	**Flag Meaning**
0	93.9_angstrom
1	131.2_angstrom
2	171.1_angstrom
3	195.1_angstrom
4	284.2_angstrom
5	303.8_angstrom

The Level 1b SUVI Solar Imagery: EUV Product Forward Filter Position Flag Values and Meanings are identified in Table 5.2.1.5.3-2 Level 1b SUVI Solar Imagery: Filter Setting Mnemonics (FILTPOS1/FILTER1). The Level 1b SUVI Solar Imagery: EUV Product Aft Filter Position Flag Values and Meanings are identified in Table 5.2.1.5.3-2 Level 1b SUVI Solar Imagery: Filter Setting Mnemonics (FILTPOS2/FILTER2).

Table 5.2.1.5.4-3 Level 1b SUVI Solar Imagery: EUV Product CCD Readout Flag Values and Meanings

CCD Readout Settings (CCD_READ)	
Flag Value	**Flag Meaning**
0	not_configured
1	left_readout_amplifier
2	right_readout_amplifier

Table 5.2.1.5.4-4 Level 1b SUVI Solar Imagery: EUV Product Contamination Correction State Flag Values and Meanings

Contamination Correction State Flags (CONT_FLG)	
Flag Value	**Flag Meaning**
0	FALSE
1	TRUE

Table 5.2.1.5.4-5 Level 1b SUVI Solar Imagery: EUV Product Contamination Correction Quality Flag Values and Meanings

Contamination Correction Quality Flags (CONT_QF)	
Flag Value	**Flag Meaning**
0	standard_contamination_correction_applied
1	nonstandard_or_no_contamination_correction_applied_between_bakeout_end_and_midnight_UTC

Table 5.2.1.5.4-5 Level 1b SUVI Solar Imagery: EUV Product Eclipse Flag Values and Meanings

Eclipse Flags (ECLIPSE)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.2.1.5.4-6 Level 1b SUVI Solar Imagery: Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (YAW_FLIP)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.2.2 Instrument Calibration Data: SUVI Engineering Telemetry

5.2.2.1 Description

The SUVI Instrument Engineering Telemetry Data file contains data used to support the generation of SUVI Level 1b products, and monitor and evaluate the health and performance of the instrument. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. Most of the data pertains to the temperature of components in the instrument. This includes temperatures for the guide telescope, door mechanism, supporting structure, shutter, aperture, filter wheels, mirrors, electronics, and CCD. CCD bias voltages are also included.

Temperatures are expressed in units of kelvin, and voltages are in units of volts. Table C.2, SUVI Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter.

A netCDF-4 file containing this SUVI engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the SUVI Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.2.2.2 Data Fields

Refer to paragraph 5.1.5.2, Data Fields in the Instrument Calibration Data: ABI Engineering Telemetry section, as the identical file specification is used except all references to ABI are replaced with SUVI.

5.2.3 Instrument Calibration Data: SUVI Dark Frame Data

5.2.3.1 Description

The SUVI Dark Frame Data file contains an image produced by the SUVI with the camera's shutter closed. A dark frame measures the inherent bias and noise in the camera electronics, and is used to identify, track, and monitor permanently bad pixels. Dark frames are collected in the operational imaging epoch of the SUVI, and support the radiometric correction of the solar imagery products. Up to ten dark frames are used to support of radiometrically correcting individual solar images.

A netCDF-4 file containing this SUVI dark frame data can be generated twice per SUVI imaging epoch, but may vary.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the SUVI Dark Frame Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.2.3.2 Data Fields

The SUVI Dark Frame Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables are subordinate paragraphs containing tables that describe the values and meanings for the flag variables in the data file.

The filename conventions for the SUVI Dark Frame Data file are located in Appendix A.

Table 5.2.3.2-1 SUVI Dark Frame Data File: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SUVI Dark Frame Calibration Data	string
summary	SUVI dark frame calibration data and statistics, and related instrument configuration data.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Solar Ultraviolet Imager	string
instrument_ID	***serial number of the SUVI instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.2.3.2-2 SUVI Dark Frame Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
image_time	double	n/a	long_name	J2000 epoch start time of SUVI dark frame in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
exposure_time	short	n/a	long_name	SUVI actual dark frame exposure time	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	10 1000	short
			units	ms	string
readout_side	byte	n/a	long_name	flags indicating the CCD readout configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
apid	short	n/a	long_name	raw data downlink CCSDS APID SUVI dark frame is received	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	802 815	short
			units	1	string
image	short	y_size=1330 x_size=1292	long_name	SUVI dark frame calibration data (in digital numbers)	string
			_FillValue	-32768	short
			valid_range	0 16383	short
			units	count	string
DQF	byte	y_size=1330 x_size=1292	long_name	SUVI dark frame calibration data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
image_min	short	n/a	long_name	minimum digital number in dark frame calibration data	string
			_FillValue	-32768	short

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			valid_range	0 16383	short
			units	count	string
image_max	short	n/a	long_name	maximum digital number in dark frame calibration data	string
			_FillValue	-32768	short
			valid_range	0 16383	short
			units	count	string
image_mean	float	n/a	long_name	maximum digital number in fdark frame calibration data	string
			_FillValue	-999	float
			valid_range	0.0 16383.0	float
			units	count	string
image_stddev	float	n/a	long_name	standard deviation of digital numbers in dark frame calibration data	string
			_FillValue	-999	float
			units	count	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.2.3.2.1, SUVI Dark Frame Data Flag Values and Meanings.

5.2.3.2.1 SUVI Dark Frame Data Flag Values and Meanings

Table 5.2.3.2.1-1 SUVI Dark Frame Data Quality Flag Values and Meanings

Data Quality Flags (DQF)	
Flag Value	Flag Meaning
0	good
1	missing

Table 5.2.3.2.1-2 SUVI Dark Frame Data CCD Readout Flag Values and Meanings

CCD Readout Settings (readout_side)	
Flag Value	Flag Meaning
0	not_configured
1	left_readout_amplifier
2	right_readout_amplifier

5.2.4 Instrument Calibration Data: SUVI Miscellaneous Frame Data

5.2.4.1 Description

The SUVI Miscellaneous Frame Data file contains a special image produced by the SUVI to support several calibration related activities. Specific types of images include glass, flat-field, and light transfer curve.

These images are used to find the solar limb for alignment and solar coordinate purposes, support radiometric correction of the solar images, measure differences in pixel to pixel sensitivities across the CCD, measure gain constant and linearity of the CCD, cross-calibrate with EXIS, check focus, find leaks, and support other tests in support of anomaly resolution. Visible light images and those images required for EXIS cross-calibration are collected at least daily. Flat field images are collected semi-annually. Images to support light transfer measurements are collected quarterly and during eclipses. Checking focus is performed annually, at a minimum. These images can be collected during normal operations using designated calibration slots in the SUVI imaging epoch. The specific types of SUVI miscellaneous calibration frames are identified in paragraph 5.2.4.2.1, SUVI Miscellaneous Frame Data Quantity Characteristics.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the SUVI Miscellaneous Frame Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.2.4.2 Data Fields

The SUVI Miscellaneous Frame Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables are subordinate paragraphs containing tables that describe the types of miscellaneous frames, and values and meanings for the flag variables in the data file.

The filename conventions for the SUVI Miscellaneous Frame Data file are located in Appendix A.

Table 5.2.4.2-1 SUVI Miscellaneous Frame Data File: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SUVI Miscellaneous Calibration Frame Data	string
summary	SUVI miscellaneous calibration frame data (flat-field, focus, leak, test, etc.) and statistics, and related instrument configuration data.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Solar Ultraviolet Imager	string
instrument_ID	***serial number of the SUVI instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.2.4.2-2 SUVI Miscellaneous Frame Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
image_time	double	n/a	long_name	J2000 epoch start time of SUVI miscellaneous calibration frame in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
exposure_time	short	n/a	long_name	SUVI actual miscellaneous calibration frame exposure time	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	1 1000	short
			units	ms	string
band_wavelength	float	n/a	long_name	SUVI miscellaneous calibration frame wavelength	string
			_FillValue	-999	float
			valid_range	93.9 303.8	double
			units	angstrom	string
filterwheel1_position	short	n/a	long_name	forward filter wheel setting	string
			_FillValue	-1	short
			valid_range	0 4	short
			units	1	string
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string
filterwheel2_position	short	n/a	long_name	aft filter wheel setting	string
			_FillValue	-1	short
			valid_range	0 4	short
			units	1	string
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string
readout_side	byte	n/a	long_name	flags indicating the CCD readout configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
apid ***see note [1]***	short	n/a	long_name	raw data downlink CCSDS APID SUVI miscellaneous calibration frame is received	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	802 815	short
			units	1	string
image	short	y_size=1330 x_size=1292	long_name	SUVI miscellaneous calibration frame data (in digital numbers)	string
			_FillValue	-32768	short
			valid_range	0 16383	short
			units	count	string
DQF	byte	y_size=1330 x_size=1292	long_name	SUVI miscellaneous calibration frame data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
image_min	short	n/a	long_name	minimum digital number in miscellaneous calibration frame data	string
			_FillValue	-32768	short
			valid_range	0 16383	short
			units	count	string
image_max	short	n/a	long_name	maximum digital number in miscellaneous calibration frame data	string
			_FillValue	-32768	short
			valid_range	0 16383	short
			units	count	string
image_mean	float	n/a	long_name	maximum digital number in miscellaneous calibration frame data	string
			_FillValue	-999	float
			valid_range	0.0 16383.0	float
			units	count	string
image_stddev	float	n/a	long_name	standard deviation of digital numbers in miscellaneous calibration frame data	string
			_FillValue	-999	float
			units	count	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note 1: APID value identifies the type of calibration frame, which are identified in paragraph 5.2.4.2.1, SUVI Miscellaneous Frame Data Quantity Characteristics.

Note "flags and meanings": Flag values and meanings are located in paragraph 5.2.4.2.2, SUVI Miscellaneous Frame Data Flag Values and Meanings.

5.2.4.2.1 SUVI Miscellaneous Frame Data Quantity Characteristics

Table 5.2.4.2.1 SUVI Miscellaneous Calibration Frame Types

CCSDS Packet APID (apid) (hexadecimal values)	Calibration Frame Type
0x323	Front Filter Light Leak Glass
0x324	Analysis Filter Light Leak
0x325	Miscellaneous Test Image via Spacecraft Test and Operations Language
0x326	One Second Test Sequence
0x327	Non Frame Definition Block TAP (manual image readout)
0x328	Long and Short Flat-Field
0x329	Flat-Field Glass
0x32A	Miscellaneous Test Images via Sequence (excludes one second test sequences)
0x32B	Guide Telescope / EUV Telescope Cross Calibration Long Limb Tracking Glass
0x32C	LED Light Transfer Image (readout with shutter open) Solar Light Transfer Image (readout with shutter open)
0x32D	One Millisecond Yaw Flip
0x32E	Bakeout Long Tracking
0x32F	Focus Check

5.2.4.2.2 SUVI Miscellaneous Frame Data Flag Values and Meanings

Table 5.2.4.2.2-1 SUVI Miscellaneous Frame Data Quality Flag Values and Meanings

Data Quality Flags (DQF)	
Flag Value	**Flag Meaning**
0	good
1	missing

Table 5.2.4.2.2-2 SUVI Miscellaneous Frame Data CCD Readout Flag Values and Meanings

CCD Readout Settings (readout_side)	
Flag Value	**Flag Meaning**
0	not_configured
1	left_readout_amplifier
2	right_readout_amplifier

Table 5.2.4.2.2-3 SUVI Miscellaneous Frame Data Forward Filter Position Flag Values and Meanings

Forward Filter Position Settings (filterwheel1_position)	
Flag Value	**Flag Meaning**
0	thick_aluminum
1	open
2	thin_aluminum
3	thin_zirconium
4	thick_zirconium

Table 5.2.4.2.1-4 SUVI Miscellaneous Frame Data Aft Filter Position Flag Values and Meanings

Aft Filter Position Settings (filterwheel2_position)	
Flag Value	**Flag Meaning**
0	thick_aluminum
1	fused_silica
2	open
3	thin_aluminum
4	thin_zirconium

5.3 EXIS Level 1b Products and Data

5.3.1 Solar Flux: Extreme Ultraviolet Product

5.3.1.1 Description

The Solar Flux: EUV product contains a 23 bin solar irradiance spectrum proxy model that covers the wavelength range of 5 to 127 nm over successive 30 second observation intervals. The product includes processing and data quality information associated with the availability and characteristics of the observation data received from the EUVS and XRS, the generation of the spectrum proxy model, and whether geocorona absorption occurred during the 30 second observation interval. The definition of the spectrum proxy model wavelength bins is located in paragraph 5.3.1.5.1, Solar Flux: EUV Product Quantity Characteristics.

The units of measure for the solar irradiance spectrum proxy model values are "watts per square meter per nanometer".

The precise look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are available from the Product Distribution and Access system.

The Solar Flux: EUV performance requirements are summarized in Table 5.3.1.1, Solar Flux: EUV Performance Requirements.

Table 5.3.1.1 Solar Flux: EUV Performance Requirements

	Measurement			Mapping
Region	**Range**	**Accuracy**	**Precision**	**Uncertainty**
solar disk	1/2 solar minimum to 10 times solar maximum	20% at the specified minimum flux	20%	+/- 2 arcmin

Metadata in the Solar Flux: EUV product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product. The 30 second observation interval starts at the beginning of the wall clock minute or at the 30 second mark in the wall clock minute.
- Satellite location, spacecraft ACRF to J2000 ECI attitude quaternion, and earth to sun distance.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Mean Sun Positioning Sensor (SPS) dispersion and cross-dispersion angles over the 30 second observation interval.
- Wavelength ranges for each of the spectrum proxy model bins.
- Number of Solar Flux: X-Ray reports used, and EUVS-A, EUVS-B, and EUVS-C observations used in the generation of the spectrum proxy model.
- Number of good quality XRS-A, XRS-B, EUVS-A, and EUVS-B irradiance values, and Mg II core-to-wing ratio values used in the generation of the spectrum proxy model.
- Quality information for the Solar Flux: X-Ray, EUVS-A, EUVS-B, and EUVS-C L1b processing and data used in the generation of the spectrum proxy model.
- Mean XRS-A, XRS-B, EUVS-A, and EUVS-B irradiance values, and EXIS and NOAA Mg II core-to-wing ratio values over the 30 second observation interval.
- Mean XRS-A, XRS-B, EUVS-A, and EUVS-B irradiance values, and NOAA Mg II core-to-wing ratio values over the previous 24 hours.

- Mean temperature of the EUVS-A, EUVS-B, and EUVS-C detectors over the 30 second observation interval.

The detailed description of the ISO series metadata for the Solar Flux: EUV product is located in the standalone Appendix X, ISO Series Metadata.

5.3.1.2 Dynamic Source Data

The Solar Flux: EUV product is derived using EUVS Level 0 raw science telemetry, XRS Level 1b Solar Flux: X-Ray product data, EXIS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Solar Flux: EUV algorithm is named in Table 5.3.1.5-2, Solar Flux: EUV: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_EUVS_L0_data" and attribute_name "input_XRS_L1b_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.3.1.3 Level 1b Semi-Static Source Data

There are three categories of semi-static source data employed in the EUVS Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Solar calibration parameters.
- Model processing parameters.

Semi-static source data files from the three categories above are contained in a single zip file, rolled up to the instrument level - all EXIS semi-static parameter files are in one zip file. Some files fit into more than one category. The filename conventions for the Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are used by the algorithms to calibrate the raw signals recorded by the instrument components into engineering units. The EUVS instrument is composed of three sensor subcomponents: EUVS-A, EUVS-B, and EUVS-C. In addition, EUVS-C is composed of two separate channels: EUVS-C1 and EUVS-C2. Specific types of sensor calibration parameters for the sensor subcomponents are defined in Table 5.3.1.3, EUVS Sensor Calibration Parameters. This table also specifies whether a parameter is applicable to all sensor subcomponents, associated with the parent instrument, or with one of the EUVS-C channel subcomponents.

Table 5.3.1.3 EUVS Sensor Calibration Parameters

Description of Parameter(s)	EUVS-A	EUVS-B	EUVS-C	EUVS-C1	EUVS-C2
Number of sensor photodiodes	x	x	x		
Number of diode layout table columns	x	x			
Number of sensor channels			x		
Number of solar emission lines	x	x			
Number of filter wheel positions for acceptable solar viewing	x	x		x	x
Number of days in the in-flight gain correction factor tables	x	x			
Number of samples in the linear gain correction factor tables	x	x	x		

Description of Parameter(s)	EUVS-A	EUVS-B	EUVS-C	EUVS-C1	EUVS-C2
Number of Digital Number samples in the temperature look-up tables	x	x	x		
Number of angles in the field of view correction factor tables	x	x			
Number of polynomial coefficients used to evaluate the flatfield and degradation corrections for each diode	x	x	x		
Number of polynomial coefficient used by the flatfield and degradation correction computations	x	x			
Number of Gaussian curve-fitting parameters			x		
Number of pixel modes requiring decoding			x		
Number of pixel modes indicating non-science data			x		
Number of flush-dead count pairs requiring addition of an extra time shift			x		
Processing intervals	x	x	x		
Time intervals for retaining previous raw dark diode signals	x	x			
Time interval for retaining previous masked dark diode signal averages			x		
Filter wheel absolute step numbers indicating that the filter position allows sunlight to detector	x	x		x	x
Absolute step number indicating that the door is closed	x	x	x		
Instrument invalid flag processing values	x	x	x		
Minimum and maximum bad dispersion and cross-dispersion angle thresholds	x	x	x		
Minimum and maximum degraded and warning dispersion and cross-dispersion angle thresholds	x	x			
Valid integration time threshold for processing	x	x			
Valid detector change count thresholds for processing	x	x	x		
Diode layout table mapping to ASIC and solar lines	x	x			
Sensor integration time calibration parameters	x	x	x		
Temperature calibration tables	x	x		x	x
Detector low and high temperature thresholds	x	x	x		
Mask identifying diodes used in the solar line processing	x	x			
Saturation threshold value for the solar line diode signals	x	x			
Minimum dark-corrected current amplitude threshold of solar line diodes	x	x			
Temperature-dependent pre-flight gain coefficients tables	x	x			
Time-dependent gain correction factor tables	x	x			
Amplitude-dependent signal linearity correction factor tables	x	x		x	x
Time-dependent flatfield correction coefficient tables	x	x		x	x

Description of Parameter(s)	EUVS-A	EUVS-B	EUVS-C	EUVS-C1	EUVS-C2
Time-dependent degradation correction coefficient tables	x	x			
Uncalibrated diode electrometer signal table	x	x			
Temperature-dependent diode thermal dark signal tables	x	x			
Dark diode weighting factors	x	x			
Diode dark current scaling factor tables	x	x			
Diode scattering light correction current tables	x	x		x	x
Diode order sorting correction current tables	x	x			
Split-diode identification table	x	x			
Filter-dependent diode sensor responsivity table	x				
Filter-independent diode sensor responsivity table		x			
Instrument field of view dispersion and cross-dispersion correction factor angle tables	x	x			
Instrument field of view dispersion and cross-dispersion correction factor tables	x	x			
Pixel mode identification parameters			x		
Diode signal offset for pixel decode mode			x		
Signal amplitude threshold for particle-filtering algorithm			x		
Active photodiode to blue wing, red wing, h-line, k-line, and masked region mappings				x	x
Low signal threshold value for the raw amplitudes of the photodiodes in the blue wing, red wing, h-line, and k-line regions				x	x
Saturation signal threshold value for the raw amplitudes of the photodiodes in the blue wing, red wing, h-line, and k-line regions				x	x
Diode dark flatfield correction tables				x	x
Diode dark signal offset tables				x	x
Diode red- and blue-wing weighting factor table				x	x
Initial Gaussian fitting parameters determining the Mg II h-line and k-line spectral peak regions			x		
Diode wavelength table for the Mg II h-line and k-line spectral peak regions			x		
Scale and offset values to convert the Mg II core-to-wing ratio from the EXIS resolution to the NOAA historical record			x		
Geocoronal absorption start and end time		x			

Following are the file names of sensor calibration parameters within the zip file. XML and HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- EUVSA_Cal_INR.h5
- EUVSB_Cal_INR.h5
- EUVSC_Cal_INR.h5
- ESPEC_Cal_INR.h5

Solar calibration parameters are those associated with the distance, on a daily basis, between the earth and the sun.

Following is the file name containing solar calibration parameters within the zip file. The HDF5 and XML files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- 1AU_Correction_Data.h5

Model processing parameters are those associated with the EUV spectrum proxy model. Specific types include:

- Number of wavelength bins in the EUV spectrum proxy model.
- Lower and upper limit for each of the wavelength bins in the EUV spectrum proxy model.
- Number of proxies used in EUV spectrum generation.
- EUV spectrum generation sensor data collection interval.
- Time intervals required to compute the averages for each of the trailing proxies.
- Minimum XRS-A, XRS-B, EUVS-A, and EUVS-B irradiance values used to calculate the slower time-average variability.
- Minimum EUVS-C NOAA Mg II core-to-wing ratio value used to calculate the slower time-average variability.
- Solar minimum irradiance amplitudes of each wavelength in the EUV spectrum proxy model.
- P and Q proxy exponent coefficients as a function of the sensor proxies.
- P and Q proxy amplitude coefficients as a function of the wavelength and sensor proxies for each of the seven cases.

Following are the file names of sensor calibration parameters within the zip file. XML and HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file names.

- EUVSA_Cal_INR.h5
- EUVSB_Cal_INR.h5
- EUVSC_Cal_INR.h5
- ESPEC_Cal_INR.h5

5.3.1.4 Production Notes

The Solar Flux: EUV product is generated by EXIS Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector data from the CCSDS packets. The Level 1b algorithm uses the XRS-A and XRS-B irradiance values from the Solar Flux: X-Ray reports, and EUVS-A and EUVS-B observations, and the EUVS-C Mg II core-to-wing ratios from the 30 second observation interval. The algorithm calculates the Mg II core-to-wing ratio by determining the total irradiances for the h- and k-line spectra, and the blue and red wing regions from the entire medium ultraviolet spectrum measured by the EUVS-C, which is from 275-285 nm.

Rather than the product data being a calibrated form of the observation data from the sensor, it is a spectrum proxy model. This spectrum proxy model is generated at a 30 second cadence regardless of whether observation data is received by the ground system. In addition, the algorithm generates calibrated irradiance values for the three EUVS-A spectral emission lines and four EUVS-B spectral emission lines, and calibrated Mg II core-to-wing ratios for the EUVS-C measurements. However, the algorithm only includes the average values for these quantities over the 30 second observation interval.

The algorithm uses EUVS-A and EUVS-B dark diode values to estimate the in-situ radiation background. The algorithm uses the EUVS-C filtered signal values to remove contamination from large particles.

The L1b algorithm executes and product data is generated when the instrument is in any mode, but not when the satellite is in the on-orbit storage mode. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.3.1.5 Data Fields

The Solar Flux: EUV product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the wavelength bins associated with the reported spectrum proxy model, mapping between the spectrum proxy model wavelength bins and the irradiance values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for the Solar Flux: EUV product are located in Appendix A.

Table 5.3.1.5-1 Solar Flux: EUV: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f7087580-e5a8-11e3-ac10-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	EXIS EUVSL1b Solar Flux: EUV	string
summary	The Solar Flux: EUV product consists of a solar irradiance spectrum proxy model covering the wavelength range from 5 to 127 nm during a 30 second interval. To generate this proxy model, measurements are obtained from channels XRS-A and XRS-B, sensing wavelength ranges between 0.05 and 0.4 nm, and 0.1 and 0.8 nm, respectively. Measurement are also obtained from EUVS-A at wavelengths 25.6, 28.4, and 304 nm, EUVS-B at wavelengths 117.5, 121.6, 133.5, and 140.5 nm, and EUVS-C at the extreme ultraviolet h-line and k-line, blue wing, and red wing spectral regions. In addition, the product contains average irradiance and MG II core-to-wing ratio values, as applicable, from the contributing XRS and EUVS detectors over the time interval associated with EUV proxy spectrum model, and, in the case of EUVS measurements, the previous 24 hours. Furthermore, the product contains XRS and EUVS observation count statistics, processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > ULTRAVIOLET WAVELENGTHS > ULTRAVIOLET FLUX, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR IRRADIANCE, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR ULTRAVIOLET EMISSIONS	string
cdm_data_type	Profile	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string

Global Attribute Name	Value	Type
instrument_type	GOES-R Series EXIS Extreme Ultraviolet Sensor	string
instrument_ID	***serial number of the instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.3.1.5-2 Solar Flux: EUV: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
ECEF_X	float	report_number = 1	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = 1	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = 1	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q1	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	1	string
quaternion_Q2	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	start and end time of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
time	double	report_number = 1	long_name	EUV spectrum observation center time, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
wavelength_bin_label ***value = WaveBin-5_to_10nm WaveBin-10_to_15nm WaveBin-15_to_20nm WaveBin-20_to_25nm WaveBin-25_to_30nm WaveBin-30_to_35nm WaveBin-35_to_40nm WaveBin-40_to_45nm WaveBin-45_to_50nm***	char	wavelength_bin = 23 wavelength_bin_str_len = 20	long_name	labels for 23 wavelength bins associated with the EUV proxy spectrum model. labels are ordered the same as applicable data variables	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
WaveBin-50_to_55nm WaveBin-55_to_60nm WaveBin-60_to_65nm WaveBin-65_to_70nm WaveBin-70_to_75nm WaveBin-75_to_80nm WaveBin-80_to_85nm WaveBin-85_to_90nm WaveBin-90_to_95nm WaveBin-95_to_100nm WaveBin-100_to_105nm WaveBin-105_to_110nm WaveBin-110_to_115nm WaveBin-117_to_127nm					
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I***	char	solar_array_current_channel_index = 4 solar_array_mnemonic_str_len = 25	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
EPS_SA_CHAN_13_16_RETRN_I					
irradianceSpectrum	float	report_number = 1 wavelength_bin = 23	long_name	irradiance spectrum for wavelengths between 5 and 127 nm calculated using a proxy model based on inputs from XRS A and B channels, and EUVS A, B. and C channels	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
lowWavelength	float	report_number = 1 wavelength_bin = 23	long_name	lower limit of each of wavelength bin, all 5nm in width except for the last 10 nm bin, used in EUV spectrum proxy model	string
			_FillValue	-999	float
			valid_range	5.0 117.0	float
			units	nm	string
highWavelength	float	report_number = 1 wavelength_bin = 23	long_name	upper limit of each of wavelength bin, all 5nm in width except for the last 10 nm bin, used in EUV spectrum proxy model	string
			_FillValue	-999	float
			valid_range	10.0 127.0	float
			units	nm	string
EUV_CaseNumber	byte	report_number = 1	long_name	EUV spectrum product quality case number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 9	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
qualityFlags	uint64	report_number = 1	long_name	EUVS L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	18446744073709551615	uint64
			valid_range	0 17592186044415	uint64
			units	1	string
			flag_masks	***see note [flags and meanings]***	long
			flag_values	***see note [flags and meanings]***	long
			flag_meanings	***see note [flags and meanings]***	string
au_factor	float	report_number = 1	long_name	earth to sun distance multiplicative correction factor to normalize to 1-AU at time of observation. not applied in EUVS L1b processing	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	0	float
			valid_range	0.97594972 1.0167257	float
			units	1	string
SC_yaw_flip_flag	byte	report_number = 1	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
nXRS	byte	report_number = 1	long_name	number of XRS L1b reports generated during time interval associated with EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGoodXRSA	byte	report_number = 1	long_name	number of calculated good quality XRS-A 0.05 to 0.4 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGoodXRSB	byte	report_number = 1	long_name	number of calculated good quality XRS-B 0.1 to 0.8 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nEUVSA	byte	report_number = 1	long_name	number of EUVS-A observations (L0) processed during time interval associated with EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood256	byte	report_number = 1	long_name	number of calculated good quality EUVS-A 25.6 nm irradiance values used in generation of EUV proxy spectrum model	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood284	byte	report_number = 1	long_name	number of calculated good quality EUVS-A 28.4 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood304	byte	report_number = 1	long_name	number of calculated good quality EUVS-A 30.4 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nEUVSB	byte	report_number = 1	long_name	number of EUVS-B observations (L0) processed during time interval associated with EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood1175	byte	report_number = 1	long_name	number of calculated good quality EUVS-B 117.5 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood1216	byte	report_number = 1	long_name	number of calculated good quality EUVS-B 121.6 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood1335	byte	report_number = 1	long_name	number of calculated good quality EUVS-B 133.5 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nGood1405	byte	report_number = 1	long_name	number of calculated good quality EUVS-B 140.5 nm irradiance values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 30	byte
			units	count	string
nEUVSC	byte	report_number = 1	long_name	number of EUVS-C observations (L0) processed during time interval associated with EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 120	byte
			units	count	string
nGoodMg	byte	report_number = 1	long_name	number of calculated good quality Mg II core-to-wing ratio values used in generation of EUV proxy spectrum model	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 120	byte
			units	count	string
xrsQualityFlags	int	report_number = 1 max_num_XRS_obs_spectrum_interval = 30	long_name	XRS L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 524287	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
euvsaQualityFlags	int	report_number = 1	long_name	EUVS-A L1b processing and data quality flags	string
		max_num_EUVS_A_obs_spectrum_interval = 30	_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 262143	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
euvsbQualityFlags	int	report_number = 1 max_num_EUVS_B_obs_spectrum_interval = 30	long_name	EUVS-B L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 4194303	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
euvscQualityFlags	int	report_number = 1 max_num_EUVS_C_obs_spectrum_interval = unlimited	long_name	EUVS-C L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 2097151	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
euvsaAvgTemp	float	report_number = 1	long_name	average temperature of EUVS-A detector during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
euvsbAvgTemp	float	report_number = 1	long_name	average temperature of EUVS-B detector during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
euvsc1AvgTemp	float	report_number = 1	long_name	average temperature of EUVS-C detector #1 during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
euvsc2AvgTemp	float	report_number = 1	long_name	average temperature of EUVS-C detector #2 during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
avgIrradianceXRSA	float	report_number = 1	long_name	average primary irradiance at wavelengths between 0.05 and 0.4 nm (XRS-A) during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 0.04	float
			units	W m-2	string
avgIrradianceXRSB	float	report_number = 1	long_name	average primary irradiance at wavelengths between 0.1 and 0.8 nm (XRS-B) during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 0.03	float
			units	W m-2	string
avgIrradiance256	float	report_number = 1	long_name	EUVS-A 25.6 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 2.0	float
			units	W m-2 nm-1	string
avgIrradiance284	float	report_number = 1	long_name	EUVS-A 28.4 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 2.0	float
			units	W m-2 nm-1	string
avgIrradiance304	float	report_number = 1	long_name	EUVS-A 30.4 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 3.0	float
			units	W m-2 nm-1	string
avgIrradiance1175	float	report_number = 1	long_name	EUVS-B 117.5 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
avgIrradiance1216	float	report_number = 1	long_name	EUVS-B 121.6 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
avgIrradiance1335	float	report_number = 1	long_name	EUVS-B 133.5 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
avgIrradiance1405	float	report_number = 1	long_name	EUVS-B 140.5 nm average irradiance during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
avgRatioMgExis	float	report_number = 1	long_name	EUVS-C average EXIS Mg II core-to-wing ratio during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
avgRatioMgNoaa	float	report_number = 1	long_name	EUVS-C average NOAA historical Mg II core-to-wing ratio during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
dailyIrradiance256	float	report_number = 1	long_name	EUVS-A 25.6 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 2.0	float
			units	W m-2 nm-1	string
dailyIrradiance284	float	report_number = 1	long_name	EUVS-A 28.4 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 2.0	float
			units	W m-2 nm-1	string
dailyIrradiance304	float	report_number = 1	long_name	EUVS-A 30.4 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 3.0	float
			units	W m-2 nm-1	string
dailyIrradiance1175	float	report_number = 1	long_name	EUVS-B 117.5 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
	float	report_number = 1	long_name	EUVS-B 121.6 nm average irradiance for previous 24 hours	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
dailyIrradiance1216			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
dailyIrradiance1335	float	report_number = 1	long_name	EUVS-B 133.5 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
dailyIrradiance1405	float	report_number = 1	long_name	EUVS-B 140.5 nm average irradiance for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	W m-2 nm-1	string
dailyRatioMgNoaa	float	report_number = 1	long_name	EUVS-C average NOAA historical Mg II core-to-wing ratio for previous 24 hours	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
Average_SPS_dispersion_angle	float	report_number = 1	long_name	average dispersion direction pointing angle from SPS during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-10.0 10.0	float
			units	degree	string
Average_SPS_cross_dispersion_angle	float	report_number = 1	long_name	average cross-dispersion direction pointing angle from SPS during time interval associated with EUV proxy spectrum model	string
			_FillValue	-999	float
			valid_range	-10.0 10.0	float
			units	degree	string
solar_array_current	short	report_number = unlimited solar_array_current_channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
SC_eclipse_flag	byte	report_number = 1	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Total_SPS_angles	byte	report_number = 1	long_name	number of SPS measurements used to determine the Average_SPS_dispersion_angle and Average_SPS_cross_dispersion_angle values	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 120	byte
			units	count	string
Total_valid_SPS_angle_pairs	byte	report_number = 1	long_name	number of valid SPS measurements used during XRS L1b processing	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 120	byte
			units	count	string
euvscIntegrationTime	float	n/a	long_name	EUVS-C packet Integration Time, in seconds	string
			_FillValue	-999.0	float
			valid_range	0.25 64.0	float
			units	seconds	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_EUVS_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string
			input_XRS_L1b_data	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.3.1.5.2, Solar Flux: EUV Product Flag Values and Meanings.

5.3.1.5.1 Solar Flux: EUV Product Quantity Characteristics

Table 5.3.1.5.1 Solar Flux: EUV Product Spectrum Proxy Model Wavelength Characteristics

Wavelength Bin (in nm)	Order in Product Data Structure	Product Label Variable Mnemonic
5 - 10	1	WaveBin-5_to_10nm
10 -15	2	WaveBin-10_to_15nm
15 - 20	3	WaveBin-15_to_20nm
20 - 25	4	WaveBin-20_to_25nm
25 - 30	5	WaveBin-25_to_30nm
30 - 35	6	WaveBin-30_to_35nm
35 - 40	7	WaveBin-35_to_40nm
40 - 45	8	WaveBin-40_to_45nm
45 - 50	9	WaveBin-45_to_50nm
50 - 55	10	WaveBin-50_to_55nm
55 - 60	11	WaveBin-55_to_60nm
60 - 65	12	WaveBin-60_to_65nm
65 - 70	13	WaveBin-65_to_70nm
70 - 75	14	WaveBin-70_to_75nm
75 - 80	15	WaveBin-75_to_80nm
80 - 85	16	WaveBin-80_to_85nm
85 - 90	17	WaveBin-85_to_90nm
90 - 95	18	WaveBin-90_to_95nm
95 - 100	19	WaveBin-95_to_100nm
100 - 105	20	WaveBin-100_to_105nm
105 - 110	21	WaveBin-105_to_110nm
110 - 115	22	WaveBin-110_to_115nm
117 - 127	23	WaveBin-117_to_127nm

5.3.1.5.2 Solar Flux: EUV Product Flag Values and Meanings

Table 5.3.1.5.2-1 Solar Flux: EUV Product EUVS L1b Processing and Data Quality Flag Values and Meanings

EUVS L1b Processing and Data Quality Flags (qualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
17592186044415	0	good_quality_qf
1	1	degraded_due_to_all_bad_sensor_pointing_qf
2	2	degraded_due_to_all_invalid_sensor_filter_position_qf
4	4	degraded_due_to_all_low_sensor_temperature_qf
8	8	degraded_due_to_all_high_sensor_temperature_qf
16	16	degraded_due_to_XRS-A_average_irradiance_near_zero_qf
32	32	degraded_due_to_XRS-B_average_irradiance_near_zero_qf
64	64	degraded_due_to_EUVS-A_25.6nm_average_irradiance_near_zero_qf
128	128	degraded_due_to_EUVS-A_28.4nm_average_irradiance_near_zero_qf

EUVS L1b Processing and Data Quality Flags (qualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
256	256	degraded_due_to_EUVS-A_30.4nm_average_irradiance_near_zero_qf
512	512	degraded_due_to_EUVS-B_117.5nm_average_irradiance_near_zero_qf
1024	1024	degraded_due_to_EUVS-B_121.6nm_average_irradiance_near_zero_qf
2048	2048	degraded_due_to_EUVS-B_135.5nm_average_irradiance_near_zero_qf
4096	4096	degraded_due_to_EUVS-B_140.5nm_average_irradiance_near_zero_qf
8192	8192	degraded_due_to_XRS-A_average_irradiance_at_saturation_qf
16384	16384	degraded_due_to_XRS-B_average_irradiance_at_saturation_qf
32768	32768	degraded_due_to_EUVS-A_25.6nm_average_irradiance_at_saturation_qf
65536	65536	degraded_due_to_EUVS-A_28.4nm_average_irradiance_at_saturation_qf
131072	131072	degraded_due_to_EUVS-A_30.4nm_average_irradiance_at_saturation_qf
262144	262144	degraded_due_to_EUVS-B_117.5nm_average_irradiance_at_saturation_qf
524288	524288	degraded_due_to_EUVS-B_121.6nm_average_irradiance_at_saturation_qf
1048576	1048576	degraded_due_to_EUVS-B_135.5nm_average_irradiance_at_saturation_qf
2097152	2097152	degraded_due_to_EUVS-B_140.5nm_average_irradiance_at_saturation_qf
4194304	4194304	degraded_due_to_truncation_of_all_XRS_integration_qf
8388608	8388608	degraded_due_to_truncation_of_all_EUVS-A_integration_qf
16777216	16777216	degraded_due_to_truncation_of_all_EUVS-B_integration_qf
33554432	33554432	degraded_due_to_truncation_of_all_EUVS-C_integration_qf
67108864	67108864	degraded_due_to_flatfield_LED_flash_during_sensor_integrations_qf
134217728	134217728	degraded_due_to_off_point_calibration_maneuver_received_from_ground_qf
268435456	268435456	degraded_due_to_planetary_transit_state_received_from_ground_qf
536870912	536870912	degraded_due_to_lunar_transit_state_received_from_ground_qf
1073741824	1073741824	degraded_due_to_eclipse_state_received_from_ground_qf
2147483648	2147483648	degraded_due_to_fov_state_not_received_from_ground_qf
4294967295	4294967295	degraded_due_to_all_invalid_XRS-A_L1b_report_qf
8589934592	8589934592	degraded_due_to_all_invalid_XRS-B_L1b_report_qf
17179869184	17179869184	degraded_due_to_all_invalid_EUVS-A_25.6nm_observation_qf
34359738368	34359738368	degraded_due_to_all_invalid_EUVS-A_28.4nm_observation_qf
68719476736	68719476736	degraded_due_to_all_invalid_EUVS-A_30.4nm_observation_qf
137438953472	137438953472	degraded_due_to_all_invalid_EUVS-B_117.5nm_observation_qf
274877906944	274877906944	degraded_due_to_all_invalid_EUVS-B_121.6nm_observation_qf
549755813888	549755813888	degraded_due_to_all_invalid_EUVS-B_135.5nm_observation_qf
1099511627776	1099511627776	degraded_due_to_all_invalid_EUVS-B_140.5nm_observation_qf
2199023255552	2199023255552	EUVS-C_channel_1_primary_inactive_qf
4398046511104	4398046511104	EUVS-C_channel_2_secondary_active_qf
8796093022208	8796093022208	degraded_due_to_all_invalid_Mg_II_h-line_or_k-line_or_blue_wing_or_red_wing_spectral_region_observation_qf

Table 5.3.1.5.2-2 Solar Flux: EUV Product Spectrum Product Quality Case Number Flag Values and Meanings

EUV Spectrum Product Quality Case Number Flags (EUV_CaseNumber)	
Flag Value	**Flag Meaning**
0	normal_operations
1	XRS_LO_and_EUVS-A_LO_and_EUVS-B_LO_and_EUVS-C_LO_and_no_geocorona
2	XRS_LO_and_EUVS-A_LO_and_EUVS-B_LO_and_EUVS-C_LO_and_geocorona
3	XRS_LO_and_no_EUVS-A_LO_and_no_EUVS-B_LO_and_EUVS-C_LO_and_no_geocorona
4	XRS_LO_and_EUVS-A_LO_and_EUVS-B_LO_and_no_EUVS-C_LO_and_no_geocorona
5	XRS_LO_and_no_EUVS-A_LO_and_EUVS-B_LO_and_EUVS-C_LO_and_no_geocorona
6	XRS_LO_and_EUVS-A_LO_and_no_EUVS-B_LO_and_EUVS-C_LO_and_no_geocorona
7	no_XRS_LO_and_EUVS-A_LO_and_EUVS-B_LO_and_EUVS-C_LO_and_no_geocorona
8	XRS_LO_and_no_EUVS-A_LO_and_no_EUVS-B_LO_and_no_EUVS-C_LO
9	no_XRS_LO_and_no_EUVS-A_LO_and_no_EUVS-B_LO_and_no_EUVS-C_LO

Table 5.3.1.5.2-3 Solar Flux: EUV Product XRS L1b Processing and Data Quality Flag Values and Meanings

XRS L1b Processing and Data Quality Flags (xrsQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
524287	0	good_quality_qf
1	1	invalid_due_to_out_of_range_XRS_pointing_qf
2	2	degraded_due_to_uncalibrated_range_XRS_pointing_qf
4	4	degraded_due_to_calibrated_but_exceeds_requirements_XRS_pointing_qf
8	8	invalid_due_to_XRS_L0_data_checksum_error_qf
16	16	degraded_due_to_low_XRS_A_and_B_temperature_qf
32	32	degraded_due_to_high_XRS_A_and_B_temperature_qf
64	64	degraded_due_to_XRS-A_solar_minimum_channel_signal_near_zero_qf
128	128	degraded_due_to_XRS-A_solar_maximum_channel_signal_near_zero_qf
256	256	degraded_due_to_XRS-B_solar_minimum_channel_signal_near_zero_qf
512	512	degraded_due_to_XRS-B_solar_maximum_channel_signal_near_zero_qf
1024	1024	degraded_due_to_XRS-A_solar_minimum_channel_signal_at_saturation_qf
2048	2048	degraded_due_to_XRS-A_solar_maximum_channel_signal_at_saturation_qf
4096	4096	degraded_due_to_XRS-B_solar_minimum_channel_signal_at_saturation_qf
8192	8192	degraded_due_to_XRS-B_solar_maximum_channel_signal_at_saturation_qf
16384	16384	degraded_due_to_flatfield_LED_flash_during_XRS_integration_qf
32768	32768	degraded_due_to_insufficient_number_of_integrations_after_XRS_reset_qf
65536	65536	degraded_due_to_non-nominal_XRS-A_irradiance_qf
131072	131072	degraded_due_to_non-nominal_XRS-B_irradiance_qf
262144	262144	degraded_due_to_out_of_valid_range_primary_XRS-B_to_XRS-A_irradiance_ratio_qf

Table 5.3.1.5.2-4 Solar Flux: EUV Product EUVS-A L1b Processing and Data Quality Flag Values and Meanings

EUVS-A L1b Processing and Data Quality Flags (euvsaQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
262143	0	good_quality_qf
1	1	invalid_due_to_out_of_range_EUVS-A_pointing_qf
2	2	degraded_due_to_uncalibrated_range_EUVS-A_pointing_qf
4	4	degraded_due_to_calibrated_but_exceeds_requirements_EUVS-A_pointing_qf
8	8	invalid_due_to_EUVS-A_L0_data_checksum_error_qf
16	16	degraded_due_to_EUVS-A_25.6nm_signal_near_zero_qf

EUVS-A L1b Processing and Data Quality Flags (euvsaQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
32	32	degraded_due_to_EUVS-A_25.6nm_signal_at_saturation_qf
64	64	degraded_due_to_EUVS-A_28.4nm_signal_near_zero_qf
128	128	degraded_due_to_EUVS-A_28.4nm_signal_at_saturation_qf
256	256	degraded_due_to_EUVS-A_30.4nm_signal_near_zero_qf
512	512	degraded_due_to_EUVS-A_30.4nm_signal_at_saturation_qf
1024	1024	degraded_due_to_low_EUVS-A_temperature_qf
2048	2048	degraded_due_to_high_EUVS-A_temperature_qf
4096	4096	degraded_due_to_flatfield_LED_flash_during_EUVS-A_integration_qf
8192	8192	invalid_due_to_invalid_EUVS-A_filter_position_qf
16384	16384	invalid_due_to_invalid_EUVS-A_door_position_qf
32768	32768	degraded_due_to_invalid_EUVS-A_25.6nm_observation_qf
65536	65536	degraded_due_to_invalid_EUVS-A_28.4nm_observation_qf
131072	131072	degraded_due_to_invalid_EUVS-A_30.4nm_observation_qf

Table 5.3.1.5.2-5 Solar Flux: EUV Product EUVS-B L1b Processing and Data Quality Flag Values and Meanings

EUVS-B L1b Processing and Data Quality Flags (euvsbQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
4194303	0	good_quality_qf
1	1	invalid_due_to_out_of_range_EUVS-B_pointing_qf
2	2	degraded_due_to_uncalibrated_range_EUVS-B_pointing_qf
4	4	degraded_due_to_calibrated_but_exceeds_requirements_EUVS-B_pointing_qf
8	8	degraded_due_to_EUVS-B_L0_data_checksum_error_qf
16	16	degraded_due_to_EUVS-B_117.5nm_signal_near_zero_qf
32	32	degraded_due_to_EUVS-B_117.5nm_signal_at_saturation_qf
64	64	degraded_due_to_EUVS-B_121.6nm_signal_near_zero_qf
128	128	degraded_due_to_EUVS-B_121.6nm_signal_at_saturation_qf
256	256	degraded_due_to_EUVS-B_133.5nm_signal_near_zero_qf
512	512	degraded_due_to_EUVS-B_133.5nm_signal_at_saturation_qf
1024	1024	degraded_due_to_EUVS-B_140.5nm_signal_near_zero_qf
2048	2048	degraded_due_to_EUVS-B_140.5nm_signal_at_saturation_qf
4096	4096	degraded_due_to_low_EUVS-B_temperature_qf
8192	8192	degraded_due_to_high_EUVS-B_temperature_qf
16384	16384	degraded_due_to_flatfield_LED_flash_during_EUVS-B_integration_qf
32768	32768	invalid_due_to_invalid_EUVS-B_filter_position_qf

EUVS-B L1b Processing and Data Quality Flags (euvsbQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
65536	65536	invalid_due_to_invalid_EUVS-B_door_position_qf
131072	131072	degraded_due_to_invalid_EUVS-B_117.5nm_observation_qf
262144	262144	degraded_due_to_invalid_EUVS-B_121.6nm_observation_qf
524288	524288	degraded_due_to_invalid_EUVS-B_133.5nm_observation_qf
1048576	1048576	degraded_due_to_invalid_EUVS-B_140.5nm_observation_qf
2097152	2097152	degraded_due_to_geocorona_condition_qf

Table 5.3.1.5.2-6 Solar Flux: EUV Product EUVS-C L1b Processing and Data Quality Flag Values and Meanings

EUVS-C L1b Processing and Data Quality Flags (euvscQualityFlags)		
Flag Mask	**Flag Value**	**Flag Meaning**
2097151	0	good_quality_qf
1	1	degraded_due_to_uncalibrated_range_EUVS-C_pointing_qf
2	2	degraded_due_to_EUVS-C_L0_data_checksum_error_qf
4	4	degraded_due_to_EUVS-C_blue_wing_spectral_region_signals_near_zero_qf
8	8	degraded_due_to_EUVS-C_blue_wing_spectral_region_signals_at_saturation_qf
16	16	degraded_due_to_EUVS-C_red_wing_spectral_region_signals_near_zero_qf
32	32	degraded_due_to_EUVS-C_red_wing_spectral_region_signals_at_saturation_qf
64	64	degraded_due_to_EUVS-C_h-line_spectral_region_signals_near_zero_qf
128	128	degraded_due_to_EUVS-C_h-line_spectral_region_signals_at_saturation_qf
256	256	degraded_due_to_EUVS-C_k-line_spectral_region_signals_near_zero_qf
512	512	degraded_due_to_EUVS-C_k-line_spectral_region_signals_at_saturation_qf
1024	1024	degraded_due_to_low_EUVS-C_temperature_qf
2048	2048	degraded_due_to_high_EUVS-C_temperature_qf
4096	4096	degraded_due_to_flatfield_LED_flash_during_EUVS-C_integration_qf
8192	8192	degraded_due_to_insufficient_number_of_integrations_after_EUVS-C_reset_qf
16384	16384	invalid_due_to_invalid_EUVS-C_filter_position_qf
32768	32768	invalid_due_to_invalid_EUVS-C_door_position_qf
65536	65536	degraded_due_to_invalid_EUVS-C_h-line_spectral_region_observation_qf
131072	131072	degraded_due_to_invalid_EUVS-C_k-line_spectral_region_observation_qf
262144	262144	degraded_due_to_invalid_EUVS-C_blue_wing_spectral_region_observation_qf
524288	524288	degraded_due_to_invalid_EUVS-C_red_wing_spectral_region_observation_qf
1048576	1048576	degraded_due_to_at_least_one_invalid_Mg_II_h-line_or_k-line_or_blue_wing_or_red_wing_spectral_region_observation_qf

Table 5.3.1.5.2-7 Solar Flux: EUV Product Eclipse Flag Values and Meanings

Eclipse Flags (SC_eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.3.1.5.2-8 Solar Flux: EUV Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (SC_yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.3.2 Solar Flux: X-Ray Product

5.3.2.1 Description

The Solar Flux: X-Ray product contains up to 30 irradiance values in the X-ray portion of the electromagnetic spectrum. Irradiance values are produced at one-second observation intervals, so each Solar Flux:X-Ray product spans 30 seconds. Two values are obtained from both the XRS-A and XRS-B sensors. XRS-A has a band pass of 0.05 to 0.4 nm, and XRS-B has a band pass of 0.1 to 0.8 nm. To span the full dynamic X-ray irradiance range over the eleven year solar cycle, the XRS-A and XRS-B include a solar minimum and a solar maximum detector. The resulting irradiance value from each detector is included in the product. Indication is provided of whether the irradiance value from the solar minimum or solar maximum detector is the primary irradiance value for each channel. The product includes processing and data quality information associated with the availability and characteristics of the observation data received from the XRS, the generation of the product irradiance values, and indications that the observation data may be invalid.

The units of measure for the solar irradiance values are "watts per square meter".

The precise look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are available from the Product Distribution and Access system.

The Solar Flux: X-Ray performance requirements are summarized in Table 5.3.2.1, Solar Flux: X-Ray Performance Requirements.

Table 5.3.2.1 Solar Flux: X-Ray Performance Requirements

	Measurement			Mapping
Region	Range	Accuracy	Precision	Uncertainty
solar disk	(1) XRS-A: 5×10^{-9} to 5×10^{-4} W/m^2 (2) XRS-B: 2×10^{-8} to 2×10^{-3} W/m^2	+/- 20% at 20 times the specified minimum flux	2%	+/- 2 arcmin

Metadata in the Solar Flux: X-Ray product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product.
- Time of each observation.
- Satellite location, spacecraft ACRF to J2000 ECI attitude quaternion, and earth to sun distance.
- Eclipse of the sun and other field of view related indications.
- Satellite yaw flip configuration.
- Mean SPS dispersion and cross-dispersion angles, and number of SPS observations associated with the XRS observation.
- Ratio between XRS-A and XRS-B irradiance values.
- Corrected current values for the XRS-A and XRS-B solar maximum detectors.
- EXIS and XRS component configuration information and settings.
- Temperature of the XRS-A and XRS-B ASICs, and Sun Positioning Sensor.
- XRS and SPS observation and integration times.

5.3.2.2 Dynamic Source Data

The Solar Flux: X-Ray product is derived using XRS Level 0 raw science telemetry, EXIS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Solar Flux: X-Ray algorithm is named in Table 5.3.2.5-2, Solar Flux: X-Ray: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_XRS_L0_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.3.2.3 Level 1b Semi-Static Source Data

There are two categories of semi-static source data employed in the XRS Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Solar calibration parameters

Semi-static source data files from the two categories above are contained in a single zip file, rolled up to the instrument level - all EXIS semi-static parameter files are in one zip file. Some files fit into more than one category. The filename conventions for the Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are those associated with the XRS and SPS sensors' radiometric and geometric observing characteristics, its raw outputs, and the subsequent calibration related processing. The XRS is composed of sensor subcomponents, XRS-A and XRS-B. Specific types of sensor calibration parameters for the sensors and sensor subcomponents are defined in Table 5.3.2.3, XRS Level 1b Algorithm Sensor Calibration Parameters.

Table 5.3.2.3 XRS Level 1b Algorithm Sensor Calibration Parameters

Description of Parameter(s)	XRS Sensor	XRS-A Channel	XRS-B Channel	SPS Sensor
Number of sensor diodes	x			x
Number of diode layout table columns	x			
Number of days in the in-flight gain correction factor table	x			x
Number of Digital Number samples in the temperature look-up tables	x			x
Number of angles in the field of view correction factor tables	x			x
Number of samples in the linear gain correction factor tables	x			x
Processing interval	x			
Dark diode history interval	x			
Instrument invalid flag processing values	x			x
Minimum and maximum bad dispersion and cross-dispersion angle thresholds	x			
Minimum and maximum degraded and warning dispersion and cross-dispersion angle thresholds	x			
Valid integration time threshold for processing	x			x
Valid detector change count thresholds for processing	x			x
Diode layout table mapping to ASIC and channel	x			x
Sensor integration time calibration parameters	x			x

Description of Parameter(s)	XRS Sensor	XRS-A Channel	XRS-B Channel	SPS Sensor
Temperature calibration tables	x			x
Detector low and high temperature limits	x			x
Diode saturation threshold values		x	x	
Diode minimum dark-corrected current amplitude threshold values		x	x	
Temperature-dependent pre-flight gain coefficient tables	x			x
Time-dependent gain correction factor tables	x			x
Amplitude-dependent signal linearity correction factor tables	x			x
Uncalibrated diode electrometer signal table	x			x
Temperature-dependent diode thermal dark signal tables	x			x
Dark diode weighting factors	x			
Diode dark current scaling factor tables	x			
Channel responsivity tables		x	x	
Instrument field of view dispersion and cross-dispersion correction factor angle tables	x			
Instrument field of view dispersion and cross-dispersion correction factor tables		x	x	
Channel irradiance threshold for setting the primary channel flag		x	x	
Minimum total signal threshold for determining if the SPS sensor is operating within an acceptable range of pointing angles				x
Dispersion and cross-dispersion pointing angle tables				x
Parameter to convert normalized pointing values to pointing table indices				x

Solar calibration parameters are those associated with the distance, on a daily basis, between the earth and the sun.

Following is the file name of the files in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- SPS_Cal_INR.h5
- XRS_Cal_INR.h5

5.3.2.4 Production Notes

The Solar Flux: X-Ray product is generated by EXIS Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector observation data from the CCSDS packets. The Level 1b algorithm converts the raw data from the XRS-A and XRS-B detectors into electrical current. The Level 1b algorithm removes the effects of background radiation, and the detectors' thermal contributions, and converts the solar minimum and the solar maximum currents to irradiance values using the instrument responsivity and field of view correction data generated from the SPS pointing data. In addition, the primary irradiance values for XRS-A and XRS-B are determined.

The L1b algorithm executes and product data is generated when the instrument is in any mode, but not when the satellite is in the on-orbit storage mode. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.3.2.5 Data Fields

The Solar Flux: X-Ray product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables is a subordinate paragraph containing tables that describe the values and meanings for the flag variables in the product.

The filename conventions for the Solar Flux: X-Ray product are located in Appendix A.

Table 5.3.2.5-1 Solar Flux: X-Ray: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f7087581-e5a8-11e3-ac10-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	EXIS XRS L1b Solar Flux: X-Ray	string
summary	The Solar Flux: X-Ray product consists of two irradiance measurements in the x-ray portion of the electromagnetic spectrum resulting from observing the sun. The two measurements are obtained from channels XRS-A and XRS-B. The XRS-A and XRS-B channels sense wavelength ranges between 0.05 and 0.4 nm, and 0.1 and 0.8 nm, respectively. To span the full dynamic x-ray irradiance range over the solar cycle, each channel includes a solar minimum photodiode and a solar maximum quadrant photodiode set, and the resulting irradiance value from each are included in the product. A flag indicates whether the irradiance value from the solar minimum or solar maximum photodiodes is the primary irradiance value for each channel. The product also includes a set of XRS state flags, processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > X-RAY > X-RAY FLUX, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR IRRADIANCE, SUN-EARTH INTERACTIONS > SOLAR ACTIVITY > SOLAR X-RAY EMISSIONS, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > X-RAY FLUX	string
cdm_data_type	Point	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series EXIS X-Ray Sensor	string

Global Attribute Name	Value	Type
instrument_ID	***serial number of the instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.3.2.5-2 Solar Flux: X-Ray: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
ecef_X	float	report_number = unlimited	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ecef_Y	float	report_number = unlimited	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ecef_Z	float	report_number = unlimited	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q1	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	1	string
quaternion_Q2	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	start and end time of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
time	double	report_number = unlimited	long_name	center time of XRS observation for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I***	char	solar_array_current_channel_index = 4 solar_array_mnemonic_str_len = 25	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
irradiance_xrsa1	float	report_number = unlimited	long_name	irradiance at wavelengths between 0.05 and 0.4 nm calculated from XRS-A solar minimum channel (photodiode)	string
			_FillValue	-999	float
			valid_range	0.0 0.0005	float
			units	W m-2	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
irradiance_xrsa2	float	report_number = unlimited	long_name	irradiance at wavelengths between 0.05 and 0.4 nm calculated from XRS-A solar maximum channel (quadrant photodiode)	string
			_FillValue	-999	float
			valid_range	0.0 0.04	float
			units	W m-2	string
primary_xrsa	byte	report_number = unlimited	long_name	flags indicating which of two XRS-A channels, solar minimum channel 1 or solar maximum channel 2, provides the primary irradiance value	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
irradiance_xrsb1	float	report_number = unlimited	long_name	irradiance at wavelengths between 0.1 and 0.8 nm calculated from XRS-B solar minimum channel (photodiode)	string
			_FillValue	-999	float
			valid_range	0.0 0.0004	float
			units	W m-2	string
irradiance_xrsb2	float	report_number = unlimited	long_name	irradiance at wavelengths between 0.1 and 0.8 nm calculated from XRS-B solar maximum channel (quadrant photodiode)	string
			_FillValue	-999	float
			valid_range	0.0 0.03	float
			units	W m-2	string
primary_xrsb	byte	report_number = unlimited	long_name	flags indicating which of two XRS-B channels, solar minimum channel 1 or solar maximum channel 2, provides the primary irradiance value	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
xrs_ratio	float	report_number = unlimited	long_name	ratio calculated by XRS-A primary irradiance divided by XRS-B primary irradiance	string
			_FillValue	-999	float
			valid_range	0.0 9999999.0	float
			units	1	string
corrected_current_xrsa_1	float	report_number = unlimited	long_name	corrected current for 1st quadrant of XRS-A solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsa_2	float	report_number = unlimited	long_name	corrected current for 2nd quadrant of XRS-A solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsa_3	float	report_number = unlimited	long_name	corrected current for 3rd quadrant of XRS-A solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsa_4	float	report_number = unlimited	long_name	corrected current for 4th quadrant of XRS-A solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsb_1	float	report_number = unlimited	long_name	corrected current for 1st quadrant of XRS-B solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsb_2	float	report_number = unlimited	long_name	corrected current for 2nd quadrant of XRS-B solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
corrected_current_xrsb_3	float	report_number = unlimited	long_name	corrected current for 3rd quadrant of XRS-B solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
corrected_current_xrsb_4	float	report_number = unlimited	long_name	corrected current for 4th quadrant of XRS-B solar maximum channel's quadrant photodiode	string
			_FillValue	-999	float
			valid_range	0.0 5.0	float
			units	A	string
dispersion_angle	float	report_number = unlimited	long_name	average dispersion direction pointing angle from SPS during time interval associated with observation	string
			_FillValue	-999	float
			valid_range	-10.0 10.0	float
			units	degree	string
crossdispersion_angle	float	report_number = unlimited	long_name	average cross-dispersion direction pointing angle from SPS during time interval associated with observation	string
			_FillValue	-999	float
			valid_range	-10.0 10.0	float
			units	degree	string
sc_power_side	byte	report_number = unlimited	long_name	flags indicating which of two EXIS power boards, A or B, is active	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
exis_flight_model	byte	report_number = unlimited	long_name	flags indicating EXIS flight model. also serves as serial number of instrument	string
			_Unsigned	TRUE	string
			_FillValue	0	byte
			valid_range	1 255	byte
			units	1	string
	short	report_number = unlimited	long_name	EXIS configuration identifier	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
exis_configuration _id			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	1	string
xrs_runctrlmd	byte	report_number = unlimited	long_name	flags indicating XRS internal gain calibration circuit and data retrieval indicator settings	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
integration_time	float	report_number = unlimited	long_name	XRS integration time used to collect data associated with observation	string
			_FillValue	0	float
			valid_range	0.239 63.989	float
			units	s	string
exs_sl_pwr_ena	byte	report_number = unlimited	long_name	flags indicating whether power to currently selected EXIS stimulus lamp is enabled	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
asic1_temperature	float	report_number = unlimited	long_name	temperature of XRS ASIC board #1	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
asic2_temperature	float	report_number = unlimited	long_name	temperature of XRS ASIC board #2	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
invalid_flags	byte	report_number = unlimited	long_name	flags indicating observation data may be invalid	string
			_Unsigned	TRUE	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	255	byte
			valid_range	0 8	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
xrs_det_chg	short	report_number = unlimited	long_name	count of XRS detector measurements since last sensor power-on or settings change	string
			_Unsigned	TRUE	string
			_FillValue	0	short
			valid_range	1 65535	short
			units	count	string
xrs_mode	byte	report_number = unlimited	long_name	instrument (sensor) mode	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
sps_obs_time	double	report_number = unlimited sps_measurement_count = 4	long_name	time of observation for each SPS 4 Hz measurement, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
sps_int_time	float	report_number = unlimited sps_measurement_count = 4	long_name	SPS integration time for each (4 Hz) SPS measurement	string
			_FillValue	0	float
			valid_range	0.239 63.989	float
			units	seconds	string
sps_temperature	float	report_number = unlimited sps_measurement_count = 4	long_name	temperature of SPS detector for (4 Hz) each SPS measurement	string
			_FillValue	-999	float
			valid_range	-142.51690 933.17316	float
			units	degrees_C	string
sps_det_chg	short	report_number = unlimited sps_measurement_count = 4	long_name	counter, which resets after SPS power-on or setting change, indicating whether to disregard observation (conditions to disregard: .lt. configurable value after	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
				power on; .lt. configurable value after internal gain calibration)	
			_Unsigned	TRUE	string
			_FillValue	0	short
			valid_range	1 65535	short
			units	count	string
num_angle_pairs	short	report_number = unlimited	long_name	number of valid SPS measurements used during XRS L1b processing	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 4	short
			units	count	string
yaw_flip_flag	byte	report_number = unlimited	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
au_factor	float	report_number = unlimited	long_name	earth to sun distance multiplicative correction factor to normalize to 1-AU at time of observation. not applied in XRS L1b processing	string
			_FillValue	0	float
			valid_range	0.97594972 1.0167257	float
			units	1	string
quality_flags	int	report_number = unlimited	long_name	XRS L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 524287	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
packet_count	int	report_number = unlimited	long_name	current count of XRS L0 telemetry packets received since instrument start-up or reset	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 65535	int
			units	count	string
fov_unknown	byte	report_number = unlimited	long_name	flags indicating whether instrument has received field-of-view information (eclipse, planetary and lunar transit, off-pointing calibration maneuver conditions) provided by ground system	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
fov_eclipse	byte	report_number = unlimited	long_name	flags indicating whether sun being obscured by earth is imminent or in progress as provided by ground system	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
fov_lunar_transit	byte	report_number = unlimited	long_name	flags indicating whether lunar transit across sun is imminent or in progress as provided by ground system	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
fov_planet_transit	byte	report_number = unlimited	long_name	flags indicating whether planetary transit across sun is imminent or in progress as provided by ground system	string
			_Unsigned	TRUE	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
fov_off_point	byte	report_number = unlimited	long_name	flags indicating whether off-pointing calibration maneuver is imminent or in progress as provided by ground system	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
solar_array_current	short	report_number = unlimited solar_array_current_channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
SC_eclipse_flag	byte	report_number = unlimited	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_XRS_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
SUVI_CROTA	float	n/a	long_name	angular offset of the solar north rotational pole in image with positive values measured clockwise	string
			comment	solar north pole angular offset	string
			_FillValue	-999	float
			valid_range	0.0 359.99999	float
			units	degree	string
SUVI_CROTA_time	double	n/a	long_name	time of SUVI_CROTA measurement, in seconds since J2000 epoch (2000-01-01 12:00:00 UTC)	string
			_FillValue	-999	float
			units	seconds since 2000-01-01 12:00:00	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.3.2.5.1, Solar Flux: X-Ray Product Flag Values and Meanings.

5.3.2.5.1 Solar Flux: X-Ray Product Flag Values and Meanings

Table 5.3.2.5.1-1 Solar Flux: X-Ray Product XRS-A Primary Irradiance Flag Values and Meanings

XRS-A Primary Irradiance Flags (primary_xrsa)	
Flag Value	Flag Meaning
0	solar_minimum_channel_1_is_primary
1	solar_maximum_channel_2_is_primary

Table 5.3.2.5.1-2 Solar Flux: X-Ray Product XRS-B Primary Irradiance Flag Values and Meanings

XRS-B Primary Irradiance Flags (primary_xrsb)	
Flag Value	Flag Meaning
0	solar_minimum_channel_1_is_primary
1	solar_maximum_channel_2_is_primary

Table 5.3.2.5.1-3 Solar Flux: X-Ray Product XRS L1b Processing and Data Quality Flag Values and Meanings

XRS L1b Processing and Data Quality Flags (quality_flags)		
Flag Mask	**Flag Value**	**Flag Meaning**
524287	0	good_quality_qf
1	1	invalid_due_to_out_of_range_XRS_pointing_qf
2	2	degraded_due_to_uncalibrated_range_XRS_pointing_qf
4	4	degraded_due_to_calibrated_but_exceeds_requirements_XRS_pointing_qf
8	8	invalid_due_to_XRS_L0_data_checksum_error_qf
16	16	degraded_due_to_low_XRS_A_and_B_temperature_qf
32	32	degraded_due_to_high_XRS_A_and_B_temperature_qf
64	64	degraded_due_to_XRS-A_solar_minimum_channel_signal_near_zero_qf
128	128	degraded_due_to_XRS-A_solar_maximum_channel_signal_near_zero_qf
256	256	degraded_due_to_XRS-B_solar_minimum_channel_signal_near_zero_qf
512	512	degraded_due_to_XRS-B_solar_maximum_channel_signal_near_zero_qf
1024	1024	degraded_due_to_XRS-A_solar_minimum_channel_signal_at_saturation_qf
2048	2048	degraded_due_to_XRS-A_solar_maximum_channel_signal_at_saturation_qf
4096	4096	degraded_due_to_XRS-B_solar_minimum_channel_signal_at_saturation_qf
8192	8192	degraded_due_to_XRS-B_solar_maximum_channel_signal_at_saturation_qf
16384	16384	degraded_due_to_flatfield_LED_flash_during_XRS_integration_qf
32768	32768	degraded_due_to_insufficient_number_of_integrations_after_XRS_reset_qf
65536	65536	degraded_due_to_non-nominal_XRS-A_irradiance_qf
131072	131072	degraded_due_to_non-nominal_XRS-B_irradiance_qf
262144	262144	degraded_due_to_out_of_valid_range_primary_XRS-B_to_XRS-A_irradiance_ratio_qf

Table 5.3.2.5.1-4 Solar Flux: X-Ray Product Potentially Invalid Data Quality Flag Values and Meanings

Potentially Invalid Flags (invalid_flags)	
Flag Value	**Flag Meaning**
0	no_potentially_invalid_condition
1	potentially_invalid_due_to_XRS_integration_time_change
2	potentially_invalid_due_to_stimulus_lamp_power_change
4	EDAC_single_bit_error_detected_and_corrected
8	potentially_invalid_due_to_EDAC_multi_bit_error_detected

Table 5.3.2.5.1-5 Solar Flux: X-Ray Product Field of View Data Availability Flag Values and Meanings

Field of View Data Availability Flags (fov_unknown)	
Flag Value	**Flag Meaning**
0	known
1	unknown

Table 5.3.2.5.1-6 Solar Flux: X-Ray Product Eclipse in Field of View Flag Values and Meanings

Eclipse in Field of View Flags (fov_eclipse)	
Flag Value	**Flag Meaning**
0	FALSE
1	TRUE

Table 5.3.2.5.1-7 Solar Flux: X-Ray Product Lunar Transit in Field of View Flag Values and Meanings

Lunar Transit in Field of View Flags (fov_lunar_transit)	
Flag Value	**Flag Meaning**
0	FALSE
1	TRUE

Table 5.3.2.5.1-8 Solar Flux: X-Ray Product Planet Transit in Field of View Flag Values and Meanings

Planet Transit in Field of View Flags (fov_planet_transit)	
Flag Value	**Flag Meaning**
0	FALSE
1	TRUE

Table 5.3.2.5.1-9 Solar Flux: X-Ray Product Off-Pointing Field of View Flag Values and Meanings

Off-Pointing Field of View Flags (fov_off_point)	
Flag Value	**Flag Meaning**
0	FALSE
1	TRUE

Table 5.3.2.5.1-10 Solar Flux: X-Ray Product XRS Instrument Mode Flag Values and Meanings

XRS Instrument Mode Flags (xrs_mode)	
Flag Value	**Flag Meaning**
0	operational_mode
1	in-flight_calibration_mode
2	instrument_diagnostic_mode
3	failsafe_recovery_mode

Table 5.3.2.5.1-11 Solar Flux: X-Ray Product XRS Internal Settings Flag Values and Meanings

XRS Internal Settings Flags (xrs_runctrlmd)	
Flag Value	**Flag Meaning**
0	bad_data_no_mode
1	science_observation_in_progress
2	calibration_in_progress
3	bad_data_undetermined_mode

Table 5.3.2.5.1-12 Solar Flux: X-Ray Product EXIS Power Configuration Flag Values and Meanings

EXIS Power Configuration Flags (sc_power_side)	
Flag Value	**Flag Meaning**
0	EXIS_power_board_A_active
1	EXIS_power_board_B_active
2	EXIS_power_board_A_and_B_failure_type_1
3	EXIS_power_board_A_and_B_failure_type_2

Table 5.3.2.5.1-13 Solar Flux: X-Ray Product EXIS Stimulus Lamp Power Flag Values and Meanings

EXIS Stimulus Lamp Power Flags (exs_sl_pwr_ena)	
Flag Value	**Flag Meaning**
0	power_disabled
1	power_enabled

Table 5.3.2.5.1-14 Solar Flux: X-Ray Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

Table 5.3.2.5.1-15 Solar Flux: X-Ray Product Eclipse Flag Values and Meanings

Eclipse Flags (SC_eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

5.3.3 Instrument Calibration Data: EXIS Engineering Telemetry

5.3.3.1 Description

The EXIS Instrument Engineering Telemetry Data file contains data used to support the generation of EUVS and XRS Level 1b products, and monitor and evaluate the health and performance of the sensor suite. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. Some of the data pertains to the temperature of components in the sensor suite. This includes temperatures for the power board, interface board, operational heater, entrance slit, detectors, detector boards, microprocessor board, EUVS-C analog to digital converter, and XRS ASICs and other sub-assemblies. Other telemetry includes XRS-A and XRS-B solar minimum and maximum dark current and field of view corrections, and gains.

Temperatures are expressed in units of kelvin, and the other telemetry items are in units of counts, counts per digital number, or have no units of measure. Table C.3, EXIS Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter.

A netCDF-4 file containing this EXIS engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the EXIS Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.3.3.2 Data Fields

Refer to paragraph 5.1.5.2, Data Fields, in the Instrument Calibration Data: ABI Engineering Telemetry section, as the identical file specification is used except all references to ABI are replaced with EXIS.

5.4 SEISS Level 1b Products and Data

5.4.1 Energetic Heavy Ions Product

5.4.1.1 Description

The Energetic Heavy Ions product contains heavy ion directional differential flux values measured in situ from geostationary orbit. The differential flux values are produced for the Hydrogen (H), Helium (He), Carbon-Nitrogen-Oxygen (CNO), Neon-Sulfur (Ne-S), and Chlorine-Nickel (Cl-Ni) mass groups, and the Beryllium to Copper (Be-Cu) elemental group over successive, valid one minute observation intervals within a five minute interval. For the Be-Cu group, differential flux values are generated for all elements in the periodic table from Be to Cu. The product includes data quality information that provides an assessment of the differential flux values, including an indication of good or degraded quality, or invalid, and the rationale.

For each mass group, heavy ion flux is reported in five energy bands for one angular zone. Similarly, for each element in the elemental group, heavy ion flux is reported in five energy bands for one angular zone. The five energy bands are evenly spaced logarithmically spanning from 10 to 200 MeV per nucleon for the H and He mass groups. The pre-flight nominal definition of the five energy bands for the H and He mass groups is located in paragraph 5.4.1.5.1, Energetic Heavy Ions Product Quantity Characteristics. For all the mass groups and the elemental group, the energy band bounds are dynamic and included in the product.

The one angular zone has a central look-angle that is anti-earthward and has a 60 degree conical field of view. The precise look angle of the angular zone relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data is available from the Product Distribution and Access system.

The units of measure for the directional differential flux values are "particles per second per square centimeter per steradian per (megaelectron volt per nucleon)".

The Energetic Heavy Ions performance requirements are summarized in Table 5.4.1.1, Energetic Heavy Ions Performance Requirements.

Table 5.4.1.1 Energetic Heavy Ions Performance Requirements

	Measurement			Mapping
Region	**Range**	**Accuracy**	**Precision**	**Uncertainty**
anti-earthward with a 60 degree field of view from perspective of GOES-R satellite	10 to 200 MeV/nuc for H and He. [1]	25%: when flux level above background > 10 times minimum flux 45%: when flux level above background is between minimum flux & 10 times minimum flux	flux values associated with 10 counts above background in the 5 minute observation interval	not applicable

[1] Range for ions heavier than He is species-dependent, corresponding approximately to the same stopping distance in silicon as He.

Metadata in the Energetic Heavy Ions product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product.
- Instrument data acquisition start and end times for the elemental flux, hardware coincident rate, and pulse height analysis event count measurements.
- Satellite location and spacecraft ACRF to J2000 ECI attitude quaternion.

- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Differential flux statistical errors, differential flux instrumental errors, and differential energy bounds for the H, He, CNO, Ne-S, and Cl-Ni mass groups and the Be-Cu elemental group for each data channel (i.e., energy band).
- Elemental flux, hardware coincident rate, and pulse height analysis event count observation, and engineering telemetry data availability information.
- Data validity information.
- High flux rate indication.
- Indications of sensor calibration and configuration changes.
- Instrument mode and serial number.

When the satellite is in on-orbit storage mode, the Energetic Heavy Ions product data format and content are the same.

The detailed description of the ISO series metadata for the Energetic Heavy Ions product is located in the standalone Appendix X, ISO Series Metadata.

5.4.1.2 Dynamic Source Data

The Energetic Heavy Ions product is derived using EHIS Level 0 raw science telemetry, SEISS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Energetic Heavy Ions algorithm is identified in Table 5.4.1.5-2, Energetic Heavy Ions: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_EHIS_L0_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.4.1.3 Level 1b Semi-Static Source Data

There are two categories of semi-static source data employed in the SEISS EHIS Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Algorithm processing parameters.

One semi-static HDF5 source data file contains both categories above. This file is included with semi-static parameters for the other SEISS products in a single zip file. The filename conventions for Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are those associated with the sensor's observing characteristics, or its raw outputs. Specific types include:

- Hydrogen and Helium prime (i.e., high flux condition) and non-prime (i.e., low flux condition) geometric factors for each of the five energy bands, which are properties of the sensor used to convert the raw count rate to differential flux; additionally, the uncertainties in the geometric factors contribute to determining the instrumental error associated with the calculated differential flux values.
- Initial Hydrogen and Helium prime and non-prime energy band boundaries for each of the five energy bands, which are used to bin sensed raw count data, and calculate dynamic energy band bounds; additionally, energy bandpass uncertainties contribute to determining the instrumental error associated with the calculated differential flux values.
- Prime and non-prime deadtime correction factor profiles, which are used to calibrate the differential flux values.

- Proton-Contamination-to-Helium prime and non-prime contamination factors for each of the five bands, which are used to calibrate the differential flux values; uncertainties in the contamination factors contribute to determining the instrumental error associated with the calculated differential flux values.
- Heavy ion prime and non-prime geometric factors and their uncertainties for each of the five energy bands.
- Initial Elemental (i.e., for 26 elements from Be through Cu) prime and non-prime energy band boundaries and energy bandpass uncertainties for each of the five energy bands.
- Elemental peak positions and sigmas, in histogram units, which are used during maximum likelihood fitting of the histogram data.
- Sensor acquisition time intervals (3 seconds and 1 minute) and time correction (offset) parameters.

Algorithm processing parameters are those associated with configurable decision-making logic in the algorithm associated with tolerances, and iteration and convergence. Specific types include:

- Maximum number of attempts to find a stable set of fit parameters allowed by the Maximum Likelihood fitting procedure.
- Maximum distance (in peak sigmas) a particular histogram bin can be away from a particular element's peak position in order to be included in that element's Gaussian integral set.
- Change in Likelihood relative to the maximum Likelihood value which defines the 1-Sigma level.
- Tolerance to which two Likelihood values are considered the same.

Following is the file name of the HDF5 file in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- EHIS_CALINR_Parameters.h5

5.4.1.4 Production Notes

The Energetic Heavy Ions product is generated by SEISS EHIS Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector data from the CCSDS packets. The Level 1b algorithm uses the in situ heavy ion count rate measurements from the Earth's geomagnetic environment to determine the directional differential flux values. The Level 1b algorithm corrects for instrument dead-time, removes out-of-band contamination, and converts count rates to directional differential flux values using sensor viewing geometry and area, and energy band characteristics.

The observation data is time stamped on the satellite with a known offset of one minute. This is adjusted by the Level 1b algorithm such that the time stamps reported in the Level 1b product metadata represent actual acquisition times, accurate to within 0.5 seconds. The acquisition times represent the start of a one second observation period.

Both instrument and statistical errors associated with the reported differential flux values are reported. For H and He, the statistical errors, σstat, are reported as symmetric errors; the lower and upper flux statistical limits are defined as flux – σstat and flux + σstat, respectively. In contrast to the H and He groups, statistical errors of the other group and elemental fluxes are reported as lower and upper bounds, $\sigma-$ and $\sigma+$, such that the lower and upper flux statistical limits are defined as flux – $\sigma-$ and flux + $\sigma+$, respectively.

The Level 1b algorithm generates valid product data from the combination of all one minute observation periods when the instrument is in the operational mode during a five minute period. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.4.1.5 Data Fields

The Energetic Heavy Ions product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the energy bands associated with the reported heavy ion fluxes, element fluxes reported in the Be-Cu elemental group, mapping between the energy bands and Be-Cu elements, and the heavy ion flux values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for the Energetic Heavy Ions product are located in Appendix A.

Table 5.4.1.5-1 Energetic Heavy Ions: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f7087582-e5a8-11e3-ac10-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SEISS EHIS L1b Energetic Heavy Ions	string
summary	The GOES-R L1b Energetic Heavy Ions Product consists of heavy ion differential fluxes derived from in situ measurements of heavy ion count rates. Differential fluxes are produced for Hydrogen (H), Helium (He), Carbon-Nitrogen-Oxygen (CNO) mass group, Neon-Sulfur (Ne-S) mass group, Chlorine-Nickel (Cl-Ni) mass group, and Beryllium to Copper (Be-Cu) 26 elements group. For each mass and element group, the fluxes are produced for five energy bands, and one angular zone. The 5 energy bands are evenly spaced logarithmically spanning from 10 to 200 MeV/nucleon for H and He. The energy range for ions heavier than He is species-dependent, corresponding approximately to the same stopping distance in silicon as He. The one angular zone has a central, anti-earthward look-angle (-Z direction in spacecraft body-reference-frame coordinates), and a 60 degree field-of-view. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ELECTRIC FIELDS/ELECTRIC CURRENTS, SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ION CHEMISTRY/IONIZATION, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > HEAVY NUCLEI FLUX, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > ION FLUX	string
cdm_data_type	Point	string

Global Attribute Name	Value	Type
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series SEISS Energetic Heavy Ion Sensor	string
instrument_ID	***serial number of the instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.4.1.5-2 Energetic Heavy Ions: Variables

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
ECEF_X	float	report_number = 1	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = 1	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = 1	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q1	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q2	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = 1	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bo unds = 2	long_name	start and end time of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
HCR_StartStop_Time	double	report_number = 1 number_of_time_bo unds = 2	long_name	instrument Hardware Coincident Rate (HCR) data acquisition start and stop times for observation period, accurate to within 0.5 seconds of onboard data acquisition start time, associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
PEC_StartStopTime	double	report_number = 1 number_of_time_bo unds = 2	long_name	instrument Pulse Height Analysis Event Count (PEC) data acquisition start and stop times for observation period, accurate to within 0.5 seconds of onboard data acquisition start time, associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
ELF_StartStopTime	double	report_number = 1 number_of_time_bo unds = 2	long_name	instrument Elemental Flux (ELF) data acquisition start and stop times for observation period, accurate to within 0.5 seconds of onboard data acquisition start time, associated with product. this is also the time of observation by sensor for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
energy_label ***value = EnergyBand-1 EnergyBand-2***	char	energy = 5 energy_label_str_le n = 12	long_name	labels for five energy bands reported, which are evenly spaced logarithmically spanning from 10 to 200 MeV/nucleon for H and He. energy range for ions heavier than He is species-dependent,	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
EnergyBand-3 EnergyBand-4 EnergyBand-5				corresponding approximately to the same stopping distance in silicon as He. labels are ordered the same as applicable data variables	
energy_bounds_label ***value = MinEnergy MaxEnergy***	char	energy_bounds = 2 energy_bounds_str_len = 9	long_name	labels for minimum and maximum bounding energy levels for an energy band ordered the same as applicable data variables	string
element_label ***value = Be B C N O F Ne Na Mg Al Si P S Cl Ar K Ca Sc Ti V Cr Mn Fe Co Ni Cu***	char	element = 26 element_str_len = 2	long_name	labels for 26 elements of the periodic table ranging from Be to Cu ordered the same as applicable data variables	string
error_bounds_label ***value = LowerError UpperError***	char	error_bounds = 2 error_bounds_str_len = 10	long_name	labels for lower and upper error bounds of a measurement. labels are ordered the same as applicable data variables	string
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I***	char	solar_array_current_channel_index = 4 solar_array_mnemonic_str_len = 25	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
minute_interval_label ***value = Minute-1 Minute-2 Minute-3 Minute-4 Minute-5***	char	minute_interval = 5 minute_interval_str_len = 8	long_name	labels for five 1 minute intervals constituting an energetic heavy ions product. labels are ordered the same as applicable flag and data variables	string
H5MinuteDifferentialFluxes	float	report_number = 1 energy = 5	long_name	Hydrogen (H) differential flux for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
H5MinuteDifferentialFluxStatErrors	float	report_number = 1 energy = 5	long_name	Hydrogen (H) differential flux statistical errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
H5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5	long_name	Hydrogen (H) differential flux instrumental errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
H5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 energy_bounds = 2	long_name	Hydrogen (H) differential flux dynamic energy bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
He5MinuteDifferentialFluxes	float	report_number = 1 energy = 5	long_name	Helium (He) differential flux for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
He5MinuteDifferentialFluxStatErrors	float	report_number = 1 energy = 5	long_name	Helium (He) differential flux statistical errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
He5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5	long_name	Helium (He) differential flux instrumental errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
He5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 energy_bounds = 2	long_name	Helium (He) differential flux dynamic energy bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
CNO5MinuteDifferentialFluxes	float	report_number = 1 energy = 5	long_name	Carbon-Nitrogen-Oxygen (CNO) mass group differential flux for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
CNO5MinuteDifferentialFluxStatErrorsBounds	float	report_number = 1 energy = 5 error_bounds = 2	long_name	Carbon-Nitrogen-Oxygen (CNO) mass group differential flux statistical error bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
CNO5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 energy_bounds = 2	long_name	Carbon-Nitrogen-Oxygen (CNO) mass group differential flux dynamic energy bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
CNO5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5	long_name	Carbon-Nitrogen-Oxygen (CNO) mass group differential flux instrumental errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
NeS5MinuteDifferentialFluxes	float	report_number = 1 energy = 5	long_name	Neon-Sulfur (Ne-S) mass group differential flux for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
NeS5MinuteDifferentialFluxStatErrorsBounds	float	report_number = 1 energy = 5 error_bounds = 2	long_name	Neon-Sulfur (Ne-S) mass group differential flux statistical error bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
NeS5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 energy_bounds = 2	long_name	Neon-Sulfur (Ne-S) mass group differential flux dynamic energy bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
NeS5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5	long_name	Neon-Sulfur (Ne-S) mass group differential flux instrumental errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
ClNi5MinuteDifferentialFluxes	float	report_number = 1 energy = 5	long_name	Chlorine-Nickel (Cl-Ni) mass group differential flux for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
ClNi5MinuteDifferentialFluxStatErrorsBounds	float	report_number = 1 energy = 5 error_bounds = 2	long_name	Chlorine-Nickel (Cl-Ni) mass group differential flux statistical errors for each energy band	string
			_FillValue	-1.00E+31	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
ClNi5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 energy_bounds = 2	long_name	Chlorine-Nickel (Cl-Ni) mass group differential flux dynamic energy bounds for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
ClNi5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5	long_name	Chlorine-Nickel (Cl-Ni) mass group differential flux instrumental errors for each energy band	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
BeCu5MinuteDifferentialFluxes	float	report_number = 1 energy = 5 element = 26	long_name	Beryllium to Copper (Be-Cu) differential flux for each element's energy bands	string
			_FillValue	-1.00E+31	float
			valid_range	-99999.999 99999.999	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
BeCu5MinuteDifferentialFluxStatErrorsBounds	float	report_number = 1 energy = 5 element = 26 error_bounds = 2	long_name	Beryllium to Copper (Be-Cu) flux statistical error bounds for each element's energy bands	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
BeCu5MinuteDifferentialEnergyBounds	float	report_number = 1 energy = 5 element = 26 energy_bounds = 2	long_name	Beryllium to Copper (Be-Cu) flux dynamic energy bounds for each element's energy bands	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	MeV	string
BeCu5MinuteDifferentialFluxInstErrors	float	report_number = 1 energy = 5 element = 26	long_name	Beryllium to Copper (Be-Cu) (26) instrumental errors for each element's energy bands	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 (MeV nuc-1)-1	string
H5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5	long_name	Hydrogen (H) differential flux data quality flag for each energy band	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
He5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5	long_name	Helium (He) differential flux data quality flag for each energy band	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
CNO5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5	long_name	Carbon-Nitrogen-Oxygen (CNO) mass group differential flux data quality flag for each energy band	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
NeS5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5	long_name	Neon-Sulfur (Ne-S) mass group differential flux data quality flag for each energy band	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
ClNi5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5	long_name	Chlorine-Nickel (Cl-Ni) mass group differential flux data quality flag for each energy band	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_meanings	***see note [flags and meanings]***	string
BeCu5MinuteDifferentialFluxDQFs	byte	report_number = 1 energy = 5 element = 26	long_name	Beryllium to Copper (Be-Cu) (26) differential flux data quality flag for each element's energy bands	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 60	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Overall_Validity_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating viability of each one minute interval of data for L1b processing; reasons for a minute interval not being viable include missing L0 data, instrument in non-operational mode, and a science configuration change occurred	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Process_Together_Flag	byte	report_number = 1	long_name	flags indicating whether valid one minute intervals of data can be processed together. if the science configuration change flag indicates a configuration change for any of the one minute intervals, processing one minute intervals of data together is not possible. this affects the 5 minute flux calculations for all the elements and mass groups (H, He, CNO, Ne-S, Ni-Cl, and Be-Cu)	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_EngData_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating availability of instrument engineering telemetry data (instrument mode and serial number)	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_PECData_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating availability of instrument Pulse Height Analysis Event Count (PEC) science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_HCRData_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating availability of instrument Hardware Coincident Rate (HCR) science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_ELFData_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating availability of instrument elemental Flux (ELF) source science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
HFR_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating presence of high flux rate conditions	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
IFC_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags indicating whether instrument is in In-Flight Calibration (IFC) mode	string
			_Unsigned	TRUE	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
SCC_Flag	byte	report_number = 1 minute_interval = 5	long_name	flags from instrument hardware indicating whether a science configuration change has occurred	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
N_blocks	byte	report_number = 1	long_name	number of one minute blocks of EHIS L0 data used to create Energetic Heavy Ions product	string
			_Unsigned	TRUE	string
			_FillValue	0	byte
			valid_range	1 5	byte
			units	count	string
Instrument_Mode	byte	report_number = 1 minute_interval = 5	long_name	instrument (sensor) mode	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Instrument_Serial_Number	byte	report_number = 1	long_name	SEISS EHIS instrument (sensor) serial number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 255	byte
			units	1	string
yaw_flip_flag	byte	report_number = 1	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
eclipse_flag	byte	report_number = 1	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
solar_array_current	short	report_number = unlimited solar_array_current _channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
percent_uncorrectable _L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_in put_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_EHIS_L0 _data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.4.1.5.2, Energetic Heavy Ions Product Flag Values and Meanings.

5.4.1.5.1 Energetic Heavy Ions Product Quantity Characteristics

Table 5.4.1.5.1-1 Energetic Heavy Ions Product H and He Mass Group Nominal Energy Band Characteristics

Energy Band (in MeV/nuc) [1]	Order in Product Data Structure	Product Label Variable Mnemonic
9 - 31	1	EnergyBand-1
31 - 43	2	EnergyBand-2
43 - 55	3	EnergyBand-3
55 - 110	4	EnergyBand-4

Energy Band (in MeV/nuc) [1]	Order in Product Data Structure	Product Label Variable Mnemonic
110 - 200	5	EnergyBand-5

[1] The energy band values in this table are pre-flight nominal values. The precise values for the non-prime and prime energy bands and their uncertainties used by the Level 1b algorithm are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.1.3, Level 1b Semi-Static Source Data. Note that the EHIS energy band limits are dynamic and included in the Energetic Heavy Ions product.

For the other mass groups and the elemental group, the energy band bounds are dynamic and included in the product.

Table 5.4.1.5.1-2 Energetic Heavy Ions Product Be-Cu Elemental Group Characteristics

Element (product label variable mnemonic in parenthesis)	Order in Product Data Structure	Element (periodical table symbol)	Order in Product Data Structure	Element (periodical table symbol)	Order in Product Data Structure
(Be)rylium	1	(Al)uminum	10	(Ti)tanium	19
(B)oron	2	(Si)licon	11	(V)anadium	20
(C)arbon	3	(P)hosphorus	12	(Cr) Chromium	21
(N)itrogen	4	(S)ulfur	13	(Mn) Manganese	22
(O)xygen	5	(Cl) Chlorine	14	(Fe) Iron	23
(F)luorine	6	(Ar)gon	15	(Co)balt	24
(Ne)on	7	(K) Potassium	16	(Ni)ckel	25
(Na) Sodium	8	(Ca)lcium	17	(Cu) Copper	26
(Mg) Magnesium	9	(Sc)andium	18		

5.4.1.5.2 Energetic Heavy Ions Product Flag Values and Meanings

Table 5.4.1.5.2-1 Energetic Heavy Ions Product H, He, CNO, Ne-S, Cl-Ni, & Be-Cu Group Flux Data Quality Flag Values and Meanings

Mass and Elemental Group Flux Data Quality Flags (H5MinuteDifferentialFluxDQFs, He5MinuteDifferentialFluxDQFs, CNO5MinuteDifferentialFluxDQFs, NeS5MinuteDifferentialFluxDQFs, ClNi5MinuteDifferentialFluxDQFs, & BeCu5MinuteDifferentialFluxDQFs)		
Flag Mask	**Flag Value**	**Flag Meaning**
63	0	good_quality_qf
1	1	invalid_due_to_missing_L0_data_or_not_operational_mode_qf
2	2	invalid_due_to_calibration_failed_qf
4	4	degraded_due_to_deadtime_correction_threshold_exceeded_qf [1]
8	8	degraded_due_to_out_of_band_contamination_level_threshold_exceeded_qf [2]
16	16	degraded_due_to_dynamic_error_threshold_exceeded_or_dynamic_error_not_calculable_qf [3]
32	32	degraded_due_to_dynamic_lower_error_bound_not_calculable_only_upper_limit_exists_qf

[1] Dead-time correction threshold is the limiting case where 25% of the raw counts are restored to account for dead-time. The data is considered degraded if the correction exceeds this threshold.
[2] Out-of-band contamination correction threshold is the limiting case of 0.33 for the ratio of the out-of-band contamination term to the valid raw counts for EHIS. Out-of-band contamination includes particles arriving at the detector that are the wrong species, look-direction, energy, or a combination of these deficiencies. The data is considered degraded if the ratio exceeds this threshold.
[3] Dynamic flux error threshold is the limiting case of 0.25 for the ratio of the flux uncertainty to the flux. The data is considered degraded if the ratio exceeds this threshold.

Table 5.4.1.5.2-2 Energetic Heavy Ions Product Elemental Flux, Hardware Coincident Rate, Pulse Count Height Analysis Event Count, and Engineering Telemetry Data Availability Flag Values and Meanings

Data Availability Flags (L1a_ELFData_Flag, L1a_HCRData_Flag, L1a_PECData_Flag, & L1a_EngData_Flag)	
Flag Value	**Flag Meaning**
0	all_data_available
1	some_data_available
2	all_data_missing

Table 5.4.1.5.2-3 Energetic Heavy Ions Product High Flux Rate Flag Values and Meanings

High Flux Rate Flags (HFR_Flag)	
Flag Value	**Flag Meaning**
0	no_high_flux_rate_conditions_exist_and_L1b_algorithm_uses_non_prime_rates_for_this_minute
1	high_flux_rate_conditions_exist_and_L1b_algorithm_uses_prime_rates_for_this_minute

Table 5.4.1.5.2-4 Energetic Heavy Ions Product Overall Validity Quality Flag Values and Meanings

Overall Validity Quality Flags (Overall_Validity_Flag)	
Flag Value	**Flag Meaning**
0	processing_not_viable
1	processing_viable

Table 5.4.1.5.2-5 Energetic Heavy Ions Product Process Together Flag Values and Meaning

Process Together Flags (Process_Together_Flag)	
Flag Value	**Flag Meaning**
0	multiple_minute_intervals_of_data_cannot_be_processed_together
1	multiple_minute_intervals_of_data_can_be_processed_together

Table 5.4.1.5.2-6 Energetic Heavy Ions Product In-Flight Calibration Flag Values and Meaning

In-Flight Calibration Flags (IFC_Flag)	
Flag Value	**Flag Meaning**
0	instrument_not_in_IFC_mode_data_suitable_for_L1b_algorithm
1	instrument_in_IFC_mode_data_not_suitable_for_L1b_algorithm

Table 5.4.1.5.2-7 Energetic Heavy Ions Product Science Configuration Change Flag Values and Meaning

Science Configuration Change Flags (SCC_Flag)	
Flag Value	**Flag Meaning**
0	no_science_configuration_change
1	science_configuration_change_occurred_accounted_for_in_L1b_algorithm

Table 5.4.1.5.2-8 Energetic Heavy Ions Product EHIS Instrument Mode Flag Values and Meaning

EHIS Instrument Mode Flags (Instrument_Mode)	
Flag Value	**Flag Meaning**
0	failsafe_recovery_mode
1	operational_mode
2	in-flight_calibration_mode
3	instrument_diagnostic_mode

Table 5.4.1.5.2-9 Energetic Heavy Ions Product Eclipse Flag Values and Meanings

Eclipse Flags (eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.4.1.5.2-10 Energetic Heavy Ions Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.4.2 Magnetospheric Electrons and Protons: Low Energy Product

5.4.2.1 Description

The Magnetospheric Electrons and Protons: Low Energy product contains up to 30 successive sets of directional differential electron and ion flux values of relatively low energy measured in situ from geostationary orbit. Note that the MPS-LO sensor is unable to distinguish protons from other ions. As a result, ion fluxes are reported rather than proton fluxes. A set is a block of processed observation data containing differential flux values produced over a one second observation interval. The product includes data quality information that provides an assessment of the differential flux values, including an indication of good or degraded quality, or invalid, and the rationale.

Electron and ion differential flux are reported in fifteen energy bands for fourteen angular zones. The fifteen energy bands are evenly spaced logarithmically spanning from 30 eV to 30 keV. The fourteen angular zones, which have a central look angle that is anti-earthward, span a total angular range of 180 degrees in the north to south direction. Each zone, which has a rectangular frustum shaped field of view, is fifteen degrees in the north to south direction and five degrees in the east to west direction. Although there are fourteen angular zones, there are only twelve unique look-angles with the two adjacent central angular zones measured twice. The definition of the pre-flight nominal fifteen energy bands and angular zones are located in paragraph 5.4.2.5.1, Magnetospheric Electrons and Protons: Low Energy Product Quantity Characteristics.

The units of measure for the directional differential flux values are "particles per second per square centimeter per steradian per kiloelectron volt".

The Magnetospheric Electrons and Protons: Low Energy performance requirements are summarized in Table 5.4.2.1, Magnetospheric Electrons and Protons: Low Energy Performance Requirements.

Table 5.4.2.1 Magnetospheric Electrons and Protons: Low Energy Performance Requirements

	Measurement			Mapping
Region	Range	Accuracy	Precision	Uncertainty
anti-earthward with a 180 degree north to south field of view from perspective of GOES-R satellite	30 eV to 30 keV	25%: when flux level above background > 10 times minimum flux 45%: when flux level above background is between minimum flux & 10 times minimum flux	flux values associated with 10 counts above background in the 5 minute observation interval	not applicable

Metadata in the Magnetospheric Electrons and Protons: Low Energy product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the aggregated product (i.e., start time of the first observation and end time of the last).
- Time of each observation.
- Satellite location and spacecraft ACRF to J2000 ECI attitude quaternion.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Dynamic error estimate of differential flux for each zone's electron and ion data channels (i.e., energy bands).
- Electron and ion count observation, and engineering telemetry data availability information.

- Processing quality information.
- Instrument mode and serial number.

When the satellite is in on-orbit storage mode, the Magnetospheric Electrons and Protons: Low Energy product data format and content are the same except that the observation data is subsampled such that it is provided every one in three seconds.

The detailed description of the ISO series metadata for the Magnetospheric Electrons and Protons: Low Energy product is located in the standalone Appendix X, ISO Series Metadata.

5.4.2.2 Dynamic Source Data

The Magnetospheric Electrons and Protons: Low Energy product is derived using MPS-LO Level 0 raw science telemetry, SEISS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Magnetospheric Electrons and Protons: Low Energy algorithm is identified in Table 5.4.2.5-2, Magnetospheric Electrons and Protons: Low Energy: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_MPS-LO_L0_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.4.2.3 Level 1b Semi-Static Source Data

There are two categories of semi-static source data employed in the SEISS MPS-LO Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Algorithm processing parameters.

One semi-static HDF5 source data file contains both categories above. This file is included with semi-static parameters for the other SEISS products in a single zip file. The filename conventions for Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are those associated with the sensor's observing characteristics, or its raw outputs. Specific types include:

- Ion and electron geometric factors for each of the fifteen energy steps and fourteen angular zones, which are properties of the sensor used to convert the raw count rate to differential flux; additionally, the uncertainties in the geometric factors contribute to determining the dynamic error estimate associated with the calculated differential flux values.
- Energy step boundaries, bandpasses, and central values for each of the fifteen energy steps. Note that these are currently not used by the L1b algorithm as energy-dependence has been folded into the geometric factors.
- Ion and electron dead times, which are used to calibrate the differential flux values.
- Fractional background removal coefficients as a function of two species (ion and electron), two sensor heads (R- and L-sensor heads) and four background zones (Ions/R, Ions/L, Electrons/R and Electrons/L).
- Overall scaling background removal coefficients as a function of species and sensor head.
- Sensor acquisition time interval.

Algorithm processing parameters are those associated with configurable decision-making logic in the algorithm. Specific types include:

- Data quality flag thresholds which define excessive threshold values for the dead-time correction, the out-of-band contamination correction and the fractional error on flux; these thresholds are used to calculate the data quality flag associated with each flux value.

Following is the file name of the HDF5 file in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- MPSLO_CALINR_Parameters.h5

5.4.2.4 Production Notes

The Magnetospheric Electrons and Protons: Low Energy product is generated by SEISS MPS-LO Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector observation data from the CCSDS packets. The Level 1b algorithm uses the in situ low energy electron and ion count rate measurements from the Earth's geomagnetic environment to determine the directional differential flux values. The Level 1b algorithm corrects for instrument dead-time, removes out-of-band contamination, and converts count rates to directional differential flux values using sensor viewing geometry and area, and energy band characteristics.

The flux uncertainties reported in the product are total uncertainties that include both instrument and statistical uncertainties.

The Level 1b algorithm generates valid product data only when the instrument is in the operational mode. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.4.2.5 Data Fields

The Magnetospheric Electrons and Protons: Low Energy product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the energy bands associated with the reported electron and ion fluxes, definition of the angular zones, mapping between the energy bands and angular zones, and the electron and ion flux values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for the Magnetospheric Electrons and Protons: Low Energy product are located in Appendix A.

Table 5.4.2.5-1 Magnetospheric Electrons and Protons: Low Energy: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f7087583-e5a8-11e3-ac10-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SEISS MPS-L0 L1b Magnetospheric Electrons and Protons: Low Energy	string
summary	The GOES-R Magnetospheric Electrons and Protons: Low Energy Product consists of fluxes of relatively low energy electrons and ions derived from in situ measurements of electron and ion count rates. Differential electron and ion fluxes are reported at fifteen energy bands in fourteen angular zones. The energy bands are evenly spaced logarithmically spanning from 30 eV to 30 keV. Collectively, the fourteen angular zones, each with a fifteen degree field-of-view, span a total angular range of 180 degrees in the Y-Z plane, with the central zones having an anti-earthward look-angle and are parallel to the minus Z-axis (in spacecraft body-reference-frame coordinates). Although there are fourteen angular zones, there are only twelve unique look-angles with the two adjacent central angular zones measured twice. With respect to the earth, the zones are arranged from north to south with the central zones pointing anti-earthward. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ELECTRIC FIELDS/ELECTRIC CURRENTS, SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ION CHEMISTRY/IONIZATION, SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > SOLAR WIND, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > ELECTRON FLUX, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > ION FLUX	string
cdm_data_type	Point	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string

Global Attribute Name	Value	Type
instrument_type	GOES-R Series SEISS Magnetospheric Particle Sensor Low Energy Range (MPS-LO)	string
instrument_ID	***serial number of the instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.4.2.5-2 Magnetospheric Electrons and Protons: Low Energy: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
ECEF_X	float	report_number = unlimited	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = unlimited	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = unlimited	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q1	float		long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
		report_number = unlimited	_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q2	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	start and end time of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
L1a_SciData_TimeStamp	double	report_number = unlimited	long_name	time of observation by sensor, accurate to within 0.5 seconds of onboard data acquisition start time, for each report, in seconds since 2000-01-01 12:00:00 [see Note 1]	string
			_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
field_of_view_label ***value = Zone-1 Zone-2 Zone-3 Zone-4 Zone-5 Zone-6R Zone-7R Zone-6L Zone-7L Zone-8 Zone-9 Zone-10 Zone-11 Zone-12***	char	field_of_view = 14	long_name	label for instrument's fourteen angular electron and ion sensing zones, each with 15 degree (solid) angular zone field of view ordered the same as applicable data variables	string
		field_of_view_str_len = 7			
differential_flux_energy_band_label ***value = Band1_30.0keV Band2_18.2keV Band3_11.3keV Band4_6.588keV Band5_4.094keV Band6_2.49keV Band7_1.514keV Band8_0.926keV***	char	differential_flux_energy_band = 15	long_name	labels for fifteen energy bands reported, which are evenly spaced logarithmically spanning from 30 keV to 30 eV. labels are ordered the same as applicable data variables	string
		differential_flux_energy_band_str_len = 16			

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
Band9_0.546keV ***Band10_0.346keV*** ***Band11_0.212keV*** ***Band12_0.13keV*** ***Band13_0.08keV*** ***Band14_0.049keV*** ***Band15_0.03keV***					
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I***	char	solar_array_current_channel_index = 4	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
		solar_array_mnemonic_str_len = 25			
DiffElectronFluxes	float	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	differential electron flux at specific energy bands for each zone's primary electron data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
DiffElectronFluxDQFs	byte	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	differential electron flux data quality flag at specific energy bands for each zone's primary electron data channels	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
DiffIonFluxes	float	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	differential ion flux at specific energy bands for each zone's primary ion data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
DiffIonFluxDQFs	byte	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	differential ion flux data quality flag at specific energy bands for each zone's primary ion data channels	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
DiffElectronUncertainties	float	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	dynamic error estimate of differential electron flux at specific energy bands for each zone's primary electron data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
DiffIonUncertainties	float	report_number = unlimited field_of_view = 14 differential_flux_energy_band = 15	long_name	dynamic error estimate of differential ion flux at specific energy bands for each zone's primary ion data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
L1a_EngData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument engineering telemetry data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_IonData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument ion count science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_EleData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument electron count science data	string
			_Unsigned	TRUE	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1b_Processing_Flag	byte	report_number = unlimited	long_name	flags indicating status of L1b product processing	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
N_blocks	byte	report_number = unlimited	long_name	number of one second blocks of MPS-LO data used to create Magnetospheric Electrons and Protons: Low Energy product reports	string
			_Unsigned	TRUE	string
			_FillValue	0	byte
			valid_range	1 1	byte
			units	count	string
Instrument_Mode	byte	report_number = unlimited	long_name	instrument (sensor) mode	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 4	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Instrument_Serial_Number	byte	report_number = unlimited	long_name	SEISS MPS-LO instrument (sensor) serial number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 255	byte
			units	1	string
yaw_flip_flag	byte	report_number = unlimited	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
eclipse_flag	byte	report_number = unlimited	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
solar_array_current	short	report_number = unlimited solar_array_current_ channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_MPS-LO_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.4.2.5.2, Magnetospheric Electrons and Protons: Low Energy Product Flag Values and Meanings.

The designation of "primary" for the sensor data channels is used in the long_name attribute values for the channels where the primary observation data is acquired to distinguish it from the channels collecting background data.

Note 1: The timestamp corresponds to the end of a one-second energy sweep. Each angular zone collects data during approximately 1/16 of a second every second. The first 1/16s interval is used for a voltage fly-back step and subsequent 15 intervals correspond to 15 energy channels from highest to lowest (30 keV to 0.030 keV). The energy step data acquisition interval is slightly less than 1/16s as the first 0.001s of each 1/16s is not collected to allow the power supply to settle at the new voltage setting.

5.4.2.5.1 Magnetospheric Electrons and Protons: Low Energy Product Quantity Characteristics

Table 5.4.2.5.1-1 Magnetospheric Electrons and Protons: Low Energy Product Electron and Ion Energy Band Characteristics

Energy Band (central value in eV) [1] [2]	Order in Product Data Structure	Product Label Variable Mnemonic
30000	1	EnergyBand-1
18320	2	EnergyBand-2
11180	3	EnergyBand-3
6828	4	EnergyBand-4
4168	5	EnergyBand-5
2545	6	EnergyBand-6
1554	7	EnergyBand-7
949	8	EnergyBand-8
579	9	EnergyBand-9
354	10	EnergyBand-10
216	11	EnergyBand-11
132	12	EnergyBand-12
80	13	EnergyBand-13
49	14	EnergyBand-14
30	15	EnergyBand-15

[1] The nominal width of each energy band divided by its central energy value is a constant = 6.67%.
[2] The energy band values in this table are pre-flight nominal values. The precise values for the energy bands, and bandpasses allowing count rate to be converted to flux used by the Level 1b algorithm are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.2.3, Level 1b Semi-Static Source Data.

Table 5.4.2.5.1-2 Magnetospheric Electrons and Protons: Low Energy Product Electron and Ion Flux Angular Zone Characteristics

<table>
<tr><th>Angular Zone Direction [1] [2]</th><th>Order in Product Data Structure</th><th>Product Label Variable Mnemonic</th></tr>
<tr><td>North (TBR)</td><td>1</td><td>Zone-1</td></tr>
<tr><td rowspan="10">Total angular range of 180 degrees. Each angular zone is 15 degrees. Central look angle is anti-earthward. Two adjacent central angular zones, 6 and 7, are measured twice.</td><td>2</td><td>Zone-2</td></tr>
<tr><td>3</td><td>Zone-3</td></tr>
<tr><td>4</td><td>Zone-4</td></tr>
<tr><td>5</td><td>Zone-5</td></tr>
<tr><td>6</td><td>Zone-6R</td></tr>
<tr><td>7</td><td>Zone-7R</td></tr>
<tr><td>8</td><td>Zone-6L</td></tr>
<tr><td>9</td><td>Zone-7L</td></tr>
<tr><td>10</td><td>Zone-8</td></tr>
<tr><td>11</td><td>Zone-9</td></tr>
</table>

Angular Zone Direction [1] [2]	Order in Product Data Structure	Product Label Variable Mnemonic
	12	Zone-10
	13	Zone-11
South (TBR)	14	Zone-12

[1] When satellite is in yaw flip configuration, angular zone direction is reversed.
[2] The angular zone values in this table are pre-flight nominal values. The precise values for the look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.2.3, Level 1b Semi-Static Source Data.

5.4.2.5.2 Magnetospheric Electrons and Protons: Low Energy Product Flag Values and Meanings

Table 5.4.2.5.2-1 Magnetospheric Electrons and Protons: Low Energy Product Electron and Ion Flux Data Quality Flag Values and Meanings

Flux Data Quality Flags (DiffElectronFluxDQFs & DiffIonFluxDQFs)		
Flag Mask	**Flag Value**	**Flag Meaning**
31	0	good_quality_qf
1	1	invalid_due_to_missing_L0_data_or_not_operational_mode_qf
2	2	invalid_due_to_calibration_failed_qf
4	4	degraded_due_to_deadtime_correction_threshold_exceeded_qf [1]
8	8	degraded_due_to_out_of_band_contamination_level_threshold_exceeded_qf [2]
16	16	degraded_due_to_dynamic_error_threshold_exceeded_qf [3]

[1] Dead-time correction threshold is the limiting case where 25% of the raw counts are restored to account for dead-time. The data is considered degraded if the correction exceeds this threshold.
[2] Out-of-band contamination correction threshold is the limiting case of 1.0 for the ratio of the out-of-band contamination term to the valid raw counts. Out-of-band contamination includes particles arriving at the detector that are the wrong species, look-direction, energy, or a combination of these deficiencies. The data is considered degraded if the ratio exceeds this threshold.
[3] Dynamic flux error threshold is the limiting case of 0.25 for the ratio of the flux uncertainty to the flux. The data is considered degraded if the ratio exceeds this threshold.

Table 5.4.2.5.2-2 Magnetospheric Electrons and Protons: Low Energy Product Electron and Ion Count, and Engineering Telemetry Data Availability Flag Values and Meanings

Data Availability Flags (L1a_EleData_Flag, L1a_IonData_Flag, & L1a_EngData_Flag)	
Flag Value	**Flag Meaning**
0	all_data_available
1	some_data_available
2	all_data_missing

Table 5.4.2.5.2-3 Magnetospheric Electrons and Protons: Low Energy Product MPS-LO L1b Processing Quality Flag Values and Meaning

MPS-LO L1b Processing Quality Flags (L1b_Processing_Flag)	
Flag Value	**Flag Meaning**
0	good_processing_qf
1	failed_processing_qf
2	processing_not_attempted_due_to_missing_L0_data_qf
3	processing_not_attempted_due_to_non_operational_mode_qf

Table 5.4.2.5.2-4 Magnetospheric Electrons and Protons: Low Energy Product MPS-LO Instrument Mode Flag Values and Meaning

MPS-LO Instrument Mode Flags (Instrument_Mode)	
Flag Value	**Flag Meaning**
0	no_mode_indicated
1	standby_operational_mode
2	operational_mode
3	instrument_diagnostic_mode
4	in-flight_calibration_mode

Table 5.4.2.5.2-5 Magnetospheric Electrons and Protons: Low Energy Product Eclipse Flag Values and Meanings

Eclipse Flags (eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.4.2.5.2-6 Magnetospheric Electrons and Protons: Low Energy Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.4.3 Magnetospheric Electrons and Protons: Medium and High Energy Product

5.4.3.1 Description

The Magnetospheric Electrons and Protons: Medium and High Energy product contains up to 30 sets of directional differential electron and proton flux values and directional integral electron flux values of medium and high energy measured in situ from geostationary orbit. A set is a block of processed observation data containing differential and integral flux values produced over a one second observation interval. The product includes data quality information that provides an assessment of the differential and integral flux values, including an indication of good or degraded quality, or invalid, and the rationale.

Differential and integral electron flux are reported in eleven energy bands for five angular zones. Differential electron flux is reported in ten of the energy bands, which are evenly spaced logarithmically spanning from 50 keV to 4 MeV. Integral electron flux is reported in the eleventh band for energies greater than 2 MeV. Differential proton flux is reported in eleven energy bands for the same five angular zones. These eleven proton energy bands are evenly spaced logarithmically spanning from 80 keV to 12 MeV. The five angular zones, which have a central look angle that is anti-earthward, span a total angular range of 170 degrees in the north to south direction. Each zone has a 30 degree conical field of view. The definition of the pre-flight nominal energy bands and angular zones are located in paragraph 5.4.3.5.1, Magnetospheric Electrons and Protons: Medium and High Energy Product Quantity Characteristics.

The product also contains calibrated ionizing radiation dose values in two energy ranges measured in situ from geostationary orbit. The low and high energy ranges are from 50 keV to 1 MeV and 1 MeV to 10 MeV, respectively. Like the differential flux values, the ionizing radiation dose values are produced over successive one second observation intervals. The product includes data quality information that provides an assessment of the calibrated ionizing radiation dose values, including an indication of good or degraded quality, or invalid, and the rationale.

The units of measure for the directional differential flux values are "particles per second per square centimeter per steradian per kiloelectron volt". The units of measure for the directional integral flux values are "particles per second per square centimeter per steradian". The units of measure for the ionizing radiation dose values are "centigrays".

The Magnetospheric Electrons and Protons: Medium and High Energy performance requirements are summarized in Table 5.4.3.1, Magnetospheric Electrons and Protons: Medium and High Energy Performance Requirements.

Table 5.4.3.1 Magnetospheric Electrons and Protons: Medium and High Energy Performance Requirements

	Measurement [1]			Mapping
Region	**Range**	**Accuracy**	**Precision**	**Uncertainty**
anti-earthward with a 170 degree north to south field of view from perspective of GOES-R satellite	(1) electrons: 50 keV to 4 MeV & > 2 MeV (2) protons: 80 keV to 12 MeV	25%: when flux level above background > 10 times minimum flux 45%: when flux level above background is between minimum flux & 10 times minimum flux	flux values associated with 10 counts above background in the 5 minute observation interval	not applicable

[1] Performance requirements for ionizing radiation dose has not been specified.

Metadata in the Magnetospheric Electrons and Protons: Medium and High Energy product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product.
- Time of each observation.
- Satellite location and spacecraft ACRF to J2000 ECI attitude quaternion.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Dynamic error estimate of differential electron and proton flux, and integral electron flux for each zone's electron and proton data channels (i.e., energy bands).
- Electron and proton count observation, dosimeter count observation, and engineering telemetry data availability information.
- Processing quality information.
- Instrument mode and serial number.

When the satellite is in on-orbit storage mode, the Magnetospheric Electrons and Protons: Medium and High Energy product data format and content are the same except that the observation data is subsampled such that it is provided every one in three seconds.

The detailed description of the ISO series metadata for the Magnetospheric Electrons and Protons: Medium and High Energy product is located in the standalone Appendix X, ISO Series Metadata.

5.4.3.2 Dynamic Source Data

The Magnetospheric Electrons and Protons: Medium and High Energy product is derived using MPS-HI Level 0 raw science telemetry, SGPS Level 1b Solar and Galactic Protons product data, SEISS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Magnetospheric Electrons and Protons: Medium and High Energy algorithm is identified in Table 5.4.3.5-2, Magnetospheric Electrons and Protons: Medium and High Energy: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_MPS-HI_L0_data" and attribute name "input_SGPS_L1b_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.4.3.3 Level 1b Semi-Static Source Data

There are two categories of semi-static source data employed in the SEISS MPS-HI Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Algorithm processing parameters.

One semi-static HDF5 source data file contains both categories above. This file is included with semi-static parameters for the other SEISS products in a single zip file. The filename conventions for Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are those associated with the sensor's observing characteristics, or its raw outputs. Specific types include:

- Geometric factors for each of the five electron telescopes' one integral energy band, and for the five proton telescopes' eleven differential bands are properties of the sensor, which are used to convert the raw count rate to flux; additionally, the uncertainties in the geometric factors contribute to determining the dynamic error estimate associated with the calculated flux values.
- Energy band boundaries for each of the five electron telescopes' ten differential bands and five proton telescopes' eleven differential bands.
- Electron and proton deadtime correction factors (both digital and analog), which are used to calibrate the flux values.

- Electron inverse instrument matrices for each of the five electron telescopes, which are used to convert count rate to unfolded count rate for the electron energy bands.
- An uncertainty parameter, which is used to estimate the uncertainty in the determination of the instrument response matrix.
- Out of band weighting factors (alpha, beta, gamma) for the five electron telescopes' four electron energy bands, E9, E10, E10A and Ell, which are used to scale the SGPS-X flux data during contamination removal.
- High Linear Energy Transfer (HILET) dosimeter 1 and 2, and Low Linear Energy Transfer (LOLET) dosimeter 1 and 2 factors, which are used to convert raw dose to calibrated dose.
- Sensor acquisition time interval.

Algorithm processing parameters are those associated with configurable decision-making logic in the algorithm. Specific types include:

- Data quality flag thresholds, which define excessive threshold values for the dead-time correction, the out-of-band contamination correction, and the fractional error on flux; these thresholds are used to calculate the data quality flag associated with each flux value.

Following is the file name of the HDF5 file in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- MPSHI_CALINR_Parameters.h5

5.4.3.4 Production Notes

The Magnetospheric Electrons and Protons: Medium and High Energy product is generated by SEISS MPS-HI Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector and radiation dose observation data from the CCSDS packets. The Level 1b algorithm uses the in situ medium and high electron and proton count rate measurements from the Earth's geomagnetic environment to determine the directional differential and integral flux values. The Level 1b algorithm corrects for instrument dead-time, removes out-of-band contamination, and converts count rates to directional differential and integral flux values using sensor viewing geometry and area, and energy band characteristics. For the out-of-band contamination correction of the higher energy electron data channels, the Level 1b algorithm uses SGPS L1b telescope 3 directional differential proton flux values.

In addition, the Level 1b algorithm uses the in situ ionizing radiation dose values from a pair of Low Linear Energy Transfer (LOLET) and a pair of High Linear Energy Transfer (HILET) dosimeters to determine calibrated ionizing radiation dose values from each of the four dosimeters. Multiplicative factors are used to calibrate the raw ionizing radiation dose values.

The flux uncertainties reported in the product are total uncertainties that include both instrument and statistical uncertainties.

The Level 1b algorithm generates valid product data only when the instrument is in the operational mode. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.4.3.5 Data Fields

The Magnetospheric Electrons and Protons: Medium and High Energy product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the energy bands associated with the reported electron and proton fluxes, mapping between the energy bands and angular zones, and the electron and proton flux values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for the Magnetospheric Electrons and Protons: Medium and High Energy product are located in Appendix A.

Table 5.4.3.5-1 Magnetospheric Electrons and Protons: Medium and High Energy: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f7087584-e5a8-11e3-ac10-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SEISS MPS-HI L1b Magnetospheric Electrons and Protons: Medium and High Energy	string
summary	The GOES-R Magnetospheric Electrons and Protons: Medium and High Energy Product consists of fluxes of medium and high energy electrons and protons derived from in situ measurements of electron and proton count rates. Differential and integral electron fluxes are reported at eleven energy bands in five angular zones. Ten of the energy bands are evenly spaced logarithmically spanning from 50 keV to 4 MeV with differential electron flux being reported. The eleventh energy band collects electrons with energies greater than 2 MeV with electron integral flux being reported. In addition, differential proton fluxes are reported at eleven energy bands in the same five angular zones. The eleven proton energy bands are evenly spaced logarithmically and range from 80 keV to 12 MeV. Collectively, the five angular zones, each with a 30 degree field-of-view, span a total angular range of 170 degrees in the Y-Z arranged north to south with the central zone having an anti-earthward look-angle and are parallel to the minus Z-axis (in spacecraft body-reference-frame coordinates). With respect to the earth, the zones are arranged from north to south with the central zone pointing anti-earthward. In addition, the product contains ionizing radiation doses in two energy ranges, 50 keV to 1 MeV and 1 MeV to 10 MeV, obtained from a pair of Low and High Linear Energy Transfer dosimeters, respectively. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ELECTRIC FIELDS/ELECTRIC CURRENTS, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX >	string

Global Attribute Name	Value	Type
	ELECTRON FLUX, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > PROTON FLUX, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE PROPERTIES > ENERGY DEPOSITION	
cdm_data_type	Point	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series SEISS Magnetospheric Particle Sensor High Energy Range (MPS-HI)	string
instrument_ID	***serial number of the instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.4.3.5-2 Magnetospheric Electrons and Protons: Medium and High Energy: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
ECEF_X	float	report_number = unlimited	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = unlimited	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = unlimited	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q1	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q2	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	maximum and minimum CCSDS header time codes of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
L1a_SciData_TimeStamp	double	report_number = unlimited	long_name	time of observation by sensor, accurate to within 0.5 seconds of onboard data acquisition start time, for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
direction_label ***value = Telescope-1 Telescope-2 Telescope-3 Telescope-4 Telescope-5***	char	direction = 5	long_name	labels for instrument's five paired identical electron and proton sensing telescopes, each with 30 degree (solid) angular zone fields of view. labels are ordered the same as applicable data variables	string
		telescope_label_str_len = 11			
energy_electron_label	char	energy_electron =10	long_name	labels for ten electron energy bands reported, which are evenly spaced logarithmically spanning from 50 keV to 4 MeV, labels are ordered the same as applicable data variables	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
value = ***ElectronEnergyBand-1*** ***ElectronEnergyBand-2*** ***ElectronEnergyBand-3*** ***ElectronEnergyBand-4*** ***ElectronEnergyBand-5*** ***ElectronEnergyBand-6*** ***ElectronEnergyBand-7*** ***ElectronEnergyBand-8*** ***ElectronEnergyBand-9*** ***ElectronEnergyBand-10***		electron_energy_label_str_len = 24			
energy_proton_label ***value =*** ***ProtonEnergyBand-1*** ***ProtonEnergyBand-2*** ***ProtonEnergyBand-3*** ***ProtonEnergyBand-4*** ***ProtonEnergyBand-5*** ***ProtonEnergyBand-6*** ***ProtonEnergyBand-7*** ***ProtonEnergyBand***	char	energy_proton =11	long_name	labels for eleven proton energy bands reported, which are evenly spaced logarithmically spanning from 80 keV to 12 MeV. labels are ordered the same as applicable data variables	string
		proton_energy_label_str_len = 24			

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
-8 ProtonEnergyBand -9 ProtonEnergyBand -10 ProtonEnergyBand -11					
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I***	char	solar_array_current_channel_index = 4	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
		solar_array_mnemonic_str_len = 25			
DiffElectronFluxes	float	report_number = unlimited direction = 5 energy_electron = 10	long_name	differential electron flux at specific energy bands for each telescope's ten primary data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
IntgElectronFluxes	float	report_number = unlimited direction = 5	long_name	integral electron flux at energy band > 2000 keV for each telescope's primary data channel E11	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1	string
DiffProtonFluxes	float	report_number = unlimited direction = 5 energy_proton = 11	long_name	differential proton flux at specific energy bands for each telescope's eleven primary data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
DiffElectronUncertainties	float	report_number = unlimited direction = 5	long_name	dynamic error estimate of differential electron flux at specific energy bands for each telescope's ten primary data channels	string
			_FillValue	-1.00E+31	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
		energy_electron = 10	valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
IntgElectronUncertainties	float	report_number = unlimited direction = 5	long_name	dynamic error estimate of integral electron flux at energy band > 2000 keV for each telescope's primary data channel E11	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1	string
DiffProtonUncertainties	float	report_number = unlimited direction = 5 energy_proton = 11	long_name	dynamic error estimate of differential proton flux at specific energy bands for each telescope's eleven primary data channels	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
DiffElectronFluxDQFs	byte	report_number = unlimited direction = 5 energy_electron = 10	long_name	differential electron flux data quality flags at specific energy bands for each telescope's primary data channels	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
DiffProtonFluxDQFs	byte	report_number = unlimited direction = 5 energy_proton = 11	long_name	differential proton flux data quality flags at specific energy bands for each telescope's primary data channels	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
IntgElectronFluxDQFs	byte	report_number = unlimited direction = 5	long_name	integral electron flux data quality flags at energy band > 2000 keV for each telescope's primary data channel E11	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Dos1_HiLetDose	float	report_number = unlimited	long_name	calibrated dose from High Linear Energy Transfer (HILET) dosimeter 1, which measures energy between 1 and 10 MeV	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cGy	string
Dos1_HiLetDqf	byte	report_number = unlimited	long_name	flags indicating calibrated measurement derived from HILET dosimeter 1	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Dos2_HiLetDose	float	report_number = unlimited	long_name	calibrated dose from High Linear Energy Transfer (HILET) dosimeter 2, which measures energy between 1 and 10 MeV	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cGy	string
Dos2_HiLetDqf	byte	report_number = unlimited	long_name	flags indicating calibrated measurement derived from HILET dosimeter 2	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Dos1_LoLetDose	float	report_number = unlimited	long_name	calibrated dose from Low Linear Energy Transfer (LOLET) dosimeter 1, which measures energy between 50 keV and 1 MeV	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cGy	string
Dos1_LoLetDqf	byte	report_number = unlimited	long_name	flags indicating calibrated measurement derived from LOLET dosimeter 1	string
			_Unsigned	TRUE	string
			_FillValue	255	byte

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Dos2_LoLetDose	float	report_number = unlimited	long_name	calibrated dose from Low Linear Energy Transfer (LOLET) dosimeter 2, which measures energy between 50 keV and 1 MeV	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cGy	string
Dos2_LoLetDqf	byte	report_number = unlimited	long_name	flags indicating calibrated measurement derived from LOLET dosimeter 2	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_EngData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument engineering telemetry data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_ProtonData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument proton count science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_EleData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument electron count science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_DosData_Flag	byte	report_number = unlimited	long_name	flags indicating availability of instrument dosimeter count science data	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1b_Processing_Flag	byte	report_number = unlimited	long_name	flags indicating status of L1b product processing	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
N_blocks	byte	report_number = unlimited	long_name	number of one second blocks of MPS-HI data used to create Magnetospheric Electrons and Protons: Medium and High Energy product reports	string
			_Unsigned	TRUE	string
			_FillValue	0	byte
			valid_range	1 1	byte
			units	count	string
Instrument_Mode	byte	report_number = unlimited	long_name	instrument (sensor) mode	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 4	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Instrument_Serial_Number	byte	report_number = unlimited	long_name	SEISS MPS-HI instrument (sensor) serial number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 255	byte
			units	1	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
yaw_flip_flag	byte	report_number = unlimited	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
eclipse_flag	byte	report_number = unlimited	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
solar_array_current	short	report_number = unlimited solar_array_current_channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_MPS-HI_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string
			input_SGPS_L1b_data	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.4.3.5.2, Magnetospheric Electrons and Protons: Medium and High Energy Product Flag Values and Meanings.

The designation of "primary" for the sensor data channels is used in the long_name attribute values for the channels where the primary observation data is acquired to distinguish it from the channels collecting singles data.

5.4.3.5.1 Magnetospheric Electrons and Protons: Medium and High Energy Product Quantity Characteristics

Table 5.4.3.5.1-1 Magnetospheric Electrons and Protons: Medium and High Energy Product Electron Energy Band Characteristics

Energy Band (in keV)	Order in Product Data Structure	Product Label Variable Mnemonic
50 - 80	1	ElectronEnergyBand-1
80 - 140	2	ElectronEnergyBand-2
140 - 200	3	ElectronEnergyBand-3
200 - 300	4	ElectronEnergyBand-4
300 - 450	5	ElectronEnergyBand-5
450 - 700	6	ElectronEnergyBand-6
700 - 1100	7	ElectronEnergyBand-7
1100 - 1700	8	ElectronEnergyBand-8
1700 - 2600	9	ElectronEnergyBand-9
2600 - 4000	10	ElectronEnergyBand-10
> 4000	1	not applicable

[1] The energy band values in this table are pre-flight nominal values. The precise values for the electron energy bands used by the Level 1b algorithm are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.3.3, Level 1b Semi-Static Source Data.

Table 5.4.3.5.1-2 Magnetospheric Electrons and Protons: Medium and High Energy Product Proton Energy Band Characteristics

Energy Band (in keV) [1]	Order in Product Data Structure	Product Label Variable Mnemonic
80 - 115	1	ProtonEnergyBand-1
115 - 165	2	ProtonEnergyBand-2
165 - 235	3	ProtonEnergyBand-3
235 - 340	4	ProtonEnergyBand-4
340 - 500	5	ProtonEnergyBand-5
500 - 700	6	ProtonEnergyBand-6

Energy Band (in keV) [1]	Order in Product Data Structure	Product Label Variable Mnemonic
700 - 1000	7	ProtonEnergyBand-7
1000 - 1900	8	ProtonEnergyBand-8
1900 - 3200	9	ProtonEnergyBand-9
3200 - 6500	10	ProtonEnergyBand-10
6500 - 10000	11	ProtonEnergyBand-11

[1] The energy band values in this table are pre-flight nominal values. The precise values for the proton energy bands used by the Level 1b algorithm are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.3.3, Level 1b Semi-Static Source Data.

Table 5.4.3.5.1-3 Magnetospheric Electrons and Protons: Medium and High Energy Product Proton Flux Angular Zone Characteristics

Angular Zone Direction [1] [2]	Order in Product Data Structure	Product Label Variable Mnemonic
North (TBR)	1	Telescope-1
Total angular range of 170 degrees. Each angular zone is 30 degrees. Central look angle is anti-earthward.	2	Telescope-2
	3	Telescope-3
	4	Telescope-4
South (TBR)	5	Telescope-5

[1] When satellite is in yaw flip configuration, angular zone direction is reversed.
[2] The angular zone values in this table are pre-flight nominal values. The precise values for the look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.3.3, Level 1b Semi-Static Source Data.

5.4.3.5.2 Magnetospheric Electrons and Protons: Medium and High Energy Product Flag Values and Meanings

Table 5.4.3.5.2-1 Magnetospheric Electrons and Protons: Medium and High Energy Product Electron and Proton Flux Data Quality Flag Values and Meanings

Electron and Proton Flux Data Quality Flags (DiffElectronFluxDQFs, IntgElectronFluxDQFs, & DiffProtonFluxDQFs)		
Flag Mask	**Flag Value**	**Flag Meaning**
31	0	good_quality_qf
1	1	invalid_due_to_missing_L0_data_or_not_operational_mode_qf
2	2	invalid_due_to_calibration_failed_qf
4	4	degraded_due_to_deadtime_correction_threshold_exceeded_qf [1]
8	8	degraded_due_to_out_of_band_contamination_level_threshold_exceeded_qf [2]
16	16	degraded_due_to_dynamic_error_threshold_exceeded_qf [3]

[1] Dead-time correction threshold is the limiting case where 25% of the raw counts are restored to account for dead-time. The data is considered degraded if the correction exceeds this threshold.
[2] Out-of-band contamination correction threshold is the limiting case of 1.0 for the ratio of the out-of-band contamination term to the valid raw counts. Out-of-band contamination includes particles arriving at the detector that are the wrong species, look-direction, energy, or a combination of these deficiencies. The data is considered degraded if the ratio exceeds this threshold.
[3] Dynamic flux error threshold is the limiting case of 0.25 for the ratio of the flux uncertainty to the flux. The data is considered degraded if the ratio exceeds this threshold.

Table 5.4.3.5.2-2 Magnetospheric Electrons and Protons: Medium and High Energy Product Radiation Dose Data Quality Flag Values and Meanings

Energy Radiation Dose Data Quality Flags (Dos1_HiLetDqf, Dos2_HiLetDqf, Dos1_LoLetDqf, & Dos2_LoLetDqf)	
Flag Value	**Flag Meaning**
0	good_quality_qf
1	invalid_due_to_missing_L0_data_or_not_operational_mode_qf

Table 5.4.3.5.2-3 Magnetospheric Electrons and Protons: Medium and High Energy Product Electron and Proton Count, Radiation Dose, and Engineering Telemetry Data Availability Flag Values and Meanings

Data Availability Flags (L1a_EleData_Flag, L1a_ProtonData_Flag, L1a_DosData_Flag, & L1a_EngData_Flag)	
Flag Value	**Flag Meaning**
0	all_data_available
1	some_data_available
2	all_data_missing

Table 5.4.3.5.2-4 Magnetospheric Electrons and Protons: Medium and High Energy Product MPS-HI L1b Processing Quality Flag Values and Meaning

MPS-HI L1b Processing Quality Flags (L1b_Processing_Flag)	
Flag Value	**Flag Meaning**
0	good_processing_qf
1	failed_processing_qf
2	processing_not_attempted_due_to_missing_L0_data_qf

MPS-HI L1b Processing Quality Flags (L1b_Processing_Flag)	
Flag Value	**Flag Meaning**
3	processing_not_attempted_due_to_non_operational_mode_qf

Table 5.4.3.5.2-5 Magnetospheric Electrons and Protons: Medium and High Energy Product MPS-HI Instrument Mode Flag Values and Meaning

MPS-HI Instrument Mode Flags (Instrument_Mode)	
Flag Value	**Flag Meaning**
0	no_mode_indicated
1	standby_operational_mode
2	operational_mode
3	instrument_diagnostic_mode
4	in-flight_calibration_mode

Table 5.4.3.5.2-6 Magnetospheric Electrons and Protons: Medium and High Energy Product Eclipse Flag Values and Meanings

Eclipse Flags (eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.4.3.5.2-7 Magnetospheric Electrons and Protons: Medium and High Energy Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.4.4 Solar and Galactic Protons Product

5.4.4.1 Description

The Solar and Galactic Protons product contains up to 60 sets of directional differential and integral proton flux values of very high energy measured in situ from geostationary orbit. A set is a block of processed observation data containing differential and integral flux values produced over a one second observation interval. The product includes data quality information that provides an assessment of the differential and integral flux values, including an indication of good or degraded quality, or invalid, and the rationale.

Differential and integral proton flux are reported in fourteen energy bands for two angular zones. Differential proton flux is reported in thirteen of the energy bands, which span from 1 to 500 MeV. Integral proton flux is reported in the fourteenth band for energies greater than 500 MeV. The two angular zones have a westward and eastward central look angle. Separate sensor units support each of the two angular zones. The size of the conical fields-of-view for the energy bands vary. The definition of the pre-flight nominal energy bands, and the angular zones and size of their fields-of-view are located in paragraph 5.4.4.5.1, Solar and Galactic Protons Product Quantity Characteristics.

The precise look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are available from the Product Distribution and Access system.

The units of measure for the directional differential flux values are "particles per second per square centimeter per steradian per kiloelectron volt". The units of measure for the directional integral flux values are "particles per second per square centimeter per steradian".

The Solar and Galactic Protons performance requirements are summarized in Table 5.4.4.1, Solar and Galactic Protons Performance Requirements.

Table 5.4.4.1 Solar and Galactic Protons Performance Requirements

	Measurement			Mapping
Region	Range	Accuracy	Precision	Uncertainty
westward and eastward from perspective of GOES-R satellite with varying fields-of-view for different energy bands	1 to 500 MeV & > 500 MeV	25%: when flux level above background > 10 times minimum flux 45%: when flux level above background is between minimum flux & 10 times minimum flux	flux values associated with 10 counts above background in the 5 minute observation interval	not applicable

Metadata in the Solar and Galactic Protons product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product.
- Time of each observation.
- Satellite location and spacecraft ACRF to J2000 ECI attitude quaternion.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Dynamic error estimate of differential and integral proton flux for each zone's data channels (i.e., energy bands).
- Proton count observation and engineering telemetry data availability information.
- Processing quality information.
- On-board out-of-band contamination removal enabled indication.

- Instrument mode and serial number.

When the satellite is in on-orbit storage mode, the Solar and Galactic Protons product data format and content are the same except that the observation data is subsampled such that it is provided every one in three seconds.

The detailed description of the ISO series metadata for the Solar and Galactic Protons product is located in the standalone Appendix X, ISO Series Metadata.

5.4.4.2 Dynamic Source Data

The Solar and Galactic Protons product is derived using SGPS Level 0 raw science telemetry, SEISS engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Solar and Galactic Protons algorithm is identified in Table 5.4.4.5-2, Solar and Galactic Protons: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_SGPS_L0_data".

Table 5.4.4.2 Primary Sensor Data

Dynamic Data Category	Dynamic Data Type
L0 Products	input_SGPS_L0_data

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.4.4.3 Level 1b Semi-Static Source Data

There are two categories of semi-static source data employed in the SEISS SGPS Level 1b ground processing algorithm:

- Sensor calibration parameters.
- Algorithm processing parameters.

One semi-static HDF5 source data file contains both categories above. This file is included with semi-static parameters for the other SEISS products in a single zip file. The filename conventions for Level 1b semi-static source data files are located in Appendix A.

Sensor calibration parameters are those associated with the sensor's observing characteristics, or its raw outputs. Specific types include:

- Geometric factors for each of the three telescopes' energy bands, which are properties of the sensor and used to convert the raw count rate to flux; additionally, the uncertainties in the geometric factors contribute to determining the dynamic error estimate associated with the calculated flux values.
- Energy band boundaries for each of the three telescopes' differential energy bands.
- Deadtime correction factor, which is used to calibrate the flux values.
- Out-of-band contamination removal overall scaling factors and weighting factors for those channels undergoing out-of-band contamination removal (i.e., P5, P8CF, P9F and P10).
- Sensor acquisition time interval.

There are separate parameter instances for the SGPS-X and SGPS+X units.

Algorithm processing parameters are those associated with configurable decision-making logic in the algorithm. Specific types include:

- Data quality flag thresholds, which define excessive threshold values for the dead-time correction, the out-of-band contamination correction and the fractional error on flux; these thresholds are used to calculate the data quality flag associated with each flux value.

Following is the file name of the HDF5 file in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- SGPS_CALINR_Parameters.h5

5.4.4.4 Production Notes

The Solar and Galactic Protons product is generated by SEISS SGPS Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw detector observation data from the CCSDS packets. The Level 1b algorithm uses the in situ very high energy proton count rate measurements from the Earth's geomagnetic environment to determine the directional differential and integral flux values. The Level 1b algorithm corrects for instrument dead-time, removes out-of-band contamination, and converts count rates to directional differential and integral flux values using sensor viewing geometry and area, and energy band characteristics.

The flux uncertainties reported in the product are total uncertainties that include both instrument and statistical uncertainties.

The Level 1b algorithm generates valid product data only when the instrument is in the operational mode. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.4.4.5 Data Fields

The Solar and Galactic Protons product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the energy bands associated with the reported electron and proton flux values, mapping between the energy bands and angular zones, and the proton flux values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for Solar and Galactic Protons product are located in Appendix A.

Table 5.4.4.5-1 Solar and Galactic Protons: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	67e28dc8-4a39-11e4-9e35-164230d1df67	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SEISS SGPS L1b Solar and Galactic Protons	string
summary	The GOES-R Solar and Galactic Protons Product consists of fluxes of very high energy protons derived from in situ measurements of proton count rates. Differential proton fluxes are reported at thirteen energy bands spanning from 1 to 500 MeV, and one integral proton flux is reported for particles > 500 MeV. One angular zone, having a central westward or eastward look-angle, is observed by the three telescopes on each of two sensor units, one facing west (-X) and another facing east (+X). Each telescope provides for a subset of the reported energy bands. Telescope 1 and 2 have 60 degree fields-of-view, and telescope 3 has a 90 degree field-of-view. A yaw-flip reverses the direction observed by the two sensor units. The product also contains processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > ELECTRIC FIELDS/ ELECTRIC CURRENTS, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > ALPHA PARTICLE FLUX, SUN-EARTH INTERACTIONS > SOLAR ENERGETIC PARTICLE FLUX > PROTON FLUX	string
cdm_data_type	Point	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series SEISS Solar and Galactic Proton Sensor	string

Global Attribute Name	Value	Type
SGPS_MinusX_instrument_ID	***serial number of the SGPS-X instrument (sensor).***	string
SGPS_PlusX_instrument_ID	***serial number of the SGPS+X instrument (sensor).***	string
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.4.4.5-2 Solar and Galactic Protons: Variables

Name	Type	Shape	Name	Value	Type
ECEF_X	float	report_number = unlimited	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = unlimited	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = unlimited	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
quaternion_Q0	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string

Name	Type	Shape	Name	Value	Type
quaternion_Q1	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q2	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
quaternion_Q3	float	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	float
			valid_range	-1.0 1.0	float
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	maximum and minimum CCSDS header time codes of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
L1a_SciData_TimeStamp	double	report_number = unlimited	long_name	time of observation, accurate to within 0.5 seconds of onboard data acquisition start time, for the two sensor units for each report, in seconds since 2000-01-01 12:00:00	string
		sensor_unit = 2	_FillValue	-1.00E+31	double
			units	seconds since 2000-01-01 12:00:00	string
sensor_unit_label ***value = SGPS-X SGPS+X***	char	sensor_unit =2	long_name	labels for the two Solar and Galactic Proton Sensor units nominally (i.e., no yaw flip) providing fields of view in the westward (-X) and eastward (+X) direction. labels are ordered the same as applicable data variables	string
		sensor_unit_str_len = 6			
energy_T1_label ***value = EnergyBand-P1:1-1.9MeV EnergyBand-P2A:1.9-2.3MeV EnergyBand-P2B:2.3-3.4MeV EnergyBand-P3:3.4-6.5MeV EnergyBand-P4:6.5-12MeV***	char	energy_T1 = 6	long_name	labels for six energy bands reported from telescope 1 spanning from 1 to 25 MeV. labels are ordered the same as applicable data variables	string
		energy_T1_str_len = 25			

Name	Type	Shape	Name	Value	Type
EnergyBand-P5:12-25MeV					
energy_T2_label ***value = EnergyBand-P6:25-40MeV EnergyBand-P7:40-80MeV***	char	energy_T2 =2	long_name	labels for two energy bands reported from telescope 2 spanning from 25 to 80 MeV. labels are ordered the same as applicable data variables	string
		energy_T2_str_len = 22			
energy_T3_label ***value = EnergyBand-P8AF:83-99MeV EnergyBand-P8BF:99-118MeV EnergyBand-P8CF:118-150MeV EnergyBand-P9F:150-275MeV EnergyBand-P10:275-500MeV***	char	energy_T3 = 5	long_name	labels for five energy bands reported from telescope 3 spanning from 80 to 500 MeV. labels are ordered the same as applicable data variables	string
		energy_T3_str_len = 26			
Diff31_logic_channel_label ***value = D3-D1_Logic:P7 D3-D1_Logic:P8CF D3-D1_Logic:P9F***	char	channel =3	long_name	labels for three primary proton channels supporting on-board out-of-band contamination removal. labels are ordered the same as applicable data variable	string
		channel_str_len = 16			
solar_array_current_channel_index_label ***value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I***	char	solar_array_current_channel_index = 4 solar_array_mnemonic_str_len = 25	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
T1_DifferentialProtonFluxes	float	report_number = unlimited sensor_unit = 2 energy_T1 = 6	long_name	differential proton flux at specific energy bands for telescope 1's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string

Name	Type	Shape	Name	Value	Type
T1_DifferentialProtonFlux Uncertainties	float	report_number = unlimited sensor_unit = 2 energy_T1 = 6	long_name	dynamic error estimate of differential proton flux at specific energy bands for telescope 1's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
T1_DifferentialProtonFlux DQFs	byte	report_number = unlimited sensor_unit = 2 energy_T1 = 6	long_name	differential proton flux data quality flag at specific energy bands for telescope 1's primary proton data channels on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
T2_DifferentialProtonFlux es	float	report_number = unlimited sensor_unit = 2 energy_T2 = 2	long_name	differential proton flux at specific energy bands for telescope 2's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
T2_DifferentialProtonFlux Uncertainties	float	report_number = unlimited sensor_unit = 2 energy_T2 = 2	long_name	dynamic error estimate of differential proton flux at specific energy bands for telescope 2's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
T2_DifferentialProtonFlux DQFs	byte	report_number = unlimited sensor_unit = 2 energy_T2 = 2	long_name	differential proton flux data quality flag at specific energy bands for telescope 2's primary proton data channels on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string

Name	Type	Shape	Name	Value	Type
T3_DifferentialProtonFluxes	float	report_number = unlimited sensor_unit = 2 energy_T3 = 5	long_name	differential proton flux at specific energy bands for telescope 3's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
T3_DifferentialProtonFluxUncertainties	float	report_number = unlimited sensor_unit = 2 energy_T3 = 5	long_name	dynamic error estimate of differential proton flux at specific energy bands for telescope 3's primary proton data channels on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1 keV-1	string
T3_DifferentialProtonFluxDQFs	byte	report_number = unlimited sensor_unit = 2 energy_T3 = 5	long_name	differential proton flux data quality flag at specific energy bands for telescope 3's primary proton data channels on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
T3P11_IntegralProtonFlux	float	report_number = unlimited sensor_unit = 2	long_name	integral proton flux at energy band > 500 MeV for telescope 3's primary integral data channel P11 on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1	string
T3P11_IntegralProtonFluxUncertainties	float	report_number = unlimited sensor_unit = 2	long_name	dynamic error estimate of integral proton flux at energy band > 500 MeV for telescope 3's primary integral data channel P11 on each of the two sensor units	string
			_FillValue	-1.00E+31	float
			valid_range	-9999999.0 9999999.0	float
			units	cm-2 sr-1 s-1	string
T3P11_IntegralProtonFluxDQFs	byte	report_number = unlimited sensor_unit = 2	long_name	integral proton flux data quality flag at energy band > 500 MeV for telescope 3's primary integral data channel P11 on each of the two sensor units	string
			_Unsigned	TRUE	string

Name	Type	Shape	Name	Value	Type
			_FillValue	255	byte
			valid_range	0 28	byte
			units	1	string
			flag_masks	***see note [flags and meanings]***	byte
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_EngData_Flag	byte	report_number = unlimited sensor_unit = 2	long_name	flags indicating availability of instrument engineering telemetry data on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1a_SciData_Flag	byte	report_number = unlimited sensor_unit = 2	long_name	flags indicating availability of instrument proton count science data on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
L1b_Processing_Flag	byte	report_number = unlimited	long_name	flags indicating status of L1b product processing	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
N_blocks	byte	report_number = unlimited sensor_unit = 2	long_name	number of one second blocks of SGPS data used to create Solar and Galactic Protons product reports on each of the two sensor units	string
			_Unsigned	TRUE	string
			_FillValue	0	byte
			valid_range	1 1	byte
			units	count	string
Instrument_Mode	byte	report_number = unlimited	long_name	SGPS-X and SGPS+X instrument (sensor) mode	string
			_Unsigned	TRUE	string

Name	Type	Shape	Name	Value	Type
		sensor_unit = 2	_FillValue	255	byte
			valid_range	0 4	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
Instrument_Serial_Number	byte	report_number = unlimited sensor_unit = 2	long_name	SEISS SGPS-X and SGPS+X instrument (sensor) serial number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 255	byte
			units	1	string
Diff31_Logic_Flags	byte	report_number = unlimited	long_name	flags indicating whether on-board out-of-band contamination removal is enabled for primary proton data channels P7, P8CF and P9F on each of the two sensor units	string
		sensor_unit = 2 channel = 3	_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 1	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
yaw_flip_flag	byte	report_number = unlimited	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
eclipse_flag	byte	report_number = unlimited	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string

Name	Type	Shape	Name	Value	Type
solar_array_current	short	report_number = unlimited solar_array_current_channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_SGPS_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.4.4.5.2, Solar and Galactic Protons Product Flag Values and Meanings.

The designation of "primary" for the sensor data channels is used in the long_name attribute values for the channels where the primary observation data is acquired to distinguish it from the channels collecting singles data.

5.4.4.5.1 Solar and Galactic Protons Product Quantity Characteristics

Table 5.4.4.5.1-1 Solar and Galactic Protons Product Field of View and Proton Energy Band Characteristics

Telescope [1]	Field of View [2] [3]	Energy Band (in MeV) [4]	Order in Product Data Structure	Product Label Variable Mnemonic
Telescope 1	*60 degrees*	1 - 1.9	1	EnergyBand-P1:1-1.9MeV
		1.9 - 2.3	2	EnergyBand-P2A:1.9-2.3MeV
		2.3 - 3.4	3	EnergyBand-P2B:2.3-3.4MeV
		3.4 - 6.5	4	EnergyBand-P3:3.4-6.5MeV
		6.5 - 12	5	EnergyBand-P4:6.5-12MeV
		12 - 25	6	EnergyBand-P5:12-25MeV
Telescope 2	*60 degrees*	25 - 40	1	EnergyBand-P6:25-40MeV
		40 - 80	2	EnergyBand-P7:40-80MeV
Telescope 3	*90 degrees*	83 - 99	1	EnergyBand-P8AF:83-99MeV
		99 - 118	2	EnergyBand-P8BF:99-118MeV
		118 - 150	3	EnergyBand-P8CF:118-150MeV
		150 - 275	4	EnergyBand-P9F:150-275MeV

Telescope [1]	Field of View [2] [3]	Energy Band (in MeV) [4]	Order in Product Data Structure	Product Label Variable Mnemonic
		275 - 500	5	EnergyBand-P10:275-500MeV
		> 500	1	not applicable

[1] Three telescopes, which have identical central look angles, collectively support the fourteen data channels (i.e., energy bands). Separate data structures are used to store the differential fluxes associated with each telescope.
[2] Field-of-view for the three telescopes is conical.
[3] The angular zone values in this table are pre-flight nominal values. The precise values for the look angles of the angular zones relative to the GOES-R spacecraft body reference frame required for use and subsequent processing of this level 1b product data are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.4.3, Level 1b Semi-Static Source Data.
[4] The energy band values in this table are pre-flight nominal values. The precise values for the energy bands used by the Level 1b algorithm are semi-static source data. These values are available from the Product Distribution and Access system. Additional details are located in paragraph 5.4.4.3, Level 1b Semi-Static Source Data.

Table 5.4.4.5.1-2 Solar and Galactic Protons Product Sensor Unit Characteristics

Angular Zone Direction [1]	Order in Product Data Structure	Product Label Variable Mnemonic
Westward (TBR)	1	SGPS-X
Eastward (TBR)	2	SGPS+X

[1] When satellite is in yaw flip configuration, angular zone direction for sensor units is reversed.

5.4.4.5.2 Solar and Galactic Protons Product Proton Flux Data Quality Flag Values and Meanings

Table 5.4.4.5.2-1 Solar and Galactic Protons Product Proton Flux Data Quality Flag Values and Meanings

Proton Flux Data Quality Flags (T1_DifferentialProtonFluxDQFs, T2_DifferentialProtonFluxDQFs, T3_DifferentialProtonFluxDQFs, & T3_DifferentialProtonFluxDQFs)		
Flag Mask	**Flag Value**	**Flag Meaning**
31	0	good_quality_qf
1	1	invalid_due_to_missing_L0_data_or_not_operational_mode_qf
2	2	invalid_due_to_calibration_failed_qf
4	4	degraded_due_to_deadtime_correction_threshold_exceeded_qf [1]
8	8	degraded_due_to_out_of_band_contamination_level_threshold_exceeded_qf [2]
16	16	degraded_due_to_dynamic_error_threshold_exceeded_qf [3]

[1] Dead-time correction threshold is the limiting case where 25% of the raw counts are restored to account for dead-time. The data is considered degraded if the correction exceeds this threshold.
[2] Out-of-band contamination correction threshold is the limiting case of 1.0 for the ratio of the out-of-band contamination term to the valid raw counts. Out-of-band contamination includes particles arriving at the detector that are the wrong species, look-direction, energy, or a combination of these deficiencies. The data is considered degraded if the ratio exceeds this threshold.

[3] Dynamic flux error threshold is the limiting case of 0.25 for the ratio of the flux uncertainty to the flux. The data is considered degraded if the ratio exceeds this threshold.

Table 5.4.4.5.2-2 Solar and Galactic Protons Product Proton Count and Engineering Telemetry Data Availability Flag Values and Meanings

Data Availability Flags (L1a_SciData_Flag & L1a_EngData_Flag)	
Flag Value	**Flag Meaning**
0	all_data_available
1	some_data_available
2	all_data_missing

Table 5.4.4.5.2-3 Solar and Galactic Protons Product SGPS L1b Processing Quality Flag Values and Meaning

SGPS L1b Processing Quality Flags (L1b_Processing_Flag)	
Flag Value	**Flag Meaning**
0	good_processing_qf
1	failed_processing_qf
2	processing_not_attempted_due_to_missing_L0_data_qf
3	processing_not_attempted_due_to_non_operational_mode_qf

Table 5.4.4.5.2-4 Solar and Galactic Protons Product On-Board Contamination Removal Flag Values and Meaning

On-Board Contamination Removal Flags (Diff31_Logic_Flags)	
Flag Value	**Flag Meaning**
0	on_board_contamination_removal_disabled
1	on_board_contamination_removal_enabled

Table 5.4.4.5.2-5 Solar and Galactic Protons Product SGPS Instrument Mode Flag Values and Meaning

SGPS Instrument Mode Flags (Instrument_Mode)	
Flag Value	**Flag Meaning**
0	no_mode_indicated
1	standby_operational_mode

SGPS Instrument Mode Flags (Instrument_Mode)	
Flag Value	**Flag Meaning**
2	operational_mode
3	instrument_diagnostic_mode
4	in-flight_calibration_mode

Table 5.4.4.5.2-6 Solar and Galactic Protons Product Eclipse Flag Values and Meanings

Eclipse Flags (eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.4.4.5.2-7 Solar and Galactic Protons Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip_flag)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.4.5 Instrument Calibration Data: SEISS Engineering Telemetry

5.4.5.1 Description

The SEISS Instrument Engineering Telemetry Data file contains data used to monitor and evaluate the health and performance of the sensor suite. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. All the data pertains to the temperature of components in the sensor suite. Primarily, this includes temperatures for the telescopes and other sensing components.

Temperatures are expressed in units of kelvin. Table C.4, SEISS Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter.

A netCDF-4 file containing this SEISS engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the SEISS Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.4.5.2 Data Fields

Refer to paragraph 5.1.5.2, Data Fields, in the Instrument Calibration Data: ABI Engineering Telemetry section, as the identical file specification is used except all references to ABI are replaced with SEISS.

5.4.6 Instrument Calibration Data: SEISS Calibration Data

5.4.6.1 Description

The SEISS Calibration Data file contains data used to support the generation of EHIS, MPS-LO, MPS-HI, and SGPS Level 1b products, and monitor and evaluate the health and performance of the sensor suite. This file contains derived level 1b calibration parameters including raw sensor count rates, valid raw sensor count data percentages, and dead-time and contamination correction factors needed for the production of all the SEISS products.

The reporting interval for different SEISS calibration parameters varies. Parameters are reported at a one second, three second, and one minute intervals. The "Shape" column in Table 5.4.6.2-2, SEISS Calibration Data: Variables, identifies the reporting intervals for the variables storing the parameters. Dimension "t" indicates the parameter is reported every second. Dimension "three_second_interval_t" indicates the parameter is reported every three seconds. Dimension "minute_interval_t" indicates the parameter is reported once a minute.

The instruments' multiple telescopes or angular zones, and multiple detectors or energy steps made the use of instrument-specific multi-dimensional arrays optimal. The definition of these characteristics for each of the instruments and their mapping to the data structures in the SEISS Calibration Data file are located in paragraph 5.4.6.2.1, SEISS Calibration Data Quantity Characteristics. The definitions of the telescope and angular zone fields-of-view are located in the applicable level 1b product description and quantity characteristics paragraphs included in this volume of the PUG.

A netCDF-4 file containing this SEISS calibration data is generated hourly.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the SEISS Calibration Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.4.6.2 Data Fields

The SEISS Calibration Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables is a subordinate paragraph containing tables that describe characteristics and file data structure mappings for the EHIS priority categories, EHIS priority categories for non-prime and prime conditions, MPS-LO energy steps, angular zones, and sensor heads, MPS-HI telescopes and electron and proton detectors, and SGPS telescopes and detectors.

The filename conventions for the SEISS Calibration Data file are located in Appendix A.

Table 5.4.6.2-1 SEISS Calibration Data: Global Attributes

Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	SEISS Instrument Calibration Data	string
summary	SEISS sensor telescope, angular zone, detector, and priority category dependent calibration data for a one hour period.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Space Environment In-Situ Suite	string
EHIS_instrument_ID	***serial number of the SEISS EHIS instrument (sensor).***	string
MPS-HI_instrument_ID	***serial number of the SEISS MPS-HI instrument (sensor).***	string
MPS-LO_instrument_ID	***serial number of the SEISS MPS-LO instrument (sensor).***	string
SGPS_MinusX_instrument_ID	***serial number of the SEISS SGPS-X instrument (sensor).***	string
SGPS_PlusX_instrument_ID	***serial number of the SEISS SGPS+X instrument (sensor).***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string

Name	Value	Type
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.4.6.2-2 SEISS Calibration Data: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
t	double	t = unlimited	long_name	time associated with the telemetry item in seconds since J2000 epoch (2000-01-01 12:00:00). used for data reported at a 1 second interval	string
			units	seconds since 2000-01-01 12:00:00	string
three_second_interval_t	double	three_second_interval_t = unlimited	long_name	time associated with the telemetry item in seconds since J2000 epoch (2000-01-01 12:00:00). used for data reported at a 3 second interval	string
			units	seconds since 2000-01-01 12:00:00	string
minute_interval_t	double	minute_interval_t = unlimited	long_name	time associated with the telemetry item in seconds since J2000 epoch (2000-01-01 12:00:00). used for data reported at a 1 minute interval	string
			units	seconds since 2000-01-01 12:00:00	string
EHIS_priority ***value = P1-Heavy_Ions P2-Helium P3-Hydrogen***	char	num_EHIS_priorities=3 EHIS_priority_strlen=13	long_name	labels for EHIS three priority categories	string
EHIS_HCR_priority ***value = Non-Prime_P1 Non-Prime_P2 Non-Prime_P3 Prime_P1 Prime_P2 Prime_P3***	char	num_EHIS_HCR_priorities =6 EHIS_HCR_priority_strlen =12	long_name	labels for EHIS three priority categories for non-prime and prime conditions	string
EHIS_HCR_datatypes ***value = Non-Prime Prime***	char	num_EHIS_HCR_datatypes=2 EHIS_HCR_datatypes_strlen=9	long_name	labels for two EHIS hardware coincident rate data type categories	string
MPS-HI_telescope ***value = T1 T2 T3 T4 T5***	char	num_MPS-HI_telescopes=5 telescope_strlen=2	long_name	labels for MPS-HI telescopes	string
MPS-HI_electron_detector	char		long_name	labels for MPS-HI electron telescopes' detectors	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
value = D1 D2 D3A D3B		num_MPS-HI_electron_detectors=4 detector_strlen=3			
MPS-HI_proton_detector ***value = D1 D2 D3***	char	num_MPS-HI_proton_detectors=3 detector_strlen=3	long_name	labels for MPS-HI proton telescopes' detectors	string
MPS-LO_angular_zone ***value = ZGR Z1 Z2 Z3 Z4 Z5 Z6R Z7R Z6L Z7L Z8 Z9 Z10 Z11 Z12 ZGL***	char	num_MPS-LO_angular_zones=16 MPS-LO_angular_zone_strlen=3	long_name	labels for MPS-LO angular zones	string
MPS-LO_sensor_head ***value = R_HEAD L_HEAD***	char	num_MPS-LO_sensor_heads=2 MPS-LO_sensor_head_strlen=6	long_name	labels for MPS-LO sensor heads	string
MPS-LO_energy_step ***value = E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15***	char	num_MPS-LO_energy_steps=15 MPS-LO_energy_step_strlen=3	long_name	labels for MPS-LO energy steps	string
SGPS_telescope ***value = T1 T2 T3***	char	num_SGPS_telescopes=3 telescope_strlen=2	long_name	labels for SGPS telescopes	string
SGPS_detector ***value = D1 D2 D3***	char	num_SGPS_detectors=3 detector_strlen=3	long_name	labels for SGPS telescopes' detectors. telescope 1 only has 2 detectors	string
ehis_hcr_priority_count_rate	float	num_EHIS_HCR_priorities=6 three_second_interval_t=unlimited	long_name	measured hardware coincident count rate for the three EHIS priority categories in non-prime and prime conditions	string
			_FillValue	-999	float
			units	count (3 s)-1	string
ehis_relative_hcr_priority_counts	float	num_EHIS_HCR_datatypes=2 three_second_interval_t=unlimited	long_name	difference between Priority 3 (Hydrogen) and Priority 1 (Heavy Ions) measured hardware coincident count rate for non-prime and prime condition. value should always be positive	string
			_FillValue	-999	float
			units	count (3 s)-1	string
ehis_relative_pec_counts	float	num_EHIS_priorities=3 minute_interval_t=unlimited	long_name	percent of pulse height analysis event counts that are valid for the three EHIS priority categories	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	percent	string
ehis_dead_time_corrections	float	three_second_interval_t = unlimited	long_name	energetic heavy ions count rate multiplicative dead-time correction factor for EHIS	string
			_FillValue	-999	float
			units	1	string
ehis_rear-entry_contamination_corrections	float	num_EHIS_priorities=3 minute_interval_t=unlimited	long_name	rear-entry multiplicative contamination correction factor for each of the three EHIS priority categories	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
mps-hi_electron_singles_channel_count_rate	float	num_MPS-HI_telescopes=5 num_MPS-HI_electron_detectors=4 t=unlimited	long_name	measured electron singles channel count rate for each MPS-HI electron telescopes' logical detectors	string
			_FillValue	-999	float
			units	count s-1	string
mps-hi_proton_singles_channel_count_rate	float	num_MPS-HI_telescopes=5 num_MPS-HI_proton_detectors=3 t=unlimited	long_name	measured proton singles channel count rate for each MPS-HI proton telescopes' logical detectors	string
			_FillValue	-999	float
			units	count s-1	string
mps-hi_electron_dead_time_corrections	float	num_MPS-HI_telescopes=5 t=unlimited	long_name	electron count rate dead-time correction factor in divisor form for each MPS-HI electron telescope	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
mps-hi_proton_dead_time_corrections	float	num_MPS-HI_telescopes=5 t=unlimited	long_name	proton count rate dead-time correction factor in divisor form for each MPS-HI proton telescope	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
mps-lo_electron_background_channel_count_rate	float	num_MPS-LO_sensor_heads=2 t=unlimited	long_name	average electron background channel count rate for each MPS-LO sensor head	string
			_FillValue	-999	float
			units	count s-1	string
mps-lo_ion_background_channel_count_rate	float	num_MPS-LO_sensor_heads=2 t=unlimited	long_name	average ion background channel count rate for each MPS-LO sensor head	string
			_FillValue	-999	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	count s-1	string
mps-lo_electron_dead_time_corrections	float	num_MPS-LO_angular_zones=16 num_MPS-LO_energy_steps=15 t=unlimited	long_name	electron count rate dead-time correction factor in divisor form for each MPS-LO angular zone's energy bands	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
mps-lo_ion_dead_time_corrections	float	num_MPS-LO_angular_zones=16 num_MPS-LO_energy_steps=15 t=unlimited	long_name	ion count rate dead-time correction factor in divisor form for each MPS-LO angular zone's energy bands	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
sgps-x_singles_channel_count_rate	float	num_SGPS_telescopes=3 num_SGPS_detectors=3 t=unlimited	long_name	measured singles channel count rate for each SGPS-X telescope's detectors	string
			_FillValue	-999	float
			units	count s-1	string
sgps+x_singles_channel_count_rate	float	num_SGPS_telescopes=3 num_SGPS_detectors=3 t=unlimited	long_name	measured singles channel count rate for each SGPS+X telescope's detectors	string
			_FillValue	-999	float
			units	count s-1	string
sgps-x_proton_dead_time_corrections	float	num_SGPS_telescopes=3 t=unlimited	long_name	proton count rate dead-time correction factor in divisor form for each SGPS-X telescope	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	1	string
sgps+x_proton_dead_time_corrections	float	num_SGPS_telescopes=3 t=unlimited	long_name	proton count rate dead-time correction factor in divisor form for each SGPS+X telescope	string
			_FillValue	-999	float
			units	1	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

5.4.6.2.1 SEISS Calibration Data Quantity Characteristics

Table 5.4.6.2.1-1 SEISS Calibration Data EHIS Priority Category Characteristics

Priority Category	Order in File Data Structure	File Label Variable Mnemonic
Heavy Ions	1	P1-Heavy_Ions
Helium	2	P2-Helium
Hydrogen	3	P3-Hydrogen

Table 5.4.6.2.1-2 SEISS Calibration Data EHIS Priority Category For Non-Prime and Prime Conditions Characteristics

Non-Prime / Prime Condition	EPriority Category	Order in File Data Structure	File Label Variable Mnemonic
Non-Prime	Heavy Ions	1	Non-Prime_P1
	Helium	2	Non-Prime_P2
	Hydrogen	3	Non-Prime_P3
Prime	Heavy Ions	4	Prime_P1
	Helium	5	Prime_P2
	Hydrogen	6	Prime_P3

Table 5.4.6.2.1-3 SEISS Calibration Data MPS-LO Energy Step Characteristics

Energy Step (in eV)	Order in File Data Structure	File Label Variable Mnemonic
30000	1	E1
18320	2	E2
11180	3	E3
6828	4	E4
4168	5	E5
2545	6	E6
1554	7	E7
949	8	E8
579	9	E9
354	10	E10
216	11	E11
132	12	E12
80	13	E13
49	14	E14

Energy Step (in eV)	Order in File Data Structure	File Label Variable Mnemonic
30	15	E15

Table 5.4.6.2.1-4 SEISS Calibration Data MPS-LO Angular Zone Characteristics

Angular Zone	Order in File Data Structure	File Label Variable Mnemonic
Background Zone Right	1	ZGR
Zone 1	2	Z1
Zone 2	3	Z2
Zone 3	4	Z3
Zone 4	5	Z4
Zone 5	6	Z5
Zone 6 Right	7	Z6R
Zone 7 Right	8	Z7R
Zone 6 Left	9	Z6L
Zone 7 Left	10	Z7L
Zone 8	11	Z8
Zone 9	12	Z9
Zone 10	13	Z10
Zone 11	14	Z11
Zone 12	15	Z12
Background Zone Left	16	ZGL

Table 5.4.6.2.1-5 SEISS Calibration Data MPS-LO Sensor Head Characteristics

Sensor Head	Order in File Data Structure	File Label Variable Mnemonic
Right Sensor Head	1	R_HEAD
Left Sensor Head	2	L_HEAD

Table 5.4.6.2.1-6 SEISS Calibration Data MPS-HI Telescope Characteristics

Telescope	Order in File Data Structure	File Label Variable Mnemonic
Telescope 1	1	T1
Telescope 2	2	T2
Telescope 3	3	T3
Telescope 4	4	T4
Telescope 5	5	T5

Table 5.4.6.2.1-7 SEISS Calibration Data MPS-HI Electron Detector Characteristics

Detector	Order in File Data Structure	File Label Variable Mnemonic
Detector 1, Threshold 1	1	D1
Detector 2, Threshold 1	2	D2
Detector 3A, Threshold 1	3	D3A
Detector 3B, Threshold 1	4	D3B

Table 5.4.6.2.1-8 SEISS Calibration Data MPS-HI Proton Detector Characteristics

Detector	Order in File Data Structure	File Label Variable Mnemonic
Detector 1, Threshold 1	1	D1
Detector 2, Threshold 1	2	D2
Detector 3, Threshold 1	3	D3

Table 5.4.6.2.1-9 SEISS Calibration Data SGPS Telescope Characteristics

Telescope	Order in File Data Structure	File Label Variable Mnemonic
Telescope 1	1	T1
Telescope 2	2	T2
Telescope 3	3	T3

Table 5.4.6.2.1-10 SEISS Calibration Data SGPS Detector Characteristics

Detector	Order in File Data Structure	File Label Variable Mnemonic
Detector 1, Threshold 1	1	D1
Detector 2, Threshold 1	2	D2
Detector 3 [1], Threshold 1	3	D3

[1] Telescope 1 does not have a third detector.

5.5 Magnetometer Level 1b Product and Data

5.5.1 Geomagnetic Field Product

5.5.1.1 Description

The Geomagnetic Field product contains up to 60 sets of Earth ambient magnetic field values measured in situ from geostationary orbit. A set is a block of processed observation data containing ten samples of the Earth's ambient magnetic field acquired at one-tenth of a second intervals produced over one second observation intervals. The Earth's ambient magnetic field is reported in four coordinate reference systems. The four coordinate reference systems are as follows:

- Earth Polar Normal (EPN).
- Earth-Centric Inertial (ECI).
- Spacecraft Body Reference Frame (BRF)
- Attitude Control Reference Frame (ACRF).

For the EPN, ECI, and BRF, the Earth's ambient magnetic field values are produced in three orthogonal directions along their axes. For the ACRF, a total ambient magnetic field value is produced. The product also contains compensated magnetic field values in the native magnetometer reference frames from the two magnetometers, inboard and outboard, on the satellite. The ambient and compensated magnetic field values are produced at ten hertz. The product includes processing and data quality information that provides an assessment of the level 1b processing and ambient magnetic field values, including an indication of good, potentially degraded, or degraded quality, or invalid, and the rationale.

Although the ambient and compensated magnetic field values, and data quality information are reported at ten hertz, product metadata other than magnetometer data acquisition status is reported for each set of values, which is over successive one second observation intervals.

The units of measure for the ambient and compensated magnetic field values are "nanoteslas".

The Geomagnetic Field performance requirements are summarized in Table 5.5.1.1, Geomagnetic Field Performance Requirements.

Table 5.5.1.1 Geomagnetic Field Performance Requirements

Measurement				Mapping
Region	**Range**	**Accuracy**	**Precision**	**Uncertainty**
GOES-R satellite in situ environment, three axes must be orthogonal to within +/- 0.5 degrees	-512 nT ≤ geomagnetic field ≤ 512 nT per axis (3-axis vector)	(1) 2.3nT (2) 4 nT at end of life	0.016 nT	+/- 1 degree

Metadata in the Geomagnetic Field product provides statistical and other properties of the observation and processed data and information required for the generation of level 2 products, and supports diagnosis of algorithm anomalies. Specific metadata includes:

- Start and end time of the observation data in the product.
- Time of each set of observations for both the inboard and outboard magnetometers.
- Satellite location.
- Spacecraft ACRF to J2000 ECI and J2000 ECI to spacecraft Orbital Reference Frame (ORF) attitude quaternions, and their time stamps.
- Eclipse of the sun indication.
- Satellite yaw flip configuration.
- Inboard and outboard magnetometer data acquisition status.
- Instrument mode and serial number.

When the satellite is in on-orbit storage mode, the Geomagnetic Field product data format and content are the same.

The detailed description of the ISO series metadata for the Geomagnetic Field product is located in the standalone Appendix X, ISO Series Metadata.

5.5.1.2 Dynamic Source Data

The Geomagnetic Field product is derived using MAG Level 0 raw science telemetry, MAG engineering telemetry, and satellite ephemeris related telemetry.

The primary sensor data used by the Level 1b Geomagnetic Field algorithm is identified in Table 5.5.1.5-2, Geomagnetic Field: Variables, in variable name "algorithm_dynamic_input_data_container", with attribute name "input_MAG_L0_data".

Refer to the Level 0 product volume of the PUG for a description of the Level 0 product dynamic source data.

5.5.1.3 Level 1b Semi-Static Source Data

There are four categories of semi-static source data employed in the MAG Level 1b ground processing algorithm:

- Factory calibration parameters.
- On-orbit calibration parameters.
- Sensor calibration parameters.
- Algorithm processing parameters.

One semi-static HDF5 source data file contains all four categories above and is included in a single MAG zip file. The filename conventions for Level 1b semi-static source data files are located in Appendix A.

Factory calibration parameters are those associated with sensor and electronic temperature dependent, and alignment corrections required that were determined pre-launch. Specific types include:

- Inboard and outboard sensor alignment correction vectors.
- Inboard and outboard sensor scale factor compensation constants used in support of correcting for temperature dependent effects when calculating the raw magnetic field measurements.
- Inboard and outboard sensor zero offset compensation constants used to calculate temperature dependent factory zero offsets for the raw magnetic field measurements.
- Sensor and electronic compensation reference temperatures.
- Inboard and outboard sensor temperature dependent scaling factors.

On-orbit calibration parameters are those that account for launch shift and in-flight drifts. These parameters are applied to the compensated (factory calibrated) magnetic field measurements. Specific types include:

- Inboard and outboard sensor alignment correction vectors.
- Inboard and outboard sensor scale factor adjustment parameters.
- Inboard and outboard sensor zero offset adjustment parameters.

Note that there are up to 30 sets of each of on-orbit calibration parameters available for use.

Sensor calibration parameters are those associated with magnetometer hardware, valid telemetry ranges, and coordinate transformation matrices. Specific types include:

- Attitude Control Reference Frame (ACRF) to Body Reference Frame (BRF) transformation matrix.
- Orbit Reference Frame (ORF) to Earth Polar Normal (EPN) transformation matrix

- Magnetometer boom base reference system (BOOM) to ACRF transformation matrix.
- Counts to voltage scale factor.
- Current source (Amps) used to correct sensor temperature.
- Sensor and electronic temperature conversion coefficients.
- Sensor and electronic temperature upper and lower limits.
- MFIB to BOOM and MFOB to BOOM transformation matrices. MFIB and MFOB frames are the calibrated orthogonal frames in which the inboard and outboard magnetometers provide their respective magnetic field measurements.
- Resistance (Ohms) of reference resistor.
- Voltage reference levels (1.25V and 3.75V)

Algorithm processing parameters are those associated with the gradiometer model, and valid time and temperature thresholds. Specific types include:

- Butterworth filter coefficients.
- Engineering telemetry validity time window.
- Gradiometer Q-factors.
- Magnetometer measurement temperature upper and lower limits.

Following is the file name of the HDF5 file in the zip file. HDF5 files are internally self-describing. Date qualifiers and other version-specific information have been removed from the file name.

- MAG_CALINR_Parameters.h5

5.5.1.4 Production Notes

The Geomagnetic Field product is generated by MAG Level 0 and Level 1b ground processing algorithms. The Level 0 algorithm extracts the raw in situ detector data from the CCSDS packets. The Level 1b algorithm uses the extracted magnetic field measurements to determine the Earth's ambient magnetic field values in three coordinate reference systems, EPN, ECI, and BRF, and the total ambient field. The Level 1b algorithm time correlates measurements from the inboard and outboard magnetometers, applies factory and on-orbit calibration corrections, uses a gradiometer-based method to estimate the ambient magnetic field, and performs transformations to the required coordinate reference systems.

The L1b algorithm executes and product data is generated when the instrument is in the operational and diagnostic modes. The product files are available in the GOES-R ground system's two-day revolving storage to support anomaly resolution and algorithm analysis.

For product refresh rate and latency information, refer to Appendix B, Product Refresh Rates and Latencies.

5.5.1.5 Data Fields

The Geomagnetic Field product is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the product specification tables are subordinate paragraphs containing tables that describe the mapping between the coordinate axes and magnetometers, and the magnetic field values in the product data structures, and values and meanings for the flag variables in the product.

The filename conventions for the Geomagnetic Field product are located in Appendix A.

Table 5.5.1.5-1 Geomagnetic Field: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for L1b products in Appendix A. Default values are noted in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	f5816f50-fd6d-11e3-a3ac-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	Magnetometer L1b Geomagnetic Field	string
summary	The Geomagnetic Field product consists of the estimated ambient magnetic field in four coordinate reference frames, Earth Polar Normal, J2000 Earth-Centered Inertial, and the spacecraft's Body Reference Frame and Attitude Control Reference Frame. The product also includes the compensated (calibrated and misalignment corrected) magnetic field in the native reference frame for both the inboard and outboard magnetometers. Furthermore, the product includes inboard and outboard magnetometer status flags, processing and data quality metadata, satellite state and location information, and data required for the generation of level 2 products.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > MAGNETIC FIELDS/MAGNETIC CURRENTS, SUN-EARTH INTERACTIONS > IONOSPHERE/MAGNETOSPHERE DYNAMICS > MAGNETIC STORMS	string
cdm_data_type	Point	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Magnetometer	string
inboard_MAG_instrument_ID	***serial number of the inboard magnetometer.***	string
outboard_MAG_instrument_ID	***serial number of the outboard magnetometer.***	string

Global Attribute Name	Value	Type
processing_level	National Aeronautics and Space Administration (NASA) L1b	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
L1b_processing_parm_version	***refer to filename conventions for L1b processing parameters in Appendix A***	string
algorithm_version	***refer to filename conventions for L1b algorithm packages in Appendix A***	string
product_version	***format is vVVrRR where VV is major release # and RR is minor revision #***	string

Table 5.5.1.5-2 Geomagnetic Field: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
number_samples_per_report ***value = 10***	int	n/a	long_name	number of magnetometer observations associated with each L1b report in product file	string
			_FillValue	-1	int
			valid_range	10 10	int
			units	count	string
ECEF_X	float	report_number = unlimited	long_name	spacecraft ECEF X coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Y	float	report_number = unlimited	long_name	spacecraft ECEF Y coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-42171520.0 42171520.0	float
			units	m	string
ECEF_Z	float	report_number = unlimited	long_name	spacecraft ECEF Z coordinate	string
			_FillValue	-1.00E+31	float
			valid_range	-7360.0 7360.0	float
			units	m	string
attitude_quat_Q0	double		long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q0	string

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
		report_number = unlimited	_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
attitude_quat_Q1	double	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q1	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
attitude_quat_Q2	double	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q2	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
attitude_quat_Q3	double	report_number = unlimited	long_name	spacecraft ACRF to J2000 ECI attitude quaternion Q3	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
orbit_quat_Q0	double	report_number = unlimited	long_name	J2000 ECI to spacecraft ORF orbit quaternion Q0	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
orbit_quat_Q1	double	report_number = unlimited	long_name	J2000 ECI to spacecraft ORF orbit quaternion Q1	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
orbit_quat_Q2	double	report_number = unlimited	long_name	J2000 ECI to spacecraft ORF orbit quaternion Q2	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
orbit_quat_Q3	double	report_number = unlimited	long_name	J2000 ECI to spacecraft ORF orbit quaternion Q3	string
			_FillValue	-1.00E+31	double
			valid_range	-1.0 1.0	double
			units	1	string
product_time	double	number_of_time_bounds = 2	long_name	start and end time of observations associated with product, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
IB_time	double	report_number = unlimited number_samples_per_report = 10	long_name	time of 10 Hz inboard magnetometer observations for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
OB_time	double	report_number = unlimited number_samples_per_report = 10	long_name	time of 10 Hz outboard magnetometer observations for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
quat_timestamp	double	report_number = unlimited	long_name	time of corresponding ACRF to J2000 ECI attitude and J2000 ECI to ORF orbit quaternions for each report, in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
sensor_label ***value = InboardMagnetometer outboardMagnetometer***	char	number_of_sensors = 2 sensor_str_len = 20	long_name	labels for the two magnetometers on the satellite. labels are ordered the same as applicable data variable	string
coordinate_label ***value = x y z***	char	coordinate = 3 coordinate_str_len = 1	long_name	labels for the 3 orthogonal axes in a 3-D coordinate reference system. labels are ordered the same as applicable data variables	string
solar_array_current_channel_index_label	char	solar_array_current_channel_index = 4 solar_array_mnemonic_str_len = 25	long_name	labels for four solar array current telemetry mnemonics. labels are ordered the same as applicable data variable	string
value = EPS_SA_CHAN_1_4_RETRN_I EPS_SA_CHAN_5_8_RETRN_I EPS_SA_CHAN_9_12_RETRN_I EPS_SA_CHAN_13_16_RETRN_I					
IB_data	float	report_number = unlimited	long_name	compensated (temperature calibrated and misalignment corrected) magnetic field for x, y, and z direction in calibrated orthogonal reference frame for inboard magnetometer (MFIB)	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
		number_samples_per_report = 10 coordinate = 3	_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
OB_data	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated (temperature calibrated and misalignment corrected) magnetic field for x, y, and z direction in calibrated orthogonal reference frame for outboard magnetometer (MFOB)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
IB_mag_ACRF	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (inboard magnetometer) for x, y, and z direction in spacecraft's Attitude Control Reference Frame (ACRF) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
OB_mag_ACRF	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (outboard magnetometer) for x, y, and z direction in spacecraft's Attitude Control Reference Frame (ACRF) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
IB_mag_ECI	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (inboard magnetometer) for x, y, and z direction in J2000 Earth-Centered Inertial reference frame (ECI) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
OB_mag_ECI	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (outboard magnetometer) for x, y, and z direction in J2000 Earth-Centered Inertial reference frame (ECI) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float

Variable			Attribute		
Name	Type	Shape	Name	Value	Type
			units	nT	string
IB_mag_EPN	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (inboard magnetometer) for x, y, and z direction in Earth Polar Normal reference frame (EPN) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
OB_mag_EPN	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (outboard magnetometer) for x, y, and z direction in Earth Polar Normal reference frame (EPN) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
IB_mag_BRF	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (inboard magnetometer) for x, y, and z direction in spacecraft's Body Reference Frame (BRF) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
OB_mag_BRF	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	compensated magnetic field (outboard magnetometer) for x, y, and z direction in spacecraft's Body Reference Frame (BRF) (after factory and on-orbit calibration)	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
amb_mag_EPN	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	estimated ambient magnetic field for x, y, and z direction in Earth Polar Normal reference frame	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
amb_mag_ECI	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	estimated ambient magnetic field for x, y, and z direction in J2000 Earth-Centered Inertial reference frame	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			units	nT	string
amb_mag_BRF	float	report_number = unlimited number_samples_per_report = 10 coordinate = 3	long_name	estimated ambient magnetic field for x, y, and z direction in spacecraft's Body Reference Frame	string
			_FillValue	-999	float
			valid_range	-512.0 512.0	float
			units	nT	string
total_mag_ACRF	float	report_number = unlimited number_samples_per_report = 10	long_name	estimated total ambient magnetic field in spacecraft's Attitude Control Reference Frame	string
			_FillValue	-999	float
			valid_range	0 887.0	float
			units	nT	string
DQF	int	report_number = unlimited number_samples_per_report = 10	long_name	magnetometer L1b processing and data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	4294967295	int
			valid_range	0 8388607	int
			units	1	string
			flag_masks	***see note [flags and meanings]***	int
			flag_values	***see note [flags and meanings]***	int
			flag_meanings	***see note [flags and meanings]***	string
IB_status	short	report_number = unlimited number_samples_per_report = 10	long_name	inboard magnetometer status flags	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 8191	short
			units	1	string
			flag_masks	***see note [flags and meanings]***	short
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string
OB_status	short	report_number = unlimited number_samples_per_report = 10	long_name	outboard magnetometer status flags	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 8191	short
			units	1	string
			flag_masks	***see note [flags and meanings]***	short
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
Instrument_ID	byte	report_number = unlimited number_of_sensors = 2	long_name	magnetometer instrument (sensor) serial number	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 254	byte
			units	1	string
yaw_flip	byte	report_number = unlimited	long_name	flags indicating whether spacecraft is operating in yaw flip configuration	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 2	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
eclipse_flag	byte	report_number = unlimited	long_name	flags indicating whether sun is obscured by earth as provided by spacecraft	string
			_Unsigned	TRUE	string
			_FillValue	255	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
solar_array_current	short	report_number = unlimited solar_array_current_channel_index = 4	long_name	solar array current in DN for 4 channel groups (1-4, 5-8, 9-12, 13-16)	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 65534	short
			units	count	string
percent_uncorrectable_L0_errors	float	n/a	long_name	percent data lost due to uncorrectable L0 errors	string
			_FillValue	-999	float
			valid_range	0.0 1.0	float
			units	percent	string
algorithm_dynamic_input_data_container	int	n/a	long_name	container for filenames of dynamic algorithm input data	string
			input_MAG_L0_data	***refer to filename conventions for L0 products in Appendix A. Default values are noted in Appendix A.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.5.1.5.2, Geomagnetic Field Product Flag Values and Meanings.

5.5.1.5.1 Geomagnetic Field Product Quantity Characteristics

Table 5.5.1.5.1-1 Geomagnetic Field Product Coordinate Axis Characteristics

Coordinate Axis	Order in Product Data Structure	Product Label Variable Mnemonic
x-axis	1	x
y-axis	2	y
z-axis	3	z

Table 5.5.1.5.1-2 Geomagnetic Field Product Sensor Characteristics

Sensor	Order in Product Data Structure	Product Label Variable Mnemonic
Inboard Magnetometer	1	InboardMagnetometer
Outboard Magnetometer	2	OutboardMagnetometer

5.5.1.5.2 Geomagnetic Field Product Flag Values and Meanings

Table 5.5.1.5.2-1 Geomagnetic Field Processing and Data Quality Flag Values and Meanings

Processing and Data Quality Flags (DQF)		
Flag Mask	**Flag Value**	**Flag Meaning**
8388607	0	good_quality_qf
1	1	invalid_due_to_missing_L0_IB_and_OB_MAG_data_qf
2	2	degraded_due_to_IB_MAG_x-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf
4	4	degraded_due_to_IB_MAG_y-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf
8	8	degraded_due_to_IB_MAG_z-axis_potential_failure_or_off_state_or_IB_mag_potentially_in_maintenance_mode_qf
16	16	degraded_due_to_OB_MAG_x-axis_potential_failure_or_off_state_or_OB_mag_potentially_in_maintenance_mode_qf
32	32	degraded_due_to_OB_MAG_y-axis_potential_failure_or_off_state_or_OB_mag_potentially_in_maintenance_mode_qf
64	64	degraded_due_to_OB_MAG_z-axis_potential_failure_or_off_state_or_OB_mag_potentially_in_maintenance_mode_qf
128	128	degraded_due_to_IB_MAG_x-axis_magnetic_field_at_saturation_qf
256	256	degraded_due_to_IB_MAG_y-axis_magnetic_field_at_saturation_qf

Processing and Data Quality Flags (DQF)		
Flag Mask	**Flag Value**	**Flag Meaning**
512	512	degraded_due_to_IB_MAG_z-axis_magnetic_field_at_saturation_qf
1024	1024	degraded_due_to_OB_MAG_x-axis_magnetic_field_at_saturation_qf
2048	2048	degraded_due_to_OB_MAG_y-axis_magnetic_field_at_saturation_qf
4096	4096	degraded_due_to_OB_MAG_z-axis_magnetic_field_at_saturation_qf
8192	8192	degraded_due_to_MAG_calibration_maneuver_in_progress_qf
16384	16384	degraded_due_to_potentially_stale_MAG_engineering_data_qf
32768	32768	potentially_degraded_due_to_out_of_valid_range_IB_MAG_x-axis_thermistor_temperature_qf
65536	65536	potentially_degraded_due_to_out_of_valid_range_IB_MAG_y-axis_thermistor_temperature_qf
131072	131072	potentially_degraded_due_to_out_of_valid_range_IB_MAG_z-axis_thermistor_temperature_qf
262144	262144	potentially_degraded_due_to_out_of_valid_range_OB_MAG_x-axis_thermistor_temperature_qf
524288	524288	potentially_degraded_due_to_out_of_valid_range_OB_MAG_y-axis_thermistor_temperature_qf
1048576	1048576	potentially_degraded_due_to_out_of_valid_range_OB_MAG_z-axis_thermistor_temperature_qf
2097152	2097152	potentially_degraded_due_to_out_of_valid_range_IB_electronics_temperature_qf
4194304	4194304	potentially_degraded_due_to_out_of_valid_range_OB_electronics_temperature_qf

Table 5.5.1.5.2-2 Geomagnetic Field Product Inboard and Outboard Magnetometer Data Acquisition Status Flag Values and Meanings

Data Acquisition Status Flags (IB_status & OB_status)		
Flag Mask	**Flag Value**	**Flag Meaning**
1	0	operational_mode
1	1	instrument_diagnostic_mode
8190	0	good_status
2	2	x-axis_data_error
4	4	y-axis_data_error
8	8	z-axis_data_error
16	16	unrecoverable_RAM_error_detected_by_EDAC
32	32	uncorrected_EEPROM_page_0_embedded_software_image_error
64	64	uncorrected_EEPROM_page_1_embedded_software_image_error
128	128	uncorrected_EEPROM_page_2_embedded_software_image_error
256	256	uncorrected_EEPROM_page_3_embedded_software_image_error
512	512	uncorrected_EEPROM_page_0_calibration_factor_error
1024	1024	uncorrected_EEPROM_page_1_calibration_factor_error
2048	2048	uncorrected_EEPROM_page_2_calibration_factor_error
4096	4096	uncorrected_EEPROM_page_3_calibration_factor_error

Note: Instrument mode is embedded in the data acquisition status flags.

Table 5.5.1.5.2-3 Geomagnetic Field Product Eclipse Flag Values and Meanings

Eclipse Flags (eclipse_flag)	
Flag Value	**Flag Meaning**
0	no eclipse
1	penumbra, preceding full eclipse
2	umbra, full eclipse
3	penumbra, following full eclipse

Table 5.5.1.5.2-4 Geomagnetic Field Product Satellite Yaw Flip Flag Values and Meanings

Satellite Yaw Flip Flags (yaw_flip)	
Flag Value	**Flag Meaning**
0	UPRIGHT
1	NEITHER
2	INVERTED

5.5.2 Instrument Calibration Data: Magnetometer Engineering Telemetry

5.5.2.1 Description

The Magnetometer Instrument Engineering Telemetry Data file contains data used to support the generation of the Magnetometer Level 1b product, and monitor and evaluate the health and performance of the two magnetometers. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. Some of the data pertains to the temperature of components of the magnetometers. This includes temperatures for the electronics and sensors. Other telemetry includes reference voltages and temperature dependent scale factors and offsets relating raw observed counts to magnetic field units (nanoteslas) for the two magnetometers.

Temperatures are expressed in units of Kelvin, voltages in units of volts, and the other telemetry items are in units of counts, or counts per nanotesla. Table C.5, Magnetometer Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter.

A netCDF-4 file containing this Magnetometer engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the Magnetometer Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.5.2.2 Data Fields

Refer to paragraph 5.1.5.2, Data Fields, in the Instrument Calibration Data: ABI Engineering Telemetry section, as the identical file specification is used except all references to ABI are replaced with Magnetometer.

5.5.3 Instrument Calibration Data: Magnetometer Calibration Data

5.5.3.1 Description

The Magnetometer Calibration Data file contains raw observation counts and data acquisition status from the inboard and outbound magnetometers for a one second interval during a calibration maneuver. Nominally, this file contains ten observation samples acquired at one-tenth of a second intervals.

A netCDF-4 file containing this magnetometer calibration data is generated every second during a calibration maneuver with multiple files produced to cover the entire period associated with the maneuver.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the Magnetometer Calibration Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.5.3.2 Data Fields

The Magnetometer Calibration Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables is a subordinate paragraph containing tables that describe the values and meanings for the flag variables in the product.

The filename conventions for the Magnetometer Calibration Data file are located in Appendix A.

Table 5.5.3.2-1 Magnetometer Calibration Data: Global Attributes

Global Attribute Name	Value	Type
id	***attribute is added dynamically when the file is created.***	string
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	Magnetometer Calibration Maneuver Data	string
summary	Inboard and outboard magnetometer data and status information collected during a calibration maneuver for a one second period.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Magnetometer	string
inboard_MAG_instrument_ID	***serial number of the inboard magnetometer.***	string
outboard_MAG_instrument_ID	***serial number of the outboard magnetometer.***	string
date_created	***format is YYYY-MM-DD”T”HH:MM:SS.s”Z”. Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD”T”HH:MM:SS.s”Z”. Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD”T”HH:MM:SS.s”Z”. Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.5.3.2-2 Magnetometer Calibration Data: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
t	double	t = unlimited	long_name	time of the magnetometer observation in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
mag_dqf	byte	t = unlimited	long_name	magnetometer data quality flags	string
			_FillValue	15	byte
			valid_range	0 1	short
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
ib_mag_status	short	t = unlimited	long_name	inboard magnetometer status flags	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 8191	short
			units	1	string
			flag_masks	***see note [flags and meanings]***	short
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string
ob_mag_status	short	t = unlimited	long_name	outboard magnetometer status flags	string
			_Unsigned	TRUE	string
			_FillValue	65535	short
			valid_range	0 8191	short
			units	1	string
			flag_masks	***see note [flags and meanings]***	short
			flag_values	***see note [flags and meanings]***	short
			flag_meanings	***see note [flags and meanings]***	string
ib_mag_x_coord	short	t = unlimited	long_name	inboard magnetometer raw x measurement	string
			_FillValue	-32768	short
			units	count	string
ib_mag_y_coord	short	t = unlimited	long_name	inboard magnetometer raw y measurement	string
			_FillValue	-32768	short
			units	count	string
ib_mag_z_coord	short	t = unlimited	long_name	inboard magnetometer raw z measurement	string

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
			_FillValue	-32768	short
			units	count	string
ob_mag_x_coord	short	t = unlimited	long_name	outboard magnetometer raw x measurement	string
			_FillValue	-32768	short
			units	count	string
ob_mag_y_coord	short	t = unlimited	long_name	outboard magnetometer raw y measurement	string
			_FillValue	-32768	short
			units	count	string
ob_mag_z_coord	short	t = unlimited	long_name	outboard magnetometer raw z measurement	string
			_FillValue	-32768	short
			units	count	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.5.3.2.1, Magnetometer Calibration Data Flag Values and Meanings.

5.5.3.2.1 Magnetometer Calibration Data Flag Values and Meanings

Table 5.5.3.2.1-1 Magnetometer Calibration Data Quality Flags

Data Quality Flag (mag_dqf)	
Flag Value	**Flag Meaning**
0	good
1	missing

Table 5.5.3.2.1-2 Magnetometer Calibration Data Inboard and Outboard Magnetometer Data Acquisition Status Flag Values and Meanings

Data Acquisition Status Flags (ib_mag_status & ob_mag_status) [1]		
Flag Mask	**Flag Value**	**Flag Meaning**
1	0	operational_mode
1	1	instrument_diagnostic_mode

Data Acquisition Status Flags (ib_mag_status & ob_mag_status) [1]		
Flag Mask	**Flag Value**	**Flag Meaning**
8190	0	good_status
2	2	x-axis_data_error
4	4	y-axis_data_error
8	8	z-axis_data_error
16	16	unrecoverable_RAM_error_detected_by_EDAC
32	32	uncorrected_EEPROM_page_0_embedded_software_image_error
64	64	uncorrected_EEPROM_page_1_embedded_software_image_error
128	128	uncorrected_EEPROM_page_2_embedded_software_image_error
256	256	uncorrected_EEPROM_page_3_embedded_software_image_error
512	512	uncorrected_EEPROM_page_0_calibration_factor_error
1024	1024	uncorrected_EEPROM_page_1_calibration_factor_error
2048	2048	uncorrected_EEPROM_page_2_calibration_factor_error
4096	4096	uncorrected_EEPROM_page_3_calibration_factor_error

[1] Instrument mode is embedded in the data acquisition status flags.

5.6 GLM Level 1b Data

5.6.1 Instrument Calibration Data: GLM Engineering Telemetry

5.6.1.1 Description

The GLM Instrument Engineering Telemetry Data file contains data used to monitor and evaluate the health and performance of the GLM. This data is transmitted to the ground in raw digital counts, and subsequently converted into physical units by the ground system. Some of the data pertains to the temperature of components of the GLM. This includes temperatures for the CCD pedestal, focal plane array, and filtering temperatures. Other telemetry includes the number of events rejected by instrument on-board processing filters and background image count statistics.

Temperatures are expressed in units of kelvin and the other telemetry items are in units of counts. Table C.6, GLM Instrument Engineering Telemetry in Appendix C identifies each telemetry parameter.

A netCDF-4 file containing this GLM engineering telemetry is generated hourly. Telemetry parameter values are included at one second intervals, and summary statistics, including minimum, maximum, mean and standard deviation, are produced for the one hour period.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the GLM Instrument Engineering Telemetry Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.6.1.2 Data Fields

Refer to paragraph 5.1.5.2, Data Fields, in the Instrument Calibration Data: ABI Engineering Telemetry section, as the identical file specification is used except all references to ABI are replaced with GLM.

5.6.2 Instrument Calibration Data: GLM Background Image Data

5.6.2.1 Description

The GLM Background Image Data file contains the average background value in digital counts for pixels in the instrument's CCD. The averaging is performed by the instrument prior to downlink. This data is used to support the generation of GLM Level 1b products.

A netCDF-4 file containing this GLM background image data is generated every 150 seconds.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the GLM Background Image Data, is located in the standalone Appendix X, ISO Series Metadata.

5.6.2.2 Data Fields

The GLM Background Image Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow. Following the data specification tables is a subordinate paragraph containing a table that describes the values and meanings for the flag variable in the data file.

The filename conventions for the GLM Background Image Data file are located in Appendix A.

Table 5.6.2.2-1 GLM Background Image Data: Global Attributes

Global Attribute Name	Value	Type
dataset_name	***refer to filename conventions for instrument calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	GLM Background Image Calibration Data	string
summary	GLM native background image calibration data and associated data quality flags.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > SENSOR CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
instrument_type	GOES-R Series Geostationary Lightning Mapper	string
instrument_ID	***serial number of the GLM instrument.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.6.2.2-2 GLM Background Image Data: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
t	double	n/a	long_name	J2000 epoch start time of GLM background image in seconds since 2000-01-01 12:00:00	string
			_FillValue	-999	double
			units	seconds since 2000-01-01 12:00:00	string
image	short	y=1372 x=1300	long_name	GLM native background image (in digital numbers)	string
			_FillValue	-999	short
			valid_range	0 16383	short
			units	count	string
image_dqf	byte	y=1372 x=1300	long_name	GLM native background image data quality flags	string
			_Unsigned	TRUE	string
			_FillValue	15	byte
			valid_range	0 3	byte
			units	1	string
			flag_values	***see note [flags and meanings]***	byte
			flag_meanings	***see note [flags and meanings]***	string
data_file_version_container	int	n/a	long_name	container for version of instrument calibration data file	string
			data_file_version	***format is vVVrRR where VV is major release # and RR is minor revision #.***	string

Note "flags and meanings": Flag values and meanings are located in paragraph 5.6.2.2.1, GLM Background Image Data Flag Values and Meanings.

5.6.2.2.1 GLM Background Image Data Flag Values and Meanings

Table 5.6.2.2.1 GLM Background Image Data Quality Flags

Data Quality Flags (image_dqf)	
Flag Value	**Flag Meaning**
0	good
3	missing_or_corrupt

5.7 Satellite Instrument Calibration Data

5.7.1 Description

The Satellite Instrument Calibration Data file contains satellite position, and its velocity/attitude vectors over time. The position of the satellite is expressed in terms of the J2000 inertial reference frame. Satellite velocity/attitude is expressed in terms of a quaternion whose values are relative to the difference between the J2000 inertial and body frame references. The satellite position and velocity/attitude vectors are included in the data file at a frequency of once per second.

A netCDF-4 file containing the satellite position, and its velocity/attitude information is generated hourly.

The detailed description of the ISO series metadata for all instrument calibration data, which contains the ISO metadata for the Satellite Instrument Calibration Data, is located in the standalone Appendix X, ISO Series Metadata document.

5.7.2 Data Fields

The Satellite Instrument Calibration Data is delivered using the netCDF-4 file format. Its global attributes and the variables are defined in the tables that follow.

The filename conventions for the Satellite Instrument Calibration Data file are located in Appendix A.

Table 5.7.2-1 Satellite Instrument Calibration Data File: Global Attributes

Name	Value	Type
dataset_name	***refer to filename conventions for satellite calibration data in Appendix A.***	string
naming_authority	gov.nesdis.noaa	string
institution	DOC/NOAA/NESDIS> U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services	string
project	GOES	string
iso_series_metadata_id	fbd4e2a0-3749-11e3-aa6e-0800200c9a66	string
Metadata_Conventions	Unidata Dataset Discovery v1.0	string
keywords_vocabulary	NASA Global Change Master Directory (GCMD) Earth Science Keywords, Version 7.0.0.0.0	string
title	Satellite Ephemeris Data	string
summary	Satellite location and quaternions for a one hour period.	string
license	Unclassified data. Access is restricted to approved users only.	string
keywords	SPECTRAL/ENGINEERING > PLATFORM CHARACTERISTICS > ORBITAL CHARACTERISTICS, SPECTRAL/ENGINEERING > PLATFORM CHARACTERISTICS > ATTITUDE CHARACTERISTICS	string
orbital_slot	***possible values are GOES-East, GOES-West, GOES-Test, and GOES-Storage.***	string
platform_ID	***possible values are G16 and G17.***	string
date_created	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
production_site	***possible values are WCDAS and RBU.***	string
production_environment	***possible values are OE, ITE, and DE. Default value is n/a***	string
production_data_source	***possible values are Realtime, Simulated, Playback, and Test. Default value is n/a***	string
time_coverage_start	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string
time_coverage_end	***format is YYYY-MM-DD"T"HH:MM:SS.s"Z". Default value is 2000-01-00T00:00:00.0Z***	string

Table 5.7.2-2 Satellite Instrument Calibration Data File: Variables

Variable			Attribute		
Name	**Type**	**Shape**	**Name**	**Value**	**Type**
attitudeTimes	double	t = unlimited	long_name	time of the attitude observation (Q0, Q1, Q2, and Q3) in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
orbitTimes	double	t = unlimited	long_name	time of the orbit observation (x, y, z, theta_x, theta_y, theta_z) in seconds since J2000 epoch (2000-01-01 12:00:00)	string
			units	seconds since 2000-01-01 12:00:00	string
x	float	t = unlimited	long_name	x-position of the spacecraft in the J2000 inertial reference frame	string
			units	km	string
y	float	t = unlimited	long_name	y-position of the spacecraft in the J2000 inertial reference frame	string
			units	km	string
z	float	t = unlimited	long_name	z-position of the spacecraft in the J2000 inertial reference frame	string
			units	km	string
theta_x	float	t = unlimited	long_name	x-velocity of the spacecraft in the J2000 inertial reference frame	string
			units	km s-1	string
theta_y	float	t = unlimited	long_name	y-velocity of the spacecraft in the J2000 inertial reference frame	string
			units	km s-1	string
theta_z	float	t = unlimited	long_name	z-velocity of the spacecraft in the J2000 inertial reference frame	string
			units	km s-1	string
Q0	float	t = unlimited	long_name	Q0 = cos(phi / 2). phi is the angle between the J2000 reference and body frame of reference	string
			units	1	string
Q1	float	t = unlimited	long_name	Q1 = e1 * sin(phi / 2). phi is the angle between the J2000 reference and body frame of reference. e1 is a component of the unit rotation vector u in either frame	string
			units	1	string
Q2	float	t = unlimited	long_name	Q2 = e2 * sin(phi / 2). phi is the angle between the J2000 reference and body frame of reference. e2 is a component of the unit rotation vector u in either frame	string
			units	1	string
Q3	float	t = unlimited	long_name	Q3 = e3 * sin(phi / 2). phi is the angle between the J2000 reference and body frame of reference. e3 is a component of the unit rotation vector u in either frame	string
			units	1	string
data_file_version_container	int	n/a	long_name	container for version of satellite calibration data file	string
			data_file_version	***format is v##r## where VV is major release # and RR is minor revision #.***	string

APPENDIX A L1B - PRODUCT, DATA, AND ALGORITHM PACKAGE FILENAME CONVENTIONS

The main volume of the PUG contains a summary level description of the filename conventions used for all GOES-R product and data files. This appendix contains the detailed filename conventions for Level 1b products and data files defined in this volume of the PUG.

As discussed in the main volume of the PUG, filenames consist of a set of string fields delimited by an underscore or a period that are concatenated together. The content and format of several of the filename string fields are common across more than one of the Level 1b product and data filenames. Refer to Table A-1, Common Filename String Fields.

Table A-1 Common Filename String Fields

Common String Field	Description	Values and Meanings
System Environment	Defines whether the file is created by the operational system or a test system. Also defines whether the data in the file is real-time, test, playback, or simulated data.	"OR" = operational system real-time data "OT" = operational system test data "IR" = test system real-time data "IT" = test system test data "IP" = test system playback data "IS" = test system simulated data Note: Real-time data created by the operational system (i.e., "OR") support the operational mission. Default value is "OR".
Platform Identifier	Identifies the applicable GOES-R series satellite.	"G16" = GOES-16 (R) "G17" = GOES-17 (S) Default value is "Gnn"
Observation Period Date & Time	Start & end date & time of the raw or processed observation data in the file.	"sYYYYDDDHHMMSSs" = start date & time "eYYYYDDDHHMMSSs" = end date & time Notes: ➢ YYYY = year: e.g., 2015 ➢ DDD = day of year: 001-366 ➢ HH = UTC hour of day: 00-23 ➢ SSs = second of minute: 00-60 (60 indicates leap second and third "s" is tenth of second) Default value is 20000011200000.
Creation Date & Time	Date & time the file is created.	"cYYYYDDDHHMMSSs" Notes: ➢ YYYY = year: e.g., 2015 ➢ DDD = day of year: 001-366 ➢ HH = UTC hour of day: 00-23 ➢ MM = minute of hour: 00-59 ➢ SSs = second of minute: 00-59 (60 indicates leap second and third "s" is tenth of second) Default value is 20000011200000.
Version	Version associated with the data file. Composed of a major version & minor revision number.	"v##r##" Notes: ➢ v = major version number: 01-99 ➢ r = minor revision number: 00-Z9

Table A-2, Appendix A Filename Convention Paragraphs for Specific Level 1b Product or Data Types, identifies the subordinate paragraph where Level 1b product and data unique Data Set Names (DSNs), and product and data specific file extensions are defined. In addition, example filenames are included in the subordinate paragraphs.

Table A-2 Appendix A Filename Convention Paragraphs for Specific Level 1b Product or Data Types

Level 1b Product or Data Types	Appendix A Paragraph
Level 1b Products	Paragraph A.1
ABI Sample Outlier Data	Paragraph A.2
Instrument Calibration Data	Paragraph A.3
Satellite Calibration Data	Paragraph A.4
Level 0 Products	Paragraph A.5
Level 1b Semi-Static Source Data	Paragraph A.6
Level 1b Algorithm Packages	Paragraph A.7

A.1 Level 1b Product Filenames

Level 1b product filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields. The DSN for Level 1b products include the following sub-fields:

- Instrument and processing level
- Product acronym
- ABI image type
- ABI mesoscale image number
- ABI mode
- ABI channel

The DSNs for Level 1b product types other than Radiances are composed of two sub-fields. The DSN for the Radiances product is composed of four sub-fields, except in the case of the mesoscale Radiances product filename, which includes an additional sub-field to distinguish between the two different mesoscale regions observed during ABI mode 3 and mode 6. Refer to Table A.1 for an understanding of the DSN sub-fields used in Level 1b product filenames.

Table A.1 Level 1b Product Filename DSN Sub-Fields

Level 1b Product DSN Sub-Field	Values and Meanings
Instrument & Processing Level	"ABI-L1b" = Advanced Baseline Imager Level 1b "SUVI-L1b" = Solar Ultraviolet Imager Level 1b "EXIS-L1b" = Extreme Ultra-Violet/X-Ray Irradiance Sensors Level 1b "SEIS-L1b" = Space Environment In-Situ Suite Level 1b "MAG-L1b" = Magnetometer Level 1b
Product Acronym [1]	"-Rad" = ABI Radiances "-Fe093" = Solar Imagery: EUV at 93.9 Angstroms "-Fe131" = Solar Imagery: EUV at 131.2 Angstroms "-Fe171" = Solar Imagery: EUV at 171.1 Angstroms "-Fe195" = Solar Imagery: EUV at 195.1 Angstroms "-Fe284" = Solar Imagery: EUV at 284.2 Angstroms "-He303" =Solar Imagery: EUV at 303.8 Angstroms "-SFXR" = Solar Flux: X-Ray "-SFEU" = Solar Flux: EUV "-EHIS" = Energetic Heavy Ions "-MPSL" = Magnetometer Electrons & Protons: Low Energy "-MPSH" = Magnetometer Electrons & Protons: Medium & High Energy "-SGPS" = Solar and Galactic Protons "-GEOF" = Geomagnetic Field
ABI Image Type	"F" = Full Disk "C" = CONUS "M" = Mesoscale Default value is "X".
ABI Mesoscale Image Number	"1" = Region 1 "2" = Region 2
ABI Mode	"-M3" = ABI Mode 3 "-M4" = ABI Mode 4 "-M6" = ABI Mode 6 Default value is "-Mm".
ABI Channel (Band)	"CXX" Note: XX = channel (band) number: 01-16

[1] Note that for SUVI solar imagery, exposure time is identified in a product metadata field.

The file extension for a Level 1b product file is ".nc" for a netCDF-4 file and ".fits" for a Solar Imagery: EUV product file in FITS format.

The filename for a GOES S satellite operational Solar Flux: EUV product on February 1, 2016 with an observation start time of midnight UTC with a file creation time of 15 seconds past midnight is:

"OR_EXIS-L1b-SFEU_G17_s20160320000000_e20160320000300_c20160320000150.nc"

The filename for a GOES R satellite operational mesoscale region #2 band 13 Radiances product for February 2, 2016 with an observation start time of noon UTC with a file creation time of 20 seconds past noon is:

"OR_ABI-L1b-RadM2-M3C13_G16_s2016033120000_e2016033120030_ c2016033120020.nc"

A.2 ABI Sample Outlier Data Filenames

ABI sample outlier data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

The DSN for ABI sample outlier data is composed of four and as many as six sub-fields. A sample outlier data filename for a mesoscale image requires an additional sub-field to distinguish between the two different mesoscale regions observed during ABI mode 3 and mode 6. A sample outlier data filename for ABI channel (band) 2 data requires an additional sub-field to distinguish among its five data processing paths. Refer to Table A.2, Sample Outlier Data Filename DSN.

Table A.2 Sample Outlier Data Filename DSN

Level 1b Product DSN Sub-Field	Values and Meanings
Instrument, Processing Level, & Data Acronym	"ABI-L1b-SOF" = ABI Level 1b sample outlier data
ABI Image Type	"F" = Full Disk "C" = CONUS "M" = Mesoscale
ABI Mesoscale Image Number	"1" = Region 1 "2" = Region 2
ABI Mode	"-M3" = ABI mode 3 "-M4" = ABI mode 4 "-M6" = ABI mode 6
ABI Channel (Band)	"CXX" Note: XX = channel number: 01-16
ABI Channel (Band) Data Path	"PX" Note: X = data path number: 1-5 (all bands except 2 have only 1 data path)

The file extension for an ABI sample outlier data file is ".nc". netCDF-4 is the file format.

The filename for a Mode 3 GOES R satellite operational mesoscale region #2 band 2, data path 4 sample outlier data for February 2, 2016 with an observation start time of noon UTC with a file creation time of 20 seconds past noon is:

"OR_ABI-L1b-SOFM2-M3C2P4_G16_s20160331200000_e20160331200300_ c20160331200200.nc"

A.3 Instrument Calibration Data Filenames

The calibration data files for different instruments vary in number and content. The instrument calibration data filenames for each instrument are defined in subordinate paragraphs that follow. Refer to Table A.3, Instrument Calibration Data Filename Paragraphs.

Table A.3 Instrument Calibration Data Filename Paragraphs

GOES-R Instrument	Appendix A Paragraph
ABI	Paragraph A.3.1
SUVI	Paragraph A.3.2
EXIS	Paragraph A.3.3
SEISS	Paragraph A.3.4
Magnetometer	Paragraph A.3.5
GLM	Paragraph A.3.6

A.3.1 ABI Instrument Calibration Data Filenames

ABI instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time>_<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There are three types of ABI instrument calibration data files, each with a unique DSN. For an ABI calibration data file containing engineering telemetry, the DSN is "ABI-INST-CAL-ENG". For an ABI instrument calibration data file containing space, blackbody, star, and solar calibration target looks, and lunar scans, the DSN is composed of three or four sub-fields. An ABI instrument calibration data filename for ABI channel (band) 2 data requires an additional sub-field to distinguish among its five data processing paths. Refer to Table A.3.1, ABI Instrument Calibration Filename DSNs.

Table A.3.1 ABI Instrument Calibration Filenames DSNs

ABI Instrument Calibration Data DSN Sub-Field	Values and Meanings
Instrument & Processing Level	"ABI-INST-CAL" = ABI instrument calibration data
Calibration Data Type	"-LUN" = Lunar scan ABI mode 3 or mode 6 (mesoscale sized region) "-ENG" = Engineering
ABI Mode	"-M2" = Solar calibration target look ABI mode 2 "-M3" = Space, blackbody, and star look ABI mode 3 "-M4" = Space, blackbody, and star look ABI mode 4 "-M6" = Space, blackbody, and star look ABI mode 6
ABI Channel (Band)	"CXX" Note: XX = channel (band) number: 01-16 - For Solar Calibration Target: XX = 01-06 - For Infrared Calibration Target (blackbody): XX = 07-16 - For all other calibration looks, XX = 01-16
ABI Channel (Band) 2 Data Path	"-X" Note: X = data path number: 1-5

The file extension for an ABI instrument calibration data file is ".nc" for netCDF-4 files.

The filename for a GOES R satellite ABI lunar scan for channel 16 occurring on January 2, 2016 with an observation start time of noon UTC with a file creation time of 15 seconds past noon is:

"OR_ABI-INST-CAL-LUN-M3C16_G16_s20160021200000_e20160021214599_c20160021200150.nc"

A.3.2 SUVI Instrument Calibration Data Filenames

SUVI instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There are three types of SUVI instrument calibration data files, each with a unique DSN. For a SUVI calibration data file containing engineering telemetry, the DSN is "SUVI-INST-CAL-ENG". For a SUVI instrument calibration data file containing a dark frame, the DSN is "SUVI-INST-CAL-DARK". For a SUVI instrument calibration data file containing one of several wavelength-dependent calibration frames, refer to Table A.3.2, SUVI Instrument Calibration Miscellaneous Frame Filename DSNs.

Table A.3.2 SUVI Instrument Calibration Miscellaneous Frame Filenames DSNs

SUVI Instrument Calibration Miscellaneous Frame DSN Sub-Field	Values and Meanings	
Instrument & Processing Level	"SUVI-INST-CAL-IMG" = SUVI instrument calibration data	
SUVI Channel (Band)	"-093" "-131" "-171" "-195" "-284" "-303"	Six SUVI wavelengths in angstroms.

The file extension for SUVI instrument calibration data files is ".nc" for netCDF-4 files.

The filename for a GOES S satellite SUVI instrument calibration miscellaneous frame at a wavelength of 284 angstrom occurring on January 3, 2016 with an observation start time of noon UTC with a file creation time of 11 seconds past noon is:

"OR_SUVI-INST-CAL-IMG-284_G17_s20160031200000_e20160031200999_c20160031200110.nc"

A.3.3 EXIS Instrument Calibration Data Filenames

EXIS instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There is one type of EXIS instrument calibration data file and it has a unique DSN. The only type of EXIS calibration data file contains engineering telemetry, and the DSN is "EXIS-INST-CAL-ENG".

The file extension for an EXIS instrument calibration data file is ".nc" for netCDF-4 files.

A.3.4 SEISS Instrument Calibration Data Filenames

SEISS instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There are two types of SEISS instrument calibration data files, each with a unique DSN. For a SEISS calibration data file containing engineering telemetry, the DSN is "SEIS-INST-CAL-ENG". For a SEISS instrument calibration data file containing primarily correction parameters used to calibrate data in the Level 1b product data, the DSN is "SEIS-INST-CAL".

The file extension for a SEISS instrument calibration data file is ".nc" for netCDF-4 files.

A.3.5 Magnetometer Instrument Calibration Data Filenames

Magnetometer instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There are two types of Magnetometer instrument calibration data files, each with a unique DSN. For a Magnetometer calibration data file containing engineering telemetry, the DSN is "MAG-INST-CAL-ENG". For a Magnetometer instrument calibration data file containing raw magnetic field measurements obtained during a calibration maneuver, the DSN is "MAG-INST-CAL-MAN".

The file extension for a MAG instrument calibration data file is ".nc" for netCDF-4 files.

A.3.6 GLM Instrument Calibration Data Filenames

GLM instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

There are two types of GLM instrument calibration data files, each with a unique DSN. For a GLM calibration data file containing engineering telemetry, the DSN is "GLM-INST-CAL-ENG". For a GLM instrument calibration data file containing a background image, the DSN is "GLM-INST-CAL-BACK".

The file extension for a GLM instrument calibration data file is ".nc" for netCDF-4 files.

A.4 Satellite Calibration Data Filename

Satellite instrument calibration data filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time> _<Observation Period End Date & Time> _<Creation Date & Time>.<File Extension>

The string fields other than DSN and file extension are defined above in Table A-1, Common Filename String Fields.

The DSN for satellite calibration data files is "SAT-INST-CAL-EPH".

The file extension for satellite calibration data files is ".nc". netCDF-4 is the file format.

The filename for a GOES S hourly satellite calibration data file for January 2, 2016 with an observation start time of midnight UTC with a file creation time of one hour and one second past midnight:

"OR_SAT-INST-CAL-EPH_G17_s20160020000000_e20160020059599_ c20160020100010.nc"

A.5 Level 1b Semi-Static Source Data Filenames

There is a single aggregate semi-static source data file for each Level 1b algorithm. Refer to Table A.5, Level 1b Semi-Static Source Data Filenames.

Table A.5 Level 1b Semi-Static Source Data Filenames

Instrument	Filename
ABI	OR_ABI-L1b-PARM_***<Platform ID>***_***<Version>***.zip
GLM [1]	OR_GLM-L1b-PARM_***<Platform ID>***_***<Version>***.zip
SUVI	OR_SUVI-L1b-PARM_***<Platform ID>***_***<Version>***.zip
EXIS	OR_EXIS-L1b-PARM_***<Platform ID>***_***<Version>***.zip
SEISS	OR_SEIS-L1b-PARM_***<Platform ID>***_***<Version>***.zip
Magnetometer	OR_MAG-L1b-PARM_***<Platform ID>***_***<Version>***.zip

[1] GLM Level 1b semi-static source data is described in PUG Volume 5.
[2] ***<Platform ID>*** and ***<Version>*** details are defined in Table A-1, Common Filename String Fields.

A.6 Level 1b Algorithm Packages

Table A.6 Level 1b Algorithm Packages

Level 1b Algorithm	Filename
ABI	OR_ABI-L1b-ALG_< ***Version>***.zip
SUVI	OR_SUVI-L1b-ALG_***<Version>***.zip
EXIS	OR_EXIS-L1b-ALG_***<Version>***.zip
SEISS	OR_SEIS-L1b-ALG_***<Version>***.zip
Magnetometer	OR_MAG-L1b-ALG_***<Version>***.zip

<Version> details are defined in Table A-1, Common Filename String Fields

A.7 Level 0 Product Filenames

Level 0 product filename conventions are included in this volume because they are identified in the dynamic source data paragraphs for each Level 1b product, and in the Level 1b product metadata.

Level 0 product filenames are assembled using filename string fields as follows:

<System Environment>_<DSN>_<Platform ID>_<Observation Period Start Date & Time>_<Observation Period End Date & Time>_<Creation Date & Time>.<File Extension>

The string fields other than Data Set Name (DSN) and file extension are defined above in Table A-1, Common Filename String Fields. The DSNs for Level 0 products are defined in Table A.7 Level 0 Product File Data Set Names.

Table A.7 Level 0 Product File Data Set Names

Level 0 Product File Type	Data Set Name
Advanced Baseline Imager (ABI)	**ABI-L0**
Geostationary Lightning Mapper (GLM)	**GLM-L0**

Level 0 Product File Type	**Data Set Name**
Solar Ultraviolet Imager (SUVI)	**SUVI-L0**
Extreme Ultraviolet and X-ray Irradiance Sensor (EXIS)	**EXIS-L0**
Space Environment In-Situ Suite (SEISS)	**SEIS-L0**
Magnetometer (MAG)	**MAG-L0**

The file extension for a Level 0 product file is ".nc" for a netCDF-4 file.

The filename for a GOES R satellite operational GLM Level 0 product on February 4, 2016 with an observation start and end time of midnight UTC, and 12 minutes past midnight, respectively, with a file creation time of 15 seconds past midnight is:

"OR_GLM-L0_G16_s20160350000000_e20160350007200_c20160350000150.nc".

A.8 Level 1b ISO Series File Naming Convention

Table A.8 L1b ISO Series Naming Convention

Field Name	Description	Values and Meanings
System Environment	Defines whether the file is created by the operational system or a test system. Also defines whether the data in the file is real-time or test.	"OR" = operational system real-time data "OT" = operational system test data "IR" = test system real-time data "IT" = test system test data Default value is "OR".
Data Short Name	Product identifier	"_ABI-L1b-Rad" = Radiances "_EXIS-L1b-SFEU" = Solar Flux Extreme Ultra-Violet "_EXIS-L1b-SFXR" = Solar Flux X-Ray "_SEIS L1b-EHIS" = Energetic Heavy Ions "_SEIS L1b-MPSL" = Magnetospheric Electrons and Protons: Low Energy "_SEIS L1b-MPSH" = Magnetospheric Electrons and Protons: Medium & High Energy "_SEIS L1b-SGPS" = Solar and Galactic Protons "_MAG-L1b-GEOF" = Geomagnetic Field "_SUVI-L1b-SUVI" = Solar Ultraviolet Imager
		This sub-field is always preceded by a dash, "-". ISO Series identifier that is: "-ISO-SERIES"
Creation Date & Time	Identifies the Date and Time when the product level metadata was produced. Starts with an underscore "_" followed by a letter "c" followed by a subfield for the UTC Date and Time (to tenth of second).	"_c"<YYYYDDDhhmmsst> The 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)

		t = tenths of seconds (1 character: 0 – 9)
Extension	Identifies the file extension.	".xml" = XML

Example file name: OR_ABI-L1b-Rad-ISO-SERIES_c20162881413000.xml

APPENDIX B PRODUCT REFRESH RATES AND LATENCIES

This appendix contains the refresh rates and latencies associated with Level 1b products and data available from the NOAA Product Distribution and Access (PDA) system. This appendix does not address instrument calibration data.

The refresh rate is defined as the time between the completion of the n^{th} update of the product and the completion of the $(n+1)^{th}$ update of the same product for the user.

Vendor Allocated Ground Latency (VAGL) for Level 1b products and data is defined as the interval between the end of an observation by an instrument on the satellite to the arrival of the product to the ingest point of the GOES-R Access Subsystem.

Refer to Table B, Product and Data Refresh Rates and Latencies.

Table B Product and Data Refresh Rates and Latencies

	Level 1b Product / Data	Product Refresh Rate (ABI)			Product Refresh Rate (other than ABI)	Vendor Allocated Ground Latency
		Mode 3	Mode 4	Mode 6		
Radiances	Full Disk	15 min	5 min	10 min		55 sec
	CONUS	5 min	5 min	5 min		55 sec
	Mesoscale	0.5 min *(note 1)*		0.5 min *(note 1)*		28 sec
	Solar Imagery: EUV				10 sec *(note 2)*	50 sec
	Solar Flux: X-Ray				30 sec	1.8 sec
	Solar Flux: EUV				30 sec	24 sec
	Energetic Heavy Ions				5 min	267 sec
	Magnetospheric Electrons and Protons: Low Energy				30 sec	51 sec
	Magnetospheric Electrons and Protons: Medium & High Energy				30 sec	51 sec
	Solar and Galactic Protons				60 sec	51 sec
	Geomagnetic Field				60 sec	1.8 sec
	GRB Information				5 min	

Note 1: The refresh rate for mesoscale products applies to each of the two mesoscale scenes in the ABI mode 3 epoch.

Note 2: There is a four minute epoch associated with the entire sequence of solar images at different wavelengths and exposure periods. Four to six images are observed in any minute of this epoch. The best case refresh rate is 10 seconds.

The latency values presented in this table are not based on actual performance. Five seconds are associated with the combination of sensing and data processing on the satellite, downlink from the satellite, receipt by the ground antenna, transmission of the GRB data stream by the ground antenna, uplink and downlink of the GRB data stream, and cataloguing by the PDA system. The remainder of the latency value is associated with data processing by the ground system.

The Radiances product latency values presented in this table are minimum performance requirements necessary to achieve end-product refresh rates.

APPENDIX C INSTRUMENT ENGINEERING TELEMETRY PARAMETERS AND UNITS

This appendix identifies the instrument engineering telemetry item names and their units. There is a separate paragraph and table for each instrument.

The data variables in the netCDF-4 files that contain instrument engineering telemetry items and their units of measure are container variables where the telemetry item and unit names are loaded into character string arrays. The netCDF-4 file specification does not identify the names of telemetry items or their units. The units conform to the Unidata's udunits. The udunits library and associated documentation is available at http://www.unidata.ucar.edu/packages/udunits/.

C.1 ABI Instrument Engineering Telemetry

Table C.1 ABI Instrument Engineering Telemetry

Telemetry Item	Units (if applicable)
ICT Temperature #01	K
ICT Temperature #02	K
ICT Temperature #03	K
ICT Temperature #04	K
ICT Temperature #05	K
ICT Temperature #06	K
ICT Temperature #07	K
ICT Temperature #08	K
ICT Temperature #09	K
ICT Temperature #10	K
ICT Temperature #11	K
ICT Temperature #12	K
N-S Mirror Temperature #1	K
N-S Mirror Temperature #2	K
N-S Mirror Temperature #3	K
E-W Mirror Temperature #1	K
E-W Mirror Temperature #2	K
E-W Mirror Temperature #3	K
LWIR Focal Plane Module Temperature	K
MWIR Focal Plane Module Temperature	K
VNIR Focal Plane Module Temperature	K
Thermal Bus Temperature #1	K
Thermal Bus Temperature #2	K
Radiator Temperature #1	K
Radiator Temperature #2	K
Radiator Temperature #3	K
Radiator Temperature #4	K
Radiator Temperature #5	K
Radiator Temperature #6	K
Fixed Diffuser Assembly Temperature	K
Optical Port Cover Latch Temperature	K
Solar Cal Cover Temperature	K
Solar Cal Cover Hinge Temperature	K
LWIR/MWIR Stage Outgas Heater Temperature	K
VNIR Stage Outgas Heater Temperature	K

Telemetry Item	Units (if applicable)
Aft Optics Housing Heater Temperature	K
Telescope Mirror Temperature #1	K
Telescope Mirror Temperature #2	K
Telescope Mirror Temperature #3	K
Telescope Mirror Temperature #4	K
IR/VIS Beamsplitter Mount Temperature	K
IR/VIS Beamsplitter Wall Temperature	K
Optical Bench Temperature #1	K
Optical Bench Temperature #2	K
Optical Bench Temperature #3	K
Optical Bench Temperature #4	K
Optical Bench Temperature #5	K
LHP Startup (Evaporator) Heater Temperature #1	K
LHP Startup (Evaporator) Heater Temperature #2	K
LHP Control (Compensation Chamber) Heater Temperature #1	K
LHP Control (Compensation Chamber) Heater Temperature #2	K
VNIR Video Processor Temperature	K
IR Video Processor Temperature	K
Peripheral and Thermal Control Temperature	K

C.2 SUVI Instrument Engineering Telemetry

Table C.2 SUVI Instrument Engineering Telemetry

Telemetry Item	Units (if applicable)
CCD Heater Block platinum resistance thermometer reading primary)	K
CCD Heater Block platinum resistance thermometer reading redundant)	K
Door mechanism thermistor reading primary)	K
Door mechanism thermistor reading redundant)	K
GT Forward thermistor reading primary)	K
GT Forward thermistor reading redundant)	K
GT Aft thermistor reading primary)	K
GT Aft thermistor reading redundant)	K
CEB thermistor reading primary)	K
CEB thermistor reading redundant)	K
SEB base plate thermistor reading primary)	K
SEB base plate thermistor reading redundant)	K
SEB top thermistor reading primary)	K
SEB top thermistor reading redundant)	K
SEB Power Converter thermistor reading primary)	K
SEB Power Converter thermistor reading redundant)	K
SEB CPU thermistor reading primary)	K
SEB CPU thermistor reading redundant)	K
Front Aperture Housing thermistor reading primary)	K
Front Aperture Housing thermistor reading redundant)	K
Spider Assembly thermistor reading primary)	K

Telemetry Item	Units (if applicable)
Spider Assembly thermistor reading redundant)	K
Shutter Housing thermistor reading primary)	K
Shutter Housing thermistor reading redundant)	K
Filterwheel Housing temperature primary)	K
Filterwheel Housing temperature redundant)	K
CCD temperature 1	K
CCD temperature 2	K
Primary Mirror Temperature primary)	K
Primary Mirror Temperature redundant)	K
Secondary Mirror Temperature primary)	K
Secondary Mirror Temperature redundant)	K
CEB Internal PWB Temperature	K
CCD Bias Voltage, Dump Drain	V
CCD Bias Voltage, JFET Drain	V
CCD Bias Voltage, Output Drain	V
CCD Bias Voltage, Output Gate 1	V
CCD Bias Voltage, Output Gate 2	V
CCD Bias Voltage, Reset Drain	V
CCD Bias Voltage Reference	V
CCD Bias Voltage, Substrate Supply	V

C.3 EXIS Instrument Engineering Telemetry

Table C.3 EXIS Engineering Instrument Telemetry

Telemetry Item	Units (if applicable)
30-second EUVS-A detector board temperature	K
30-second EUVS-B detector board temperature	K
30-second EUVS-C1 detector temperature	K
30-second EUVS-C2 detector temperature	K
EUV entrance slit temperature	K
EUVS-C C1/C2 ADC temperature	K
EXIS case operational heater temperature	K
EXIS Interface board temperature	K
EXIS Microprocessor board FPGA temperature	K
EXIS power board temperature	K
XRS ASIC-1 board temperature	K
XRS ASIC-1 dark gain	count (counts per digital number)
XRS ASIC-2 board temperature	K
XRS ASIC-2 dark gain	count (counts per digital number)
XRS filter holder temperature	K
XRS Magnet assembly temperature	K
XRS-A solar maximum FOV correction	*dimensionless*

Telemetry Item	Units (if applicable)
XRS-A solar minimum dark current correction	*dimensionless*
XRS-A solar minimum FOV correction	*dimensionless*
XRS-A solar minimum gain	C/DN
XRS-B solar maximum FOV correction	*dimensionless*
XRS-B solar minimum dark current correction	*dimensionless*
XRS-B solar minimum FOV correction	*dimensionless*
XRS-B solar minimum gain	count (counts per digital number)
SPS silicon detector temperature	K
XRS-A solar maximum gain 1	count (counts per digital number)
XRS-A solar maximum gain 2	count (counts per digital number)
XRS-A solar maximum gain 3	count (counts per digital number)
XRS-A solar maximum gain 4	count (counts per digital number)
XRS-B solar maximum gain 1	count (counts per digital number)
XRS-B solar maximum gain 2	count (counts per digital number)
XRS-B solar maximum gain 3	count (counts per digital number)
XRS-B solar maximum gain 4	count (counts per digital number)
XRS-A solar maximum dark current correction 1	count
XRS-A solar maximum dark current correction 2	count
XRS-A solar maximum dark current correction 3	count
XRS-A solar maximum dark current correction 4	count
XRS-B solar maximum dark current correction 1	count
XRS-B solar maximum dark current correction 2	count
XRS-B solar maximum dark current correction 3	count
XRS-B solar maximum dark current correction 4	count

C.4 SEISS Instrument Engineering Telemetry

Table C.4 SEISS Instrument Engineering Telemetry

Telemetry Item	Units (if applicable)
EHIS Telescope Temperature 1	K
EHIS Telescope Temperature 2	K
EHIS Linear Board 2 Temperature	K
MPS-LO R-sensor Temperature 1	K
MPS-LO L-sensor Temperature 2	K
MPS-HI Proton Telescope Temperature 1	K
MPS-HI Electron Telescope Temperature 4	K
SGPS-X Telescope 3 Temperature 1	K

Telemetry Item	Units (if applicable)
SGPS-X Telescope 2 Temperature 4	K
SGPS+X Telescope 3 Temperature 1	K
SGPS+X Telescope 2 Temperature 4	K

C.5 Magnetometer Instrument Engineering Telemetry

Table C.5 Magnetometer Instrument Engineering Telemetry

Telemetry Item	Units (if applicable)
IB electronic temperature	K
IB reference voltage 1.25 V	V
IB reference voltage 3.75 V	V
IB voltage over precision RIU3 resistor 1	V
IB voltage over precision RIU3 resistor 2	V
OB electronic temperature	K
OB reference voltage 1.25 V	V
OB reference voltage 3.75 V	V
OB voltage over precision RIU4 resistor 2	V
Temperature dependent IB factory scale factor x)	count nT-1
Temperature dependent IB factory scale factor y)	count nT-1
Temperature dependent IB factory scale factor z)	count nT-1
Temperature dependent IB factory zero offset x)	count
Temperature dependent IB factory zero offset y)	count
Temperature dependent IB factory zero offset z)	count
Temperature dependent OB factory scale factor x)	count nT-1
Temperature dependent OB factory scale factor y)	count nT-1
Temperature dependent OB factory scale factor z)	count nT-1
Temperature dependent OB factory zero offset x)	count
Temperature dependent OB factory zero offset y)	count
Temperature dependent OB factory zero offset z)	count
IB x-axis sensor temperature	K
IB y-axis sensor temperature	K
IB z-axis sensor temperature	K
OB x-axis sensor temperature	K
OB y-axis sensor temperature	K
OB z-axis sensor temperature	K

C.6 GLM Instrument Engineering Telemetry

Table C.6 GLM Instrument Engineering Telemetry

Telemetry Item	Units (if applicable)
CCD pedestal temperature	K
Narrow band filter temperature	K

Telemetry Item	Units (if applicable)
Solar blocking filter temperature	K
Solar rejection filter temperature	K
Number of events rejected by CCD mask	count
Number of events rejected by 2nd level threshold filter	count
Number of events rejected by CCD radiation track filter	count
Number of events rejected by frame transfer noise filter	count
Number of events rejected by coherency filter	count
Number of events rejected by contrast filter	count
Maximum background image counts	count
Mean background image counts	count
Minimum background image counts	count
Standard deviation background image counts	count

APPENDIX D INSTRUMENT CALIBRATION PARAMETERS

This appendix identifies and describes the parameters that are inputs to the calibration, image navigation, and registration ("Cal INR") processing portion of the Level 1b product generation process. There is a separate paragraph and set of tables for each instrument.

This appendix describes the semi-static Calibration, Image Navigation, and Registration ("Cal INR") processing parameters used in the ABI, SUVI, EXIS and EUVS, SEISS, MAG and GLM L1b Radiometric Calibration ground processing software. Cal INR data files are encapsulated in an instrument-specific, version zip file and sent to PDA. Upon updating the Cal INR information, a parameter manifest file listing the 6 zip file names is uplinked to GRB as a GRB-INFO-STATIC file alerting users to the existence/update to the parameters. This version-number-named zip file name is also included in the L1b product metadata. Any user that requires information from the Cal INR data could request the file from PDA. To support users, documentation of the content and format of this Cal INR data is included below.

The design of each GS L1b algorithm included sets of semi-static scalar parameters and tables for generation of the L1b intermediate and block-level products. The GOES-R ground segment provides the ability for updating and revision of these parameters on an as-needed basis.

In addition to the processing parameters required by the L1b software, the Cal INR files may include parameter values used by Product Performance. All parameters are documented here.

The description of the Cal INR parameters is based loosely on the conventions used elsewhere in the PUG for the GOES-R products and instrument calibration data. The Cal INR files are modeled on a simple key-value pair structure with limited descriptive information. If metadata is included in these files it does not necessarily follow standard conventions and is not referenced in this section. Within this section, the UDUNITS conventions for units have been followed, with some exceptions. For example, a given parameter can include values representing several different units; in this case the units are identified as "various". Also, "unitless" has been adopted to specify the units of unitless quantities rather than the value of "1" used elsewhere in the PUG. Additional information is provided in the summary column.

The quantities used in the documentation of Cal INR data are summarized in Table D-1. This includes standard quantities such as Field Name, Type, Shape, Units, and Summary (Description).

Table D-1 Cal INR Description

Field Name	Parameter name in the HDF5 Cal INR file.
Type	Data type for the Cal INR parameter.
Shape	Dimensions of the Cal INR parameter. Dimensions are generally of fixed length; where this is not the case, nominal values will be provided and this will be discussed in the Summary column.
Units	Parameter units in standard convention.
Summary	Parameter description.

D.1 ABI Instrument Calibration Parameters

The ABI L1b Radiometric Calibration algorithm CSC consists of six algorithm CSUs: Spacelook algorithm, Infrared Calibration Target (ICT) algorithm, Solar Calibration Target (SCT) algorithm, Infrared (IR) Radiance Retrieval algorithm, Visible and Near Infrared (VNIR) Radiance Retrieval algorithm, and Starlook algorithm. Each of the algorithms processes the L1a science data corresponding to a particular ABI scene ID and band using a set of Cal INR data objects. Each Cal INR file contains a top-level HDF group matching the filename without the .h5 extension. Table D.1-1 lists the complete set of HDF5 data files used for the ABI L1b radiometric calibration data objects.

Table D.1-1 List of All ABI Cal INR HDF5 Files Used by the ABI L1b Radiometric Calibration Algorithms

ABI L1b Algorithm Parameters	ABI L1b Algorithm Q-Table Parameters	ABI L1b Algorithm Radiance Look Up Table Parameters
ABI_SpaceLookParam.h5	Q_TableBand1.h5	RadianceLUT_Band7.h5
ABI_SolarSpaceLookParam.h5	Q_TableBand2.h5	RadianceLUT_Band8.h5
ABI_ICT_Record.h5	Q_TableBand3.h5	RadianceLUT_Band9.h5
ABI_SCT_Record.h5	Q_TableBand4.h5	RadianceLUT_Band10.h5
StarLookParameters.h5	Q_TableBand5.h5	RadianceLUT_Band11.h5
IR_RetrievalParameters.h5	Q_TableBand6.h5	RadianceLUT_Band12.h5
VNIR_RetrievalParameters.h5	Q_TableBand7.h5	RadianceLUT_Band13.h5
ABI_Mirror_Record.h5	Q_TableBand8.h5	RadianceLUT_Band14.h5
CalTargetTimeIntervals.h5	Q_TableBand9.h5	RadianceLUT_Band15.h5
ABI_BandSaturationLimits.h5	Q_TableBand10.h5	RadianceLUT_Band16.h5
ABI_DeadRowListParams.h5	Q_TableBand11.h5	
ABI_ICM_ConversionConsts.h5	Q_TableBand12.h5	
ABI_ICM_SensorCoefficients.h5	Q_TableBand13.h5	
	Q_TableBand14.h5	
	Q_TableBand15.h5	
	Q_TableBand16.h5	

Additional notes:

- All files support L1b processing except files ABI_ICM_ConversionConsts.h5 and ABI_ICM_SensorCoefficients.h5 that are used exclusively by Product Performance.
- Dimensions identified in the "Shape" column are described in the "Summary" column.

Table D.1-2 Description of ABI_SpaceLookParams Processing Parameters

Field Name	Type	Shape	Units	Summary
theInitialNumberOfSpaceLookSamples	int32	2 x 16	unitless	Number of samples to process for initial Space Look average per instrument side for all bands
theMinimumNumberOfSpaceLookSamplesToProcess	int32	2 x 16	unitless	Minimum number of samples required for valid Space Look average after filtering per instrument side for all bands
theMinimumSpaceLookDetectorCount	int32	2 x 16	count	Lower bound for Space Look sample saturation test per instrument side for all bands

Field Name	Type	Shape	Units	Summary
theMaximumSpaceLookDetector Count	int32	2 x 16	count	Upper bound for Space Look sample saturation test per instrument side for all bands
theSpaceLookMinimumStandard Deviation	double	2 x 16	count	Minimum standard deviation of Space Look average for outlier elimination per instrument side for all bands
theSpaceLookOutlierCoefficient	int32	2 x 16	unitless	Coefficient defining extent of outlier filter for Space Look measurements per instrument side for all bands
theVNIR_Thresholds	double	6	W m-2 sr-1 um-1	VNIR channel average spectral radiance difference limit used for lunar filtering for all VNIR bands
theIR_Thresholds	double	10	mW m-2 sr-1 (cm-1)-1	IR channel average spectral radiance difference limit used for lunar filtering for all IR bands
theIntegrationFactor	uint16	2	unitless	Space Look scene integration factor per instrument side

Table D.1-3 Description of ABI_SolarSpaceLookParams Processing Parameters

Field Name	Type	Shape	Units	Summary
theInitialNumberOfSCT_SpaceLookSamples	int32	2 x 6	unitless	Number of samples to process for initial Solar Cal Space Look average per instrument side for all VNIR bands
theMinimumNumberOfSCT_SpaceLookSamplesToProcess	int32	2 x 6	unitless	Minimum number of samples required for valid Solar Cal Space Look average after filtering per instrument side for all VNIR bands
theMinimumSCT_SpaceLookDetectorCount	int32	2 x 6	count	Lower bound for Solar Cal Space Look sample saturation test per instrument side for all VNIR bands
theMaximumSCT_SpaceLookDetectorCount	int32	2 x 6	count	Upper bound for Solar Cal Space Look sample saturation test per instrument side for all VNIR bands
theSCT_SpaceLookMinimumStandardDeviation	double	2 x 6	count	Minimum standard deviation of Solar Cal Space Look average for outlier elimination per instrument side for all VNIR bands
theSCT_SpaceLookOutlierCoefficient	int32	2 x 6	unitless	Coefficient defining extent of outlier filter for Solar Cal Space Look measurements per instrument side for all VNIR bands
theVNIR_Thresholds	double	6	W m-2 sr-1 um-1	VNIR channel average spectral radiance difference limit used for lunar filtering for all VNIR bands
theIR_Thresholds	double	10	mW m-2 sr-1 (cm-1)-1	IR channel average spectral radiance difference limit used for lunar filtering for all IR bands
theIntegrationFactor	uint16	2	unitless	Solar Cal Space Look scene integration factor per instrument side

Table D.1-4 Description of ABI_ICT_Record Processing Parameters

Field Name	Type	Shape	Units	Summary
theInitialNumberOfICT_Samples	int32	2 x 10	unitless	Number of samples to process for initial ICT average per instrument side for all IR bands
theMinimumNumberOfICT_SamplesToProcess	int32	2 x 10	unitless	Minimum number of samples required for valid ICT average after filtering per instrument side for all IR bands
theMinimumICT_DetectorCount	int32	2 x 10	count	Lower bound for ICT sample saturation test per instrument side for all IR bands
theMaximumICT_DetectorCount	int32	2 x 10	count	Upper bound for ICT sample saturation test per instrument side for all IR bands
theICT_MinimumStandardDeviation	double	2 x 10	count	Minimum standard deviation of ICT average for outlier elimination per instrument side for all IR bands
theICT_OutlierCoefficient	int32	2 x 10	unitless	Coefficient defining extent of outlier filter for ICT measurements per instrument side for all IR bands
theICT_EmissivityValues	double	2 x 10	unitless	Wavelength dependent emissivity of the ICT per instrument side for all IR bands
theICT_PRT_TemperatureWeightValues	double	2 x 12	unitless	ICT Platinum Resistance Thermistors (PRT) weight coefficients per instrument side for all PRTs
theIntegrationFactor	uint16	2	unitless	ICT scene integration factor per instrument side
theLowFixedResistance	double	2 x 12	ohms	Minimum resistance coefficient for converting PRT counts to resistance per instrument side for all PRTs
theHighFixedResistance	double	2 x 12	ohms	Minimum resistance coefficient for converting PRT counts to resistance per instrument side for all PRTs
theKelvinTemperatureOffset	double	*scalar*	K	The temperature reference value in Kelvin corresponding to 0° C
theR0_Values	double	2 x 12	ohms	Resistance coefficient to convert PRT resistance to temperature per instrument side for all PRTs
theA_CoefficientPRT_Values	double	2 x 12	K-1	First coefficient to convert PRT resistance to temperature per instrument side for all PRTs
theB_CoefficientPRT_Values	double	2 x 12	K-2	Second coefficient to convert PRT resistance to temperature per instrument side for all PRTs

Table D.1-5 Description of ABI_SCT_Record Processing Parameters

Field Name	Type	Shape	Units	Summary
theInitialNumberOfSCT_Samples	int32	2 x 6	unitless	Number of samples to process for initial SCT average per instrument side for all VNIR bands
theMinimumNumberOfSCT_SamplesToProcess	int32	2 x 6	unitless	Minimum number of samples required for valid SCT average after filtering per instrument side for all VNIR bands

Field Name	Type	Shape	Units	Summary
theMinimumSCT_DetectorCount	int32	2 x 6	count	Lower bound for SCT sample saturation test per instrument side for all VNIR bands
theMaximumSCT_DetectorCount	int32	2 x 6	count	Upper bound for SCT sample saturation test per instrument side for all VNIR bands
theSCT_MinimumStandardDeviation	double	2 x 6	count	Minimum standard deviation of SCT average for outlier elimination per instrument side for all VNIR bands
theSCT_OutlierCoefficient	int32	2 x 6	unitless	Coefficient defining extent of outlier filter for SCT measurements per instrument side for all VNIR bands
theIntegrationFactorForSCT_Scene	uint16	2	unitless	SCT scene integration factor per instrument side
theSCT_UnitNormalVector	double	2 x 3	unitless	Solar Cal Target unit normal vector in ARF coordinate system per instrument side for each vector component
theTheta_InstrumentAlignmentAngle	double	2	radians	Instrument-to-spacecraft Theta alignment angles per instrument side
thePhi_InstrumentAlignmentAngle	double	2	radians	Instrument-to-spacecraft Phi alignment angles per instrument side
thePsi_InstrumentAlignmentAngle	double	2	radians	Instrument-to-spacecraft Psi alignment angles per instrument side
theLambertianSceneRadiance	double	2 x 6	W m-2 sr-1 um-1	Lookup table of channel average spectral radiances for 100% albedo Lambertian scene with sun at 1 AU per instrument side for all VNIR bands
theMeanEarthSunDistance	double	*scalar*	AU	The mean Earth-Sun distance in AU
theBand1_SCT_K_Coefficients	double	2 x 676 x 6	various	SCT Band 1 polynomial coefficients used to determine effective bidirectional reflectance distribution function with units of sr-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 1 for each of the six coefficients
theBand2_SCT_K_Coefficients	double	2 x 1460 x 6	various	SCT Band 2 polynomial coefficients used to determine effective bidirectional reflectance distribution function with units of sr-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 2 for each of the six coefficients
theBand3_SCT_K_Coefficients	double	2 x 676 x 6	various	SCT Band 3 polynomial coefficients used to determine effective bidirectional reflectance distribution function with units of sr-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 3 for each of the six coefficients
theBand4_SCT_K_Coefficients	double	2 x 372 x 6	various	SCT Band 4 polynomial coefficients used to determine effective

Field Name	Type	Shape	Units	Summary
				bidirectional reflectance distribution function with units of sr-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 4 for each of the six coefficients
theBand5_SCT_K_Coefficients	double	2 x 676 x 6	various	SCT Band 5 polynomial coefficients used to determine effective bidirectional reflectance distribution function with units of sr/-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 5 for each of the six coefficients
theBand6_SCT_K_Coefficient	double	2 x 372 x 6	various	SCT Band 6 polynomial coefficients used to determine effective bidirectional reflectance distribution function with units of sr-1 times radians-1 to the ith power for i = 0,5, per instrument side for each detector column in band 6 for each of the six coefficients
theSecondsInADay	double	*scalar*	s	Number of seconds in one Julian day
theDaysInACentury	double	*scalar*	days	Number of days in one Julian century
theG1_Coefficient	double	*scalar*	degrees	First coefficient in equation for g parameter in geocentric apparent ecliptic longitude of sun
theG2_Coefficient	double	*scalar*	degrees daynumber-1	Second coefficient in equation for g parameter in geocentric apparent ecliptic longitude of sun
theQ1_Coefficient	double	*scalar*	degrees	First coefficient in equation for q parameter in geocentric apparent ecliptic longitude of sun
theQ2_Coefficient	double	*scalar*	degrees daynumber-1	Second coefficient in equation for q parameter in geocentric apparent ecliptic longitude of sun
theL1_Coefficient	double	*scalar*	degrees	First coefficient in equation for L parameter in geocentric apparent ecliptic longitude of sun
theL2_Coefficient	double	*scalar*	degrees	Second coefficient in equation for L parameter in geocentric apparent ecliptic longitude of sun
theR1_Coefficient	double	*scalar*	AU	First coefficient in equation for computing the distance of the Sun
theR2_Coefficient	double	*scalar*	AU	Second coefficient in equation for computing the distance of the Sun
theR3_Coefficient	double	*scalar*	AU	Third coefficient in equation for computing the distance of the Sun
theFirstEclipticObliquityCoefficient	double	*scalar*	degrees	First coefficient in equation for computing the obliquity of the ecliptic
theSecondEclipticObliquityCoefficient	double	*scalar*	degrees	Second coefficient in equation for computing the obliquity of the ecliptic

Field Name	Type	Shape	Units	Summary
theFirstZetaCoefficient	double	*scalar*	arcsec	First coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theSecondZetaCoefficient	double	*scalar*	arcsec s-1	Second coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theThirdZetaCoefficient	double	*scalar*	arcsec s-2	Third coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theFourthZetaCoefficient	double	*scalar*	arcsec s-3	Fourth coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theFifthZetaCoefficient	double	*scalar*	arcsec s-4	Fifth coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theSixthZetaCoefficient	double	*scalar*	arcsec s-5	Sixth coefficient in equation for Zeta parameter in conversion from J2K to TOD reference frame
theFirstZaCoefficient	double	*scalar*	arcsec	First coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theSecondZaCoefficient	double	*scalar*	arcsec s-1	Second coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theThirdZaCoefficient	double	*scalar*	arcsec s-2	Third coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theFourthZaCoefficient	double	*scalar*	arcsec s-3	Fourth coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theFifthZaCoefficient	double	*scalar*	arcsec s-4	Fifth coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theSixthZaCoefficient	double	*scalar*	arcsec s-5	Sixth coefficient in equation for Z parameter in conversion from J2K to TOD reference frame
theFirstThetaCoefficient	double	*scalar*	arcsec s-1	First coefficient in equation for Theta parameter in conversion from J2K to TOD reference frame
theSecondThetaCoefficient	double	*scalar*	arcsec s-2	Second coefficient in equation for Theta parameter in conversion from J2K to TOD reference frame
theThirdThetaCoefficient	double	*scalar*	arcsec s-3	Third coefficient in equation for Theta parameter in conversion from J2K to TOD reference frame
theFourthThetaCoefficient	double	*scalar*	arcsec s-4	Fourth coefficient in equation for Theta parameter in conversion from J2K to TOD reference frame
theFifthThetaCoefficient	double	*scalar*	arcsec s-5	Fifth coefficient in equation for Theta parameter in conversion from J2K to TOD reference frame
theSecondsToRadiansConversionFactor1	double	*scalar*	degrees radian-1	Number of degrees in PI radians

Field Name	Type	Shape	Units	Summary
theSecondsToRadiansConversion Factor2	double	*scalar*	arcsec degrees-1	Number of arcseconds in 1 degree
theMinimumBetaAngle	double	*scalar*	degrees	Minimum bound on calculated value of effective beta angle
theMaximumBetaAngle	double	*scalar*	degrees	Maximum bound on calculated value of effective beta angle
theSwathSelection	uint8	6	unitless	Table specifying optimal swath for all VNIR band

Table D.1-6 Description of StarLookParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theNumberOfStarSpaceLookSam ples	int32	2	unitless	Number of samples to use for each detector as the space look data for the star scene per instrument side
theIntegrationFactor	int16	2	unitless	Star scene integration factor per instrument side
theNSNPacketsForRecovery	int32	*scalar*	unitless	The number duration of the north/south spike recovery loop in units of scan telemetry packets
theEWNPacketsForRecovery	int32	*scalar*	unitless	The number duration of the east/west spike recovery loop in units of scan telemetry packets
theStarRetrievalNormalScanStart TimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the first non-space sample
theStarRetrievalNormalScanEndT imeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the last non-space sample

Table D.1-7 Description of IR_RetrievalParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theIntegrationFactor	uint16	2	unitless	Star scene integration factor per instrument side
theIR_RetrievalNormalScanStart TimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the IR radiance block
theIR_RetrievalNormalScanEndT imeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the IR radiance block
theIR_RetrievalSU_EngineeringS tartTimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all SU engineering telemetry objects coincident in time with the IR radiance block
theIR_RetrievalSU_EngineeringE ndTimeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all SU engineering

Field Name	Type	Shape	Units	Summary
				telemetry objects coincident in time with the IR radiance block

Table D.1-8 Description of VNIR_RetrievalParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theIntegrationFactor	uint16	2	unitless	Star scene integration factor per instrument side
theVNIR_RetrievalNormalScanStartTimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the VNIR radiance block
theVNIR_RetrievalNormalScanEndTimeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the VNIR radiance block

Table D.1-9 Description of ABI_Mirror_Record Processing Parameters

Field Name	Type	Shape	Units	Summary
theEastWestLineOfSightOffset	double	2 x 16	unitless	East-west line-of-sight offset from field-of-view center per instrument side for all bands
theEastWestScanMirrorCoefficient	double	2 x 16 x 3	various	East-west mirror reflectivity coefficients with units of degrees-1 to the ith power where i = 0, 2, per instrument side for all bands and all three coefficients
theNorthSouthScanMirrorCoefficient	double	2 x 16 x 3	various	North-south mirror reflectivity coefficients with units of degrees-1 to the ith power where i = 0, 2, per instrument side for all bands and all three coefficients
theEastWestScanMirrorTemperatureWeights	double	2 x 3	unitless	East-west mirror thermistor weight coefficients per instrument side for each thermistor
theNorthSouthScanMirrorTemperatureWeights	double	2 x 3	unitless	North-south mirror thermistor weight coefficients per instrument side for each thermistor
theFirst_EW_MirrorResistance	int32	*scalar*	ohms	First coefficient to convert EW scan mirror parameters to resistance
theSecond_EW_MirrorResistance	int32	*scalar*	ohms	Second coefficient to convert EW scan mirror parameters to resistance
theFirst_NS_MirrorResistance	int32	*scalar*	ohms	First coefficient to convert NS scan mirror parameters to resistance
theSecond_NS_MirrorResistance	int32	*scalar*	ohms	Second coefficient to convert NS scan mirror parameters to resistance
theThermistor_A_coefficients	double	2 x 3 x 2	K-1	First coefficient to convert thermistor resistance to temperature per instrument side for each thermistor and for both the EW and NS mirrors

Field Name	Type	Shape	Units	Summary
theThermistor_B_coefficients	double	2 x 3 x 2	K-1	Second coefficient to convert thermistor resistance to temperature per instrument side for each thermistor and for both the EW and NS mirrors
theThermistor_C_coefficients	double	2 x 3 x 2	K-1	Third coefficient to convert thermistor resistance to temperature per instrument side for each thermistor and for both the EW and NS mirrors

Table D.1-10 Description of CalTargetTimeInterval Processing Parameters

Field Name	Type	Shape	Units	Summary
theCalTargetNormalScanStartTimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the ICT or SCT science block
theCalTargetNormalScanEndTimeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all the Normal Scan telemetry objects coincident in time with the ICT or SCT science block
theCalTargetSU_EngineeringStartTimeInterval	double	*scalar*	s	The start time interval in J2K seconds used for retrieval of all SU engineering telemetry objects coincident in time with the ICT or SCT science block
theCalTargetSU_EngineeringEndTimeInterval	double	*scalar*	s	The end time interval in J2K seconds used for retrieval of all SU engineering telemetry objects coincident in time with the ICT or SCT science block

Table D.1-11 Description of ABI_BandSaturationLimits Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand1_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 1 radiance limits for under/over saturation per instrument side and limit number
theBand2_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 2 radiance limits for under/over saturation per instrument side and limit number
theBand3_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 3 radiance limits for under/over saturation per instrument side and limit number
theBand4_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 4 radiance limits for under/over saturation per instrument side and limit number
theBand5_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 5 radiance limits for under/over saturation per instrument side and limit number

Field Name	Type	Shape	Units	Summary
theBand6_SaturationLimits	double	2 x 2	W m-2 sr-1 um-1	The minimum and maximum Band 6 radiance limits for under/over saturation per instrument side and limit number
theBand7_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 7 radiance limits for under/over saturation per instrument side and limit number
theBand8_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 8 radiance limits for under/over saturation per instrument side and limit number
theBand9_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 9 radiance limits for under/over saturation per instrument side and limit number
theBand10_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 10 radiance limits for under/over saturation per instrument side and limit number
theBand11_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 11 radiance limits for under/over saturation per instrument side and limit number
theBand12_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 12 radiance limits for under/over saturation per instrument side and limit number
theBand13_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 13 radiance limits for under/over saturation per instrument side and limit number
theBand14_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 14 radiance limits for under/over saturation per instrument side and limit number
theBand15_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 15 radiance limits for under/over saturation per instrument side and limit number
theBand16_SaturationLimits	double	2 x 2	mW m-2 sr-1 (cm-1)-1	The minimum and maximum Band 16 radiance limits for under/over saturation per instrument side and limit number

Table D.1-12 Description of ABI_DeadRowListParams Processing Parameters

Field Name	Type	Shape	Units	Summary
theDeadRowIndices_DP1_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 1 and side A

Field Name	Type	Shape	Units	Summary
theDeadRowIndices_DP1_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 1 and side B
theDeadRowIndices_DP2_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 2 and side A
theDeadRowIndices_DP2_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 2 and side B
theDeadRowIndices_DP3_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 3 and side A
theDeadRowIndices_DP3_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 3 and side B
theDeadRowIndices_DP4_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 4 and side A
theDeadRowIndices_DP4_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 4 and side B
theDeadRowIndices_DP5_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 5 and side A
theDeadRowIndices_DP5_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 5 and side B
theDeadRowIndices_DP6_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 6 and side A
theDeadRowIndices_DP6_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 6 and side B
theDeadRowIndices_DP7_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 7 and side A
theDeadRowIndices_DP7_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 7 and side B
theDeadRowIndices_DP8_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 8 and side A
theDeadRowIndices_DP8_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 8 and side B
theDeadRowIndices_DP9_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 9 and side A
theDeadRowIndices_DP9_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 9 and side B
theDeadRowIndices_DP10_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 10 and side A

Field Name	Type	Shape	Units	Summary
theDeadRowIndices_DP10_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 10 and side B
theDeadRowIndices_DP11_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 11 and side A
theDeadRowIndices_DP11_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 11 and side B
theDeadRowIndices_DP12_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 12 and side A
theDeadRowIndices_DP12_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 12 and side B
theDeadRowIndices_DP13_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 13 and side A
theDeadRowIndices_DP13_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 13 and side B
theDeadRowIndices_DP14_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 14 and side A
theDeadRowIndices_DP14_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 14 and side B
theDeadRowIndices_DP15_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 15 and side A
theDeadRowIndices_DP15_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 15 and side B
theDeadRowIndices_DP16_SideA	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 16 and side A
theDeadRowIndices_DP16_SideB	uint16	unlimited	unitless	Array of the detector row indices indicating dead rows for band 16 and side B

Table D.1-13 Description of Q_TableBand1 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand1SecondOrderCoefficient	double	2 x 676 x 3	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 1 per instrument side, detector columns, and detector rows

Table D.1-14 Description of Q_TableBand2 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand2SecondOrderCoefficient	double	2 x 1460 x 3	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 2 per instrument side, detector columns, and detector rows

Table D.1-15 Description of Q_TableBand3 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand3SecondOrderCoefficient	Doubl e	2 x 676 x 3	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 2 per instrument side, detector rows, and detector columns

Table D.1-16 Description of Q_TableBand4 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand4SecondOrderCoefficient	Doubl e	2 x 372 x 6	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 4 per instrument side, detector rows, and detector columns

Table D.1-17 Description of Q_TableBand5 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand5SecondOrderCoefficient	double	2 x 676 x 6	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 5 per instrument side, detector rows, and detector columns

Table D.1-18 Description of Q_TableBand6 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand6SecondOrderCoefficient	double	2 x 372 x 6	W m-2 sr-1 um-1 count-2	Quadratic coefficients in detector response model for Band 6 per instrument side, detector rows, and detector columns

Table D.1-19 Description of Q_TableBand7 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand7SecondOrderCoefficient	double	2 x 332 x 6	mW m-2 sr-1 (cm-	Quadratic coefficients in detector response model for Band 7 per

Field Name	Type	Shape	Units	Summary
			1)-1 count-2	instrument side, detector rows, and detector columns

Table D.1-20 Description of Q_TableBand8 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand8SecondOrderCoefficient	double	2 x 332 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 8 per instrument side, detector rows, and detector columns

Table D.1-21 Description of Q_TableBand9 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand9SecondOrderCoefficient	double	2 x 332 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 9 per instrument side, detector rows, and detector columns

Table D.1-22 Description of Q_TableBand10 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand10SecondOrderCoefficient	Double	2 x 332 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 10 per instrument side, detector rows, and detector columns

Table D.1-23 Description of Q_TableBand11 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand11SecondOrderCoefficient	double	2 x 332 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 11 per instrument side, detector rows, and detector columns

Table D.1-24 Description of Q_TableBand12 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand12SecondOrderCoefficient	double	2 x 332 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 12 per instrument side, detector rows, and detector columns

Table D.1-25 Description of Q_TableBand13 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand13SecondOrderCoefficient	double	2 x 408 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 13 per instrument side, detector rows, and detector columns

Table D.1-26 Description of Q_TableBand14 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand14SecondOrderCoefficient	double	2 x 408 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 14 per instrument side, detector rows, and detector columns

Table D.1-27 Description of Q_TableBand15 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand15SecondOrderCoefficient	double	2 x 408 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 15 per instrument side, detector rows, and detector columns

Table D.1-28 Description of Q_TableBand16 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand	int64	*scalar*	unitless	ABI band ID number
theBand16SecondOrderCoefficient	double	2 x 408 x 6	mW m-2 sr-1 (cm-1)-1 count-2	Quadratic coefficients in detector response model for Band 16 per instrument side, detector rows, and detector columns

Table D.1-29 Description of RadianceLUT_Band7 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand7_RadianceLUT	double	2 x 33901	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 7 (mW m-2 sr-1 (cm-1)-1)

Table D.1-30 Description of RadianceLUT_Band8 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand8_RadianceLUT	double	2 x 25901	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 8 (mW m-2 sr-1 (cm-1)-1)

Table D.1-31 Description of RadianceLUT_Band9 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand9_RadianceLUT	double	2 x 26001	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 9 (mW m-2 sr-1 (cm-1)-1)

Table D.1-32 Description of RadianceLUT_Band10 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand10_RadianceLUT	double	2 x 26101	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 10 (mW m-2 sr-1 (cm-1)-1)

Table D.1-33 Description of RadianceLUT_Band11 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand11_RadianceLUT	double	2 x 27301	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 11 (mW m-2 sr-1 (cm-1)-1)

Table D.1-34 Description of RadianceLUT_Band12 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand12_RadianceLUT	double	2 x 26401	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 12 (mW m-2 sr-1 (cm-1)-1)

Table D.1-35 Description of RadianceLUT_Band13 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand13_RadianceLUT	double	2 x 27601	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 13 (mW m-2 sr-1 (cm-1)-1)

Table D.1-36 Description of RadianceLUT_Band14 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand14_RadianceLUT	double	2 x 27701	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 14 (mW m-2 sr-1 (cm-1)-1)

Table D.1-37 Description of RadianceLUT_Band15 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand15_RadianceLUT	double	2 x 27901	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 15 (mW m-2 sr-1 (cm-1)-1)

Table D.1-38 Description of RadianceLUT_Band16 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand16_RadianceLUT	double	2 x 26901	various	Lookup table of temperature (K) vs. channel average spectral radiance for band 16 (mW m-2 sr-1 (cm-1)-1)

Table D.1-39 Description of ABI_ICM_ConversionConsts Processing Parameters

Field Name	Type	Shape	Units	Summary
theCentigradeToKelvinShift	double	*scalar*	K	The temperature reference value in Kelvin corresponding to 0° C
thePRT2_WithFlexTransitionValue	double	*scalar*	unitless	The threshold transition value for determining calibration equation parameters for TLM ID=34-35 in PRT sensor group 2
thePRT2_SansFlexTransitionValue	double	*scalar*	unitless	The threshold transition value for determining calibration equation parameters for TLM ID=36-47 in PRT sensor group 2
theSteinhartHartNumerator	double	*scalar*	ohms	The scale value for computing resistance from digital numbers for TLM ID=64-79 in thermistor group 1
theSteinhartHartSubtrahend	double	*scalar*	ohms	The offset value for computing resistance from digital numbers for TLM ID=64-79 in thermistor group 1
theDiodeTransitionValue	double	*scalar*	volts	The threshold transition value for determining calibration equation parameters for TLM ID=96-98 in diode sensor group
theDiodeMultiplicand	double	*scalar*	unitless	The scale value for the Vdiode on P&TC CCA to compute the scaling parameter for determining the input to the calibration equation
theDiodeAddend	double	*scalar*	unitless	The scale value for the Vdiode on P&TC CCA to compute the offset parameter for determining the input to the calibration equation

Table D.1-40 Description of ABI_ICM_SensorCoefficients Processing Parameters

Field Name	Type	Shape	Units	Summary
prt_4_wire_side_a_calibrating_resistance_pair	double	2	ohms	The low and high resistance values for calibrating the 4-wire PRT sensor group (TLM ID=2-13) for side A
prt_4_wire_side_b_calibrating_resistance_pair	double	2	ohms	The low and high resistance values for calibrating the 4-wire PRT sensor group (TLM ID=2-13) for side B
prt1_calibrating_resistance_pair	double	2	ohms	The low and high resistance values for calibrating the PRT group 1 sensors (TLM ID=16-31)
prt2_calibrating_resistance_pair	double	2	ohms	The low and high resistance values for calibrating the PRT group 2 sensors (TLM ID=34-47)

Field Name	Type	Shape	Units	Summary
rtd_calibrating_resistance_pair	double	2	ohms	The low and high resistance values for calibrating the RTD group 1 sensors (TLM ID=16-31)
diode_v0_array	double	2	volts	The measured value of the Vdiode on P&TC CCA for calibrating the diode sensor group (TLM ID=96-98) for both instrument sides
prt_4_wire_coefficients_array	double	12 x 6	various	The set of calibration coefficients for each of the 12 sensors in the 4-wire PRT group (TLM ID=2-13) containing the A, B, and R0 values for side A and the A, B, and R0 values for side B from the calibration equation
prt1_coefficients_array	double	10 x 3	various	The set of calibration coefficients for each of the 10 sensors in the PRT1 group (TLM ID=16-31) containing the A, B, and C values from the calibration equation
prt2_coefficients_array	double	3 x 8	various	The set of calibration coefficients for each of the 3 sets of sensors in the PRT2 group (TLM ID=34, 35, and 36-47) containing the A, B, and C values for below the transition threshold, the A, B, and C values for above the transition threshold, and the flex resistance values for side A and side B
rtd_coefficients_array	double	6 x 3	various	The set of calibration coefficients for each of the 6 sensors in the RTD group (TLM ID = 56-61) containing the A, B, and C values
thermistor1_coefficients_array	double	9 x 3	various	The set of calibration coefficients for each of the 9 sensors in the Thermistor 1 group (TLM ID=66-70,71-74) containing the A, B, and C values from the calibration equation
thermistor2_coefficients_array	double	9 x 3	various	The set of calibration coefficients for each of the 9 sensors in the Thermistor 2 group (TLM ID=83-85,88-93) containing the A, B, and C values from the calibration equation
diode_coefficients_array	double	3 x 16	various	The set of calibration coefficients for each of the three sensors in the Diode sensor group (TLM ID=96-98) containing the A, B, C, and D values for below the transition threshold and the A, B, C, and D values for above the transition threshold for side A and the same 8 parameters for side B

D.2 SUVI Instrument Calibration Parameters

The documentation of the SUVI L1b Cal INR data file is consistent with the HDF5 file (SUVI_CalINR.h5). The SUVI L1b Cal INR processing parameters are documented in Table D.2-1.

Additional notes:

- A bad column parameter file was not received in instrument vendor provided deliveries. As such, it is assumed that no bad columns have been identified for the GOES-R SUVI instrument. Accordingly, the SUVI_BAD_COL parameter has been populated with fill values.
- Processing parameters associated with contamination correction (shown below) are expected to be updated during the GOES-R PLT time period.
    - THICK_COEF284, THICK_COEF304, WEIGHT284, WEIGHT304, EXT_COEF
- Dimensions identified in the "Shape" column are described in the "Summary" column.

The SUVI Product Performance (PP) Cal INR processing parameters are contained within the same HDF5 file as the SUVI L1b processing parameters (SUVI_CalINR.h5). The documentation of the SUVI PP Cal INR data file is consistent with the HDF5 file created based primarily on processing parameter values provided by the instrument vendor. The SUVI PP Cal INR processing parameters are documented in Table D.2-2.

Table D.2-1 Description of SUVI L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
AS_HI	uint32	6	count	Aperture selector encoder counts upper limits for positions 0-5
AS_LOW	uint32	6	count	Aperture selector encoder counts lower limits for positions 0-5
CCD_TEMP1_WEIGHT	double	*scalar*	unitless	Weight to use when calculating mean CCD temperature
CCD_TEMP2_WEIGHT	double	*scalar*	unitless	Weight to use when calculating mean CCD temperature
CMD_EXP_CONV	double	*scalar*	second/ millisecond	Scale factor to convert commanded exposure time from milliseconds to seconds
CONVERT_GAINS	double	14	unitless	Gain coefficients for the 14 SUVI image types; used to scale final pixel radiance values from floating point precision to 16 bit integers
CONVERT_OFFSETS	double	14	unitless	Offset coefficients for the 14 SUVI image types; used to scale final pixel radiance values from floating point precision to 16 bit integers

Field Name	Type	Shape	Units	Summary
DAY_THRESH	uint32	*scalar*	second	Number of days allowed to use dark frames
ENTRANCE_FILTER_TRANSMISSION	double	6	unitless	Entrance filter transmission table indexed by aperture selector position (wavelength)
EUVS_DAYS	uint32	*scalar*	day	The number of previous daily EUVS irradiances required for the SUVI-EXIS cross-calibration analysis
EXP_THRESH	double	*scalar*	unitless	Time allowance (percentage) in determining short vs. long image exposure time
EXP_TIME_CONV	double	*scalar*	second/ microsecond	Scale factor to convert actual exposure time from microseconds to seconds
EXT_COEF	double	6	unitless	The extinction coefficients for each wavelength used to determine the SUVI signal loss for a given contamination thickness
FLAT_FIELD0	float	1280 x 1280	count	94 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combinations
FLAT_FIELD1	float	1280 x 1280	count	94 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; second filter wheel combination
FLAT_FIELD2	float	1280 x 1280	count	131 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combination
FLAT_FIELD3	float	1280 x 1280	count	131 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; second filter wheel combination
FLAT_FIELD4	float	1280 x 1280	count	171 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combination
FLAT_FIELD5	float	1280 x 1280	count	171 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; second filter wheel combination
FLAT_FIELD6	float	1280 x 1280	count	195 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combination
FLAT_FIELD7	float	1280 x 1280	count	195 Å composite flat field image corrects for vignetting and pixel to pixel variations

Field Name	Type	Shape	Units	Summary
				in response; second filter wheel combination
FLAT_FIELD8	float	1280 x 1280	count	284 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combination
FLAT_FIELD9	float	1280 x 1280	count	284 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; second filter wheel combination
FLAT_FIELD10	float	1280 x 1280	count	304 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; first filter wheel combination
FLAT_FIELD11	float	1280 x 1280	count	304 Å composite flat field image corrects for vignetting and pixel to pixel variations in response; second filter wheel combination
FOCAL_PLANE_FILTER1_ TRANSMISSION	double	6 x 5	unitless	Focal plane filter transmission table indexed by aperture selector position and filter wheel 1 position
FOCAL_PLANE_FILTER2_ TRANSMISSION	double	6 x 5	unitless	Focal plane filter transmission table indexed by aperture selector position and filter wheel 1 position
FW1_HI	uint32	5	count	Filter wheel 1 encoder counts upper limits for positions 0-4
FW1_LOW	uint32	5	count	Filter wheel 1 encoder counts lower limits for positions 0-4
FW1_NAMES	string	5	unitless	String names identifying filters on filter wheel 1.
FW2_HI	uint32	5	count	Filter wheel 2 encoder counts upper limits for positions 0-4
FW2_LOW	uint32	5	count	Filter wheel 2 encoder counts lower limits for positions 0-4
FW2_NAMES	string	5	unitless	String names identifying filters on filter wheel 2.
GAIN_TEMP	double	61	degrees_C	List of temperatures used to index amplifier gain tables
IMG_TYPE_FLT	double	15 x 5	various	Table that defines SUVI image types; col1=enum image type (unitless),

Field Name	Type	Shape	Units	Summary
				col2=aperture selector pos (unitless), col3=exposure (second), col4=FW1 pos (unitless), col5=FW2 pos (unitless)
IMG_TYPE_STR	string	15	unitless	Array of string descriptions corresponding to entries in image type table.
LONG_EXP_TIME	double	*scalar*	second	Nominal long exposure time
MIN_GAIN_TEMP	double	*scalar*	degrees_C	Lowest temperature in either the left or right CCD gain tables
MIRROR_REFLECT_PRIMARY	double	6	unitless	Primary mirror reflectance table indexed by aperture selector position (wavelength)
MIRROR_REFLECT_SECONDARY	double	6	unitless	Secondary mirror reflectance table indexed by aperture selector position (wavelength)
NUM_COLS	int32	*scalar*	unitless	Number of image columns after overscan region removal
NUM_DARK_FRAMES	int32	*scalar*	unitless	Number of dark frames needed to calculate median dark image
NUM_ROWS	int32	*scalar*	unitless	Number of image rows after overscan region removal
OVERSCAN_LEAD_COLS	int32	*scalar*	unitless	Number of overscan columns on leading image edge
OVERSCAN_LEAD_ROWS	int32	*scalar*	unitless	Number of overscan rows on leading image edge
OVERSCAN_TRAIL_COLS	int32	*scalar*	unitless	Number of overscan columns on trailing image edge
OVERSCAN_TRAIL_ROWS	int32	*scalar*	unitless	Number of overscan rows on trailing image edge
PHOT_ELEC_CONVERSION	double	6	electron photon-1	Electron to photon conversion factor table indexed by aperture selector position (wavelength)
PHOT_ENG_CONVERSION	double	6	joule	Photon energy conversion table indexed by aperture selector position (wavelength)
PIX_BUFF	int32	*scalar*	pixel	Pixel buffer to avoid edge effects when calculating bias
PIXEL_FILL_VALUE	int16	*scalar*	unitless	Pixel value used if a valid pixel radiance cannot be calculated

Field Name	Type	Shape	Units	Summary
SAT_THRESH	double	*scalar*	count	Threshold value to determine saturated pixels; 95% full well capacity
SHORT_EXP_TIME	double	*scalar*	second	Nominal short exposure time
SNR	double	*scalar*	count	Signal to noise ratio
SOLID_ANG	double	*scalar*	steradian	Extent of the field of view for each CCD pixel
SUVI_BAD_COL	uint32	SUVI_NUM_ BAD_COL x 3	unitless	Column locations of bad SUVI columns and up to 2 good neighboring columns
SUVI_BAD_PIXELS	uint32	SUVI_NUM_BAD_ PIXELS x 9 x 2	unitless	Row and column locations of bad SUVI pixels and up to 8 good neighboring pixels
SUVI_BAD_UNDEFINED	int32	*scalar*	unitless	Undefined row or column value in the SUVI bad pixel or column tables
SUVI_GAIN_ CONSTANT_LEFT	double	61	electron count-1	Left readout amplifier, per-pixel electron to DN gain table indexed by CCD temperature (GAIN_TEMP)
SUVI_GAIN_ CONSTANT_RIGHT	double	61	electron count-1	Right readout amplifier, per-pixel electron to DN gain table indexed by CCD temperature (GAIN_TEMP)
SUVI_GEOM_AREA	double	*scalar*	m2	Physical area of SUVI data collection surface
SUVI_LINEARITY	double	16384	unitless	Per-pixel non-linearity correction table indexed by DN
SUVI_NUM_BAD_COL	int32	*scalar*	unitless	Number of columns in bad column list (SUVI_BAD_COL)
SUVI_NUM_BAD_PIXELS	int32	*scalar*	unitless	Number of pixels in bad pixel list (SUVI_BAD_PIXELS)
SUVI_QE	double	6	unitless	Quantum efficiency table indexed by aperture selector position (wavelength)
TEMP_THRESH	double	*scalar*	degrees_C	CCD temperature threshold for determining valid dark frames
TEMP1_COEF	double	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C per count to the power of 0 through 5

Field Name	Type	Shape	Units	Summary
TEMP2_COEF	double	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C per count to the power of 0 through 5
THICK_COEF284	double	*scalar*	unitless	The coefficient for 284 Å contamination thickness
THICK_COEF304	double	*scalar*	unitless	The coefficient for 304 Angstroms contamination thickness
WAVELENGTH_OFFSET	double	6	angstrom	SUVI measurement wavelengths
WEIGHT284	double	*scalar*	unitless	The weighting coefficient for the 284 Angstroms contamination thickness
WEIGHT304	double	*scalar*	unitless	The weighting coefficient for the 304 Angstroms contamination thickness

Table D.2-2 Description of SUVI Product Performance Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
T_CCD_HTR_PTR_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C /count to the power of 0 through 5
T_CCD_HTR_PTR_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C /count to the power of 0 through 5
T_CEB_INTERNAL_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C /count to the power of 0 through 5
T_CEB_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C /count to the power of 0 through 5
T_CEB_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_DOOR_MECH_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units;

Field Name	Type	Shape	Units	Summary
				units are degrees_C /count to the power of 0 through 5
T_DOOR_MECH_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_FRONT_AP_HOUSING_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_FRONT_AP_HOUSING_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_FW_HOUSING_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_FW_HOUSING_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_GT_AFT_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_GT_AFT_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_GT_FORWARD_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_GT_FORWARD_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_PRI_MIRROR_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5

Field Name	Type	Shape	Units	Summary
T_PRI_MIRROR_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_BASE_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_BASE_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_CPU_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_CPU_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_POWER_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_POWER_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_TOP_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEB_TOP_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEC_MIRROR_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SEC_MIRROR_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units;

Field Name	Type	Shape	Units	Summary
				units are degrees_C/count to the power of 0 through 5
T_SHUTTER_HOUSING_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SHUTTER_HOUSING_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SPIDER_PRI_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
T_SPIDER_RED_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_DUMP_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_GATE1_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_GATE2_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_JFET_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_OUTDRAIN_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_REF_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5

Field Name	Type	Shape	Units	Summary
V_CCD_BIAS_RESET_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5
V_CCD_BIAS_SUBSTRATE_COEF	float	6	various	Polynomial coefficients to convert temperature from DN to engineering units; units are degrees_C/count to the power of 0 through 5

D.3 EXIS Instrument Calibration Parameters

The current design of the Harris GOES-R Core-GS system divides the EXIS processing into two computer software components (CSCs): the EXIS L1b Algorithm CSC and the EUVS L1b Algorithm CSC. The EXIS L1b Algorithm CSC generates the product data required for production of the Solar Flux: X-Ray product data and the EUVS L1b Algorithm CSC generates the product data and block-level metadata required for production of the Solar Flux: EUV Product Data. Each Cal INR file contains a top-level HDF group matching the filename without the .h5 extension. Table D.3-1 lists the complete set of HDF5 data files used for the EXIS and EUVS L1b radiometric calibration data objects.

Table D.3-1 List of All Cal INR HDF5 Files Used by the EXIS and EUVS L1b Algorithms

EXIS L1b Algorithm Parameters	EUVS L1b Algorithm Parameters	Common Parameters
SPS_Cal_INR.h5	EUVSA_Cal_INR.h5	1AU_Correction_Data.h5
XRS_Cal_INR.h5	EUVSB_Cal_INR.h5	
	EUVSC_Cal_INR.h5	
	ESPEC_Cal_INR.h5	

Additional notes:

- Dimensions identified in the "Shape" column are described in the "Summary" column.

Table D.3-2 Description of SPS_Cal_INR Processing Parameters

Field Name	Type	Shape	Units	Summary
n_diodes	uint16		unitless	Total number of SPS diodes
nDays	uint16	*scalar*	unitless	Number of days in the SPS in-flight gain correction table
nAngles	uint16	*scalar*	unitless	Number of angles in the SPS field-of-view correction tables
n_temp_dn	uint32	*scalar*	unitless	Number of sample count values
n_linear	uint32	*scalar*	unitless	Number of samples in the SPS linearity correction table
sps_inval_good	uint8	*scalar*	unitless	Invalid flag value indicating good status
sps_inval_edac	uint8	*scalar*	unitless	Invalid flag value for EDAC single bit error corrected status
int_time_good	uint16	*scalar*	count	Integration time step in units of counts corresponding to good value
min_det_chg	uint16	*scalar*	count	Minimum number of detector change count required for processing valid data
diode_layout	uint16	6	unitless	Array mapping the identity of the SPS diodes
integration_scale	float	*scalar*	s count-1	Integration time scale factor
integration_offset	float	*scalar*	count	Integration time offset value
integration_delta	float	*scalar*	s	Integration time shift value
temperature_tableA	float	65536	degrees_C	Array for converting counts to temperature for power side A
temperature_tableB	float	65536	degrees_C	Array for converting counts to temperature for power side B

Field Name	Type	Shape	Units	Summary
low_temp_threshold	float	*scalar*	count	Detector board low temperature threshold
high_temp_threshold	float	*scalar*	count	Detector board high temperature threshold
preflight_gain	float	65536 x 6	coulomb count-1	Pre-flight gain coefficients for each detector temperature count and each SPS diode
convert_sec_days	float	*scalar*	day s-1	Conversion factor from seconds to Julian days since the J2K epoch
gain_factor_time	double	4	day	Array of validity times in Julian days since J2K epoch for the time-dependent gain correction factors
gain_factor_value	float	4 x 6	unitless	Table of time-dependent gain correction factor values for each day in gain_factor_time and each SPS diode
gain_linearity_dn	uint32	100	count	Array of count values for each gain linearity correction value
gain_linearity_value	float	100 x 6	unitless	Table of gain linearity correction values for each count value and SPS diode
electrometer_table	float	6	count	Array of electrometer signal value for each SPS diode
thermal_dark_a	float	65536 x 6	count	Table of thermal dark signal from each count value and each SPS diode for power side A
thermal_dark_b	float	65536 x 6	count	Table of thermal dark signal from each count value and each SPS diode for power side B
total_signal_threshold	float	*scalar*	count	Minimum total signal threshold for determining if SPS sensor line-of-sight is within acceptable range of pointing angles
angle_index	float	*scalar*	amp	Parameter used to compute the angle table indices
alpha_angle_table	float	2001	degrees	Alpha angle conversion table from normalized values to degrees
beta_angle_table	float	2001	degrees	Beta angle conversion table from normalized values to degrees

Table D.3-3 Description of XRS_Cal_INR Processing Parameters

Field Name	Type	Shape	Units	Summary
n_diodes	uint16	*scalar*	unitless	Number of XRS diodes
n_ident	uint16	*scalar*	unitless	Number of diode layout table columns
n_days	uint16	*scalar*	unitless	Number of days in the XRS in-flight gain correction table
n_angles	uint16	*scalar*	unitless	Number of angles in the field-of-view correction tables
n_temp_dn	uint32	*scalar*	unitless	Number of sample count values
n_linear	uint32	*scalar*	unitless	Number of samples in XRS linearity correction table
processing_interval	float	*scalar*	s	XRS algorithm processing time interval
dark_diode_interval	float	*scalar*	s	XRS algorithm dark diode history interval

Field Name	Type	Shape	Units	Summary
xrs_inval_good	uint8	*scalar*	unitless	Invalid flag value indicating good status
xrs_inval_edac	uint8	*scalar*	unitless	Invalid flag value for EDAC single bit error corrected status
xrs_inval_flatfield	uint8	*scalar*	unitless	Invalid flag value for flatfield chirp on status
min_alpha_bad	float	*scalar*	degrees	Minimum bad dispersion angle threshold
max_alpha_bad	float	*scalar*	degrees	Maximum bad dispersion angle threshold
min_alpha_degrade	float	*scalar*	degrees	Minimum degraded dispersion angle threshold
max_alpha_degrade	float	*scalar*	degrees	Maximum degraded dispersion angle threshold
min_alpha_warn	float	*scalar*	degrees	Minimum warning dispersion angle threshold
max_alpha_warn	float	*scalar*	degrees	Maximum warning dispersion angle threshold
min_beta_bad	float	*scalar*	degrees	Minimum bad cross-dispersion angle threshold
max_beta_bad	float	*scalar*	degrees	Maximum bad cross-dispersion angle threshold
min_beta_degrade	float	*scalar*	degrees	Minimum degraded cross-dispersion angle threshold
max_beta_degrade	float	*scalar*	degrees	Maximum degraded cross-dispersion angle threshold
min_beta_warn	float	*scalar*	degrees	Minimum warning cross-dispersion angle threshold
max_beta_warn	float	*scalar*	degrees	Maximum warning cross-dispersion angle threshold
int_time_good	uint16	*scalar*	count	Integration time step in counts corresponding to good value
min_det_chg	uint16	*scalar*	count	Minimum detector change count required for processing valid data
diode_layout	uint16	12 x 2	unitless	Table mapping the diodes for ASIC1 and ASIC2
integration_scale	float	*scalar*	s count-1	XRS integration time scale factor
integration_offset	float	*scalar*	count	XRS integration time offset value
integration_delta	float	*scalar*	s	XRS integration time delta value
temperature_tableA	float	65536	degrees_C	Array for converting counts to temperature for power side A
temperature_tableB	float	65536	degrees_C	Array for converting counts to temperature for power side B
low_temp_threshold	float	*scalar*	count	XRS detector board low temperature threshold
high_temp_threshold	float	*scalar*	count	XRS detector board high temperature threshold
xrsa1_saturation	float	*scalar*	count	XRS-A solar minimum diode saturation threshold
xrsa2_saturation	float	*scalar*	count	XRS-A solar maximum diode saturation threshold
xrsb1_saturation	float	*scalar*	count	XRS-B solar minimum diode saturation threshold

Field Name	Type	Shape	Units	Summary
xrsb2_saturation	float	*scalar*	count	XRS-B solar maximum diode saturation threshold
xrsa1_low_threshold	float	*scalar*	amp	XRS-A solar minimum diode dark-corrected current threshold
xrsa2_low_threshold	float	*scalar*	amp	XRS-A solar maximum diode dark-corrected current threshold
xrsb1_low_threshold	float	*scalar*	amp	XRS-B solar minimum diode dark-corrected current threshold
xrsb2_low_threshold	float	*scalar*	amp	XRS-B solar maximum diode dark-corrected current threshold
preflight_gain	float	65536 x 12	coulomb count-1	Table of XRS pre-flight gain coefficients for each temperature count value and each diode
convert_sec_days	float	*scalar*	day s-1	Conversion factor from seconds to Julian days since the J2K epoch
gain_factor_time	double	4	day	Array of validity times in Julian days since J2K epoch for the time-dependent gain correction factors
gain_factor_value	float	4 x 12	unitless	Table of time-dependent gain correction factor values for each day in gain_factor_time and each XRS diode
gain_linearity_dn	uint32	100	count	Array of count values for each gain linearity correction value
gain_linearity_value	float	100 x 12	unitless	Table of gain linearity correction values for each linearity count value and XRS diode
electrometer_table	float	12	count	Array of electrometer signal value for each XRS diode
thermal_dark_asic1_a	float	65536 x 12	count	Table of XRS thermal dark signal for each count value and each XRS diode based on ASCI1 detector temperature for power side A
thermal_dark_asic1_b	float	65536 x 12	count	Table of XRS thermal dark signal for each count value and each XRS diode based on ASCI1 detector temperature for power side B
thermal_dark_asic2_a	float	65536 x 12	count	Table of XRS thermal dark signal for each count value and each XRS diode based on ASCI2 detector temperature for power side A
thermal_dark_asic2_b	float	65536 x 12	count	Table of XRS thermal dark signal for each count value and each XRS diode based on ASCI2 detector temperature for power side B
dark_weight1	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 1 to radiation dark current
dark_weight2	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 2 to radiation dark current
dark_scaling	float	12	unitless	Array of XRS dark current scaling factors for each diode
xrsa1_responsivity	float	*scalar*	amp W-1 m2	XRS-A solar minimum responsivity
xrsa2_responsivity	float	*scalar*	amp W-1 m2	XRS-A solar maximum responsivity

Field Name	Type	Shape	Units	Summary
xrsb1_responsivity	float	*scalar*	amp W-1 m2	XRS-B solar minimum responsivity
xrsb2_responsivity	float	*scalar*	amp W-1 m2	XRS-B solar maximum responsivity
fov_alpha_lut	float	5	degrees	Array of XRS field-of-view dispersion angles
fov_beta_lut	float	5	degrees	Array of XRS field-of-view cross-dispersion angles
fov_xrsa_min	float	5 x 5	unitless	Table of XRS-A solar minimum field-of-view correction factors as a function of field-of-view dispersion and cross-dispersion angles
fov_xrsa_max	float	5 x 5	unitless	Table of XRS-A solar maximum field-of-view correction factors as a function of field-of-view dispersion and cross-dispersion angles
fov_xrsb_min	float	5 x 5	unitless	Table of XRS-B solar minimum field-of-view correction factors as a function of field-of-view dispersion and cross-dispersion angles
fov_xrsb_max	float	5 x 5	unitless	Table of XRS-B solar maximum field-of-view correction factors as a function of field-of-view dispersion and cross-dispersion angles
xrsa_threshold	float	*scalar*	W m-2	XRS-A irradiance threshold for determining primary irradiance
xrsb_threshold	float	*scalar*	W m-2	XRS-B irradiance threshold for determining primary irradiance

Table D.3-4 Description of EUVSA_Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
nDiodes	uint16	*scalar*	unitless	Number of EUVS-A diodes
nIdent	uint16	*scalar*	unitless	Number of diode layout table columns
nSolLines	uint16	*scalar*	unitless	Number of EUVS-A solar emission lines
nFilter	uint16	*scalar*	unitless	Number of acceptable EUVS-A filter wheel positions for unobstructed solar observation
nDays	uint16	*scalar*	unitless	Number of days in the EUVS-A in-flight gain correction table
nLinear	uint32	*scalar*	unitless	Number of samples in EUVS-A linearity correction table
nTempDN	uint32	*scalar*	unitless	Number of sample count values
nAngles	uint16	*scalar*	unitless	Number of angles in the field-of-view correction tables
nPoly	uint16	*scalar*	unitless	Number of polynomial coefficients used to evaluate the EUVS-A flatfield and degradation corrections for each diode
nCoefs	uint16	*scalar*	unitless	Total number of polynomial coefficients for all diodes

Field Name	Type	Shape	Units	Summary
processing_interval	float	*scalar*	s	EUVS-A algorithm processing time interval
dark_diode_interval	float	*scalar*	s	EUVS-A algorithm dark diode history interval
filter_sun_position	uint16	24	unitless	Array of EUVS-A filter wheel absolute step numbers indicating the acceptable filter positions for solar measurements
door_close_position	uint16	*scalar*	unitless	EUVS-A door absolute step number indicating the door is closed
euv_inval_good	uint8	*scalar*	unitless	Invalid flag value indicating good status
euv_inval_edac	uint8	*scalar*	unitless	Invalid flag value for EDAC single bit error corrected status
euv_inval_flatfield	uint8	*scalar*	unitless	Invalid flag value for flatfield chirp on status
min_alpha_bad	float	*scalar*	degrees	Minimum bad dispersion angle threshold
max_alpha_bad	float	*scalar*	degrees	Maximum bad dispersion angle threshold
min_alpha_degrade	float	*scalar*	degrees	Minimum degraded dispersion angle threshold
max_alpha_degrade	float	*scalar*	degrees	Maximum degraded dispersion angle threshold
min_alpha_warn	float	*scalar*	degrees	Minimum warning dispersion angle threshold
max_alpha_warn	float	*scalar*	degrees	Maximum warning dispersion angle threshold
min_beta_bad	float	*scalar*	degrees	Minimum bad cross-dispersion angle threshold
max_beta_bad	float	*scalar*	degrees	Maximum bad cross-dispersion angle threshold
min_beta_degrade	float	*scalar*	degrees	Minimum degraded cross-dispersion angle threshold
max_beta_degrade	float	*scalar*	degrees	Maximum degraded cross-dispersion angle threshold
min_beta_warn	float	*scalar*	degrees	Minimum warning cross-dispersion angle threshold
max_beta_warn	float	*scalar*	degrees	Maximum warning cross-dispersion angle threshold
int_time_good	uint16	*scalar*	count	Integration time step in counts corresponding to good value
min_det_chg_count	uint16	*scalar*	count	Minimum detector change count required for processing valid data
diode_layout	uint16	24 x 2	unitless	Table mapping the EUVS-A diodes to ASIC number and solar line
integration_scale	float	*scalar*	s count-1	EUVS-A integration time scale factor
integration_offset	float	*scalar*	count	EUVS-A integration time offset value
integration_delta	float	*scalar*	s	EUVS-A integration time delta value
temperature_tableA	float	65536	degrees_C	Array for converting counts to temperature for power side A
temperature_tableB	float	65536	degrees_C	Array for converting counts to temperature for power side B
low_temp_threshold	float	*scalar*	count	EUVS-A detector board low temperature threshold

Field Name	Type	Shape	Units	Summary
high_temp_threshold	float	*scalar*	count	EUVS-A detector board high temperature threshold
mask	uint8	24	unitless	Array specifying the diodes to use in solar line processing
saturation_256	float	*scalar*	count	Saturation threshold for the EUVS-A 25.6-nm solar line diode signals
saturation_284	float	*scalar*	count	Saturation threshold for the EUVS-A 28.4-nm solar line diode signals
saturation_304	float	*scalar*	count	Saturation threshold for the EUVS-A 30.4-nm solar line diode signals
low_current_256	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-A 25.6-nm solar line diodes
low_current_284	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-A 28.4-nm solar line diodes
low_current_304	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-A 30.4-nm solar line diodes
preflight_gain	float	65536 x 24	coulomb count-1	Table of EUVS-A pre-flight gain coefficients for each temperature count value and each diode
convert_sec_days	float	*scalar*	day s-1	Conversion factor from seconds to Julian days since the J2K epoch
gain_factor_time	double	4	day	Array of validity times in Julian days since J2K epoch for the time-dependent gain correction factors
gain_factor_value	float	4 x 24	unitless	Table of time-dependent gain correction factor values for each day in gain_factor_time and each EUVS-A diode
gain_linearity_dn	uint32	100	count	Array of count values for each gain linearity correction value
gain_linearity_value	float	100 x 24	unitless	Table of gain linearity correction values for each linearity count value and EUVS-A diode
flatfield_time	double	4	day	Array of validity times in Julian days for the flatfield correction polynomial coefficients
flatfield_correction	float	4 x 120	unitless	Table containing the polynomial coefficient for computing the flatfield correction for each day and for the set of 5 coefficients for each diode
electrometer_table	float	24	count	Array of electrometer signal value for each EUVS-A diode
thermalTableA	float	65536 x 24	count	Table of EUVS-A thermal dark signal for each count value and each XRS diode based on detector temperature for power side A
thermalTableB	float	65536 x 24	count	Table of EUVS-A thermal dark signal for each count value and each XRS diode based on detector temperature for power side B

Field Name	Type	Shape	Units	Summary
dark_weight1	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 1 to radiation dark current
dark_weight2	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 2 to radiation dark current
dark_scaling	float	24	unitless	Array of XRS dark current scaling factors for each diode
scattered_light	float	24	amp	Array of EUVS-A scattered light correction current for each diode
order_sorting	float	24	amp	Array of EUVS-A order sorting correction current for each diode
split_diode_304	uint8	2	unitless	Array containing the diode layout table indices for the EUVS-A 30.4-nm solar line split diodes
responsivity_table	float	24 x 24	amp W-1 m2	Table of EUVS-A sensor responsivity for each acceptable filter wheel position and each diode
fov_alpha_lut	float	5	degrees	Array of EUVS-A field-of-view dispersion angles
fov_beta_lut	float	5	degrees	Array of EUVS-A field-of-view cross-dispersion angles
fov_table_01	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 1 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_02	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 2 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_03	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 3 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_04	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 4 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_05	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 5 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_06	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 6 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_07	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 7 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_08	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 8 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_09	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 9 in the

Field Name	Type	Shape	Units	Summary
				diode layout table as a function of dispersion and cross-dispersion angles
fov_table_10	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 10 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_11	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 11 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_12	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 12 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_13	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 13 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_14	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 14 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_15	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 15 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_16	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 16 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_17	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 17 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_18	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 18 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_19	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 19 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_20	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 20 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_21	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 21 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_22	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 22 in the diode layout table as a function of dispersion and cross-dispersion angles

Field Name	Type	Shape	Units	Summary
fov_table_23	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 23 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_24	float	5 x 5	unitless	Table of EUVS-A field-of-view correction factors for diode 24 in the diode layout table as a function of dispersion and cross-dispersion angles
degradation_time	double	4	day	Array of validity times in Julian days for the degradation correction polynomial coefficients
degradation_correction	float	4 x 120	unitless	Table containing the polynomial coefficient for computing the flatfield correction for each day and for the set of 5 coefficients for each diode

Table D.3-5 Description of EUVSB_Cal_INR Processing Parameters

Field Name	Type	Shape	Units	Summary
nDiodes	uint16	*scalar*	unitless	Number of EUVS-B diodes
nIdent	uint16	*scalar*	unitless	Number of diode layout table columns
nSolLines	uint16	*scalar*	unitless	Number of EUVS-B solar emission lines
nFilter	uint16	*scalar*	unitless	Number of acceptable EUVS-B filter wheel positions for unobstructed solar observation
nDays	uint16	*scalar*	unitless	Number of days in the EUVS-B in-flight gain correction table
nLinear	uint32	*scalar*	unitless	Number of samples in EUVS-B linearity correction table
nTempDN	uint32	*scalar*	unitless	Number of sample count values
nAngles	uint16	*scalar*	unitless	Number of angles in the field-of-view correction tables
nPoly	uint16	*scalar*	unitless	Number of polynomial coefficients used to evaluate the EUVS-B flatfield and degradation corrections for each diode
nCoefs	uint16	*scalar*	unitless	Total number of polynomial coefficients for all diodes
processing_interval	float	*scalar*	s	EUVS-B algorithm processing time interval
dark_diode_interval	float	*scalar*	s	EUVS-B algorithm dark diode history interval
filter_sun_position	uint16	93	unitless	Array of EUVS-B filter wheel absolute step numbers indicating the acceptable filter positions for solar measurements
door_close_position	uint16	*scalar*	unitless	EUVS-B door absolute step number indicating the door is closed
euv_inval_good	uint8	*scalar*	unitless	Invalid flag value indicating good status
euv_inval_edac	uint8	*scalar*	unitless	Invalid flag value for EDAC single bit error corrected status

Field Name	Type	Shape	Units	Summary
euv_inval_flatfield	uint8	*scalar*	unitless	Invalid flag value for flatfield chirp on status
min_alpha_bad	float	*scalar*	degrees	Minimum bad dispersion angle threshold
max_alpha_bad	float	*scalar*	degrees	Maximum bad dispersion angle threshold
min_alpha_degrade	float	*scalar*	degrees	Minimum degraded dispersion angle threshold
max_alpha_degrade	float	*scalar*	degrees	Maximum degraded dispersion angle threshold
min_alpha_warn	float	*scalar*	degrees	Minimum warning dispersion angle threshold
max_alpha_warn	float	*scalar*	degrees	Maximum warning dispersion angle threshold
min_beta_bad	float	*scalar*	degrees	Minimum bad cross-dispersion angle threshold
max_beta_bad	float	*scalar*	degrees	Maximum bad cross-dispersion angle threshold
min_beta_degrade	float	*scalar*	degrees	Minimum degraded cross-dispersion angle threshold
max_beta_degrade	float	*scalar*	degrees	Maximum degraded cross-dispersion angle threshold
min_beta_warn	float	*scalar*	degrees	Minimum warning cross-dispersion angle threshold
max_beta_warn	float	*scalar*	degrees	Maximum warning cross-dispersion angle threshold
int_time_good	uint16	*scalar*	count	Integration time step in counts corresponding to good value
min_det_chg_count	uint16	*scalar*	count	Minimum detector change count required for processing valid data
diode_layout	uint16	24 x 2	unitless	Table mapping the EUVS-B diodes to ASIC number and solar line
integration_scale	float	*scalar*	s count-1	EUVS-B integration time scale factor
integration_offset	float	*scalar*	count	EUVS-B integration time offset value
integration_delta	float	*scalar*	s	EUVS-B integration time delta value
temperature_tableA	float	65536	degrees_C	Array for converting counts to temperature for power side A
temperature_tableB	float	65536	degrees_C	Array for converting counts to temperature for power side B
low_temp_threshold	float	*scalar*	count	EUVS-B detector board low temperature threshold
high_temp_threshold	float	*scalar*	count	EUVS-B detector board high temperature threshold
mask	uint8	24	unitless	Array specifying the diodes to use in solar line processing
saturation_1175	float	*scalar*	count	Saturation threshold for the EUVS-B 117.5-nm solar line diode signals
saturation_1216	float	*scalar*	count	Saturation threshold for the EUVS-B 121.6-nm solar line diode signals
saturation_1335	float	*scalar*	count	Saturation threshold for the EUVS-B 1335-nm solar line diode signals
saturation_1405	float	*scalar*	count	Saturation threshold for the EUVS-B 1405-nm solar line diode signals

Field Name	Type	Shape	Units	Summary
low_current_1175	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-B 117.5-nm solar line diodes
low_current_1216	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-B 121.6-nm solar line diodes
low_current_1335	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-B 133.5-nm solar line diodes
low_current_1405	float	*scalar*	amp	Minimum dark-corrected current amplitude for EUVS-B 140.5-nm solar line diodes
preflight_gain	float	65536 x 24	coulomb count-1	Table of EUVS-B pre-flight gain coefficients for each temperature count value and each diode
convert_sec_days	float	*scalar*	day s-1	Conversion factor from seconds to Julian days since the J2K epoch
gain_factor_time	double	4	day	Array of validity times in Julian days since J2K epoch for the time-dependent gain correction factors
gain_factor_value	float	4 x 24	unitless	Table of time-dependent gain correction factor values for each day in gain_factor_time and each EUVS-B diode
gain_linearity_dn	uint32	100	count	Array of count values for each gain linearity correction value
gain_linearity_value	float	100 x 24	unitless	Table of gain linearity correction values for each linearity count value and EUVS-B diode
flatfield_time	double	4	day	Array of validity times in Julian days for the flatfield correction polynomial coefficients
flatfield_correction	float	4 x 120	unitless	Table containing the polynomial coefficient for computing the flatfield correction for each day and for the set of 5 coefficients for each diode
electrometer_table	float	24	count	Array of electrometer signal value for each EUVS-B diode
thermalTableA	float	65536 x 24	count	Table of EUVS-B thermal dark signal for each count value and each XRS diode based on detector temperature for power side A
thermalTableB	float	65536 x 24	count	Table of EUVS-B thermal dark signal for each count value and each XRS diode based on detector temperature for power side B
dark_weight1	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 1 to radiation dark current
dark_weight2	float	*scalar*	unitless	XRS weighting factor for contribution of dark diode 2 to radiation dark current
dark_scaling	float	24	unitless	Array of XRS dark current scaling factors for each diode
scattered_light	float	24	amp	Array of EUVS-B scattered light correction current for each diode

Field Name	Type	Shape	Units	Summary
order_sorting	float	24	amp	Array of EUVS-B order sorting correction current for each diode
split_diode_1216	uint8	2	unitless	Array containing the diode layout table indices for the EUVS-B 121.6-nm solar line split diodes
responsivity_table	float	24	amp W-1 m2	Table of EUVS-B sensor responsivity for each diode
fov_alpha_angle	float	5	degrees	Array of EUVS-B field-of-view dispersion angles
fov_beta_angle	float	5	degrees	Array of EUVS-B field-of-view cross-dispersion angles
fov_table_01	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 1 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_02	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 2 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_03	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 3 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_04	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 4 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_05	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 5 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_06	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 6 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_07	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 7 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_08	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 8 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_09	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 9 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_10	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 10 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_11	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 11 in the

Field Name	Type	Shape	Units	Summary
				diode layout table as a function of dispersion and cross-dispersion angles
fov_table_12	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 12 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_13	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 13 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_14	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 14 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_15	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 15 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_16	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 16 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_17	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 17 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_18	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 18 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_19	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 19 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_20	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 20 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_21	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 21 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_22	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 22 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_23	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 23 in the diode layout table as a function of dispersion and cross-dispersion angles
fov_table_24	float	5 x 5	unitless	Table of EUVS-B field-of-view correction factors for diode 24 in the diode layout table as a function of dispersion and cross-dispersion angles

Field Name	Type	Shape	Units	Summary
degradation_time	double	4	day	Array of validity times in Julian days for the degradation correction polynomial coefficients
degradation_correction	float	4 x 120	unitless	Table containing the polynomial coefficient for computing the flatfield correction for each day and for the set of 5 coefficients for each diode
geocoronaStartTime	float	*scalar*	s	Starting UTC time in seconds since beginning of day for period of geocoronal absorption
geocoronaEndTime	float	*scalar*	s	Ending UTC time in seconds since beginning of day for period of geocoronal absorption

Table D.3-6 Description of EUVSC_Cal_INR Processing Parameters

Field Name	Type	Shape	Units	Summary
nDiodes	uint16	*scalar*	unitless	Number of EUVS-C diodes
nChannel	uint16	*scalar*	unitless	Number of EUVS-C sensor channels
nFilterC1	uint16	*scalar*	unitless	Number of acceptable EUVS-C1 filter wheel positions for unobstructed solar observation
nFilterC2	uint16	*scalar*	unitless	Number of acceptable EUVS-C2 filter wheel positions for unobstructed solar observation
nLinear	uint32	*scalar*	unitless	Number of samples in EUVS-A linearity correction table
nTempDN	uint32	*scalar*	unitless	Number of sample count values
nGauss	uint16	*scalar*	unitless	Number of Gaussian curve-fitting parameters
nDecodeMode	uint16	*scalar*	unitless	Number of EUVS-C pixel modes requiring decoding
nBadMode	uint16	*scalar*	unitless	Number of EUVS-C pixel modes indicating invalid science data
nShift	uint16	*scalar*	unitless	Number of flush-dead count pairs requiring addition of extra time shift
nPoly	uint16	*scalar*	unitless	Number of polynomial coefficients used to evaluate the EUVS-C flatfield for each diode
processing_interval	float	*scalar*	s	EUVS-C algorithm processing time interval
dark_diode_interval	float	*scalar*	s	EUVS-C algorithm dark diode history interval
filter_sun_position_c1	uint16	97	unitless	Array of EUVS-C1 filter wheel absolute step numbers indicating the acceptable filter positions for solar measurements
filter_sun_position_c2	uint16	94	unitless	Array of EUVS-C2 filter wheel absolute step numbers indicating the acceptable filter positions for solar measurements
door_close_position	uint16	*scalar*	unitless	EUVS-A door absolute step number indicating the door is closed

Field Name	Type	Shape	Units	Summary
euv_inval_good	uint8	*scalar*	unitless	Invalid flag value indicating good status
euv_inval_edac	uint8	*scalar*	unitless	Invalid flag value for EDAC single bit error corrected status
euv_inval_flatfield	uint8	*scalar*	unitless	Invalid flag value for flatfield chirp on status
min_alpha_bad	float	*scalar*	degrees	Minimum bad dispersion angle threshold
max_alpha_bad	float	*scalar*	degrees	Maximum bad dispersion angle threshold
min_beta_bad	float	*scalar*	degrees	Minimum bad cross-dispersion angle threshold
max_beta_bad	float	*scalar*	degrees	Maximum bad cross-dispersion angle threshold
min_det_chg_count	uint16	*scalar*	count	Minimum detector change count required for processing valid data
pixel_mode_decode	uint16	2	unitless	Array of EUVS-C pixel mode values indicating valid science data requiring decoding
pixel_mode_reference	uint16	*scalar*	unitless	Array of EUVS-C pixel mode values indicating reference data only
decode_offset	float	2	unitless	Array of offset values for EUVS-C1 and EUVS-C2 channels used for decoding
filter_threshold	float	*scalar*	count	EUVS-C diode signal amplitude threshold for the particle filtering scheme
blue_wing_mask	uint8	2 x 512	unitless	Table indicating diodes in the EUVS-C blue wing region per channel and per diode
red_wing_mask	uint8	2 x 512	unitless	Table indicating diodes in the EUVS-C red wing region per channel and per diode
h_line_mask	uint8	2 x 512	unitless	Table indicating diodes in the EUVS-C h-line region per channel and per diode
k_line_mask	uint8	2 x 512	unitless	Table indicating diodes in the EUVS-C k-line region per channel and per diode
dark_mask	uint8	2 x 512	unitless	Table indicating diodes in the EUVS-C dark region per channel and per diode
blue_wing_low	uint16	*scalar*	count	The low signal threshold for diode amplitudes in the EUVS-C blue wing region
red_wing_low	uint16	*scalar*	count	The low signal threshold for diode amplitudes in the EUVS-C red wing region
h_line_low	uint16	*scalar*	count	The low signal threshold for diode amplitudes in the EUVS-C h-line region
k_line_low	uint16	*scalar*	count	The low signal threshold for diode amplitudes in the EUVS-C k-line region
blue_wing_saturation	uint16	*scalar*	count	The saturation signal threshold for diode amplitudes in the EUVS-C blue wing region

Field Name	Type	Shape	Units	Summary
red_wing_saturation	uint16	*scalar*	count	The saturation signal threshold for diode amplitudes in the EUVS-C red wing region
h_line_saturation	uint16	*scalar*	count	The saturation signal threshold for diode amplitudes in the EUVS-C h-line region
k_line_saturation	uint16	*scalar*	count	The saturation signal threshold for diode amplitudes in the EUVS-C k-line region
integ_scale	float	*scalar*	unitless	EUVS-C sensor integration time scale factor
integ_offset	float	*scalar*	count	EUVS-C sensor integration time offset factor
dead_scale	float	*scalar*	unitless	EUVS-C sensor dead time scale factor
dead_offset	float	*scalar*	count	EUVS-C sensor dead time offset factor
flush_scale	float	*scalar*	unitless	EUVS-C sensor flush time scale factor
flush_offset	float	*scalar*	count	EUVS-C sensor flush time offset factor
integration_convert	float	*scalar*	count s-1	EUVS-C conversion factor from counts to seconds
flush_extra	float	*scalar*	count	Array containing the values of the EUVS-C flush time requiring addition of extra time shift
dead_extra	float	*scalar*	count	Array containing the values of the EUVS-C dead time requiring addition of extra time shift
integration_delta	float	*scalar*	s	EUVS-C sensor integration time shift required for specified values of the flush and dead time counts
pixel_time	float	*scalar*	s	EUVS-C pixel offset time
c1_temperature_table	float	65536	degrees_C	Array for converting counts to temperature for EUVS-C1 detector
c2_temperature_table	float	65536	degrees_C	Array for converting counts to temperature for EUVS-C2 detector
low_temp_threshold	float	*scalar*	degrees_C	EUVS-C detector board low temperature threshold
high_temp_threshold	float	*scalar*	degrees_C	EUVS-C detector board high temperature threshold
dark_flatfield	float	2 x 512	unitless	Table containing the EUVS-C dark flatfield values for each channel and each diode
dark_offset	float	2 x 512	count	Table containing the EUVS-C dark offset values for each channel and each diode
flatfield_correction_c1	float	5 x 512	unitless	Table containing the five polynomial coefficient for computing the flatfield correction for each diode
flatfield_correction_c2	float	5 x 512	unitless	Table containing the five polynomial coefficient for computing the flatfield correction for each diode
gain_linearity_dn	uint32	65536	count	Array of count values for each gain linearity correction value
gain_linearity_value	float	512 x 65536	unitless	Table of gain linearity correction values for each linearity count value and EUVS-C diode

Field Name	Type	Shape	Units	Summary
scattered_light	float	2 x 512	count	Table of EUVS-C scattered light correction counts for each channel and for each diode
bluewing_weights	float	2 x 512	unitless	Table of EUVS-C blue wing weighting factors for each channel and for each diode
redwing_weights	float	2 x 512	unitless	Table of EUVS-C red wing weighting factors for each channel and for each diode
hline_initial_params	float	4	various	Array of 4 initial parameters for Gaussian fitting of the EUVS-C h-line spectral peak consisting of magnitude (count), peak offset (nm), peak width (nm), and background (count)
kline_initial_params	float	4	various	Array of 4 initial parameters for Gaussian fitting of the EUVS-C k-line spectral peak consisting of magnitude (count), peak offset (nm), peak width (nm), and background (count)
hline_wavelength	float	2 x 512	nm	Table of wavelength values used for Gaussian fitting of the EUVS-C h-line spectral peak per channel and per diode
kline_wavelength	float	2 x 512	nm	Table of wavelength values used for Gaussian fitting of the EUVS-C k-line spectral peak per channel and per diode
noaa_scale_factor	float	*scalar*	unitless	Scale factor to convert the EXIS Mg II core-to-wing ratio to match the NOAA historical record
noaa_offset_factor	float	*scalar*	unitless	Offset factor to convert the EXIS Mg II core-to-wing ratio to match the NOAA historical record

Table D.3-7 Description of ESPEC_Cal_INR Processing Parameters

Field Name	Type	Shape	Units	Summary
nWaveBins	uint16	*scalar*	unitless	Number of wavelength bins in the model EUV spectrum
nProxies	uint16	*scalar*	unitless	Number of proxies used in EUV spectrum generation
process_interval	float	*scalar*	s	Processing interval for EUV spectrum generation in units of seconds
euv_inval_time_warn	uint16	*scalar*	unitless	Telemetry invalid flag value corresponding to "Integration Time Warning"
trailing_interval	float	10	s	Array of the time intervals, in units of seconds, required to compute the averages for each of the trailing proxies
minimum_xrsa	float	*scalar*	W m-2	Minimum XRS-A irradiance value used to compute the slower time-average variability
minimum_xrsb	float	*scalar*	W m-2	Minimum XRS-B irradiance value used to compute the slower time-average variability

Field Name	Type	Shape	Units	Summary
minimum_256	float	*scalar*	W m-2	Minimum EUVS-A 25.6-nm irradiance value used to compute the slower time-average variability
minimum_284	float	*scalar*	W m-2	Minimum EUVS-A 28.4-nm irradiance value used to compute the slower time-average variability
minimum_304	float	*scalar*	W m-2	Minimum EUVS-A 30.4-nm irradiance value used to compute the slower time-average variability
minimum_1175	float	*scalar*	W m-2	Minimum EUVS-B 117.5-nm irradiance value used to compute the slower time-average variability
minimum_1216	float	*scalar*	W m-2	Minimum EUVS-B 121.6-nm irradiance value used to compute the slower time-average variability
minimum_1335	float	*scalar*	W m-2	Minimum EUVS-B 133.5-nm irradiance value used to compute the slower time-average variability
minimum_1405	float	*scalar*	W m-2	Minimum EUVS-B 140.5-nm irradiance value used to compute the slower time-average variability
minimum_mg	float	*scalar*	unitless	Minimum EUVS-C NOAA Mg II core-to-wing ratio value used to compute the slower time-average variability
a_coefficient	float	23	W m-2 nm-1	Array of the solar minimum irradiance amplitudes of each wavelength
m_exponent	float	10	unitless	Array of the P proxy exponent coefficients as a function of the 10 sensor proxies
n_exponent	float	10	unitless	Array of the Q proxy exponent coefficients as a function of the 10 sensor proxies
j_case1	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 1 as a function per wavelength and per proxies
k_case1	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 1 as a function per wavelength and per proxies
j_case2	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 2 as a function per wavelength and per proxies
k_case2	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 2 as a function per wavelength and per proxies
j_case3	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 3 as a function per wavelength and per proxies
k_case3	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 3 as a function per wavelength and per proxies
j_case4	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 4 as a function per wavelength and per proxies

Field Name	Type	Shape	Units	Summary
k_case4	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 4 as a function per wavelength and per proxies
j_case5	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 5 as a function per wavelength and per proxies
k_case5	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 5 as a function per wavelength and per proxies
j_case6	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 6 as a function per wavelength and per proxies
k_case6	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 6 as a function per wavelength and per proxies
j_case7	float	23 x 10	W m-2 nm-1	Table of the P proxy amplitude coefficients for case 7 as a function per wavelength and per proxies
k_case7	float	23 x 10	W m-2 nm-1	Table of the Q proxy amplitude coefficients for case 7 as a function per wavelength and per proxies
low_wavelength	float	23	nm	Array containing the lower limit for each of the 5-nm wavelength bins used by the proxy spectrum model
high_wavelength	float	23	nm	Array containing the upper limit for each of the 5-nm wavelength bins used by the proxy spectrum model

Table D.3-8 Description of 1AU_Correction_Data Processing Parameters

Field Name	Type	Shape	Units	Summary
n_1au_days	int32	*scalar*	unitless	Number of days in AU correction factor table
n_ident	int32	*scalar*	unitless	Number of columns in AU correction factor table
au_year	int32	*scalar*	year	Valid year for AU correction factor table
au_table	float	(366 or 367) x 7	various	Table containing an array of the day number, the 1 AU correction factor at 0 UT, and the 5 polynomial coefficients for computing the 1 AU correction factor from the fractional day number for each day of the year from January 1 of the current year to January 1 of the next year (366 days for normal year and 367 days for leap year)

D.4 SEISS Instrument Calibration Parameters

The documentation of the SEISS L1b Cal INR data file is consistent with the HDF5 files created based primarily on processing parameter provided by the instrument vendor. The data is in HDF5 format. Each HDF5 file has a top level HDF group. The groups are titled `SeissMpsLoCalInrParameters`, `SeissMpsHiCalInrParameters`, `SeissSgpsCalInrParameters`, and `SeissEhisCalInrParameters`, for the MPS-Lo, MPS-Hi, SGPS and EHIS sensors, respectively. All variable fields below this group are documented in the SEISS MPS-LO L1b Cal INR Processing Parameters table (see Table D.4-1), the SEISS MPS-HI L1b Cal INR Processing Parameters table (see Table D.4-2), the SEISS SGPS L1b Cal INR Processing Parameters table (see Table D.4-3) and the SEISS EHIS L1b Cal INR Processing Parameters table (see Table D.4-4).

Additional notes:

- Dimensions identified in the "Shape" column are described in the "Summary" column.

Table D.4-1 Description of SEISS MPS-Lo L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
theElectronicsDeadTime	float	*scalar*	s	Electronics dead time; Used in calculation to estimate number of events not counted while the sensor electronics were busy with other tasks.
theAcquisitionTimeInterval	float	*scalar*	s	Data acquisition interval; The time spent collecting data at a particular energy step before cycling to the next energy step; it is a little bit less than 1/16th of a second, and equals 0.0615 s; Static.
theBackgroundRemovalCoefficients	float	2 x 2 x 4	unitless	Background Removal Coefficients; Ordered by species (0=Ions, 1=Ele), sensor-head (0=R-sensor, 1=L-sensor) and zone grouping (0=Ions/R, 1=Ions/L, 2=Ele/R, 3=Ele/L).
theBackgroundRemovalOverallScalingCoefficients	float	2 x 2	unitless	Background Removal Overall Scaling Coefficients; Ordered by species (0=Ions, 1=Ele) and sensor-head (0=R-sensor, 1=L-sensor).
theGeometricFactors	float	2 x 14 x 15	cm2 sr keV	Geometric Factors (energy-dependent); Ordered by species (0=Ions, 1=Ele), primary angular zone (0=Z1 thru 13=Z12) and energy step (0=E1 thru 14=E15).
theGeometricFactorUncertainties	float	2 x 14 x 15	cm2 sr keV	Geometric Factor Uncertainties (energy-dependent); Ordered by species (0=Ions, 1=Ele), primary angular zone (0=Z1 thru 13=Z12) and energy step (0=E1 thru 14=E15).
theEnergyChannelCenterValues	float	15	keV	Energy channel center values for 15 energy steps; **Parameter not currently used by L1b algorithm.**
theEnergyChannelBoundaries	float	15 x 2	keV	Energy channel boundaries (low, high), for 15 energy steps; **Parameter not currently used by L1b algorithm.**
theEnergyChannelBandpass	float	15	keV	Energy channel bandpass (deltaE), for 15 energy steps; **Parameter not currently used by L1b algorithm.**
theNumBlocks	byte	*scalar*	unitless	The number of blocks of data used to create the MPS-LO L1b product data; Static Value=1.
theIonDeadTimeCorrLimit	float	*scalar*	unitless	The limit used to determine if the ion dead-time correction is excessive or not; used when setting the ion flux data quality flag
theElectronDeadTimeCorrLimit	float	*scalar*	unitless	The limit used to determine if the electron dead-time correction is excessive or not; used when setting the electron flux data quality flag
theIonBackgroundCorrLimit	float	*scalar*	unitless	The limit used to determine if the ion background correction is excessive or not; used when setting the ion flux data quality flag

Field Name	Type	Shape	Units	Summary
theElectronBackgroundCorrLimit	float	*scalar*	unitless	The limit used to determine if the electron background correction is excessive or not; used when setting the electron flux data quality flag
theIonFluxErrorLimit	float	*scalar*	unitless	The limit used to determine if the ion flux uncertainty is excessive or not; used when setting the ion flux data quality flag
theElectronFluxErrorLimit	float	*scalar*	unitless	The limit used to determine if the electron flux uncertainty is excessive or not; used when setting the electron flux data quality flag

Table D.4-2 Description of SEISS MPS-Hi L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
theProtonTelescopeAnalogElectronicsDeadTime	float	*scalar*	s	Proton telescope analog electronics dead time; Used in calculation to estimate number of events not counted while the sensor electronics were busy with other tasks.
theProtonTelescopeDigitalElectronicsDeadTime	float	*scalar*	s	Proton telescope digital electronics dead time; Used in calculation to estimate number of events not counted while the sensor electronics were busy with other tasks.
theProtonGeometricFactors	float	5 x 11	cm2 sr	Proton geometric factors; Used to convert count rate to flux; ordered by telescope (1 – 5) and energy band (P1 – P11).
theProtonGeometricFactorUncertainties	float	5 x 11	cm2 sr	Proton geometric factor uncertainties; Used to calculate the uncertainty on the flux; ordered by telescope (1 – 5) and energy band (P1 – P11).
theProtonEnergyBandBoundaries	float	5 x 11 x 2	keV	Proton energy band boundaries; Used to form the energy bandpass $\Delta E = E_{upp} - E_{low}$, which is used to convert counts to flux; ordered by telescope (1 – 5), energy band (P1 – P11), and energy band bound (low, high).
theElectronTelescopeElectronicsAnalogDeadTime	float	*scalar*	s	Electron telescope analog electronics dead time; Used in calculation to estimate number of events not counted while the sensor electronics were busy with other tasks.
theElectronTelescopeElectronicsDigitalDeadTime	float	*scalar*	s	Electron telescope digital electronics dead time; Used in calculation to estimate number of events not counted while the sensor electronics were busy with other tasks.

Field Name	Type	Shape	Units	Summary
theOutOfBandWeightingFactors	float	5 x 4 x 3	various	The 3 out-of-band weighting factors (alpha, beta, gamma) for the 4 energy bands E9, E10, E10A and E11, on each of the 5 electron telescopes; used to scale SGPS-X flux data during contamination removal for these four electron channels. Units for alpha and beta are cm2 sr keV; units for gamma are cm2 sr.
theElectronInverseInstrumentResponseMatrix	float	5 x 11 x 11	cm-2 sr-1	Electron Inverse Instrument Response Matrices; used to convert signal count rate to unfolded counts for electron energy bands E1 through E10A (11 channels); an 11x11 matrix for each of the 5 electron telescopes; the size of 11 refers to the 11 energy bands E1 through E10A; for the i^{th} telescope, the matrix has the following index notation: R(i:p,m). Unfolded counts for the p^{th} energy channel is calculated as: UnfoldedCounts(i:p) = R(i:p,m) * M(i:m) (sum over m implied).
theElectronGeometricFactorForChannelE11	float	5	cm2 sr	Electron geometric factor for channel E11; Used to convert count rate to integral flux for the integral channel E11; ordered by telescope (1 – 5).
theElectronGeometricFactorUncertaintyForChannelE11	float	5	cm2 sr	Electron geometric factor uncertainty for channel E11; Used to calculate uncertainty on integral flux; ordered by telescope (1 – 5).
theElectronGeometricFactorsForDifferentialEnergyBands	float	5 x 10	cm2 sr	The MPS-HI Electron Telescope geometric factors for differential energy bands E1 - E10; **Parameter not currently used by L1b algorithm.**
theElectronGeometricFactorUncertaintiesForDifferentialEnergyBands	float	5 x 10	cm2 sr	The MPS-HI Electron Telescope geometric factor uncertainties for differential energy bands E1 - E10; **Parameter not currently used by L1b algorithm.**
theElectronEnergyBandBoundaries	float	5 x 10 x 2	keV	Electron energy band boundaries; Used to form the energy bandpass $\Delta E = E_{upp} - E_{low}$, which is used to convert unfolded counts to flux; ordered by telescope (1 – 5), energy band (E1 – E10) and energy band bound (low, high).
theDoseCalibrationFactors	float	4	rads count-1	Dose calibration factors; Used to convert raw dose to calibrated dose; For the four dosimeter channels DOS1 HiLET, DOS1 LoLET, DOS2 HiLET, DOS2 LoLET.
theResponseMatrixUncertaintyParameter	float	*scalar*	unitless	Response matrix uncertainty parameter; Equal to 0.19; used to estimate the uncertainty in the determination of the instrument response matrix.

Field Name	Type	Shape	Units	Summary
theNumBlocks	uint8	*scalar*	unitless	The number of blocks of data used to create the MPS-HI L1b product data; Static Value=1.
theAcquisitionTimeInterval	float	*scalar*	s	The MPS-HI instrument acquisition time interval; the collection time for one block; Static Value=1.0.
theProtonDeadTimeCorrLimit	float	*scalar*	unitless	The limit used to determine if the proton dead-time correction is excessive or not; used when setting the proton flux data quality flag
theElectronDeadTimeCorrLimit	float	*scalar*	unitless	The limit used to determine if the electron dead-time correction is excessive or not; used when setting the electron flux data quality flag
theElectronContamCorrLimit	float	*scalar*	unitless	The limit used to determine if the electron out-of-band contamination correction is excessive or not; used when setting the electron flux data quality flag
theProtonFluxErrorLimit	float	*scalar*	unitless	The limit used to determine if the proton flux uncertainty is excessive or not; used when setting the proton flux data quality flag
theElectronFluxErrorLimit	float	*scalar*	unitless	The limit used to determine if the electron flux uncertainty is excessive or not; used when setting the electron flux data quality flag

Documentation provided by the instrument vendor states: "SN-101 is installed as the "+X" unit on the spacecraft".

Therefore, the mapping from SN101 and SN102 to the "+X" and "-X" nomenclature in this document is as follows:

- SGPS-X = SGPS SN102
- SGPS+X = SGPS SN101

Table D.4-3 Description of SEISS SGPS L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
theSGPS_MX_ElectronicsDeadTime	float	*scalar*	s	The Electronics Dead Time for SGPS-X.
theSGPS_PX_ElectronicsDeadTime	float	*scalar*	s	The Electronics Dead Time for SGPS+X.
theSGPS_MX_T1_OutOfBandContaminationRemovalWeightingFactors	float	2	unitless	Out-of-band removal weighting factors for SGPS-X T1 Channel P5; There are two factors; Ordered by factor-type: 1st factor multiplies P7*, 2nd factor multiplies P8AF*.

Field Name	Type	Shape	Units	Summary
theSGPS_PX_T1_OutOfBandContaminationRemovalWeightingFactors	float	2	unitless	Out-of-band removal weighting factors for SGPS+X T1 Channel P5; There are two factors; Ordered by factor-type: 1st factor multiplies P7*, 2nd factor multiplies P8AF*.
theSGPS_MX_T1_OutOfBandContaminationRemovalOverallScalingFactor	float	*scalar*	cm2 sr keV	Out-of-band removal overall scaling factor for SGPS-X T1 Channel P5.
theSGPS_PX_T1_OutOfBandContaminationRemovalOverallScalingFactor	float	*scalar*	cm2 sr keV	Out-of-band removal overall scaling factor for SGPS+X T1 Channel P5.
theSGPS_MX_T1_GeometricFactors	float	6	cm2 sr	Geometric Factors for SGPS-X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5).
theSGPS_PX_T1_GeometricFactors	float	6	cm2 sr	Geometric Factors for SGPS+X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5).
theSGPS_MX_T1_GeometricFactorUncertainties	float	6	cm2 sr	Geometric Factor Uncertainties for SGPS-X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5).
theSGPS_PX_T1_GeometricFactorUncertainties	float	6	cm2 sr	Geometric Factor Uncertainties for SGPS+X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5).
theSGPS_MX_T1_EnergyBandBoundaries	float	6 x 2	keV	Energy channel bounds for SGPS-X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5) and bound (lower, upper).
theSGPS_PX_T1_EnergyBandBoundaries	float	6 x 2	keV	Energy channel bounds for SGPS+X T1; Ordered by energy (P1, P2A, P2B, P3, P4, P5) and bound (lower, upper).
theSGPS_MX_T2_GeometricFactors	float	2	cm2 sr	Geometric Factors for SGPS-X T2; Ordered by energy (P6, P7).
theSGPS_PX_T2_GeometricFactors	float	2	cm2 sr	Geometric Factors for SGPS+X T2; Ordered by energy (P6, P7).
theSGPS_MX_T2_GeometricFactorUncertainties	float	2	cm2 sr	Geometric Factor Uncertainties for SGPS-X T2; Ordered by energy (P6, P7).
theSGPS_PX_T2_GeometricFactorUncertainties	float	2	cm2 sr	Geometric Factor Uncertainties for SGPS+X T2; Ordered by energy (P6, P7).
theSGPS_MX_T2_EnergyBandBoundaries	float	2 x 2	keV	Energy channel bounds for SGPS-X T2; Ordered by energy (P6, P7) and bound (lower, upper).
theSGPS_PX_T2_EnergyBandBoundaries	float	2 x 2	keV	Energy channel bounds for SGPS+X T2; Ordered by energy (P6, P7) and bound (lower, upper).
theSGPS_MX_T3_OutOfBandContaminationRemovalWeightingFactors	float	3 x 2	unitless	Out-of-band removal weighting factors for SGPS-X T3; Ordered by data channel (P8CF, P9F, P10) and factor type (there are two factors per data channel).

Field Name	Type	Shape	Units	Summary
theSGPS_PX_T3_OutOfBandContaminationRemovalWeightingFactors	float	3 x 2	unitless	Out-of-band removal weighting factors for SGPS+X T3; Ordered by data channel (P8CF, P9F, P10) and factor type (there are two factors per data channel).
theSGPS_MX_T3_OutOfBandContaminationRemovalOverallScalingFactors	float	3	unitless	Out-of-band removal overall scaling factors for SGPS-X T3 Channels P8CF, P9F and P10.
theSGPS_PX_T3_OutOfBandContaminationRemovalOverallScalingFactors	float	3	unitless	Out-of-band removal overall scaling factors for SGPS+X T3 Channels P8CF, P9F and P10.
theSGPS_MX_T3_GeometricFactors	float	6	cm2 sr	Geometric Factors for SGPS-X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10, P11).
theSGPS_PX_T3_GeometricFactors	float	6	cm2 sr	Geometric Factors for SGPS+X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10, P11).
theSGPS_MX_T3_GeometricFactorUncertainties	float	6	cm2 sr	Geometric Factor Uncertainties for SGPS-X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10, P11).
theSGPS_PX_T3_GeometricFactorUncertainties	float	6	cm2 sr	Geometric Factor Uncertainties for SGPS+X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10, P11).
theSGPS_MX_T3_EnergyBandBoundaries	float	5 x 2	keV	Energy channel bounds for SGPS-X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10) and bound (lower, upper).
theSGPS_PX_T3_EnergyBandBoundaries	float	5 x 2	keV	Energy channel bounds for SGPS+X T3; Ordered by energy (P8AF, P8BF, P8CF, P9F, P10) and bound (lower, upper).
theNumBlocks	uint8	*scalar*	unitless	The number of blocks of data (either SGPS-X or SGPS+X) used to create the SGPS L1b product data. Static Value=1.
theAcquisitionTimeInterval	float	*scalar*	s	The SGPS instrument acquisition time interval; the collection time for one block; in units of seconds. Static Value =1.0
theProtonDeadTimeCorrLimit	float	*scalar*	unitless	The limit used to determine if the proton dead-time correction is excessive or not; used when setting the proton flux data quality flag.
theProtonContamCorrLimit	float	*scalar*	unitless	The limit used to determine if the electron out-of-band contamination correction is excessive or not; used when setting the electron flux data quality flag.
theProtonFluxErrorLimit	float	*scalar*	unitless	The limit used to determine if the proton flux uncertainty is excessive or not; used when setting the proton flux data quality flag.

Table D.4-4 Description of SEISS EHIS L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
theNonPrimeDeadTimeCorrectionTable	double	3 x 100	various	Non-Prime Dead Time correction table with units by column of counts/3s (1st column) and unitless (2nd and 3rd columns).
thePrimeDeadTimeCorrectionTable	double	3 x 100	various	Prime Dead Time correction table with units by column of counts/3s (1st column) and unitless (2nd and 3rd columns).
theNonPrimeH1_H5GeometricalFactors	double	5	cm2 sr	Non-Prime Hydrogen geometrical factors; ordered by energy bin (E1 – E5).
theNonPrimeH1_H5GeometricalFactorUncertainties	double	5	cm2 sr	Non-Prime Hydrogen geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimeH1_H5EnergyBoundaries	double	5 x 2	MeV nuc-1	Non-Prime Hydrogen energy boundaries; ordered by energy bin (E1 – E5) and energy band bound (low, high).
theNonPrimeH1_H5EnergyBandpassUncertainties	double	5	MeV nuc-1	Non-Prime Hydrogen energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeH1_H5GeometricalFactors	double	5	cm2 sr	Prime Hydrogen geometrical factors; ordered by energy bin (E1 – E5).
thePrimeH1_H5GeometricalFactorUncertainties	double	5	cm2 sr	Prime Hydrogen geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeH1_H5EnergyBoundaries	double	5 x 2	MeV nuc-1	Prime Hydrogen energy boundaries; ordered by energy bin (E1 – E5) and energy band bound (low, high).
thePrimeH1_H5EnergyBandpassUncertainties	double	5	MeV nuc-1	Prime Hydrogen energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimeHE1_HE5GeometricalFactors	double	5	cm2 sr	Non-Prime Helium geometrical factors; ordered by energy bin (E1 – E5).
theNonPrimeHE1_HE5GeometricalFactorUncertainties'	double	5	cm2 sr	Non-Prime Helium geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimeHE1_HE5EnergyBoundaries	double	5 x 2	MeV nuc-1	Non-Prime Helium energy boundaries; ordered by energy bin (E1 – E5) and energy band bound (low, high).
theNonPrimeHE1_HE5EnergyBandpassUncertainties	double	5	MeV nuc-1	Non-Prime Helium energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimeHE1_HE5ProtonContaminationFactors	double	5	unitless	Non-Prime Helium proton contamination factors; ordered by energy bin (E1 – E5).
theNonPrimeHE1_HE5ProtonContaminationFactor Uncertainties	double	5	unitless	Non-Prime Helium proton contamination factor instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeHE1_HE5GeometricalFactors	double	5	cm2 sr	Prime Helium geometrical factors; ordered by energy bin (E1 – E5).

Field Name	Type	Shape	Units	Summary
thePrimeHE1_HE5GeometricalFactorUncertainties	double	5	cm2 sr	Prime Helium geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeHE1_HE5EnergyBoundaries	double	5 x 2	MeV nuc-1	Prime Helium energy boundaries; ordered by energy bin (E1 – E5) and energy band bound (low, high).
thePrimeHE1_HE5EnergyBandpassUncertainties	double	5	MeV nuc-1	Prime Helium energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeHE1_HE5ProtonContaminationFactors	double	5	unitless	Prime Helium proton contamination factors; ordered by energy bin (E1 – E5).
thePrimeHE1_HE5ProtonContaminationFactorUncertainties	double	5	unitless	Prime Helium proton contamination factor instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimePeakPositions	double	5 x 30	unitless	Non-Prime Elemental Peak positions in units of histogram bin; ordered by energy bin (E1 – E5) and element (H – Cu). There are 600 bins: bins 0-29 correspond to Hydrogen; bins 30 to 59 to Helium; bins 60 to 598 to heavy ion data; and bin 599 for heavy ion flux calculations. Peak positions are specified as non-integer values of the 0 to 599 bin index range.
theNonPrimePeakWidths	double	5 x 30	unitless	Non-Prime Elemental Peak widths in units of histogram bin; ordered by energy bin (E1 – E5) and element (H – Cu). There are 600 bins: bins 0-29 correspond to Hydrogen; bins 30 to 59 to Helium; bins 60 to 598 to heavy ion data; and bin 599 for heavy ion flux calculations. Peak widths are specified as non-integer values.
thePrimePeakPositions	double	5 x 30	unitless	Prime Elemental Peak positions in units of histogram bin; ordered by energy bin (E1 – E5) and element (H – Cu). There are 600 bins: bins 0-29 correspond to Hydrogen; bins 30 to 59 to Helium; bins 60 to 598 to heavy ion data; and bin 599 for heavy ion flux calculations. Peak positions are specified as non-integer values of the 0 to 599 bin index range.
thePrimePeakWidths	double	5 x 30	unitless	Prime Elemental Peak widths in units of histogram bin; ordered by energy bin (E1 – E5) and element (H – Cu). There are 600 bins: bins 0-29 correspond to Hydrogen; bins 30 to 59 to Helium; bins 60 to 598 to heavy ion data; and bin 599 for heavy ion flux calculations. Peak widths are specified as non-integer values.
theNonPrimeHistogramGeometricalFactors	double	5	cm2 sr	Non-Prime histogram geometrical factors; ordered by energy bin (E1 – E5).

Field Name	Type	Shape	Units	Summary
theNonPrimeHistogramGeometricalFactorUncertainties	double	5	cm2 sr	Non-Prime histogram geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
theNonPrimeHistogramEnergyBoundaries	double	5 x 30 x 2	MeV nuc-1	Non-Prime histogram energy boundaries; ordered by energy bin (E1 – E5), element (H – Cu) and energy band bound (low, high).
theNonPrimeHistogramEnergyBandpassUncertainties	double	5 x 30	MeV nuc-1	Non-Prime histogram energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5) and element (H – Cu).
thePrimeHistogramGeometricalFactors	double	5	cm2 sr	Prime histogram geometrical factors; ordered by energy bin (E1 – E5).
thePrimeHistogramGeometricalFactorUncertainties	double	5	cm2 sr	Prime histogram geometrical factor instrumental uncertainties; ordered by energy bin (E1 – E5).
thePrimeHistogramEnergyBoundaries	double	5 x 30 x 2	MeV nuc-1	Prime histogram energy boundaries; ordered by energy bin (E1 – E5), element (H – Cu) and energy band bound (low, high).
thePrimeHistogramEnergyBandpassUncertainties	double	5 x 30	MeV nuc-1	Prime histogram energy bandpass instrumental uncertainties; ordered by energy bin (E1 – E5) and element (H – Cu).
theNumBlocksIngested	uint8	*scalar*	unitless	Number of blocks of data ingested by the L1b algorithm; Static Value=5. **Parameter no longer needed in Cal INR file, as it is hardwired in source code (i.e., it is static).**
theAcquisitionTimeInterval	float	*scalar*	s	The acquisition time interval for one block of data; Static Value=60.
theSciHcrAcquisitionTimeInterval	float	*scalar*	s	The acquisition time interval for one record of SCI HCR data; Static Value=3.
theLikelihoodConvergenceTolerance	float	*scalar*	unitless	The convergence tolerance on Likelihood for the Maximum Likelihood Fitting routine. **Parameter no longer needed in Cal INR file, as it is hardwired in source code (i.e., it is static).**
theMaxNumCycles	uint16	*scalar*	unitless	The maximum number of cycles for the Maximum Likelihood Fitting routine. **Parameter no longer needed in Cal INR file, as it is hardwired in source code (i.e., it is static).**
theNumPeakSigmas	uint8	*scalar*	unitless	The maximum number of peak sigmas away a histogram bin can be from a particular elemental peak in order for the Gaussian calculation to take place for that bin/peak pair; in the Maximum Likelihood Fitting routine. **Parameter no longer needed in Cal INR file, as it is hardwired in source code (i.e., it is static).**

Field Name	Type	Shape	Units	Summary
theOneSigmaDeltaL	float	*scalar*	unitless	The change in Likelihood relative to the maxima of the Likelihood surface that defines the 1-sigma uncertainty level. **Parameter no longer needed in Cal INR file, as it is hardwired in source code (i.e., it is static).**

Table D.4-5 Description of SEISS Product Performance Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
theMPSLO_TemperatureConversionFactor	float	*scalar*	K count-1	Multiplicative factor used to convert temperature from DN to K.
theMPSHI_TemperatureConversionFactor	float	*scalar*	K count-1	Multiplicative factor used to convert temperature from DN to K.
theSGPS_TemperatureConversionFactor	float	*scalar*	K count-1	Multiplicative factor used to convert temperature from DN to K.
theEHIS_TemperatureConversionFactor	float	*scalar*	K count-1	Multiplicative factor used to convert temperature from DN to K.

D.5 Magnetometer Instrument Calibration Parameters

The documentation of the Magnetometer L1b Cal INR data file is consistent with the HDF5 file created based primarily on processing parameter values in the Magnetometer Calibration Data Book, SC-MAGN-03. The data is in HDF5 format. The HDF5 file has a top level HDF group titled MAG_CAL_INR. All variable fields below this group are documented in the Magnetometer Cal INR Processing Parameters table (see Table D.5-1).

Additional notes:

- All on-orbit calibration parameters (with "on_orbit" in their name and having dimensions MAX_ONORBIT_INDEX x 3) may have up to 30 values stored in the Cal INR Database. The processing parameter "on_orbit_cal_index" determines which value to use in the Magnetometer L1b Algorithm.
- The source of the factory zero offset and factory scale factor correction coefficients (listed below) is SC-MAGN-03. However, the units for these parameters given in SC-MAGN-03 imply that the polynomial coefficients are in descending order. For example: [counts/ºC3, counts/ºC2, counts/ºC1]. However, SC-MAGN-04 implies that these coefficients are utilized in ascending order, which is an apparent discrepancy in documentation. Here it is assumed that these coefficients are stored in ascending order in the Cal INR Database, which is the order in which they are applied by the Magnetometer L1b software, and therefore the units provided in the table below are in ascending order.
    - ib_fact_zero_offset_comp_const_ai
    - ob_fact_zero_offset_comp_const_ai
    - ib_fact_zero_offset_comp_const_bi
    - ob_fact_zero_offset_comp_const_bi
    - ib_fact_scal_comp_const_ci
    - ob_fact_scal_comp_const_ci
    - ib_fact_scal_comp_const_di
    - ob_fact_scal_comp_const_di
- Dimensions identified in the "Shape" column are described in the "Summary" column.

Table D.5-1 Description of Magnetometer Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
deg_ib_zero_offset_temp_correct_poly	byte	3	unitless	One less than the degree of IB zero offset temperature correction polynomial. The maximum value of this array is adopted as the dimension for various coefficients described below and referenced as $\mathbf{n}_{\mathbf{off\_IBmax}}$ in this document.
deg_ob_zero_offset_temp_correct_poly	byte	3	unitless	One less than the degree of OB zero offset temperature correction polynomial. The maximum value of this array is adopted as the dimension for various coefficients

Field Name	Type	Shape	Units	Summary
				described below and referenced as $\mathbf{n_{off\_OBmax}}$ in this document.
deg_ib_scale_factor_temp_correct_poly	byte	3	unitless	One less than the degree of IB scale factor temperature correction polynomial. The maximum value of this array is adopted as the dimension for various coefficients described below and referenced as $\mathbf{n_{sf\_OBmax}}$ in this document.
deg_ob_scale_factor_temp_correct_poly	byte	3	unitless	One less than the degree of OB scale factor temperature correction polynomial. The maximum value of this array is specified as the dimension for various coefficients described below and referenced as $\mathbf{n_{sf\_OBmax}}$ in this document.
ib_fact_zero_offset_comp_const_bo	double	3	count	IB factory zero offset compensation constants.
ob_fact_zero_offset_comp_const_bo	double	3	count	OB factory zero offset compensation constants.
ib_fact_zero_offset_comp_const_ai	double	n_{off_IBmax} x 3	various	IB factory zero offset compensation constants. Dimensions are n_{off_IB}max x [X, Y, Z]. Units are count/degrees_C to the power of 1 through n_{off_IBmax}.
ob_fact_zero_offset_comp_const_ai	double	n_{off_OBmax} x 3	various	OB factory zero offset compensation constants. Dimensions are n_{off_OBmax} x [X, Y, Z]. Units are count/degrees_C to the power of 1 through n_{off_OBmax}.
ib_fact_zero_offset_comp_const_bi	double	n_{off_IBmax} x 3	various	IB factory zero offset compensation constants. Dimensions are n_{off_IBmax} x [X, Y, Z]. Units are count/degrees_C to the power of 1 through n_{off_IBmax}.
ob_fact_zero_offset_comp_const_bi	double	n_{off_OBmax} x 3	various	OB factory zero offset compensation constants. Dimensions are n_{off_OBmax} x [X, Y, Z]. Units are count/degrees_C to the power of 1 through n_{off_OBmax}.
ib_temp_dep_fact_scaling_facts_so	double	3	count/nT	IB temperature dependent factory scaling factors.
ob_temp_dep_fact_scaling_facts_so	double	3	count/nT	OB temperature dependent factory scaling factors.
ib_fact_scal_comp_const_ci	double	n_{off_IBmax} x 3	various	IB factory scaling compensation constants. Dimensions are n_{off_IBmax} x [X, Y, Z]. Units are count/nT/degrees_C to the power of 1 through n_{off_IBmax}.
ob_fact_scal_comp_const_ci	double	n_{off_OBmax} x 3	various	OB factory scaling compensation constants. Dimensions are n_{off_OBmax} x [X, Y, Z]. Units are count/nT/degrees_C to the power of 1 through n_{off_OBmax}.

Field Name	Type	Shape	Units	Summary
ib_fact_scal_comp_const_di	double	n_{off_IBmax} x 3	various	IB factory scaling compensation constants. Dimensions are n_{off_IBmax} x [X, Y, Z]. Units are count/nT/degrees_C to the power of 1 through n_{off_IBmax}.
ob_fact_scal_comp_const_di	double	n_{off_OBmax} x 3	various	OB factory scaling compensation constants. Dimensions are n_{off_OBmax} x [X, Y, Z]. Units are count/nT/degrees_C to the power of 1 through n_{off_OBmax}.
sensor_comp_ref_temp	double	*scalar*	degrees_C	Sensor compensation reference temperature.
elec_comp_ref_temp	double	*scalar*	degrees_C	Electronic compensation reference temperature.
ib_fact_align_correct_parms	double	3 x 3	radians	IB factory alignment correction parameters.
ob_fact_align_correct_parms	double	3 x 3	radians	OB factory alignment correction parameters.
on_orbit_cal_index	byte	*scalar*	unitless	On-orbit calibration index. [0-29] Multiple sets of on-orbit calibration parameters can be stored and retrieved for use in the GPA (up to 30). By default, the most recent should be used, but this index allows for other historical sets of parameters to be used.
on_orbit_index_max	byte	*scalar*	unitless	Maximum number of historical on-orbit calibration values.
ib_on_orbit_zero_offsets	double	on_orbit_index_max x 3	nT	IB on-orbit zero offsets. Offset applied in GPA is secondary to factory instrument offset.
ob_on_orbit_zero_offsets	double	on_orbit_index_max x 3	nT	OB on-orbit zero offsets. Offset applied in GPA is secondary to factory instrument offset.
ib_on_orbit_align_correct_vec	double	on_orbit_index_max x 3	radians	IB on-orbit alignment correction vector. Alignment correction applied in GPA is secondary to factory instrument alignment correction.
ob_on_orbit_align_correct_vec	double	on_orbit_index_max x 3	radians	OB on-orbit alignment correction vector. Alignment correction applied in GPA is secondary to factory instrument alignment correction.
ib_on_orbit_scale_factor_adj	double	on_orbit_index_max x 3	unitless	IB on-orbit scale factor adjustment. Scale factor applied in GPA is secondary to factory instrument scale factor.
ob_on_orbit_scale_factor_adj	double	on_orbit_index_max x 3	unitless	OB on-orbit scale factor adjustment. Scale factor applied in GPA is secondary to factory instrument scale factor.
gradiometer_q_facts	double	3	unitless	Gradiometer Q-factors model parameter; incorporates the ratio of modeled distances from S/C dipole to IB and OB magnetometers.

Field Name	Type	Shape	Units	Summary
elec_temp_range_min	float	*scalar*	degrees_C	Electronic temperature range min used in data screening.
elec_temp_range_max	float	*scalar*	degrees_C	Electronic temperature range max used in data screening.
sensor_temp_range_min	float	*scalar*	degrees_C	Sensor temperature range min used in data screening.
sensor_temp_range_max	float	*scalar*	degrees_C	Sensor temperature range max used in data screening.
measurement_range_min	float	*scalar*	count	Measurement range min used in data screening. -511nT x 64counts/nT = -32704 counts.
measurement_range_max	float	*scalar*	count	Measurement range max used in data screening. 511nT x 64counts/nT = 32704 counts.
mfib_to_boom_trans_matrix	double	3 x 3	unitless	MFIB to BOOM transformation matrix.
mfob_to_boom_trans_matrix	double	3 x 3	unitless	MFOB to BOOM transformation matrix.
boom_to_acrf_trans_matrix	double	3 x 3	unitless	BOOM to ACRF transformation matrix.
orf_to_epn_trans_matrix	double	3 x 3	unitless	ORF to EPN transformation matrix.
acrf_to_brf_trans_matrix	double	3 x 3	unitless	ACRF to BRF transformation matrix.
butterworthfilter_coeff_a0	double	*scalar*	unitless	Butterworth filter coefficient.
butterworthfilter_coeff_a1	double	*scalar*	unitless	Butterworth filter coefficient.
butterworthfilter_coeff_b0	double	*scalar*	unitless	Butterworth filter coefficient.
butterworthfilter_coeff_b1	double	*scalar*	unitless	Butterworth filter coefficient.
elec_temp_conv_coeffs	double	10	various	Electronic temperature conversion coefficients; units are degrees_C/count to the power of 0 through 9.
sensor_temp_conv_coeffs_XY	double	10	various	Sensor temperature conversion coefficients (XY); units are degrees_C/count to the power of 0 through 9.
sensor_temp_conv_coeffs_Z	double	10	various	Sensor temperature conversion coefficients (Z); units are degrees_C/count to the power of 0 through 9.
eng_datavalidity_time_window	double	*scalar*	second	Engineering data validity time window.
counts_to_volt_scale_factor	double	*scalar*	volts/count	Counts to voltage scale factor.
volt_ref_3_75V	double	*scalar*	volts	Voltage reference (3.75V).
volt_ref_1_25V	double	*scalar*	volts	Voltage reference (1.25V).

Field Name	Type	Shape	Units	Summary
current_source	double	*scalar*	amps	Current source.
resistance_ref_resistor	double	*scalar*	ohms	Resistance of reference resistor.

D.6 GLM Instrument Calibration Parameters

The documentation of the GLM L1b Cal INR data file is consistent with the HDF5 file created based on the processing parameter values in instrument vendor provided documentation.

Additional notes:

- Dimensions identified in the "Shape" column are described in the "Summary" column.

Table D.6-1 Description of GLM L1b Cal INR Processing Parameters

Field Name	Type	Shape	Units	Summary
the5MSB_Background	uint16	32	unitless	Factor used in the drift test of the contrast leakage filter
theBurstFilterThreshol d	uint16	*scalar*	count	Threshold used in data formatter burst filter
theCcdMapPoint1	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint2	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint3	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint4	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint5	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint6	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint7	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMapPoint8	uint16	*scalar*	unitless	CCD specification constant used in event normalization
theCcdMappingSideA	uint8	56	unitless	CCD specification constant; table mapping the channel ID, computed from the RTEP ID and Data Formatter ID, into the CCD subarray for GLM instrument side A
theCcdMappingSideB	uint8	56	unitless	CCD specification constant; table mapping the channel ID, computed from the RTEP ID and Data Formatter ID, into the CCD subarray for GLM instrument side B

Field Name	Type	Shape	Units	Summary
theCcdX_Width	uint16	*scalar*	unitless	CCD specification constant; CCD X-axis width
theCcdY_Width	uint16	*scalar*	unitless	CCD specification constant; CCD Y-axis width
theClusterWidth	uint16	*scalar*	pixel	The width in pixel space used to determine if a pixel is a member of a cluster of events; used in frame transfer noise filter
theCoherencyPixelPadding	uint32	*scalar*	pixel	Pixel padding value
theCoherencyProbThreshold	double	*scalar*	unitless	Threshold for coherency event filter
theCoherencyTimeThreshold	double	*scalar*	second	Threshold for coherency event filter
theCrosstalkMatrix	double	56 x 56	unitless	A lookup table indexed by [aggressor event CCD subarray ID x victim event subarray ID], containing the crosstalk amplitude coupling factors for events in the aggressor CCD subarray to generate ghost amplitudes in each of the 55 victim subarrays.
theEventFilterSwitch	uint16	*scalar*	unitless	Series of 1-bit flags used to turn on or off GLM L1b event filters. One bit reserved for toggling between LIS and GLM orientation for the frame transfer noise filter.
theF_Jitter	double	*scalar*	unitless	Scale factor used in contrast leakage filter
theGlintBackgroundThreshold	double	*scalar*	count	Threshold used in solar glint filter
theGlintMaxAmpThreshold	double	*scalar*	count	Threshold used in solar glint filter
theGlintMinAmpThreshold	double	*scalar*	count	Threshold used in solar glint filter
theGlintSpotAmplificationFactor	double	*scalar*	unitless	Threshold intended for solar glint filter; not currently used in GLM L1b calibration processing
theGlintUpdatePeriod	double	*scalar*	second	Threshold intended for solar glint filter; not currently used in GLM L1b calibration processing

Field Name	Type	Shape	Units	Summary
theInitialTrackNeighborCount	uint16	*scalar*	event	Factor used in radiation track filter
theJitterFactor1	double	*scalar*	unitless	Scale factor used in contrast leakage filter
theK_Drift	double	*scalar*	unitless	Factor used in the drift metric calculation of the contrast leakage filter
theMaskedRegionLUT	int8	1300 x 1372	unitless	Indexed by pixel (x,y) in the CCD focal plane, each element is either a one or zero indicating whether the pixel is masked (1) or active (0). Element (0,0) corresponds to the pixel in the upper left corner of the CCD.
theMaxBkgndInitialValue	uint16	*scalar*	count	Threshold used in contrast leakage filter
theMicrosecondsPerMillisecond	uint16	*scalar*	microsecond / millisecond	Conversion factor used in time normalization
theMicrosecondsPerSecond	uint32	*scalar*	microsecond / second	Conversion factor used in time normalization
theMin5MsbBkgndDifference	uint16	*scalar*	unitless	Factor used in the drift test of the contrast leakage filter
theMinAxesRatio	double	*scalar*	unitless	Factor used in the CCD Frame Transfer Noise Filter to determine if there is a streak of events that will be removed.
theMinBkgndDifference	uint16	*scalar*	count	Threshold used in contrast leakage filter
theMinCountCluster	uint16	*scalar*	event	The minimum count to determine if a set of pixels constitutes a cluster of lightning events.
theMinNumAdjacentEvents	uint16	*scalar*	event	Threshold used in CCD Frame Transfer Noise Filter
theNumDarkPixelsPerLine	uint16	*scalar*	pixel	Factor used in overshoot filter
theNumDataFormatters	uint16	*scalar*	unitless	Constant used in data formatter burst filter
theNumFramesPerSec	uint16	*scalar*	frame	CCD specification constant
theNumPixels	uint32	*scalar*	pixel	CCD specification constant
theNumPixelsPerRtep	uint16	*scalar*	pixel	Constant used in data formatter burst filter

Field Name	Type	Shape	Units	Summary
theNumRTEPS_perDataFormatter	uint16	*scalar*	unitless	CCD specification constant; the number of RTEPS per data formatter
theNumUnmaskedPixels	uint32	*scalar*	pixel	Factor used in Coherency filter
theNumberOfFramesPerTimePacket	uint32	*scalar*	frame	The number of event frames per time packet
theNumberOfSecondsPerDay	uint16	*scalar*	second/ day	The number of seconds per day
theOvershootFactorLUT	double	32 x 56	unitless	The overshoot factors based on the CCD subarray and the event 5-MSB background used by the Overshoot filter to correct the amplitudes in subsequent events after a sudden increase.
theProbabilityLUT	double	54 x 32 x 2	unitless	A lookup table indexed by [Event Amplitude x Event 5 MSB background x Instrument Electronics Side], where each element holds the probability of an event for each event amplitude and event background combination. The 0th element of the first dimension holds the event background levels, while the 0th element of the second dimension holds the event amplitude levels. The third dimension is the instrument side (side A/ side B).
theRTEP_ThresholdTable	uint16	32 x 56 x 2	pixel	Used in contrast leakage filter
theRTEP_Y_Height	uint16	*scalar*	pixel	CCD specification constant used in event normalization
theRadiometricCalibrationLUT_SideA	float	32 x 1300 x 1372	joule/ count	A lookup table indexed by [5 MSB background x CCD columns x CCD rows], representing the calibration coefficients used for converting the event amplitude to radiometric units of joules based on the event x-pixel, y-pixel, and background 5 most significant bits for instrument side A.
theRadiometricCalibrationLUT_SideB	float	32 x 1300 x 1372	joule/ count	A lookup table indexed by [5 MSB background x CCD columns x CCD rows], representing the calibration coefficients used for converting the event amplitude to radiometric units of joules based on the event x-pixel, y-pixel, and background 5 most significant bits for instrument side B.

Field Name	Type	Shape	Units	Summary
theSecondLevelThresholdLUT	uint16	1300 x 1372 x 2	count	A lookup table indexed by pixel (x,y) in the CCD focal plane and instrument electronics side (side A/side B), where each element is 2 bytes (unsigned) to hold the 14 bit value that effectively raises the background threshold. Used during the 2nd Level Threshold Filter and the Contrast Leakage Filter.
theStreakSearchOffset	uint16	*scalar*	pixel	Factor used in the CCD Frame Transfer Noise filter
theTrackNeighborCount	uint16	*scalar*	event	Factor used in the Radiation Track filter

D.7 ABI Image, Navigation and Registration (INR) Parameters

The ABI L1b INR algorithms consists of three CSCs: the ABI L1b INR StarNav Algorithm, the ABI L1b INR Kalman Filter Algorithm, and the ABI L1b Resampling Algorithm Each of the algorithms processes the ABI L1a telemetry or L1-alpha science data using a set of Cal INR data objects. Each Cal INR file contains a single top-level XML group comprising one or more variables.

In some cases, there are multiple CalINR files that share a common structure, each containing data specific to a single ABI band. In such cases, the ABI Band to which the file applies is denoted in the file name by the word "Band", followed by a one or two digit number.

Table D.7-1 lists the complete set of CalINR data files used for the ABI L1b INR StarNav Algorithm.

Table D.7-1 List of ABI INR Cal INR Files Used by the ABI L1b INR StarNav Algorithm

FTEParameters.xml	StarDetectionParams.xml
ABI_NavigationRDP_Band2.xml	ABI_NavigationRDP_Band7.xml

Table D.7-2 lists the complete set of CalINR data files used for the ABI L1b INR Kalman Filter Algorithm.

Table D.7-2 List of ABI INR Cal INR Files Used by the ABI L1b INR Kalman Filter Algorithm

KalmanAstroConsts.xml	KalmanFilterControls.xml	KalmanMeasMaxSensibles.xml
KalmanPreprocessorControls.xml	KalmanStarCatalogs.xml	KalmanReferenceData.xml

Table D.7-3 lists the complete set of CalINR data files used for the ABI L1b Resampling Algorithm. For those file names with the wildcard character "*" in their filename there are sixteen files where the "*" can take any value from 1 through 16 inclusive corresponding to the ABI band the file applies to.

Table D.7-3 List of ABI INR Cal INR Files Used by the ABI L1b Resampling Algorithm

ABI_NavigationParameters_Band*.xml	ABI_NavigationRDP_Band*.xml
ABI_ResamplingImplementation_Band*.xml	ABI_ResamplingParameters_Band*.xml
ResamplingScaledConversion.xml	

Note that in operational use the name of CalINR files will differ from that given above by the inclusion of the time stamp before the file type suffix (e.g. KalmanReferenceData.xml may be implemented as KalmanReferenceData-777.0.xml).

Table D.7-4 Description of FTEParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theBoundingAngleMin	double	*scalar*	radians	The minimum value for the bounding angle used in the servo error message
theBoundingAngleMax	double	*scalar*	radians	The maximum value for the bounding angle used in the servo error message
theCountsToRadiansNS	double	*scalar*	radians / count	Coefficient used to convert scan encoder angle from units of radians to digital counts in the NS direction.
theCountsToRadiansEW	double	*scalar*	radians / count	Coefficient used to convert scan encoder angle from units of radians to digital counts in the EW direction.
theScanAngleSampleSize	uint	*scalar*	unitless	The number of servo error and scan angle samples.
theHarmonicFreqRangesCount	uint	*scalar*	unitless	The number of harmonic frequency ranges.
theHarmonicFreqRanges	double	5 x 2	Hz	Narrow limiting bounds within which each harmonic frequency is found, per harmonic and frequency. The first two values are zero and are ignored in processing.
theMovingAverageWindowSize	uint	*scalar*	unitless	Moving average filter window size.

Table D.7-5 Description of StarDetectionParams Processing Parameters

Field Name	Type	Shape	Units	Summary
theOmegaE	double	*scalar*	μrad/sec	Earth Rotation rate / Sidereal Drift Rate
theDetectorSubsetUsed	double	16 x 2 x 4	unitless	Number of detector elements used for star scene per channel. Only parameters for ABI Band 2 and ABI Band 7 are used.
theScansUsed	double	16	unitless	Number of scans used in star collect channel - approximate, actual in telemetry. Only parameters for ABI Band 2 and ABI Band 7 are used.
theN_EW	double	16	unitless	Number of elements in E/W median filter for processing the channel star data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theN_LP	double	16	unitless	Number of elements in E/W Low Pass filter for processing the channel star data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theM_EW	double	16	unitless	Number of elements in E/W median filter for processing the channel star data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theM_LP	double	16	unitless	Number of elements in E/W Low Pass filter for processing the channel star

Field Name	Type	Shape	Units	Summary
				data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theDelta_LP	double	16	columns	Interval at which the E/W low pass filter is applied for processing the channel star data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theN_NS	double	16	unitless	Number of elements used in the N/S median removal for processing the channel star data. Only parameters for ABI Band 2 and ABI Band 7 are used.
theDelta_N	double	2 x 16	radians	Star image North offset, with dimensions of the number of ABI instrument sides and bands. Only parameters for ABI Band 2 and ABI Band 7 are used.
theDelta_S	double	2 x 16	radians	Star image South offset, with dimensions of the number of ABI instrument sides and bands. Only parameters for ABI Band 2 and ABI Band 7 are used.
theA_N_EW_Offset	double	2 x 16	radians	Northern group E/W offset, with dimensions of the number of ABI instrument sides and bands. Only parameters for ABI Band 2 and ABI Band 7 are used.
theA_S_EW_Offset	double	2 x 16	radians	Southern group E/W offset, with dimensions of the number of ABI instrument sides and bands. Only parameters for ABI Band 2 and ABI Band 7 are used.
theS_Threshold	double	16	$W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$ (VNIR), $mW / (m^2\ sr\ cm^{-1})$ (IR)	Radiance threshold for star detection Only parameters for ABI Band 2 and ABI Band 7 are used.
theSigmaPointing	double	*scalar*	micro-radians	ABI Pointing Uncertainty Noise threshold for navigation
theScanRate	double	16	unitless	Scan rate Multiplier for Visible and IR.
theStarCalPercentile	double	16	unitless	Percentile threshold for star calibration

Table D.7-6 Description of ABI_NavigationRDP_Band2 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand2_EW_RDP	double	2 x 1460 x 3	radians	The ABI EW Relative Detector positions
theBand2_NS_RDP	double	2 x 1460 x 3	radians	The ABI NS Relative Detector positions

Table D.7-7 Description of ABI_NavigationRDP_Band7 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand2_EW_RDP	double	2 x 332 x 6	radians	The ABI EW Relative Detector positions
theBand2_NS_RDP	double	2 x 332 x 6	radians	The ABI NS Relative Detector positions

Table D.7-8 Description of KalmanAstroConsts Processing Parameters

Field Name	Type	Shape	Units	Summary
theAstronomicalUnit	double	*scalar*	km	Astronomical Unit
theEarthSemiMajorAxis	double	*scalar*	km	Earth mean equatorial radius
theEarthInverseFlattening	double	*scalar*	unitless	Inverse earth flattening
theEarthRotationRate	double	*scalar*	radians/s	Nominal earth rotation rate
theEarthGravitationalConstant	double	*scalar*	km^3s^{-2}	Earth gravitation constant
theSunGravitationalConstant	double	*scalar*	km^3s^{-2}	Sun gravitation constant
theMoonGravitationalConstant	double	*scalar*	km^3s^{-2}	Moon gravitation constant
theSunRadius	double	*scalar*	km	Radius of the visible sphere of the Sun
theMoonRadius	double	*scalar*	km	Moon equatorial radius
theSolarFlux	double	*scalar*	W/m	Solar flux at 1 Astronomical Unit

Table D.7-9 Description of KalmanFilterControls Processing Parameters

Field Name	Type	Shape	Units	Summary
theABI_QBoost_NumberOfEntries	int	*scalar*	unitless	Number of vector / array elements
theABI_QBoost_MinBeta	double	*scalar*	degrees	Minimum sun "beta" angles
theABI_QBoost_MaxBeta	double	*scalar*	degrees	Maximum sun "beta" angles
theABI_QBoost_BoostStartSlt	double	*scalar*	HHMM of day	Start spacecraft-local-time for Qboost
theABI_Qboost_BoostStopSlt	double	*scalar*	HHMM of day	Stop spacecraft-local-time for Qboost
theABI_QBoost_NominalSigmaUm	double	1X9	micro-radians/ $sec^{3/2}$	Nominal (non-boost) thermal rate random walk standard deviations for \`NUM_ANGLE_STATES\` model angle states
theABI_QBoost_NominalSigmaVm	double	1X9	micro-radians/ $sec^{1/2}$	Nominal (non-boost) thermal angle random walk standard deviations for \`NUM_ANGLE_STATES\` model angle states
theABI_QBoost_BoostSigmaUm	double	1X9	micro-radians/ $sec^{3/2}$	Boost thermal rate random walk standard deviations for \`NUM_ANGLE_STATES\` model angle states
theABI_QBoost_BoostSigmaVm	double	1X9	micro-radians/ $sec^{1/2}$	Boost thermal angle random walk standard deviations for \`NUM_ANGLE_STATES\` model angle states

Field Name	Type	Shape	Units	Summary
theAngRateBufferSize	int	*scalar*	unitless	Number of entries in cyclic buffer storing past angular rate samples. Since ABI star sense windows will be about 2 seconds, buffer should about 3 seconds, i.e., 3 sec *100samples/sec =300 samples.
theFilterInitializationSigma	double	*scalar*	micro-radians	Threshold for 1-sigma pointing uncertainty (microradians) required before filter status is set to "normal" and (e.g., 10 microradians)
theFilterInitializationStarCount	int	*scalar*	unitless	Required number of VIS stars processed after filter initialization to start meeting INR requirements, i.e., "normal" filter status, (e.g., 4)
theInitialStateSigma	double	18	micro-radians and micro-radians/s	State initial 1-sigma
theInitialStateValue	double	18	micro-radians and micro-radians/s	State initial value
theIrResidSigma	double	*scalar*	micro-radians	Expected 1-sigma for visible-to-IR star residuals. Only used for editing test.
theIrStarAngleNoiseSigma	double	2	micro-radians	IR star measurement noise 1-sigma for E/W and N/S angles
theIrStarFitHalfWindowTime	double	*scalar*	minutes	Half-window time duration (minutes) of span used for polynomial fit of vis-IR star residuals (360 min)
theQRefDeltaTimeSec	double	*scalar*	s	Time interval (s) for integrating the process noise variance to compute the first performance metric, e.g., 100 s
theResidualStatisticsWindow	double	*scalar*	minutes	Sliding time window (window) for computing statistics on star residuals (e.g., 30 minutes)
theSpacecraftSigmaE	double	3	micro-radians	Spacecraft angle white noise standard deviation (roll, pitch, yaw)
theSpacecraftSigmaU	double	3	micro-radians/ $sec^{3/2}$	Spacecraft rate random walk standard deviation (roll, pitch, yaw)
theSpacecraftSigmaV	double	3	micro-radians/ $sec^{1/2}$	Spacecraft angle random walk standard deviation (roll, pitch, yaw)
theStarEditCount_ResetFilter	int	*scalar*	unitless	Number of consecutive star measurements edited in Kalman filter before a full filter reset is triggered (10)
theStarResidual_NSigmaLimit	double	*scalar*	unitless	If abs(star residual) > starResidual_NsigmaLimit * expected residual 1-sigma, star is edited from filter
theStatePhaseInTime	double	*scalar*	s	Smoothed state vector update (phase-in) period (nominally 150 sec).

Field Name	Type	Shape	Units	Summary
theUseGpsEphemerisFlag	int	*scalar*	unitless	True if PG Kalman is using the downlinked GPS ephemeris. False if using INR O&A-predicted ephemeris
theVisStarAngleNoiseSigma	double	2	micro-radians	Star measurement noise 1-sigma for E/W and N/S angles

Table D.7-10 Description of KalmanMeasMaxSensibles Processing Parameters

Field Name	Type	Shape	Units	Summary
theAngularRate	double	*scalar*	micro-radians/s	Maximum spacecraft angular rates (e.g., 300 microrad/s)
theAttitudeQuaternionTolerance	float	*scalar*	unitless	Maximum deviation from unity for magnitude of attitude quaternion
theIrLandmarkDetectorEw	double	*scalar*	micro-radians	Landmark absolute MWIR EW detector angle for any channel (microradians)
theLandmarkDetectorNs	double	*scalar*	micro-radians	Maximum landmark absolute NS detector angle (e.g., 8000 microradians)
theLandmarkMirrorAngles	double	*scalar*	radians	Maximum landmark mirror encoder angles (radians) before multiplication by 2 (e.g., 0.08)
theLandmarkPositionTolerance	double	*scalar*	km	The maximum allowed deviation from the nominal landmark position (theEarthSemiMajorAxis)
theNominalOrbitPositionMagnitude	float	*scalar*	m	Nominal Geostationary orbital radius
theNominalOrbitVelocityMagnitude	float	*scalar*	m/s	Nomincal Geostationary orbital velocity
theOrbitEccentricityLimit	float	*scalar*	unitless	Dimensionless.
theOrbitPositionTolerance	float	*scalar*	m	The maximum allowed deviation for orbital position from nominal.
theOrbitVelocityTolerance	float	*scalar*	m/s	The maximum allowed deviation for orbital velocity from nominal.
theStarEwDetector	double	*scalar*	micro-radians	Star absolute E/W detector angle (e.g., 8000 microradians)
theStarMirrorAngles	double	*scalar*	radians	Maximum star mirror encoder angles (radians) before multiplication by 2 (e.g., 0.125)
theStarNsDetector	double	*scalar*	micro-radians	Star absolute N/S detector angle (e.g., 8000 microradians)
theVisLandmarkDetectorEw	double	*scalar*	micro-radians	Maximum landmark absolute visible EW detector angle (microradians).

Table D.7-11 Description of KalmanPreprocessorControls Processing Parameters

Field Name	Type	Shape	Units	Summary
theAngularRateGapLimit_ResetFilter	double	*scalar*	s	Time gap since last valid angular rate to trigger reset of filter

Field Name	Type	Shape	Units	Summary
theAngularRateGapLimit_Warning	double	*scalar*	s	Time gap (s) since last valid angular rate to trigger warning message (1.0)
theAngularRateSamplingInterval	double	*scalar*	s	Sampling time interval (0.01 s) for angular rates (100 Hz: DO NOT RESET)
theAttitudeRejectCountLimit	int	*scalar*	unitless	Number of consecutive rejected spacecraft attitude quaternions triggering a warning message (e.g., 10)
theDataGapTime_Reset	double	*scalar*	s	Time interval (s) of no measurements before a filter reset of 3 attitude states is triggered (e.g., 300.0 s)
theHeartbeatFileTimeIncrement	double	*scalar*	s	Nominal interval (s) between heartbeat messages written to file (e.g., 1.0)
theIrStarRejectCountLimit	int	*scalar*	unitless	Number of consecutive rejected IR star measurements triggering warning message
theLandmarkStaleTime	double	*scalar*	s	The age limit for which a star measurement is considered stale.
theLoopWaitTimeInMilliSec	double	*scalar*	ms	Wait time at beginning of each main processing loop iteration
theOrbitGapLimit	double	*scalar*	s	Time gap (s) in orbit samples stopping generation of smoothed states (e.g., 900)
theOrbitRejectCountLimit	int	*scalar*	unitless	Number of consecutive rejected spacecraft orbit samples triggering a warning message (e.g., 10)
theSc_GndDelayUpdateInterval	double	*scalar*	s	Sliding time window (seconds) for computing the space-to-ground delay
theSmoothStateGapLimit	double	*scalar*	s	The maximum time gap (seconds) between publishing of smooth states before switching the Backup Filter to Primary.
theStarGapLimit_ResetFilter	double	*scalar*	s	Time gap (s) in star measurements triggering a filter reset (e.g., 600)
theStarGapLimit_Warning	double	*scalar*	s	Time gap (s) in star measurements triggering a warning message (e.g., 300)
theStarStaleTime	double	*scalar*	s	The age limit for which a star measurement is considered stale.
theVisStarRejectCountLimit	int	*scalar*	unitless	Number of consecutive rejected visible star measurements triggering warning message (e.g., 5)

Table D.7-12 Description of KalmanStarCatalogs Processing Parameters

Field Name	Type	Shape	Units	Summary
theChannelsUsed	int	2006	unitless	Channels used for sensing this star (0 =0.64 visible, 1 =3.90 IR, 2 =both)
theDeclination	double	2006	radians	Star J2000 declination
theID_Num	int	2006	unitless	Star location in ground catalog (should match index of starCat)

Field Name	Type	Shape	Units	Summary
theID_Ref	int	2006	unitless	Star number in SKY2000 catalog
theMagnitudeIR	double	2006	mW-cm/ m^2/sr	Star MWIR (3.90 micron) intensity (radiance mW-cm/m^2/sr)
theMagnitudeVisible	double	2006	W/m^2/sr/ micrometer	Star visible (0.64 micron) intensity (radiance W/m^2/sr/micrometer)
theParallax	double	2006	radians	Parallax constant
theProperMotionDec	double	2006	radians/ year	Star proper motion J2000 declination
theProperMotionRA	double	2006	radians/ year	Star proper motion: J2000 right ascension
theRightAscension	double	2006	radians	Star J2000 right ascension
theFiller4	int	*scalar*	unitless	4-byte filler to double word boundary

Table D.7-13 Description of KalmanReferenceData Processing Parameters

Field Name	Type	Shape	Units	Summary
theReferenceWestLongitude	double	*scalar*	degrees	GOES-R or S reference west longitude
theReferenceGeosyncRadius	double	*scalar*	km	GOES-R or S reference geosynchronous radius
theYawFlip	int	*scalar*	unitless	Yaw flip status (+1 =up, -1 = invert) from telemetry
theEwStarOffsetVis	double	*scalar*	micro-radians	EW offset (microradians) of linear array used for star detection (visible)
theEwStarOffsetIr	double	*scalar*	micro-radians	EW offset (microradians) of linear array used for star detection (IR)
theEwStarOffsetNs	double	2	micro-radians	EW offset (microradians) from center of focal plane during star sense using north (1) or south (2) end of focal plane

Table D.7-14 Description of ABI_NavigationParameters_Band[1to16] Processing Parameters

Field Name	Type	Shape	Units	Summary
theStackHeight	int	*scalar*	unitless	Maximum number of rows in detector stack
theNumberOfRedundantColumns	int	*scalar*	unitless	The number of redundant DetectorSelectMap columns
theScanRate	double	*scalar*	radians/s	Nominal East-West can rate in radians/s
theResetTime	double	*scalar*	s	Sample timing related reset time (s)
theDelaySample	double	*scalar*	s	Sample timing related delay parameter (s).
theFrameTime	double	*scalar*	s	Frame time in seconds
theASD	double	*scalar*	unitless	Parameter no longer used in software but retained to keep format consistent.
theIFOV_EW	double	*scalar*	unitless	Parameter no longer used in software but retained to keep format consistent.
theIFOV_NS	double	*scalar*	radians	IFOV NS (radians)

Field Name	Type	Shape	Units	Summary
theStartingRow	int	*scalar*	unitless	Starting row for active detectors on detector stack
theNumberOfActiveRows	int	*scalar*	unitless	Number of active detector rows in stack
theIntegrationTimeFactor	int	*scalar*	unitless	Integration Time Factor multiples default integration time
theGeostationaryOrbitRadius	double	*scalar*	m	Geostationary orbit radius, meters
theEarthEquatorialRadius	double	*scalar*	m	Equatorial Earth radius, meters
theEarthPolarRadius	double	*scalar*	m	Polar Earth radius, meters
theEarthFlattening	double	*scalar*	unitless	GRS80 Earth flattening
theBandEnabledFlagArray	ubyte	16	unitless	Parameter no longer used in software but retained to keep format consistent.

Table D.7-15 Description of ABI_NavigationRDP_Band[1or3] Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand[1or3]_EW_RDP	double	2 x 676 x 3	radians	The ABI EW Relative Detector positions
theBand[1or3]_NS_RDP	double	2 x 676 x 3	radians	The ABI NS Relative Detector positions

Table D.7-16 Description of ABI_NavigationRDP_Band[4or6] Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand[4or6]_EW_RDP	double	2 x 372 x 6	radians	The ABI EW Relative Detector positions
theBand[4or6]_NS_RDP	double	2 x 372 x 6	radians	The ABI NS Relative Detector positions

Table D.7-17 Description of ABI_NavigationRDP_Band5 Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand5_EW_RDP	double	2 x 676 x 6	radians	The ABI EW Relative Detector positions
theBand5_NS_RDP	double	2 x 676 x 6	radians	The ABI NS Relative Detector positions

Table D.7-18 Description of ABI_NavigationRDP_Band[8to12] Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand[8or9or10or11or12]_EW_RDP	double	2 x 332 x 6	radians	The ABI EW Relative Detector positions

Field Name	Type	Shape	Units	Summary
theBand[8or9or10or11or12]_NS_RDP	double	2 x 332 x 6	radians	The ABI NS Relative Detector positions

Table D.7-19 Description of ABI_NavigationRDP_Band[13to16] Processing Parameters

Field Name	Type	Shape	Units	Summary
theBand[13or14or15or16]_EW_RDP	double	2 x 408 x 6	radians	The ABI EW Relative Detector positions
theBand[13or14or15or16]_NS_RDP	double	2 x 408 x 6	radians	The ABI NS Relative Detector positions

Table D.7-20 Description of ABI_ResamplingImplementation_Band[1to16] Processing Parameters

Field Name	Type	Shape	Units	Summary
theMissingSampleFillValue	double	*scalar*	Vis: W/m^2/sr/micrometer IR: mW-cm/m^2/sr	Sample fill value for missing samples. This does apply to input L1-alpha data, but will also be used in output pixels that have zero contributors but are not "fill", i.e. pixels where all contributors are missing and/or non-nominal.
theSaturationRadiance	double	*scalar*	Vis: W/m^2/sr/micrometer IR: mW-cm/m^2/sr	Sample radiance value corresponding to saturation. One value per band
theUnderSaturationRadiance	double	*scalar*	Vis: W/m^2/sr/micrometer IR: mW-cm/m^2/sr	Sample radiance value corresponding to under saturation. One value per band
theMaxAllowedPixelRadiance	double	*scalar*	Vis: W/m^2/sr/micrometer IR: mW-cm/m^2/sr	Maximum allowed Pixel radiance for this band. Pixels that have computed radiances greater than this value will have their radiance reset to this value within the ABI L1b Resampling Algorithm prior to block level metadata calculation.
theMinAllowedPixelRadiance	double	*scalar*	Vis: W/m^2/sr/micrometer IR: mW-cm/m^2/sr	Minimum allowed Pixel radiance for this band. Pixels that have computed radiances less than this value will have their radiance reset to this value within the ABI L1b Resampling Algorithm prior to block level metadata calculation.
theConditionalUseMethodIsWeightBased	int	*scalar*	unitless	Is The Pixel Conditional Use Method Based on Weights? True = 1, false = 0.

Field Name	Type	Shape	Units	Summary
				If true, then the conditional use flag for a pixel is based on the sum of the weights of the valid contributing samples. If false, then the conditional use flag depends on the number of non-missing contributing samples.
theConditionalUseWeightThreshold	double	*scalar*	unitless	Conditional Use Threshold Sum of Weights. One value per band. Used if theConditionalUseMethodIsWeightBased is true.
theMinContributingSamplesThreshold	int	*scalar*	unitless	Conditional Use Minimum Contributing Samples (if weight based method = false). One value per band. If the number of samples contributing to a pixel is less than this the pixel will be set as conditional use. Used if theConditionalUseMethodIsWeightBased is false;
theDataFabricQueryFailureTimeThreshold	double	*scalar*	s	Data Fabric Query Failure Time Threshold (seconds). If Data Fabric queries consistently fail for longer than this period, then Resampling will treat this as a non-recoverable FATAL error. The presumption is that the Data Fabric is no longer in a state to support ongoing computation. This applies to both inputs and outputs via the Data Fabric.
theSparsenessFactor	int	*scalar*	unitless	Navigation Array Sparseness. One value per band
theAverageOutlierSampleFraction	double	*scalar*	unitless	Average Sample Outlier Fraction Expected (fraction of all samples expected to be saturated). One value per band
theOutlierProcessingCutOffMultiplier	double	*scalar*	unitless	Outlier Processing Cut-Off Multiplier (multiple of average rate). One value per band. If the fraction of the samples in the current block that have been identified as outliers is greater than this multiplier times the average expected outlier sample fraction, then Resampling will cease to identify outliers in the current block. This is to prevent the computational cost associated with outlier processing from introducing unacceptable latency to the time-critical L1b product generation.
theProcessingTimeOut	double	*scalar*	s	Processing Time Out Window to activate automatic shutdown (seconds). If no new L1-alpha blocks appear within this time after the last one

Field Name	Type	Shape	Units	Summary
				received, then the resampler will shut down.
theOperationalMode	int	*scalar*	unitless	Operational Mode. Used to enables Pixel-level Diagnostic Mode, where 0=Normal Mode and 1=Diagnostic Mode
theResamplingIsDimensionallySplit	int	*scalar*	unitless	Is Dimensionally Split Operation Pixel Resampling Allowed for DeltaN < DeltaNMax? True = 1, False = 0. If dimensionally split resampling is allowed, then the resampler checks if the difference in deltaN values for each sample in a row of contributing samples is less than DeltaNMax, and if so then it can apply the same North-weight to those samples. If DeltaN >= DeltaNMax then individual North weights are calculated. If this flag is false, then individual North weights are always calculated.
theDeltaNMax	double	*scalar*	unitless	Maximum DeltaN Beyond Which Pixel Resampling Cannot Be Dimensional Split (Units of ASD_NS). The default value is one half of a resampling kernel bin width, i.e., theDeltaNMax = 0.5*2*ASD/128 = ASD/128;
theAdditionalSPM	double	*scalar*	radians	Additional Swath Processing Margin introduced by the shifts for each band detector
theMaxConsecutiveDisabledSMA	int	*scalar*	unitless	The allowable number of consecutive disabled scan mirror angle elements

Table D.7-21 Description of ABI_ResamplingParameters_Band[1to16] Processing Parameters

Field Name	Type	Shape	Units	Summary
theFG_Spacing	double	*scalar*	radians	FG pixel spacing in radians
theASD_EW	double	*scalar*	radians	ASD EW (ASD) radians
theASD_NS	double	*scalar*	radians	ASD NS equals IFOV NS radians
theSwathP_MarginEW	double	*scalar*	radians	Swath processing margin EW in radians
theSwathP_MarginNS	double	*scalar*	radians	Swath processing margin NS radians
theSceneDimensions	double	5 x 4	unitless	Scene Dimensions is an array of dimensions [scenes][dimensions]. Indices are provided by C++ enumerations. The scenes enumeration is enum ABI_SCENES {FD = 0, MESO = 1, CONUS_E = 2, CONUS_W = 3, CONUS_TEST = 4}. The dimensions enumeration is enum ABI_DIMENSION_INDEX {CENTER_EW = 0, CENTER_NS = 1, WIDTH_EW = 2, HEIGHT_NS = 3}.

Field Name	Type	Shape	Units	Summary
theEW_WeightingKernel	double	2 x 16 x 128	unitless	The scan-direction (roughly EW) weighting function for the appropriate band/data path/side. Dimensions are [ABI_SIDES][BANDS][WEIGHT_COUNT]
theNS_WeightingKernel	double	2 x 16 x 128	unitless	The cross-scan-direction (roughly NS) weighting function for the appropriate band/data path/side. Dimensions are [ABI_SIDES][BANDS][WEIGHT_COUNT]
theAlignmentDeltaEeOffset	double	*scalar*	radians	Line of Sight alignment offset E
theAlignmentDeltaNeOffset	double	*scalar*	radians	Line of Sight alignment offset N

Table D.7-22 Description of ResamplingScaledConversion Processing Parameters

Field Name	Type	Shape	Units	Summary
BitDepth	int	16	unitless	Band-specific bit depth for conversion of floating point radiances to scaled integer radiance.
MaxValue	int	16	unitless	Maximum allowed 16-bit value, corresponds to 2^BitDepth – 1. This value is used as the fill value for missing or space pixels.
Gains	double	16	unitless	The gain value G in the relationship between output scaled integer radiance S and floating point radiance R, where S = G*R+B.
Biases	double	16	unitless	The bias value B in the relationship between output scaled integer radiance S and floating point radiance R, where S = G*R+B.

D.8 SUVI Image, Navigation and Registration (INR) Parameters

The SUVI L1b INR Algorithm processes the SUVI L1-alpha science data using Cal INR data objects. Each Cal INR file contains a single top-level XML group comprising one or more variables.

Table D.8-1 lists the complete set of CalINR data files used for the SUVI L1b INR Algorithm.

Table D.8-1 List of all SUVI Cal INR Files Used by the SUVI L1b INR Algorithm

SUVI_NavigationParameters.xml	

Note that in operational use the name of Cal INR files will differ from that given above by the inclusion of the time stamp before the file type suffix (e.g. SUVI_NavigationParameters.xml may be implemented as SUVI_NavigationParameters-888.0.xml).

Table D.8-2 Description of SUVI_NavigationParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
PLATE_SCALE	double	*scalar*	arcseconds / pixel	Scale factor for converting pixels to arcseconds
WAVELENGTH_X_OFFSETS	double	6	pixel	Wavelength offsets in the X direction
WAVELENGTH_Y_OFFSETS	double	6	pixel	Wavelength offsets in the Y direction
GUIDE_TELESCOPE_EUV_X_OFFSET	double	*scalar*	arcseconds	The Guide Telescope to Extreme Ultra Violet Telescope offsets in X direction
GUIDE_TELESCOPE_EUV_Y_OFFSET	double	*scalar*	arcseconds	The Guide Telescope to Extreme Ultra Violet Telescope offsets in Y direction
GT_X_DIODE_READING_CONVERSION	double	*scalar*	pixel / (diode reading)	The correlations between GT X Diode Readings to the sun
GT_Y_DIODE_READING_CONVERSION	double	*scalar*	pixel / (diode reading)	The correlations between GT Y Diode Readings to the sun
SPP_TO_SUVI_CCD_ALIGNMENT_ROLL_OFFSET	double	*scalar*	arcseconds	The Offset roll angle between the SUVI feet attached to the SPP and SUVI Boresight

D.9 GLM Image, Navigation and Registration (INR) Parameters

The SUVI L1b INR Algorithm processes the SUVI L1-alpha science data using Cal INR data objects. Each Cal INR file contains a single top-level XML group comprising one or more variables.

The GLM L1b INR Algorithm CSC consists of three algorithm CSUs: GLM Alignment Update CSU, GLM Coastline Identification CSU, and GLM Lightning Event Geolocate CSU. Each of the algorithms processes L1a or L1-alpha level science data using one or more Cal INR data objects. Each Cal INR file contains a single top-level XML group comprising one or more variables.

Table D.9-1 lists the complete set of CalINR data files used for the GLM L1b INR Algorithm.

Table D.9-1 List of all GLM Cal INR Files Used by the GLM L1b INR Algorithm

GLM_AlignmentParameters.xml	GLM_BG_Assemble.xml
GLM_CoastlineID_Parameters.xml	GLM_DownSamplingLUTs.xml
GLM_GSHHS_data.xml	GLM_LightningSphereRadiusLUT.xml
GLMNavigationParams.xml	

Note that in operational use the name of CalINR files will differ from that given above by the inclusion of the time stamp before the file type suffix (e.g. GLMNavigationParams.xml may be implemented as GLMNavigationParams-888.0.xml).

Table D.9-2 Description of GLM_AlignmentParameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theDavg	uint	*scalar*	days	The number of days over which roll, pitch and yaw (RPY) readings are averaged in creating the daily average RPY
theNvalid	uint	*scalar*	unitless	The minimum number of valid RPY measurements necessary to computed a daily average RPY from
theAlignmentUpdateStartTime	uint	*scalar*	seconds	Start of time window within which the algorithm should run. UTC seconds since the start of the day counting from the 2000 January 01 12:00PM epoch
theAlignmentUpdateEndTime	uint	*scalar*	seconds	End of time window within which the algorithm should run. UTC seconds since the start of the day counting from the 2000 January 01 12:00PM epoch

Table D.9-3 Description of GLM_BG_Assemble Processing Parameters

Field Name	Type	Shape	Units	Summary
theSubarrayNum	ushort	*scalar*	unitless	The number of subarrays
theSubarrayRows	ushort	*scalar*	unitless	The rows per subarray

Field Name	Type	Shape	Units	Summary
theSubarrayCols	ushort	*scalar*	unitless	The columns per subarray
theSubarrayPixels	uint	*scalar*	unitless	The number of pixels per subarray
theRTEP_MapSet1	ushort	56	unitless	The GLM CCD sub-array mapping table 1
theRTEP_MapSet2	ushort	56	unitless	The GLM CCD sub-array mapping table 2

Table D.9-4 Description of GLM_CoastlineID_Parameters Processing Parameters

Field Name	Type	Shape	Units	Summary
theGaussianBlurFilter	float	5 x 5	unitless	The Gaussian blur filter used before Sobel filtering
theSobelBlurFilterX	float	3 x 3	unitless	The Sobel blur filter in x
theSobelBlurFilterY	float	3 x 3	unitless	The Sobel blur filter in y
theHystThreshLow	float	*scalar*	unitless	The hysteresis thresholds lower threshold, as a percentage of the image WhiteValue
theHystThreshHigh	float	*scalar*	unitless	The hysteresis thresholds upper threshold, as a percentage of the image WhiteValue
theHystThreshMaxIterations	uint	*scalar*	unitless	The maximum number of loops through the hysteresis thresholding algorithm
theWhiteValue	ushort	*scalar*	unitless	The non-zero value representing edge pixels in edge-detected coastline
theGaussianFilter	float	11	unitless	The Gaussian filter
theGaussianDiffFilter	float	11	unitless	The Gaussian difference filter
theLucasKanadeMaxIterations	uint	*scalar*	unitless	The maximum number of Lucas-Kanade iterations
theLucasKanadeTol	float	*scalar*	pixels or radians	The Lucas-Kanade convergence tolerance
theNeighRangeEW	uint	*scalar*	pixels	The neighborhood range, east-west
theNeighRangeNS	uint	*scalar*	pixels	The neighborhood range, north - south
theCoastlineID_StartTime	uint	*scalar*	seconds	The start of the UTC time window used to ensure that coastline matching only done during daylight
theCoastlineID_EndTime	uint	*scalar*	seconds	The end of the UTC time window used to ensure that coastline matching only done during daylight

Table D.9-5 Description of GLM_DownSamplingLUTs Processing Parameters

Field Name	Type	Shape	Units	Summary
theDS_Rows	uint	*scalar*	unitless	The number of rows in the downsampling arrays
theDS_Cols	uint	*scalar*	unitless	The number of columns in the downsampling arrays
theDS_MaxContributors	uint	*scalar*	unitless	The maximum number of GLM CCD pixels that could be contained (partially or wholly) in a given downsampled pixel
theDS_PixelSize	uint	*scalar*	micrometers	The size of downsampled pixels

Field Name	Type	Shape	Units	Summary
theDS_XCorner	uint	*scalar*	micrometers	The length (X coordinate) of a quadrant of the downsampled grid
theDS_YCorner	uint	*scalar*	micrometers	The height (Y coordinate) of a quadrant of the downsampled grid
theDS_NumContributors	ushort	1186 x 1176	unitless	The number of GLM CCD pixels that contributed to each downsampled pixel
theDS_RowIndices	ushort	1186 x 1176 x 9	unitless	The row coordinate of each GLM CCD pixel that contributed to each downsampled pixel
theDS_ColIndices	ushort	1186 x 1176 x 9	unitless	The column coordinate of each GLM CCD pixel that contributed to each downsampled pixel
theDS_Weights	Float	1186 x 1176 x 9	unitless	The weight of each GLM CCD pixel that contributed to each downsampled pixel

Table D.9-6 Description of GLM_GSHHS_Data Processing Parameters

Field Name	Type	Shape	Units	Summary
theDM_Vectors	double	5424 x 5424 x 3	km	The shoreline vectors from the Global Self-consistent, Hierarchical, High-resolution Shoreline (GSHHS) binned onto a 2km x 2km scale pixel fixed grid

Table D.9-7 Description of GLM_LightningSphereRadiusLUT Processing Parameters

Field Name	Type	Shape	Units	Summary
theLUT	double	5424 x 5424	km	The lightning sphere radius Look-Up Table (LUT) gives the radius from the center of the Earth at which lightning is assumed to occur, binned onto a 2km x 2km scale pixel fixed grid

Table D.9-8 Description of GLMNavigationParams Processing Parameters

Field Name	Type	Shape	Units	Summary
theT_Samples	ushort	*scalar*	unitless	The number of temperature samples to be included in the averaging process
theTofLA_Coeff	double	6	Celsius	Calibration coefficients for the Lens Assembly temperature T_{LA}
theTofCCD_Coeff	double	6	Celsius	Calibration coefficients for the CCD temperature T_{CCD}
theTofBipodCoeff	double	6	Celsius	Calibration coefficients for the Bipod temperatures, T_{-X}, T_{+X}, T_{-Y}
theTofLA_Ref	float	*scalar*	Celsius	The lens assembly reference temperature
theEFL_Coeff	double	*scalar*	mm/°C	The thermal coefficient for lens
theNomTemp	float	*scalar*	Celsius	The nominal temperature
theNomEffectFocalLen	double	*scalar*	mm	The nominal effective focal length
theRefFocalLen	double	*scalar*	mm	The reference focal length
theKofDistCoeff	double	*scalar*	mm/mm^3	The optical distortion coefficient

Field Name	Type	Shape	Units	Summary
theKofRefDistCoeff	double	*scalar*	mm/mm^3	The reference optical distortion coefficient
theCCD_DistCoeffsA	double	10	varies from mm to mm/mm^3	The CCD distortion coefficient matrix (a)
theCCD_DistCoeffsB	double	10	varies from mm to mm/mm^3	The CCD distortion coefficient matrix (b)
theCTE_SI	double	*scalar*	$°C^{-1}$	The coefficient of thermal expansion
theBipodMap	short	3	unitless	Mapping of bipods 1,2,3 to -X,+X,-Y using numerical order of letter in the alphabet to map to integer values
theKofX_Bp	double	*scalar*	rad/°C	The bipod temperature correction constant in the x direction
theKofY_Bp	double	*scalar*	rad/°C	The bipod temperature correction constants in the y direction
thePhi0PlusX_FPGA	double	*scalar*	rad	The bias angle phi for the primary instrument side (+ FPGA configuration)
theTheta0PlusX_FPGA	double	*scalar*	rad	The bias angle theta for the primary instrument side (+ FPGA configuration)
thePhi0MinusX_FPGA	double	*scalar*	rad	The bias angle phi for the redundant instrument side (-FPGA configuration)
theTheta0MinusX_FPGA	double	*scalar*	rad	The bias angle theta for the redundant instrument side (-FPGA configuration)
theP_Rate	double	*scalar*	seconds	The nominal attitude rate sampling time period
theCOI_Time	float	*scalar*	ms	The center of integration time constant
theCosAlpha	float	*scalar*	unitless	The cosine of the velocity aberration compensation angle
theSinAlpha	float	*scalar*	unitless	The sine of the velocity aberration compensation angle
theCompTime	float	*scalar*	seconds	The Earth rotation compensation time
theOrbitR_Nom	double	*scalar*	km	The ideal satellite to Earth vector magnitude
theFG_LonNom	float	*scalar*	degrees	The fixed grid reference longitude
theEquatorialRadius	double	*scalar*	km	The equatorial radius of the earth
theEarthFlattening	double	*scalar*	unitless	The flattening of the earth
theLightningSphereAltitudeNom	float	*scalar*	km	The nominal lightning sphere altitude
theLightSpeed	double	*scalar*	m/s	The speed of light in a vacuum
theRA_CIO	float	3	arcseconds	The right ascension of the CIO at the J2000.0, J2100.0 and J2200.0 epochs
theCCD_X_Microns	short	9	µm	The measured x values between regions of differently sized pixels
theCCD_X_Sizes	ushort	8	µm	The sizes of pixels in the x-direction
theCCD_X_Pixels	ushort	8	µm	The number of pixels in each size band in the x-direction
theCCD_Y_Microns	short	13	µm	The measured y values between regions of differently sized pixels
theCCD_Y_Sizes	ushort	12	µm	The sizes of pixels in the y-direction
theCCD_Y_Pixels	ushort	12	µm	The number of pixels in each size band in the y-direction

Field Name	Type	Shape	Units	Summary
theCCD_X_Max	ushort	*scalar*	µm	The CCD field of view, x maximum
theCCD_Y_Max	ushort	*scalar*	µm	The CCD field of view, y maximum
theCCD_R_Max	ushort	*scalar*	µm	The CCD field of view, maximum radius