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

27 October 2017

REVISION 1.1

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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APPENDIX X: ISO SERIES METADATA

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	03240	03/02/2017	All	CDRL SE-16 under Government Control. Harris DCN 7035538 PUG Vol 1 Main Rev E has been placed under Gov. GS control as GOES-R Series 416-R-PUG-Main-0345 Vol 1 Rev 1.0.
Rev. 1.1	03332	10/27/2017	All	CDRL SE-16 under Government Control. Harris DCN 7035538 PUG Vol 1 Main Rev F has been placed under Gov. GS control as GOES-R Series 416-R-PUG-Main-0345 Vol 1 Rev 1.1.

PRODUCT DEFINITION AND USER'S GUIDE (PUG)

VOLUME 1: MAIN

FOR

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

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

PRODUCT DEFINITION AND USER'S GUIDE (PUG)

VOLUME 1: MAIN

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

_____

Susan Redmond
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

_____

Kevin Hurd
GOES-R Deputy Project Manager

ALL SIGNATURES ON FILE

Approved By: _____

Romy Olaisen
GOES-R VP, Project Manager

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 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

REVISION	DATE	DESCRIPTION
		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	6 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, and the PUG L0 and L1b volumes. 2) Other than the system and instrument overviews, and the point of contact table, this volume has been completely revised with new and updated content. 3) 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 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 filename conventions, and several miscellaneous topics.

REVISION	DATE	DESCRIPTION
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 • 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

REVISION	DATE	DESCRIPTION
		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 • 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
D	13 May 2015	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

REVISION	DATE	DESCRIPTION
		• 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
D.1	11 August 2015	PTR-14093 • Change 132.8 Angstroms wavelength to 131.2 Angstroms in SUVI documentation PTR-14107 • Update various L2 product lineage issues 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
D.2	24 March 2016	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
E	15 June 2016	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

REVISION	DATE	DESCRIPTION
		• 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 • 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 PUG - Update 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 to reflect 2 minute EXIS L0 LZSS file aggregation time PTRDOC-17088

REVISION	DATE	DESCRIPTION
		• 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 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.

REVISION	DATE	DESCRIPTION
		• 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) 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.

REVISION	DATE	DESCRIPTION
		• 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
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

REVISION	DATE	DESCRIPTION
		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 • 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

ITEMS TO BE RESOLVED

The following TBx terminology is used in this and the other PUG volumes:

1. TBD: the item is To Be Determined. There is missing information where the TBD is placed. The missing information is unknown at this time.
2. TBR: the item is To Be Resolved or To Be Reviewed. The item is subject to review for appropriateness and/or subject to revision. The TBR immediately follows the item To Be Resolved or Reviewed.
3. TBS: the item is To Be Supplied. There is missing information where the TBS is placed.

Action Item	Title	Action Required
None		

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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 1: Main contains reference material, product and data overview information and cross-reference tables to specific product and data paragraphs in the other volumes. The remaining volumes are divided by product in the following manner: Volume 2: Level 0, Volume 3: Level 1b, Volume 4: GOES-R Rebroadcast, and Volume 5: Level 2+. In addition, there is a separate standalone Appendix X containing detailed descriptions of ISO series metadata for GOES-R products and data made available to users.

1.2 System Overview

Note: This section reflects the overview at GOES-R GS Critical Design Review. Refer to GOES-R GS CDRL SE-07, Ground Segment Design Description (DCN 7035551) for the latest overview section.

The National Oceanic and Atmospheric Administration (NOAA) operates a system of Geostationary Operational Environmental Satellites (GOES) to provide continuous weather imagery and monitoring of meteorological and space environment data to protect life and property across the United States. Two GOES satellites remain operational (75 degrees west and 135 degrees west longitude) at all times providing coverage for the eastern United States and most of the Atlantic Ocean and the western United States and Pacific Ocean basin. Post-Launch Test (PLT) of new satellites is performed at 89.5 degrees west longitude. After PLT, an on-orbit spare satellite is maintained at 105 degrees west longitude (or the PLT location) to permit rapid recovery from a failure of either of the operational satellites. GOES satellites provide critical atmospheric, oceanic, climatic and space weather products supporting weather forecasting and warnings, climatologic analysis and prediction, ecosystems management, and safe and efficient public and private transportation.

The next generation GOES (designated the GOES-R Series) provides continuity of the GOES mission (at 75 degrees west and 137 degrees west longitude) and improvement of its remotely-sensed environmental data. The GOES-R system consists of the Space and Ground Segments. The Space Segment comprises the spacecraft bus, and its remote-sensing instruments and communications payloads. The Ground Segment, comprising all Earth-based functions, provides satellite operations and instrument product generation and distribution.

The primary GOES-R instrument is the Advanced Baseline Imager (ABI) that provides Full Disk, CONtinental United States (CONUS), and Mesoscale imagery for global and CONUS forecasting and severe weather warning. Secondary instruments include the Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS), Solar Ultraviolet Imager (SUVI), Space Environment In-Situ Suite (SEISS), Magnetometer (MAG), and Geostationary Lightning Mapper (GLM). Additionally, GOES-R provides a set of communications services (Unique Payload Services) in support of the Data Collection System (DCS), High-Rate Information Transmission/Emergency Managers Weather Information Network (HRIT/EMWIN), and Search-and-Rescue Satellite Aided Tracking (SARSAT).

The GOES-R GS operates from three sites. The NOAA Satellite Operations Facility (NSOF) in Suitland, MD houses the primary Mission Management (MM), and selected Enterprise Management (EM), Product Generation (PG), and Product Distribution (PD) functions. The Wallops Command and Data Acquisition Station (WCDAS), located in Wallops, VA, provides the primary space communications services, EM and

MM functions, and selected PG and PD functions. The third site is a geographically diverse Remote Backup Facility (RBU), located at Fairmont, WV. It functions as a completely independent backup for the MM and selected PG and PD functions for the production of Key Performance Parameters (KPPs) and GOES Rebroadcast (GRB) data, and is capable of concurrent and remote operations from the NSOF and the WCDAS. The RBU has visibility to all operational and on-orbit spare satellites. The KPPs consist of the L2+ Cloud and Moisture Imagery (CONUS, Full Disk, and Mesoscale) product and its sectorized products. Reference Figure 1.2-1 for the GOES-R System and Ground Segment Overview.

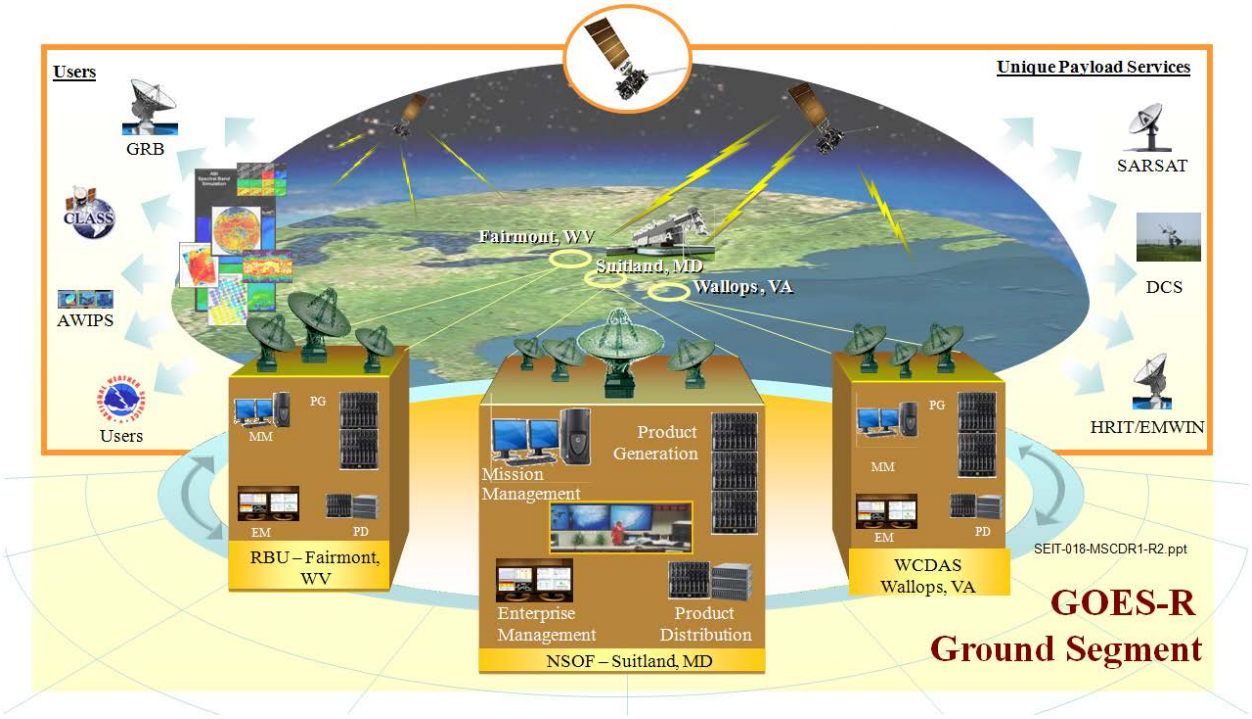

Figure 1.2-1 GOES-R System and Ground Segment Overview

The satellites are commanded throughout their mission lifetime from the NOAA Satellite Operational Control Center (SOCC) located at NSOF with the ground station radio frequency (RF) interface located at the WCDAS, or RBU. The engineering telemetry streams are received by WCDAS, and RBU, and ground relayed to the SOCC for processing and monitoring at all locations.

The raw sensor data are received by WCDAS, processed by the PG function at WCDAS to create L1b and L2+ GLM products. These L1b and L2+ GLM products are then rebroadcasted through the spacecraft GRB transponder. The GRB data are then received at NSOF where the rest of the L2+ products are created. Ancillary data used in generating the L2+ products are ingested from the Ancillary Data Relay System (ADRS). Applicable products are directly distributed to 1) the National Weather Service (NWS) Advanced Weather Interactive Processing System (AWIPS) where key NWS Weather Forecast Offices (WFO) and other AWIPS users get their data, 2) the Product Distribution and Access (PDA) component of the Environmental Satellite Processing and Distribution System (ESPDS), which includes the GOES-R Access Subsystem (GAS) functionality, provides data to National Environmental Satellite, Data, and Information Service (NESDIS), NWS, and other GOES data users, and 3) the Comprehensive Large Array-data Stewardship System (CLASS) for long term archive and access supporting retrospective users of GOES data. Figure 1.2-2 shows the primary data flow through the system.

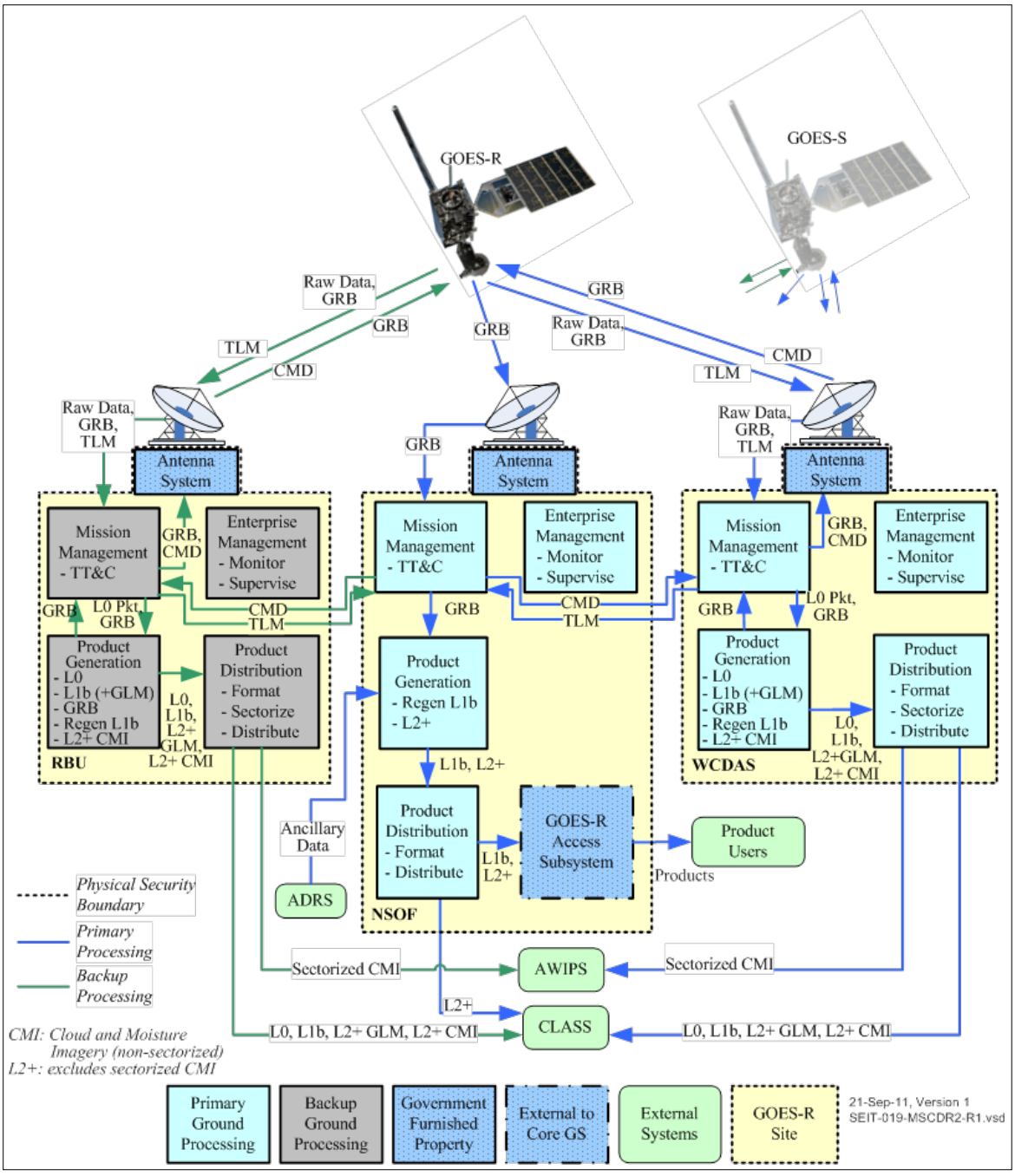

Figure 1.2-2 Ground Segment Primary Data Flow

At the RBU, the raw sensor data, as well as GRB, are received through its RF interface and processed by the PG function. The RBU is limited to the production of data to support L0, L1b, and L2+ GLM distribution to CLASS, creation and distribution of GRB, and the production of sectorized KPPs for distribution to AWIPS and non-sectorized KPPs for distribution to CLASS.

The GS includes separate development and integration and test (I&T) environments for the purposes of ongoing development and (I&T) throughout the GOES-R mission. Portions of these environments are located at both NSOF and WCDAS to support local site development and I&T activities (Reference Master Technical Project Overview 20120413).

1.3 Document Overview

The purpose of this main volume is to provide product and data overview information including a summary of file formats, standards and conventions, product and data overviews, and a cross-reference to detailed product and data information in the other PUG volumes. 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 main PUG volume includes the following sections:

- Introduction
- Reference Documents
- Instrument Overview
- Product and Data File Formats
- Product and Data Conformance with Standards and Conventions
- Off-the-Shelf netCDF Applications and Utilities
- Summary Product and Data Descriptions
- Product and Data Filename Conventions
- Points of Contact and Primary Responsibility
- Acronym List

2.0 REFERENCE DOCUMENTS

All documents referenced in the volumes and appendices of the PUG are listed in Table 2.0. Document number, title, version, if applicable, and date are specified for each document.

Table 2.0 Reference Documents

Document Number	Title	Date
n/a	netCDF User's Guide Version 4.1.3	June 2011
n/a	HDF5 User's Guide	November 2013
n/a	Extensible Markup Language 1.0 Fifth Edition	26 November 2008
n/a	netCDF Climate and Forecast (CF) Metadata Conventions Version 1.7, DRAFT	28 March 2014
n/a	Definition of the Flexible Image Transport System (FITS), The FITS Standard Version 3.0	10 July 2008
ISO 19915:2003	Geographic Information – Metadata	5 January 2003
ISO 19115-2:2009	Geographic Information – Metadata – Part 2: Extensions for Imagery and Gridded Data	3 February 2009
ISO/TS 19139:2007	Geographic Information – Metadata – XML Schema that defines implementation.	17 April 2007
ETSI EN 302 307	Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications (DVB-S2) V1.2.1	August 2009
CCSDS 732.0-B-2	AOS Space Data Link Protocol Blue Book	July 2006

Document Number	Title	Date
CCSDS 133.0-B-1	Space Packet Protocol	September 2003
ISO 13239	High-Level Data Link Control (HDLC)	15 July 2002
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Cloud and Moisture Imagery Product (CMIP) (Version 2.3)	15 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research ABI Algorithm Theoretical Basis Document For Daytime Cloud Optical and Microphysical Properties (DCOMP) (Version 2.0)	6 June 2011
n/a	NOAA NESDIS Center for Satellite Applications and Research Algorithm Theoretical Basis Document ABI Aerosol Detection Product (Version 2.0)	30 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research Algorithm Theoretical Basis Document for Suspended Matter/Aerosol Optical Depth and Aerosol Size Parameter (Version 2.0)	25 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research Algorithm Theoretical Basis Document ABI Cloud Height (Version 2.0)	7 June, 2011
n/a	NOAA NESDIS Center for Satellite Applications and Research Algorithm Theoretical Basis Document ABI Cloud Mask (Version 2.0)	6 June 2011
n/a	NOAA NESDIS Center for Satellite Applications and Research Algorithm Theoretical Basis Document GLM Lightning Cluster-Filter Algorithm (Version 2.0)	24 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Volcanic ash (Detection and Height) (Version 2.0)	15 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Cloud Type and Cloud Phase (Version 2.0)	15 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Nighttime Cloud Optical Depth, Cloud Particle Size, Cloud Ice Water path, and Cloud Liquid Water Path (Version 2.0)	15 July 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Rainfall Rate (QPE) (Version 2.0)	24 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Fire / Hot Spot Characterization (Version 2.0)	27 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Land Surface Temperature (Version 2.0)	21 September 2010

Document Number	Title	Date
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Downward Shortwave Radiation (Surface), and Reflected Shortwave Radiation (TOA) (Version 2.0)	27 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Legacy Atmospheric Moisture Profile, Legacy Atmospheric Temperature Profile, Total Precipitable Water, and Derived Atmospheric Stability Indices (Version 2.0)	September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document for Sea Surface Temperature (Version 2.0)	30 August 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Derived Motion Winds	30 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Hurricane Intensity	15 September 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R ABI Snow Depth Algorithm Theoretical Basis Document (Version 0.3)	13 October 2010
n/a	NOAA NESDIS Center for Satellite Applications and Research GOES-R Advanced Baseline Imager (ABI) Algorithm Theoretical Basis Document For Sea Surface Temperature (Version 2.0)	20 September 2009
CDRL 0043-13	ABI Flight Telemetry and Command Handbook (CDRL 43-13)	9 July 2015
CDRL 0043	GLM Flight Telemetry and Command Handbook (CDRL 43) (Revision H)	09 September 2015
CDRL 0043 / SUVP-RQ-08-0858	SUVI Flight Telemetry and Command Handbook (CDRL 43) (Revision G)	21 October 2014
CDRL 0043 / 109743	EXIS Flight Telemetry and Command Handbook (CDRL 43) (Revision G)	22 April 2013
CDRL 0043 / SEISS-D-SY043	SEISS Flight Telemetry and Command Handbook (CDRL 43) (Revision M)	31 March 2015
CDRL SC C&DH-01 GOES-RQ-11-0159	GOES-R Spacecraft Telemetry and Command Handbook (Revision E)	4 February 2016
CDRL 0079	ABI Calibration Data Books PFM-1_Rev- Groundstation Processing Inputs (Revision D)	8 April 2016
CDRL 0080-1D	ABI Ground Processing Algorithm Description: Overview	16 March 2015
CDRL 0080-2D	ABI Ground Processing Algorithm Description: Data Extraction and Decompression	16 March 2015
CDRL 0080-3D	ABI Ground Processing Algorithm Description: Calibration	16 March 2015
CDRL 0080-4D	ABI Ground Processing Algorithm Description: Navigation	16 March 2015
CDRL 0080-5D	ABI Ground Processing Algorithm Description: Resampler and Downsampler	16 March 2015

Document Number	Title	Date
CDRL 0080-6D	ABI Ground Processing Algorithm Description: Scanner Calibration	16 March 2015
CDRL 0120-5	ABI Operations Handbook	22 February 2016
DCN 7035551	SE-07 Ground Segment Design Description (Revision E)	12 May 2016

3.0 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 Solar Pointing Sensor (SPS), X-ray Sensor (XRS) and the Extreme Ultraviolet Sensors (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 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 Solar Pointing Sensor (SPS) is not a science sensor, but rather is used to determine the relative boresight pointing of the Sun in the fields of view of the other EXIS sensors.

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

The Space Environment In-Situ Suite (SEISS) is comprised of four sensors that will monitor 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.

4.0 PRODUCT AND DATA FILE FORMATS

4.1 Network Common Data Format (netCDF)

The netCDF file format is a general-purpose scientific data file format. It provides considerable flexibility, and includes Application Programmer Interfaces (APIs) for several programming languages including, but not limited to Java, C++, C, and Fortran.

GOES-R netCDF product and data files use the netCDF-4 format. NetCDF-4 supports both a classic and enhanced data model. NetCDF-4 uses an enhanced version of the Hierarchical Data Format version 5 (HDF5) as the storage layer. NetCDF-4 files are created with the HDF5 library, and can be read without the netCDF-4 interface.

The enhanced data model includes contemporary data structures, user defined data types, and groups. Groups allow data to be organized into hierarchies, and define a separate namespace. Other than a few cases, such as using multiple unlimited dimensions in Level 0 product files, instrument calibration data files, and GLM L2+ Lightning Detection product files, GOES-R product data is not of sufficient complexity to warrant the use of the enhanced data model. For this reason, and because both the CF metadata conventions makes use of the classic data model, and the off-the-shelf toolset for the classic data model is more extensive, the classic data model is used. Refer to Figure 4.1, netCDF Classic Data Model.

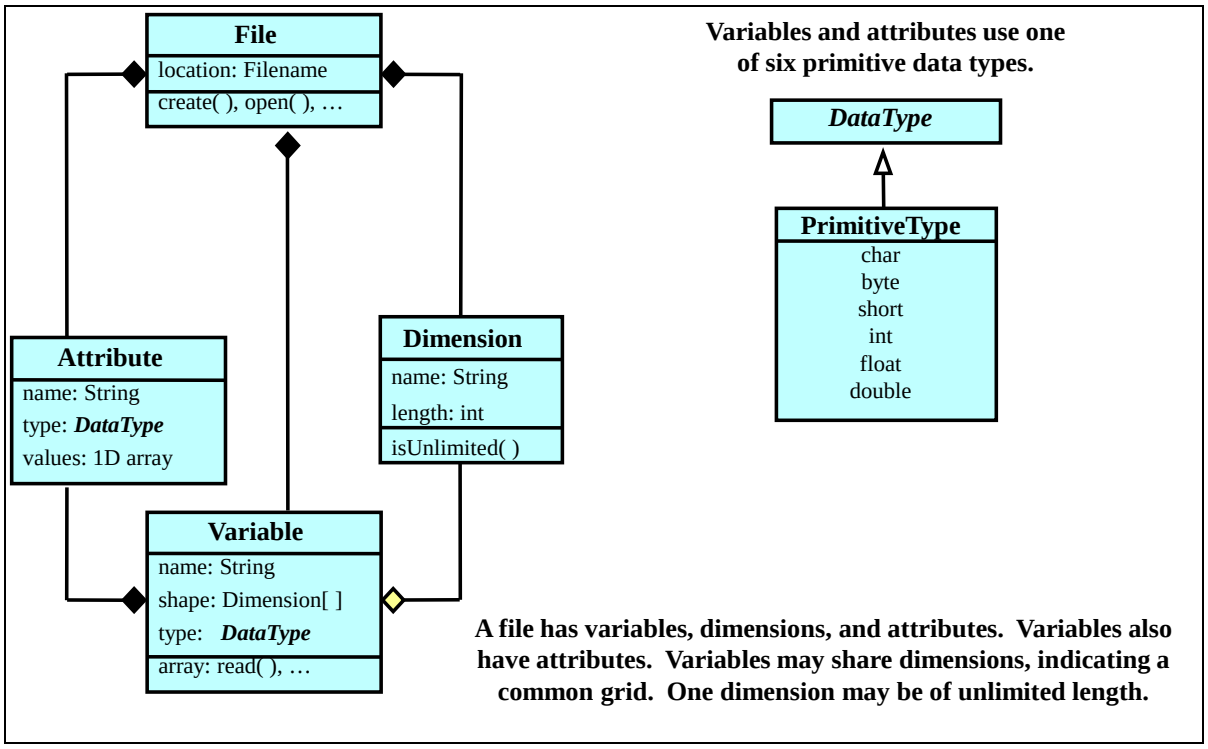

Figure 4.1 netCDF Classic Data Model

A netCDF file is composed of dimensions, variables, and attributes. Rather than user applications accessing file sectors and records, they make use of an API allowing the creation and access of dimensions, variables, and attributes. This API provides the user applications with a logical interface to access the content of files, and insulates the applications from the physical addressing where specific data in a file is stored.

Dimensions are used to size dimensional variables (i.e., arrays). Attributes can be attached to the file (i.e., global attributes) or a file's variables. Attribute conventions have been established to promote interoperability. These attribute convention are discussed in paragraph 5.0, Product and Data Conformance with Standards and Conventions.

Some GOES-R products are very large. For example, the ABI L1b/L2+ Full Disk and CONUS gridded product files are tens to hundreds of megabytes or larger. To improve performance of the user applications when accessing product files, chunking provided by the HDF5 storage layer is used. The chunking configured in these large files is based on a tiling of the regions associated with product data, which is anticipated to align with the typical access pattern.

In addition to chunking, the large netCDF-4 product files are reduced in size using compression/ decompression capabilities in the HDF5 storage layer. netCDF-4 ABI L1b/L2+ gridded product files are compressed. This reduction in size allows less storage and bandwidth to be required by access, archive, and user systems, and enabling network. The netCDF-4 APIs insulate the user applications from the complexity associated with compression. A small performance penalty is incurred when compressed netCDF-4 files are read.

Additional details on the netCDF-4 file format are found in the Unidata netCDF User's Guide (NUG). An on-line version of the NUG is located at http://www.unidata.ucar.edu/software/netcdf/docs/netcdf.html.

GOES-R netCDF-4 product and files are specified using the XML-based netCDF Markup Language (NcML) version 2.2. Additional details on NcML are located at http://www.unidata.ucar.edu/software/thredds/current/netcdf-java/ncml/.

4.2 Flexible Image Transport System (FITS) Format

The FITS format is used for the SUVI Level 1b Solar Imagery: EUV product. The FITS format is the standard archival data format for astronomical data sets. The FITS format is specified to the bit level, and defines the organization and content of all standard FITS data structures. A key element of the FITS format is the "keyword", which in concert with the keyword's value, defines a physical, syntactic, or semantic characteristic of the product data or metadata. There are standard keywords, some of which are mandatory. In addition, user-defined keywords can be in included as required. The applicable version of the FITS standard is located at http://fits.gsfc.nasa.gov/standard30/fits_standard30aa.pdf.

4.3 Unix Text File Format

The Unix text file format is used in a small subset of the Level 1b and 2+ semi-static source data files. The Unix text file format, less the end-of-file character, is embedded in GRB metadata packets to store the XML-based netCDF Markup Language (NcML) representation of the netCDF file specifications, which includes the values for product metadata.

The Unix text file format is a sequence of lines (i.e., records), potentially variable in length, of electronic text. For the GOES-R ground system, the electronic text, newline, and end-of-file characters conform to the American Standard Code for Information Interchange (ASCII). At the end of each line is the newline character. At the end of file, there is an end-of-file character.

4.4 Hierarchical Data Format (HDF)

The HDF file format is a general purpose scientific data file format. It provides considerable flexibility and includes Application Programmer Interfaces (APIs) for several programming language including Java, C++, C, and Fortran.

The GOES-R ground system uses version 5 of HDF (i.e., HDF5). This format is used for several Level 1b semi-static source data files.

An HDF file is composed of datasets, attributes, and other constructs. Rather than user applications accessing file sectors and records, they make use of an API allowing the creation and access of datasets, attributes, and other constructs. This API provides the user applications with a logical interface to access the content of files, and insulates these applications from the physical addressing where specific data in a file are stored.

Note that because netCDF-4 uses HDF5 for its storage layer, off-the-shelf HDF software tools can be used to provide rudimentary display and access functionality for GOES-R product files.

An HDF5 User's Guide is available, and is located at http://www.hdfgroup.org/HDF5/doc1.6/UG/.

5.0 PRODUCT AND DATA CONFORMANCE WITH STANDARDS AND CONVENTIONS

5.1 netCDF User's Guide (NUG) Conventions

The NUG includes several general recommendations for attributes in a netCDF file potentially applicable to all GOES-R products and data. These attribute conventions are identified and described in Table 5.1, NUG Recommended Attributes.

Table 5.1 NUG Recommended Attributes

Attribute Name	Attribute Definition
title	A global attribute that is a character array providing a succinct description of what is in the dataset.
Conventions	If present, "Conventions" is a global attribute that is a character array for the name of the conventions followed by the product. This attribute is used in the ABI L1b and L2+ products that comply with the CF Metadata Conventions.
long_name	A long descriptive name for each variable.
_FillValue	A scalar value that identifies missing data. It is of the same data type as the variable to which it is attached.
valid_range	A delimited vector of two numbers specifying the minimum and maximum valid values for the variable to which it is attached.
scale_factor and add_offset[1]	If present, the data is first scaled (i.e., multiplied) before the offset is added. 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. 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.
units	A character string that specifies the units used for the variable's data. Unidata has developed a freely-available library of routines to convert between character string and binary forms of unit specifications and to perform various useful operations on the binary forms. Using the recommended units syntax permits data represented in conformable units to be automatically converted to common units for arithmetic operations. The library and associated documentation are available at http://www.unidata.ucar.edu/packages/udunits/.

[1] Scaling is used in the SUVI Level 1b and ABI Level 1b and Level 2+ image products, and the GLM Level 2+ product. The scaling approach uses the vast majority of the range provided by 16 bit unsigned and signed values, 65530 for unsigned values and 32767 for signed values with the minimum scaled value equal to the minimum valid value in unpacked form. This approach minimizes data loss due to scaling, which is, conservatively, no greater than two orders of magnitude less than the required product measurement precision. Note that for unsigned values, 65535 is reserved for the fill value.

5.2 Attribute Convention for Data Discovery (ACDD)

The Attribute Convention for Data Discovery (ACDD) is one area of support in which Unidata recommends a specification of netCDF attributes to be used to catalog environmental science data in support of efficient access. These attributes correspond to general discovery metadata content to allow interoperability with metadata services such as Thematic Real-time Environmental Distributed Data Services (THREDDS).

GOES-R netCDF products and data comply with the ACDD version 1.0.

There are four categories of ACDD metadata:

- Highly recommended global attributes.
- Recommended global attributes.
- Suggested global attributes.
- Highly recommended attributes within variable.

The attributes and variables being referred to here are netCDF dataset components used to construct product and data files. The highly recommended attributes within variables category is discussed in paragraph 5.3, Climate and Forecast (CF) Metadata Conventions that follows.

Table 5.2 identifies the highly recommended, recommended, and suggested ACDD global attributes. The attributes in plain text are used in GOES-R products and data where applicable. The attribute names in italic

font are not used in GOES-R products and data. In these cases, the description column provides the rationale for their exclusion.

Table 5.2 ACDD Global Attributes

Highly Recommended	
Attribute Name	**Description**
title	A short description of the dataset
summary	A paragraph describing the dataset
keywords	A comma separated list of key words and phrases

Recommended	
Attribute Name	**Description**
id	The combination of the "naming authority" and the "id" should be a globally unique identifier for the dataset.
naming_authority	
keywords_vocabulary	If you are following a guideline for the words/phrases in your "keywords" attribute, put the name of that guideline here.
cdm_data_type	The THREDDS data type appropriate for this dataset.
history	Provides an audit trail for modifications to the original data. *Not applicable to GOES-R datasets delivered directly by the producer.*
comment	Miscellaneous information about the data. *Metadata for GOES-R products and data is extensive. No miscellaneous information has been identified.*
date_created	The date on which the data was created.
creator_name	The data creator's name, URL, and email. The "institution" attribute will be used if the "creator_name" attribute does not exist. *GOES-R metadata includes "institution".*
creator_url	
creator_email	
institution	
project	The scientific project that produced the data.
processing_level	A textual description of the processing (or quality control) level of the data.
acknowledgement	A place to acknowledge various type of support for the project that produced this data. *Not applicable to GOES-R end-products.*
geospatial_bounds	Describes geospatial extent using any of the geometric objects (2D or 3D) supported by the Well-Known Text (WKT) format. *This is a new ACDD attribute added after the GOES-R metadata was defined.*
geospatial_lat_min	Describes a simple latitude/longitude bounding box. Geospatial_lat_min specifies the southernmost latitude; geospatial_lat_max specifies the northernmost latitude; geospatial_lon_min specifies the westernmost longitude; geospatial_lon_max specifies the easternmost longitude of the bounding box. The values of geospatial_lon_min and geospatial_lon_max reflect the actual longitude data values. Cases where geospatial_lon_min is greater than geospatial_lon_max indicate the bounding box extends from geospatial_lon_max, through the longitude range discontinuity meridian (either the 12ntemeridian or Prime Meridian), to geospatial_lon_min. *GOES-R netCDF ABI Level 1b and 2+ end-products use the following attributes:* *geospatial_westbound_longitude,* *geospatial_northbound_latitude,* *geospatial_eastbound_longitude and* *geospatial_southbound_latitude*
geospatial_lat_max	
geospatial_lon_min	
geospatial_lon_max	

Recommended	
Attribute Name	**Description**
	as well as *geospatial_lat_center,* *geospatial_lon_center,* *geospatial_lat_nadir and* *geospatial_lon_nadir.*
geospatial_vertical_min	Describes a simple vertical bounding box. *Not applicable to GOES-R end-products.*
geospatial_vertical_max	
time_coverage_start	Describes the temporal coverage of the data as a time range. *Duration and resolution were considered redundant information to time coverage start and end.*
time_coverage_end	
time_coverage_duration	
time_coverage_resolution	
standard_name_vocabulary	The name of the controlled vocabulary from which variable standard names are taken.
license	Describes the restrictions to data access and distribution.

Suggested	
Attribute	**Description**
contributor_name	The name and role of any individuals or institutions that contributed to the creation of this data. *Not applicable to GOES-R end-products.*
contributor_role	
publisher_name	The data publisher's name, URL, and email. The publisher may be an individual or an institution. *The archive or Data Center may add this metadata.*
publisher_url	
publisher_email	
date_modified	The date on which this data was last modified. *Not applicable to GOES-R datasets delivered directly by the producer.*
date_issued	The date on which this data was formally issued. *Considered redundant with "date_created" for GOES-R end-products.*
geospatial_lat_units	Further refinement of the geospatial bounding box can be provided by using these units and resolution attributes. *GOES-R products and data use the attribute:* *"spatial_resolution" which is the resolution at nadir, as applicable.* *Vertical extents are not defined for GOES-R products and data.*
geospatial_lon_units	
geospatial_lat_resolution	
geospatial_lon_resolution	
geospatial_vertical_units	
geospatial_vertical_resolution	
geospatial_vertical_positive	

Refer to http://wiki.esipfed.org/index.php/Attribute_Convention_for_Data_Discovery_(ACDD) for additional details.

5.3 Climate and Forecast (CF) Metadata Conventions

The ABI Level 1b and 2+ products conform to the CF Metadata Conventions version 1.7. The CF conventions are designed to promote the processing and sharing of files created with the netCDF Application Programming Interface (API). The conventions define metadata that provide a definitive description of what the data in each variable represents, and of the spatial and temporal properties of the

data. This enables users of data from different sources to decide which quantities are comparable, and facilitates building applications with comprehensive extraction, regridding, and display capabilities.

The CF conventions applicable to the ABI Level 1b and 2+ products include metadata that provides:

- Identification and semantics of environmental data in gridded (e.g., imagery) and discrete sampling geometry form.
- Extensions to the netCDF User's Guide (NUG) defined coordinate variables, which enable locating environmental data in space and time, and that support application-specific coordinates that are meaningful in the science domains associated with different products.
- Precise definition of each variable via specification of a standard name and its units of measure.
- Spatial coordinates for gridded and discretely sampled data.
- Descriptions of coordinate intervals, multidimensional cells, and data values that are representative of a spatial or temporal based interval or cell.

The netCDF interface enables but does not require the creation of self-describing datasets. The purpose of the CF conventions is to require conforming datasets to contain sufficient metadata so that they are self-describing in the sense that each variable in the file has an associated description of what it represents, including units of the physical quantity if appropriate, and that each value can be located in space and time. Note that space not only refers to physical location but can refer to wavelength within the electromagnetic spectrum, atmospheric pressure levels, location relative to Sun or the sensing platform, and other points of reference meaningful to the particular data quantity.

The CF conventions are based on the netCDF classic data model, and do not use enhanced data model constructs such as groups and structures. The netCDF classic data model is discussed in Paragraph 4.1.

While this paragraph is intended to provide the essential background information required to interpret and use the conforming ABI L1b/L2+ products, there may be cases when additional technical details and depth available in the CF Metadata Conventions are useful to product users. The CF Metadata Conventions document is located at http://cfconventions.org/.

The remainder of this paragraph and subordinate paragraphs provide the essential CF conventions-related background information required to interpret and use the ABI L1b/L2+ products.

The CF metadata convention topics discussed in the subordinate paragraphs that follow are defined in the Table 5.3, CF Metadata Convention Topics.

Table 5.3 CF Metadata Convention Topics

CF Conventions Topic	Summary Description
Standard Names	Name identifying a specific physical quantity.
Units	Identity of measure associated with physical quantities.
Ancillary Data	Association between variables to express that one data variable provides metadata about the individual values of another data variable.
Flags	Integer data variables whose possible values are enumerated and associated with specific meanings.
Coordinates	One-dimensional array and scalar variables associated with data variables and enable their data elements to be located in space and time.
Grid Mappings and Projections	Provide the means to project data values to locations on the earth.
Cells	Comprehensively describes the extent of a data value when it is associated with a spatio-temporal volume.
Discrete Sampling Geometries	Provides the means to represent non-gridded environmental data.
Packed Data	Supports the reduction of product file size through the use of scaled integers rather than floating point for data values.

These topics are discussed in the CF Metadata Conventions document in greater detail. This document also provides examples for each of these topics.

5.3.1 Standard Names

A standard name allows users of data from different sources to determine whether quantities are comparable. All GOES-R ABI Level 1b and 2+ quantities in the products that could possibly be compared or fused by other application software systems have standard names.

Standard names associated with dimensional quantities have canonical units, which are precise units of measure for the physical quantity. The units attribute for a variable with a standard name must use the canonical units or units that are physically equivalent. Note that there are CF conventions for dimensionless quantities and are discussed in the Units paragraph that follows.

A standard name is associated with a variable via the standard_name attribute. The value of this attribute is a valid standard name from the CF Standard Name Table. When an ABI L1b/L2+ product data variable does not have a standard name, the attribute long_name, whose value is an ad-hoc string value, is the sole data variable attribute describing its content.

The complete set of standard names, their descriptions and canonical units, and additional documentation is located at http://cfconventions.org/, then navigate to the CF Standard Name Table.

5.3.2 Units

The "units" attribute captures the identity of the units of measure associated with data quantities. The units attribute is a NUG defined attribute, but discussed here to further elaborate the usage of this attribute in the ABI L1b/L2+ products.

The units attribute is included for all variables except boundary variables, which are defined in the Cells paragraph below, and container variables, such as the grid mapping variable, which is defined in the Grid Mappings and Projections paragraph.

The units for dimensional quantities conform to the Unidata UDUNITS-2 package. UDUNITS-2 quantities, descriptions, documentation, and library software is located at https://www.unidata.ucar.edu/software/udunits/udunits-2-units.html.

Conventions have been established for dimensionless quantities: "percent" and "count". When the quantity is dimensionless and not "percent" or "count", "1" is used.

5.3.3 Ancillary Data

Ancillary data provides for associations between variables to indicate that one data variable provides metadata about the individual values of another data variable. An example of ancillary data is a data quality flag variable that has a relationship with its primary data variable(s).

The "ancillary_variables" attribute is used to express these types of relationships. It is a string attribute whose value is a delimited list of variable names (note that the delimiter in GOES-R netCDF datasets is a blank space). This attribute is attached to a primary data variable and contains the variable name(s) of the ancillary data variable(s) to provide the linkage indicating the association between the variables. The nature of the relationship between variables associated via ancillary_variables is determined by other attributes.

5.3.4 Flags

Flag variables, which are enumeration types, provide a means to associate an integer value with a meaning. All the Level 1b and 2+ products have at least one flag variable which is typically the data quality variable that is dimensioned to correspond to its associated data variable. In some cases, flag variables are used for the primary data in a product, such as is the case with the Aerosol Detection product.

The attributes "flag_values", "flag_mask", and "flag_meanings" support making variables that contain flag values to be self-describing. Status codes and Boolean condition flags may be expressed with different combinations of flag_values and flag_masks attribute definitions.

There are two distinct methods used in the specification of a flag variable for ABI L1b/L2+ products:

1) The declaration of flag_values and flag_meanings attributes when a status flag consists of mutually exclusive coded values. The flag_values attribute is the same data type as the variable to which it is attached, and contains a list of the possible flag values. The flag_meanings attribute value is a string whose value is a blank separated list of descriptive words or phrases, one for each flag value.
2) The declaration of flag_masks, flag_values and flag_meanings attributes describe a blend of independent Boolean conditions and enumerated status codes. Using this method, a single flag value supports indication of multiple statuses. The flag_masks and flag_values attributes are both the same type as the variable to which they are attached. A flagged condition is identified by a bitwise AND of the variable value and each flag_masks value; a result that matches the flag_values value indicates a true condition. Repeated flag_masks define a bit field mask that identifies a number of status conditions with different flag_values. The flag_meanings attribute is defined as above, one for each flag_masks bit field and flag_values definition. Each flag_values and flag_masks value must coincide with a flag_meanings value.

The attribute standard_name for the flag variables, which contain an indication of quality, always has a value of "status_flag". This describes the ancillary data relationship between the data and the flag variable.

Specific examples of the use of these flag attributes are located in Chapter 3.5 Flags of the CF Metadata Conventions.

5.3.5 Coordinates

Coordinate variables provide the capability to locate individual data values in space and time. Space not only refers to physical location but can refer to wavelength within the electromagnetic spectrum, atmospheric pressure levels, location relative to Sun or the sensing platform, and other points of reference meaningful to a particular data quantity.

The CF conventions call out coordinate variables and auxiliary coordinate variables. The distinction is a result of the coordinate variable definition provided in the NUG. In the case of coordinate variables, the

name of the dimension and the coordinate variable are the same. When this is not the case, the variable is an auxiliary coordinate variable, except in the case where the coordinate variable is scalar, which is discussed in this paragraph below.

Coordinate variable values are the coordinates. Typically, geo-location coordinate values are in units of latitude and longitude, but can be in other units such as meters, or, in the case of the products on the ABI fixed grid, radians. The geo-location coordinate variables for the ABI L1b/L2+ gridded products are discussed in further detail in the ABI Fixed Grid paragraph in the Level 1b, GRB, and Level 2+ volumes of the PUG.

A set of related CF metadata constructs are provided to allow user applications to map geolocation coordinate values, such as radians, to latitude and longitude. These related constructs are discussed in paragraph 5.3.6, Grid Mapping and Projections. Other examples of coordinate variables include time and electromagnetic radiation. The CF compliant representations are discussed in detail in paragraph 4.4, Time Coordinates of the CF Metadata Conventions.

The value of the attribute coordinates is a delimited list of the names of auxiliary coordinate variables, and optionally the coordinate variable names. Although optional, all ABI L1b/L2+ product data variables identify both types of coordinate variables in the coordinate attribute specification.

For the gridded ABI L1b/L2+ products, the fixed grid or lat/lon coordinates, and atmospheric pressure level coordinate in the case of the Vertical Temperature and Pressure Profile products, are dimensioned coordinate variables where the name of the dimension is the same as the coordinate variable name.

For the gridded ABI L1b/L2+ products, time is a scalar coordinate variable because the image is generated over a single reporting interval. In addition, there are other scalar coordinate variables and scalar auxiliary coordinate variables including, but not limited to, electromagnetic radiation wavelength, ABI channel number, solar zenith angle, and platform zenith angle. It is important to note that cell-related CF conventions are used to capture the volume extent of some of these scalar coordinate variables, including time, and is described in paragraph 5.3.7, Cells, below.

Scalar coordinate variables do not have to be associated with a data variable array dimension. When scalar coordinate variables are used their names must be included in the attribute coordinate string value to identify that the scalar variable is a coordinate variable. In the case of data variables where the electromagnetic radiation wavelength and ABI band are included as coordinates, these variables are declared as one dimensional arrays with "dimension = 1" despite the fact that they are scalar values to indicate the dependency that exists between ABI band number and wavelength.

Coordinates for the non-gridded ABI L1b/L2+ products, Derived Motion Winds and Hurricane Intensity Estimate, are discussed in paragraph 5.3.7.3, Discrete Sampling Geometries.

5.3.6 Grid Mappings and Projections

Grid mappings coupled with geo-location coordinate variables provide the means to determine the latitude and longitude of a data point on the ABI fixed grid whose native coordinate values are the E/W scanning angle and N/S elevation angle in units of radians relative to the location of the satellite. For all ABI gridded L1b/L2+ products, the names of these coordinate variables are x for the E/W scanning angle and y for the N/S elevation angle, respectively.

The "grid_mapping" attribute is used to describe the mapping between the geo-location coordinate variables and latitude and longitude coordinates. This attribute is attached to data variables whose values are associated with specific earth locations. The attribute is a string value containing the name of another variable in the file that provides the description of the mapping via a collection of attached attributes. This variable is called a grid mapping variable and is of arbitrary type since it contains no data. Its purpose is to act as a container for the attributes that define the mapping.

The one attribute that all grid mapping variables must have is grid_mapping_name, which takes a string value that contains the mapping's name. In the case of ABI L1b/L2+ gridded products whose data is on the ABI fixed grid projection, the grid_mapping_name value is "geostationary". The other attributes required for this projection are those that specify the parameters associated with the selected earth model to use for the GOES-R ABI L1b/L2+ products, the Geodetic Reference System 1980 (GRS 80), lat/lon origin of the projection, and a parameter that identifies the scanning pattern associated with the ABI instrument.

To make use of a grid mapping to directly calculate latitude and longitude values it is necessary to associate the coordinate variables with the independent variables of the mapping. This is done by assigning the standard names "projection_x_coordinate" and "projection_y_coordinate" to the geo-location coordinate variables. Off-the-shelf, open-source projection software is available to perform the "geostationary" grid mapping. Additional details on this software is located in the ABI Fixed Grid paragraph in the Level 1b, GRB, and Level 2+ volumes of the PUG.

In the case of the ABI L2+ shortwave radiation products, Downward Shortwave Radiation: Surface and Reflected Shortwave Radiation: Top-Of-Atmosphere, the two ABI L2+ non-gridded products, Derived Motion Winds and Hurricane Intensity, and the GLM L2+ Lightning Detection product, the grid mapping is used to solely identify the GRS 80 earth model parameters. The name of this grid mapping is "latitude_longitude".

5.3.7 Cells

When data values do not represent point values of a field but instead represent some characteristic of the field within cells of finite "volume," a complete description of the variable includes metadata that describes the domain or extent of each cell, and the characteristic of the field that the cell values represent.

Two distinct cell-related CF metadata constructs are employed in the ABI L1b/L2+ products.

1) Cell boundary constructs provide the means to identify the specific "volume" associated with the "volume" of space or interval of time associated with data values.
2) Cell methods constructs provide the means to describe the characteristics of data values that are associated with a cell.

These constructs are discussed in the following paragraphs.

5.3.7.1 Cell Boundaries

To represent cells, the "bounds" attribute is used in the specification of the appropriate coordinate variable(s). The value of bounds is the name of the variable that contains the vertices of the cell boundaries. This type of variable is referred to as a boundary variable. A boundary variable has one more dimension than its associated coordinate or auxiliary coordinate variable. The additional dimension is the most rapidly varying one, and its size is the maximum number of cell vertices. Since a boundary variable is considered to be part of a coordinate variable's metadata, it is not necessary to provide it with attributes such as long_name and units.

An example of the use of cell boundaries in ABI L1b/L2+ products is the time coordinate variable. The ABI L1b/L2+ product design associates an interval of time with the image. The time coordinate variable value is the mid-point in time of the image and the time boundary variable values are the start and end time associated with the sensing period.

The data values associated with ABI L1b/L2+ gridded data (i.e., imagery) represent the environmental condition of an area on the earth corresponding to the resolution of the product. The "resolution" attribute is used to identify the area associated with a grid data point (i.e., imagery pixel). This attribute is used in the specification of the applicable data variable. The value of the attribute is a string containing the names of the geo-location coordinate variables for the E/W scanning angle and N/S scanning angle with each associated with the resolution of the data values in the native ABI fixed grid units, radians. For example,

the specification of this attribute for a 2 km (i.e., 0.000056 radian) fixed grid product is resolution = "y: 0.000056 rad x: 0.000056 rad".

Note that variable name for the E/W scanning angle and N/S elevation angle are "x" and "y", respectively.

Also note that the use of the resolution attribute is not yet a CF metadata convention.

5.3.7.2 Cell Methods

The "cell_methods" attribute provides the means to describe the following characteristics of celled ABI L1b/L2+ data values:

- Whether the data value is associated with (a) an individual observation or moment in time (i.e., point), (b) summation of observations or time interval (i.e., sum), or (c) a statistic associated with a cell of observations (e.g., mean).
- Spacing of the cell's constituent original observation data values.
- Statistics applying to portion of cells.
- Non-standard, GOES-R specific characteristics.

The value for this attribute has components that allow for the specification of all these characteristics. This is a string attribute composed of a list of blank-separated words of the form "name: method". Each "name: method" pair indicates that for an axis identified by name, the cell values representing the field have been determined or derived by the specified method. For example, if data values are associated with a moment (i.e., point) in time, this is indicated with cell_methods="t: point", assuming that the name of the time dimension variable is "t".

In the specification of the cell_method, "name" can be a dimension of the variable, a scalar coordinate variable, a valid standard name, or the word "area". For GOES-R ABI L1b/L2+ products, "name" can be the time, platform zenith angle, solar zenith angle, or latitude scalar coordinate variables. For those ABI L2+ products where valid data values are constrained by the angle of the satellite or Sun, or latitude, cell methods are used to express this. The word "area" is used for "name" to identify the combination of the horizontal coordinates. For example, "area" for ABI L1b/L2+ products on the fixed grid, identifies the area identified by the its geo-location coordinate variables with names "x" and "y", for the E/W scanning angle and N/S elevation angle, respectively.

In the specification of the cell_method, "method" can take on the value of point, sum, minimum, maximum, mean, and standard_deviation for ABI L1b/L2+ products. The method applies only to the axis designated in cell_methods by name, and different methods may apply to other axes.

Proper assignment of the "method" depends on whether the quantity is extensive, which depends on the size of the cell, or intensive, which does not. For the ABI L1b/L2+ primary physical quantity gridded data, the data values are expressed as instantaneous (i.e., point) values in space and time. For ABI L1b/L2+ product-level metadata, which are often statistics associated with the entire image, "method" takes on the specific type of statistic (e.g., minimum, maximum, etc.) for the "area" axis, and "sum" for the time axis because the celled data quantity is a statistic associated with the sensing period associated with the entire image.

For the ABI L1b/L2+ product-level summary statistics, the spacing of the original data used to generate the statistic is identified after the "method" using the "interval" keyword followed by the actual interval, which is enclosed in parentheses. For ABI L1b/L2+ gridded products, the actual interval is expressed as the resolution of the original data (e.g., 0.000056 radians).

For some ABI L2+ products, the product-level statistics do not apply to the entire image (i.e., cell). In this case, the attribute cell_methods includes a string of the form "name: method where type". For example, "name" could be "area" and "type" may be any of the strings permitted for a variable with a standard_name of area_type. The complete set of area_types allowed by the CF metadata conventions is located at

http://cfconventions.org. Navigate to the CF Standard Name Table, then to standard name "area_type", then to the "area_type_table".

Generally, when product-level statistics are generated, not all data values in the image are used. For example, it is often the case that only data points of good quality are used when generating statistics. The value for the attribute cell_method can include non-standard information, and this feature is used to express system-unique constraints associated with the calculation of cell data values. The "comments" keyword, which is enclosed in the same set of parentheses as the "interval" keyword is used to express these types of constraints.

An example that makes use of all the components and keywords of the attribute cell_methods is included here. This value for attribute cell_methods that follows is an attribute of the product-level average cloud top pressure variable in the Cloud Top Pressure product. The standard_name of this quantity is "air_pressure_at_cloud_top".

Cell_methods = "local_zenith_angle: sum solar_zenith_angle: sum t: sum area: mean (interval: 0.000280 rad comment: good quality pixels only) where cloud"

Explanation: local_zenith_angle, solar_zenith_angle and t are scalar coordinate variables for this statistic. Each of these coordinate variables has an associated boundary variable to capture the continuous range of values associated with these coordinates. The method "sum" is used for these scalar coordinate variables because the value of the variable the cell_methods attribute is attached, the cloud top pressure average, uses cloud top pressure image pixel values that are within the range defined by the cells associated with the values of the local and solar zenith angle, and time coordinate and boundary variables. The area axis, which identifies the two horizontal coordinates, has a method of "mean" to indicate the quantity is the average value. The interval keyword identifies the spacing of the original data used to calculate the mean (e.g., 0.000280 radians). The non-standard portion, which is identified with the "comment" keyword, indicates that only pixels of good quality are used in the calculation. The "where cloud" portion of the value indicates that the calculation uses only pixels where cloudy conditions exist.

Additional details on cell methods are located in Chapter 7 of the CF Metadata Conventions.

5.3.8 Discrete Sampling Geometries

Two of the ABI Level 2 products are not gridded, Derived Motion Winds and Hurricane Intensity Estimate. The CF metadata conventions include constructs to identify and capture the semantics of discrete sampling geometries, which are typically "paths" through space and time, but can also be collections of the same type of data at arbitrary locations.

There are several types of discrete sampling geometries. The type of a discrete sampling geometry is referred to as its featureType. The featureTypes for Derived Motion Winds and Hurricane Intensity Estimate are "point" and "trajectory", respectively. A featureType of point is characterized by there being individual data points in the product that have no implied coordinate relationship to other points. A featureType of trajectory is characterized by there being a series of data points along a path through space with monotonically increasing times. Both of these product types include collections of features. A feature is a single instance of a discrete sampling geometry. The Derived Motion Winds product contains a collection of wind vectors. The Hurricane Intensity Estimate product, which includes all the characteristics of the cyclone over its life-cycle, contains a collection of reports where each report contains the data and metadata, including spatiotemporal information, associated with an execution of the hurricane intensity algorithm.

The syntax of the netCDF file specification for these two featureTypes as they relate to the Derived Motion Winds and Hurricane Intensity Estimate products is very similar. For each product, there are one-dimensional data variables, each containing a data quantity associated with the product, and a set of one-dimensional coordinate variables that capture the location of the data quantities in space and time. The CF Metadata Conventions refer to these one-dimensional coordinate variables as instance variables because

they provide the metadata that differentiates individual features. The data and coordinate/instance variables are related through the use of the subscript associated with their single dimension. This dimension is referred to as the instance dimension. The subscript identifies the particular wind vector in the case of the Derived Motion Winds product, and the hurricane location at a particular time in the case of the Hurricane Intensity Estimate product.

The attribute coordinates is attached to every data variable. Its value identifies the coordinate/instance variables needed to locate the data in space and time.

Additional details on discrete sampling geometries methods are located in Chapter 9 of the CF Metadata Conventions.

5.3.9 Packed Data

Many of the ABI L1b/L2+ products use 16-bit scaled integers (i.e., short or NC_SHORT) for physical data quantities rather than 32-bit floating point values to minimize the size of the product files. The NUG-defined attributes, scale_factor and add_offset, are used to allow conversion to and from the actual value associated with the physical quantity. User applications must first apply the scale_factor and then apply the add_offset to the 16-bit scaled integer using multiplication and addition, respectively.

The CF metadata conventions are more restrictive than the NUG with respect to the use of the scale_factor and add_offset attributes; ambiguities and precision problems related to data type conversions are resolved by these restrictions. If the scale_factor and add_offset attributes are of a different data type from the variable (containing the packed data), which is the case for ABI L1b/L2+ scaled integer products, then the unpacked data matches the type of these attributes, which must both be of type float. An additional restriction in this case is that the variable containing the packed data must be of type byte, short, or int. In addition, the attributes _FillValue and valid_range defined in the NUG must be of the same data type as the packed data.

5.4 Flexible Image Transport System (FITS) Standard

In addition to a netCDF version, the SUVI Solar Imagery: EUV product also conforms to the 2008 FITS standard.

For the GOES-R solar imagery product, the FITS file is composed of a primary header and data unit, and one conforming extension that contains both an extension header and data unit. The primary and extension headers are composed of 80 character ASCII records that are used to store solar imagery product metadata. The primary and extension data units are used to store the solar imagery data, and corresponding data quality flags for each image pixel, respectively. Refer to Figure 5.4, GOES-R FITS Level 1b Solar Imagery: EUV Product File Layout.

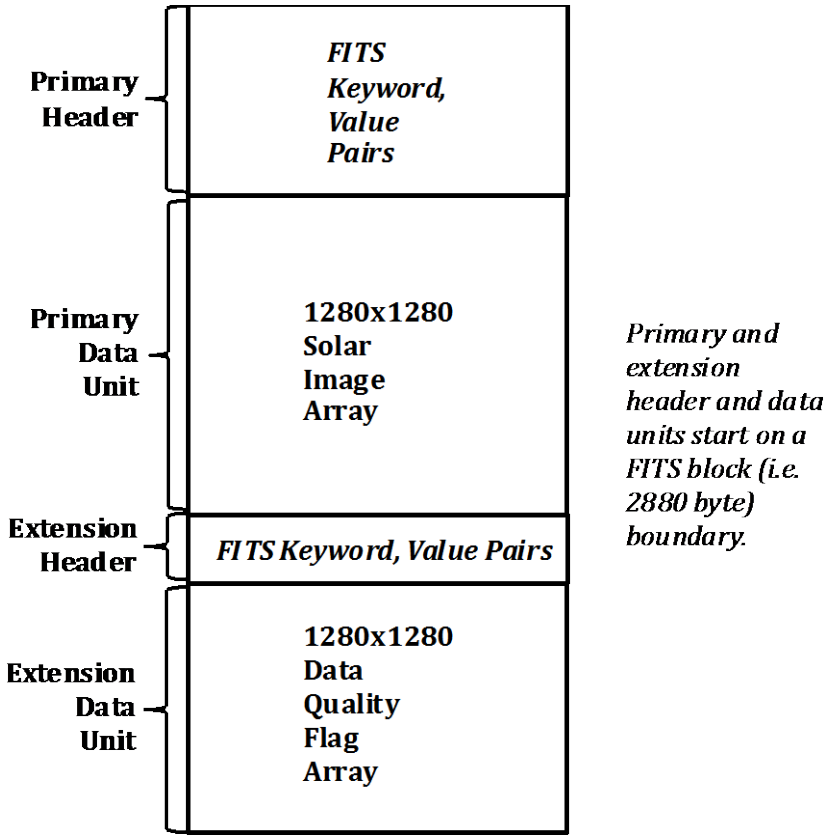

Figure 5.4 GOES-R FITS Level 1b Solar Imagery: EUV Product File Layout

A FITS header record is ASCII, 80 characters in length, includes a keyword, often includes a value associated with the keyword, and includes a comment field. The metadata in the primary header includes the physical and logical characteristics of the constituent solar imagery data, the temporal, spatial, and quality characteristics of the solar imagery, the settings and health of the SUVI, and lineage information. The metadata in the extension header includes the physical and logical characteristics of the constituent data quality flag array.

The FITS standard includes conventions for expressing integers, floating point values, and character strings, and units of measures.

Keywords provide the mechanism to define metadata in a FITS file that is self-describing. The FITS keywords, which are used in the Level 1b SUVI Solar Imagery: EUV product, are as follows:

- Mandatory keywords.
- Standard world coordinate system related keywords.
- Standard and commonly used keywords.
- Non-standard keywords.

These categories are not entirely mutually exclusive, but they provide an adequate partitioning to discuss and explain how the FITS standard has been applied on GOES-R. Keywords that span these categories are identified and described in the first applicable sub-paragraph.

5.4.1 FITS Mandatory Keywords

There is a set of FITS keywords that must exist in the GOES-R Level 1b SUVI Solar Imagery: EUV product file to conform to the FITS standard. Table 5.4.1, Applicable FITS Mandatory Keywords, identifies and defines the mandatory keywords.

Table 5.4.1 Applicable FITS Mandatory Keywords

Keyword	Description
SIMPLE	Start of primary header.
BITPIX	Number of bits per image pixel (primary header) or data quality flag value (extension header).
NAXIS	Number of axes (dimensions) in data stored in primary/extension data unit.
NAXIS1	Length of primary and extension data axis 1.
NAXIS2	Length of primary and extension data axis 2.
OBJECT	Science objective of observation (primary header only).
XTENSION	Name of extension type (extension header only).
PCOUNT	Defines the data structure in the extension data unit.
GCOUNT	Defines the data structure in the extension data unit.
END	Last keyword in primary and extension header.

Notes:

[1] Both the solar image and data quality flag values are two-dimensional arrays.

[2] The total number of bits in the primary data array, exclusive of fill that is needed after the data to complete the last 2880-byte data block (see section 3.3.2 of the FITS Standard), is given by the following expression:

BITPIX × (NAXIS1 × NAXIS2)

[3] The total number of bits in the extension data array (exclusive of fill that is needed after the data to complete the last 2880 byte data block) is given by the following expression:

BITPIX × GCOUNT × (PCOUNT + NAXIS1 × NAXIS2)

5.4.2 FITS Standard World Coordinate System (WCS) Related Keywords

There is a set of standard FITS keywords in the primary header that provide a mapping between the solar image data array coordinates and the physical (i.e., world) coordinate system. A detailed description of the mapping is located in section 8 of the FITS Standard. Refer to Table 5.4.2, Applicable Standard FITS WCS Related Keywords. The applicable standard WCS related keywords and descriptions are included in this table. For detailed descriptions of these keywords, refer to the Level 1b SUVI Solar Imagery: EUV product paragraph in PUG Volume 3: Level 1b.

Table 5.4.2 Applicable Standard FITS WCS Related Keywords

Keyword	Description
WCSNAME, CTYPE1, CTYPE2	Helioprojection (i.e., solar coordinate system) and its axes.
CRPIX1, CRPIX2, CRVAL1, CRVAL2	Reference coordinates (i.e., center of the solar disk) in the solar image data array and the corresponding helioprojection coordinates.
CDELT1, CDELT2, CUNIT1, CUNIT2	Image pixel angular coverage.
ORIENT	Sun's orientation in solar image data array.
PC1_1, PC1_2, PC2_1, PC2_2, CROTA, SOLAR_B0	Solar north rotational pole and equatorial plane rotations. Note that CROTA2 has been deprecated in favor of the general purpose Pc*i_j* linear transformation matrix keywords in the 2008 FITS standard, but the GOES-R-specific keyword "CROTA" has been included to avoid using the deprecated keyword and also provide the value for CROTA2.
CSYER1, CSYER2	Uncertainty in pixel coordinates due to systematic errors.

Keyword	Description
OBSGEO-X, OBSGEO-Y, OBSGEO-Z	Location of the observation platform (i.e., GOES-R satellite).
LONPOLE	Projection location relative to celestial sphere.
DATE-OBS	Start date and time of solar observation.

5.4.3 FITS Standard and Commonly Used Keywords

There is a set of additional standard and commonly used FITS keywords in the primary header that provide metadata about the constituent solar image, and the configuration of the solar imager at the time of observation. Refer to Table 5.4.3, Applicable FITS Standard and Commonly Used Keywords. The applicable standard keywords and descriptions are included in this table. For detailed descriptions of these keywords, refer to the Level 1b SUVI Solar Imagery: EUV product paragraph in Volume 3: Level 1b.

Table 5.4.3 Applicable FITS Standard and Commonly Used Keywords

Keyword	Description
TITLE, SUMMARY	Product type and product description.
FILENAME	Product file name.
ORIGIN	Institution making the product available.
TELESCOP, INSTRUME	Observation platform and type of solar imager.
SCI_OBJ	Detailed characteristics (e.g., wavelength, exposure time) of the solar image in character string form.
WAVELNTH, WAVEUNIT	Wavelength in numeric form and its units of measure.
TIMESYS, DATE, DATE-END, DATE-BKE, DATE-DFM, DATE-DFx (x = 0 to 9)	Time system for time-related keyword values, and keywords whose values are time stamps.
EXPTIME	Actual imaging exposure time.
DSUN_OBS	Distance to the center of sun from the observation platform.
FILTER1, FILTER2	Forward and aft imaging filter settings in character string form.
LONGSTRN	OGIP Long String Keyword Convention allowing keyword values to span multiple 80 ASCII character header records.
EXTNAME, EXTVER	String and integer primary and extension header and data unit identifiers

5.4.4 FITS Non-Standard Keywords

There is a set of non-standard FITS keywords in the primary header that provide metadata about the constituent solar image, and the configuration and state of the SUVI (solar imager) at the time of observation. Refer to Table 5.4.4, Applicable FITS Non-Standard Keywords. The applicable non-standard keywords and descriptions are included in this table. For detailed descriptions of these keywords, refer to the Level 1b SUVI Solar Imagery: EUV product paragraph in Volume 3: Level 1b.

Table 5.4.4 FITS Non-Standard Keywords

Keyword	Description
PROJECT, LICENSE, NAMEAUTH	Program controlling data access and distribution restrictions, data access and distribution restrictions for product data, and naming authority for product
PRODSITE, PRODENV, DATA_SRC	Production site, ground system environment, and production data source usage scenario.
UUID, ISO_META	Unique product identifier, and applicable ISO series metadata identifier
KEYVOCAB, KEYWORDS	Search keyword vocabulary identification information, and search keywords for product
LEVEL	Processing level designation.
INST_ID	SUVI (solar imager) serial number.
CMD_EXP	Commanded imaging exposure time.
DIAM_SUN	Diameter of sun in terms of image pixels.
GOOD_PIX, FIX_PIX, SAT_PIX, MISS_PIX	Number of good, corrected, saturated, and missing pixels in solar image.
IMGTII, IMGTIR	Total irradiance and radiance of solar image.
IMG_MIN, IMG_MAX, IMG_MEAN, IMG_SDEV	Minimum, maximum, mean, and standard deviation of image pixels' radiance values.
CONTAMIN, CONT_FLG, CONT_QF	
DER_SNR, SAT_THR, CCD_BIAS	SUVI (solar imager) CCD signal to noise ratio, saturation threshold, and background noise.
CONTAMIN, CONT_FLG, CONT_QF	SUVI (solar imager) lens contamination thickness, and contamination processing indicators.
FILTPOS1, FILTPOS2	Forward and aft imaging filter settings in integer form.
CCD_TMP1, CCD_TMP2, CCD_READ	Camera temperature at time of observation, and CCD readout configuration for solar image.
YAW_FLIP	Satellite orientation (i.e., yaw flip) at time of observation.
ECLIPSE, SOLCURRx (x = 1 to 4)	Satellite obscured by earth indication, and the satellite's solar array current at time of observation.
PCTL0ERR	Level 0 image data loss percentage.
NDFRAMES	Number of dark frame images used to radiometrically correct image.

5.5 Extensible Markup Language (XML) Standard

XML is a subset of the Standard Generalized Markup Language (SGML) designed for ease of implementation and use. XML is text based, and provides a hierarchical structure, and tag/value pairs for labeling and defining data. The XML in GOES-R products and data conform to the ASCII standard.

The primary use of XML in GOES-R products and data is for GRB metadata packets that encapsulate the XML-based NMS representation of the netCDF file specifications, including the values for product metadata.

Additional details on XML are located in the extensible Markup Language specification at http://www.w3.org/TR/xml/.

5.6 ISO Series Metadata Standards

ISO series metadata is associated with each type of GOES-R products and data made available to users.

The ISO series metadata conforms to several ISO standards:

- ISO 19115:2003, Geographic Information – Metadata.
- ISO 19115-2:2009, Geographic Information – Metadata – Part 2: Extensions for Imagery and Gridded Data that define metadata content, and a technical specification.
- ISO/TS 19139:2007, Geographic Information – Metadata – XML Schema that defines implementation.

ISO 19115 and 19115-2 contain many normative reference 191xx standards. Normative standards provide guidelines for properly implementing the main standards. Refer to ISO 19115 and 19115-2 documentation for further information on their normative reference standards.

ISO 19115 contains fourteen UML packages. Each package contains a number of other packages and entities:

- Metadata entity set information (package) – the root level that contains information about the metadata file itself and contains the following packages:
    - Identification information (package) – information to uniquely identify the data and the following entities:
        - Format of the data
        - Browse graphic – graphic overview of the data
        - Usage – specific uses of the data
        - Constraints (package) – constraints placed on the resource
            - Legal constraints
            - Security constraints
        - Keywords – keywords describing the resource
        - Maintenance Information – how often the data is scheduled to be updated and the scope of the update
        - Aggregate Information – information about datasets that are aggregate parts of the dataset that the metadata describes
    - Constraint information – contains information concerning the restrictions placed on the data.
    - Data quality information – contains dataset quality information and lineage information.
    - Maintenance information – contains information about the scope and frequency of updating data.
    - Spatial representation information – contains information concerning the mechanisms used to represent spatial information in a dataset.
    - Reference system information – contains the description of the spatial and temporal reference system(s) used.
    - Content information – contains information identifying the feature catalog used and/or information describing the content of a coverage dataset.
    - Portrayal Catalog reference information – contains information identifying the portrayal catalog used, if any.
    - Distribution information – contains information about the distributor of, and options for obtaining a resource.
    - Metadata extension information – contains information about user specified extensions, if any.
    - Application schema information – contains information about the application schema used to build a dataset, if any.

ISO 19115-2 adds one package:

- Acquisition information – contains information on instruments, operations, platforms, objectives, requirements and acquisition plan

ISO 19115-2 extends the following ISO 19115 packages with structures specific to gridded data:

- Data quality information
- Spatial representation information
- Content information

GOES-R ISO Series Metadata uses applicable parts of all ISO 19115 and 19115-2 packages except Portrayal Catalog, Application Schema and Metadata Extensions.

6.0 OFF-THE-SHELF NETCDF APPLICATIONS AND UTILITIES

There are many off-the-shelf netCDF visualization and analysis applications, some of which interpret the CF metadata convention projections and other constructs. For example, Unidata's Integrated Data Viewer (IDV) and NASA's Panoply netCDF Viewer can plot CF-compliant netCDF files on a variety of map backgrounds.

Unidata has a web page that is updated periodically containing a list of commercial and open-source software products that provide visualization and analysis capabilities. This web page is located at https://www.unidata.ucar.edu/software/.

There is also a set of generic netCDF utilities that provide the capability to dump (ncdump), copy (nccopy), generate (ncgen), and compare (nccmp). The first three are tools described in the NUG, and are developed by Unidata. These software tools are located at the Unidata web site. The compare tool software is located at http://nccmp.sourceforge.net.

7.0 SUMMARY PRODUCT AND DATA DESCRIPTIONS

7.1 Level 0 Products Overview

Level 0 products contain the observation data (i.e., science telemetry) received from the instruments on-board the GOES-R series satellites. The data is in the form of CCSDS packets as generated by the instruments or spacecraft. The Level 0 products contain an array of CCSDS packets generated and downlinked. The CCSDS packets in the Level 0 products have not been modified by the ground system.

The Level 0 products contain spacecraft generated Orbit and Attitude/Angular Rate (OAR) data in a CCSDS packet for the science data's sensing period. This OAR data is needed to navigate the Level 0 data.

In addition, instrument engineering telemetry, and diagnostic data, if available, are inserted in the Level 0 products.

The Level 0 products contain metadata that can be used for cataloguing, such as formal product name, sensing period, resolution, data source related information, search keywords, and error information.

There are six types of GOES-R Level 0 product files corresponding to the following instruments or instrument suites:

- ABI
- GLM
- SUVI
- EXIS
- SEISS
- MAG

The EXIS Level 0 product includes CCSDS packets from both the XRS and EUVS. The SEISS Level 0 product includes CCSDS packets from each sensor in the space environment suite including the EHIS, MPS-HI, MPS-LO, and SGPS.

Level 0 product files use the netCDF-4 file format and contain data for a specific time interval. The time interval contained within a Level 0 product file varies for each type of Level 0 product based on the science data volume.

The volume and paragraph where detailed information on each type of Level 0 product is defined in Table 7.1, PUG Location for Level 0 Products.

Table 7.1 PUG Location for Level 0 Products

Level 0 Product	PUG Volume, Paragraph
ABI	Volume 2, Paragraph 2.2
EXIS	Volume 2, Paragraph 2.3
GLM	Volume 2, Paragraph 2.4
MAG	Volume 2, Paragraph 2.5
SEISS	Volume 2, Paragraph 2.6
SUVI	Volume 2, Paragraph 2.7

7.2 Level 1B Products Overview

The Level 1b products contain radiometrically calibrated, and, in the case of ABI, GLM, and SUVI data, geometrically corrected Level 0 observation data. The Level 0 observation data is processed so that its values are in standard units of physical quantities that simplify subsequent processing. The Level 1b products contain the navigation data and timing information that enable locating the Level 1b processed observation data in space and time.

In the case of the ABI Level 1b product, Radiances, the Level 0 instrument detector samples 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 (i.e., GVAR) enabling the product's image data to be geospatially normalized.

Instances of an ABI Level 1b product, Radiances, contain different areas of earth coverage. The standard coverage regions are defined in Table 7.2-1, Radiances Product Standard Coverage Regions.

Table 7.2-1 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 events, is not distributed to users. Only the GLM Level 2+ product that contains the Level 1b high energy events and the derived lightning detection product data is made available to users.

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 made available in two forms using two different distribution mechanisms. NetCDF-4 Level 1b product files are made available by the NOAA Product Distribution and Access (PDA) system. Note that a FITS formatted Level 1b SUVI Solar Imagery: EUV (also referred to as Solar Imagery: X-Ray) product file is also available. In addition, a CCSDS space packet form of the Level 1b products is made available via GRB.

The volume and paragraph where detailed information on each type and form of Level 1b product is defined in Table 7.2-2, PUG Location for Level 1b Products.

Table 7.2-2 PUG Location for Level 1b Products

	PUG Volume, Paragraph	
Level 1b Product	**netCDF / FITS**	**GRB**
Radiances	Volume 3, Paragraph 5.1.3	Volume 4, Paragraph 7.1.3
Lightning Detection (See Level 2+; GLM Level 1b not available)		Volume 4, Paragraph 7.2.1
Level 1b SUVI Solar Imagery: EUV (also referred to as Solar Imagery: X-Ray)	Volume 3, Paragraph 5.2.1	Volume 4, Paragraph 7.3.1
Solar Flux: EUV	Volume 3, Paragraph 5.3.1	Volume 4, Paragraph 7.4.1
Solar Flux: X-Ray	Volume 3, Paragraph 5.3.2	Volume 4, Paragraph 7.4.2
Energetic Heavy Ions	Volume 3, Paragraph 5.4.1	Volume 4, Paragraph 7.5.1
Magnetospheric Electrons and Protons: Low Energy	Volume 3, Paragraph 5.4.2	Volume 4, Paragraph 7.5.2
Magnetospheric Electrons and Protons: Medium and High Energy	Volume 3, Paragraph 5.4.3	Volume 4, Paragraph 7.5.3
Solar and Galactic Protons	Volume 3, Paragraph 5.4.4	Volume 4, Paragraph 7.5.4
Geomagnetic Field	Volume 3, Paragraph 5.5.1	Volume 4, Paragraph 7.6.1

7.3 Level 2+ Products Overview

The Level 2+ products contain environmental physical quantities, such as Cloud Top Height, Land Surface (Skin) Temperature, and Hurricane Intensity. Except for the Lightning Detection product, the primary source for generating the Level 2+ products are the 16 bands of ABI Level 1b Radiances product data. In addition to the ABI Level 1b data, National Weather Prediction (NWP) forecast model output data, which is received by the GOES-R series ground system several times a day, is key ancillary source data for generating several of the Level 2+ products. Furthermore, there are a few other dynamic ancillary data sets used in the generation of Level 2+ product containing information, such as current snow and ice extents, and sea surface temperature in the western hemisphere.

There are nine types of Level 2+ products. There are one or more Level 2+ products of each type. The types of Level 2+ products are as follows:

- Clouds
- Aerosols
- Atmospheric Vertical Profiles
- Precipitation
- Winds
- Land
- Ocean
- Radiation
- Lightning

All of the Level 2+ products other than the Derived Motion Winds, Hurricane Intensity, and Lightning Detection products are gridded data sets. There are two projections associated with these gridded Level 2+ products: the ABI fixed grid and the global latitude/longitude grid. The ABI fixed grid is a projection

relative to the ideal location of a satellite in geostationary orbit. The global latitude/longitude grid has data points at specific degrees of latitude and longitude, or fractions thereof. The radiation products are the only gridded Level 2+ products on the global latitude/longitude grid. The remaining gridded Level 2+ products are on the ABI fixed grid. The environmental quantity data for the winds, hurricane intensity, and lightning products is geo-located using latitude/longitude coordinates.

Instances of an ABI Level 2+ product contain different areas of earth coverage. The standard coverage regions are defined in Table 7.3-1, ABI Level 2+ Product Standard Coverage Regions.

Table 7.3-1 ABI Level 2+ 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 Level 2+ products contain product-level metadata that include statistics such as minimum, maximum, mean, and standard deviation values associated with data elements in the product, and other data that is useful in interpreting the environmental physical quantity data, and verifying its integrity. The Level 2+ products also contain product-level metadata that can be used for cataloguing, such as formal product name, geographic coverage area, sensing period, resolution, data source related information, search keywords, and error information.

The volume and paragraph where detailed information on each type of Level 2+ product is defined in Table 7.3-2, PUG Location for Level 2+ Products.

Table 7.3-2 PUG Location for Level 2+ Products

Level 2+ Product Type	Level 2+ Product	PUG Volume, Paragraph
Clouds	Cloud and Moisture Imagery	Volume 5, Paragraph 5.1
	Clear Sky Masks	Volume 5, Paragraph 5.2
	Cloud Top Phase	Volume 5, Paragraph 5.3
	Cloud Top Height	Volume 5, Paragraph 5.4
	Cloud Top Pressure	Volume 5, Paragraph 5.5
	Cloud Top Temperature	Volume 5, Paragraph 5.6
	Cloud Optical Depth	Volume 5, Paragraph 5.7
	Cloud Particle Size Distribution	Volume 5, Paragraph 5.8
Aerosols	Aerosol Detection (including Smoke and Dust)	Volume 5, Paragraph 5.9
	Aerosol Optical Depth	Volume 5, Paragraph 5.10
	Volcanic Ash: Detection and Height	Volume 5, Paragraph 5.11
Atmospheric Vertical Profiles	Legacy Vertical Temperature Profile	Volume 5, Paragraph 5.12
	Legacy Vertical Moisture Profile	Volume 5, Paragraph 5.13
	Total Precipitable Water	Volume 5, Paragraph 5.14
	Derived Stability Indices (5 indices: CAPE, Lifted Index, K-index, Showalter Index, Total Totals Index)	Volume 5, Paragraph 5.15
Precipitation	Rainfall Rate (QPE)	Volume 5, Paragraph 5.16
Winds	Derived Motion Winds	Volume 5, Paragraph 5.17
	Hurricane Intensity	Volume 5, Paragraph 5.18
Land	Fire (Hot Spot Characterization)	Volume 5, Paragraph 5.19
	Land Surface (Skin) Temperature	Volume 5, Paragraph 5.20
	Snow Cover	Volume 5, Paragraph 5.21
Ocean	Sea Surface (Skin) Temperature	Volume 5, Paragraph 5.23
Radiation	Downward Shortwave Radiation: Surface	Volume 5, Paragraph 5.24
	Reflected Shortwave Radiation: TOA	Volume 5, Paragraph 5.25
Lightning	Lightning Detection: 1) Flashes 2) Groups 3) Events	Volume 5, Paragraph 5.26

7.4 Instrument Calibration Data Overview

Instrument calibration data is a general term used for one or more of the following: downlinked science telemetry obtained from instrument-specific calibration targets, instrument engineering telemetry, and parameters used to radiometrically correct Level 0 data. Ephemeris and attitude data received from the satellite is also considered instrument calibration data. Instrument calibration data is used to:

- Radiometrically calibrate and navigate observation data during Level 1b processing.
- Support the revision of configuration-controlled calibration parameters used in Level 1b processing over the instruments life-cycle.
- Monitor and evaluate the health and performance of the instruments over their life-cycle.

Some calibration targets are integrated into an instrument, such as an internal calibrated black body, a solar reflective 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.

The GOES-R imagers, ABI and SUVI, perform 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: Internal Calibration Target (ICT) looks, space looks, Solar Calibration Target (SCT) looks, and lunar scans.

ICT data is used to compute detector gain coefficients for the ABI emissive channels. Space and SCT looks are used to compute detector gain coefficients for ABI reflective channels. 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.

The volume and paragraph where detailed information on each type and form of instrument calibration data is defined in Table 7.4, PUG Location for Level 1b Products.

Table 7.4 PUG Location for Instrument Calibration Data

Instrument	PUG Volume, Paragraph
ABI	Volume 3, Paragraphs 5.1.5-5.1.7
SUVI	Volume 3, Paragraphs 5.2.2-5.2.4
EXIS	Volume 3, Paragraph 5.3.3
SEISS	Volume 3, Paragraphs 5.4.5-5.4.6
MAG	Volume 3, Paragraph 5.5.2-5.5.3
GLM	Volume 3, Paragraph 5.6.1-5.6.2
Satellite Instrument Calibration	Volume 3, Paragraph 5.7

7.5 Semi-Static Source Data Overview

Semi-static source data is used by level 1b and level 2+ algorithms that does not change often. It is received in a source format from external system or input by a GS operator. Software tools are often employed to pre-process the data so it can be used by the operational Level 1b and Level 2+ algorithms. Calibration INR database parameters are an example of Level 1b semi-static source data. Monthly surface emissivity data is an example of Level 2+ gridded semi-static source data.

7.6 ISO Series Metadata Overview

GOES-R metadata is designed to serve two purposes:

- To support long-term archive and facilitate data discovery, evaluation, retrieval, use and reuse.
- To provide supplemental information for further processing, algorithm development, diagnostic and anomaly resolution and better understanding of each dataset.

For each Level 0, Level 1b, and Level 2+ product, ABI sample outlier data, instrument calibration data, and Level 1b and Level 2+ semi-static source data and 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 and is used to discover, display, exploit and further process the data. ISO series metadata is a set of "quasi-static" metadata elements that describe a collection of instances of a product or other related datasets. Their format, content, and citations to documents and points of contact are provided in the standalone Appendix X. 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 made available by the NOAA Data Centers.

The detailed listings of ISO series metadata for GOES-R 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.

8.0 PRODUCT AND DATA FILENAME CONVENTIONS

The filenames for GOES-R product and data files follow a set of conventions to achieve standardization.

GOES-R product and data filenames are case-sensitive and no greater than 255 characters. Alphanumeric characters, underscores, hyphens, and periods are used, and blanks are not used. GOES-R filenames indicate the source, content, file type, and creation date and time of the product or data. In the case of observation

data, the period of time when the observation occurred is included. In the case of time-sensitive status information, the start time of when it is valid is included. In the case of GOES-R data files that are configuration controlled internally by the GOES-R system, the version associated with the data file is included.

The syntax for capturing this information is structured. String fields are used to identify each of these characteristics. String fields are concatenated together in a prescribed order and delimited by underscores to create a filename string. A period is used to delimit the final string field, file extension, which indicates the file format.

Source

Two string fields are related to identifying the product or data file's source. They are as follows:

- System environment where the file is created. The system environment defines whether the file is created by the operational system or a test system. The system environment also defines whether the data in the file is real-time, test, playback, or simulated data. Real-time data created by the operational system support the mission. GOES-R configuration managed data files made available to users, including ISO series metadata, semi-static source data, and algorithm packages, do not include the system environment string field in their filenames.
- Platform (i.e., satellite) identifier associated with the file. The data in the file is associated with only one of the GOES-R series satellites, either the source of the data in the file, or data that is applicable to only one of the satellites. Specific Level 0, 1b, and 2+ product files are associated with a single satellite. Semi-static source data used by Level 1b software are associated with an instrument on a specific satellite.

Content

The Data Short Name (DSN) is a GOES-R standard term for a string field identifying the content of a GOES-R product or data file. DSN strings for GOES-R product and data files are often composed of multiple concatenated sub-fields. For example, in the case of ABI Level 1b product files, the DSN is a concatenation of:

- Instrument identifier, processing level, and type of product ("ABI-L1b-RAD")
- Type of image sensed ("F" for Full Disk, "C" for CONUS, and "M" for mesoscale)
- Mesoscale image number ("1" or "2")
- ABI mode of operation ("M3" for mode 3, "M6" for mode 6 and "M4" for mode 4)
- ABI channel ("Cxx" where xx = 01 – 16)

For example, the DSN for an ABI Level 1b Radiances full disk channel 7 product sensed in mode 3 is "ABI-L1b-RADF-M3C07".

File Extension

Every GOES-R product and data file has a file extension. The file extension defines the format of the file. It is the last string field in the filename, and delimited by a period. For example, the file extension for a netCDF-4 product file is "nc".

Creation Date and Time

The date and time the file is created. This string field is included in all GOES-R products and data filenames except GOES-R configuration managed data files made available to users, including semi-static source data and algorithm packages.

Observation Period Date and Time

The start and end date and time associated with the raw or processed observation data in the file. GOES-R configuration managed data files made available to users, including ISO series metadata, semi-static source data parameters, and algorithm packages, do not include this string field in their filenames.

Status Valid Date and Time

The start time of the data file that contains status information. This string field applies to the GRB Information file only.

Version

The version associated with the data file. This string field applies to semi-static source data and algorithm packages only.

Table 8.0, Product and Data Filename Applicable Fields summarize the filename string fields used for different types of GOES-R product and data files.

Table 8.0 Product and Data Filename Applicable Fields

	Source				Date and Time Fields			
	System Env	**Platform ID**	**Content (DSN)**	**File Extension**	**Creation**	**Observation Period Start & End**	**Status Valid Start**	**Version**
Level 0 Product	x	x	x	x	x	x		
Level 1b Product	x	x	x	x	x	x		
Level 2+ Product	x	x	x	x	x	x		
GRB Information	x	x	x	x	x		x	
ABI Sample Outlier Data	x	x	x	x	x	x		
Instrument Calibration Data	x	x	x	x	x	x		
ISO Series Metadata			x	x	x			
Algorithm Package			x	x				x
Level 1b Semi-Static Source Data		x	x	x				x
Level 2+ Semi-Static Source Data			x	x				x

Appendix A in the Level 0, 1b, and 2+ PUG volumes provide the comprehensive filename specifications for the products and data files defined in the respective volume.

9.0 POINTS OF CONTACT AND PRIMARY RESPONSIBILITY

Table 9.0 lists the Points of Contact (POC) for all data items included in this PUG.

Table 9.0 POC for Data Issues and Questions

For data issues and anomalies, the POC is: ESPC Helpdesk ESPCoperations@noaa.gov (301) 817-3880
For data questions, the POC is: OSPO User Services SPSD.UserServices@noaa.gov

APPENDIX A ACRONYM AND GLOSSARY LIST

The following acronyms are used throughout the volumes of this document.

Acronym	Description(s)
A	Amp
ABI	Advanced Baseline Imager
ADC	Analog to Digital Converter
ADRS	Ancillary Data Relay System
ADT	Advanced Dvorak Technique
ACDD	Attribute Convention for Data Discovery
ACH	ABI Cloud Height
ACM	ABI Cloud Mask
ACRF	Attitude Control Reference Frame
ACT	ABI Cloud Top Type and Phase
ADP	Aerosol Detect Product
ANSI	American National Standards Institute
AOD	Aerosol Optical Depth
AOS	Advanced Orbiting Systems
API	Application Programming Interface
APID	Application Process Identifier
ASCII	American Standard Code for Information Interchange
ASIC	Application-Specific Integrated Circuit
ATCF	Automated Tropical Cyclone Format
AU	Astronomical Unit
AVHRR	Advanced Very High Resolution Radiometer
AWG	Algorithm Working Group
AWIPS	Advanced Weather Interactive Processing System
arcmin	Arcminute
arcsec	Arcsecond
BCH	Bose Chaudhuri Hocquenghem
Be-Cu	Beryllium-Copper
BOOM	Magnetometer boom base reference system
BPSK	Binary Phase Shift Keying
BRDF	Bi-directional Reflectance Distribution Function
BRF	Spacecraft Body Reference Frame
BT	Brightness Temperature

Acronym	Description(s)
BTD	Brightness Temperature Difference
C-N-O	Carbon-Nitrogen-Oxygen
CAL Cal	Calibration
CAPE	Convective(ly) Available Potential Energy
CBU	Consolidated Backup Facility
CCD	Charge-Coupled Device
CCSDS	Consultative Committee for Space Data Systems
CCW	Counterclockwise
CDA	Command and Data Acquisition
CDO	Central Dense Overcast
CDRL	Contract Data Requirements List
CEB	Camera Electronics Box
CF	Climate and Forecast
Ch	Channel
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CLASS	Comprehensive Large Array-data Stewardship System
CMI	Cloud and Moisture Imagery
CMIP	Cloud and Moisture Imagery Product
CNO	Carbon-Nitrogen-Oxygen
COD	Cloud Optical Depth
COMP	Cloud Microphysical and Optical Properties
CONUS	Contiguous United States
CPS	Cloud Particle Size
CRC	Cyclic Redundancy Check
CSR	Clear Sky Radiance
CRTM	Community Radiative Transfer Model
cGy	Centigray (equivalent to rad)
cm	Centimeter
DC	Direct Current
DCOMP	Daytime Cloud Optical and Microphysical Properties
DEM	Digital Elevation Model
DID	Data Item Description
DLR	Downward Longwave Radiation: Surface
DMSP	Defense Meteorological Satellite Program
DN	Digital Number

Acronym	Description(s)
DQF	Data Quality Flag
DSN	Data Short Name
DSR	Downward Shortwave Radiation
DVB-S2	Digital Video Broadcast – Second Generation
double	64 Bit Floating Point Number (IEEE 754 Compliant)
8PSK	8 level Phase Shift Keying
E	East
ECI	Earth-Centered Inertial
ECEF	Earth-Centered Earth-Fixed
EHIS	Energetic Heavy Ion Sensor
EIR	Enhanced Infrared
EM	Enterprise Management
EMWIN	Emergency Managers Weather Information Network
EOS	Earth Observing System
EPN	Earth Polar Normal
ESPC	Environmental Satellite Processing Center
EU	Electronics Unit
EUV	Extreme Ultraviolet
EUVS	Extreme Ultraviolet Spectrometer
EXIS	EUV and X-Ray Irradiance Sensors
E/W	East/West
eV	Electron Volt
F&PS	Functional & Performance Specification
FDC	Fire Characterization
Fe	Iron
FEC	Forward Error Correction
FFT	Fast Fourier Transform
FITS	Flexible Image Transport System
FNC	Filename Convention
FPGA	Field-Programmable Gate Array
FTE	Fine Track Error
FOR	Field of Regard
FOV	Field of View
float	32 Bit Floating Point Number (IEEE 754 Compliant)
GCMD	Global Change Master Directory
GFP	Government Furnished Property

Acronym	Description(s)
GFS	Global Forecast System
GLM	Geostationary Lightning Mapper
GSFC	Goddard Space Flight Center (NASA)
GOES	Geostationary Operational Environmental Satellite
GPA	Ground Processing Algorithm
GPG	GOES-R Product Generation
GRB	GOES-R series Rebroadcast
GRS 80	Geodetic Reference System 1980
GS	Ground Segment
GTOP	Global Topographic
GVAR	GOES Variable Format
H	Hydrogen
HDF	Hierarchical Data Format
HDLC	High-Level Data Link Control
HDU	Header and Data Units
He	Helium
HILET	High Linear Energy Transfer
HRIT	High Rate Information Transmission
HSC	Hot Spot Characterization
Hz	Hertz
hPa	Hectopascal
IB	Inboard
ICAO	International Civil Aviation Organization
ICT	Infrared Calibration Target
ID	Identification
IDV	Integrated Data Viewer
IF	Intermediate Frequency
IFC	In-Flight Calibration
IMS	Interactive Multisensor Snow and Ice Mapping System
INFO	Information
ISM	ISO Series Metadata
IO	Input/Output
IR	Infrared
ISO	International Organization for Standardization
ITT	International Telephone and Telegraph Industries
int	32 Bit Signed Integer

Acronym	Description(s)
int16	16 Bit Signed Integer
int32	32 Bit Signed Integer
J	Joule
JFET	Juncture Field-Effect Transistor
K	Kelvin
KI	K-Index
KPP	Key Performance Parameter
keV	Kiloelectron Volt
kg	kilogram
km	kilometer
L0	Level 0
L1b	Level 1b
L2+	Level 2+
LAP	Legacy Atmospheric Profile
LCFA	Lightning Cluster-Filter Algorithm
LED	Light Emitting Diode
LET	Linear Energy Transfer
LDPC	Low Density Parity Check
LHCP	Left Hand Circular Polarization
LHP	Long Heat Pipe
LI	Lifted Index
LNA	Low Noise Amplifier
LOLET	Low Linear Energy Transfer
LOS	Line of Sight
LR	Lower Right
LRC	Local Radiative Center
LSB	Least Significant Bit
LSE	Low Surface Emissivity
LST	Land Surface (Skin) Temperature
LUT	Look-up Table
LVM	Legacy Vertical Moisture
LVT	Legacy Vertical Temperature
LZA	Local Zenith Angle
LWIR	Long Wave Infrared
MAG	Magnetometer
MeV	Megaelectron Volt

Acronym	Description(s)
MFIB	Magnetometer Sensor Frame Inboard
MFOB	Magnetometer Sensor Frame Outboard
Mg	Magnesium
MM	Mission Management
MODIS	Moderate Resolution Imaging Spectrometer
MP	Mixed Phase
MPS-HI	Magnetospheric Particle Sensor – High Energy
MPS-LO	Magnetospheric Particle Sensor – Low Energy
MSB	Most Significant Bit
MSG	Meteosat Second Generation
MSLP	Mean Sea Level Pressure
MUV	Mid Ultraviolet
MW	Megawatt Microwave
MWIR	Medium Wave Infrared
m	meter
mm	millimeter
ms	millisecond
N	North
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center (part of NESDIS)
NCEP	National Center for Environmental Predictions (part of NWS)
NCOMP	Nighttime Cloud Optical and Microphysical Properties
NcML	netCDF Markup Language
NedN	Noise Equivalent Change in Radiance
NedT	Noise Equivalent Differential Temperature
Ne-S	Neon-Sulfur
NESDIS	National Environmental Satellite, Data and Information Service
NGDC	National Geophysical Data Center
NHC	National Hurricane Center
NIRREF	Near Infrared Reflectance
NOAA	National Oceanic and Atmospheric Administration
NSIDC	National Snow and Ice Data Center
NSOF	NOAA Satellite Operations Facility
Nuc	Nucleon
NUG	netCDF User's Guide

Acronym	Description(s)
NWP	Numerical Weather Prediction
NWS	National Weather Service
N/S	North/South
netCDF	Network Common Data Format
nm	Nanometer
nT	Nanotesla
OB	Outboard
OAR	Orbit and Attitude/Angular Rate
ORF	Orbital Reference Frame
OSPO	Office of Satellite and Product Operations
O&A	Orbit and Attitude
PD	Product Distribution
PDA	Product Distribution and Access
PFMFT	Positive Four Minus Five Test
PG	Product Generation
PLT	Post Launch Test
PMW	Passive Microwave
POC	Point(s) of Contact
POR	Probability of Rainfall
PORD	Performance and Operational Requirements Documents
POST	Power On Self Test
PRT	Platinum Resistance Thermometer
PTR	Program Tracking Report
PUG	Product Definition and User's Guide
QA	Quality Assurance
QC	Quality Control
QCF	Quality Control Flags
QPE	Quantitative Precipitation Estimation
QPSK	Quadrature Phase Shift Keying
RAD	Radiances
RBU	Remote Backup Facility
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RMSE	Root Mean Squared Error
RRQPE	Rainfall Rate Quantitative Precipitation Estimation
RT	Real-time

Acronym	Description(s)
	Radiative Transfer
S	South
SARSAT	Search-and-Rescue Satellite Aided Tracking
SC	Spacecraft
SCT	Solar Calibration Target
SEB	SUVI Electronics Box
SEISS	Space Environment In-Situ Suite
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SGML	Standard Generalized Markup Language
SGPS	Solar and Galactic Proton Sensor
Si	Silicon
SI	Showalter Index
SLW	Supercooled Liquid Water
SNR	Signal to Noise Ratio
SOCC	Satellite Operations Control Center
SOF	Sample Outlier File
SPP	Sun Pointing Platform
SPS	Sun Positioning Sensor
SSCA	SEISS SGPS L1b Calibration Algorithm
SSEC	Space Science and Engineering Center (University of Wisconsin)
SSMI	Special Sensor Microwave Imager
SSMIS	Special Sensor Microwave Imager/Sounder
SST	Sea Surface Temperature
STAR	Center for Satellite Applications and Research
SU	Sensor Unit
SUVI	Solar Ultraviolet Imager
SZA	Solar Zenith Angle
s	second
sr	Steradian
TBD	To Be Determined
TBR	To Be Resolved/Reviewed
TBS	To Be Supplied
TBX	The aggregation of TBD, TBR, and TBS
TC	Tropical Cyclone
TCFC	Tropical Cyclone Forecast Center
THREDDS	Thematic Real-time Environmental Distributed Data Services

Acronym	Description(s)
TOA	Top-Of-Atmosphere
TPW	Total Precipitable Water
TT	Total Totals Index
UUID	Universally Unique Identifier
UL	Upper Left
URL	Uniform Resource Locator
USGS	United States Geological Survey
UTC	Coordinated Universal Time
ua	Astronomical Unit
uint	32 Bit Unsigned Integer
uint16	16 Bit Unsigned Integer
uint32	32 Bit Unsigned Integer
um	Micrometer Micron
V	Volt
VA	Volcanic Ash
VIS	Visible
VLEN	Variable Length
VNIR	Visible Near Infrared
W	Watt West
WCDAS	Wallops Command and Data Acquisition Station
WFO	Weather Forecast Offices
WMO	World Meteorological Organization
WVMD	Water Vapor Multilayered Detection
XML	Extensible Markup Language
XRS	X-Ray Sensor
XSD	XML Schema Document