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Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for Advanced Technology Microwave Sounder (ATMS) Resampling (Remap) Sensor Data Record (SDR) Software

For Public Release

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Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for Advanced Technology Microwave Sounder (ATMS) Resampling (Remap) Sensor Data Record (SDR) Software JPSS Electronic Signature Page

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Preface

This document is under JPSS Ground Algorithm ERB configuration control. Once this document is approved, JPSS approved changes are handled in accordance with Class I and Class II change control requirements as described in the JPSS Configuration Management Procedures, and changes to this document shall be made by complete revision.

Any questions should be addressed to:

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Change History Log

Revision	Effective Date	Description of Changes (Reference the CCR & CCB/ERB Approve Date)
Original	07/31/2011	This version incorporates **474-CCR-11-0107**: (This version baselines D41883, Rev B dated 04/28/2010. This is the version that was approved for NPP launch. Per NPOESS CDFCB - External, Volume V – Metadata, doc number D34862-05, this has been approved for Public Release into CLASS.) to create JPSS version, Rev-. This was approved by the JPSS Ground Algorithm ERB on June 3, 2011.
Revision A	01/18/2012	**474-CCR-11-0251:** This version baselines 474-00092. Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for Advanced Technology Microwave Sounder (ATMS) Resampling (Remap) Sensor Data Record (SDR) Software, for the Mx 6 IDPS release. This CCR was approved by the JPSS Algorithm ERB on January 18, 2012.
Revision B	05/14/2013	**474-CCR-13-0948:** This version authorizes 474-00092, JPSS OAD Document for ATMS Remap SDR Software, for the Mx 7.0 IDPS release. Includes Raytheon PCR032720; 474-CCR-13-0916/ECR-ALG-0037: Update applicable OAD filenames/template/Rev/etc. for Mx7 Release.

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

OPERATIONAL ALGORITHM DESCRIPTION DOCUMENT FOR ATMS RESAMPLING

SDRL No. S141
SYSTEM SPECIFICATION SS22-0096

RAYTHEON COMPANY
INTELLIGENCE AND INFORMATION SYSTEMS (IIS)
NPOESS PROGRAM
OMAHA, NEBRASKA

IAW DFAR 252.227-7036, Raytheon hereby declares that, to the best of its knowledge and belief, the technical data delivered under Subcontract No. 7600002744 is complete, accurate, and complies with all requirements of the Subcontract.

TITLE: NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) OPERATIONAL ALGORITHM DOCUMENT FOR ATMS RESAMPLING

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Engineering & Manufacturing Development (EMD) Phase
Acquisition & Operations Contract

CAGE NO. 11982

Operational Algorithm Description Document for ATMS Resampling

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Revision: C2

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This document has been identified per the NPOESS Common Data Format Control Book – External Volume 5 Metadata, D34862-05, Appendix B as a document to be provided to the NOAA Comprehensive Large Array-data Stewardship System (CLASS) via the delivery of NPOESS Document Release Packages to CLASS.

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NORTHROP GRUMMAN

Raytheon

Revision/Change Record

Document Number **D41883**

Revision	Document Date	Revision/Change Description	Pages Affected
---	8-8-05	Initial Release – Reflects Science To Operational Code Conversion.	All
A1	8-10-07	Updates associated with implementation of Tech Memo NP-EMD-2007.510.0019 as well as handling of missing ATMS data. Also QF and DQN updates.	5-9, 11-15
A2	9-17-07	Updated logo, header, dates, etc. Delivered to NGST.	All
A3	11-27-07	ECR-127 Updates.	All
A4	1-24-08	Reformat in accordance to new template. Delivered to NGST.	All
A5	4-30-08	Removed Table 9 and added a reference to the DPIS ICD for CrIS SDR GEO format details instead. Added description of (new) optional output CrIS-SDR-ExitAng-IP to Table 6. Updated description of generateCrisGeolocation.	6,9-22, 11
A6	5-14-08	Prepare for delivery to ACCB. Implemented new cover sheet from NGST.	All
A	05-28-08	ECR A- 154. Incorporating interim comments for approval by ACCB.	None
B1	06-16-08	New terrain-corrected radian CrIS GEO product updates: • Updated Table 6 • Updated Paragraph 2.1.2.10	7,12
B	4-28-10	Updated for TIM/ARB/ACCB	All
C1	10-14-10	Updated due to document convergence to include tech memo 2010.510.0015	All
C2	09-28-11	Updated OAD for PCR027830.	2,5,6,11-14

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1.0 INTRODUCTION

1.1 Objective

The purpose of the Operational Algorithm Description (OAD) document is to express, in computer-science terms, the remote sensing algorithms that produce the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) end-user data products. These products are individually known as Raw Data Records (RDRs), Temperature Data Records (TDRs), Sensor Data Records (SDRs) and Environmental Data Records (EDRs). In addition, any Intermediate Products (IPs) produced in the process are also described in the OAD.

The science basis of an algorithm is described in a corresponding Algorithm Theoretical Basis Document (ATBD). The OAD provides a software description of that science as implemented in the operational ground system -- the Data Processing Element (DPE).

The purpose of an OAD is two-fold:

1. Provide initial implementation design guidance to the operational software developer.
2. Capture the “as-built” operational implementation of the algorithm reflecting any changes needed to meet operational performance/design requirements.

An individual OAD document describes one or more algorithms used in the production of one or more data products. There is a general, but not strict, one-to-one correspondence between OAD and ATBD documents.

This particular document describes the operational software implementation for resampling the ATMS SDR data to the CrIS Field of Regard (FOR) locations. The terms “resampling” and “remap” or “remapping” are generally considered to be synonymous.

1.2 Scope

The scope of this document is limited to the description of the core operational algorithm(s) required to create the ATMS brightness temperatures at the CrIS fields of regard.

1.3 References

The primary software detailed design documents listed here include science software documents, NPOESS programs documents, plus source code and test data references.

1.3.1 Reference Documents

The science and system engineering documents relevant to the algorithms described in this OAD are listed in Table 1.

Table 1. Reference Documents

Document Title	Document Number/Revision	Revision Date
Advanced Technology Microwave Sounder (ATMS) SDR Radiometric Calibration Algorithm Theoretical Basis Document	474-00043	Latest
JPSS Environmental Data Record (EDR) Production Report for NPP	474-00012	Latest

Document Title	Document Number/Revision	Revision Date
JPSS Environmental Data Record (EDR) Interdependency Report (IR) for NPP	474-00007	Latest
JPSS Common Data Format Control Book - External - –Block 1.2.2 (All Volumes)	474-00001-01-B0122 CDFCB-X Vol I 474-00001-02-B0122 CDFCB-X Vol II 474-00001-03-B0122 CDFCB-X Vol III 474-00001-04-01-B0122 CDFCB-X Vol IV Part 1 474-00001-04-02-B0122 CDFCB-X Vol IV Part 2 474-00001-04-03-B0122 CDFCB-X Vol IV Part 3 474-00001-04-04-B0122 CDFCB-X Vol IV Part 4 474-00001-05-B0122 CDFCB-X Vol V 474-00001-06-B0122 CDFCB-X Vol VI 474-00001-08-B0122 CDFCB-X Vol VIII	Latest
JPSS Common Data Format Control Book - External - Block 1.2.3 (All Volumes)	474-00001-01-B0123 CDFCB-X Vol I 474-00001-02-B0123 CDFCB-X Vol II 474-00001-03-B0123 CDFCB-X Vol III 474-00001-04-01-B0123 CDFCB-X Vol IV Part 1 474-00001-04-02-B0123 CDFCB-X Vol IV Part 2 474-00001-04-03-B0123 CDFCB-X Vol IV Part 3 474-00001-04-04-B0123 CDFCB-X Vol IV Part 4 474-00001-05-B0123 CDFCB-X Vol V 474-00001-06-B0123 CDFCB-X Vol VI 474-00001-08-B0123 CDFCB-X Vol VIII	Latest
NPP Mission Data Format Control Book and App A (MDFCB)	429-05-02-42_MDFCB	Latest
NPP Command and Telemetry (C&T) Handbook	D568423 Rev. C	30 Sep 2008
Operational Algorithm Description Document for Advanced Technology Microwave Sounder (ATMS) Sensor Data Record (SDR)	474-00076	Latest
SDD – SDR Algorithm for the Advanced Technology Microwave Sounder	REPORT #13516 Rev. 1.1	12 Nov 2004
Operational Algorithm Description Document for Common Geolocation	474-00091	Latest
Operational Algorithm Description Document for Cross-track Infrared Sounder (CrIS) Sensor Data Record (SDR)	474-00071	Latest
Operational Algorithm Description Document for Cross-track Infrared and Advanced Technology Microwave Sounder Suite (CrIMSS) Environmental	474-00065	Latest

Document Title	Document Number/Revision	Revision Date
Data Records (EDR)		
JPSS CGS Data Processor Inter-subsystem Interface Control Document (DPIS ICD) Vol I – IV	IC60917-IDP-002	Latest
JPSS Program Lexicon	474-00175	Latest
NGST/SE technical memo – ATMS and CrIS Data Matching	NP-EMD-2004.510.0042 Rev. ---	12 Nov 2004
NGST/SE technical memo –NPP ATMS Lunar Instrusion Handling Implementation	NP-EMD-2007.510.0018	11 Jan 2007
NGST/SE technical memo – NPP CrIMSS EDR Geolocation with ATMS data only	NP-EMD-2007.510.0019 Rev. ---	12 Jan 2007
NGST/SE technical memo: SAD_OAD_Last_Drop_Corrections	NPOESS GJM-2010.510.0015	22 Sep 2010
Joint Polar Satellite System (JPSS) Common Ground System (CGS) IDPS PRO Software User's Manual Part 2	UG60917-IDP-026 Rev -	18 Jul 2011

1.3.2 Source Code References

The science and operational code and associated documentation relevant to the algorithms described in this OAD are listed in Table 2.

Table 2. Source Code References

Reference Title	Reference Tag/Revision	Revision Date
ATMS SDR science-grade software (original reference source)	ISTN_ATMS_SDR_2.1 (ECR A32)	17 Sep 2004
ATMS Remap Operational Software	Build 1.4 (OAD Rev ---)	08 Aug 2005
ATMS SDR science-grade follow-on software	ISTN_ATMS_SDR_3.1 (ECR A116)	06 Apr 2007
ATMS Resampling operational software includes implementation of Tech Memo 2007.510.0019	B1.5 (OAD Rev A2)	30 Aug 2007
ATMS Resampling operational software	(ECR 127) B1.5.x.1 (OAD Rev A3)	27 Nov 2007
ACCB (no code updates)	OAD Rev A (ECR A154)	28 May 2008
PCR 17910 (CrIS Terrain Corrected Geo updates)	Build B1.5.x.1 (OAD Rev B1)	16 Jun 2008
ACCB (no code updates)	OAD Rev B	28 Apr 2010
Convergence Updates (No code updates)	(OAD Rev C1)	14 Oct 2010
PCR027830 (OAD update for ADL)	(OAD Rev C2)	28 Sep 2011
OAD transitioned to JPSS Program – this table is no longer updated.		

2.0 ALGORITHM OVERVIEW

This document details the operational algorithm description of the ATMS Resampling Algorithm which produces ATMS brightness temperatures at each CrIS Field of Regard (FOR) location. The resampled output data is used by the CrIMSS EDR algorithm since it requires ATMS data which is collocated with the CrIS data. The CrIMSS EDR algorithm assumes the ATMS resampled footprints are co-located with the CrIS FORs and it uses information for the center CrIS Field of View (FOV) when location information is needed.

The resampling algorithm performs two main tasks. The first task involves preprocessing of the data in preparation for resampling and the other task is the resampling of the ATMS data. The preprocessing consists of adding additional scans from surrounding granules before and after the ATMS granule to be resampled and identifying the ATMS scans which are synched with the scans in the corresponding CrIS granule. The aggregated scan data is then used in the Backus-Gilbert resampling of the ATMS data to the CrIS FOR locations. CrIS and ATMS SDR data, LUT data, and configurable parameters used for tuning are read from the Data Management Subsystem (DMS). Figure 1 illustrates the general flow control of the modules.

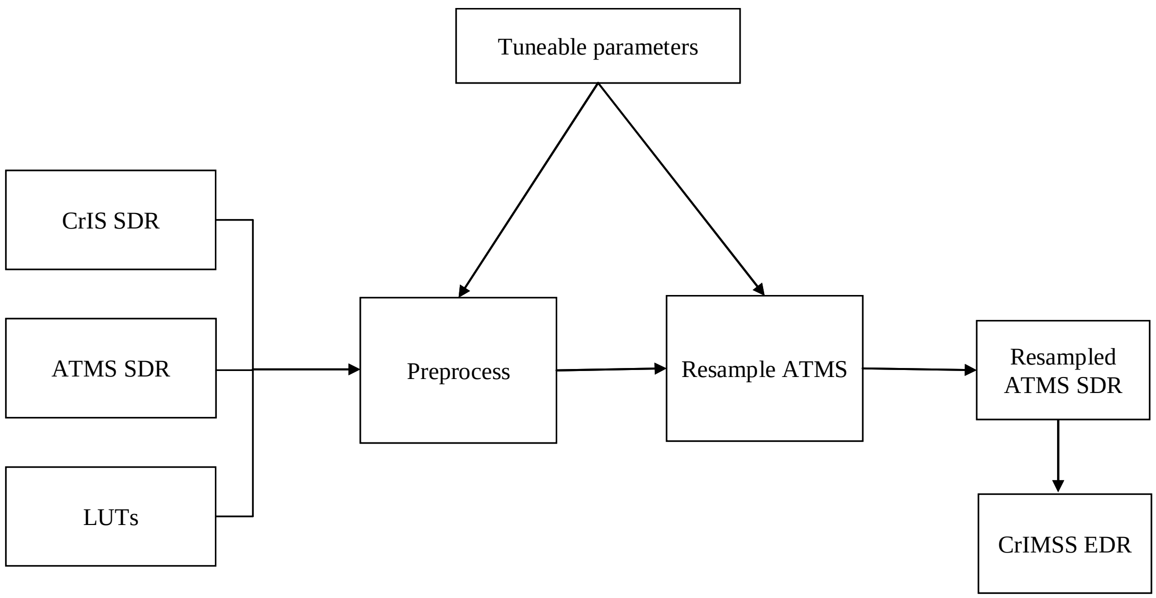

Figure 1. Processing Chain

Fortran code used for the ATMS resampling algorithm was originally delivered as a portion of the ATMS SDR code. Subroutines used to perform the resampling were removed from the ATMS SDR algorithm. The subroutine which performs the resampling was converted from Fortran to C++ since this is the only Fortran routine needed. This eliminates the need for duplicate Fortran structures, passing and associating C++ to Fortran pointers, and duplicate constant files. It also makes algorithm maintenance easier.

2.1 ATMS Resampling Description

2.1.1 Interfaces

The ATMS resampling process is called after a CrIS and\or an ATMS SDR is generated. To begin data processing, the Infrastructure (INF) Subsystem Software Item (SI) tasks the process. The tasking information includes the granule ID of the data to be processed. The DMS SI provides data storage and retrieval capability. The ATMS SDR resampling process is transient so the process shuts down after processing a granule, rather than requesting tasking information from INF for a new granule as other SDR algorithms do. A library of C++ classes is used to implement the SI interfaces. More information regarding SI interfaces is found in document UG60917-IDP-026 with reference in particular to sections regarding PRO Common (CMN) processing and the IPO Model.

2.1.1.1 Inputs

Table 3 shows the tunable parameters used by the ATMS resampling algorithm. A description of the inputs read from DMS can be found in Table 4 with outputs stored to DMS shown in Table 6.

Table 3. ATMS Resampling Tunable Parameters

Parameter	Type	Description/Source	Assigned Values	Units
coefSumLimit	Float32	If the sum of the Backus-Gilbert coefficients used for resampling to a CrIS FOR does not exceed this value, the resampled data are set to erroneous fill.	0 - 1	milliseconds
expTimeDiff	Int32	Expected time difference between the mid-point of CrIS FOR 15 and the mid-point of ATMS beam position 47. This parameter is needed to allow other synchronization schemes to be implemented without changing code. If synchronization scheme is middle of FOR 15 and beam position 47 this parameter should be zero.	-1334 – 1334	milliseconds
synchDeltaMax	Int32	The maximum deviation from the ideal time synchronization.	0 – 20	milliseconds
viewVec	Float64	Exit vectors used to calculate CrIS geolocation when CrIS data is not available.	Various, calculated off-line	unitless

Table 4. ATMS Resampling - Inputs

Input	Description/Source
CrIS SDR Geolocation Data	CrIS SDR geolocation information – FOR time is needed from here to determine synched ATMS scans. In addition the scan's start and mid time; spacecraft position, velocity and attitude at scan's mid-time; and the GEO quality flag are added. (FOR time is assumed to be the time at the end of the dwell)
ATMS SDR Data	Contains brightness temperatures (K) with beam efficiency and bias corrections applied. In addition to the tasked granule, scans from previous and next granules are read by the algorithm. Also beam time (microseconds) is used from here. (the beam time in the SDR data is assumed to be the time at the end of the integration period)
Resampling beam position and track offset data	LUT input to the Backus-Gilbert resampling - includes the number of ATMS samples to use for each CrIS FOR position, beam position number and track offset of each sample, and the maximum positive and negative track offsets.
Resampling B-G coefficients	LUT input to the Backus-Gilbert resampling. Contains a coefficient for each beam position to be used in resampling an ATMS channel to a CRIS FOR.
Tunable parameters	Run-time adjustable parameters (shown in Table 3).

2.1.1.1.1 Config Guide Inputs

There are two configurable values read from the algorithms configuration guide file (PRO_ATMS_REMAP_CFG.xml) that are used to determine which ATMS SDR granules should be accessed from DMS. The values define the number of ATMS scans needed previous to and following the ATMS granule to be resampled. These values, along with the number of scans in a granule are used to determine the number of ATMS SDR granules needed previous to and following the ATMS granule to be resampled. The configuration guide inputs are shown in Table 5.

Table 5. Configuration Guide Values Used

Config Guide Name	Description
ProSdrAtmsRemap.<spacecraft>.NumPreviousScans	Number of scans needed preceding the resampled ATMS granule for the Backus-Gilbert resampling.
ProSdrAtmsRemap.<spacecraft>.NumFollowingScans	Number of scans needed following the resampled ATMS granule for the Backus-Gilbert resampling.

2.1.1.2 Outputs

Table 6. ATMS Resampling Outputs

Output	Description
ATMS Remap SDR data - See Table 7	Contains ATMS brightness temperatures resampled to the center of the CrIS field of regard locations. Also contains the resampled FOR quality flags (shown in Table 10) and granule level quality flags (shown in Table 9).
ATMS Remap SDR GEO data - See Table 8	Contains Solar Zenith Angle, Solar Azimuth Angle, Sensor Zenith Angle, Sensor Azimuth Angle, and Terrain Height, Range and geodetic latitude and longitude values for the center FOV of each CrIS FOR. All these values are in degrees. Also contains the CrIS FOR times; scan's start and mid times; spacecraft position, velocity and attitude at mid scan time; and GEO quality flag.
CrIS SDR GEO (optional output)	In the rare case when CrIS data is not available, the algorithm produces CrIS SDR RGEO and RGEO-TC products. They are the products created by CrIS SDR, including lat/lon as well as solar/sensor zenith and azimuth angles in radians. (Refer to the CDFCB-X (D34862) for format details.) Only the terrain-corrected RGEO product is required downstream, so the non-terrain-corrected product is output to the heap.
CrIS SDR Exit Angles IP (optional output)	CrIS sensor exit angles required by CrIS GIP to calculate elliptical FOV boundary points for off-nadir FORs. (Refer to the CDFCB-X (474-00001) for format details.)

Constants used in Type/size expressions in Tables 7 through 8:

CRIS_SCAN_PER_GRAN	4
EV_FOR_PER_SCAN	30
NUM_CHANNELS	22
VEC_SIZE	3
CRIS_MAX_FOV	9

Table 7. ATMS Remap SDR Data

Output	Type/size	Description	Units/valid range
Granule level			
Brightness temperature scale	Float32	Brightness temperature scale factor	Unitless
Brightness temperature offset	Float32	Brightness temperature offset	Unitless
Scan level			
Synchronization error flags	UInt8 * CRIS_SCAN_PER_GRAN	Synch Error Check - ATMS scan is synched and the CrIS scan cannot be found.	Unitless
Pixel level			
Brightness temperature	UInt16 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN * NUM_CHANNELS	Calibrated scene brightness temperature for each ATMS channel and beam position remapped to the CrIS FORs. This output is the Rayleigh equivalent temperature and not the Planck blackbody equivalent temperature.	Kelvin
Quality flag 1	UInt8 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	ATMS channel 1 missing samples in resampling ATMS channel 2 missing samples in resampling ATMS channel 3 missing samples in resampling ATMS channel 4 missing samples in resampling ATMS channel 5 missing samples in resampling ATMS channel 6 missing samples in resampling ATMS channel 7 missing samples in resampling ATMS channel 8 missing samples in resampling	Unitless
Quality flag 2	UInt8 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	ATMS channel 9 missing samples in resampling ATMS channel 10 missing samples in resampling ATMS channel 11 missing samples in resampling ATMS channel 12 missing samples in resampling ATMS channel 13 missing samples in resampling ATMS channel 14	Unitless

Output	Type/size	Description	Units/valid range
		missing samples in resampling ATMS channel 15 missing samples in resampling ATMS channel 16 missing samples in resampling	
Quality flag 3	UInt8 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	ATMS channel 17 missing samples in resampling ATMS channel 18 missing samples in resampling ATMS channel 19 missing samples in resampling ATMS channel 20 missing samples in resampling ATMS channel 21 missing samples in resampling ATMS channel 22 missing samples in resampling	Unitless

Table 8. ATMS Remap SDR GEO data

Output	Type/size	Description	Units/valid range
Scan level			
Start time	Int64 * CRIS_SCAN_PER_GRAN	Starting Time of CrIS Scan in IET	Microsecond
Mid time	Int64 * CRIS_SCAN_PER_GRAN	Mid Time of CrIS Scan in IET	Microsecond
Pixel level			
CrIS FOR time	Int64 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	CrIS Field of Regards times (IET) used to create remapped product.	Microsecond
Latitude	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Latitude - positive north.	Degree/ (-90 – 90)
Longitude	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Longitude - Positive east.	Degree/ (-180 – 180)
Solar zenith	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Solar Zenith Angle at the CrIS FOV #5 position.	Degree/ 0 – 180)
Solar azimuth	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Solar Azimuth Angle at the CrIS FOV #5 position.	Degree/ (-180 – 180)
Satellite zenith	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Satellite Zenith Angle at the CrIS FOV #5 position.	Degree/ (0 – 70)
Satellite azimuth	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Satellite Azimuth Angle at the CrIS FOV #5 position. Positive east of north.	Degree/ (-180 – 180)
Height	Float32 *	Ellipsoid-Geoid	Meter

Output	Type/size	Description	Units/valid range
	CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	separation	
Range	Float32 * CRIS_SCAN_PER_GRAN * EV_FOR_PER_SCAN	Line of sight distance from the ellipsoid intersection to the satellite	Meter
SC position	Float32 * CRIS_SCAN_PER_GRAN * VEC_SIZE	Spacecraft position in ECR Coordinates (X, Y, Z) at the midtime of scan.	Meter
SC velocity	Float32 * CRIS_SCAN_PER_GRAN * VEC_SIZE	Spacecraft velocity in ECR Coordinates (dx/dt, dy/dt, dz/dt) at the midtime of scan.	Meter/sec
SCAttitude	Float32 * CRIS_SCAN_PER_GRAN * VEC_RPY_SIZE	Roll, pitch, and yaw at the midtime of scan	Arcseconds
geoQualFlag	Uint8 * CRIS_SCANS_PER_GRAN	Attitude and ephemeris availability status	Unitless

2.1.2 Algorithm Processing

The ATMS Remap SDR algorithm is run operationally by a higher level controller. The ATMS Remap Controller algorithm runs the ATMS Remap SDR algorithm. When the ATMS Remap SDR algorithm completes, the controller runs the CrIS ancillary data granulation algorithms via the CrIS granulate ancillary (gran anc) controller. The CrIS ancillary data is granulated after ATMS Remap since there needs to be ancillary data granulated to the CrIS FORs for the CrIMSS EDR algorithm even if no CrIS data is available. Since the CrIS geolocation data is produced by ATMS Remap in this case, the gran anc algorithms must execute after ATMS Remap.

The ATMS resampling algorithm consists of two steps. First ATMS scan data, including granule data before and after the ATMS granule to be resampled, are aggregated together to create the input to the resample function. Also, ATMS scans, which are synched with the scans in the corresponding CrIS granule, are identified. This is the preprocessing step and is performed using functions in the derived algorithm class (ProSdrAtmsRemap).

The aggregated scan data is then used in the resample function. This function uses Backus-Gilbert resampling to calculate brightness temperatures at CrIS FOR locations.

2.1.2.1 ProSdrAtmsRemap class (ProSdrAtmsRemap.cpp)

This is the derived algorithm class for the ATMS resampling algorithm and is a subclass of the ProCmnSdrAlgorithm class. All the functions in the algorithm are contained in this class. ProSdrAtmsRemap reads all data items required by the algorithm from DMS and passes the data into the algorithm. This class also contains functions which aggregate the ATMS scans and a function which performs the resampling. ATMS SDR data for a number of granules (depending on granule size) preceding and succeeding the granule to be resampled are retrieved. The ATMS scan data is grouped in time sorted order. Scans, which are synched to CrIS scans, are flagged. The synched scans are determined by comparing the 47th ATMS beam position time against the 15th CrIS FOR time. If the time difference is within a configurable amount (synchDeltaMax) the scan is considered synched.

2.1.2.2 ProSdrAtmsRemap::setupDataItems

The purpose of the setupDataItems function is to create the input and output data items, not already setup by the auto-generated class AutoGeneratedProSdrAtmsRemap, to be processed by the algorithm. It reads, from the config guide, the number of scans necessary preceeding and following the tasked ATMS granule for the Backus-Gilbert resampling. These values are then used to calculate the number of granules previous to and following the ATMS granule that are required to perform the resampling. The inherited setupMultipleGranuleItems method is called to setup these data items.

2.1.2.3 ProSdrAtmsRemap::groupAtmsScans

This function groups the ATMS scan data used for resampling. Scan data for the granule for which the algorithm was tasked, the previous granules, and the next granule's data are stored in time order. Data from the previous and next ATMS granules are needed since the resampling uses ATMS scans before the first and after the last ATMS scan to be resampled. The function uses vectors containing keys in the inputData_ map to previous and next granule data in order to access the correct SDR data.

2.1.2.4 ProSdrAtmsRemap::findSynchedScans

This function finds the ATMS scans, which are synched to the CrIS scans in a granule. The grouped ATMS data, including previous and next ATMS granule scans, is searched to look for a scan which is synched with each of the CrIS scans.

An ATMS scan is determined to be synched with a CrIS scan if the time difference between the mid-points of the 47^{th} ATMS beam position and the 15th CrIS FOR is within the delta time specified by the tunable parameter synchDeltaMax. In order for an alternate synchronization scheme to be used later without changing code, another tunable parameter (expTimeDiff) was added. This parameter gives the expected time difference between beam position 47 and FOR 15. Using these variables:

atmsSync = time of the middle of the ATMS beam position 47
crisSync = time of the middle of the CrIS FOR 15
expTimeDiff = expected value of (crisSync - atmsSync)
synchDeltaMax = maximum delta time allowed, this is a tunable parameter

An ATMS scan is considered synched with a CrIS scan if:

abs(crisSync - atmsSync - expTimeDiff) <= synchDeltaMax

When a synched scan is found, the function updates the synchedAtmsScan_ array element value to the CrIS scan number which is synched to that scan. If a synched ATMS scan cannot be found for a CrIS scan, the synch error flag is set for that CrIS scan. Handling of synchronization errors is described further in the exception handling section (Section 2.1.4).

2.1.2.5 ProSdrAtmsRemap::Resample

The primary purpose of the resampling function is to produce estimates of microwave brightness temperature at the CrIS FOR locations with an effective 3.3° FOV for ATMS channels 3-22 and 5.2° for channels 1-2. The resampling algorithm performs a weighted average of brightness temperature using the Backus-Gilbert coefficients provided in the footprint matching data. The resampled brightness temperatures are not calculated if there are not enough valid ATMS brightness temperatures available for resampling. The sum of the coefficients used to resample to a CrIS FOR must reach the coefSumLimit tunable parameter value or the resampled data is set to fill values. For more information on the Footprint Matching Coefficient File Description (Backus-Gilbert coefficients) and the Calculation of Resampled Latitude, Longitude and Brightness Temperature; refer to the SDD – SDR Algorithm for the Advanced Technology Microwave Sounder, REPORT #13516 Rev. 1.1, 12 Nov 2004, specifically sections 5.3.2 and 5.3.3. This SDD was included in the ISTN_ATMS_NGST_3.1 drop.

2.1.2.6 ProSdrAtmsRemap::generateGeoProduct

This function generates the ATMS Remap SDR geolocation product. The routine reads CrIS SDR GEO data and copies data from the middle FOV of each CrIS FOR to the ATMS Remap geolocation output buffer. It also copies FOR times from CrIS and some start and mid scan values.

2.1.2.7 ProSdrAtmsRemap::setupQualityData

This routine creates the quality test objects needed for quality checking. A quality test object is instantiated which allows the percentage of fill data in the output product to be determined and output in the metadata. Also, a quality test object is instantiated which results in a DQN being issued depending on whether synch flags indicate there were synch errors.

2.1.2.8 ProSdrAtmsRemap::generateCrisGeolocation

This routine is only called in the case where CrIS SDR data is not available. It creates the CrIS geolocation, terrain-corrected geolocation, and CrIS exit angles products using ATMS SDR data and the ideal exit vectors from configurable parameters, respectively. It calls calcCrisFORTimes to get calculated CrIS FOR times. The calculated CrIS times are then used as they would have been in CrIS SDR to generate geolocation. Also, ideal exit vectors are read from the processing coeffs LUT rather than calculated from the CrIS RDR data, as is done in CrIS SDR. The following equations are used to convert the ideal exit vectors to their ideal exit angles equivalents:

$$pitch = -\arcsin(Vx)$$
$$roll = \arcsin(Vy / \cos(pitch))$$

2.1.2.9 ProSdrAtmsRemap::calCrisFORTimes

This routine uses ATMS beam times to calculate CrIS FOR times assuming a perfect synch between the instruments. CrIS FOR times are calculated for the end of the dwell period.

2.1.2.9.1 FootPrint Matching Coefficients

For more information on the Footprint Matching Coefficient File Description (Backus-Gilbert coefficients) and the Calculation of Resampled Latitude, Longitude and Brightness Temperature; refer to the SDD – SDR Algorithm for the Advanced Technology Microwave Sounder, REPORT #13516 Rev. 1.1, 12 Nov 2004, specifically sections 5.3.2 and 5.3.3. This SDD was included in the ISTN_ATMS_NGST_3.1 drop.

The Backus-Gilbert footprint-matching coefficients needed for the resampling algorithm are pre-calculated and are read from a DMS LUT. The coefficient data read from DMS is accessed using the FootPrintMatchingDataType structure. The structure contains six fields:

- Maximum positive track (down-track) offset of the coeffs
- Maximum negative track (up-track) offset of the coeffs
- numResBeamPos contains the number of coefficients (one per beam position) to use for each FOR position and ATMS channel
- ScanPos contains the scan position for each coefficient
- trackOff contains the ATMS along-track relative scan number indexing for each coefficient
- bgCoeffs contains the values of the coefficients and always sums to 1

The along-track indexing is relative to the ATMS scan on which scan position 47 is aligned with the CrIS FOR 15 (see Figure 2). The synched scan can be found by checking whether the synchedAtmsScan_ array element corresponding to the CrIS scan is a value other than NOT_SYNCHED. Samples on the synched scan have along-track scan number, trackOff=0; samples on the next scan down-track have scan number, trackOff=1; and samples on the previous (up-track) scan have scan number, trackOff=-1.

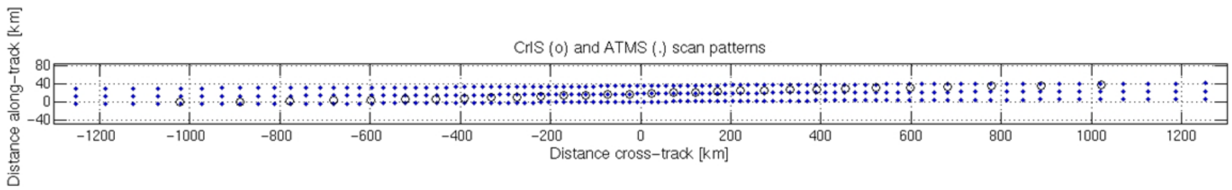

Figure 2. CrIS (o) and ATMS (.) Earth-Projected Sample Locations

The function resamples one synched scan at a time. First, the maximum positive and negative track offset values are checked against the available scans for resampling to be sure there are enough scans available.

For each CrIS FOR to be resampled to, the function loops through each ATMS sample for a given channel. It reads the beam position and track offset from the synched scan to use, and multiplies the weighting coefficient with the brightness temperature. If the brightness temperature is a missing value the sample is not used and the coefficient is not added to the sum of coefficient values. Otherwise the coefficient and brightness temperature product is added to an intermediate sum.

After all samples for a channel have been processed, if the sum of coefficients used is not greater than the tunable parameter coefSumLimit, the resampled brightness temperature value is set to missing fill. Otherwise the sum of the brightness temperature and coefficient products is divided by the sum of the coefficient values used.

2.1.3 Graceful Degradation

If CrIS SDR data is not available, the algorithm generates and uses a faux CrIS SDR GEO product as detailed in Section 2.1.4.4.

2.1.4 Exception Handling

There are a few cases where an error causes processing of the granule data to end. The granule ID utility should always be able to return a granule ID for a given time period. If there is an error returned from the utility, processing of the granule ends and a status message is sent to the operator by the common code. Also, if there is a problem reading the footprint matching LUT data or the tunable parameters from DMS, processing ends with a status message sent to the operator by the common code. These situations should rarely, if ever, occur. The subsections below provide details about algorithm handling of errors, which are expected to occur most frequently.

2.1.4.1 ATMS Brightness Temperature Availability

The ATMS SDR algorithm can produce brightness temperatures containing missing or erroneous values in some circumstances. Before a brightness temperature is used for resampling in a function resample, the value is checked to make sure it is not an erroneous or missing fill value. If it is a fill value, it is not used in resampling. If a fill value is found for an ATMS sample used in resampling to an FOR, the resample quality flag (Table 10) is set to true for that FOR and ATMS channel since not all possible samples are used.

There must be enough ATMS samples for use in resampling to a CrIS FOR. For each resampled FOR, the coefficient values, which were applied to valid brightness temperatures to obtain the resampled brightness temperature, are summed. If the sum of the coefficient values used is less than the tunable parameter coefSumLimit, the resampled brightness temperature value is set to missing fill.

2.1.4.2 Missing ATMS SDR Granules

If ATMS SDR data is not available for the granule which is to be resampled within a configurable amount of time, the ATMS Remap SDR and ATMS Remap SDR GEO products are not produced. However, the algorithm still completes with a successful completion code. The algorithm issues an EDR_NOACTION status for the SDR product to notify Infrastructure that products were not produced, but the processing chain should continue. In this case CrIS granulated ancillary data is still produced and the CrIMSS EDR algorithm is still tasked by Infrastructure.

The algorithm also needs some preceding and succeeding ATMS scans. If preceding and succeeding granules are not found when DMS is initially queried, the algorithm queries for the data for a configurable amount of time. If some of the granules are still not available, resampling of the ATMS data to the CrIS FOR locations still occurs. The brightness temperatures of the ATMS granules which could not be obtained are set to missing fill values and therefore are not used in resampling. Since the resample quality flag for a CrIS FOR is set if all ATMS data is not available for resampling, the resample quality flag is set for any FOR in which this missing data would have been used.

2.1.4.3 Synchronization errors

Section 2.1.2.6 explains how the function findSynchedScans checks for the ATMS scan synched with each CrIS scan. The synch error flag (shown in Table 9) is set to one for each scan in the CrIS granule to which the ATMS data is to be resampled, if an ATMS scan that is synched to the CrIS scan cannot be found.

If the ATMS granule which corresponds to the resampled CrIS granule is available, processing continues even if an ATMS scan which is synched to a CrIS scan cannot be found. In this case, a check is made for the closest off-synch ATMS scan. If the nearest ATMS scan in time is within one half of an ATMS scan period (4/3 seconds) of the ideal synch, the closest scan is used for resampling. If an off-synch ATMS scan cannot be found, the resampled ATMS brightness temperatures are set to missing for this CrIS scan.

2.1.4.4 Missing CrIS SDR data

In the rare case where the CrIS SDR data is missing, the algorithm can still process using calculated CrIS SDR GEO data. The algorithm calculates CrIS SDR FOR times using the ATMS SDR beam times and assuming a perfect synch between the instruments. Using the calculated CrIS FOR times, attitude and ephemeris information can be obtained from the spacecraft diary RDRs. The algorithm generates the CrIS SDR GEO data using the same calls to the common GEO routines as in the CrIS SDR algorithm, but it uses ideal exit vectors read from the processing coefficients data rather than calculating them from CrIS RDR data. Metadata is also generated for the CrIS SDR GEO data in the same manner as is done in the CrIS SDR algorithm. The ATMS Remap algorithm outputs the CrIS SDR GEO product so that it can be used to granulate CrIS data and for use by the CrIMSS EDR algorithm.

2.1.5 Data Quality Monitoring

The ATMS resampling algorithm produces synch error flags for each resampled scan and a resampled quality flag for each ATMS channel and resampled CrIS FOR. The synch error flag is shown in Table 9. It is a byte array that is dimensioned by the number of scans in a granule. For each scan in the resampled CrIS granule, if a synched ATMS scan could not be found, the element of the synch error flag array is set to one, otherwise it is zero. There is also a channel based flag for each CrIS FOR and scan combination. If the flag for a channel is set to true, not all of the possible ATMS samples were used for resampling to the particular CrIS FOR and scan, otherwise it is set to false.

Table 9. Granule Quality Flags

Granule Quality Flags	Dimension (assuming 4 scan granule)	Position in Quality Word	Description
Synch Error Flag	4	0	0 = No synch error 1 = ATMS and CrIS time synchronization error detected

Table 10. Resampled FOR Quality Flags

Quality Flag	# bits	Position in Quality Word	Dimension	Description
Resampled Quality Flag (ATMS channels 1-8)	8	0-7	CrIS scans per granule by FORs per scan	One bit is used for each channel 0 = All input samples were available for resampling 1 = Not all input samples were available for resampling
Quality Byte #2				

Resampled Quality Flag (ATMS channels 9-16)	8	0-7	CrIS scans per granule by FORs per scan	One bit is used for each channel 0 = All input samples were available for resampling 1 = Not all input samples were available for resampling
Quality Byte #3				
Resampled Quality Flag (ATMS channels 17-22)	6	0-5	CrIS scans per granule by FORs per scan	One bit is used for each channel 0 = All input samples were available for resampling 1 = Not all input samples were available for resampling
Spare	2	6-7	---	---

2.1.5.1 Data Quality Notifications

Table 11 shows current criteria used to determine when a Data Quality Notification (DQN) is produced. If the thresholds are met, the algorithm stores a DQN to DMS indicating the tests that failed and the number of failures. DQNs are used by DQM for quality monitoring. The table contains the thresholds used to trigger a DQN as well as the text contained in the DQN. The DQN criteria is contained in a data quality threshold table (DQTT) produced by DQM. If the ATMS resampling algorithm cannot obtain the DQTT, the algorithm still executes but no DQN tests are run.

Table 11. Data Quality Notification Criteria

Test Description	Threshold	Text	Action
Percent of scans in the granule with an ATMS and CrIS time synchronization error detected	Adjustable	Synch error flags set exceeded the threshold	Send DQN if greater than threshold

2.1.6 Computational Precision Requirements

The weighting coefficients used in the Backus-Gilbert resampling are double precision values. All other real variables are single precision.

2.1.7 Algorithm Support Considerations

2.1.7.1 Numerical Computation Considerations

The algorithm uses a LUT generated off-line to provide the coefficients used in the Backus-Gilbert resampling as well as the number of data points to use and beam position and track offset of each data point. This LUT may be updated at times. For instance, the coefficients may need to be recomputed after launch, or if timing errors are found by cal/val there may be a need to recompute the coefficients.

2.1.7.2 Software Environment Considerations

Infrastructure (INF) and DMS must be running before execution of the algorithm. Also, CrIS and ATMS SDRs needed by the algorithm must be finished processing in order to supply the algorithm with the ATMS brightness temperatures and CrIS and ATMS geolocation data. No Commercial-off-the-Shelf (COTS) software is used in this algorithm.

2.1.8 Assumptions and Limitations

2.1.8.1 Assumptions

This algorithm assumes that the CrIS and ATMS instruments are synched such that the middle of the 15^{th} FOR of a CrIS scan is synched with the middle of the 47^{th} beam time of an ATMS scan, if the expTimeDiff value is zero. The expTimeDiff value can be changed to allow alternate synchronization schemes.

2.1.8.2 Limitations

If CrIS data is not available, CrIS FOR times is calculated using the ATMS beam time information. This assumes the instruments are perfectly synched. In this case, it is also assumed that the ATMS scan synched with the first CrIS scan is the second ATMS scan in a granule.

3.0 GLOSSARY/ACRONYM LIST

3.1 Glossary

Table 12 contains terms most applicable for this OAD.

Table 12. Glossary

Term	Description
Algorithm	A formula or set of steps for solving a particular problem. Algorithms can be expressed in any language, from natural languages like English to mathematical expressions to programming languages like FORTRAN. On NPOESS, an algorithm consists of: 1. A theoretical description (i.e., science/mathematical basis) 2. A computer implementation description (i.e., method of solution) 3. A computer implementation (i.e., code)
Algorithm Configuration Control Board (ACCB)	Interdisciplinary team of scientific and engineering personnel responsible for the approval and disposition of algorithm acceptance, verification, development and testing transitions. Chaired by the Algorithm Implementation Process Lead, members include representatives from IWPTB, Systems Engineering & Integration IPT, System Test IPT, and IDPS IPT.
Algorithm Verification	Science-grade software delivered by an algorithm provider is verified for compliance with data quality and timeliness requirements by Algorithm Team science personnel. This activity is nominally performed at the IWPTB facility. Delivered code is executed on compatible IWPTB computing platforms. Minor hosting modifications may be made to allow code execution. Optionally, verification may be performed at the Algorithm Provider's facility if warranted due to technical, schedule or cost considerations.
Ancillary Data	Any data which is not produced by the NPOESS System, but which is acquired from external providers and used by the NPOESS system in the production of NPOESS data products.
Auxiliary Data	Auxiliary Data is defined as data, other than data included in the sensor application packets, which is produced internally by the NPOESS system, and used to produce the NPOESS deliverable data products.
EDR Algorithm	Scientific description and corresponding software and test data necessary to produce one or more environmental data records. The scientific computational basis for the production of each data record is described in an ATBD. At a minimum, implemented software is science-grade and includes test data demonstrating data quality compliance.
Environmental Data Record (EDR)	*[IORD Definition]* Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geophysical parameters (including ancillary parameters, e.g., cloud clear radiation, etc.). *[Supplementary Definition]* An Environmental Data Record (EDR) represents the state of the environment, and the related information needed to access and understand the record. Specifically, it is a set of related data items that describe one or more related estimated environmental parameters over a limited time-space range. The parameters are located by time and Earth coordinates. EDRs may have been resampled if they are created from multiple data sources with different sampling patterns. An EDR is created from one or more NPOESS SDRs or EDRs, plus ancillary environmental data provided by others. EDR metadata contains references to its processing history, spatial and temporal coverage, and quality.
Operational Code	Verified science-grade software, delivered by an algorithm provider and verified by IWPTB, is developed into operational-grade code by the IDPS IPT.
Operational-Grade Software	Code that produces data records compliant with the System Specification requirements for data quality and IDPS timeliness and operational infrastructure. The software is modular relative to the IDPS infrastructure and compliant with IDPS application programming interfaces (APIs) as specified for TDR/SDR or EDR code.

Term	Description
Raw Data Record (RDR)	*[IORD Definition]* Full resolution digital sensor data, time referenced and earth located, with absolute radiometric and geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data shall be unprocessed with the following exceptions: time delay and integration (TDI), detector array non-uniformity correction (i.e., offset and responsivity equalization), and data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data will be retained and communicated to the ground without lossy compression. *[Supplementary Definition]* A Raw Data Record (RDR) is a logical grouping of raw data output by a sensor, and related information needed to process the record into an SDR or TDR. Specifically, it is a set of unmodified raw data (mission and housekeeping) produced by a sensor suite, one sensor, or a reasonable subset of a sensor (e.g., channel or channel group), over a specified, limited time range. Along with the sensor data, the RDR includes auxiliary data from other portions of NPOESS (space or ground) needed to recreate the sensor measurement, to correct the measurement for known distortions, and to locate the measurement in time and space, through subsequent processing. Metadata is associated with the sensor and auxiliary data to permit its effective use.
Retrieval Algorithm	A science-based algorithm used to 'retrieve' a set of environmental/geophysical parameters (EDR) from calibrated and geolocated sensor data (SDR). Synonym for EDR processing.
Science Algorithm	The theoretical description and a corresponding software implementation needed to produce an NPP/NPOESS data product (TDR, SDR or EDR). The former is described in an ATBD. The latter is typically developed for a research setting and characterized as "science-grade".
Science Algorithm Provider	Organization responsible for development and/or delivery of TDR/SDR or EDR algorithms associated with a given sensor.
Science-Grade Software	Code that produces data records in accordance with the science algorithm data quality requirements. This code, typically, has no software requirements for implementation language, targeted operating system, modularity, input and output data format or any other design discipline or assumed infrastructure.
SDR/TDR Algorithm	Scientific description and corresponding software and test data necessary to produce a Temperature Data Record and/or Sensor Data Record given a sensor's Raw Data Record. The scientific computational basis for the production of each data record is described in an Algorithm Theoretical Basis Document (ATBD). At a minimum, implemented software is science-grade and includes test data demonstrating data quality compliance.
Sensor Data Record (SDR)	*[IORD Definition]* Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to calibrated brightness temperatures with associated ephemeris data. The existence of the SDRs provides reversible data tracking back from the EDRs to the Raw data. *[Supplementary Definition]* A Sensor Data Record (SDR) is the recreated input to a sensor, and the related information needed to access and understand the record. Specifically, it is a set of incident flux estimates made by a sensor, over a limited time interval, with annotations that permit its effective use. The environmental flux estimates at the sensor aperture are corrected for sensor effects. The estimates are reported in physically meaningful units, usually in terms of an angular or spatial and temporal distribution at the sensor location, as a function of spectrum, polarization, or delay, and always at full resolution. When meaningful, the flux is also associated with the point on the Earth geoid from which it apparently originated. Also, when meaningful, the sensor flux is converted to an equivalent top-of-atmosphere (TOA) brightness. The associated metadata includes a record of the processing and sources from which the SDR was created, and other information needed to understand the data.

Term	Description
Temperature Data Record (TDR)	*[IORD Definition]* Temperature Data Records (TDRs) are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts. *[Supplementary Definition]* A Temperature Data Record (TDR) is the brightness temperature value measured by a microwave sensor, and the related information needed to access and understand the record. Specifically, it is a set of the corrected radiometric measurements made by an imaging microwave sensor, over a limited time range, with annotation that permits its effective use. A TDR is a partially-processed variant of an SDR. Instead of reporting the estimated microwave flux from a specified direction, it reports the observed antenna brightness temperature in that direction.
Model Validation	The process of determining the degree to which a model is an accurate representation of the real-world from the perspective of the intended uses of the model. [Ref.: DoDD 5000.59-DoD Modeling and Simulation Management]
Model Verification	The process of determining that a model implementation accurately represents the developer's conceptual description and specifications. [Ref.: DoDD 5000.59-DoD Modeling and Simulation Management]

3.2 Acronyms

Table 13 contains terms most applicable for this OAD.

Table 13. Acronyms

Acronym	Terms
ACO	Atmospheric Correction over Ocean
ADCS	Advanced Data Collection System
ADS	Archive and Distribution Segment
AFB	Air Force Base
AFM	Airborne Fluxes and Meteorology Group
AFSCN	Air Force Satellite Control Network
AFWA	Air Force Weather Agency
AFWWS	Air Force Weather Weapon System
AGE	Aerospace Ground Equipment
AIAA	American Institute of Aeronautics and Astronautics
ANSI	American National Standards Institute
Ao	Operational Availability
AOS	Acquisition of Signal
ATMS	Advanced Technology Microwave Sounder
BIT	Built-in Test
BITE	Built-in Test Equipment
BMMC	Backup Mission Management Center
C2	Command and Control
C3S	Command, Control, and Communications Segment
CCSDS	Consultative Committee for Space Data Systems
CDA	Command and Data Acquisition
CDDIS	Crustal Dynamics Data Information System
CDR	Climate Data Records
CERES	Cloud and Earth Radiant Energy System
CGMS	Coordination Group for Meteorological Satellites
CI	Configured Item
CLASS	Comprehensive Large-Array data Stewardship System
CMIS	Conical Microwave Imager Sounder

Acronym	Terms
CMOC	Cheyenne Mountain Operations Center
COMSAT	Communications Satellite
COMSEC	Communications Security
CONUS	Continental United States
COTS	Commercial Off the Shelf
CrIMSS	Cross-Track Infrared Microwave Sounding Suite
CrIS	Cross-Track Infrared Sounder
CSCI	Computer Software Configured Item
DCP	Data Collection Platforms
DES	Digital Encryption System
DFCB	Data Format Control Book
DHN	Data Handling Node
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DoD	Department of Defense
DQTT	Data Quality Threshold Table
DRR	Data Routing and Retrieval
EDR	Environmental Data Records
EELV	Evolved Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMD	Engineering and Manufacturing Development
EOL	End of Life
EOS	Earth Observing System
ERBS	Earth Radiation Budget Suite
ESD	Electrostatic Discharge
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWR	Eastern and Western Ranges
FFRDC	Federally Funded Research and Development Center
FMH	Federal Meteorological Handbook
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FOC	Full Operational Capability
FOR	Field Of Regard
FOV	Field Of View
FTS	Field Terminal Segment
FVS	Flight Vehicle Simulator
GFE	Government Furnished Equipment
GIID	General Instrument Interface Document
GN	NASA Ground Network
GPS	Global Positioning System
GPSOS	GPS Occultation Suite
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HIJACK	Data Conversion Software
HRD	High Rate Data
IAW	In Accordance With
ICD	Interface Control Document
IDPS	Interface Data Processor Segment
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IGS	International GPS Service
IJPS	Initial Joint Polar System
ILS	Integrated Logistics Support
IOC	Initial Operational Capability

Acronym	Terms
IORD	Integrated Operational Requirements Document
IOT&E	Initial Operational Tests & Evaluation
IP	Intermediate Product
IPL	Integrated Priority List
IPO	Integrated Program Office
IRD	Interface Requirements Document
ISO	International Standards Organization
ITRF	International Terrestrial Reference Frame
ITU	International Telecommunications Union
JPS	Joint Polar System
JSC	Johnson Space Center
JTA	Joint Technical Architecture
km	kilometer
LEO&A	Launch, Early Orbit, & Anomaly Resolution
LOS	Loss of Signal
LRD	Low Rate Data
LSS	Launch Support Segment
LST	Local Solar Time
LUT	Look-Up Table or Local User Terminal
LV	Launch Vehicle
MDT	Mean Down Time
Metop	Meteorological Operational Program
MMC	Mission Management Center
MOU	Memorandum of Understanding
MSS	Mission System Simulator
MTBCF	Mean Time Between Critical Failures
MTBDE	Mean Time Between Downing Events
MTTRF	Mean Time to Restore Function
NA	Non-Applicable
NACSEM	NPOESS Acquisition Cost Estimating Model
NASA	National Aeronautics and Space Administration
NAVOCEANO	Naval Oceanographic Office
NCA	National Command Authority
NCEP	National Centers for Environmental Prediction
NDT	Nitrate-Depletion Temperature
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Program
NSA	National Security Agency
NTIA	National Telecommunications Information Agency
OC/C	Ocean Color/Chlorophyll
O&M	Operations and Maintenance
OMPS	Ozone Mapping and Profiling Suite
P3I	Potential Pre-planned Product Improvements
PHS&T	Packaging, Handling, Storage, and Transportation
PIP	Program Implementation Plan
PM&P	Parts, Materials, and Processes
PMT	Portable Mission Terminal
POD	Precise Orbit Determination
POES	Polar Orbiting Environmental Satellite
RDR	Raw Data Records

Acronym	Terms
RPIE	Real Property Installed Equipment
RSR	Remote Sensing Reflectance
S&R	Search and Rescue
SARSAT	Search and Rescue Satellite Aided Tracking
SCA	Satellite Control Authority
SDC	Surface Data Collection
SDD	Software Design Description
SDE	Selective Data Encryption
SDP	Software Development Plan
SDR	Sensor Data Records
SDS	Science Data Segment
SESS	Space Environmental Sensor Suite
SGI®	Silicon Graphics, Inc.
SI	International System of Units
SMD	Stored Mission Data
SN	NASA Space Network
SOC	Satellite Operations Center
SRD	Sensor Requirements Documents
SS	Space Segment
SST	Sea Surface Temperature
STDN	Spaceflight Tracking and Data Network
SVE	Space Vehicle Equipment
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
TDR	Temperature Data Records
TDRSS	Tracking and Data Relay Satellite System
TEMPEST	Telecommunications Electronics Material Protected from Emanating Spurious Transmissions
TOA	Top of the Atmosphere
TRD	Technical Requirements Document
TSIS	Total Solar Irradiance Sensor
USAF	United States Air Force
USB	Unified S-band
USG	United States Government
UTC	Universal Time Coordinated
VIIRS	Visible/Infrared Imager Radiometer Suite

4.0 OPEN ISSUES

Table 14. TBXs

TBX ID	Title/Description	Resolution Date
None		