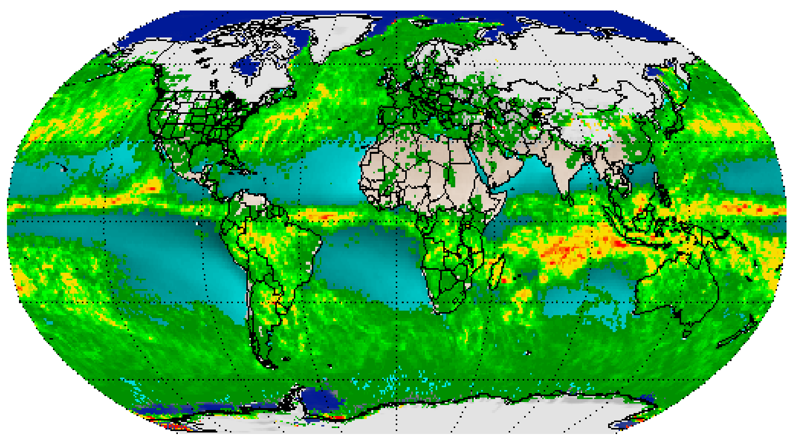
Microwave Integrated Retrieval System (MIRS)

Interface Control Document (ICD)

September 2014



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National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
Center for Satellite Applications and Research (STAR)

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Version 1.11

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DCN No.	Revision	Date	Description of Change
	1.0	January 31st, 2007	Initial Release of MIRS Interface Control Document
	1.1	April 26th, 2007	Kleespies Initial Review
	1.2	June 15th, 2007	Second Release of MIRS Interface Control Document
	1.3	December 15th, 2007	Third Release of MIRS Interface Control Document
	1.4	June 15th, 2008	Fourth Release of MIRS Interface Control Document
	1.5	December 15th, 2008	Fifth Release of MIRS Interface Control Document
	1.6	June 15th, 2009	Sixth Release of MIRS Interface Control Document
	1.7	June 15th, 2010	Seventh Release of MIRS Interface Control Document
	1.8	November 9th, 2012	Eighth Release of the MIRS Interface Control Document
	1.9	January 8th, 2013	Ninth Release of the MIRS Interface Control Document
	1.10	March 31, 2014	Tenth Release of the MIRS Interface Control Document
	1.11	September, 2014	Eleventh Release of the MIRS Interface Control Document

Preface

This document comprises the National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS) publication of the Microwave Integrated Retrieval System (MIRS) *Interface Control Document (ICD)*.

This document contains a detailed description of the MIRS input, intermediate, and output datasets including details on function, type, format, naming convention and content.

The document is controlled under the configuration management tool in NOAA/NESDIS/STAR and will be updated as required.

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Section 1.0 Introduction

1.1 Document Overview

This document is organized as follows:

Section 1.0 – provides an overall description of the MIRS system, data and directory structure. It also presents the linkage between the input, intermediate and output files, how they are generated, by which component and what they are used for.

Section 2.0 – provides a description of input data files, including function, type, format, naming convention and content.

Section 3.0 – provides a description of intermediate data files including function, type, format, naming convention and content.

Section 4.0 – provides a description of output data files including function, type, format and naming convention and content.

Appendix A – defines each acronym, as necessary.

Appendix B – defines the naming conventions of the different MIRS files.

Appendix C – lists the references.

Appendix D – lists the software used to read binary swath files.

1.2 Scope

This document specifies the interface files of the Microwave Integrated Retrieval System (MIRS).
MIRS is an *end-to-end retrieval system* that utilizes microwave sensor data to generate geophysical products. MIRS optimally and simultaneously retrieves important surface and atmospheric state parameters in all-weather conditions using different instrumental configurations and microwave sensor radiances with state-of-the-art retrieval algorithms.

This document provides an overview of the MIRS system and applications, followed by detailed descriptions of input, intermediate, and output datasets. Data description includes details on format, type, range and special error values, the mechanisms for input/output handling, file naming conventions and data content. For additional documentation on the MIRS system, the reader is referred to the MIRS User's Manual (UM) and MIRS' System Description Document (SDD).

1.3 MIRS System Overview

1.3.1 Main Processes and Data Flow

External level 1-b sensor data undergo *radiance processing* followed by *inversion processing* to generate the retrieved MIRS products swath binary file (level II-a). The MIRS swath binary file is further converted into other level II swath data formats such as HDF-EOS, NetCDF4, BUFR and gridded files of daily (level III-a), weekly (level III-b) and monthly (level III-c) composites. Figure 1 gives an overview of MIRS end-to-end component processes and satellite data flow from external level 1 b sensor data to gridded level III products.

Figure 2 and Figure 3 provide diagrams of radiance and inversion processing respectively, and the data flow for generating MIRS retrieved product. The AMSU-MHS sensor is provided as an example of sensor data being processed. Other sensor data currently being processed include the SSMI/S and ATMS measurements. It is important to emphasize that the data flow and processes depicted reflect the same conceptual and software design for current and future satellite systems. The data flow shown in each figure indicates the input, intermediate and output files and how they fit within the big picture of MIRS. In these diagrams, the data are represented with parallelogram-shaped symbols and processes are represented with green rectangle-shaped symbols. Input data are coded as “blue”, intermediate data as “yellow” and output data as ‘red’. Static data are represented by flag-shaped, “gold” symbols.

Following is a brief description of the radiance processing and the inversion processing sub-systems:

- The *radiance processing* sub-system uses external level 1-b sensor data files to generate ready-to-invert brightness temperature data files (level 1-e). First, level 1-b sensor data are converted into level 1-b MIRS internal format sensor data (TDR). Next, TDR data are corrected for antenna patterns (AP), which generates the antenna temperature data (SDR, level 1-c). The footprint matching (FM) process resolves frequency-dependent footprints contained in SDR, and generates footprint-matched, brightness temperature data (FM-SDR, level 1-d). The final step is the asymmetry & bias correction, which are generically called error correction (EC), and which generate ready-to-invert brightness temperature data (EC-FM-SDR, level 1-e). Biases and RTM uncertainty files are generated semi-statically by the forward simulator (FWD) which uses CRTM files and NWP or forecast data files as input to generate simulated brightness temperature files. These simulated brightness temperature data files are then compared with measured FM-SDR. The noise file is dynamically generated (whenever possible) from level 1-b data as well by computing NEDT from calibration warm load readings.

- The *inversion processing* subsystem uses the ready-to-invert-radiances (level 1-e) generated from the radiance processing as input to perform inversion and generate the level II-a retrieved product swath binary file. Other inputs include ancillary data consisting of the noise file and the static data. The system provides the user with the option of utilizing external geophysical data as a "first-guess". These external data sources can be obtained from NWP or forecast models or derived from brightness temperature data using "heritage" microwave retrieval algorithms. New regression-based algorithms have been developed for the retrieval of a wide range of geophysical data that can be integrated more efficiently and utilized in MIRS 1DVAR processing as first guesses. Next, other products labeled as "derived products" are generated using MIRS main products as inputs. The heritage, MIRS main and derived products are combined to finally generate the MIRS product swath binary file.

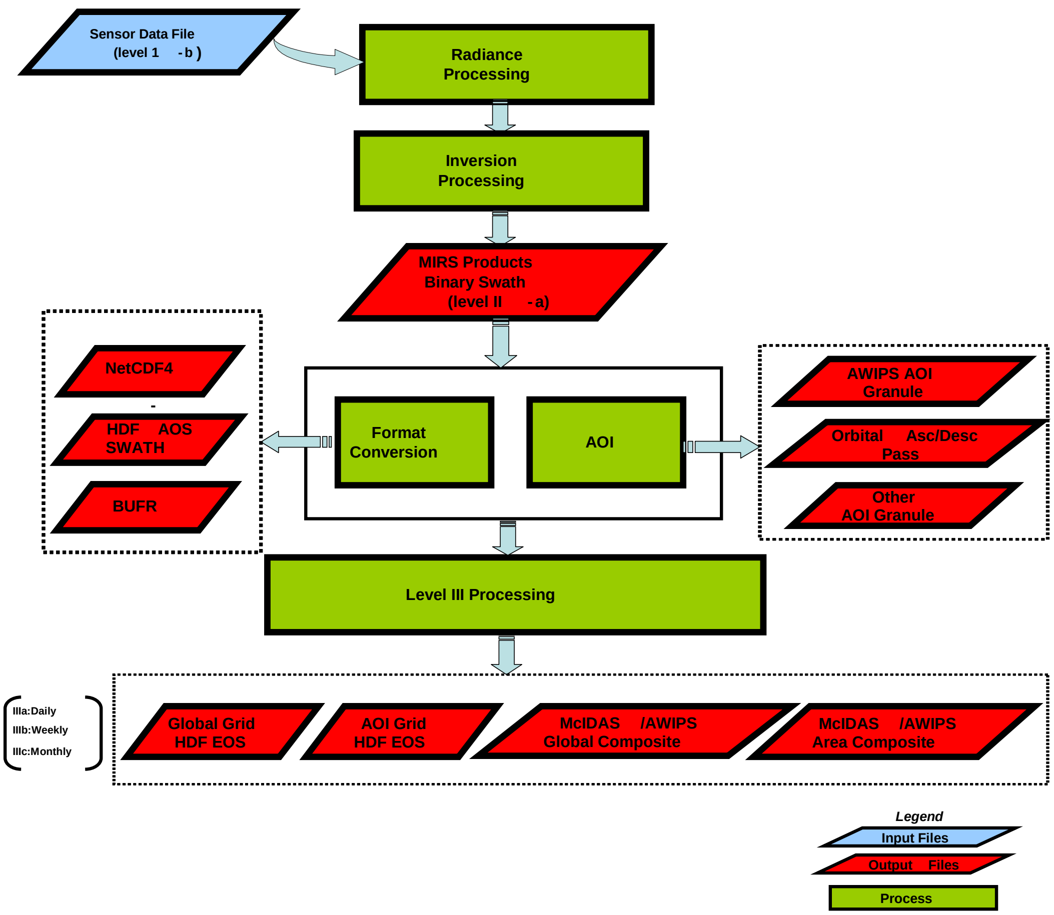

Figure 1. Overview of MIRS component processes and satellite data flow. Data presented are the external sensor data sources (level 1-b) and the retrieved level II and III satellite products (end-to-end capability). Shown also are the MIRS radiance and inversion processes that generate the MIRS swath product (level II) and the other format (level II and III) conversion processes.

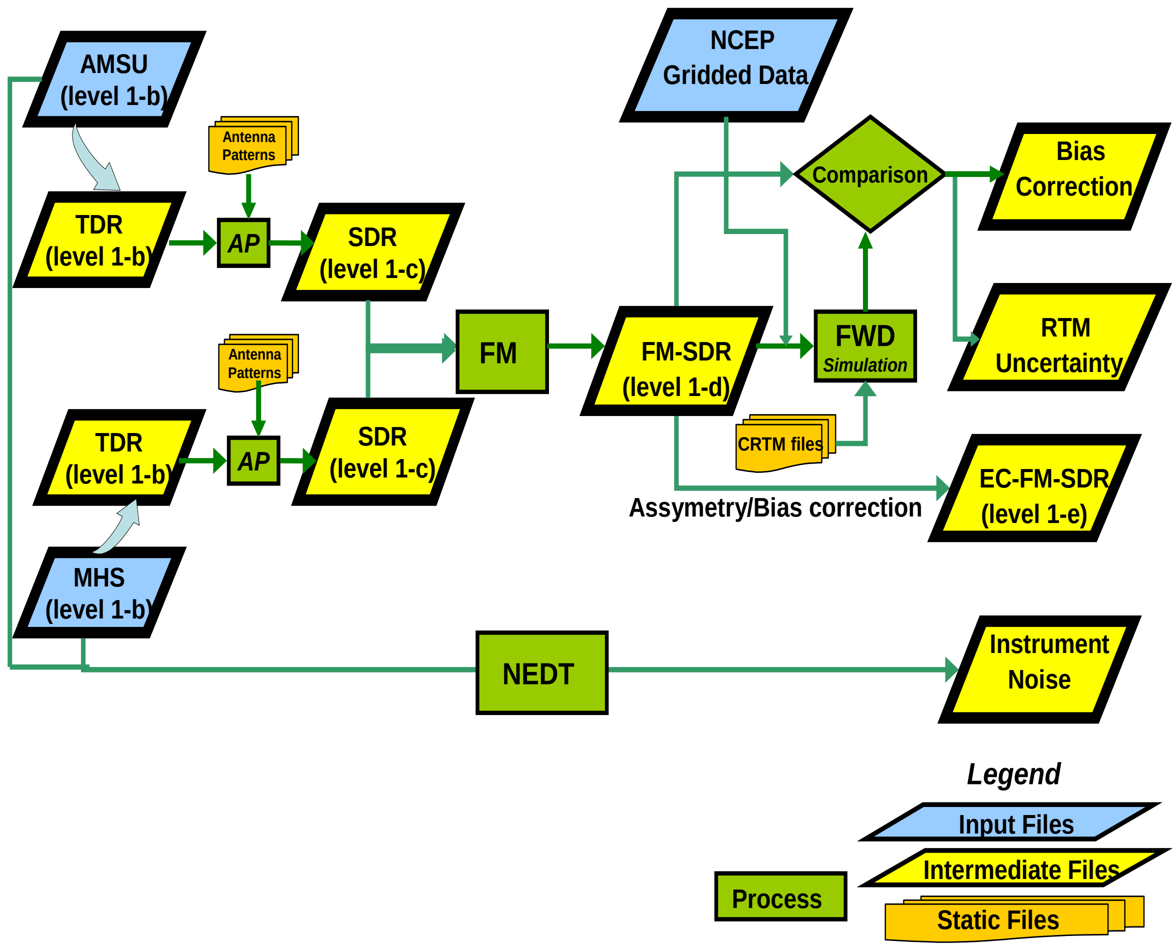

Figure 2. Radiance processing and data flow. Presented are the input, intermediate and static data files and the processes used to generate ready-to-invert radiances (level 1-e) from the external level 1-b sensor data. Radiances are represented in the diagram with their official file naming conventions and processes with abbreviations described in this paragraph. See also Appendix B for a complete description of the satellite data naming conventions.

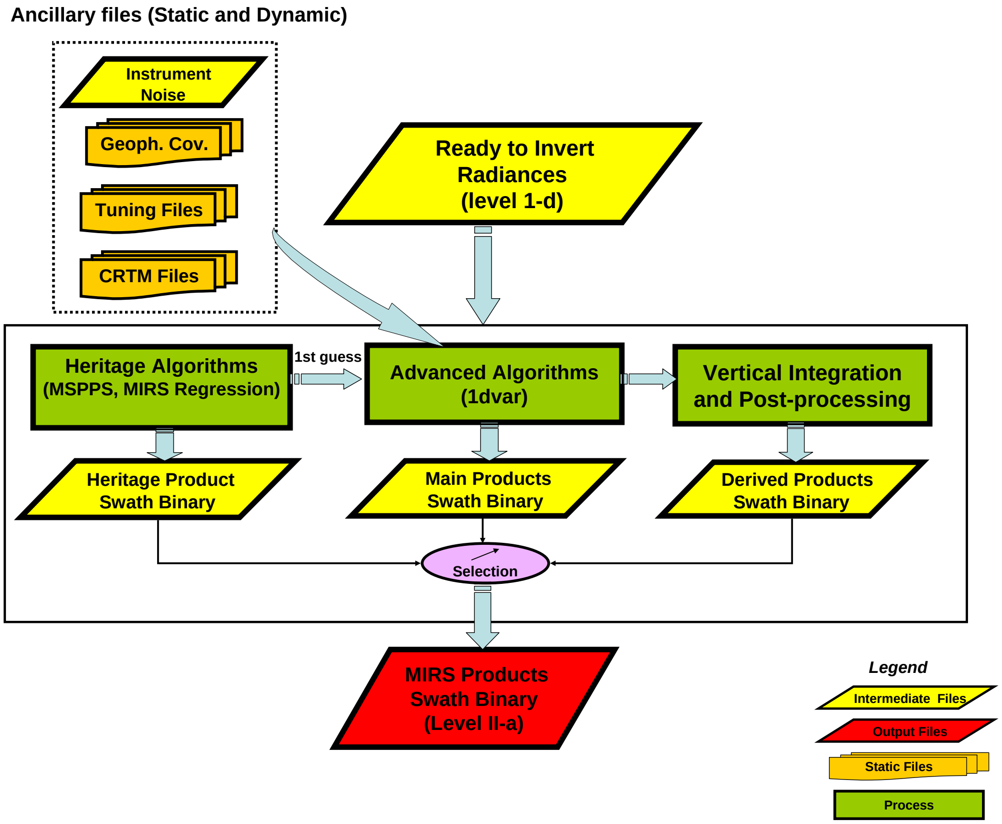

Figure 3. Inversion processes and data flow. Presented are the intermediate and ancillary data used as input to inversion processes and the intermediate and output swath product files (level II). The intermediate noise and ready-to-invert radiance files are generated from the radiance processing component of MIRS.

1.3.2 Directory Structure

The directory structure has been designed to be streamlined and compatible with operational needs and requirements. Figure 4 presents the top level directory structure with the expanded data subdirectory system. The following is a brief description of MIRS top level directories:

- The "`/doc`" directory contains MIRS documentation including User's Manual, Interface Control Document, System Description Document and Directory Structure
- The "`/bin`" directory contains the executable files. Sensor-specific processes and applications are distinguished by prefix. For example, the "`fm_n18_amsua_mhs`" executable runs the process of foot-print matching, represented by the "fm" prefix for NOAA 18 AMSU-MHS.
- The "`/data`" directory contains the data files
- The "`/logs`" directory contains the log files
- The "`/gui`" directory contains the GUI-based MIRS Control Panel (MCP) that allows the user to interactively control processes and applications.

- The "/scripts" directory contains the scripts (called sequence control scripts or SCS) used for controlling processes and applications. The user can manually modify these scripts or generate them automatically via the GUI-based MCP. These scripts could be used as templates by users to schedule operational running.
- The "/setup" directory" contains control files that define the paths to system components, i.e., data, processes and applications. Some of these set-up files could be controlled by the MCP and others need to be updated manually.
- "/src" directory" contains all source files coded in Fortran-95, IDL, BASH and Java.

The main highlights of the MIRS directory structure are:

- Consolidation of all executables into the "/bin" directory
- Consolidation of all src (Fortran-95, IDL, Java and BASH) into the "/src" directory, decoupled from the control and input files. This makes it easy to remove all source files from the package, e.g., when transitioning to operations.
- Scripts are written to be *data-location-independent* (most file and path names moved into setup files) Data directory structure can be modified through the setup file with the control scripts.

The factors that played a role in the directory structure design are sometimes conflicting with each other. These are (1) streamlined operations, (2) research cohesiveness, (3) keeping all MIRS into one package, and (4) having a stand-alone package (that does not require user to provide a unique file structure). The data sub-directory naming convention is intuitively and functionally designed to indicate data file type stored. A brief description of the content of the data directory is provided below:

- The "/TestbedData" sub-directory contains data related to real time applications.
- The "/TestbedData/PerfsMonitoring" sub-directory contains dynamically generated performance monitoring image files such as time series plots of simulated brightness temperatures and channel mean biases and standard deviations.
- The "/TestbedData/nedt" sub-directory contains dynamically generated noise files. These files are stored for monitoring purposes.
- The "/TestbedData/Outputs" sub-directory contains retrieved product files including main ("/edr" sub-directory) and derived ("/dep" subdirectory) binary swath, the gridded and point-to-point binary ("/grid" subdirectory) and the image ("/figs" subdirectory) files.
- The "/TestbedData/DynamicData" sub-directory contains dynamically generated (intermediate) data files, e.g., brightness temperature SDR (level 1-c), FM-SDR (level 1-d), and collocated NWP analysis files. These files are purged when no longer needed.
- The "SemiStatic" sub-directory contains data files of a semi-static nature, e.g., bias correction data files and the regression algorithms coefficients data files that are not dynamically or frequently changed.

- The “InputsData” sub-directory contains data files that have input file name and directory information needed by the control files.
- The “StaticData” subdirectory contains input data files of a static nature, e.g., tuning files, antenna patterns data files, CRTM data files, nominal noise (NEDT) data files, topography data files and emissivity catalogue files. The covariance matrices (generated by a MIRS ancillary tool) are also in this directory.
- The “ControlData” sub-directory contains the control files for running MIRS applications.
- The “ExternalData” sub-directory contains external sensor data files, e.g., level 1-b AMSU and MHS, SSMIS, AMSR-E, and the NWP analysis and forecast data files. These files are obtained from external sources (outside of MIRS).
- The “BenchmarkData” sub-directory contains reference data that come with the MIRS package.

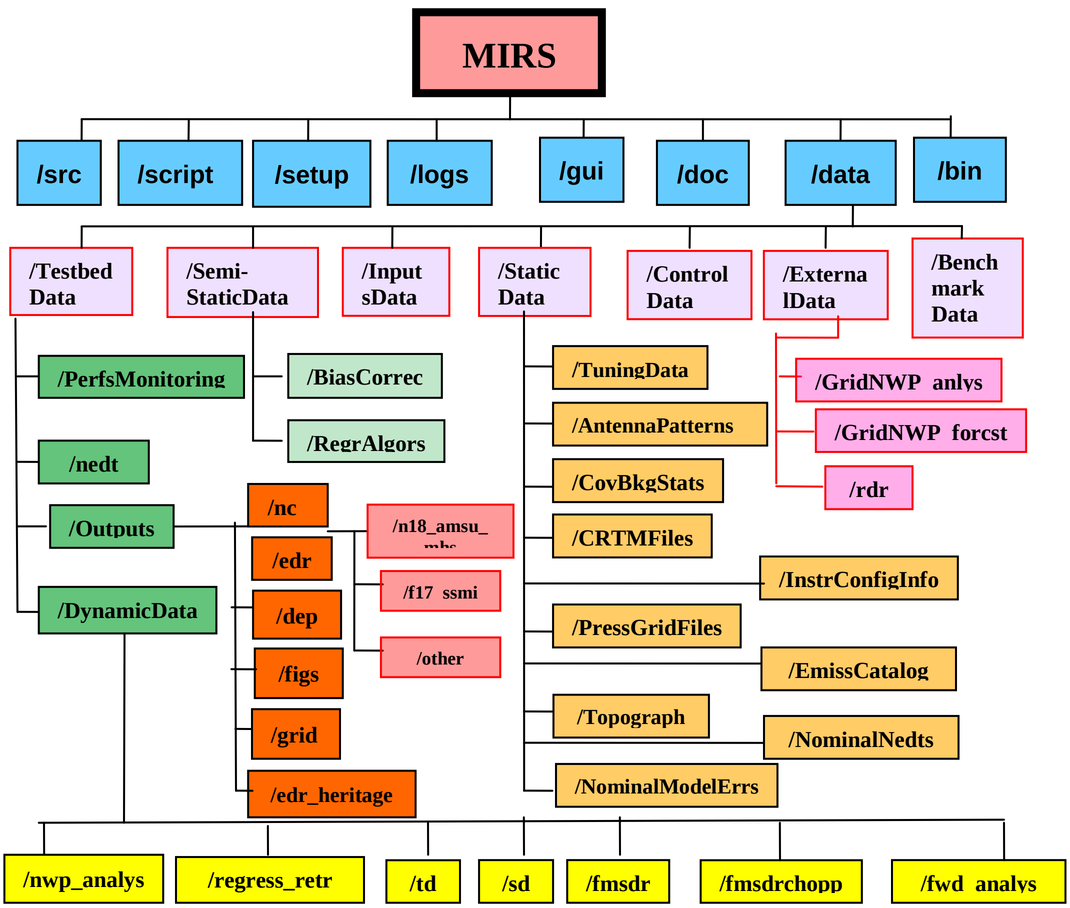

Figure 4. MIRS directory structure with the expanded data files directory system. Shown is the directory system of the software package that generates MIRS (level II) binary swath products and image files.

1.4 Microwave Systems Supported by MIRS

The following are the current and future the microwave sensors supported by MIRS:

- NOAA Polar-orbiting Operational Environmental Satellites (POES) AMSU/MHS suite
- European Meteorological Operational Satellite (METOP) AMSU/MHS suite
- US Department of Defense (DoD) polar-orbiting satellites DMSP SSMI/S
- National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) ATMS
- National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) AMSR-E
- NASA Tropical Precipitation Measurement Mission Microwave Imager (TRMM TMI)
- Indian/French Megha-Tropiques Satellite SAPHIR (the MADRAS instrument failed in early 2013)

The main characteristics of each are given in Tables 1 through 7.

Channel Number	Center Frequency (MHz)	No of bands	Bandwidth (MHz)	Beam width (deg)	CF Stability (MHz)	Sensitivity (NEDT) (K)	Accuracy (K)	Polarization at Nadir
1	23000	1	270	3.3	10	0.3	2.0	V
2	31400	1	180	3.3	10	0.3	2.0	V
3	50300	2	180	3.3	10	0.4	1.5	V
4	52800	1	400	3.3	5	0.25	1.5	V
5	53596 ±115	1	170	3.3	5	0.25	1.5	H
6	54400	1	400	3.3	5	0.25	1.5	H
7	54940	1	400	3.3	5	0.25	1.5	V
8	55500	1	330	3.3	10	0.25	1.5	H
9	57290.344	1	330	3.3	0.5	0.25	1.5	H
10	57290.344 ±217	2	78	3.3	0.5	0.4	1.5	H
11	57290.344 ±322.2 ±48	4	36	3.3	1.2	0.4	1.5	H
12	57290.344 ±322.2 ±22	4	16	3.3	1.2	0.6	1.5	H
13	57290.344 ±322.2 ±10	4	8	3.3	0.5	0.8	1.5	H
14	57290.344 ±322.2 ±4.5	4	3	3.3	0.5	1.2	1.5	H
15	89000	1	< 6000	3.3	50	0.5	2.0	V

Table 1. Nominal AMSU-A channels and pass band characteristics

Channel Number (see Note 1)	Center Frequency (GHz)	No of pass bands	CF band width (see Note 2)	Sensitivity (NEDT) (K) (see Note 3)	Polarization at Nadir (see Note 4)
H1	89	1	2800	0.22	V
H2	157	1	2800	0.34	V
H3	183.311 ± 1.0	2	2 x 500	0.51	H
H4	183.311 ± 3.0	2	2 x 1000	0.40	H
H5	190.311	1	2200	0.46	V

Table 2. MHS channels and pass band characteristics

Notes:
1.The five MHS channels provide data continuity with AMSU-B channels 16 to 20, with some minor changes in frequency allocation and polarization, and improved performance.
2. The quoted values for the maximum bandwidths are double-sideband values and represent the maximum permissible bandwidths at the 3 dB points.
3. Ground measured values for the first flight model (NOAA-N).
4.The V and H polarizations correspond respectively to electrical fields normal or parallel to the ground track at nadir, both rotating by an angle equal to the scan angle for off-nadir directions.

Channel	Center Frequency (GHz)	Pass bands (MHz)	Frequency stability (MHz)	Polarization	NEDT (Max) (K)	Sampling Interval (km)	IFOV (km)
1	50.3	400	10	H	0.4	37.5	38 x 39
2	52.8	400	10	H	0.4	37.5	38 x 39
3	53.596	400	10	H	0.4	37.5	38 x 39
4	54.4	400	10	H	0.4	37.5	38 x 39
5	55.5	400	10	H	0.4	37.5	38 x 39
6	57.29	350	10	RCP	0.5	37.5	38 x 39
7	59.4	250	10	RCP	0.6	37.5	38 x 39
8	150	1500	200	H	0.88	37.5	13 x 15
9	183.31±6.6	1500	200	H	1.2	37.5	13 x 15
10	183.31±3	1000	200	H	1	37.5	13 x 15
11	183.31±1	400	200	H	1.25	37.5	13 x 15
12	19.35	400	75	H	0.7	25	47 x 74
13	19.35	400	75	V	0.7	25	47 x 74
14	22.235	500	75	V	0.7	25	47 x 74
15	37	1500	75	H	0.5	25	45 x 31
16	37	1500	75	V	0.5	25	45 x 31
17	91.655	1500	100	V	0.9	12.5	13 x 15
18	91.655	1500	100	H	0.9	12.5	13 x 15
19	63.283248 ± 0.285271	3.0	0.08	RCP	2.4	75	75 x 75
20	60.792668 ± 0.357892	3.0	0.08	RCP	2.4	75	75 x 75
21	60.792668 ± 0.357892 ± ?0.002	6.0	0.08	RCP	1.8	75	75 x 75
22	60.792668 ± 0.357892 ± 0.0055	12.0	0.12	RCP	1.0	75	75 x 75
23	60.792668 ± 0.357892 ± 0.016	32.0	0.34	RCP	0.6	75	75 x 75
24	60.792668 ± 0.357892 ± 0.050	120.0	0.84	RCP	0.7	37.5	38 x 39

Table 3. Nominal SSMIS channels and pass band characteristics

Notes:
1. Channels 1-5 are vertically polarized on F17.

Channel Number	Center Frequency (GHz)	Band width (MHz)	Sensitivity (NEDT) (K)	Accuracy (K)	Static band Width (MHz)
1	23.8	0.27	0.9	2.0	5.2
2	31.4	0.18	0.9	2.0	5.2
3	50.3	0.18	1.2	1.5	2.2
4	51.76	0.4	0.75	1.5	2.2
5	52.8	0.4	0.75	1.5	2.2
6	53.596±0.115	0.17	0.75	1.5	2.2
7	54.4	0.4	0.75	1.5	2.2
8	54.94	0.4	0.75	1.5	2.2
9	55.5	0.33	0.75	1.5	2.2
10	57.2903	0.33	0.75	1.5	2.2
11	57.2903±0.115	0.078	1.2	1.5	2.2
12	57.2903	0.036	1.2	1.5	2.2
13	57.2903±0.322	0.016	1.5	1.5	2.2
14	57.2903±0.322 ±0.010	0.008	2.4	1.5	2.2
15	57.2903±0.322 ±0.004	0.003	3.6	1.5	2.2
16	87-91(88.20)	2.0	0.5	2.0	2.2
17	164-167	3.0	0.6	2.0	1.1
18	183.31±7	2.0	0.8	2.0	1.1
19	183.31±4.5	2.0	0.8	2.0	1.1
20	183.31±3	1.0	0.8	2.0	1.1
21	183.31±1.8	1.0	0.8	2.0	1.1
22	183.31±1.0	0.5	0.9	2.0	1.1

Table 4. Nominal ATMS channels and pass band characteristics

Center Frequency (GHz)	Band Width (MHz)	Beam width (deg)	Sensitivity (K)	IFOV (km x km)	Sampling rate (km x km)	Integration time (msec)	Beam efficiency (%)	Polariza tion
6.925	350	2.2	0.3	43 x 74	10 x 10	2.2	95.3	H + V
10.65	100	1.4	0.6	30 x 51	10 x 10	1.4	95.0	H +V
18.7	200	0.8	0.6	16 x 27	10 x 10	0.8	96.3	H +V
23.8	400	0.9	0.6	18 x 318	10 x 10	0.9	96.4	H +V
36.5	1000	0.14	0.6	8 x 14	10 x 10	0.4	96.3	H + V
89	3000	0.18	1.1	4 x 6	5 x 5	0.18	96.0	H + V

Table 5. AMSR-E channels and pass band characteristics

Channel Frequency (GHz)	Polarization	Bandwidth (MHz)	IFOV on Earth Surface (km)		NEdT (K)	EFOV on Earth Surface (km)	
			Along IFOV	Cross IFOV		Along Track	Cross Track
10.65	V	100	59.0	35.7	0.63	63.2	9.1
10.65	H	100	60.1	36.4	0.54	63.2	9.1
19.35	V	500	30.5	18.4	0.50	30.4	9.1
19.35	H	500	30.1	18.2	0.47	30.4	9.1
21.3	V	200	27.2	16.5	0.71	22.6	9.1
37.00	V	2000	16.0	9.7.1	0.36	16.0	9.1
37.00	H	2000	16.0	9.7.1	0.31	16.0	9.1

85.5	V	3000	6.7	4.1	0.52	7.2	4.6
85.5	H	3000	6.9	4.2	0.93	7.2	4.6

Table 6. TMI channels and pass band characteristics

Channel Number	Center Frequency (GHz)	Band Width (MHz)	Sensitivity (K)	IFOV at Nadir (km x km)	Polarization at Nadir
1	183.31±0.20	200	2.35	10 x 10	H
2	183.31±1.10	350	1.45	10 x 10	H
3	183.31±2.80	500	1.36	10 x 10	H
4	183.31±4.20	700	1.38	10 x 10	H
5	183.31±6.80	1200	1.03	10 x 10	H
6	183.31±11.0	200	1.10	10 x 10	H

Table 7. Megha-Tropiques SAPHIR channels and passband characteristics

Section 2.0 Input Datasets

Input datasets are described in detail in this section. To get a sense of where these files fit within the MIRS system, the reader is referred to section 1.3 and Figure 2 and Figure 3. The input files consist of the *set-up* files, the *external* data files and the *static* data files. The set-up files are scripts that define paths to data and applications. External data files contain dynamic input data coming from external sources: level 1-b sensor data and the NWP analysis (GDAS and ECMWF) or forecast model data. Static data files contain input data that do not or rarely change: CRTM data, the nominal instrumental noise (NEDT) data, the nominal geophysical covariance matrices data, the topography data, the tuning data and the emissivity catalog data. Table 8 provides a summary description of the input files including their source, function, directory and file naming convention, format and frequency of use. In the table, NOAA-18 AMSU-MHS and NWP GDAS data are provided as an example. Other external data being currently processed include NOAA-19, Metop-A, Metop-B, DMSP F17-SSMIS, DMSP-F18, and NPP ATMS as well as the NWP ECMWF data.

Date File	Source	Purpose	File Naming	Directory and File Format	Frequency
External sensor data files (level 1-b)	AMSU-A	Primary satellite data inputs used for generating MIRS products	NSS.AMAX.NN.**D***yyddd*.**S***mmss*.**E***mmss*.B_.GC (WI,SV)	“/data/ExternalData/rdr/n18_amsua_mhs/” Binary swath	Dynamic
	MHS		NSS.MHSX.NN.**D***yyddd*.**S***mmss*.**E***mmss*.B_.GC(WI,SV)		
External ancillary data files (Optional)	NWP re-analysis	Optional datasets of atmospheric and surface state parameters used for calibration and product monitoring.	gdas_atm*yyyy-mm-dd*.t*hh* gdas_sfc*yyyy-mm-dd*.t*hh*	“/data/ExternalData/gridNWPanalys/” and “/data/ExternalData/gridNWPforcst/”	4 (gdas) and 6 (forecast) times/day

	NWP forecast	It is not used in inversion processing	avn_at**m***yyyy-mm-dd.thh* avn_sfc*yyyy-mm-dd*.*thh*	Gridded binary byte image, 180 by 360, 1° res., 0°S, 180°W to 90°S, 180°E	
Set-up files		System scripts to define and customize directory paths to data, processes and applications	paths.pro paths_idl.pro n18_pcf.bash	"/setup/" ASCII	
CRTM files	CRTM	Files that contain input parameters needed to run CRTM, used "as is"	n18_amsua_mhs_SpcCoeff.bin n18_amsua_mhs_TauCoeff.bin	"/data/StaticData/CRTMFiles/" Binary	
			mw_cloud_opt.dat	ASCII	
Nominal instrumental noise (NEDT) files	level 1-b files	File contains nominal instrument antenna temperature noise values needed as input to 1dvar processing (only for certain sensors)	NoiseFile.dat	"/data/StaticData/NominalNedts/" ASCII	
Geophysical covariance matrices files	Climatology	File contains nominal covariance matrices and mean background values for surface and atmospheric parameters; needed as input to 1dvar inversion processing	CovBkgMatrxTotAtm_all.dat CovBkgMatrxTotSfc_all_n18_amsua_mhs.dat.	"/data/StaticData/CovBkgStats/" ASCII	Static
Topography files	USGS	Used for determining land surface type and elevation	Topography.bin_sgi	"/data/StaticData/Topography/" Gridded binary byte image, 180 by 360, 1/8th° res., 0°S, 180°W to 90°S, 180°E	
Tuning files	Internally developed	File contains parameters to customize retrieval attempts. Up to two tuning files can be specified by user	TunParams_n18_amsua_mhs.in	"/data/StaticData/TuningData/" ASCII	
Emissivity catalogues	Developed off-line	Files contain emissivity spectra and properties of sea ice and snow cover obtained off-line from physical models	SeaIceEmissCatalog_n18_amsua_mhs.dat SnowEmissCatalog_n18_amsua_mhs.dat	"/data/Staticdata/EmissCatalog" ASCII	

Pressure grid files		Files containing the vertical pressure levels	PressGrid_101levs_0.005mb_1100mb.dat	"data/Staticdata/PressGridFiles" ASCII	

Table 8. Summary description of the input files. The table gives the data file category, source, purpose, file naming, format, directory and frequency of use. The AMSU-MHS sensor data are provided as an example.

Additional characteristics of each data file including functionality, directory location and content is provided below. When the file is small enough, a sample of the content is also provided for increased clarity.

2.1 Set-Up Files

The purpose of the set-up files, also called the Path and Configuration Files (PCF), is to define the paths to MIRS sub-routines, libraries, applications, processes and data. PCFs can be constructed via the GUI-based MCP or can be constructed manually. Once constructed, they are called by the MIRS Sequence Control Scripts (SCS) that reside in the "/scripts" directory. A major advantage of the PCFs is enhanced modularity which eliminates the need for hand-coding in the MIRS software.

The SCSs are the main scripts that control the flow of MIRS processes and applications. Similar to PCFs, the SCSs can also be constructed via the MCP interface or manually. SCSs are sensor-specific scripts denoted as "*sensor*_scs.bash" . where "*sensor*" denotes satellite sensor name, e.g., "n18_amsua_mhs", "n19_amsua_mhs", "metopA_amsua_mhs", "metopB_amsua_mhs", "f17_ssmis", and "f18_ssmis" for NOAA-18 AMSU-MHS, NOAA-19 AMSU-MHS, Metop-A, Metop-B AMSU-MHS, F17-SSMI/S, and F18_SSMI/S, respectively.
The MIRS PCFs reside in the "/setup" top level directory (see also Figure 4). They consist of two general utility files and a sensor-specific file, e.g., for AMSU-MHS, SSMIS, etc. The general utility files are designated as "paths" and "paths_idl.pro", and they define paths to MIRS sensor-independent libraries and subdirectories such as CRTM, IDL code libraries and execution subdirectories. The other PCF is a BASH script that defines paths to sensor-specific and sensor-independent processes, data and applications. In the case of AMSU-MHS, this set up file is named "n18_pcf.bash" . An example of the content of the PCF for NOAA-18 AMSU-MHS is provided in Figure 5.

```
#-----------------------------------------------------------------------------
# S E C T I O N  O F  D A T A  A N D   P A T H S
#-----------------------------------------------------------------------------
#   Major root paths
#-----------------------------------------------------------------------------
rootPath='/net/orbit006l/home/sidb/mirs'
dataPath=${rootPath}'/data'
binpath=${rootPath}'/bin'
#-----------------------------------------------------------------------------
```

```
#      External data & Paths
#-------------------------------------------------------------------------------
externalDataPath=${dataPath}'/ExternalData'
rdrOrbitPath=${externalDataPath}/rdr/OrbitalMode
nwpGridAnalysPath=/net/orbit063l/disk3/pub/GDAS
-----------------------------
#      Static data & Paths
#-------------------------------------------------------------------------------
staticDataPath=${dataPath}'/StaticData'
instrumentPath=${staticDataPath}/InstrConfigInfotopographyFile=${staticDataPath}/Topography/topography.bin_sgi
#------------------------------------------------------------------------
# S E C T I O N  O F  S W I T C H E S(W H I C H  A P P L I C A T I O N  T O  R U N)
#------------------------------------------------------------------------
step_rdr2tdrSensor1=1   #RDR->TDR (Sensor1)
step_rdr2tdrSensor2=1   #RDR->TDR (Sensor2)
step_mergeNedt=1        #MERGE NEDTs (Sensor1 and Sensor2)
#------------------------------------------------------------------------
#  S E C T I O N OF C O N T R O L L I N G F L A G S
#------------------------------------------------------------------------
processMode=1   #0:Orbit processing  1:Daily processing
sensorId=1      #Sensor:1:N18,2:MetopA,3:F16, 4:Windsat
nAttempts=1     #Number of retrieval attempts in case of non-convergence
```

Figure 5. Sample of the setup file

2.2 External Data Files

The external data are input files coming from sources outside of MIRS. They consist of the level 1-b sensor data files and the NWP analysis or forecast model files. These files reside in the "`/data/ExternalData`" sub-directory (as also shown in Figure 4).

2.2.1 Sensor Data Files *(level-1b)*

For the case of NOAA-18 AMSU-MHS, these are level 1b data files. For DMSP sensors, these are the official NRL TDR files. See also Appendix B for information on naming convention of satellite data. The following tables provide a description of AMSU and MHS level 1b header and data content.

Field Name
FILE IDENTIFICATION
Data Set Creation Site ID CMS=Centre de Meteorologie Spatiale/France DSS=Dundee Satellite Receiving Station/UK NSS=National Environmental Satellite, Data and Information Service/USA UKM=United Kingdom Meteorological Office/UK
<ASCII blank = x20>
Level 1b Format Version Number
Level 1b Format Version Year *(four digits, e.g., 2000)*
Level 1b Format Version Day of Year *(e.g., 365)*
<Reserved for Logical Record Length> *(For Creation Site use only. Logical Record Length of source 1b data set prior to processing.)*
<Reserved for Block Size> *(For Creation Site use only. Block Size of source 1b data set prior to processing.)*
Count of Header Records in this Data Set
<Zero Fill>
Data Set Name
Processing Block Identification

Field Name
Spacecraft Identification Code 2=NOAA-L 4=NOAA-K 6=NOAA-M 7=NOAA-N 8=NOAA-N' 11=Metop-1 (TBC) 12=Metop-2 (TBC)
Instrument ID *Word 1: AMSU-A2 ID Number* 6=protoflight model (PFM), s/n 102 (NOAA-K) 10=flight model (FM) 1, s/n 103 (NOAA-L) 14=FM 2, s/n 104 (NOAA-M) 18=FM 3, s/n 105 (NOAA-N) 22=FM 4, s/n 106 (Metop-1) 26=FM 5, s/n 107 (NOAA-N') 34=FM 7, s/n 109 (Metop-2) *Word 2: AMSU-A1 ID Number* *5=PFM, s/n 102 (NOAA-L)* 9=FM 1, s/n 103 (NOAA-K) 13=FM 2, s/n 104 (NOAA-M) 17=FM 3, s/n 105 (NOAA-N') 21=FM 4, s/n 106 (Metop-1) 25=FM 5, s/n 107 (Metop-2) 33=FM 7, s/n 109 (NOAA-N)
Data Type Code 10=AMSU-A
TIP Source Code *(NOAA: values defined below)* or <Zero Fill> *(Metop)* 0=unused, i.e., GAC/HRPT/LAC data 1=GAC-embedded AMSU and TIP 2=stored TIP (STIP) 3=HRPT/LAC-embedded AMSU and TIP 4=stored AIP (SAIP)
Start of Data Set Day Count starting from 0 at 00h, 1 Jan 1950
Start of Data Set Year *(four digits, e.g., 2000)*
Start of Data Set Day of Year *(e.g., 365)*
Start of Data Set UTC Time of Day
End of Data Set Day Count starting from 0 at 00h, 1 Jan 1950
End of Data Set Year *(four digits, e.g., 2000)*
End of Data Set Day of Year *(e.g., 365)*
End of Data Set UTC Time of Day
Year of Last CPIDS Update *(four digits, e.g., 2000)*
Day of Year of Last CPIDS Update *(e.g., 365)*
Offset between Start of Scan and Center of First FOV
<Zero Fill>
DATA SET QUALITY INDICATORS
Instrument Status A2 *(see "Digital B Telemetry for AMSU-A2" field in data record)*

Field Name
bits 31-15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position (0=no; 1=yes) bit 11: antenna in cold cal position (0=no; 1=yes) bit 10: antenna in warm cal position (0=no; 1=yes) bit 9: full scan mode (0=no; 1=yes) bits 5-8: <zero fill> bit 4: survival heater (0=off; 1=on) bit 3: module power (0=disconnect; 1=connect) bit 2: compensator motor (0=off; 1=on) bit 1: scanner A2 power (0=off; 1=on) bit 0: <zero fill>
<Zero Fill>
Record Number of Status Change of A2 *(if 0, none occurred)*
Second Instrument Status A2 *(if previous word is 0, no change)*
Instrument Status A1 *(see "Digital B Telemetry for AMSU-A1" field in data record)* bits 31-15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position (0=no; 1=yes) bit 11: antenna in cold cal position (0=no; 1=yes) bit 10: antenna in warm cal position (0=no; 1=yes) bit 9: full scan mode (0=no; 1=yes) bits 8-6: <zero fill> bit 5: module power (0=disconnect; 1=connect) bit 4: survival heater (0=off; 1=on) bit 3: phase lock loop (0=redundant; 1=primary) bit 2: scanner A1-2 power (0=off; 1=on) bit 1: scanner A1-1 power (0=off; 1=on) bit 0: <zero fill>
<Zero Fill>
Record Number of Status Change of A1 *(if 0, none occurred)*
Second Instrument Status A1 *(if previous word is 0, no change)*
Count of Data Records in this Data Set
Count of Calibrated, Earth Located Scan Lines in this Data Set
Count of Missing Scan Lines
Count of Data Gaps in this Data Set
Count of Data Frames Without Frame Sync Word Errors *(NOAA)* or <Zero Fill> *(Metop)*
Count of PACS Detected TIP Parity Errors *(NOAA)* or <Zero Fill> *(Metop)*
Sum of All Auxiliary Sync Errors Detected in the Input Data *(NOAA)* or <Zero Fill> *(Metop)*
Time Sequence Error 0=none; otherwise, the record number of the first occurrence
Time Sequence Error Code *(These are bit flags taken from "Scan Line Quality Flags [Time Problem Code]" on data record reported in "Time Sequence Error" field above. If a bit is on (=1) then the statement is true.)* bits 15-8: <zero fill> bit 7: time field is bad but can probably be inferred from the previous good time bit 6: time field is bad and can't be inferred from the previous good time bit 5: this record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity); may be associated with a spacecraft clock update bit 4: start of a sequence that apparently repeats scan times that have been previously accepted bits 3-0: <zero fill>
SOCC Clock Update Indicator 0=none during this orbit; otherwise, the record number of the first occurrence
Earth Location Error Indicator 0=none during this orbit; otherwise, the record number of the first occurrence

Field Name
Earth Location Error Code *(These are bit flags taken from "Scan Line Quality Flags [Earth Location Problem Code]" on data record reported in "Earth Location Error Indicator" field above. If a bit is on (=1) then the statement is true.)* bits 15-8: <zero fill> bit 7: not earth located because of bad time; earth location fields zero-filled bit 6: earth location questionable: questionable time code bit 5: earth location questionable: marginal agreement with reasonableness check bit 4: earth location questionable: fails reasonableness check bit 3: earth location questionable because of antenna position check bit 2: <zero fill> bit 1: not earth located because of satellite in-plane maneuver (Metop) or <zero fill> (NOAA) bit 0: not earth located because of satellite out-of-plane maneuver (Metop) or <zero fill> (NOAA)
PACS Status Bit Field *(NOAA: value defined below)* or <Zero Fill> *(Metop)* bits 15-3: <zero fill> bit 2: pseudonoise (0=normal data; 1=pseudonoise data) bit 1: tape direction (0=reverse playback, time decrementing) bit 0: data mode (0=test data; 1=flight data)
Data Source 0=unused 1=Fairbanks, AK 2=Wallops Is., VA 3=SOCC 4=Svalbard, Norway 5=Monterey, CA
<Zero Fill>
<Reserved for the Ingester>
<Reserved for Decommutation>
<Zero Fill>
CALIBRATION
<Zero Fill>
Instrument Temperature Sensor ID Word 1: 0=RF Shelf A1-1; 1=RF Mux A1-1 Word 2: 0=RF Shelf A1-2; 1=RF Mux A1-2 Word 3: 0=RF Shelf A2; 1=RF Mux/Diplexer A2
RF Shelf A1-1 Minimum Reference Temperature, PLLO#1
RF Shelf A1-1 Nominal Reference Temperature, PLLO#1
RF Shelf A1-1 Maximum Reference Temperature, PLLO#1
RF Shelf A1-2 Minimum Reference Temperature
RF Shelf A1-2 Nominal Reference Temperature
RF Shelf A1-2 Maximum Reference Temperature
RF Shelf A2 Minimum Reference Temperature
RF Shelf A2 Nominal Reference Temperature
RF Shelf A2 Maximum Reference Temperature
RF Shelf A1-1 Minimum Reference Temperature, PLLO#2
RF Shelf A1-1 Nominal Reference Temperature, PLLO#2
RF Shelf A1-1 Maximum Reference Temperature, PLLO#2
RF Mux A1-1 Minimum Reference Temperature, PLLO#1
RF Mux A1-1 Nominal Reference Temperature, PLLO#1
RF Mux A1-1 Maximum Reference Temperature, PLLO#1
RF Mux A1-2 Minimum Reference Temperature
RF Mux A1-2 Nominal Reference Temperature
RF Mux A1-2 Maximum Reference Temperature
RF Mux/Diplexer A2 Minimum Reference Temperature
RF Mux/Diplexer A2 Nominal Reference Temperature
RF Mux/Diplexer A2 Maximum Reference Temperature

Field Name
RF Mux A1-1 Minimum Reference Temperature, PLLO#2
RF Mux A1-1 Nominal Reference Temperature, PLLO#2
RF Mux A1-1 Maximum Reference Temperature, PLLO#2
Warm Target Fixed Bias Corr Ch1 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch1 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch1 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch1
Warm Target Fixed Bias Corr Ch2 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch2 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch2 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch2
Warm Target Fixed Bias Corr Ch3 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch3 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch3 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch3
Warm Target Fixed Bias Corr Ch4 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch4 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch4 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch4
Warm Target Fixed Bias Corr Ch5 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch5 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch5 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch5
Warm Target Fixed Bias Corr Ch6 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch6 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch6 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch6
Warm Target Fixed Bias Corr Ch7 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch7 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch7 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch7
Warm Target Fixed Bias Corr Ch8 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch8 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch8 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch8
Warm Target Fixed Bias Corr Ch9 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch9 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch9 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch9
Warm Target Fixed Bias Corr Ch10 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch10 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch10 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch10
Warm Target Fixed Bias Corr Ch11 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch11 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch11 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch11
Warm Target Fixed Bias Corr Ch12 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch12 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch12 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch12

Field Name
Warm Target Fixed Bias Corr Ch13 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch13 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch13 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch13
Warm Target Fixed Bias Corr Ch14 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch14 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch14 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch14
Warm Target Fixed Bias Corr Ch15 at Min RF Shelf Temp
Warm Target Fixed Bias Corr Ch15 at Nom RF Shelf Temp
Warm Target Fixed Bias Corr Ch15 at Max RF Shelf Temp
Cold Space Fixed Bias Corr Ch15
Warm Target Bias Corr Ch9 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch9 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch9 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Warm Target Bias Corr Ch10 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch10 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch10 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Warm Target Bias Corr Ch11 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch11 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch11 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Warm Target Bias Corr Ch12 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch12 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch12 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Warm Target Bias Corr Ch13 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch13 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch13 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Warm Target Bias Corr Ch14 at PLLO#2 RF Shelf A1-1 Min Ref Temp
Warm Target Bias Corr Ch14 at PLLO#2 RF Shelf A1-1 Nom Ref Temp
Warm Target Bias Corr Ch14 at PLLO#2 RF Shelf A1-1 Max Ref Temp
Nonlinearity Coef. Ch 1 at Min Ref Temp
Nonlinearity Coef. Ch 1 at Nom Ref Temp
Nonlinearity Coef. Ch 1 at Max Ref Temp
Nonlinearity Coef. Ch 2 at Min Ref Temp
Nonlinearity Coef. Ch 2 at Nom Ref Temp
Nonlinearity Coef. Ch 2 at Max Ref Temp
Nonlinearity Coef. Ch 3 at Min Ref Temp
Nonlinearity Coef. Ch 3 at Nom Ref Temp
Nonlinearity Coef. Ch 3 at Max Ref Temp
Nonlinearity Coef. Ch 4 at Min Ref Temp
Nonlinearity Coef. Ch 4 at Nom Ref Temp
Nonlinearity Coef. Ch 4 at Max Ref Temp
Nonlinearity Coef. Ch 5 at Min Ref Temp
Nonlinearity Coef. Ch 5 at Nom Ref Temp
Nonlinearity Coef. Ch 5 at Max Ref Temp
Nonlinearity Coef. Ch 6 at Min Ref Temp
Nonlinearity Coef. Ch 6 at Nom Ref Temp
Nonlinearity Coef. Ch 6 at Max Ref Temp
Nonlinearity Coef. Ch 7 at Min Ref Temp
Nonlinearity Coef. Ch 7 at Nom Ref Temp
Nonlinearity Coef. Ch 7 at Max Ref Temp

Field Name
Nonlinearity Coef. Ch 8 at Min Ref Temp
Nonlinearity Coef. Ch 8 at Nom Ref Temp
Nonlinearity Coef. Ch 8 at Max Ref Temp
Nonlinearity Coef. Ch 9 at Min Ref Temp
Nonlinearity Coef. Ch 9 at Nom Ref Temp
Nonlinearity Coef. Ch 9 at Max Ref Temp
Nonlinearity Coef. Ch 10 at Min Ref Temp
Nonlinearity Coef. Ch 10 at Nom Ref Temp
Nonlinearity Coef. Ch 10 at Max Ref Temp
Nonlinearity Coef. Ch 11 at Min Ref Temp
Nonlinearity Coef. Ch 11 at Nom Ref Temp
Nonlinearity Coef. Ch 11 at Max Ref Temp
Nonlinearity Coef. Ch 12 at Min Ref Temp
Nonlinearity Coef. Ch 12 at Nom Ref Temp
Nonlinearity Coef. Ch 12 at Max Ref Temp
Nonlinearity Coef. Ch 13 at Min Ref Temp
Nonlinearity Coef. Ch 13 at Nom Ref Temp
Nonlinearity Coef. Ch 13 at Max Ref Temp
Nonlinearity Coef. Ch 14 at Min Ref Temp
Nonlinearity Coef. Ch 14 at Nom Ref Temp
Nonlinearity Coef. Ch 14 at Max Ref Temp
Nonlinearity Coef. Ch 15 at Min Ref Temp
Nonlinearity Coef. Ch 15 at Nom Ref Temp
Nonlinearity Coef. Ch 15 at Max Ref Temp
Nonlinearity Coef. Ch 9 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 9 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 9 for PLLO#2 at Max Ref Temp
Nonlinearity Coef. Ch 10 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 10 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 10 for PLLO#2 at Max Ref Temp
Nonlinearity Coef. Ch 11 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 11 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 11 for PLLO#2 at Max Ref Temp
Nonlinearity Coef. Ch 12 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 12 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 12 for PLLO#2 at Max Ref Temp
Nonlinearity Coef. Ch 13 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 13 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 13 for PLLO#2 at Max Ref Temp
Nonlinearity Coef. Ch 14 for PLLO#2 at Min Ref Temp
Nonlinearity Coef. Ch 14 for PLLO#2 at Nom Ref Temp
Nonlinearity Coef. Ch 14 for PLLO#2 at Max Ref Temp
<Zero Fill>
TEMPERATURE-RADIANCE CONVERSION
Temperature-radiance Ch 1 Central Wavenumber
Temperature-radiance Ch 1 Constant 1
Temperature-radiance Ch 1 Constant 2, Slope
Temperature-radiance Ch 2 Central Wavenumber
Temperature-radiance Ch 2 Constant 1
Temperature-radiance Ch 2 Constant 2, Slope
Temperature-radiance Ch 3 Central Wavenumber

Field Name
Temperature-radiance Ch 3 Constant 1
Temperature-radiance Ch 3 Constant 2, Slope
Temperature-radiance Ch 4 Central Wavenumber
Temperature-radiance Ch 4 Constant 1
Temperature-radiance Ch 4 Constant 2, Slope
Temperature-radiance Ch 5 Central Wavenumber
Temperature-radiance Ch 5 Constant 1
Temperature-radiance Ch 5 Constant 2, Slope
Temperature-radiance Ch 6 Central Wavenumber
Temperature-radiance Ch 6 Constant 1
Temperature-radiance Ch 6 Constant 2, Slope
Temperature-radiance Ch 7 Central Wavenumber
Temperature-radiance Ch 7 Constant 1
Temperature-radiance Ch 7 Constant 2, Slope
Temperature-radiance Ch 8 Central Wavenumber
Temperature-radiance Ch 8 Constant 1
Temperature-radiance Ch 8 Constant 2, Slope
Temperature-radiance Ch 9 Central Wavenumber
Temperature-radiance Ch 9 Constant 1
Temperature-radiance Ch 9 Constant 2, Slope
Temperature-radiance Ch 10 Central Wavenumber
Temperature-radiance Ch 10 Constant 1
Temperature-radiance Ch 10 Constant 2, Slope
Temperature-radiance Ch 11 Central Wavenumber
Temperature-radiance Ch 11 Constant 1
Temperature-radiance Ch 11 Constant 2, Slope
Temperature-radiance Ch 12 Central Wavenumber
Temperature-radiance Ch 12 Constant 1
Temperature-radiance Ch 12 Constant 2, Slope
Temperature-radiance Ch 13 Central Wavenumber
Temperature-radiance Ch 13 Constant 1
Temperature-radiance Ch 13 Constant 2, Slope
Temperature-radiance Ch 14 Central Wavenumber
Temperature-radiance Ch 14 Constant 1
Temperature-radiance Ch 14 Constant 2, Slope
Temperature-radiance Ch 15 Central Wavenumber
Temperature-radiance Ch 15 Constant 1
Temperature-radiance Ch 15 Constant 2, Slope
<Zero Fill>
NAVIGATION
Reference Ellipsoid Model ID *(The ellipsoid is a mathematically tractable approximation of the geoid, which is an equipotential surface at mean sea level. The maximum departure of the ellipsoid from the geoid is approximately +/- 65 meters.)* WGS-72=World Geodetic Survey 1972
Nadir Earth Location Tolerance
Earth Location Bit Field bits 15-3: <zero fill> bit 2: dynamic attitude error correction (0=not performed; 1=performed) bit 1: reasonableness test (0=inactive; 1=active) bit 0: constant attitude error correction (0=not performed; 1=performed)
<Zero Fill>
Constant Roll Attitude Error

Field Name
Constant Pitch Attitude Error
Constant Yaw Attitude Error
Epoch Year for Orbit Vector
Day of Epoch Year for Orbit Vector
Epoch UTC Time of Day for Orbit Vector
Semi-major Axis *(at the orbit vector epoch time)*
Eccentricity *(at the orbit vector epoch time)*
Inclination *(at the orbit vector epoch time)*
Argument of Perigee *(at the orbit vector epoch time)*
Right Ascension of the Ascending Node *(at the orbit vector epoch time)*
Mean Anomaly *(at the orbit vector epoch time)*
Position Vector X Component *(at the orbit vector epoch time)*
Position Vector Y Component *(at the orbit vector epoch time)*
Position Vector Z Component *(at the orbit vector epoch time)*
Velocity Vector X-dot Component *(at the orbit vector epoch time)*
Velocity Vector Y-dot Component *(at the orbit vector epoch time)*
Velocity Vector Z-dot Component *(at the orbit vector epoch time)*
Earth/Sun Distance Ratio *(at the orbit vector epoch time; relative to the mean distance of 1 AU)*
<Zero Fill>
AMSU-A1 DIGITAL A CONVERSION *Counts-to-temperature conversion coefficients for the AMSU-A1 digital A telemetry items.*
Scan Motor A1-1 Temperature Coefficient 0
Scan Motor A1-1 Temperature Coefficient 1
Scan Motor A1-1 Temperature Coefficient 2
Scan Motor A1-1 Temperature Coefficient 3
Scan Motor A1-2 Temperature Coefficient 0
Scan Motor A1-2 Temperature Coefficient 1
Scan Motor A1-2 Temperature Coefficient 2
Scan Motor A1-2 Temperature Coefficient 3
Feed Horn A1-1 Temperature Coefficient 0
Feed Horn A1-1 Temperature Coefficient 1
Feed Horn A1-1 Temperature Coefficient 2
Feed Horn A1-1 Temperature Coefficient 3
Feed Horn A1-2 Temperature Coefficient 0
Feed Horn A1-2 Temperature Coefficient 1
Feed Horn A1-2 Temperature Coefficient 2
Feed Horn A1-2 Temperature Coefficient 3
RF Mux A1-1 Temperature Coefficient 0
RF Mux A1-1 Temperature Coefficient 1
RF Mux A1-1 Temperature Coefficient 2
RF Mux A1-1 Temperature Coefficient 3
RF Mux A1-2 Temperature Coefficient 0
RF Mux A1-2 Temperature Coefficient 1
RF Mux A1-2 Temperature Coefficient 2
RF Mux A1-2 Temperature Coefficient 3
Local Oscillator Channel 3 Temperature Coefficient 0
Local Oscillator Channel 3 Temperature Coefficient 1
Local Oscillator Channel 3 Temperature Coefficient 2
Local Oscillator Channel 3 Temperature Coefficient 3
Local Oscillator Channel 4 Temperature Coefficient 0
Local Oscillator Channel 4 Temperature Coefficient 1

Field Name
Local Oscillator Channel 4 Temperature Coefficient 2
Local Oscillator Channel 4 Temperature Coefficient 3
Local Oscillator Channel 5 Temperature Coefficient 0
Local Oscillator Channel 5 Temperature Coefficient 1
Local Oscillator Channel 5 Temperature Coefficient 2
Local Oscillator Channel 5 Temperature Coefficient 3
Local Oscillator Channel 6 Temperature Coefficient 0
Local Oscillator Channel 6 Temperature Coefficient 1
Local Oscillator Channel 6 Temperature Coefficient 2
Local Oscillator Channel 6 Temperature Coefficient 3
Local Oscillator Channel 7 Temperature Coefficient 0
Local Oscillator Channel 7 Temperature Coefficient 1
Local Oscillator Channel 7 Temperature Coefficient 2
Local Oscillator Channel 7 Temperature Coefficient 3
Local Oscillator Channel 8 Temperature Coefficient 0
Local Oscillator Channel 8 Temperature Coefficient 1
Local Oscillator Channel 8 Temperature Coefficient 2
Local Oscillator Channel 8 Temperature Coefficient 3
Local Oscillator Channel 15 Temperature Coefficient 0
Local Oscillator Channel 15 Temperature Coefficient 1
Local Oscillator Channel 15 Temperature Coefficient 2
Local Oscillator Channel 15 Temperature Coefficient 3
PLLO #2 Channels 9 Through 14 Temperature Coefficient 0
PLLO #2 Channels 9 Through 14 Temperature Coefficient 1
PLLO #2 Channels 9 Through 14 Temperature Coefficient 2
PLLO #2 Channels 9 Through 14 Temperature Coefficient 3
PLLO #1 Channels 9 Through 14 Temperature Coefficient 0
PLLO #1 Channels 9 Through 14 Temperature Coefficient 1
PLLO #1 Channels 9 Through 14 Temperature Coefficient 2
PLLO #1 Channels 9 Through 14 Temperature Coefficient 3
PLLO (Reference Oscillator) Temperature Coefficient 0 *(NOAA-KLM)* or <Zero Fill> *(NOAA-NN', Metop)*
PLLO (Reference Oscillator) Temperature Coefficient 1 *(NOAA-KLM)* or <Zero Fill> *(NOAA-NN', Metop)*
PLLO (Reference Oscillator) Temperature Coefficient 2 *(NOAA-KLM)* or <Zero Fill> *(NOAA-NN', Metop)*
PLLO (Reference Oscillator) Temperature Coefficient 3 *(NOAA-KLM)* or <Zero Fill> *(NOAA-NN', Metop)*
Mixer/IF Amplifier Channel 3 Temperature Coefficient 0
Mixer/IF Amplifier Channel 3 Temperature Coefficient 1
Mixer/IF Amplifier Channel 3 Temperature Coefficient 2
Mixer/IF Amplifier Channel 3 Temperature Coefficient 3
Mixer/IF Amplifier Channel 4 Temperature Coefficient 0
Mixer/IF Amplifier Channel 4 Temperature Coefficient 1
Mixer/IF Amplifier Channel 4 Temperature Coefficient 2
Mixer/IF Amplifier Channel 4 Temperature Coefficient 3
Mixer/IF Amplifier Channel 5 Temperature Coefficient 0
Mixer/IF Amplifier Channel 5 Temperature Coefficient 1
Mixer/IF Amplifier Channel 5 Temperature Coefficient 2
Mixer/IF Amplifier Channel 5 Temperature Coefficient 3
Mixer/IF Amplifier Channel 6 Temperature Coefficient 0

Field Name
Mixer/IF Amplifier Channel 6 Temperature Coefficient 1
Mixer/IF Amplifier Channel 6 Temperature Coefficient 2
Mixer/IF Amplifier Channel 6 Temperature Coefficient 3
Mixer/IF Amplifier Channel 7 Temperature Coefficient 0
Mixer/IF Amplifier Channel 7 Temperature Coefficient 1
Mixer/IF Amplifier Channel 7 Temperature Coefficient 2
Mixer/IF Amplifier Channel 7 Temperature Coefficient 3
Mixer/IF Amplifier Channel 8 Temperature Coefficient 0
Mixer/IF Amplifier Channel 8 Temperature Coefficient 1
Mixer/IF Amplifier Channel 8 Temperature Coefficient 2
Mixer/IF Amplifier Channel 8 Temperature Coefficient 3
Mixer/IF Amplifier Channel 9/14 Temperature Coefficient 0
Mixer/IF Amplifier Channel 9/14 Temperature Coefficient 1
Mixer/IF Amplifier Channel 9/14 Temperature Coefficient 2
Mixer/IF Amplifier Channel 9/14 Temperature Coefficient 3
Mixer/IF Amplifier Channel 15 Temperature Coefficient 0
Mixer/IF Amplifier Channel 15 Temperature Coefficient 1
Mixer/IF Amplifier Channel 15 Temperature Coefficient 2
Mixer/IF Amplifier Channel 15 Temperature Coefficient 3
IF Amplifier Channel 11/14 Temperature Coefficient 0
IF Amplifier Channel 11/14 Temperature Coefficient 1
IF Amplifier Channel 11/14 Temperature Coefficient 2
IF Amplifier Channel 11/14 Temperature Coefficient 3
IF Amplifier Channel 9 Temperature Coefficient 0
IF Amplifier Channel 9 Temperature Coefficient 1
IF Amplifier Channel 9 Temperature Coefficient 2
IF Amplifier Channel 9 Temperature Coefficient 3
IF Amplifier Channel 10 Temperature Coefficient 0
IF Amplifier Channel 10 Temperature Coefficient 1
IF Amplifier Channel 10 Temperature Coefficient 2
IF Amplifier Channel 10 Temperature Coefficient 3
IF Amplifier Channel 11 Temperature Coefficient 0
IF Amplifier Channel 11 Temperature Coefficient 1
IF Amplifier Channel 11 Temperature Coefficient 2
IF Amplifier Channel 11 Temperature Coefficient 3
DC/DC Converter Temperature Coefficient 0
DC/DC Converter Temperature Coefficient 1
DC/DC Converter Temperature Coefficient 2
DC/DC Converter Temperature Coefficient 3
IF Amplifier Channel 13 Temperature Coefficient 0
IF Amplifier Channel 13 Temperature Coefficient 1
IF Amplifier Channel 13 Temperature Coefficient 2
IF Amplifier Channel 13 Temperature Coefficient 3
IF Amplifier Channel 14 Temperature Coefficient 0
IF Amplifier Channel 14 Temperature Coefficient 1
IF Amplifier Channel 14 Temperature Coefficient 2
IF Amplifier Channel 14 Temperature Coefficient 3
IF Amplifier Channel 12 Temperature Coefficient 0
IF Amplifier Channel 12 Temperature Coefficient 1
IF Amplifier Channel 12 Temperature Coefficient 2
IF Amplifier Channel 12 Temperature Coefficient 3

Field Name
RF Shelf A1-1 Temperature Coefficient 0
RF Shelf A1-1 Temperature Coefficient 1
RF Shelf A1-1 Temperature Coefficient 2
RF Shelf A1-1 Temperature Coefficient 3
RF Shelf A1-2 Temperature Coefficient 0
RF Shelf A1-2 Temperature Coefficient 1
RF Shelf A1-2 Temperature Coefficient 2
RF Shelf A1-2 Temperature Coefficient 3
Detector/preamp Assembly Temperature Coefficient 0
Detector/preamp Assembly Temperature Coefficient 1
Detector/preamp Assembly Temperature Coefficient 2
Detector/preamp Assembly Temperature Coefficient 3
A1-1 Warm Load 1 Temperature Coefficient 0
A1-1 Warm Load 1 Temperature Coefficient 1
A1-1 Warm Load 1 Temperature Coefficient 2
A1-1 Warm Load 1 Temperature Coefficient 3
A1-1 Warm Load 2 Temperature Coefficient 0
A1-1 Warm Load 2 Temperature Coefficient 1
A1-1 Warm Load 2 Temperature Coefficient 2
A1-1 Warm Load 2 Temperature Coefficient 3
A1-1 Warm Load 3 Temperature Coefficient 0
A1-1 Warm Load 3 Temperature Coefficient 1
A1-1 Warm Load 3 Temperature Coefficient 2
A1-1 Warm Load 3 Temperature Coefficient 3
A1-1 Warm Load 4 Temperature Coefficient 0
A1-1 Warm Load 4 Temperature Coefficient 1
A1-1 Warm Load 4 Temperature Coefficient 2
A1-1 Warm Load 4 Temperature Coefficient 3
A1-1 Warm Load Center Temperature Coefficient 0
A1-1 Warm Load Center Temperature Coefficient 1
A1-1 Warm Load Center Temperature Coefficient 2
A1-1 Warm Load Center Temperature Coefficient 3
A1-2 Warm Load 1 Temperature Coefficient 0
A1-2 Warm Load 1 Temperature Coefficient 1
A1-2 Warm Load 1 Temperature Coefficient 2
A1-2 Warm Load 1 Temperature Coefficient 3
A1-2 Warm Load 2 Temperature Coefficient 0
A1-2 Warm Load 2 Temperature Coefficient 1
A1-2 Warm Load 2 Temperature Coefficient 2
A1-2 Warm Load 2 Temperature Coefficient 3
A1-2 Warm Load 3 Temperature Coefficient 0
A1-2 Warm Load 3 Temperature Coefficient 1
A1-2 Warm Load 3 Temperature Coefficient 2
A1-2 Warm Load 3 Temperature Coefficient 3
A1-2 Warm Load 4 Temperature Coefficient 0
A1-2 Warm Load 4 Temperature Coefficient 1
A1-2 Warm Load 4 Temperature Coefficient 2
A1-2 Warm Load 4 Temperature Coefficient 3
A1-2 Warm Load Center Temperature Coefficient 0
A1-2 Warm Load Center Temperature Coefficient 1
A1-2 Warm Load Center Temperature Coefficient 2

Field Name
A1-2 Warm Load Center Temperature Coefficient 3
<Zero Fill>
AMSU-A1 ANALOG TELEMETRY CONVERSION *Volts-to-engineering units (e.g., temperature in Kelvin) conversion coefficients for the AMSU-A1 analog telemetry items. (NOTE: 1 count = 0.02 volts.)*
A1-1 Scan Motor Temp Intercept
A1-1 Scan Motor Temp Slope
A1-2 Scan Motor Temp Intercept
A1-2 Scan Motor Temp Slope
A1-1 RF Shelf Temp Intercept
A1-1 RF Shelf Temp Slope
A1-2 RF Shelf Temp Intercept
A1-2 RF Shelf Temp Slope
A1-1 Warm Load Temp Intercept
A1-1 Warm Load Temp Slope
A1-2 Warm Load Temp Intercept
A1-2 Warm Load Temp Slope
A1-1 Antenna Motor Current Intercept
A1-1 Antenna Motor Current Slope
A1-2 Antenna Motor Current Intercept
A1-2 Antenna Motor Current Slope
+15v Signal Processing Intercept
+15v Signal Processing Slope
+15v Antenna Drive Intercept
+15v Antenna Drive Slope
-15v Signal Processing Intercept
-15v Signal Processing Slope
-15v Antenna Drive Intercept
-15v Antenna Drive Slope
+8v Receiver Amps Intercept
+8v Receiver Amps Slope
+5v Signal Processing Intercept
+5v Signal Processing Slope
+5v Antenna Drive Intercept
+5v Antenna Drive Slope
+8.5v Phase Lock Loop Ch 9/14 Intercept *(NOAA-KLM)* or +10 VDC Receiver Mixer/IF Intercept *(NOAA-NN', Metop)*
+8.5v Phase Lock Loop Ch 9/14 Slope *(NOAA-KLM)* or +10 VDC Receiver Mixer/IF Slope *(NOAA-NN', Metop)*
+15v Phase Lock Loop Ch 9/14 Intercept
+15v Phase Lock Loop Ch 9/14 Slope
-15v Phase Lock Loop Ch 9/14 Intercept
-15v Phase Lock Loop Ch 9/14 Slope
LO Voltage 50.3 GHz Ch 3 Intercept
LO Voltage 50.3 GHz Ch 3 Slope
LO Voltage 52.8 GHz Ch 4 Intercept
LO Voltage 52.8 GHz Ch 4 Slope
LO Voltage 53.596 GHz Ch 5 Intercept
LO Voltage 53.596 GHz Ch 5 Slope
LO Voltage 54.4 GHz Ch 6 Intercept
LO Voltage 54.4 GHz Ch 6 Slope

Field Name
LO Voltage 54.94 GHz Ch 7 Intercept
LO Voltage 54.94 GHz Ch 7 Slope
LO Voltage 55.5 GHz Ch 8 Intercept
LO Voltage 55.5 GHz Ch 8 Slope
PLLO Primary Lock Detect Intercept
PLLO Primary Lock Detect Slope
PLLO Redundant Lock Detect Intercept
PLLO Redundant Lock Detect Slope
GDO Voltage 89.0 GHz Ch 15 Intercept
GDO Voltage 89.0 GHz Ch 15 Slope
<Zero Fill>
AMSU-A2 DIGITAL A CONVERSION *Counts-to-temperature conversion coefficients for the AMSU-A2 digital A telemetry items.*
Scan Motor Temp. Conv. Coeff 0
Scan Motor Temp. Conv. Coeff 1
Scan Motor Temp. Conv. Coeff 2
Scan Motor Temp. Conv. Coeff 3
Feed Horn Temp. Conv. Coeff 0
Feed Horn Temp. Conv. Coeff 1
Feed Horn Temp. Conv. Coeff 2
Feed Horn Temp. Conv. Coeff 3
RF Mux/Diplexer Temp. Conv. Coeff 0
RF Mux/Diplexer Temp. Conv. Coeff 1
RF Mux/Diplexer Temp. Conv. Coeff 2
RF Mux/Diplexer Temp. Conv. Coeff 3
Mixer/IF Amplifier Channel 1 Temp. Conv. Coeff 0
Mixer/IF Amplifier Channel 1 Temp. Conv. Coeff 1
Mixer/IF Amplifier Channel 1 Temp. Conv. Coeff 2
Mixer/IF Amplifier Channel 1 Temp. Conv. Coeff 3
Mixer/IF Amplifier Channel 2 Temp. Conv. Coeff 0
Mixer/IF Amplifier Channel 2 Temp. Conv. Coeff 1
Mixer/IF Amplifier Channel 2 Temp. Conv. Coeff 2
Mixer/IF Amplifier Channel 2 Temp. Conv. Coeff 3
Local Oscillator Channel 1 Temp. Conv. Coeff 0
Local Oscillator Channel 1 Temp. Conv. Coeff 1
Local Oscillator Channel 1 Temp. Conv. Coeff 2
Local Oscillator Channel 1 Temp. Conv. Coeff 3
Local Oscillator Channel 2 Temp. Conv. Coeff 0
Local Oscillator Channel 2 Temp. Conv. Coeff 1
Local Oscillator Channel 2 Temp. Conv. Coeff 2
Local Oscillator Channel 2 Temp. Conv. Coeff 3
Compensation Motor Temp. Conv. Coeff 0
Compensation Motor Temp. Conv. Coeff 1
Compensation Motor Temp. Conv. Coeff 2
Compensation Motor Temp. Conv. Coeff 3
Subreflector Temp. Conv. Coeff 0
Subreflector Temp. Conv. Coeff 1
Subreflector Temp. Conv. Coeff 2
Subreflector Temp. Conv. Coeff 3
DC/DC Converter Temp. Conv. Coeff 0
DC/DC Converter Temp. Conv. Coeff 1

Field Name
DC/DC Converter Temp. Conv. Coeff 2
DC/DC Converter Temp. Conv. Coeff 3
RF Shelf Temp. Conv. Coeff 0
RF Shelf Temp. Conv. Coeff 1
RF Shelf Temp. Conv. Coeff 2
RF Shelf Temp. Conv. Coeff 3
Detector/preamp Assembly Temp. Conv. Coeff 0
Detector/preamp Assembly Temp. Conv. Coeff 1
Detector/preamp Assembly Temp. Conv. Coeff 2
Detector/preamp Assembly Temp. Conv. Coeff 3
Warm Load Center Temp. Conv. Coeff 0
Warm Load Center Temp. Conv. Coeff 1
Warm Load Center Temp. Conv. Coeff 2
Warm Load Center Temp. Conv. Coeff 3
Warm Load 1 Temp. Conv. Coeff 0
Warm Load 1 Temp. Conv. Coeff 1
Warm Load 1 Temp. Conv. Coeff 2
Warm Load 1 Temp. Conv. Coeff 3
Warm Load 2 Temp. Conv. Coeff 0
Warm Load 2 Temp. Conv. Coeff 1
Warm Load 2 Temp. Conv. Coeff 2
Warm Load 2 Temp. Conv. Coeff 3
Warm Load 3 Temp. Conv. Coeff 0
Warm Load 3 Temp. Conv. Coeff 1
Warm Load 3 Temp. Conv. Coeff 2
Warm Load 3 Temp. Conv. Coeff 3
Warm Load 4 Temp. Conv. Coeff 0
Warm Load 4 Temp. Conv. Coeff 1
Warm Load 4 Temp. Conv. Coeff 2
Warm Load 4 Temp. Conv. Coeff 3
Warm Load 5 Temp. Conv. Coeff 0
Warm Load 5 Temp. Conv. Coeff 1
Warm Load 5 Temp. Conv. Coeff 2
Warm Load 5 Temp. Conv. Coeff 3
Warm Load 6 Temp. Conv. Coeff 0
Warm Load 6 Temp. Conv. Coeff 1
Warm Load 6 Temp. Conv. Coeff 2
Warm Load 6 Temp. Conv. Coeff 3
<Zero Fill>
AMSU-A2 ANALOG TELEMETRY CONVERSION *Volts-to-engineering units (e.g., temperature in Celsius) conversion coefficients for the AMSU-A2 analog telemetry items. (NOTE: 1 count = 0.02 volts.)*
A2 Scan Motor Temp Intercept
A2 Scan Motor Temp Slope
Compensator Motor Temp Intercept
Compensator Motor Temp Slope
RF Shelf Temp Intercept
RF Shelf Temp Slope
Warm Load Temp Intercept
Warm Load Temp Slope
Compensator Motor Current Intercept

Field Name
Compensator Motor Current Slope
Antenna Motor Current Intercept
Antenna Motor Current Slope
+15v Signal Processing Intercept
+15v Signal Processing Slope
+15v Antenna Drive Intercept
+15v Antenna Drive Slope
-15v Signal Processing Intercept
-15v Signal Processing Slope
-15v Antenna Drive Intercept
-15v Antenna Drive Slope
+8v Receiver Amps Intercept *(NOAA-KLM)* or +10v Receiver/Mixer/IF Amps Intercept *(NOAA-NN', Metop)*
+8v Receiver Amps Slope *(NOAA-KLM)* or +10v Receiver/Mixer/IF Amps Slope *(NOAA-NN', Metop)*
+5v Signal Processing Intercept
+5v Signal Processing Slope
+5v Antenna Drive Intercept
+5v Antenna Drive Slope
LO Voltage 23.8 GHz Ch 1 Intercept
LO Voltage 23.8 GHz Ch 1 Slope
LO Voltage 31.4 GHz Ch 2 Intercept
LO Voltage 31.4 GHz Ch 2 Slope
<Zero Fill>
LUNAR CONTAMINATION CORRECTION
Count of Scans Containing Lunar-Contaminated Space Views *(Also, see bits 6 and 7 of "Calibration Quality Flags" field in data record.)* -1=the detection algorithm for lunar contamination is turned off 0=the detection algorithm is turned on: no scans containing lunar-contaminated space views were found >0=the detection algorithm is turned on: the value in this field represents the number of scans found that contain lunar-contaminated space views
Distance Between the Earth and Moon *(average of distance computed on first and last scans of orbit)*
Angle Between the Moon and Sun *(as seen from the earth; average of angle computed on first and last scans of orbit; range: 0 - 180)*
<Zero Fill>
METOP MANEUVERS IDENTIFICATION *The fields in this section are Metop specific. For NOAA-originated AMSU-A data, these fields are spare (zero fill).*
Start of Maneuver Year *(four digits, e.g., 2000)*
Start of Maneuver Day of Year *(e.g., 365)*
Start of Maneuver UTC Time of Day
End of Maneuver Year *(four digits, e.g., 2000)*
End of Maneuver Day of Year *(e.g., 365)*
End of Maneuver UTC Time of Day
Change in Spacecraft Velocity (ΔV) Word 1: TBD Word 2: TBD Word 3: TBD
Spacecraft Mass Word 1: Mass before maneuver Word 2: Mass after maneuver
FILLER
<Zero Fill>

Table 9. AMSU-A level 1-b header record

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
SCAN LINE INFORMATION								
Scan Line Number *(cumulative, starting with 1)*	1	2	u	2	1	0		
Scan Line Year *(four digits, e.g., 2000)*	3	4	u	2	1	0		
Scan Line Day of Year *(e.g., 365)*	5	6	u	2	1	0		
Satellite Clock Drift Delta	7	8	i	2	1	0	milliseconds	
Scan Line UTC Time of Day	9	12	u	4	1	0	milliseconds	
Scan Line Bit Field bit 15: satellite direction (0=northbound; 1=southbound) bit 14: clock drift correction (0=not corrected; 1=scan time corrected for clock drift) bits 13-0: <zero fill>	13	14	u	2	1	0		
Major Frame Count *(cumulative, starting with 1) (NOAA)* or <Zero Fill> *(Metop)*	15	16	u	2	1	0		
<Zero Fill>	17	24	i	4	2	0		
QUALITY INDICATORS								
Quality Indicator Bit Field *(if a bit is on (=1), the statement is true)* bit 31: do not use scan for product generation bit 30: time sequence error detected within this scan (see below) bit 29: data gap precedes this scan bit 28: insufficient data for calibration (see below) bit 27: earth location data not available (see below) bit 26: first good time following a clock update (nominally 0) bit 25: instrument status changed with this scan bits 24-4: <zero fill> bit 3: AMSU sync error detected (NOAA) or <zero fill> (Metop) bit 2: AMSU minor frame error detected (NOAA) or <zero fill> (Metop) bit 1: AMSU major frame error detected (NOAA) or <zero fill> (Metop) bit 0: AMSU parity error detected (NOAA) or <zero fill> (Metop)	25	28	u	4	1	0		
Scan Line Quality Flags [Additional Calibration Problem Code] *(If a bit is on (=1), the statement is true. See "Scan Line Quality Flags [Calibration Problem Code]", below.)* bit 7: scan line was not calibrated because of satellite maneuver (Metop) or <zero fill> (NOAA) bits 6-0: <zero fill>	29	29	u	1	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Scan Line Quality Flags [Time Problem Code] *(If a bit is on (=1), the statement is true. All bits off implies the scan time is as expected.)* bit 7: time field is bad but can probably be inferred from the previous good time bit 6: time field is bad and can't be inferred from the previous good time bit 5: this record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity). This may be associated with a spacecraft clock update. (See bit 26, Quality Indicator Bit Field.) bit 4: start of a sequence that apparently repeats scan times that have been previously accepted bits 3-0: <zero fill>	30	30	u	1	1	0		
Scan Line Quality Flags [Calibration Problem Code] *(If a bit is on (=1), the statement is true. These bits, along with those in "Scan Line Quality Flags [Additional Calibration Problem Code]", complement the channel indicators; all bits set to 0 indicates normal calibration.)* bit 7: scan line was not calibrated because of bad time bit 6: scan line was calibrated using fewer than the preferred number of scan lines because of proximity to start or end of data set or to a data gap bit 5: scan line was not calibrated because of bad or insufficient PRT data bit 4: scan line was calibrated but with marginal PRT data bit 3: some uncalibrated channels on this scan (see channel indicators) bit 2: uncalibrated due to instrument mode bit 1: questionable calibration because of antenna position error of space view bit 0: questionable calibration because of antenna position error of blackbody view	31	31	u	1	1	0		
Scan Line Quality Flags [Earth Location Problem Code] *(If a bit is on (=1), the statement is true. All bits set to 0 implies the earth location was normal.)*	32	32	u	1	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bit 7: not earth located because of bad time; earth location fields zero-filled bit 6: earth location questionable: questionable time code (see time problem flags above) bit 5: earth location questionable: marginal agreement with reasonableness check bit 4: earth location questionable: fails reasonableness check bit 3: earth location questionable because of antenna position check bit 2: <zero fill> bit 1: not earth located because of satellite in-plane maneuver (Metop) or <zero fill> (NOAA) bit 0: not earth located because of satellite out-of-plane maneuver (Metop) or <zero fill> (NOAA)								
Calibration Quality Flags *(all bits off implies a good calibration)* *Word 1: Channel 1* bits 15-9: <zero fill> bit 8: this scan line is either the last one before or the first one after a sudden, anomalous jump (or drop) in calibration counts bit 7: lunar contamination was detected in the space view counts of this channel bit 6: the space view counts of this channel were corrected for lunar contamination when used in the calibration (only applicable if the previous flag [bit 7] is 1; otherwise, zero) bit 5: all bad blackbody view counts for scan line bit 4: all bad space view counts for scan line bit 3: all bad PRTs for this line bit 2: marginal blackbody view counts for this line bit 1: marginal space view counts for this line bit 0: marginal PRT temps on this line *Words 2-15: Channels 2-15 (in order)* *Word 16: <zero fill>*	33	64	u	2	16	0		
<Zero Fill>	65	80	i	4	4	0		
CALIBRATION COEFFICIENTS *Note: The following coefficients are only available in Full Scan mode, otherwise the coefficient fields are <Zero Fill>. Refer to Digital A Telemetry, Digital Housekeeping Word 1 for the current mode.*								
Primary Calibration Ch 1 Second Order Term, a2	81	84	i	4	1	19		
Primary Calibration Ch 1 First Order Term, a1	85	88	i	4	1	13		
Primary Calibration Ch 1 Zeroth Order Term, a0	89	92	i	4	1	9		
Primary Calibration Ch 2 Second Order Term, a2	93	96	i	4	1	19		
Primary Calibration Ch 2 First Order Term, a1	97	100	i	4	1	13		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Primary Calibration Ch 2 Zeroth Order Term, a0	101	104	i	4	1	9		
Primary Calibration Ch 3 Second Order Term, a2	105	108	i	4	1	19		
Primary Calibration Ch 3 First Order Term, a1	109	112	i	4	1	13		
Primary Calibration Ch 3 Zeroth Order Term, a0	113	116	i	4	1	9		
Primary Calibration Ch 4 Second Order Term, a2	117	120	i	4	1	19		
Primary Calibration Ch 4 First Order Term, a1	121	124	i	4	1	13		
Primary Calibration Ch 4 Zeroth Order Term, a0	125	128	i	4	1	9		
Primary Calibration Ch 5 Second Order Term, a2	129	132	i	4	1	19		
Primary Calibration Ch 5 First Order Term, a1	133	136	i	4	1	13		
Primary Calibration Ch 5 Zeroth Order Term, a0	137	140	i	4	1	9		
Primary Calibration Ch 6 Second Order Term, a2	141	144	i	4	1	19		
Primary Calibration Ch 6 First Order Term, a1	145	148	i	4	1	13		
Primary Calibration Ch 6 Zeroth Order Term, a0	149	152	i	4	1	9		
Primary Calibration Ch 7 Second Order Term, a2	153	156	i	4	1	19		
Primary Calibration Ch 7 First Order Term, a1	157	160	i	4	1	13		
Primary Calibration Ch 7 Zeroth Order Term, a0	161	164	i	4	1	9		
Primary Calibration Ch 8 Second Order Term, a2	165	168	i	4	1	19		
Primary Calibration Ch 8 First Order Term, a1	169	172	i	4	1	13		
Primary Calibration Ch 8 Zeroth Order Term, a0	173	176	i	4	1	9		
Primary Calibration Ch 9 Second Order Term, a2	177	180	i	4	1	19		
Primary Calibration Ch 9 First Order Term, a1	181	184	i	4	1	13		
Primary Calibration Ch 9 Zeroth Order Term, a0	185	188	i	4	1	9		
Primary Calibration Ch 10 Second Order Term, a2	189	192	i	4	1	19		
Primary Calibration Ch 10 First Order Term, a1	193	196	i	4	1	13		
Primary Calibration Ch 10 Zeroth Order Term, a0	197	200	i	4	1	9		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Primary Calibration Ch 11 Second Order Term, a2	201	204	i	4	1	19		
Primary Calibration Ch 11 First Order Term, a1	205	208	i	4	1	13		
Primary Calibration Ch 11 Zeroth Order Term, a0	209	212	i	4	1	9		
Primary Calibration Ch 12 Second Order Term, a2	213	216	i	4	1	19		
Primary Calibration Ch 12 First Order Term, a1	217	220	i	4	1	13		
Primary Calibration Ch 12 Zeroth Order Term, a0	221	224	i	4	1	9		
Primary Calibration Ch 13 Second Order Term, a2	225	228	i	4	1	19		
Primary Calibration Ch 13 First Order Term, a1	229	232	i	4	1	13		
Primary Calibration Ch 13 Zeroth Order Term, a0	233	236	i	4	1	9		
Primary Calibration Ch 14 Second Order Term, a2	237	240	i	4	1	19		
Primary Calibration Ch 14 First Order Term, a1	241	244	i	4	1	13		
Primary Calibration Ch 14 Zeroth Order Term, a0	245	248	i	4	1	9		
Primary Calibration Ch 15 Second Order Term, a2	249	252	i	4	1	19		
Primary Calibration Ch 15 First Order Term, a1	253	256	i	4	1	13		
Primary Calibration Ch 15 Zeroth Order Term, a0	257	260	i	4	1	9		
Secondary Calibration Ch 1 Second Order Term, a2	261	264	i	4	1	19		
Secondary Calibration Ch 1 First Order Term, a1	265	268	i	4	1	13		
Secondary Calibration Ch 1 Zeroth Order Term, a0	269	272	i	4	1	9		
Secondary Calibration Ch 2 Second Order Term, a2	273	276	i	4	1	19		
Secondary Calibration Ch 2 First Order Term, a1	277	280	i	4	1	13		
Secondary Calibration Ch 2 Zeroth Order Term, a0	281	284	i	4	1	9		
Secondary Calibration Ch 3 Second Order Term, a2	285	288	i	4	1	19		
Secondary Calibration Ch 3 First Order Term, a1	289	292	i	4	1	13		
Secondary Calibration Ch 3 Zeroth Order Term, a0	293	296	i	4	1	9		
Secondary Calibration Ch 4 Second Order Term, a2	297	300	i	4	1	19		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Secondary Calibration Ch 4 First Order Term, a1	301	304	i	4	1	13		
Secondary Calibration Ch 4 Zeroth Order Term, a0	305	308	i	4	1	9		
Secondary Calibration Ch 5 Second Order Term, a2	309	312	i	4	1	19		
Secondary Calibration Ch 5 First Order Term, a1	313	316	i	4	1	13		
Secondary Calibration Ch 5 Zeroth Order Term, a0	317	320	i	4	1	9		
Secondary Calibration Ch 6 Second Order Term, a2	321	324	i	4	1	19		
Secondary Calibration Ch 6 First Order Term, a1	325	328	i	4	1	13		
Secondary Calibration Ch 6 Zeroth Order Term, a0	329	332	i	4	1	9		
Secondary Calibration Ch 7 Second Order Term, a2	333	336	i	4	1	19		
Secondary Calibration Ch 7 First Order Term, a1	337	340	i	4	1	13		
Secondary Calibration Ch 7 Zeroth Order Term, a0	341	344	i	4	1	9		
Secondary Calibration Ch 8 Second Order Term, a2	345	348	i	4	1	19		
Secondary Calibration Ch 8 First Order Term, a1	349	352	i	4	1	13		
Secondary Calibration Ch 8 Zeroth Order Term, a0	353	356	i	4	1	9		
Secondary Calibration Ch 9 Second Order Term, a2	357	360	i	4	1	19		
Secondary Calibration Ch 9 First Order Term, a1	361	364	i	4	1	13		
Secondary Calibration Ch 9 Zeroth Order Term, a0	365	368	i	4	1	9		
Secondary Calibration Ch 10 Second Order Term, a2	369	372	i	4	1	19		
Secondary Calibration Ch 10 First Order Term, a1	373	376	i	4	1	13		
Secondary Calibration Ch 10 Zeroth Order Term, a0	377	380	i	4	1	9		
Secondary Calibration Ch 11 Second Order Term, a2	381	384	i	4	1	19		
Secondary Calibration Ch 11 First Order Term, a1	385	388	i	4	1	13		
Secondary Calibration Ch 11 Zeroth Order Term, a0	389	392	i	4	1	9		
Secondary Calibration Ch 12 Second Order Term, a2	393	396	i	4	1	19		
Secondary Calibration Ch 12 First Order Term, a1	397	400	i	4	1	13		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Secondary Calibration Ch 12 Zeroth Order Term, a0	401	404	i	4	1	9		
Secondary Calibration Ch 13 Second Order Term, a2	405	408	i	4	1	19		
Secondary Calibration Ch 13 First Order Term, a1	409	412	i	4	1	13		
Secondary Calibration Ch 13 Zeroth Order Term, a0	413	416	i	4	1	9		
Secondary Calibration Ch 14 Second Order Term, a2	417	420	i	4	1	19		
Secondary Calibration Ch 14 First Order Term, a1	421	424	i	4	1	13		
Secondary Calibration Ch 14 Zeroth Order Term, a0	425	428	i	4	1	9		
Secondary Calibration Ch 15 Second Order Term, a2	429	432	i	4	1	19		
Secondary Calibration Ch 15 First Order Term, a1	433	436	i	4	1	13		
Secondary Calibration Ch 15 Zeroth Order Term, a0	437	440	i	4	1	9		
<Zero Fill>	441	444	i	2	2	0		
NAVIGATION								
Computed Yaw Steering *(Metop: content defined below)* or <Zero Fill> *(NOAA)* Word 1: Computed roll angle Word 2: Computed pitch angle Word 3: Computed yaw angle	445	450	i	2	3	0	degrees	
Total Applied Attitude Correction Word 1: Roll Word 2: Pitch Word 3: Yaw	451	456	i	2	3	3	degrees	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Navigation Status Bit Field *(bits 20-18 are Metop specific and will contain zero fill for NOAA; bits 11-0 are NOAA specific and will contain zero fill for Metop)* bits 31-21: <zero fill> bit 20-19: yaw steering parameters usage indicator (0=no yaw steering correction; 1=computed parameters from Metop data stream; 2=measured parameters from Metop data stream; 3=computed parameters from AELDS) bit 18: Metop maneuver indicator (0=scan does not occur during a Metop in-plane or out-of-plane maneuver; 1=scan, or some part of it, occurs during a maneuver) bit 17: earth location at the satellite subpoint is accurate and reasonable, i.e., is within tolerance defined by "Nadir Earth Location Tolerance" in header (0=out of tolerance; 1=in tolerance) bit 16: earth location corrected for Euler angles (0=FALSE; 1=TRUE) bits 15-12: earth location indicator (0=earth location available; 1=user ephemeris files greater than 24 hours old; 2=no earth location available) bits 11-8: spacecraft attitude control (0=operating in YGC or NOMINAL mode; 1=operating in another mode; 2=attitude exceeds nominal tolerance; 3=both 1 and 2) bits 7-4: attitude SMODE (0=nominal mode; 1=rate nulling mode; 2=YGC mode; 3=search mode; 4=coast mode) bits 3-0: attitude PWTIP$AC (0=nominal mode/no test; 1=yaw axis test in progress; 2=roll axis test in progress; 3=pitch axis test in progress)	457	460	u	4	1	0		
Time Associated with Euler Angles	461	464	i	4	1	0	seconds	
Euler Angles *(NOTE: For Metop-originated AMSU-A data, this field is also referred to as the measured yaw steering parameters.)* Word 1: Roll Word 2: Pitch Word 3: Yaw	465	470	i	2	3	3	degrees	
Spacecraft Altitude above Reference Ellipsoid	471	472	u	2	1	1	kilometers	
Angular Relationships *(relative azimuth range +/- 180.00 degrees)* Word 1: Solar zenith angle, FOV 1 Word 2: Satellite zenith angle, FOV 1 Word 3: Relative azimuth angle, FOV 1 Word 4: Solar zenith angle, FOV 2 … (set of 3 angles every FOV) … Word 90: Relative azimuth angle, FOV 30	473	652	i	2	90	2	degrees	
Earth Location *(north latitude and east longitude are positive)*	653	892	i	4	60	4	degrees	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Latitude, FOV 1 Word 2: Longitude, FOV 1 Word 3: Latitude, FOV 2 ... (lat/lon word pair every FOV) ... Word 60: Longitude, FOV 30								
<Zero Fill>	893	896	i	4	1	0		
AMSU-A1 DIGITAL A TELEMETRY								
Synchronization Sequence *(hex FF)*	897	899	u	1	3	0		
Unit Identification and Serial Number 5=PFM, s/n 102 (NOAA-L) 9=FM 1, s/n 103 (NOAA-K) 13=FM 2, s/n 104 (NOAA-M) 17=FM 3, s/n 105 (NOAA-N') 21=FM 4, s/n 106 (Metop-1) 25=FM 5, s/n 107 (Metop-2) 33=FM 7, s/n 109 (NOAA-N)	900	900	u	1	1	0		
Digital Housekeeping *Word 1: Data 1* bit 7: <zero fill> bit 6: cold cal position msb bit 5: cold cal position lsb (cold cal position: 0=6.667 deg from -Z; 1=8.333 deg; 2=9.999 deg; 3=13.332 deg) bit 4: nadir mode (0=not in nadir; 1=nadir) bit 3: cold cal mode (0=not in cold cal; 1=cold cal) bit 2: warm cal mode (0=not in warm cal; 1=warm cal) bit 1: full scan mode (0=not full scan; 1=full scan) bit 0: <zero fill> *Word 2: Data 2* bits 7-5: <zero fill> bit 4: survival heater power (0=off; 1=on) bit 3: PLL power (0=redundant; 1=primary) bit 2: scanner A1-2 power (0=off; 1=on) bit 1: scanner A1-1 power (0=off; 1=on) bit 0: <zero fill> *Words 3-4: <Zero Fill>*	901	904	u	1	4	0		
Scene Telemetry *(Scanner is parked at warm cal position while in warm cal mode, cold cal position while in cold cal mode, and nadir position while in nadir mode (see Digital Housekeeping Word 1, above). In parked modes, words 1 through 17 are repeated 29 times for a total of 30 data sets at the designated scanner position. In full scan mode, the scanner is stepped from positions 1 to 30 as indicated.)*	905	1924	u	2	510	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Reflector A1-1, position 1, first reading Word 2: Reflector A1-2, position 1, first reading Word 3: Reflector A1-1, position 1, second reading Word 4: Reflector A1-2, position 1, second reading Words 5-17: Scene count at position 1, channels 3 through 15 (in order) Word 18: Reflector A1-1, position 2, first reading ... (17 words every position) ... Words 498-510: Scene count at position 30, channels 3 through 15 (in order)								
Cold Calibration Telemetry *(These words are zero-filled in warm cal, cold cal, and nadir modes. In full scan mode, these words contain the following data.)* Word 1: Reflector A1-1, cold calibration position, first reading Word 2: Reflector A1-2, cold calibration position, first reading Word 3: Reflector A1-1, cold calibration position, second reading Word 4: Reflector A1-2, cold calibration position, second reading Words 5-17: Cold cal count 1, channels 3 through 15 (in order) Words 18-30: Cold cal count 2, channels 3 through 15 (in order)	1925	1984	u	2	30	0	counts	
Temperature Sensor Telemetry Word 1: Scan motor A1-1 Word 2: Scan motor A1-2 Word 3: Feed horn A1-1 Word 4: Feed horn A1-2 Word 5: RF mux A1-1 Word 6: RF mux A1-2 Words 7-12: Local oscillator channels 3 - 8 Word 13: Local oscillator channel 15 Word 14: PLL LO #2 Channels 9 - 14 Word 15: PLL LO #1 Channels 9 - 14 Word 16: PLLO (reference oscillator) (NOAA-KLM) or <zero fill> (NOAA-NN', Metop) Words 17-22: Mixer/IF amplifier channels 3 - 8 Word 23: Mixer/IF amplifier channel 9/14 Word 24: Mixer/IF amplifier channel 15 Word 25: IF amplifier channel 11/14 Words 26-28: IF amplifier channels 9 - 11 Word 29: DC/DC converter Words 30-31: IF amplifier channels 13 - 14 Word 32: IF amplifier channel 12 Word 33: RF shelf A1-1 Word 34: RF shelf A1-2 Word 35: Detector/preamplifier assembly Words 36-39: A1-1 warm load 1 - 4 Word 40: A1-1 warm load center Words 41-44: A1-2 warm load 1 - 4 Word 45: A1-2 warm load center Word 46: Reference voltage	1985	2076	u	2	46	0	counts	4

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Warm Calibration Telemetry *(These words are zero-filled in warm cal, cold cal, and nadir modes. In full scan mode, these words contain the following data.)* Word 1: Reflector A1-1, warm calibration position, first reading Word 2: Reflector A1-2, warm calibration position, first reading Word 3: Reflector A1-1, warm calibration position, second reading Word 4: Reflector A1-2, warm calibration position, second reading Words 5-17: Warm cal count 1, channels 3 through 15 (in order) Words 18-30: Warm cal count 2, channels 3 through 15 (in order)	2077	2136	u	2	30	0	counts	
<Zero Fill>	2137	2140	i	4	1	0		
AMSU-A1 DIGITAL B TELEMETRY								
Digital B Telemetry Update Flags *(If bit = 1, associated telemetry item was not updated during most recent minor frame cycle - possibly due to lost frame.)* bit 15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position bit 11: antenna in cold cal position bit 10: antenna in warm cal position bit 9: full scan mode bits 8-6: <zero fill> bit 5: module power bit 4: survival heater bit 3: phase lock loop bit 2: scanner A1-2 power bit 1: scanner A1-1 power bit 0: <zero fill>	2141	2142	u	2	1	0		
Digital B Telemetry for AMSU-A1 ** If bits 9-12 are all set to 0, the instrument is either in the warm calibration position (NOAA-KLM) or operating in "NO" mode (NOAA-NN', Metop). When in "NO" mode, digital A telemetry, analog telemetry, and bits 3, 13, and 14 of the digital B telemetry should be ignored.* ** For cold cal position bits 13 and 14: 0=6.667; 1=8.333; 2=9.999; 3=13.332 degrees from -Z.*	2143	2144	u	2	1	0		1

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bit 15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position (0=no; 1=yes) bit 11: antenna in cold cal position (0=no; 1=yes) bit 10: antenna in warm cal position (0=no; 1=yes) bit 9: full scan (0=no; 1=yes) bits 8-6: <zero fill> bit 5: module power (0=disconnect; 1=connect) bit 4: survival heater (0=off; 1=on) bit 3: phase lock loop (0=redundant; 1=primary) bit 2: scanner A1-2 power (0=off; 1=on) bit 1: scanner A1-1 power (0=off; 1=on) bit 0: <zero fill>								
<Zero Fill>	2145	2148	i	4	1	0		
AMSU-A1 ANALOG TELEMETRY								
Analog Telemetry Update Flags *(If bit = 1, associated telemetry item was not updated during most recent minor frame cycle - possibly due to lost frame.)* bits 31-28: <zero fill> bit 27: GDO voltage 89.0 GHz ch. 15 bit 26: PLLO redundant lock detect bit 25: PLLO primary lock detect bit 24: LO voltage 55.5 GHz ch. 8 bit 23: LO voltage 54.94 GHz ch. 7 bit 22: LO voltage 54.4 GHz ch. 6 bit 21: LO voltage 53.596 GHz ch. 5 bit 20: LO voltage 52.8 GHz ch. 4 bit 19: LO voltage 50.3 GHz ch. 3 bit 18: -15 VDC phase lock loop ch. 9/14 bit 17: +15 VDC phase lock loop ch. 9/14 bit 16: +8.5 VDC phase lock loop ch. 9/14 (NOAA-KLM) or +10 VDC receiver mixer/IF (NOAA-NN', Metop) bit 15: +5 VDC (antenna drive) bit 14: +5 VDC (signal processing) bit 13: +8 VDC (receiver amplifiers) bit 12: -15 VDC (antenna drive) bit 11: -15 VDC (signal processing) bit 10: +15 VDC (antenna drive) bit 9: +15 VDC (signal processing) bit 8: antenna A1-2 drive motor current (avg) bit 7: antenna A1-1 drive motor current (avg) bit 6: warm load A1-2 temperature bit 5: warm load A1-1 temperature bit 4: RF shelf A1-2 temperature bit 3: RF shelf A1-1 temperature bit 2: A1-2 scanner motor temperature bit 1: A1-1 scanner motor temperature bit 0: <zero fill>	2149	2152	u	4	1	0		3

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
A1 Analog Telemetry *(range: 0 - 255)* Word 1: A1-1 scanner motor temperature Word 2: A1-2 scanner motor temperature Word 3: RF shelf A1-1 temperature Word 4: RF shelf A1-2 temperature Word 5: Warm load A1-1 temperature Word 6: Warm load A1-2 temperature Word 7: Antenna A1-1 drive motor current (Avg) Word 8: Antenna A1-2 drive motor current (Avg) Word 9: +15 VDC (signal processing) Word 10: +15 VDC (antenna drive) Word 11: -15 VDC (signal processing) Word 12: -15 VDC (antenna drive) Word 13: +8 VDC (receiver amplifiers) Word 14: +5 VDC (signal processing) Word 15: +5 VDC (antenna drive) Word 16: +8.5 VDC phase lock loop ch. 9/14 (NOAA-KLM) or +10 VDC receiver mixer/IF (NOAA-NN', Metop) Word 17: +15 VDC phase lock loop ch. 9/14 Word 18: -15 VDC phase lock loop ch. 9/14 Word 19: LO voltage 50.3 Ghz ch. 3 Word 20: LO voltage 52.8 Ghz ch. 4 Word 21: LO voltage 53.596 Ghz ch. 5 Word 22: LO voltage 54.4 Ghz ch. 6 Word 23: LO voltage 54.94 Ghz ch. 7 Word 24: LO voltage 55.5 Ghz ch. 8 Word 25: PLLO primary lock detect Word 26: PLLO redundant lock detect Word 27: GDO voltage 89.0 Ghz ch. 15 Word 28: <zero fill>	2153	2180	u	1	28	0	counts	3
<Zero Fill>	2181	2184	i	4	1	0		
AMSU-A2 DIGITAL A TELEMETRY								
Synchronization Sequence *(hex FF)*	2185	2187	u	1	3	0		
Unit Identification and Serial Number 6=PFM, s/n 102 (NOAA-K) 10=flight model (FM) 1, s/n 103 (NOAA-L) 14=FM 2, s/n 104 (NOAA-M) 18=FM 3, s/n 105 (NOAA-N) 22=FM 4, s/n 106 (Metop-1) 26=FM 5, s/n 107 (NOAA-N') 34=FM 7, s/n 109 (Metop-2)	2188	2188	u	1	1	0		
Digital Housekeeping	2189	2192	u	1	4	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Data 1 bit 7: <zero fill> bit 6: cold cal position msb bit 5: cold cal position lsb bit 4: nadir mode (0=not in nadir; 1=nadir) bit 3: cold cal mode (0=not in cold cal; 1=cold cal) bit 2: warm cal mode (0=not in warm cal; 1=warm cal) bit 1: full scan mode (0=not full scan; 1=full scan) bit 0: <zero fill> *Word 2: Data 2* bits 7-5: <zero fill> bit 4: survival heater power (0=off; 1=on) bit 3: <zero fill> bit 2: scanner compensator power (0=off; 1=on) bit 1: scanner A2 power (0=off; 1=on) bit 0: <zero fill> *Word 3: <Zero Fill>*								
Scene Telemetry *(Scanner is parked at warm cal position while in warm cal mode, cold cal position while in cold cal mode, and nadir position while in nadir mode (see Digital Housekeeping Word 1, above). In parked modes, words 1 through 4 are repeated 29 times for a total of 30 data sets at the designated scanner position. In full scan mode, the scanner is stepped from positions 1 to 30 as indicated.)* Word 1: Reflector, position 1, first reading Word 2: Reflector, position 1, second reading Words 3-4: Scene count at position 1, Channels 1 and 2 (in order) Word 5: Reflector, position 2, first reading … (4 words every position) … Words 119-120: Scene count at position 30, Channels 1 and 2 (in order)	2193	2432	u	2	120	0		
Cold Calibration Telemetry *(These words are zero-filled in warm cal, cold cal, and nadir modes. In full scan mode, these words contain the following data.)* Word 1: Reflector, cold calibration position, first reading Word 2: Reflector, cold calibration position, second reading Words 3-4: Cold cal count 1, channels 1 and 2 Words 5-6: Cold cal count 2, channels 1 and 2	2433	2444	u	2	6	0	counts	
Temperature Sensor Telemetry	2445	2484	u	2	20	0	counts	2,4

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Scan motor Word 2: Feed horn Word 3: RF mux/diplexer Words 4-5: Mixer/IF amplifier channels 1 and 2 Words 6-7: Local oscillator channels 1 and 2 Word 8: Compensation motor Word 9: Subreflector Word 10: DC/DC converter Word 11: RF shelf A2 Word 12: Detector/preamplifier assembly Word 13: Warm load center Words 14-19: Warm load 1 - 6 Word 20: Reference voltage								
Warm Calibration Telemetry *(These words are zero-filled in warm cal, cold cal, and nadir modes. In full scan mode, these words contain the following data.)* Word 1: Reflector, warm calibration position, first reading Word 2: Reflector, warm calibration position, second reading Words 3-4: Warm calibration 1, channels 1 and 2 Words 5-6: Warm calibration 2, channels 1 and 2	2485	2496	u	2	6	0	counts	
<Zero Fill>	2497	2500	i	4	1	0		
AMSU-A2 DIGITAL B TELEMETRY								
Digital B Telemetry Update Flags *(If bit = 1, associated telemetry item was not updated during most recent minor frame cycle - possibly due to lost frame.)* bit 15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position bit 11: antenna in cold cal position bit 10: antenna in warm cal position bit 9: full scan mode bits 8-5: <zero fill> bit 4: survival heater bit 3: module power bit 2: compensator motor bit 1: scanner A2 power bit 0: <zero fill>	2501	2502	u	2	1	0		
Digital B Telemetry for AMSU-A2 * If bits 9-12 are all set to 0, the instrument is either in the warm calibration position (NOAA-KLM) or operating in "NO" mode (NOAA-NN', Metop). When in "NO" mode, digital A telemetry, analog telemetry, and bits 13 and 14 of the digital B telemetry should be ignored. * For cold cal position bits 13 and 14: 0=6.667; 1=8.333; 2=9.999; 3=13.332 degrees from -Z.	2503	2504	u	2	1	0		1

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bit 15: <zero fill> bit 14: cold cal position, msb bit 13: cold cal position, lsb bit 12: antenna in nadir position (0=no; 1=yes) bit 11: antenna in cold cal position (0=no; 1=yes) bit 10: antenna in warm cal position (0=no; 1=yes) bit 9: full scan mode (0=no; 1=yes) bits 8-5: <zero fill> bit 4: survival heater (0=off; 1=on) bit 3: module power (0=disconnect; 1=connect) bit 2: compensator motor (0=off; 1=on) bit 1: scanner A2 power (0=off; 1=on) bit 0: <zero fill>								
<Zero Fill>	2505	2508	i	4	1	0		
AMSU-A2 ANALOG TELEMETRY DATA								
Analog Telemetry Update Flags *(If bit = 1, associated telemetry item was not updated during most recent minor frame cycle - possibly due to lost frame.)* bits 31-16: <zero fill> bit 15: LO voltage ch. 2 (31.4 GHz) bit 14: LO voltage ch. 1 (23.8 GHz) bit 13: +5 VDC (antenna drive) bit 12: +5 VDC (signal processing) bit 11: +8 VDC (receiver) (NOAA-KLM) or +10 VDC (receiver/mixer/IF) (NOAA-NN', Metop) bit 10: -15 VDC (antenna drive) bit 9: -15 VDC (signal processing) bit 8: +15 VDC (antenna drive) bit 7: +15 VDC (signal processing) bit 6: antenna drive motor current (avg) bit 5: compensator motor current (avg) bit 4: warm load A2 temperature bit 3: RF shelf temperature bit 2: compensator motor temperature bit 1: scanner motor temperature bit 0: <zero fill>	2509	2512	u	4	1	0		3
A2 Analog Telemetry *(range: 0 - 255)* Word 1: Scanner motor temperature Word 2: Compensator motor temperature Word 3: RF shelf temperature Word 4: Warm load A2 temperature Word 5: Compensator motor current (Avg) Word 6: Antenna drive motor current (Avg) Word 7: +15 VDC (signal processing) Word 8: +15 VDC (antenna drive) Word 9: -15 VDC (signal processing) Word 10: -15 VDC (antenna drive) Word 11: +8 VDC (receiver) (NOAA-KLM) or +10 VDC (receiver/mixer/IF) (NOAA-NN', Metop) Word 12: +5 VDC (signal processing) Word 13: +5 VDC (antenna drive) Word 14: LO voltage ch. 1 (23.8 GHz) Word 15: LO voltage ch. 2 (31.4 GHz) Word 16: <zero fill>	2513	2528	u	1	16	0	counts	3

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
LUNAR CONTAMINATION CORRECTION								
Space View Count Corrections, ΔC_c *ΔC_c = raw space count - corrected space count. If the ΔC_c value is subtracted from the raw space counts, the value of the corrected space counts used in the calibration is obtained. A value of $\Delta C_c = 0$ indicates that no correction was made. NOTE: The raw space counts are the "cold cal" counts of the "Cold Calibration Telemetry" fields. Range: 0 - 100* Word 1: ΔC_c for channel 1 Words 2-15: ΔC_c's for channels 2-15, in order	2529	2543	u	1	15	0	counts	
<Zero Fill>	2544	2544	i	1	1	0		
Lunar Azimuth Angles *(with respect to the space view position of each AMSU-A antenna; range: -180 to +180)* Word 1: Angle for A1-1 antenna Word 2: Angle for A1-2 antenna Word 3: Angle for A2 antenna	2545	2550	i	2	3	2	degrees	
Lunar Elevation Angles *(with respect to the space view position of each AMSU-A antenna; range: -90 to +90)* Word 1: Angle for A1-1 antenna Word 2: Angle for A1-2 antenna Word 3: Angle for A2 antenna	2551	2556	i	2	3	2	degrees	
FILLER								
<Zero Fill>	2557	2560	i	4	1	0		

Table 10. AMSU level 1-b data record

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
FILE IDENTIFICATION								
Data Set Creation Site ID CMS=Centre de Meteorologie Spatiale/France DSS=Dundee Satellite Receiving Station/UK NSS=National Environmental Satellite, Data and Information Service/USA UKM=United Kingdom Meteorological Office/UK	1	3	c	3	1	0		
<ASCII blank = x20>	4	4	c	1	1	0		
Level 1b Format Version Number	5	6	u	2	1	0		
Level 1b Format Version Year *(four digits, e.g., 2000)*	7	8	u	2	1	0		
Level 1b Format Version Day of Year *(e.g., 365)*	9	10	u	2	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
<Reserved for Logical Record Length> *(For Creation Site use only. Logical Record Length of source 1b data set prior to processing.)*	11	12	u	2	1	0	octets	
<Reserved for Block Size> *(For Creation Site use only. Block Size of source 1b data set prior to processing.)*	13	14	u	2	1	0	octets	
Count of Header Records in this Data Set	15	16	u	2	1	0		
<Zero Fill>	17	22	i	2	3	0		
Data Set Name	23	64	c	42	1	0		
Processing Block Identification	65	72	c	8	1	0		
Spacecraft Identification Code 7=NOAA-N 8=NOAA-N' 11=Metop-1 (TBC) 12=Metop-2 (TBC)	73	74	u	2	1	0		
Instrument ID 0=proto-flight model (PFM) (NOAA-N) 2=FM2 (NOAA-N') 3=FM3 (Metop-2) 4=FM4 (Metop-1) 5=FM5 (Metop-3)	75	76	u	2	1	0		
Data Type Code 12=MHS	77	78	u	2	1	0		
TIP Source Code *(NOAA: values defined below)* or <Zero Fill> *(Metop)* 0=unused, i.e., GAC/HRPT/LAC data 1=GAC-embedded AMSU and TIP 2=stored TIP (STIP) 3=HRPT/LAC-embedded AMSU and TIP 4=stored AIP (SAIP)	79	80	u	2	1	0		
Start of Data Set Day Count starting from 0 at 00h, 1 Jan 1950	81	84	u	4	1	0		
Start of Data Set Year *(four digits, e.g., 2000)*	85	86	u	2	1	0		
Start of Data Set Day of Year *(e.g., 365)*	87	88	u	2	1	0		
Start of Data Set UTC Time of Day	89	92	u	4	1	0	milliseconds	
End of Data Set Day Count starting from 0 at 00h, 1 Jan 1950	93	96	u	4	1	0		
End of Data Set Year *(four digits, e.g., 2000)*	97	98	u	2	1	0		
End of Data Set Day of Year *(e.g., 365)*	99	100	u	2	1	0		
End of Data Set UTC Time of Day	101	104	u	4	1	0	milliseconds	
Year of Last CPIDS Update *(four digits, e.g., 2000)*	105	106	u	2	1	0		
Day of Year of Last CPIDS Update *(e.g., 365)*	107	108	u	2	1	0		
Offset between Start of Scan and Center of First FOV	109	110	i	2	1	0	milliseconds	
<Zero Fill>	111	120	i	2	5	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
DATA SET QUALITY INDICATORS								
Instrument Status *(These are bit flags taken from "Mode and Sub-commutation Code" field and "Switch Status" field on first data record for which all of the individual status flags have been reported at least once.)* bits 31-28: mode code (0=power on; 1=warm up; 2=stand by; 3=scan; 4=fixed view; 5=self test; 6=safeing; 7=fault; 8-14=<unused>; 15=memory data packet ID) bit 27: PIE ID (0=PIE A; 1=PIE B) bits 26-24: sub-commutation code (only meaningful for telemetry packet data) bit 23: receiver channel H4 backend (0=off; 1=on) bit 22: receiver channel H3 backend (0=off; 1=on) bit 21: receiver channel H3/H4 local oscillator selected (0=A; 1=B) bit 20: receiver channel H3/H4 front-end (0=off; 1=on) bit 19: receiver channel H2 local oscillator selected (0=A; 1=B) bit 18: receiver channel H2 (0=off; 1=on) bit 17: receiver channel H1 local oscillator selected (0=A; 1=B) bit 16: receiver channel H1 (0=off; 1=on) bit 15: PROM (1=a PROM segment switch has failed ON) bit 14: signal processing electronics/scan control electronics (0=off; 1=on) bit 13: auxiliary operational heaters (0=off; 1=on) bit 12: scan mechanism operational heaters (0=off; 1=on) bit 11: receiver operational heaters (0=off; 1=on) bit 10: Rx CV (0=off; 1=on) bit 9: receiver channel H5 local oscillator selected (0=A; 1=B) bit 8: receiver channel H5 (0=off; 1=on) bit 7: FDM motor current trip status (0=enabled; 1=disabled) bit 6: RDM motor current trip status (0=enabled; 1=disabled) bit 5: FDM motor supply (0=off; 1=on) bit 4: RDM motor supply (0=off; 1=on) bit 3: FDM motor sensors selected (0=A; 1=B) bit 2: RDM motor sensors selected (0=A; 1=B) bit 1: FDM zero position sensors (0=A; 1=B) bit 0: RDM zero position sensors (0=A; 1=B)	121	124	u	4	1	0		
<Zero Fill>	125	126	i	2	1	0		
Record Number of Status Change *(if 0, none occurred)*	127	128	u	2	1	0		
Second Instrument Status *(if previous word is 0, no change)*	129	132	u	4	1	0		
Count of Data Records in this Data Set	133	134	u	2	1	0		
Count of Calibrated, Earth Located Scan Lines in this Data Set	135	136	u	2	1	0		
Count of Missing Scan Lines	137	138	u	2	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Count of Data Gaps in this Data Set *(NOTE: Gaps are due to either actual lost data, such as during transmissions, or ignored data when the instrument science data is superceded by other telemetry data during non-nominal modes of the TIP or MIU.)*	139	140	u	2	1	0		
Count of Scans Containing Lunar-Contaminated Space Views *(Also, see bits 1 and 0 of Word 1 of "Scan Line Quality Flags [Calibration Problem Code]" field in data record.)* -1=the detection algorithm for lunar contamination is turned off 0=the detection algorithm is turned on: no scans containing lunar-contaminated space views were found >0=the detection algorithm is turned on: the value in this field represents the number of scans found that contain lunar-contaminated space views	141	142	i	2	1	0		
Count of Data Frames Without Frame Sync Word Errors *(NOAA)* or <Zero Fill> *(Metop)*	143	144	u	2	1	0		
Count of PACS Detected TIP Parity Errors *(NOAA)* or <Zero Fill> *(Metop)*	145	146	u	2	1	0		
Sum of All Auxiliary Sync Errors Detected in the Input Data *(NOAA)* or <Zero Fill> *(Metop)*	147	148	u	2	1	0		
Time Sequence Error 0=none; otherwise, the record number of the first occurrence	149	150	u	2	1	0		
Time Sequence Error Code *(These are bit flags taken from "Scan Line Quality Flags [Time Problem Code]" on data record reported in "Time Sequence Error" field above. If a bit is on (=1) then the statement is true.)* bits 15-8: <zero fill> bit 7: time field is bad but can probably be inferred from the previous good time bit 6: time field is bad and can't be inferred from the previous good time bit 5: this record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity); may be associated with a spacecraft clock update bit 4: start of a sequence that apparently repeats scan times that have been previously accepted bits 3-0: <zero fill>	151	152	u	2	1	0		
SOCC Clock Update Indicator 0=none during this orbit; otherwise, the record number of the first occurrence	153	154	u	2	1	0		
Earth Location Error Indicator 0=none during this orbit; otherwise, the record number of the first occurrence	155	156	u	2	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Earth Location Error Code *(These are bit flags taken from "Scan Line Quality Flags [Earth Location Problem Code]" on data record reported in "Earth Location Error Indicator" field above. If a bit is on (=1) then the statement is true.)* bits 15-8: <zero fill> bit 7: not earth located because of bad time; earth location fields zero-filled bit 6: earth location questionable: questionable time code bit 5: earth location questionable: marginal agreement with reasonableness check bit 4: earth location questionable: fails reasonableness check bit 3: earth location questionable because of antenna position check bit 2: <zero fill> bit 1: not earth located because of satellite in-plane maneuver (Metop) or <zero fill> (NOAA) bit 0: not earth located because of satellite out-of-plane maneuver (Metop) or <zero fill> (NOAA)	157	158	u	2	1	0		
PACS Status Bit Field *(NOAA: value defined below)* or <Zero Fill> *(Metop)* bits 15-3: <zero fill> bit 2: pseudonoise (0=normal data; 1=pseudonoise data) bit 1: tape direction (0=reverse playback, time decrementing) bit 0: data mode (0=test data; 1=flight data)	159	160	u	2	1	0		
Data Source 0=unused 1=Fairbanks, AK 2=Wallops Is., VA 3=SOCC 4=Svalbard, Norway 5=Monterey, CA	161	162	u	2	1	0		
<Reserved for the Ingester>	163	170	c	8	1	0		
<Reserved for Decommutation>	171	178	c	8	1	0		
<Zero Fill>	179	194	i	2	8	0		
CALIBRATION								
Instrument Temperature Sensor ID 0=primary (H5 LO temperature [QBS5]) 1=backup (H1 LO temperature [QBS1])	195	196	i	2	1	0		
<Zero Fill>	197	198	i	2	1	0		
Primary Reference Temperature (from QBS5), Minimum	199	200	i	2	1	2	K	
Primary Reference Temperature (from QBS5), Nominal	201	202	i	2	1	2	K	
Primary Reference Temperature (from QBS5), Maximum	203	204	i	2	1	2	K	
Backup Reference Temperature (from QBS1), Minimum	205	206	i	2	1	2	K	
Backup Reference Temperature (from QBS1), Nominal	207	208	i	2	1	2	K	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Backup Reference Temperature (from QBS1), Maximum	209	210	i	2	1	2	K	
Ch. H1 Warm Load Correction Factor (minimum temperature)	211	212	i	2	1	3	K	
Ch. H1 Warm Load Correction Factor (nominal temperature)	213	214	i	2	1	3	K	
Ch. H1 Warm Load Correction Factor (maximum temperature)	215	216	i	2	1	3	K	
Ch. H1 Cold Space Temperature Correction (profile 0)	217	218	i	2	1	3	K	
Ch. H1 Cold Space Temperature Correction (profile 1)	219	220	i	2	1	3	K	
Ch. H1 Cold Space Temperature Correction (profile 2)	221	222	i	2	1	3	K	
<Reserved for Profile 3>	223	224	i	2	1	0		
Ch. H2 Warm Load Correction Factor (minimum temperature)	225	226	i	2	1	3	K	
Ch. H2 Warm Load Correction Factor (nominal temperature)	227	228	i	2	1	3	K	
Ch. H2 Warm Load Correction Factor (maximum temperature)	229	230	i	2	1	3	K	
Ch. H2 Cold Space Temperature Correction (profile 0)	231	232	i	2	1	3	K	
Ch. H2 Cold Space Temperature Correction (profile 1)	233	234	i	2	1	3	K	
Ch. H2 Cold Space Temperature Correction (profile 2)	235	236	i	2	1	3	K	
<Reserved for Profile 3>	237	238	i	2	1	0		
Ch. H3 Warm Load Correction Factor (minimum temperature)	239	240	i	2	1	3	K	
Ch. H3 Warm Load Correction Factor (nominal temperature)	241	242	i	2	1	3	K	
Ch. H3 Warm Load Correction Factor (maximum temperature)	243	244	i	2	1	3	K	
Ch. H3 Cold Space Temperature Correction (profile 0)	245	246	i	2	1	3	K	
Ch. H3 Cold Space Temperature Correction (profile 1)	247	248	i	2	1	3	K	
Ch. H3 Cold Space Temperature Correction (profile 2)	249	250	i	2	1	3	K	
<Reserved for Profile 3>	251	252	i	2	1	0		
Ch. H4 Warm Load Correction Factor (minimum temperature)	253	254	i	2	1	3	K	
Ch. H4 Warm Load Correction Factor (nominal temperature)	255	256	i	2	1	3	K	
Ch. H4 Warm Load Correction Factor (maximum temperature)	257	258	i	2	1	3	K	
Ch. H4 Cold Space Temperature Correction (profile 0)	259	260	i	2	1	3	K	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Ch. H4 Cold Space Temperature Correction (profile 1)	261	262	i	2	1	3	K	
Ch. H4 Cold Space Temperature Correction (profile 2)	263	264	i	2	1	3	K	
<Reserved for Profile 3>	265	266	i	2	1	0		
Ch. H5 Warm Load Correction Factor (minimum temperature)	267	268	i	2	1	3	K	
Ch. H5 Warm Load Correction Factor (nominal temperature)	269	270	i	2	1	3	K	
Ch. H5 Warm Load Correction Factor (maximum temperature)	271	272	i	2	1	3	K	
Ch. H5 Cold Space Temperature Correction (profile 0)	273	274	i	2	1	3	K	
Ch. H5 Cold Space Temperature Correction (profile 1)	275	276	i	2	1	3	K	
Ch. H5 Cold Space Temperature Correction (profile 2)	277	278	i	2	1	3	K	
<Reserved for Profile 3>	279	280	i	2	1	0		
LO A Ch. H1 Nonlinearity Coefficient (minimum temperature)	281	284	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H1 Nonlinearity Coefficient (nominal temperature)	285	288	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H1 Nonlinearity Coefficient (maximum temperature)	289	292	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H2 Nonlinearity Coefficient (minimum temperature)	293	296	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H2 Nonlinearity Coefficient (nominal temperature)	297	300	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H2 Nonlinearity Coefficient (maximum temperature)	301	304	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H3 Nonlinearity Coefficient (minimum temperature)	305	308	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H3 Nonlinearity Coefficient (nominal temperature)	309	312	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H3 Nonlinearity Coefficient (maximum temperature)	313	316	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H4 Nonlinearity Coefficient (minimum temperature)	317	320	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H4 Nonlinearity Coefficient (nominal temperature)	321	324	i	4	1	8	M^2-sr-cm^{-1}/mW	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
LO A Ch. H4 Nonlinearity Coefficient (maximum temperature)	325	328	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H5 Nonlinearity Coefficient (minimum temperature)	329	332	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H5 Nonlinearity Coefficient (nominal temperature)	333	336	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO A Ch. H5 Nonlinearity Coefficient (maximum temperature)	337	340	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H1 Nonlinearity Coefficient (minimum temperature)	341	344	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H1 Nonlinearity Coefficient (nominal temperature)	345	348	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H1 Nonlinearity Coefficient (maximum temperature)	349	352	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H2 Nonlinearity Coefficient (minimum temperature)	353	356	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H2 Nonlinearity Coefficient (nominal temperature)	357	360	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H2 Nonlinearity Coefficient (maximum temperature)	361	364	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H3 Nonlinearity Coefficient (minimum temperature)	365	368	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H3 Nonlinearity Coefficient (nominal temperature)	369	372	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H3 Nonlinearity Coefficient (maximum temperature)	373	376	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H4 Nonlinearity Coefficient (minimum temperature)	377	380	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H4 Nonlinearity Coefficient (nominal temperature)	381	384	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H4 Nonlinearity Coefficient (maximum temperature)	385	388	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H5 Nonlinearity Coefficient (minimum temperature)	389	392	i	4	1	8	M^2-sr-cm^{-1}/mW	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
LO B Ch. H5 Nonlinearity Coefficient (nominal temperature)	393	396	i	4	1	8	M^2-sr-cm^{-1}/mW	
LO B Ch. H5 Nonlinearity Coefficient (maximum temperature)	397	400	i	4	1	8	M^2-sr-cm^{-1}/mW	
<Zero Fill>	401	416	i	4	4	0		
TEMPERATURE-RADIANCE CONVERSION								
Temperature-radiance Ch H1 Central Wavenumber	417	420	i	4	1	6	cm^{-1}	
Temperature-radiance Ch H1 Constant 1	421	424	i	4	1	6		
Temperature-radiance Ch H1 Constant 2	425	428	i	4	1	6		
Temperature-radiance Ch H2 Central Wavenumber	429	432	i	4	1	6	cm^{-1}	
Temperature-radiance Ch H2 Constant 1	433	436	i	4	1	6		
Temperature-radiance Ch H2 Constant 2	437	440	i	4	1	6		
Temperature-radiance Ch H3 Central Wavenumber	441	444	i	4	1	6	cm^{-1}	
Temperature-radiance Ch H3 Constant 1	445	448	i	4	1	6		
Temperature-radiance Ch H3 Constant 2	449	452	i	4	1	6		
Temperature-radiance Ch H4 Central Wavenumber	453	456	i	4	1	6	cm^{-1}	
Temperature-radiance Ch H4 Constant 1	457	460	i	4	1	6		
Temperature-radiance Ch H4 Constant 2	461	464	i	4	1	6		
Temperature-radiance Ch H5 Central Wavenumber	465	468	i	4	1	6	cm^{-1}	
Temperature-radiance Ch H5 Constant 1	469	472	i	4	1	6		
Temperature-radiance Ch H5 Constant 2	473	476	i	4	1	6		
<Zero Fill>	477	492	i	4	4	0		
NAVIGATION								
Reference Ellipsoid Model ID *(The ellipsoid is a mathematically tractable approximation of the geoid, which is an equipotential surface at mean sea level. The maximum departure of the ellipsoid from the geoid is approximately +/- 65 meters.)* WGS-72=World Geodetic Survey 1972	493	500	c	8	1	0		
Nadir Earth Location Tolerance	501	502	u	2	1	1	kilometers	
Earth Location Bit Field bits 15-3: <zero fill> bit 2: dynamic attitude error correction (0=not performed; 1=performed) bit 1: reasonableness test (0=inactive; 1=active) bit 0: constant attitude error correction (0=not performed; 1=performed)	503	504	u	2	1	0		
<Zero Fill>	505	506	i	2	1	0		
Constant Roll Attitude Error	507	508	i	2	1	3	degrees	

Field Name	**Start Octet**	**End Octet**	**Data Type**	**Word Size**	**Number of Words**	**Scale Factor**	**Units**	**Notes**
Constant Pitch Attitude Error	509	510	i	2	1	3	degrees	
Constant Yaw Attitude Error	511	512	i	2	1	3	degrees	
Epoch Year for Orbit Vector	513	514	u	2	1	0		
Day of Epoch Year for Orbit Vector	515	516	u	2	1	0		
Epoch UTC Time of Day for Orbit Vector	517	520	u	4	1	0	milliseconds	
Semi-major Axis *(at the orbit vector epoch time)*	521	524	i	4	1	5	kilometers	
Eccentricity *(at the orbit vector epoch time)*	525	528	i	4	1	8		
Inclination *(at the orbit vector epoch time)*	529	532	i	4	1	5	degrees	
Argument of Perigee *(at the orbit vector epoch time)*	533	536	i	4	1	5	degrees	
Right Ascension of the Ascending Node *(at the orbit vector epoch time)*	537	540	i	4	1	5	degrees	
Mean Anomaly *(at the orbit vector epoch time)*	541	544	i	4	1	5	degrees	
Position Vector X Component *(at the orbit vector epoch time)*	545	548	i	4	1	5	kilometers	
Position Vector Y Component *(at the orbit vector epoch time)*	549	552	i	4	1	5	kilometers	
Position Vector Z Component *(at the orbit vector epoch time)*	553	556	i	4	1	5	kilometers	
Velocity Vector X-dot Component *(at the orbit vector epoch time)*	557	560	i	4	1	8	km/second	
Velocity Vector Y-dot Component *(at the orbit vector epoch time)*	561	564	i	4	1	8	km/second	
Velocity Vector Z-dot Component *(at the orbit vector epoch time)*	565	568	i	4	1	8	km/second	
Earth/Sun Distance Ratio *(at the orbit vector epoch time; relative to the mean distance of 1 AU)*	569	572	u	4	1	6		
<Zero Fill>	573	588	i	4	4	0		
THERMISTOR TELEMETRY CONVERSION *Counts-to-temperature (K) conversion coefficients for the 24 housekeeping thermistors.*								
Thermistor Temperature Coefficient 0	589	592	i	4	1	4	K	
Thermistor Temperature Coefficient 1	593	596	i	4	1	7	K/count	
Thermistor Temperature Coefficient 2	597	600	i	4	1	10	K/count^2	
Thermistor Temperature Coefficient 3	601	604	i	4	1	12	K/count^3	
Thermistor Temperature Coefficient 4	605	608	i	4	1	15	K/count^4	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
<Zero Fill>	609	624	i	4	4	0		
RAW CURRENT CONSUMPTION CONVERSION								
EE and SM +5V Current Coefficient 0	625	628	i	4	1	6	amps	
EE and SM +5V Current Coefficient 1	629	632	i	4	1	6	amps/ count	
Receiver +8V Current Coefficient 0	633	636	i	4	1	6	amps	
Receiver +8V Current Coefficient 1	637	640	i	4	1	6	amps/ count	
Receiver +15V Current Coefficient 0	641	644	i	4	1	6	amps	
Receiver +15V Current Coefficient 1	645	648	i	4	1	6	amps/ count	
Receiver -15V Current Coefficient 0	649	652	i	4	1	6	amps	
Receiver -15V Current Coefficient 1	653	656	i	4	1	6	amps/ count	
RDM Motor Current Coefficient 0	657	660	i	4	1	6	amps	
RDM Motor Current Coefficient 1	661	664	i	4	1	6	amps/ count	
FDM Motor Current Coefficient 0	665	668	i	4	1	6	amps	
FDM Motor Current Coefficient 1	669	672	i	4	1	6	amps/ count	
OBCT TEMPERATURE CONVERSION *PRT resistance-to-temperature conversion coefficients, where resistance is in ohms and temperature is in K.*								
PIE-A PRT 1 Coefficient 0	673	676	i	4	1	6	K	
PIE-A PRT 1 Coefficient 1	677	680	i	4	1	6	K/ohm	
PIE-A PRT 1 Coefficient 2	681	684	i	4	1	10	K/ohm^2	
PIE-A PRT 1 Coefficient 3	685	688	i	4	1	13	K/ohm^3	
PIE-A PRT 2 Coefficient 0	689	692	i	4	1	6	K	
PIE-A PRT 2 Coefficient 1	693	696	i	4	1	6	K/ohm	
PIE-A PRT 2 Coefficient 2	697	700	i	4	1	10	K/ohm^2	
PIE-A PRT 2 Coefficient 3	701	704	i	4	1	13	K/ohm^3	
PIE-A PRT 3 Coefficient 0	705	708	i	4	1	6	K	
PIE-A PRT 3 Coefficient 1	709	712	i	4	1	6	K/ohm	
PIE-A PRT 3 Coefficient 2	713	716	i	4	1	10	K/ohm^2	
PIE-A PRT 3 Coefficient 3	717	720	i	4	1	13	K/ohm^3	
PIE-A PRT 4 Coefficient 0	721	724	i	4	1	6	K	
PIE-A PRT 4 Coefficient 1	725	728	i	4	1	6	K/ohm	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
PIE-A PRT 4 Coefficient 2	729	732	i	4	1	10	K/ohm^2	
PIE-A PRT 4 Coefficient 3	733	736	i	4	1	13	K/ohm^3	
PIE-A PRT 5 Coefficient 0	737	740	i	4	1	6	K	
PIE-A PRT 5 Coefficient 1	741	744	i	4	1	6	K/ohm	
PIE-A PRT 5 Coefficient 2	745	748	i	4	1	10	K/ohm^2	
PIE-A PRT 5 Coefficient 3	749	752	i	4	1	13	K/ohm^3	
PIE-B PRT 1 Coefficient 0	753	756	i	4	1	6	K	
PIE-B PRT 1 Coefficient 1	757	760	i	4	1	6	K/ohm	
PIE-B PRT 1 Coefficient 2	761	764	i	4	1	10	K/ohm^2	
PIE-B PRT 1 Coefficient 3	765	768	i	4	1	13	K/ohm^3	
PIE-B PRT 2 Coefficient 0	769	772	i	4	1	6	K	
PIE-B PRT 2 Coefficient 1	773	776	i	4	1	6	K/ohm	
PIE-B PRT 2 Coefficient 2	777	780	i	4	1	10	K/ohm^2	
PIE-B PRT 2 Coefficient 3	781	784	i	4	1	13	K/ohm^3	
PIE-B PRT 3 Coefficient 0	785	788	i	4	1	6	K	
PIE-B PRT 3 Coefficient 1	789	792	i	4	1	6	K/ohm	
PIE-B PRT 3 Coefficient 2	793	796	i	4	1	10	K/ohm^2	
PIE-B PRT 3 Coefficient 3	797	800	i	4	1	13	K/ohm^3	
PIE-B PRT 4 Coefficient 0	801	804	i	4	1	6	K	
PIE-B PRT 4 Coefficient 1	805	808	i	4	1	6	K/ohm	
PIE-B PRT 4 Coefficient 2	809	812	i	4	1	10	K/ohm^2	
PIE-B PRT 4 Coefficient 3	813	816	i	4	1	13	K/ohm^3	
PIE-B PRT 5 Coefficient 0	817	820	i	4	1	6	K	
PIE-B PRT 5 Coefficient 1	821	824	i	4	1	6	K/ohm	
PIE-B PRT 5 Coefficient 2	825	828	i	4	1	10	K/ohm^2	
PIE-B PRT 5 Coefficient 3	829	832	i	4	1	13	K/ohm^3	
SURVIVAL TEMPERATURE CONVERSION								

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
*Volts-to-temperature (K) conversion coefficients for the 3 survival temperature parameters. (NOTE: volts = 0.02 * counts.)*								
Survival Temperature Coefficient 0	833	836	i	4	1	6	K	
Survival Temperature Coefficient 1	837	840	i	4	1	6	K/volt	
Survival Temperature Coefficient 2	841	844	i	4	1	6	$K/volt^2$	
Survival Temperature Coefficient 3	845	848	i	4	1	6	$K/volt^3$	
Survival Temperature Coefficient 4	849	852	i	4	1	6	$K/volt^4$	
Survival Temperature Coefficient 5	853	856	i	4	1	6	$K/volt^5$	
ANTENNA POSITION CONVERSION								
Antenna Position Conversion Factor *(for converting "mid-pixel position" data of earth, space, and OBCT views to degrees)* value = 7.2/1024 = 0.00703125 degrees/count	857	860	u	4	1	8	degrees/count	
PRT CALIBRATION CHANNELS								
PIE-A Calibration Channel 1 Resistance	861	864	i	4	1	4	ohms	
PIE-A Calibration Channel 2 Resistance	865	868	i	4	1	4	ohms	
PIE-A Calibration Channel 3 Resistance	869	872	i	4	1	4	ohms	
PIE-B Calibration Channel 1 Resistance	873	876	i	4	1	4	ohms	
PIE-B Calibration Channel 2 Resistance	877	880	i	4	1	4	ohms	
PIE-B Calibration Channel 3 Resistance	881	884	i	4	1	4	ohms	
LUNAR CONTAMINATION DETECTION								
Lunar Angle Threshold *(Any space view whose lunar angle--see "Lunar Angles" field in data record--is less than this value is flagged as being "lunar contaminated" and is not used in the calibration.)*	885	886	u	2	1	2	degrees	
RFI CORRECTION								
Bias Correction Values *(ordered by channel, FOV, and transmitter) (NOAA: content defined below)* or TBD *(Metop)*	887	1726	i	2	420	0	counts	2

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Channel H1, FOV 1, STX_1 Word 2: Channel H2, FOV 1, STX_1 Word 3: Channel H3, FOV 1, STX_1 Word 4: Channel H4, FOV 1, STX_1 Word 5: Channel H5, FOV 1, STX_1 Word 6: Channel H1, FOV 5, STX_1 … (channel values for FOVs 5, 10, 15, … , 90) … Word 95: Channel H5, FOV 90, STX_1 Word 96: Channel H1, space view, STX_1 … Word 100: Channel H5, space view, STX_1 Word 101: Channel H1, OBCT view, STX_1 … Word 106: Channel H1, FOV 1, STX_2 … Word 211: Channel H1, FOV 1, STX_3 … Word 316: Channel H1, FOV 1, SARR … Word 420: Channel H5, OBCT view, SARR								
<Zero Fill>	1727	1734	i	2	4	0		
Transmitter Reference Power *(mean power at the time bias corrections were derived. Range: 0 to 255, representing analog voltages from 0 to 5.1.) (NOAA: content defined below)* or TBD *(Metop)* Word 1: STX-1 Word 2: STX-2 Word 3: STX-3 Word 4: SARR	1735	1742	i	2	4	1	counts	2
<Zero Fill>	1743	1752	i	2	5	0		
METOP MANEUVERS IDENTIFICATION *The fields in this section are Metop specific. For NOAA-originated MHS data, these fields are spare (zero fill).*								
Start of Maneuver Year *(four digits, e.g., 2000)*	1753	1754	u	2	1	0		
Start of Maneuver Day of Year *(e.g., 365)*	1755	1756	u	2	1	0		
Start of Maneuver UTC Time of Day	1757	1760	u	4	1	0	milliseconds	
End of Maneuver Year *(four digits, e.g., 2000)*	1761	1762	u	2	1	0		
End of Maneuver Day of Year *(e.g., 365)*	1763	1764	u	2	1	0		
End of Maneuver UTC Time of Day	1765	1768	u	4	1	0	milliseconds	
Change in Spacecraft Velocity (ΔV) Word 1: TBD Word 2: TBD Word 3: TBD	1769	1780	i	4	3	TBD	TBD	
Spacecraft Mass Word 1: Mass before maneuver Word 2: Mass after maneuver	1781	1788	u	4	2	TBD	TBD	
FILLER								
<Zero Fill>	1789	3072	i	2	642	0		

Table 11. MHS level 1b header record

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
SCAN LINE INFORMATION								
Scan Line Number *(cumulative, starting with 1)*	1	2	u	2	1	0		
Scan Line Year *(four digits, e.g., 2000)*	3	4	u	2	1	0		
Scan Line Day of Year *(e.g., 365)*	5	6	u	2	1	0		
Satellite Clock Drift Delta	7	8	i	2	1	0	milliseconds	
Scan Line UTC Time of Day	9	12	u	4	1	0	milliseconds	
Scan Line Bit Field bit 15: satellite direction (0=northbound; 1=southbound) bit 14: clock drift correction (0=not corrected; 1=scan time corrected for clock drift) bits 13-0: <zero fill>	13	14	u	2	1	0		
Major Frame Count *(cumulative, starting with 1) (NOAA)* or <Zero Fill> *(Metop)*	15	16	u	2	1	0		
Coarse MHS On-board Time (OBT) *(time since last reset to zero)*	17	20	u	4	1	0	seconds	
Fine MHS OBT *(fraction of second since last increment of coarse MHS OBT. Resolution: 2^{-16} seconds; range: 0 - 65,535.)*	21	22	u	2	1	0		
MHS Mode Flag 0=power-on ("empty" MHS science data) 1=warm-up ("empty" MHS science data) 2=standby ("empty" MHS science data) 3=scan (valid MHS science data) 4=fixed view (valid MHS science data, but instrument is viewing a fixed location) 5=self-test (test data) 6=safeing ("empty" MHS science data) 7=fault ("empty" MHS science data) 8-14=<undefined> (unknown data) 15=memory dump (memory dump data)	23	23	u	1	1	0		
<Zero Fill>	24	24	i	1	1	0		
QUALITY INDICATORS								
Quality Indicator Bit Field *(if a bit is on (=1), the statement is true)*	25	28	u	4	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bit 31: do not use scan for product generation bit 30: time sequence error detected within this scan (see below) bit 29: data gap precedes this scan (gap may be due to actual lost scans or scans in which the TIP or MIU are in non-nominal modes) bit 28: insufficient data for calibration (see below) bit 27: earth location data not available (see below) bit 26: first good time following a clock update (nominally 0) bit 25: instrument status changed with this scan bits 24 - 5: <zero fill> bit 4: transmitter status change occurred (see note 2) bit 3: AMSU sync error detected (NOAA) or <zero fill> (Metop) bit 2: AMSU minor frame error detected (NOAA) or <zero fill> (Metop) bit 1: AMSU major frame error detected (NOAA) or <zero fill> (Metop) bit 0: AMSU parity error detected (NOAA) or <zero fill> (Metop)								
Scan Line Quality Flags [Time Problem Code] *(If a bit is on (=1), the statement is true. All bits off implies the scan time is as expected.)* bit 7: time field is bad but can probably be inferred from the previous good time bit 6: time field is bad and can't be inferred from the previous good time bit 5: this record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity). This may be associated with a spacecraft clock update. (See bit 26, Quality Indicator Bit Field.) bit 4: start of a sequence that apparently repeats scan times that have been previously accepted bits 3-0: <zero fill>	29	29	u	1	1	0		
QUALITY INDICATORS								
Scan Line Quality Flags [Calibration Problem Code] *(If a bit is on (=1), the statement is true. These bits complement the channel indicators; all bits set to 0 indicates normal calibration.)*	30	31	u	1	2	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1 bits 7-3: <zero fill> bit 2: scan line was not calibrated because of satellite maneuver (Metop) or <zero fill> (NOAA) bit 1: scan line contains one or more space views that are lunar contaminated bit 0: lunar-contaminated scan line was able to be calibrated (only applicable if the previous flag [bit 9] is 1; otherwise, zero) *Word 2* bit 7: scan line was not calibrated because of bad time bit 6: scan line was calibrated using fewer than the preferred number of scan lines because of proximity to start or end of data set or to a data gap bit 5: scan line was not calibrated because of bad or insufficient PRT data bit 4: scan line was calibrated but with marginal PRT data bit 3: some uncalibrated channels on this scan (see channel indicators) bit 2: uncalibrated due to instrument mode bit 1: questionable calibration because of antenna position error of space view bit 0: questionable calibration because of antenna position error of OBCT view								
Scan Line Quality Flags [Earth Location Problem Code] *(If a bit is on (=1), the statement is true. All bits set to 0 implies the earth location was normal.)* bit 7: not earth located because of bad time; earth location fields zero-filled bit 6: earth location questionable: questionable time code (see time problem flags above) bit 5: earth location questionable: marginal agreement with reasonableness check bit 4: earth location questionable: fails reasonableness check bit 3: earth location questionable because of antenna position check bit 2: <zero fill> bit 1: not earth located because of satellite in-plane maneuver (Metop) or <zero fill> (NOAA) bit 0: not earth located because of satellite out-of-plane maneuver (Metop) or <zero fill> (NOAA)	32	32	u	1	1	0		
Calibration Quality Flags *(all bits off implies a good calibration)* *Word 1: Channel H1* bits 15-7: <zero fill> bit 6: this scan line is either the last one before or the first one after a sudden, anomalous jump (or drop) in calibration counts bit 5: all bad OBCT view counts for scan line bit 4: all bad space view counts for scan line bit 3: all bad PRTs for this line bit 2: marginal OBCT view counts for this line bit 1: marginal space view counts for this line bit 0: marginal PRT temps on this line *Words 2-5: Channels H2-H5 (in order)*	33	42	u	2	5	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
<Zero Fill>	43	60	i	2	9	0		
CALIBRATION COEFFICIENTS *Note: The following coefficients are only available in Scan and Fixed View modes, otherwise the coefficient fields are <Zero Fill>. Refer to bits 7-4 of the Mode and Sub-commutation Code field for the current mode.*								
Primary Calibration Ch H1 Second Order Term, a2	61	64	i	4	1	16		
Primary Calibration Ch H1 First Order Term, a1	65	68	i	4	1	10		
Primary Calibration Ch H1 Zeroth Order Term, a0	69	72	i	4	1	6		
Primary Calibration Ch H2 Second Order Term, a2	73	76	i	4	1	16		
Primary Calibration Ch H2 First Order Term, a1	77	80	i	4	1	10		
Primary Calibration Ch H2 Zeroth Order Term, a0	81	84	i	4	1	6		
Primary Calibration Ch H3 Second Order Term, a2	85	88	i	4	1	16		
Primary Calibration Ch H3 First Order Term, a1	89	92	i	4	1	10		
Primary Calibration Ch H3 Zeroth Order Term, a0	93	96	i	4	1	6		
Primary Calibration Ch H4 Second Order Term, a2	97	100	i	4	1	16		
Primary Calibration Ch H4 First Order Term, a1	101	104	i	4	1	10		
Primary Calibration Ch H4 Zeroth Order Term, a0	105	108	i	4	1	6		
Primary Calibration Ch H5 Second Order Term, a2	109	112	i	4	1	16		
Primary Calibration Ch H5 First Order Term, a1	113	116	i	4	1	10		
Primary Calibration Ch H5 Zeroth Order Term, a0	117	120	i	4	1	6		
Secondary Calibration Ch H1 Second Order Term, a2	121	124	i	4	1	16		
Secondary Calibration Ch H1 First Order Term, a1	125	128	i	4	1	10		
Secondary Calibration Ch H1 Zeroth Order Term, a0	129	132	i	4	1	6		
Secondary Calibration Ch H2 Second Order Term, a2	133	136	i	4	1	16		
Secondary Calibration Ch H2 First Order Term, a1	137	140	i	4	1	10		
Secondary Calibration Ch H2 Zeroth Order Term, a0	141	144	i	4	1	6		
Secondary Calibration Ch H3 Second Order Term, a2	145	148	i	4	1	16		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Secondary Calibration Ch H3 First Order Term, a1	149	152	i	4	1	10		
Secondary Calibration Ch H3 Zeroth Order Term, a0	153	156	i	4	1	6		
Secondary Calibration Ch H4 Second Order Term, a2	157	160	i	4	1	16		
Secondary Calibration Ch H4 First Order Term, a1	161	164	i	4	1	10		
Secondary Calibration Ch H4 Zeroth Order Term, a0	165	168	i	4	1	6		
Secondary Calibration Ch H5 Second Order Term, a2	169	172	i	4	1	16		
Secondary Calibration Ch H5 First Order Term, a1	173	176	i	4	1	10		
Secondary Calibration Ch H5 Zeroth Order Term, a0	177	180	i	4	1	6		
<Zero Fill>	181	184	i	2	2	0		
NAVIGATION								
Computed Yaw Steering *(Metop: content defined below)* or <Zero Fill> *(NOAA)* Word 1: Computed roll angle Word 2: Computed pitch angle Word 3: Computed yaw angle	185	190	i	2	3	0	degrees	
Total Applied Attitude Correction Word 1: Roll Word 2: Pitch Word 3: Yaw	191	196	i	2	3	3	degrees	
Navigation Status Bit Field *(bits 20-18 are Metop specific and will contain zero fill for NOAA; bits 11-0 are NOAA specific and will contain zero fill for Metop)*	197	200	u	4	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bits 31-21: <zero fill> bit 20-19: yaw steering parameters usage indicator (0=no yaw steering correction; 1=computed parameters from Metop data stream; 2=measured parameters from Metop data stream; 3=computed parameters from AELDS) bit 18: Metop maneuver indicator (0=scan does not occur during a Metop in-plane or out-of-plane maneuver; 1=scan, or some part of it, occurs during a maneuver) bit 17: earth location at the satellite subpoint is accurate and reasonable, i.e., is within tolerance defined by "Nadir Earth Location Tolerance" in header (0=out of tolerance; 1=in tolerance) bit 16: earth location corrected for Euler angles (0=FALSE; 1=TRUE) bits 15-12: earth location indicator (0=earth location available; 1=user ephemeris files greater than 24 hours old; 2=no earth location available) bits 11-8: spacecraft attitude control (0=operating in YGC or NOMINAL mode; 1=operating in another mode; 2=attitude exceeds nominal tolerance; 3=both 1 and 2) bits 7-4: attitude SMODE (0=nominal mode; 1=rate nulling mode; 2=YGC mode; 3=search mode; 4=coast mode) bits 3-0: attitude PWTIP$AC (0=nominal mode/no test; 1=yaw axis test in progress; 2=roll axis test in progress; 3=pitch axis test in progress)								
Time Associated with Euler Angles	201	204	i	4	1	0	seconds	
Euler Angles *(NOTE: For Metop-originated AMSU-A data, this field is also referred to as the measured yaw steering parameters.)* Word 1: Roll Word 2: Pitch Word 3: Yaw	205	210	i	2	3	3	degrees	
Spacecraft Altitude above Reference Ellipsoid	211	212	u	2	1	1	kilometers	
Angular Relationships *(relative azimuth range +/- 180.00 degrees)* Word 1: Solar zenith angle, FOV 1 Word 2: Satellite zenith angle, FOV 1 Word 3: Relative azimuth angle, FOV 1 Word 4: Solar zenith angle, FOV 2 … (set of 3 angles every FOV) … Word 270: Relative azimuth angle, FOV 90	213	752	i	2	270	2	degrees	
Earth Location *(north latitude and east longitude are positive)* Word 1: Latitude, FOV 1 Word 2: Longitude, FOV 1 Word 3: Latitude, FOV 2 … (lat/lon word pair every FOV) … Word 180: Longitude, FOV 90	753	1472	i	4	180	4	degrees	
Lunar Angles *(angles between moon and individual space views; range 0 to 180.00 degrees)*	1473	1480	u	2	4	2	degrees	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Angle between moon and space view 1 Word 2: Angle between moon and space view 2 Word 3: Angle between moon and space view 3 Word 4: Angle between moon and space view 4								
MHS SENSOR DATA *In fixed view mode, the pixel data is the same format as scan mode, but the concept of earth, space, and OBCT views does not apply. All 98 views (i.e., 90 earth + 4 space + 4 OBCT) are for the fixed view position.*								
Scene (Earth View) Data *(range: 0 - 65,535)* Word 1: Mid-pixel position for FOV 1 Word 2: Scene counts for FOV 1, channel H1 Word 3: Scene counts for FOV 1, channel H2 Word 4: Scene counts for FOV 1, channel H3 Word 5: Scene counts for FOV 1, channel H4 Word 6: Scene counts for FOV 1, channel H5 Word 7: Mid-pixel position for FOV 2 Words 8-12: Scene counts for FOV 2, channels H1-H5 (in order) … (6 words for every FOV) … Word 535: Mid-pixel position for FOV 90 Words 536-540: Scene counts for FOV 90, channels H1-H5 (in order)	1481	2560	u	2	540	0	counts	
<Zero Fill>	2561	2568	i	4	2	0		
CALIBRATION DATA								
Space View Data *(range: 0 - 65,535)* Word 1: Mid-pixel position for space view 1 Word 2: Counts for space view 1, channel H1 Word 3: Counts for space view 1, channel H2 Word 4: Counts for space view 1, channel H3 Word 5: Counts for space view 1, channel H4 Word 6: Counts for space view 1, channel H5 Word 7: Mid-pixel position for space view 2 Word 8-12: Counts for space view 2, channel H1-H5 (in order) Word 13: Mid-pixel position for space view 3 Word 14-18: Counts for space view 3, channel H1-H5 (in order) Word 19: Mid-pixel position for space view 4 Word 20-24: Counts for space view 4, channel H1-H5 (in order)	2569	2616	u	2	24	0	counts	
OBCT View Data *(range: 0 - 65,535)* Word 1: Mid-pixel position for OBCT view 1 Word 2: Counts for OBCT view 1, channel H1 Word 3: Counts for OBCT view 1, channel H2 Word 4: Counts for OBCT view 1, channel H3 Word 5: Counts for OBCT view 1, channel H4 Word 6: Counts for OBCT view 1, channel H5 Word 7: Mid-pixel position for OBCT view 2 Word 8-12: Counts for OBCT view 2, channel H1-H5 (in order) Word 13: Mid-pixel position for OBCT view 3 Word 14-18: Counts for OBCT view 3, channel H1-H5 (in order) Word 19: Mid-pixel position for OBCT view 4 Word 20-24: Counts for OBCT view 4, channel H1-H5 (in order)	2617	2664	u	2	24	0	counts	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
<Zero Fill>	2665	2672	i	4	2	0		
POSITION VALIDITY FLAGS *There is one bit flag for each FOV (earth, space, and OBCT). If bit flag = 0, then mid-pixel antenna position for corresponding FOV is within its nominal range. Otherwise (if = 1), position is outside of its nominal range.*								
Earth View Position Validity Flags Word 1: position flags for FOVs 1-8 (bits 0-7) Word 2: position flags for FOVs 9-16 (bits 0-7) ... Word 11: position flags for FOVs 81-88 (bits 0-7) Word 12: position flags for FOVs 89-90 (bits 0-1; bits 2-7 are <zero fill>)	2673	2684	u	1	12	0		3
Space View Position Validity Flags bits 7-4: <zero fill> bit 3: position flag for space view 4 bit 2: position flag for space view 3 bit 1: position flag for space view 2 bit 0: position flag for space view 1	2685	2685	u	1	1	0		3
OBCT View Position Validity Flags bits 7-4: <zero fill> bit 3: position flag for OBCT view 4 bit 2: position flag for OBCT view 3 bit 1: position flag for OBCT view 2 bit 0: position flag for OBCT view 1	2686	2686	u	1	1	0		3
FULL HOUSEKEEPING DATA								
Mode and Sub-commutation Code bits 7-4: mode code (0=power on; 1=warm up; 2=stand by; 3=scan; 4=fixed view; 5=self test; 6=safeing; 7=fault; 8-14=<unused>; 15=memory data packet ID) bit 3: PIE ID (0=PIE A; 1=PIE B) bits 2-0: sub-commutation code *(only meaningful for telemetry packet data)*	2687	2687	u	1	1	0		
Telecommand Acknowledgement and Fault Code *Words 1-2:* bit 15: TC clean (1=no parity or checksum error found in received packet) bit 14: TC conforms (1=header of received command conforms to the CCSDS format) bit 13: TC recognized (1=received command is a recognized MHS command of the correct format) bit 12: TC legal (1=received command is legal for execution in the current MHS operating mode) bit 11: FDM motor current trip status (1=instantaneous current in the FDM motor has exceeded a pre-set level, resulting in the disabling of the FDM motor drive circuit) bits 10-0: TC application ID (taken from the packet ID field of the primary header of the received serial command) *Words 3-4:* bits 15-2: TC packet sequence count bits 1-0: TC received count	2688	2692	u	1	5	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 5: bit 7: current monitor fault (1=one or more PSU current monitor parameters exceed their expected limits); see note 4 bit 6: thermistor monitor fault (1=one or more thermistor temperature monitor parameters exceed their expected limits); see note 4 bit 5: switch fault (1=a switch status telemetry parameter does not agree with its last commanded state, or a PROM board switch error has occurred) bit 4: processor fault (1=a processor internal fault has occurred (overflow, illegal address, BIT failure)) bit 3: RDM motor current trip status (1=instantaneous current in the RDM motor has exceeded a pre-set level, resulting in the disabling of the RDM motor drive circuit) bit 2: DC offset error (1=one or more channel calibration target's readings indicate a change in the DC offset is required) bit 1: scan control error (1=the measured mid-pixel position of the reflector during earth, space, or OBCT views is outside the limits for the scan mode profile, or the reflector position is outside the limits of the requested position for fixed view mode, or the position acquisition initialization has failed); see note 5 bit 0: REF CK error (1=scan control clock stops as a result of the platform reference clock stopping for a period of >= 2.5 ms)								
Switch Status *Word 1:* bit 7: receiver channel H4 backend (0=off; 1=on) bit 6: receiver channel H3 backend (0=off; 1=on) bit 5: receiver channel H3/H4 local oscillator selected (0=A; 1=B) bit 4: receiver channel H3/H4 front-end (0=off; 1=on) bit 3: receiver channel H2 local oscillator selected (0=A; 1=B) bit 2: receiver channel H2 (0=off; 1=on) bit 1: receiver channel H1 local oscillator selected (0=A; 1=B) bit 0: receiver channel H1 (0=off; 1=on) *Word 2:* bit 7: PROM (1=a PROM segment switch has failed ON) bit 6: signal processing electronics/scan control electronics (0=off; 1=on) bit 5: auxiliary operational heaters (0=off; 1=on) bit 4: scan mechanism operational heaters (0=off; 1=on) bit 3: receiver operational heaters (0=off; 1=on) bit 2: Rx CV (0=off; 1=on) bit 1: receiver channel H5 local oscillator selected (0=A; 1=B) bit 0: receiver channel H5 (0=off; 1=on)	2693	2695	u	1	3	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 3: bit 7: FDM motor current trip status (0=enabled; 1=disabled) bit 6: RDM motor current trip status (0=enabled; 1=disabled) bit 5: FDM motor supply (0=off; 1=on) bit 4: RDM motor supply (0=off; 1=on) bit 3: FDM motor sensors selected (0=A; 1=B) bit 2: RDM motor sensors selected (0=A; 1=B) bit 1: FDM zero position sensors (0=A; 1=B) bit 0: RDM zero position sensors (0=A; 1=B)								
Temperature Data *(range: 0-255)* Word 1: LO H1 temperature Word 2: LO H2 temperature Word 3: LO H3/H4 temperature Word 4: LO H5 temperature Word 5: Mixer/LNA/Multiplexer H1 temperature Word 6: Mixer/LNA/Multiplexer H2 temperature Word 7: Mixer/LNA/Multiplexer H3/H4 temperature Word 8: Mixer/LNA/Multiplexer H5 temperature Word 9: Quasi-optics baseplate temperature #1 (dichroic D1(A) or polarisor(B)) Word 10: Quasi-optics baseplate temperature #2 (dichroic D2(A) or mirror(B)) Word 11: IF baseplate temperature #1 Word 12: IF baseplate temperature #2 Word 13: Scan mechanism core temperature Word 14: Scan mechanism housing temperature Word 15: RDM SSHM temperature Word 16: FDM SSHM temperature Word 17: Structure 1 temperature (-A edge, next to baseplate cutout) Word 18: Structure 2 temperature (-A edge, in-between Rx and SM) Word 19: Structure 3 temperature (-V edge, in-between EE and SM) Word 20: Processor module temperature Word 21: Main DC/DC converter module temperature Word 22: SCE RDM module temperature Word 23: SCE FDM module temperature Word 24: RF DC/DC converter module temperature	2696	2719	u	1	24	0	counts	
Raw Current Consumption Data *(internal PSU current analog telemetry; range: 0-255)* Word 1: EE and SM +5V current Word 2: receiver +8V current Word 3: receiver +15V current Word 4: receiver -15V current Word 5: RDM motor current Word 6: FDM motor current	2720	2725	u	1	6	0	counts	
<Zero Fill>	2726	2726	i	1	1	0		
STATUS WORD								
Status Word	2727	2727	u	1	1	0		

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
bit 7: DC offset valid (1=all channels' calibration target's readings lie within acceptable limits) bit 6: scan control valid: only set in scan mode or fixed view mode (1=all mid-pixel positions of the reflector during earth, space, or OBCT views are within limits) bits 5-4: profile (0=profile 0--the nominal scan mode profile with nominal space view position; 1=profile 1--alternate space view position; 2=profile 2--alternate space view position; 3=no profile calculated--profile will be manually loaded and modified) bits 3-0: <unused>								
<Zero Fill>	2728	2734	i	1	7	0		
SIGNAL PROCESSING STATUS								
DC Offset Words *(range: 0-255)* Word 1: Channel H1 DC offset word Word 2: Channel H2 DC offset word Word 3: Channel H3 DC offset word Word 4: Channel H4 DC offset word Word 5: Channel H5 DC offset word	2735	2739	u	1	5	0	counts	
Channel Valid Flags bit 7: H1 valid (1=all samples of channel H1 for this scan lie within the ADC dynamic range) bit 6: H2 valid (1=all samples of channel H2 for this scan lie within the ADC dynamic range) bit 5: H3 valid (1=all samples of channel H3 for this scan lie within the ADC dynamic range) bit 4: H4 valid (1=all samples of channel H4 for this scan lie within the ADC dynamic range) bit 3: H5 valid (1=all samples of channel H5 for this scan lie within the ADC dynamic range) bits 2-0: SPE MUX code (0=channel H1 connected to SPE 6; 1=H2 to SPE 6; 2=H3 to SPE 6; 3=SPE 6 not used; 4=H4 to SPE 6; 5=H5 to SPE 6; 6=SPE 6 not used; 7=SPE 6 not used)	2740	2740	u	1	1	0		
Channel Gain *(i.e., gain setting of the receiver video output channels)* *Values of 0 to 3 imply 0 db gain to 3 dB gain, respectively. Values of 4 to 7 are not used.* *Word 1:* bits 7-5: channel H1 gain bits 4-2: channel H2 gain bits 1-0: <unused> *Word 2:* bits 7-5: channel H3 gain bits 4-2: channel H4 gain bits 1-0: <unused> *Word 3:* bits 7-5: channel H5 gain bits 4-2: <unused> bits 1-0: <unused>	2741	2743	u	1	3	0		
<Zero Fill>	2744	2750	i	1	7	0		
OBCT TEMPERATURE DATA								
OBCT (PRT) Readings Word 1: PRT 1 Word 2: PRT 2 Word 3: PRT 3 Word 4: PRT 4 Word 5: PRT 5	2751	2760	u	2	5	0	counts	
PRT Calibration Channels	2761	2766	u	2	3	0	counts	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Word 1: Calibration channel 1 (upper value) Word 2: Calibration channel 2 (middle value) Word 3: Calibration channel 3 (lower value)								
<Zero Fill>	2767	2768	i	2	1	0		
Computed OBCT Temperatures Word 1: OBCT temperature 1 (based on PRT 1 reading) Word 2: OBCT temperature 2 (based on PRT 2 reading) Word 3: OBCT temperature 3 (based on PRT 3 reading) Word 4: OBCT temperature 4 (based on PRT 4 reading) Word 5: OBCT temperature 5 (based on PRT 5 reading)	2769	2788	u	4	5	3	K	
SPARES								
Science Packet Spare Words *(set to zero)*	2789	2833	u	1	45	0		
<Zero Fill>	2834	2834	i	1	1	0		
DISCRETE TELEMETRY *Equivalent to digital B and analog housekeeping telemetry in other instruments.*								1
Main Bus Select Status *(indicate which main bus (A or B) is used by the MHS)* 1 (0V)=A bus (relay closed) 0 (5V)=B bus (relay opened)	2835	2835	u	1	1	0		
MHS Survival Heater *(NOAA: content defined at right)* or <Zero Fill> *(Metop)* 1=on 0=off	2836	2836	u	1	1	0		
RF Converter Protect Disable *(NOAA: content defined at right)* or <Zero Fill> *(Metop)* 1=no 0=yes	2837	2837	u	1	1	0		
MHS Power A *(NOAA: content defined at right)* or <Zero Fill> *(Metop)* 1=on 0=off	2838	2838	u	1	1	0		
MHS Power B *(NOAA: content defined at right)* or <Zero Fill> *(Metop)* 1=on 0=off	2839	2839	u	1	1	0		
Main Converter Protect Disable *(NOAA: content defined at right)* or <Zero Fill> *(Metop)* 1=no 0=yes	2840	2840	u	1	1	0		
Survival Temperatures Word 1: Receiver temperature Word 2: Electronics equipment temperature Word 3: Scan mechanism temperature	2841	2846	u	2	3	0	counts	

Field Name	Start Octet	End Octet	Data Type	Word Size	Number of Words	Scale Factor	Units	Notes
Transmitter Telemetry *(NOAA: content defined below)* or <Zero Fill> *(Metop)* Word 1: STX-1 status Word 2: STX-2 status Word 3: STX-3 status Word 4: STX-4 status Word 5: STX-1 power Word 6: STX-2 power Word 7: STX-3 power Word 8: SARR-A power Word 9: SARR-B power	2847	2864	u	2	9	0	counts	
Discrete Telemetry Update Flags *(If bit = 0, associated telemetry item is up-to-date. If bit = 1, associated telemetry item was not updated during most recent telemetry cycle - possibly due to lost frame.)* bits 31-18: <zero fill> bit 17: SARR-B power (NOAA) or <zero fill> (Metop) bit 16: SARR-A power (NOAA) or <zero fill> (Metop) bit 15: STX-3 power (NOAA) or <zero fill> (Metop) bit 14: STX-2 power (NOAA) or <zero fill> (Metop) bit 13: STX-1 power (NOAA) or <zero fill> (Metop) bit 12: STX-4 status (NOAA) or <zero fill> (Metop) bit 11: STX-3 status (NOAA) or <zero fill> (Metop) bit 10: STX-2 status (NOAA) or <zero fill> (Metop) bit 9: STX-1 status (NOAA) or <zero fill> (Metop) bit 8: Scan mechanism temperature bit 7: Electronics equipment temperature bit 6: Receiver temperature bit 5: Main converter protect disable (NOAA) or <zero fill> (Metop) bit 4: MHS power B (NOAA) or <zero fill> (Metop) bit 3: MHS power A (NOAA) or <zero fill> (Metop) bit 2: RF converter protect disable (NOAA) or <zero fill> (Metop) bit 1: MHS survival heater (NOAA) or <zero fill> (Metop) bit 0: Main bus select status	2865	2868	u	1	4	0		
FILLER								
<Zero Fill>	2869	3072	i	2	102	0		

Table 12. MHS level 1-b data record

2.2.2 Gridded NWP Analysis Data Files

The NWP analysis data files contain atmospheric (distinguished by the "`atm`" prefix) and surface (distinguished by "`sfc`" prefix) EDRs. Currently, three different sources of NWP data sets are being processed: the GDAS analysis, GFS forecast, and ECMWF analysis data. These are *optional* files and are used only for calibration in the radiance processing and in the MIRS retrieved product monitoring. They are not used in the inversion process. They might be used however in the 1DVAR as fist guesses at user discretion if it is deemed that they help convergence of certain parameters. These files reside in the "`ExternalData/gridNWP_analys`" sub-directory (see also Figure 4).

2.2.3 Gridded NWP Forecast Data Files

These are also *optional* files that could be used for the same purpose instead of NWP analysis (GDAS or ECMWF) data. They reside in the "Data/ExternalData/gridNWP_forcst" subdirectory.

2.3 Static Data Files

The static data files contain various nominal instruments, system and processes input parameters. These are permanent files. These data files include the CRTM files, nominal instrument noise files (NEDTs), geophysical covariance matrices files, topography files, tuning files and emissivity catalogue files. These data files reside in the "/Data/StaticData" sub-directory. Each of the static data files is described below.

2.3.1 CRTM Data Files

These are binary files containing coefficient parameters as input to the CRTM module. They come as part of the CRTM package and as such they should not be modified. They are used in a "as is" fashion. These data files reside in the "/Data/StaticData/CRTMFiles" sub-directory.

2.3.2 Nominal Instrumental Noise Data Files (*NEDT*)

These are static ASCII files containing instrument antenna temperature noise values needed as input to 1DVAR. These static nominal noise values are used for those sensors where MIRS is not capable to compute noise values dynamically, e.g., for SSMIS. For AMSU-MHS, the NEDTs are dynamically generated following the methodology as described in Mo (2002). These data files reside in the "/Data/StaticData/NominalNedts" sub-directory. Table 13 describes the content of the noise files.

Parameter name	Type	Description
nChan	Integer	Single value denoting number of channels, e.g., 20 for AMSU-MHS.
Centrfreq	Real	Vector with elements containing center frequency values in GHz. Vector index denotes channel number
RMS nedt	Real	Vector with elements containing root mean square error of noise values in K for each center frequency. Vector index denotes channel number
nedt	Real	Vector with elements containing noise values in K for each center frequency. Vector index denotes channel number

Table 13. NEDT data content

2.3.3 Geophysical Covariance Matrices Data Files

Geophysical covariance data are contained in two ASCII files, each containing data related to the atmospheric and surface parameters. These data consist of nominal covariance matrices and mean background values for each parameter (EDR) needed as input to 1DVAR. The covariances and background values are stratified by surface type: ocean, sea-ice, snow cover and snow-free land. These files reside in the "data/StaticData/CovBkgStats" subdirectory". The covariances and background data for the atmospheric parameters are contained in a file common to all sensors. This file is named "CovBkgMatrxTotAtm_all.dat". The data related to surface parameters is sensor-specific and has the notation "CovBkgMatrxTotSfc_all_*sensor*.dat", where "*sensor*" denotes the symbol used for a specific satellite sensor, e.g., n18_amsua_mhs, n19_amsua_mhs, metopA_amsua_mhs, f17_ssmis, f18_ssmis, and npp_atms for the NOAA-18 AMSU-MHS, NOAA-19 AMSU-MHS, Metop-A AMSU-MHS, Metop-B AMSU-MHS, DMSP F17 SSMI/S, DMSP F18 SSMI/S, and NPP ATMS sensors, respectively. Table 14 and Table 15 provide data content characteristics for the atmospheric and surface parameters, respectively.

Parameter name	Type	Explanation
nEDRs	Integer	Number of atmospheric parameters (EDRs)
EDR_IDs	Integer (vector)	The background and covariance matrix are defined for a number of parameters that are stored in order. This vector defines the indexes of each parameter within the geophysical state vector order, e.g., 1 for temperature, 101 for water vapor, 201 for ozone, 301 for cloud liquid water, 401 for rain, 501 for snow, etc.
EDR_Desc	Character (vector)	Parameter description, e.g,. "TEMP" for temperature in K, "CLW" for cloud liquid water in mm/m, RAIN for rain in mm, etc.
iSpaceMode	Integer	Control Flag specifying that the parameters are stored in background and covariance in natural space (0) or logarithm space (1)
nTypes	Integer	Number of types or classes;
Type_IDs	Integer (vector)	Class/type ID
Type_Desc	Character (vector)	Class/ Type description, e.g,. "trop" for tropical, etc.
nLev	Integer	Number of levels, range 1 to 101.
pres_lev	Real (vector)	Vector containing level pressure values in mbar for each level
pres_lay	Real (vector)	Vector containing layer pressure in mbar for each layer; number of layers is equal to the number of levels – 1;
npEDR	Integer	Matrix size for each atmospheric parameter; equal to the number of layers for the case of profiles
SA	Real (array)	Covariance Matrix array of npEDR size containing covariance values for a particular parameter; Total number of matrices contained in file equals number of classes
U	Real (array)	Transformation Matrix array of npEDR size containing covariance values for a particular parameter; Total number of matrices contained in file equals number of classes
Xb	Real (vector)	Background vector of npEDR size containing mean background parameter values; Total number of vectors contained in file equals number of classes

Table 14. Data content characteristics of the geophysical covariance matrix file related to atmospheric parameters (EDR).

Parameter name	Type	Explanation
nEDRs	Integer	Number of surface parameters

EDR_IDs	Integer (vector)	The background and Covariance matrix are defined for a number of parameters that are stored in order. This vector defines the indexes of each parameter within the geophysical state vector order, e.g., 1 for emissivity, 21 for reflectivity, 41 for windspreed, 42 for skin temperature.
EDR_Desc	Character (vector)	Surface parameter description, e.g,. EMIS for emissivity, 'REFL' for reflectivity, etc.
iSpaceMode	Integer	Control Flag specifying that the parameters are stored in background and covariance in natural space (0) or logarithm space (1)
nTypes	Integer	Number of surface types
Type_IDs	Integer (vector)	Surface type ID: 0 for ocean, 1 for sea-ice, 2 for land and 3 for snow snow cover
Type_Desc	Character (vector)	Surface Type description, e.g,. "oc" for ocean, "seaice" for sea ice, "ld" for land, and "snow" for snow cover
Nchan	Integer	Number of channels
Freq	Real (vector)	Vector containing center frequency for each channel
Polar	Integer (vector)	Vector containing polarization values at each channel, e.g., 1 for horizontal, 2 for vertical, and 3 for both horizontal and vertical
npEDR	Integer (vector)	Matrix size for each surface parameter; equal to the number of channels, e.g., 20 for AMSU-MHS, for the emissivity parameter.
SA	Real (array)	Covariance Matrix array of npEDR size containing covariance values for a particular surface parameter; Total number of matrices contained in file equals number of types.
U	Real (array)	Transformation Matrix array of npEDR size containing covariance values for a particular surface parameter. Total number of matrices contained in file equals number of types.
Xb	Real (vector)	Background vector of npEDR size containing mean background value for a particular surface parameter. Total number of vectors contained in file equals number of types

Table 15. Data content characteristics of the geophysical covariance matrix file related to surface parameters (EDR).

2.3.4 Topography Data Files

The topography files are global gridded binary files containing surface type (integer) and elevation (real number) data. The source of this file is the USGS. They reside in the "`data/StaticData/Topograph`y" subdirectory".

2.3.5 Tuning Data Files

The tuning data files are sensor-specific ASCII files that contain tuning parameters needed to customize retrieval attempts. They contain such parameters as which EDRs to retrieve, channels selected, the maximum number of iterations, etc. Up to two tuning files per sensor are permitted. This means that a retrieval is performed using the parameter set contained in the first tuning file and if the user requires it, a second retrieval will be attempted (if the first retrieval did not converge) using the second tuning file. The control of the number of attempts and the names of the tuning files are set in the paths and configuration file (PCF). These files reside in the "`data/StaticData/TuningData`" subdirectory" and follow the naming convention "TunParams_*sensor*.in", where *sensor* is notation used for a specific sensor, e.g., n18_amsua_mhs, n19_amsua_mhs, metopA_amsua_mhs, metopB_amsua_mhs, f17_ssmis, f18_ssmis, and npp_atms for NOAA-18 AMSU-MHS, NOAA-19 AMSU-MHS, Metop-A AMSU-MHS, Metop-B AMSU-MHS, F17 SSMI/S, F18 SSMI/S, and NPP ATMS respectively. An example of the content of the tuning file for the AMSU-MHS sensor is provided in Figure 6.

File name: "TunParams_n18_amsua_mhs.in"
MIRS local directory: "`data/StaticData/TuningData`

```
&TuningP
       !-------------------------------------------------------------------
       !   Sensor ID
       !-------------------------------------------------------------------
       Sensor_ID           = 1
       !-------------------------------------------------------------------
       !   Retrieval Tuning parameters
       !-------------------------------------------------------------------
       rhMaxAllowed        = 100 !Maximum Relative Humidity Allowed in retrieval
       RetrErrCharac           = 0   !Flag to output retrieval error characteristics
       !-------------------------------------------------------------------
       !   What EDRs to retrieve
       !   The labels must coincide with the contents of Cov/Bkg/Trnsf Matrx
       !-------------------------------------------------------------------
       EDR_Label_atm(1)        = 'TEMP'
       EDR_Label_atm(2)        = 'WVAP'
       EDR_Label_atm(3)        = 'OZON'
       EDR_Label_atm(4)        = 'CLW'
       EDR_Label_atm(5)        = 'RAIN'
       EDR_Label_atm(6)        = 'SNOW'
       EDR_Label_atm(7)        = 'ICE'
       EDR_Label_atm(8)        = 'GRPL'
       EDR_Label_atm(9)        = 'TSKIN'
       EDR_Label_atm(10)       = 'SFCP'

       EDR_Label_sfc(1)        = 'EMIS'
       EDR_Label_sfc(2)        = 'REFL'
       EDR_Label_sfc(3)        = 'WINDSP'
       EDR_Label_sfc(4)        = 'TSKIN'
       EDR_Label_sfc(5)        = 'DELTAT'
       EDR_Label_sfc(6)        = 'SFCP'
       !-------------------------------------------------------------------
       !   Number EOFs used 4 retrieval for each EDR
       !   Note that 0 means that EDR not retrieved @ all (not part of Xg).
       !-------------------------------------------------------------------
       EDR_nEOF_atm(1)         = 8
       EDR_nEOF_atm(2)         = 4
       EDR_nEOF_atm(3)         = 0
       EDR_nEOF_atm(4)         = 3
       EDR_nEOF_atm(5)         = 0
       EDR_nEOF_atm(6)         = 0
       EDR_nEOF_atm(7)         = 0
       EDR_nEOF_atm(8)         = 0
       EDR_nEOF_atm(9)         = 1
       EDR_nEOF_atm(10)        = 0

       EDR_nEOF_sfc(1)         = 4
       EDR_nEOF_sfc(2)         = 0
       EDR_nEOF_sfc(3)         = 0
       EDR_nEOF_sfc(4)         = 0
       EDR_nEOF_sfc(5)         = 0
       EDR_nEOF_sfc(6)         = 0
       !-------------------------------------------------------------------
       !   Control parameters that affect how potential external data are
       !   used. For those parameters to be retrieved (selected above),
       !   the following defines the use of the external data (if the flag
       !   ExternDataAvailab says they are available).
       !   0-> Do not use External data for this parameter
       !   1-> Use Ext in combination w Bkg (weighed by errors)
       !   2-> Use extern data as 1st guess only. Keep climo for Bkg.
       !   3-> Replace the Bkg & 1st guess with Extrnal data.
       !-------------------------------------------------------------------
```

```
       EDR_ExtDataUse_atm(1)=2
       EDR_ExtDataUse_atm(2)=2
       EDR_ExtDataUse_atm(3)=0
       EDR_ExtDataUse_atm(4)=2
       EDR_ExtDataUse_atm(5)=0
       EDR_ExtDataUse_atm(6)=0
       EDR_ExtDataUse_atm(7)=0
       EDR_ExtDataUse_atm(8)=0
       EDR_ExtDataUse_atm(9)=2
       EDR_ExtDataUse_atm(10)=0

       EDR_ExtDataUse_sfc(1)=2
       EDR_ExtDataUse_sfc(2)=0
       EDR_ExtDataUse_sfc(3)=0
       EDR_ExtDataUse_sfc(4)=0
       EDR_ExtDataUse_sfc(5)=0
       EDR_ExtDataUse_sfc(6)=0

       EDR_ExtDataUse_sTyp=0     !For Sfc Type, 0/1 are the only options
       !-----------------------------------------------------------------------------
-
       !   For those parameters to be retrieved (selected above), the
       !   following allow some tuning to the way the retrieval is
       !   actually performed, following the code below:
       !   0->  retrieve normally (based on X1st and Cov/Bkg)
       !   1->  retrieve normally but reduce variance by half.
       !   2->  stick to bkg (be it climo/ext depending on control param)
       !   3->  stick to bkg & uncorrelate with other EDRs
       !   4->  uncorrelate with other EDRs but not stick to bkg
       !    5->   uncorrelate with other EDRs/not stick to bkg & x 100 the diagonal
matrx value
       !   6->  uncorrelate with other EDRs/not stick to bkg & x 10 the diagonal matrx
value
        !   7->  retrieve normally but multiply variance by 2.
        !   8->  retrieve normally but multiply variance by 5.
        !   9->  retrieve normally but multiply variance by 10.
        !   10-> retrieve normally but multiply variance by 100.
       !-----------------------------------------------------------------------------
-
       EDR_cntrlRetr_atm(1)=0
       EDR_cntrlRetr_atm(2)=0
       EDR_cntrlRetr_atm(3)=0
       EDR_cntrlRetr_atm(4)=0
       EDR_cntrlRetr_atm(5)=0
       EDR_cntrlRetr_atm(6)=0
       EDR_cntrlRetr_atm(7)=0
       EDR_cntrlRetr_atm(8)=0
       EDR_cntrlRetr_atm(9)=0
       EDR_cntrlRetr_atm(10)=0

       EDR_cntrlRetr_sfc(1)=0
       EDR_cntrlRetr_sfc(2)=0
       EDR_cntrlRetr_sfc(3)=0
       EDR_cntrlRetr_sfc(4)=0
       EDR_cntrlRetr_sfc(5)=0
       EDR_cntrlRetr_sfc(6)=0
       !-------------------------------------------------------------------
       !   How to turn ON/OFF channels (based on Vector or Freq range)
       !-------------------------------------------------------------------
        ChanSelectFlag      = 0 !=0->ChanSel, =1->Frq Mn/Mx
       !---Channel selection vector (If ChanSelectFlag eq 0)
        ChanSel(1)          = 1
```

```
       ChanSel(2)         = 1
       ChanSel(3)         = 1
       ChanSel(4)         = 1
       ChanSel(5)         = 1
       ChanSel(6)         = 1
       ChanSel(7)         = 1
       ChanSel(8)         = 1
       ChanSel(9)         = 1
       ChanSel(10)        = 1
       ChanSel(11)        = 1
       ChanSel(12)        = 1
       ChanSel(13)        = 0
       ChanSel(14)        = 0
       ChanSel(15)        = 1
       ChanSel(16)        = 0
       ChanSel(17)        = 1
       ChanSel(18)        = 1
       ChanSel(19)        = 1
       ChanSel(20)        = 1
       !-------Frequency range to be selected (If ChanSelectFlag eq 1)
        FreqMin            = 10.
        FreqMax            = 50.
       !-----------------------------------------------------------------
       !   Control bias correction (by surface type)
       !-----------------------------------------------------------------
       iWhere2Apply              = -1    !-1:everywhere (use the following vectors to
!specify, -2:nowhere)
       iCorrMethod               = 0
        applyBias_oc_byChan(1:20)       = 1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
        applyBias_ic_byChan(1:20)       = 1,1,1,1,1,1,1,1,1,1,1,1,1,1,0,1,1,1,1,1
        applyBias_ld_byChan(1:20)       = 1,1,1,1,1,1,1,1,1,1,1,1,1,1,0,1,1,1,1,1
        applyBias_sn_byChan(1:20)       = 1,1,1,1,1,1,1,1,1,1,1,1,1,1,0,1,1,1,1,1
       !-----------------------------------------------------------------
       !   Scaling factors for the instrumental/modeling errors
       !-----------------------------------------------------------------
       scalFactEF_oc_byChan(1:20)       =
1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0
       scalFactEF_ic_byChan(1:20)       =
1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0
       scalFactEF_ld_byChan(1:20)       =
1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0
       scalFactEF_sn_byChan(1:20)       =
1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0
       !-----------------------------------------------------------------
       !   Convergence-related controlling items
       !-----------------------------------------------------------------
       nIterations        = 7
       ChiSqThresh        = 1.
       ChiSqThresh4Attempt = 5.
       !-----------------------------------------------------------------
       !   Non-linearity shooting-control parameter
       !-----------------------------------------------------------------
       alpha              = 17
       beta               = 0.
       !-----------------------------------------------------------------
       !   Minimum Top pressure [mb] to which sensor is sensitive
       !-----------------------------------------------------------------
        topSensPressT      = 0.
        topSensPressWV     = 0.
/
```

Figure 6. Sample of the tuning file

2.3.6 Emissivity Catalogue Data Files

The emissivity catalogue files are sensor-specific ASCII files that contain surface emissivity spectra and geophysical parameters computed off-line from physical models. These files are used as input to the MIRS Vertical Integration and Post-processing (VIPP) module to compute emissivity-based EDRs. There are two emissivity catalogue files for each sensor: the sea ice and snow cover catalogue files, each denoted as "SeaIceEmissCatalog_*sensor*.dat" and "SnowEmissCatalog_*sensor*.dat", respectively. The sea ice emissivity catalogue is used for computing sea ice parameters and the snow emissivity catalogue is used for computing snow cover parameters. These files reside in the "data/StaticData/EmissCatalog" sub-directory.

Section 3.0 Intermediate Datasets

Intermediate data files used in MIRS are described in this section. To get a sense of where these files fit within the MIRS system, the reader is referred to section 1.3. The intermediate files consist of the scientific radiance data files (level 1-c, -d, and –e), the semi-static data files (bias, RTM uncertainty, and MIRS regression algorithms coefficient files), the dynamically generated noise (NEDT) files and the performance monitoring files. Table 16 provides a summary description of these data files including category, function, file naming convention, directory and file format and frequency of use.

Satellite data (TDR)	AMSU-A (level 1b)	Antenna temperatures, one step further from level 1b raw data	TDR_AMAX.NN.**D***yyddd* .**S***mmss*.**E***mmss*.B_.*GC(WI,SV)*	/data/TestbedData/ DynamicData/tdr/n18_amsua(n18_mhs) Binary swath	Dynamic
	MHS (level 1b)		TDR_MHSX.NN. **D***yyddd* .**S**mmss.**E***mmss*.B_.*GC(WI,SV)*		
Satellite data (SDR)	AMSU-A (TDR)	Brightness temperature file where antenna patterns corrections have been applied	SDR_AMAX.NN.**D***yyddd*. **S***mmss*.**E***mmss*.B_.*GC(WI,SV)*	/data/TestbedData/ DynamicData/sdr/n18_amsua(n18_mhs) Binary swath	
	MHS (TDR)		SDR_AMAX.NM.**D***yyddd*. **S***mmss*.**E***mmss*.B_.*GC(WI,SV)*		
Satellite data (FM-SDR)	AMSU-MHS (SDR)	Footprint matched brightness temperature file	FMSDR_SX_NN.D*yyddd*. S*mmss*.E*mmss*.B_.GC(WI,SV). LR	/data/TestbedData/ DynamicData/fmsdr /n18_amsua_mhs Binary swath	
Bias and RTM uncertainty files	CRTM & MIRS tools	Files containing bias and CRTM model errors	biasCorrec_*n18*.dat ModelErrFile_*n18*.dat ModelNonErrFile_n18.dat biasMeanStdv_n18_nwp_gdas(ecmw)_yyy_mm_dd.dat	/data/TestbedData/SemiStaticData/biasCorrec/ ASCII	Semi-static
Regression coefficients files	Collocation of radiance with geophysical data (off-line)	Files contain regression coefficients to compute surface and atmospheric state vectors from brightness temperature measurements as 1dvar 1st guesses	Oc_regressCoeffs_*n18*.dat *Land*_regressCoeffs_*n18*.dat *SeaIce*_regressCoeffs_*n18*.dat *Snow*_regressCoeffs_*n18*.dat *LandSnow*_regressCoeffs_*n18*.dat *OcSeaIce*_regressCoeffs_*n18*.dat	/data/SemiStaticData/regressAlgors ASCII	
Dynamically generated noise files	Level 1b AMSU-A	File contains errors per each frequency channel	n18_amsua_mhs_nedt_*yyyy_mm_dd_befFM*.dat n18_amsua_mhs_nedt_*yyyy_mm_dd_aftFM*.dat	/data/TestbedData/nedt/n18_amsua_mhs ASCII	Dynamic
	Level 1b MHS				
Performance monitoring files	FWD simulator & MIRS tools	Files contain bias monitoring information	Mirs_adv_poes_n18_monitoring*parm_region_parm*.png	/data/TestbedData/Perfsmonitoring/n18_amsua_mhs Image (PNG)	

Table 16. Summary description of the intermediate files. The table gives the data file category, source, purpose, file naming, format, directory and frequency of use. The AMSU-MHS sensor data are provided as an example.

Additional characteristics of each data file including functionality, access location and content is provided below.

3.1 Scientific Radiance Files

3.1.1 Brightness Temperature Files *(level-1c, SDR)*

The Satellite Data Record (SDR) files are the first brightness temperature data that MIRS generates after application of antenna patterns to the sensor data contained in level-1b MIRS internal format files. Definition of SDR data structures is sensor-independent. These data files reside in the "/data/TestbedData/DynamicData/sdr" subdirectory (see also Figure 4). Table 17 and Table 18 provide the SDR Data Content characteristics. Note that these files, like the TDR ones, are organized scanline by scanline.

Parameter name	Type	Explanation
nScanL	Integer	The number of scan lines
nFOVs	Integer	Number of field of views per scan line
Nqc	Integer	Number of quality control words
Nchan	Integer	Number of channels
cFreq	Real (vector)	Vector containing center frequencies in GHz
Pol	Integer (vector)	Vector containing polarization values for each frequency

Table 17. SDR header content attributes

Parameter Name	Type	Explanation
Node	Integer	Single value denoting orbital node: Value of 0 for ascending and 1 for descending
ScanDay	Integer	Single value denoting Scan day (1-366)
ScanYear	Integer	Single value denoting calendar year, e.g., 2006
ScanUTC	Real	Single real value denoting scantime of day in seconds and miliseconds
Lat	Real (nFOVs)	Vector with size number of FOVs (nFOVs)containing geographical latitude value in Degrees; Value range:-90 to 90.
Lon	Real (nFOVs))	Vector with size number of FOVs (nFOVs) containing geographical latitude value in Degrees; Value range:-180 to 180
Angle	Real (nFOVs))	Vector with size number of FOVs (nFOVs) containing zenith angle values in Degrees. Value range for AMSU 0-58 Degrees
RelAziAngle	Real(nFovs)	Vector with size number of FOVs (nFOVs) containing relative azimuth angle values in Degrees
SolZanAngle	Real(nFovs)	Vector with size number of FOVs (nFOVs) containing solar zenith angle values in Degrees
Tb	Real(nchan,nFOVs)	Array of size number of FOVs (rows) and number of channels (column) containing the Brightness Temperature in Kelvin
Qc	Integer (nqc)	Vector equal in size to the number of quality control words

Table 18. SDR data content characteristics

3.1.2 Footprint-Matched Brightness Temperature Files *(level-1d, FM-SDR)*

These files contain the brightness temperature data after footprint matching has been applied. At this file, all channels have been processed to the same field of view. Similar to SDR, data structure is sensor-independent. The FM-SDR data reside in the "/data/TestbedData/DynamicData/fmsdr" subdirectory (see also Figure 4). Table 19 and Table 20 provide the FM-SDR Header and Data Content characteristics, respectively.

Parameter name	Type	Explanation
nMeasurData	Integer	Single integer whose value equals number of measurements
Nchan	Integer	Number of channels, e.g, 20 for AMSU-MHS
nPosScan	Integer	Number of scan positions
nScanLines		Number of scan lines
nqc	Integer	Number of quality control words
CentrFreq	Real (vector)	Vector whose elements contain frequency values in GHz (0:nchan)
polar	Integer (vector)	Vector whose elements denote polarization

Table 19. FM-SDR header file record

Parameter Name	Type	Explanation
Lat	Real	Single value denoting geographical latitude in Degrees, Value range:-90 to 90.
Lon	Real	Single value denoting geographical longitude in Degrees; Value range:-180 to 180.
Node	Integer	Single value denoting measurement mode: Value of 0 for ascending and 1 for descending
RelAziAngle	Real	Single value denoting relative azimuth angle in Degrees
SolZanAngle	Real	Single value denoting solar zenith angle in Degrees
iscanPos	Integer	Single value denoting scan position; Value range: 1-90. (for the example of the MHS resolution)
iScanLine	Integer	Single value denoting scan line index
Year	Integer	Single value denoting year, e.g., 2006
julDAY	Integer	Single value denoting Julian day Value range: 1-366
secs	Real	Single value denoting seconds and milliseconds
angle	Real (nchan)	zenith angle in Degrees, for every channel; Value range for AMSU-MHS (0-58). This can be variable with channel for some instruments, e.g., SSMI/S.
tb	Real (nchan)	Footprint matched brightness temperature for each channel
qc	Integer (nqc)	Vector with quality control values

Table 20. FM-SDR data content characteristics

3.2 Semi-Static Datasets

The semi-static datasets are by-product of the MIRS processing subsystems. They reside in the "/mirs/data/SemiStaticData" sub-directory and consist of the bias, uncertainty RTM and the MIRS regression algorithms coefficients file

3.2.1 Bias and RTM Uncertainty Files

These are ASCII files generated by the radiance processing. These files contain bias correction and CRTM model error values. Bias correction values are applied to the foot-print matched radiance data for generating read-to invert bias-corrected, footprint matched radiance data files to be used as input to 1DVAR. The CRTM model error values are needed as inputs to the 1DVAR algorithm to account for forward model uncertainties.

3.2.2 MIRS Regression Coefficients Files

These are sensor-specific ASCII files containing regression coefficient values for computing geophysical parameters (EDRs) from brightness temperature data. These brightness temperature-based EDRs can be used in MIRS as initial guesses for 1DVAR processing. These coefficients are derived off-line using brightness temperature collocated with geophysical data.
There are 24 files for each sensor; one file for each of the 6 retrieved initial guess parameters and for each of the 4 surface types (ocean, sea-ice, land, and snow). These files are denoted as "Land_regressCoeffs_*sensor_parameter*.dat", "Oc_regressCoeffs_*sensor_parameter*.dat", "Snow_regressCoeffs_*sensor_parameter*.dat", and "SeaIce_regressCoeffs_*sensor_parameter*.dat" where sensor is n18, n19, metopA, metopB, f17, f18, and npp for NOAA-18 AMSU-MHS, NOAA-19 AMSU-MHS, Metop-A AMSU-MHS, Metop-B AMSU-MHS, F17 SSMI/S, F18 SSMI/S, and NPP ATMS respectively, and parameter is tskin, em, temp, wv, clw, and tpw for skin temperature, emissivity, temperature profile, water vapor profile, cloud liquid water, and total precipitable water, respectively.

3.3 Dynamically-Generated Noise Files

These files contain dynamically generated instrument noise values (NEDTs). For AMSU-MHS, the NEDTs are dynamically generated following the methodology as described in Mo (2002). These are considered as more accurate compared to nominal NEDTs. These files reside in the "/data/TestbedData/nedt/" MIRS sub-directory (see also Figure 4). Data content of these files is the same as those of nominal NEDTs and is given in Table 21.

Parameter Name	Type	Description
nChan	Integer	Single value denoting number of channels, e.g., 20 for AMSU-MHS
CentrFreq	Real	Vector with elements containing center frequency values in GHz. Vector index denotes channel number.
nedt	Real	Vector with elements containing noise values in K for each center Frequency. Vector index denotes channel number
Computed or Default Flag	Integer	Vector with elements containing flag values to determine whether the nedt was computed (0), or not (1) in which

		case the nominal nedt value for the channel was used

Table 21. The noise values are part of the Quality Assurance (QA) daily monitoring process.

3.4 Performance Monitoring Files

These are image files in PNG format that contain time series plots of radiometric parameters such as bias, measured and simulated radiances. These files reside in the “/Data/TestbedData/PerfsMonitoring” sub-directory.

Section 4.0 Output Datasets

Output datasets pertaining to MIRS product are described in this section. To get a sense of where these files fit within the MIRS system, the reader is referred to section 1.3 and Figures 1, 3 and 4. The output data files consist of level II binary swath and HDF-EOS files and the image files. The binary swath and image files are the retrieval files generated by MIRS. The HDF-EOS files are derived from binary swath files through format conversion processing.

4.1 Retrieval Files

MIRS retrieval files consist of swath binary and image files and gridded and point-to-point binary files. The swath binary and image files represent primary output products for external access and delivery, whereas the gridded and point to point binary files contain single parameter outputs converted from swath data for map generation and plotting purposes.

The swath (level II) binary files consist of two files: the main product file (*edr*) and the derived product file (*dep*). The *edr* file contains retrieved parameters from 1dvar processing, and the *dep* file contains parameters derived from *edr* as inputs through vertical integration and post-processing algorithms. The TPW parameter in the *dep* product file is derived from retrieved profiles of water vapor, CLW is derived from retrieved profiles of cloud liquid water, Sea Ice Concentration (SIC) is derived from retrieved surface emissivities, etc. The image files are PNG files of specific retrieved or monitoring parameters.

MIRS *edr* swath files reside in the "`/data/TestBedData/Outputs/edr/`" subdirectory and the *dep* swath files reside in the "`/data/TestBedData/Outputs/dep/`" subdirectory. The grid and point-to-point binary files reside in the "`/data/TestBedData/Outputs/grid/`" subdirectory and the image files reside in the "`/data/TestBedData/Outputs/figs/`" sub-directory. Table 22 provides a summary description of these files including their source, function, file naming and format and frequency of use. In the table, details pertaining to the NOAA-18 AMSU-MHS sensor are given as an example.

Data Type	Source	Purpose	Naming	Format	Frequency
Satellite Data	1DVAR	Main MIRS product file containing retrieved EDRs and other ancillary sensor data	EDR_R_SX_NN.Dyydd.Shhmm.Ehhmm.B_.GC(WI,SV).LR.ORB	Binary swath	Near real time
	MIRS main product file	Derived MIRS product file containing post-processing EDRs and other ancillary sensor data	DEP_R_SX_NN.Dyydd.Shhmm.Ehhmm.B_.GC(WI,SV).LR.ORB		
Satellite Data	MIRS grid and point-to-point file	Each grid and point-to-point file contains a single retrieved or monitoring parameter used for ploting and	GRID_n18_yyyymmdd_parameter_node.dat P2P_n18_yyyymmdd_parameter_node.dat	Binary	Near real time

		mapping purposes			
	MIRS figures	Each image file contains a single retrieved or monitoring parameter	mirs_adv_poes_n18_amsuamhs_glb_yyyymd_parameter_sfctype_node.png*	PNG	
* MIRS generates a global image file for parameters contained in the MIRS product file. These global image files are also used for generating the product monitoring figures on the MIRS web site. This example above is given for a map of a parameter generated by the advanced algorithm (adv), 1dvar, for the POES, N18 satellite, AMSU/MHS sensor, global coverage. The parameter in question could be TPW, TSKIN, etc. This map contains only descending orbits (ds), only land measurements are shown (lnd).					

Table 22. MIRS retrieval files

Additional characteristics of primary retrieval files including functionality, access location and content is provided below.

4.1.1 Main Product Binary Swath Files *(level II-a, EDR)*

The MIRS main product swath binary file is generated by MIRS Input/Output modules written in both Fortran-95 and IDL. The code for reading this file is provided in Appendix D. Table 23 gives parameter attribute data contained in the header record and Table 24 lists MIRS retrieved parameters data content characteristics.

Parameter Name	Type	Value Range	Explanation
iTyp	Integer	0-1	Type of output file, e.g., 0 for simple (unretrieved) scene, 1 for retrieved scene. They only differ in the lack (or presence) of convergence metrics respectively.
AlgSN	Integer		Algorithm serial number
nprf	Integer	1-User Specified	Number of profiles
nLay	Integer	1-100	Number of atmospheric layers
nLev	Integer	1-101	Number of atmospheric levels; Equals number of layers plus 1
nChan	Integer	Sensor-specific, User specified	Number of center frequency channels, e.g., 20 for AMSU-MHS
nPosScan	Integer		Number of scan positions
nScanLines	Integer		Number of scan lines
nAbsorb	Integer	1-65	Number of atmospheric absorbing species; In the microwave range, it is usally 1 (for water only) or 2 (water and oxygen)
nParmCLW	Integer	0-User specified	Number of parameters for defining cloud liquid water. It could be nLay if the cloud is in profile form.
nParmRain	Integer	0-User Speficied	Number of parameters for defining rain. It could be nLay if the cloud is in profile form.
nParmSnow	Ingeger	0-User Speficied	Number of parameters for defining falling snow. It could be nLay if the cloud is in profile form.
nParmIce	Integer	0-User Speficied	Number of parameters for defining cloud ice. It could be nLay if the cloud is in profile form.
nParmGrpl	Integer	0-User Specified	Number of parameters for defining graupel ice. It could be nLay if the cloud is in profile form.
AbsorbID	Integer (vect)	1-65	Vector of size equal to the number of atmospheric absorbing species containing the absorbent ID value, e.g., 1 for water.
CentrFreq	Real (vect)	N/A	Vector of size equal to the number of channels containing center frequency values in GHz
polarity	Integer (vect)	1-3	Vector of size equal to the number of channels containing polarization values for each center frequency,
nqc	Integer	4	Number of quality control words for retrievals

Table 23. MIRS main product binary swath output file header record

Parameter	Type	Value Range	Missing Value	Explanation
ProfIndx	Integer	1- user specified	N/A	Profile number (index)
pres_lay	Real (vector)		-999	Vector containing layer pressure in mbar
pres_lev	Real (vector)	N/A	-999	Vector containing level pressure in mbar
Temp_lay	Real (vector)		-999	Vector containing layer temperature in Kelvin
Absorb_lay	Real (array)		-999	Array containing mixing ratio of absorbents for each layer in g/Kg
Clw	Real (vector)		-999	Vector containing cloud liquid water for each layer in mm (if defined in profile)
Rain	Real (vector)		-999	Vector containing rain mass in mm for each layer (if defined in profile)
Graupel	Real (vector)		-999	Vector containing graupel mass for each layer in mm (if defined in profile)
Emiss	Real (vector)	0-1	-999	Vector containing surface emissivity
Refl	Real(vector)	0-1	-999	Vector containing surface reflectivity
WindSp	Real		-999	Wind speed in m/s
Tskin	Real		-999	Skin temperature in Kelvin
DeltaT	Real		-999	Delta temperature
SfcPress	Real		-999	Surface pressure in mbar
iSfcTyp	Integer		-999	Surface type, 0: ocean, 1: sea ice ice, 2: land and 3: snow
qc	Integer (vector)		N/A	Quality control words for retrievals of size nqc
snowdepth	Real		N/A	Snow depth in mm
SWE	Real		N/A	Snow Water Equivalent in cm
soilMoist	Real		N/A	Soil moisture
lat	Real		-999	Geographical latitude in degrees
lon	Real		-999	Geographical longitude in degrees
node	Integer		N/A	Node ID, 0 for ascending and 1 for descending
RelAziAngle	Real		N/A	Single value denoting relative azimuth angle in Degrees
SolZanAngle	Real		N/A	Single value denoting solar zenith angle in Degrees
scanUTC	Real		-999	Scan time of day in sec:msec
scanYear	Integer		-999	Scan year, e.g., 1999
scanDay	Integer		-999	Scan Julian day, e.g., 255
iscanPos	Integer		-999	Scan position
iScanLine	Integer		-999	Scan line index
WindU	Real		-999	Wind speed in the U direction (m/s)
WindV	Real		-999	Wind Speed in the V direction (m/s)
nAttempt	Integer		-999	Number of retrieval attempts. Only when iTyp =1
nIter	Integer		-999	Number of iterations. Only when iTyp =1 (retrieval)
Chisq	Real		-999	Chi Square (converge metric). Only when iTyp =1
YFwd	Real (vector)			Vector of last iteration simulated brightness temperature. values in K at each frequency channel. Only when iTyp =1
Ym	Real (vector)			Vector containing footprint-matched brightness temperatures in K at each frequency channel. Only when iTyp = 1
YmCorr	Real (vector)			Vector containing bias-corrected brightness temperatures in K at each frequency channel. only when Typ = 1
ChanSel	Integer (Vector)			Vector of nChan integer elements of values zero and one denoting channels selected for retrievals
DescTypAtm	Character			Label of the Atmospheric class
DescTypSfc	Character			Label of the Surface class
iH2O	Integer		-999	Index of H2O (within absorb vector) = 1
iO3	Integer		-999	Index of O3 (within absorb vector) = 3

Table 24. MIRS main product binary swath output file data record

4.1.2 Derived Product Binary Swath Files (*level II-a, DEP*)

The MIRS Derived Product (DEP) swath binary file is generated by MIRS Input/Output modules written in both Fortran-95 and IDL. The Fortran code for reading derived swath product data is provided in Appendix D. Table 25 gives parameter attribute data contained in the header record and Table 26 lists derived parameters data content characteristics.

Parameter Name	Type	Value Range	Explanation
iTyp	Integer	0-1	Type of output file, e.g., 0 for simple (unretrieved) scene, 1 for retrieved scene. They only differ in the lack (or presence) of convergence metrics respectively.
AlgSn	Integer		Algorithm serial number
nprf	Integer	1-User Specified	Number of profiles
nPosScan	Integer	Sensor Specific	Number of scan positions
nScanLines	Integer	Sensor Specific	Number of scan lines

Table 25. MIRS derived product binary swath output file header record

Parameter	Type	Value Range	Missing Value	Explanation
ProfIndx	Integer	1- user specified	N/A	Profile number (index)
iTypAtm	Integer	0-1	-999	Retrieval type for atmospheric parameters, 0 for simple (unretrieved) scene, 1 for retrieved scene.
TPW	Real	N/A	-999	The total precipitable water in mm
CLW	Real	N/A	-999	The integrated Cloud Liquid Water in mm
RWP	Real		-999	The integrated Rain Water Path*
SWP	Real		-999	The integrated Snow Water Path*
IWP	Real		-999	The integrated Ice Water Path*
GWP	Real		-999	The Integrated Groupel Water Path*
RR	Real		-999	Rain Rate*
SFR	Real		-999	The snow Rate*
CldTop	Real		-999	Cloud top height*
Cldbase	Real		-999	Cloud base height *
CldThick	Real		-999	Cloud thickness*
PrecipType	Integer		-999	Precipitation type*
RainFlag	Integer		-999	Flag to indicate raining profile*
LWP	Real		-999	Liquid Water path
iTypSfc	Integer	1-4	N/A	Surface type, 0 indicates “ocean”, 1 indicates “sea ice’, 2 indicates “land’ and 3 indicates “snow cover”
SWE	Real		-999	The Snow Water Equivalent in cm*
SnowGS	real		-999	Snow effective grain size in mm
SIC	Real	5-100	-999	The sea ice concentration in percent*
SIC_FY	Real	5-100	-999	The first-year sea ice type concentration in percent *
SIC_MY	Real	5-100	-999	The multi-year sea ice type concentration in percent *
SnowCover	Integer	0,1	N/A	Snow cover over land,, 1 denotes snow cover and 0 denotes snow-free land*
SM	Real		-999	Soil moisture*
WindSp	Real		-999	Windspeed *
WindDir	Real		-999	Wind direction*
WindU	IReal		-999	Windspeed in the U direction
WindV	Real			Wind speed in the V direction*
qc	Integer (vector)			Quality control words of size nqc
Lat	Real		-999	Geographical latitude in degrees
Lon	Real		-999	Geographical longitude in degrees
node	Integer		-999	Node, 1 for descending and 0 for ascending
scanUTC	Real		-999	Scan time in sec.msec

scanYear	Integer		-999	Scan year, e.g., 1999
scanDay	Integer		-999	Yulian day, e.g., 255
iScanPos	Integer		-999	Scan position
iScanLine	Integer		-999	Scan line index
angle	Real		-999	Local zenith angle in degrees
nIter	Integer		-999	Number of iterations for convergence reached
Chisq	Real		-999	Chi square
DescTypAtm	character			Label of the Atmospheric class
DescTypSfc	character			Label of the Surface class

** Some of these derived products may not be part of the operational delivery at this point. See accompanying memo for specific product status information*

Table 26. MIRS derived product binary swath output file data record

4.1.3 Image Files

The image files are used for mapping of a specific retrieved or monitoring parameter. They reside in the "/TestbedData/Outputs/figs" subdirectory. The file naming convention of the image files is as follows:
mirs_*alg*_*satellite*_sensor_*region*_yyymmdd_*parameter*_*sfctype*_*node*.png

where:

alg - refers to the algorithm used, e.g., "*her*" denotes the heritage algorithm and "*adv*" denotes the advanced algorithm.

Satellite – refers to the satellite name, e.g, "poes_n18" , "poes_metopA" and "dmsp_f17" denote the POES NOAA-18 and METOP-A and DMSP satellites, respectively,

Sensor - refers to sensor name, e.g, "amsuamhs" and "ssmis" denote the AMSU-MHS and SSMIS sensors, respectively.

region –refers to the coverage area of the particular figure:. For instance, the "*glb*" notation means that the coverage is global.

yyymmdd – refers to time in year, month and day of month format, e.g., 20071125 denotes November 25, 2007.

parameter -refers to the retrieved or monitoring parameter
sfctype– refers to surface type, e.g., "lnd" over land, "sea" over water and "all" over both land and water

node– refers to the sensor node, e.g. "as" for ascending and "ds" for descending.

4.2 HDF-EOS Swath Files *(level II-a, EDR)*

For the operational data distribution and archiving, MIRS output data will be reformatted as HDF-EOS files. Each MIRS output EDR binary data file will be rewritten as 2 HDF-EOS files. One is the profile HDF-EOS file which contains the retrieved atmospheric profile products for each layer and the other one is the image product HDF-EOS file which contains the retrieved image products.

The MIRS reformatting process will follow each orbit product generating process. First the products are read out at each retrieval spot from the binary orbit output file, the position indexes are checked and the output is written into an intermediate file. Then the output data are regrouped: each product of the whole orbit is put into a swath array based on scan number and the FOV index. Finally the HDF-EOS swath structures are defined and the product arrays are written into the HDF-EOS swath. Tables Table **27** and Table **28** give MIRS HDF-EOS swath attributes and data content characteristics respectively.

Parameter Name	Data Type	Explanation
Temp_Limits	R*4	Lower and upper limits of temperatures (K)
Temp_SCAL	R*4	Scaling factor of antenna temperature
PVapor_SCAL	R*4	Scaling factor of total precipitable water
PCloud_SCAL	R*4	Scaling factor of cloud liquid water
Layer_pres	R*4 (1:100)	Pressures of the products profile layers
Total_scan	I*2	Total number of scans in the data
Num_fov	I*2	Number of FOVs in the orbit data
Num_layer	I*2	Number of layers for profiles
Num_qcatm	I*2	Number of atmosphere QC parameters
Num_qcsfc	I*2	Number of surface QC parameters

Table 27. MIRS HDF-EOS swath attributes

Parameter Name	Data Type and (Dimension)	Missing Data Value	Scale	Explanation
ScanTime_year	I*2 (1)	-999	1	Four digit calendar year (e.g., 1999)
ScanTime_doy	I*2 (1)	-999	1	Day of year (e.g., 1-366)
Latitude	R*4 (2)	-999	1	Latitude (degrees, e.g., -90 to 90)
Longitude	R*4 (2)	-999	1	Longitude (degrees, e.g., -180 to 180)
TimeUTC	R*8 (1)	-999	1	Number of seconds and fractions since 0000 UTC Jan. 1, 1993 (TAI93)
Atm_type	I*2 (2)	-999	1	Atmosphere type: 1=global
Sfc_type	I*2 (2)	-999	1	Surface Type: 0=ocean, 1=sea-ice, 2=land and 3 =snow cover.

Qc_atm	I*2 (2)	-999	1	Quality flag for retrievals: 0=retrieval; 1=no retrieval (default to background value).
Qc_sfc	I*2 (2)	-999	1	Quality flag for retrievals: 0=retrieval; 1=no retrieval (default to background value).
Chisqr	R*4 (2)	-999	1	Convergence rate: good retrievals with Chisqr <= 3; less reliable retrievals with 3< Chisqr <=10; unreliable retrieval with Chisqr > 10.
Orbit_mode	I*2 (1)	-999	1	Orbit direction: 0=ascending; 1=descending.
LZ_angle	R*4 (2)	-999	1	Local zenith angle range (degrees) Ranges from -59 to 59
pTemp	UI*2 (3)	bkv	100	Temperature profiles containing layer temperature in Kelvin
pVapor	UI*2 (3)	bkv	2000	Water Vapor profiles containing mixing ratio of absorbents for each layer in g/kg
pClw	UI*2 (3)	bkv	2000	Cloud profiles containing mixing ratio of cloud particles for each layer in g/kg.
pRain	UI*2 (3)	bkv	2000	Cloud profiles containing: rain particle amounts for each layer in kg/m^2 or mm.
pGraupel	UI*2 (3)	bkv	2000	Cloud profiles containing: graupel particle amounts for each layer in kg/m^2 or mm.
pSnow	UI*2 (3)	bkv	2000	Cloud profiles containing: snow particle particle amounts for each layer in kg/m^2 or mm.
pIce	UI*2 (3)	bkv	2000	Cloud profiles containing: ice particle amounts for each layer in kg/m^2 or mm.
Note1 : For Dimensions 1 : scan ; 2: scan*spot ; 3: scan*spot*layer				
Note 2: Error Flags Flag Value Explanation -999 Missing product bkv Background values used when no retrievals available				

Table 28. MIRS HDF-EOS swath data record

4.3 NetCDF 4 Swath Files ((*level II-a,* SND/IMG)

The NetCDF4 data format is a user driven format for MIRS processing of NPP ATMS data in the NPOESS Data Exploitation (NDE) environment. The format adheres to the Climate and Forecast metadata convention and ISO 19115 compliant NOAA Center for Satellite Applications and Research (STAR) metadata header template for NDE products. The MIRS software package

contains the necessary source code to encode MIRS EDR and DEP binary swath file content into NetCDF4. The MIRS sounding products are written to the "SND" prefixed file, while surface and precipitation products are written to the "IMG" prefixed file. Table 29 displays the metadata header information contained within the SND and IMG files, while Table **30** and Table **31** display the contents of those files, respectively. The file naming convention follows:
NPR-MIRS-SND_vX_NPP_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc and
NPR-MIRS-IMG_vX_satId_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc

where:

vX - refers to the algorithm release or version number,

satId – refers to the satellite name (e.g. NPP),

sYYYYMMDDHHMMSSS – refers to the granule or orbit start time year, month, day, hour, minute, second, and tenths of second,

eYYYYMMDDHHMMSSS – refers to the granule or orbit end time year, month, day, hour, minute, second, and tenths of second,

cYYYYMMDDHHMMSSS – refers to the MIRS output file creation time year, month, day, hour, minute, second, and tenths of second.

The default location for the output .nc files is in data/TestbedData/Outputs/nc, however this may be controlled through the PCF.

Parameter Name	Data Type	Explanation
Dimension Class		
Scanlines	I*32	Number of scanlines
Field_of_view	I*32	Number of fields of view
P_Layer	I*32	Number of vertical pressure layers
P_Level	I*32	Number of vertical pressure levels
Channel	I*32	Number of instrument channels
Qc_dim	I*32	Dimension of Quality Control array
Global Attributes		
missing_value	I*32	Value of missing data
cdf_version	R*64	NetCDF4 version
alg_version	I*32	Science algorithm version number
Conventions	String	NetCDF4 conventions version
Metadata_Conventions	String	Metadata conventions version
standard_name_vocabulary	String	Source of metadata vocabulary

project	String	Project name
title	String	Product name
summary	String	Description of products contained
date_created	String	File creation date/time
institution	String	Institution of file creator (processing center)
naming_authority	String	Domain of file creator
satellite_name	String	Satellite name products derived from
instrument_name	String	Instrument/sensor name products derived from
creator_name	String	Algorithm creator institution
creator_email	String	Algorithm creator email address
creator_url	String	Algorithm creator web url
publisher_name	String	Institution of data dissemination
publisher_email	String	Institution of data dissemination email
publisher_url	String	Institution of data dissemination web url
Metadata_Link	String	(optional/unused)
references	String	Algorithm documentation link
history	String	Algorithm history description
processing_level	String	Data processing level (e.g. Level II)
source	String	Input file name
time_coverage_start	String	Data coverage start time
time_coverage_end	String	Data coverage end time
cdm_data_type	String	Data type (e.g. Swath data)
geospatial_lat_units	String	Latitude units
geospatial_lon_units	String	Longitude units
geospatial_lat_resolution	I*4	Latitude resolution
geospatial_lon_resolution	I*4	Longitude resolution
geospatial_first_scanline_first_fov_lat	R*32	Latitude of first scanline/first FOV
geospatial_first_scanline_first_fov_lon	R*32	Longitude of first scanline/first FOV
geospatial_first_scanline_last_fov_lat	R*32	Latitude of first scanline/last FOV
geospatial_first_scanline_last_fov_lon	R*32	Longitude of first scanline/last FOV
geospatial_last_scanline_first_fov_lat	R*32	Latitude of last scanline/first FOV
geospatial_last_scanline_first_fov_lon	R*32	Longitude of last scanline/last FOV
geospatial_last_scanline_last_fov_lat	R*32	Latitude of last scanline/last FOV
geospatial_last_scanline_last_fov_lon	R*32	Longitude of last scanline/last FOV
total_number_retrievals	I*32	Total number of FOVs (scenes) in file
percentage_optimal_retrievals	R*32	Total percentage of optimal quality retrievals in file
percentage_suboptimal_retrievals	R*32	Total percentage of suboptimal quality retrievals in file
percentage_bad_retrievals	R*32	Total percentage of bad quality (failed) retrievals in file
id	String	Unique identifier for output data file

Table 29. Metadata header contents for MIRS NetCDF4 product data files. The metadata is identical for both SND and IMG files

Parameter Name	Dimension	Data Type/ (Scale Factor)	Explanation
Atm_type	Scanline x Field_of_view	I*16	Atmospheric classification (currently missing)
ChiSqr	Scanline x Field_of_view	R*32	Convergence metric
Freq	Channel	R*32	Instrument chan. central frequencies (GHz)
LZ_angle	Scanline x Field_of_view	R*32	Scene local zenith angle (degrees)
Latitude	Scanline x Field_of_view	R*32	Latitude (degrees)
Longitude	Scanline x Field_of_view	R*32	Longitude (degrees)
Orb_mode	Scanline x Field_of_view	I*16	0-ascending, 1-descending (orbit node)
PClw	Scanline x Field_of_view x P_Layer	R*32	Cloud liquid water profile (mm)
PGraupel	Scanline x Field_of_view x P_Layer	R*32	Graupel water profile (mm)
PIce	Scanline x Field_of_view x P_Layer	R*32	Ice water profile (mm)
PRain	Scanline x Field_of_view x P_Layer	R*32	Rain water profile (mm)
PSnow	Scanline x Field_of_view x P_Layer	R*32	Snow water profile (mm)
PTemp	Scanline x Field_of_view x P_Layer	R*32	Temperature Profile (K)
PVapor	Scanline x Field_of_view x P_Layer	R*32	Water vapor profile (g/kg)
Player	P_Layer	R*32	Pressure layer grid (hPa)
Plevel	P_Level	R*32	Pressure level grid (hPa)
Polo	Channel	I*16	Instrument chan. polarizations
Qc	Scanline x Field_of_view x Qc_dim	I*16	QC array: QC(0) 0-good, 1-use with caution, 2-bad
RAzi_angle	Scanline x Field_of_view	R*32	Relative Azimuth angle (degrees)
SZ_angle	Scanline x Field_of_view	R*32	Satellite Zenith angle (degrees)
ScanTime_UTC	Scanline x Field_of_view	R*64	Number of seconds since 00:00:00 UTC
ScanTime_dom	Scanline x Field_of_view	I*16	Scan time day of month
ScanTime_doy	Scanline x Field_of_view	I*16	Scan time day of year
ScanTime_hour	Scanline x Field_of_view	I*16	Scan time hour of day
ScanTime_minute	Scanline x Field_of_view	I*16	Scan time minute of hour
ScanTime_month	Scanline x Field_of_view	I*16	Scan time calendar month
ScanTime_second	Scanline x Field_of_view	I*16	Scan time second of minute
ScanTime_year	Scanline x Field_of_view	I*16	Scan time calendar year
Sfc_type	Scanline x Field_of_view	I*16	Surface classification
SurfP	Scanline x Field_of_view	I*16 (10)	Surface pressure value

Table 30. MIRS SND file contents

Parameter Name	Dimension	Data Type/ (Scale Factor)	Explanation
Atm_type	Scanline x Field_of_view	I*16	0-simple scene, 1-retrieved scene
BT	Scanline x Field_of_view x Channel	I*16 (100)	Corrected channel brightness temperature (K)
CLW	Scanline x Field_of_view	I*16 (100)	Integrated cloud liquid water (mm)
ChanSel	Scanline x Field_of_view x Channel	I*16	Channels used for retrieval
ChiSqr	Scanline x Field_of_view	R*32	Convergence metric
CldBase	Scanline x Field_of_view	I*16 (10)	Cloud base height (hPa)
CldThick	Scanline x Field_of_view	I*16 (10)	Cloud thickness (hPa)
CldTop	Scanline x Field_of_view	I*16 (10)	Cloud top height (hPa)
Emis	Scanline x Field_of_view x Channel	I*16 (10000)	Surface emissivity vector
Freq	Channel	R*32	Instrument center frequency (GHz)
GWP	Scanline x Field_of_view	I*16 (100)	Integrated graupel liquid water (mm)
IWP	Scanline x Field_of_view	I*16 (100)	Integrated ice liquid water (mm)
LWP	Scanline x Field_of_view	I*16 (100)	Integrated liquid (rain+cloud) water (mm)
LZ_angle	Scanline x Field_of_view	R*32	Local zenith angle (degrees)
Latitude	Scanline x Field_of_view	R*32	Latitude (degrees)
Longitude	Scanline x Field_of_view	R*32	Longitude (degrees)
Orb_mode	Scanline x Field_of_view	I*16	0-ascending, 1-descending (orbit node)
Polo	Channel	I*16	Instrument chan. polarizations
PrecipType	Scanline x Field_of_view	I*16	Precipitation type (frozen/liquid)
Qc	Scanline x Field_of_view x Qc_dim	I*16	QC array: QC(0) 0-good, 1-use with caution, 2-bad
RAzi_angle	Scanline x Field_of_view	R*32	Relative Azimuth angle (degrees)
RFlag	Scanline x Field_of_view	I*16	Rain flag
RR	Scanline x Field_of_view	I*16 (10)	Rain Rate (mm/h)
RWP	Scanline x Field_of_view	I*16 (100)	Integrated rain water (mm)
SFR	Scanline x Field_of_view	I*16 (100)	Snowfall Rate (mm/h)
SIce	Scanline x Field_of_view	I*16	Sea-ice Concentration (%)
SIce_FY	Scanline x Field_of_view	I*16	First-year SIC (%)
SIce_MY	Scanline x Field_of_view	I*16	Multi-year SIC (%)
SWE	Scanline x Field_of_view	I*16	Snow water equivalent (cm)
SWP	Scanline x Field_of_view	I*16 (100)	Integrated snow water (mm)
SZ_angle	Scanline x Field_of_view	R*32	Satellite zenith angle (degrees)
ScanTime_UTC	Scanline x Field_of_view	R*64	Number of seconds since 00:00:00 UTC
ScanTime_dom	Scanline x Field_of_view	I*16	Scan time day of month
ScanTime_doy	Scanline x Field_of_view	I*16	Scan time day of year
ScanTime_hour	Scanline x Field_of_view	I*16	Scan time hour of day
ScanTime_minute	Scanline x Field_of_view	I*16	Scan time minute of hour
ScanTime_month	Scanline x Field_of_view	I*16	Scan time calendar month
ScanTime_second	Scanline x Field_of_view	I*16	Scan time second of minute
ScanTime_year	Scanline x Field_of_view	I*16	Scan time calendar year

Sfc_type	Scanline x Field_of_view	I*16	Surface classification
Snow	Scanline x Field_of_view	I*16	Snow cover flag
SnowGS	Scanline x Field_of_view	I*16 (100)	Snow grain size (mm)
SurfM	Scanline x Field_of_view	I*16 (10)	Surface (soil) moisture
SurfP	Scanline x Field_of_view	I*16 (10)	Surface pressure value
TPW	Scanline x Field_of_view	I*16 (10)	Total precipitable water (mm)
TSkin	Scanline x Field_of_view	I*16 (100)	Skin temperature
WindDir	Scanline x Field_of_view	I*16 (100)	Wind direction (degrees)
WindSp	Scanline x Field_of_view	I*16 (100)	Wind speed (m/s)
WindU	Scanline x Field_of_view	I*16 (100)	Wind speed U vector (m/s)
WindV	Scanline x Field_of_view	I*16 (100)	Wind speed V vector (m/s)
YM	Scanline x Field_of_view x Channel	I*16 (100)	Uncorrected channel brightness temperature (K)

Table 31. MIRS IMG file contents

4.4 MIRS Products Monitoring Figures

Extensive use of advanced product monitoring tools and techniques is implemented in MIRS. These tools provide opportunities for users to monitor MIRS retrieved parameters qualitatively and quantitatively. Some of MIRS monitoring capabilities include:

- Product QC monitoring
- Advanced versus heritage algorithm retrievals
- Time series
- Climate
- Cross-sensor inter-comparison
- Cross-talk assessment
- Geophysical performances monitoring
- Radiometric performances monitoring
- Angle dependence monitoring (Asymmetry)
- Validation

Figure 7 below provides an example of the on-line MIRS Product Monitoring Menu. Up to four panel selections are available. Figure 8 provides an example of geophysical performance monitoring of MIRS TPW versus ECMWF TPW.

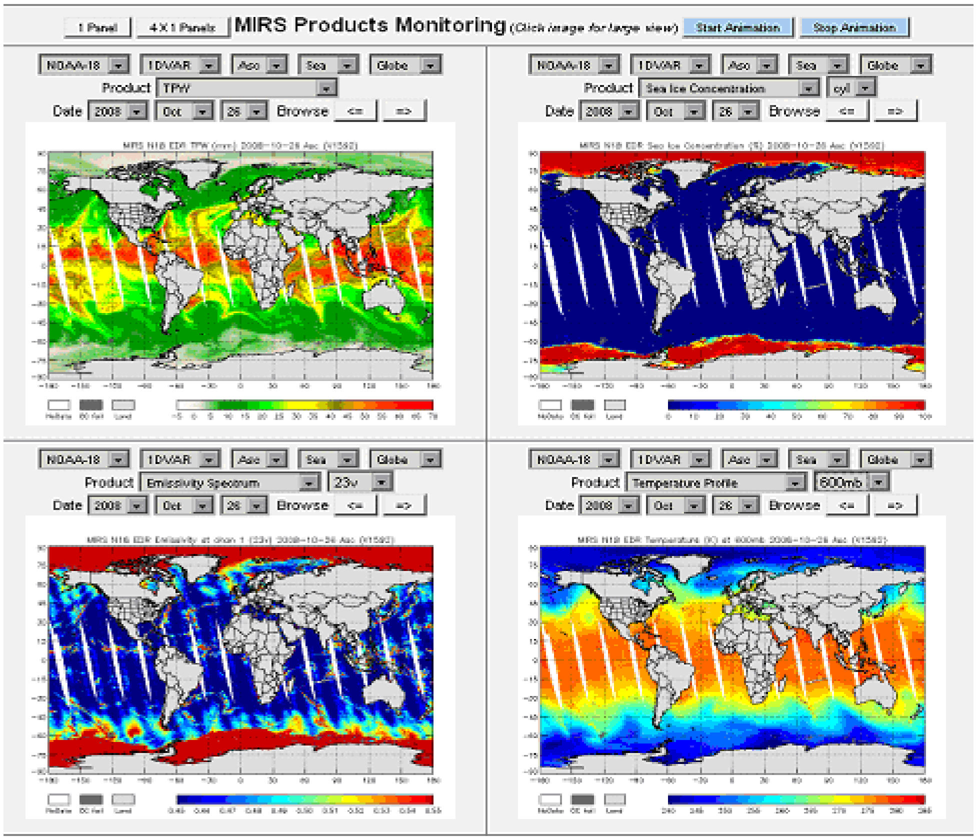

Figure 7. MIRS Product Monitoring Menu

The user is able to choose what plots to display for every panel. The panels will allow the comparison between sensors, between products (from the same sensor), between different dates (time series or animated variability of same product from same sensor), between different algorithms, between ascending/descending orbits, etc.

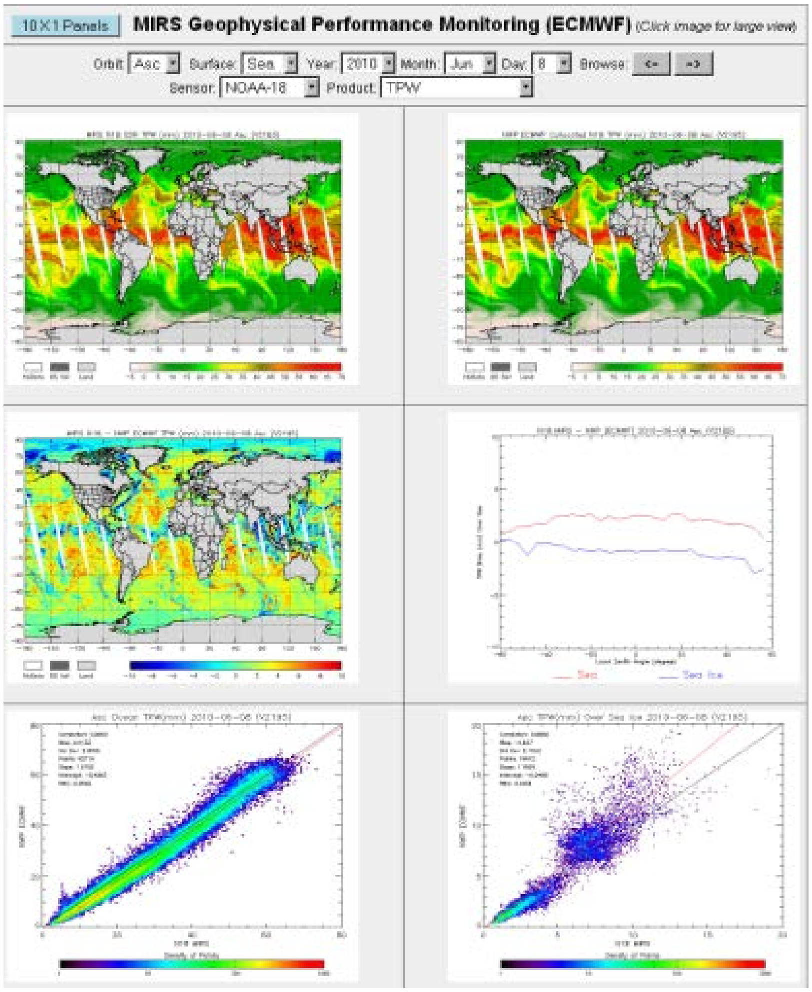

Figure 8. Example of MIRS geophysical performances monitoring of TPW versus TPW obtained from ECMWF data.

Appendix A. Acronyms and Abbreviations

Acronym	Definition
1DVAR	One dimensional variational assimilation
AD	Adjoint
ADA	Advanced Double-Adding
AMSU	Advanced Microwave Sounding Unit
AOI	Area-Of-Interest
ASCII	American Standard Code for Information Interchange
ATBD	Algorithm Theoretical Basis Document
ATMS	Advanced Technology Microwave Sounder
CLW	Non-Precipitating Liquid Cloud Amount
CRTM	Community Radiative Transfer Model
DoD	Department of Defense
DAP	Delivery Algorithm Package
GUI	Graphical User Interface
GDAS	Global Data Assimilation System
EDR	Environmental Data Records (Geophysical parameters)
ECMWF	European Center for Medium-range Weather Forecast
EOF	Empirically Orthogonal Function
EOS	Earth Observing System
FM	Footprint-Matched
HRC	Hurricane Research Center
ICD	Interface Control Document
IST	Ice Surface Temperature
IWP	Ice Water Path
SFR	Snow Fall Rate
JCSDA	Joint Center for Satellite Data Assimilation
LST	Land Surface Temperature
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NDE	NPOESS Data Exploitation
NEDT	Noise Equivalent Delta Temperature
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project
MVS	Minimum variance solution
MCP	MIRS Control Panel

Acronym	Definition
METOP	Meteorological Operational Polar Satellite
MHS	Microwave Humidity Sounder
MIRS	Microwave Integrated Retrieval System
MOMT	MIRS Online Monitoring Tool
MPS	Maximum probability solution
MSPPS	Microwave Surface & Precipitation Products System
OPTRAN	Optical Path TRANsmittance
OSPO	Office of Satellite and Product Operations
PCF	Paths & Configuration File
QC	Quality Control
OM	MIRS Operations Manual
QP	Quality parameters
RWP	Rain Water Path
RR	Rain Rate
TDR	Temperature Data Record
TL	Tangent Linear
TPW	Total Precipitable Water
SCS	Sequence Control Scripts
SDD	System Description Document
SDR	Sensor Data Record
SSM/I	Special Sensor Microwave Imager
SST	Sea Surface Temperature
STAR	Center for Satellite Applications and Research
UM	User’s Manual
VIPP	Vertical Integration & Post-Processing

Appendix B. File Naming Convention

MIRS intermediate and output files follow the naming convention described in this appendix. For consistency and for keeping a one-to-one relationship between the original data (sensor data) and the MIRS-generated files, the MIRS convention is to keep the name of the original data and add to it an extension to form the name of the MIRS files. The table below describes these extensions. The original files could either be the level-1b data for the case of AMSU and MHS (NOAA, METOP), or the TDR files from the DMSP sensors (SSMI, SSMI/S). The following table describes succinctly the MIRS-generated files and shows, for reference, the correspondence between the adopted convention and the naming convention usually adopted for DMSP sensors. Note that MIRS system starts the processing from the level-1b data, geo-located and calibrated (or with calibration coefficients readily available for calibration application). Level-1a is also included in the table for reference purposes but it is not used within MIRS.

File naming	Description	Usage in MIRS	Correspondence in DMSP convention
Level-1a	Raw count data	Not used.	RDR
Level-1b	Sensor data file, generated from external sources. This is the first file used in MIRS. It contains instrument counts with calibration and geolocation information attached.	Input to the MIRS system, format, content, etc depends on the sensor. Generated from the *rdr2tdr* sub-program which capabilities range from a simple converter to the internal format or sometimes a full raw data decoder, depending upon requirements.	TDR
Level-1c	Brightness temperature file. This assumes that antenna pattern corrections have been applied, but still assumes the original spatial resolutions (channel-dependent).	Internally generated by the *tdr2sdr* sub-program.	SDR
Level-1d	Footprint matched brightness temperatures file. At this file, all channels have been processed to the same field of view.	Generated internally by the footprint matching process. The process of FM could be either based on simple averaging or based on more sophisticated approaches (Backus-Gilbert methodology for instance).	FM-SDR
Level-1e	Bias-corrected, footprint-matched brightness temperatures file. In this file, the bias between the data and the forward operator has been removed.	Generated internally by the *fmsdr2ecfmsdr* sub-program.	EC-FM-SDR
Level-2a	Retrieval file at swath reference	Output from MIRS. Several format (binary, HDF-EOS, etc)	EDR
Level-3a	Time-averaged daily composite file	Post-processing of the output (level-2a) from the MIRS system	-
Level-3b	Time-averaged weekly composite file	Post-processing of a weeks worth of outputs (level-2a) from the MIRS system	-
Level-3c	Time-averaged monthly composite file	Post-processing of a months worth of outputs (level-2a) from the MIRS system	-

Appendix C. References

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T. Mo, "Calibration of the Advanced Microwave Sounding Unit-A radiometers for NOAA-N and NOAA-N'", NOAA technical report; NESDIS 106, 2002

Appendix D. Reading Modules for Binary Swath Main and Derived Output Files

Fortran-95 code
File: IO_Scene.f90
MIRS directory path: "../mirs/src/lib/io
Purpose: Reads MIRS main product output file

```
SUBROUTINE ReadHdrScene(iu,InputFile,Scene,nprf)
    CHARACTER(LEN=*)      :: InputFile
    INTEGER               :: iu,nPrf
    TYPE(Scene_type)      :: Scene
    !---Open file
    iu=get_lun()
    OPEN(iu,file=InputFile,form='unformatted')
    READ(iu)  Scene%iTyp,Scene%AlgSN!iTyp: =0->Simple Scene, =1->Retrieved Scene
    READ(iu)  nprf
    READ(iu)  Scene%nLay
    READ(iu)  Scene%nLev
    READ(iu)  Scene%nChan
    READ(iu)  Scene%nPosScan
    READ(iu)  Scene%nScanLines
    READ(iu)  Scene%nAbsorb
    READ(iu)  Scene%nParmCLW
    READ(iu)  Scene%nParmRain
    READ(iu)  Scene%nParmSnow
    READ(iu)  Scene%nParmIce
    READ(iu)  Scene%nParmGrpl
    ALLOCATE(Scene%AbsorbID(1:Scene%nAbsorb),Scene%CentrFreq(1:Scene%nchan),&
         Scene%polarity(1:Scene%nchan))
    READ(iu)  Scene%AbsorbID(1:Scene%nAbsorb)
    READ(iu)  Scene%CentrFreq(1:Scene%nchan)
    READ(iu)  Scene%polarity(1:Scene%nchan)
    READ(iu)  Scene%nqc
    !---Find the indexes for H2O and O3 gases
    Scene%iH2O = FindIndx(Scene%AbsorbID,H2OID)
    Scene%iO3  = FindIndx(Scene%AbsorbID,O3ID)
    !---Allocate the arrays for future reading
    ALLOCATE(Scene%pres_lay(1:Scene%nLay),Scene%Temp_lay(1:Scene%nLay), &
         Scene%Absorb_lay(1:Scene%nLay,1:Scene%nAbsorb),                &
         Scene%Clw(1:Scene%nParmCLW),Scene%Rain(1:Scene%nParmRain),     &
         Scene%Snow(1:Scene%nParmSnow),Scene%Ice(1:Scene%nParmIce),     &
         Scene%Graupel(1:Scene%nParmGrpl),Scene%Emiss(1:Scene%nchan),   &
         Scene%Refl(1:Scene%nchan),Scene%pres_lev(1:Scene%nLev),        &
         Scene%qc(1:Scene%nqc),Scene%YFwd(1:Scene%nchan),               &
         Scene%ChanSel(1:Scene%nchan),Scene%Ym(1:Scene%nchan),          &
         Scene%YmCorr(1:Scene%nchan))
    RETURN
  END SUBROUTINE ReadHdrScene
```

```
\SUBROUTINE ReadScene(iu,Scene,ierr)
    TYPE(Scene_type)   :: Scene
    INTEGER            :: iu,ierr
    ierr=0
    READ(iu,iostat=ierr,end=10) Scene%ProfIndx
    IF (ierr.ne.0) THEN
       ierr=Warn_readInvalid
       CALL ErrHandl(WarningType,Warn_readInvalid,'Scene invalid.')
       RETURN
    ENDIF
    !---Atmospheric constituents
    READ(iu,err=20) Scene%pres_lay(1:Scene%nLay)
    READ(iu,err=20) Scene%pres_lev(1:Scene%nLev)
    READ(iu,err=20) Scene%Temp_lay(1:Scene%nLay)
    READ(iu,err=20) Scene%Absorb_lay(1:Scene%nLay,1:Scene%nAbsorb)
    !---hydrometeors
    READ(iu,err=20) Scene%Clw(1:Scene%nParmCLW)
    READ(iu,err=20) Scene%Rain(1:Scene%nParmRain)
    READ(iu,err=20) Scene%Graupel(1:Scene%nParmGrpl)
    Scene%Snow(1:Scene%nParmSnow) =0.
    Scene%Ice(1:Scene%nParmIce)   =0.
    !---Emissivity/reflectivity vectors
    READ(iu,err=20) Scene%Emiss(1:Scene%nchan)
    !---Surface-level paremeters
    READ(iu,err=20)
Scene%angle,Scene%WindSp,Scene%Tskin,Scene%SfcPress,Scene%iTypSfc,Scene%WindU,S
cene%WindV,&
         Scene%RelAziAngle,Scene%SolZenAngle,Scene%SnowDepth
    !---QC variables
    READ(iu,err=20) Scene%qc(1:Scene%nqc)
    !---Positioning variables
    READ(iu,err=20)
Scene%lat,Scene%lon,Scene%node,Scene%scanUTC,Scene%scanYear,Scene%scanDay,Scene
%iscanPos,Scene%iscanLine
    !---In case the scene is a retrieved one
    IF (Scene%iTyp .eq. 1) THEN
       READ(iu,err=20) Scene%nAttempt,Scene%nIter,Scene%ChiSq
       READ(iu,err=20) Scene%YFwd(1:Scene%nchan)
       READ(iu,err=20) Scene%ChanSel(1:Scene%nchan)
       READ(iu,err=20) Scene%Ym(1:Scene%nchan)
       READ(iu,err=20) Scene%YmCorr(1:Scene%nchan)
    ENDIF
    RETURN
10  CONTINUE
    ierr=Warn_EndOfFile
    CALL ErrHandl(WarningType,Warn_EndOfFile,'')
    RETURN
20  ierr=Warn_readInvalid
    CALL ErrHandl(WarningType,Warn_readInvalid,'(ReadMeasurements)')
    RETURN
  END SUBROUTINE ReadScene
```

Fortran-95 code
File: IO_DEP.f90
MIRS directory path: "../mirs/src/lib/io
Purpose: Reads the MIRS derived product output file

```
SUBROUTINE ReadHdrDEP(iu,InputFile,DEP,nprf)
    CHARACTER(LEN=*)      :: InputFile
    INTEGER               :: iu,nPrf
    TYPE(DEP_type)        :: DEP
    !---Open file
    iu=get_lun()
    OPEN(iu,file=InputFile,form='unformatted')
    READ(iu) DEP%iTyp,DEP%AlgSN               !iTyp=0->Simple Scene, =1->Retrieved
Scene
    READ(iu) nprf
    READ(iu) DEP%nPosScan
    READ(iu) DEP%nScanLines
    RETURN
  END SUBROUTINE ReadHdrDEP
```

```
 SUBROUTINE ReadDEP(iu,DEP,ierr)
    TYPE(DEP_type)   :: DEP
    INTEGER          :: iu,ierr
    READ(iu,iostat=ierr,end=10) DEP%ProfIndx
    IF (ierr.ne.0) THEN
       CALL ErrHandl(WarningType,Warn_readInvalid,'DEP invalid.')
       RETURN
    ENDIF
    !---Atmospheric , cloud and hydrometeors constituents
    READ(iu) DEP%iTypAtm,DEP%TPW,DEP%Clw,DEP%RWP,DEP%SWP,      &
         DEP%IWP,DEP%GWP,DEP%RR,DEP%SFR,DEP%CldTop,DEP%CldBase, &
         DEP%CldThick,DEP%PrecipType,DEP%RainFlag,DEP%LWP
    !---Surface parameters
    READ(iu)  DEP%iTypSfc,DEP%SWE,DEP%SnowCover,DEP%SM,DEP%SIC,&
         DEP%WindSp,DEP%WindDir,DEP%WindU,DEP%WindV,DEP%SnowGS,&
         DEP%SIC_FY,DEP%SIC_MY
    !---QC variables
    READ(iu) DEP%qc(1:4)
    !---Positioning variables
    READ(iu)
DEP%lat,DEP%lon,DEP%node,DEP%scanUTC,DEP%scanYear,DEP%scanDay,DEP%iscanPos,DEP%iscanLi
ne,&
         DEP%angle,DEP%RelAziAngle,DEP%SolZenAngle
    !---In case the DEP is from a retrieved scene
    IF (DEP%iTyp .eq. 1) THEN
       READ(iu) DEP%nIter,DEP%ChiSq
    ENDIF
    RETURN
10  CALL ErrHandl(WarningType,Warn_EndOfFile,'')
    RETURN
  END SUBROUTINE ReadDEP
```