MSI L1 PRODUCT DEFINITION

VOLUME B: CALIBRATION PRODUCTS

ECGP

DRL REF: ECGP-TS-02

Prepared by: ECGP Team

Approved by:

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DOCUMENT STATUS SHEET

Version	Date	Pages	Changes
01.00	15/05/2015	15	Version for the TRR2 First issue of the document. Calibration products information is extracted from EC.ICD.GMV.ATL.00001 0.1 Draft and included in this Volume.
01.01	22/07/2015	13	Version for the TRR2 Close-out Following RIDs have been implemented: • RID-TRR2-43: Clarified that the headers are also included in the netCDF4/HDF5 datablock (sections 4.6, 4.7, 4.8 and 4.9) • RID-TRR2-42: Section 4 of version 01.00 removed. Subsections 7.x of version 01.00 reviewed. • RID-TRR2-47: Packaging of L0 and L1 products in a ZIP file.
01.02	12/10/2016	13	Version for the AR2 Close-out Following RID from System CDR has been implemented: • Section 4.2: MSI_SD2_1B frecquence of transfer is once a month instead of once per orbit
02.00	27/03/2017	13	Redline version generated by ESA + Additonal changes from GMV • Interface change for the MSI calibration products implementing EarthCARE metadata convention.
02.01	14/07/2017	13	Version for the ECGP V3.1: • No packaging as ZIP. • Product Format Version Specified in the scope section. • JIRA Issue ECGP-86;EC-GSCDR-198 sensing time in annotation header without GPS o time_synchronisation_status field added to MSI_BBS_1B data block, MSI_SD1_1B data block and MSI_SD2_1B data block • JIRA Issue ECGP-84;EC-GSCDR-64 MSI instrument overview o Table of applicable documents updated: Code of [AD.11] corrected.
03.00	06/04/2022	18	Version for the MSI V4: o MSI_SD1_1B, MSI_SD2_1B and MSI_BBS_1B products have been updated. o New prodcuts MSI_DRK_1B and MSI_TRF_1B have been added.
03.01	29/06/2022	18	Version for the MSI V4-rc3 AR close-out. Following RIDs have been implemented: • [ECL1-506] calibration_maintenance_gain is FLOAT not BYTE. No changes in the SW, so the Product Format Version (major and minor) are not changed.
03.02	09/12/2022	18	Version for the MSI V4-rc5 close-out. Following RIDs have been implemented: • [ECL1-528] Typo in signal_to_noise_high_flag, it has been changed to signal_to_noise_low_flag • [ECL1-527] CCDBVersion changed to string. CalibrationValueCount removed • Product format minor version bumped • Version of Applicable documents updated
03.03	08/02/2023	17	Version for the MSI V4.01-rc1: • No changes in the product format. Product format versions are not changed for any of the products. • Definition of SD2 datablok refers to SD1 because they have the same contents and structure. • Applicable documents updated • Section 4.7.3 (SPH descriptions) reshaped. No changes in the contents. Sections 4.8.3, 4.9.3, 4.10.3 and 4.11.3 refer to 4.7.3
03.04	09/10/2023	18	Version for the MSI V4.02-rc1: • Format of the Specific Product Header in the HDR file has changed. Instead of writing the variables in the SPH as <variableName>value</variableName> they are written like: <variableName> <description>description text</description> <units>if applicable</units> <scalar>value</scalar> </variableName> • Description and Units are also written in the h5 (in previous version it was not).

Version	Date	Pages	Changes
			Product format version has been bumped to 5.0 because this change breaks backward compatibility if a processor is reading information from the SPH in the HDR file.
03.05	12/04/2024	18	Version for the MSI V4.3-rc1: • Minor change in the units of time stamps. Changed from "Seconds (referred to 1/1/2000)" to "seconds since 1 Jan 2000 00:00:00" to be aligned with the code and the unit used in all PDDs

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LIST OF TABLES AND FIGURES

1. INTRODUCTION

1.1. PURPOSE

This document has been produced in the frame of the "EarthCARE Ground Processor" project and its purpose is to describe the format and content of the L1 calibration products for the MSI processor.

1.2. SCOPE

This document has been derived from the original ICD where all interfaces (commanding, monitoring, input and output data) were described. In this document, the information related to MSI L1 Calibration Products has been extracted from the original ICD and has been included in this dedicated document.

The versions of the product formats defined in this document are:

- MSI_SD1_1B: 5.0
- MSI_SD2_1B: 5.0
- MSI_DRK_1B: 5.0
- MSI_BBS_1B: 5.0
- MSI_TRF_1B: 5.0

and must be reflected in the "formatMajorVersion" and "formatMinorVersion" of the MainProductHeader.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.X]:

Table 2-1: Applicable Documents

Ref.	Title	Code	Version	Date
[AD.1]	Earth Observation Mission CFI Software - General Software User Manual	EO-MA-DMS-GS-0002	4.20	30/10/2020
[AD.2]	ECSIM Interface Control Document	ECSIM-DMS-TEC-ICD01-R	1.7	18/11/2008
[AD.3]	Architecture of the ESSS and ECGP	EC.TN.ASD.SY.00017	7	19/12/2014
[AD.4]	Volume 0 Products Definitions - Introduction	EC.ICD.ASD.SY.00004	8	12/12/2014
[AD.5]	Volume 1 Products Definitions - Common Products Definitions	EC.ICD.ASD.SY.00005	12	25/07/2019
[AD.6]	ESSS and ECGP Common Interface Control Document	EC.ICD.ASD.SY.00009	8	09/12/2014
[AD.7]	Requirements for the ESSS & ECGP	EC.RS.ASD.SYS.00007	8	26/5/2010
[AD.8]	MSI ECGP Algorithm Theoretical Baseline Document	EC.TN.SSTL.MSI.00014	17	28/07/2021
[AD.9]	EarthCARE IPF Interface Definition	EACA-GSEG-EOPG-TN-15-0001	01.04	01/09/2017
[AD.10]	Space Engineering - Software	ECSS-E-ST-40	C	6/03/2009
[AD.11]	Volume 4a Products Definitions – MSI L0 Products Definitions	EC.ICD.ASD.MSI.00020	6	11/12/2014
[AD.12]	Volume 6 Products Definitions – Auxiliary Data	EC.ICD.ASD.SY.00025	6	12/12/2014
[AD.13]	Earth Explorer Ground Segment File Format Standard	PE-TN-ESA-GS-0001	2.0	03/05/2012
[AD.14]	ECGP Interface Control Document (ICD)	EC.ICD.GMV.SY.00001	04.04	12/04/2024
[AD.15]	MSI L1 Product Definitions Volume A: Nominal Products	EC.ICD.GMV.MSI.00001	03.05	12/04/2024

2.2. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.X]:

Table 2-2: Reference Documents

Ref.	Title	Code	Version	Date
[RD.1]	List of Acronyms and Abbreviations	EC.LI.ASD.SY.00001	4	10/01/2013

3. TERMS, DEFINITIONS AND ABBREVIATED TERMS

3.1. DEFINITIONS

Concepts and terms used in this document and needing a definition are included in the following table:

Table 3-1: Definitions

Concept / Term	Definition

3.2. ACRONYMS

General EarthCARE abbreviations are in [RD.1]. Specific abbreviations used in this document are given below.

Acronyms used in this document and needing a definition are included in the following table:

Table 3-2: Acronyms

Acronym	Definition
ATLID	ATmospheric LIDar
BBR	EarthCARE Broadband Radiometer
CCDB	Characterisation/Calibration Database
ECGP	EarthCARE Level-1 Ground Processor
ESSS	EarthCARE Satellite System Simulator
FHN	Friedrichshafen – Germany
GERB	Geostationary Earth Radiation Budget
GUI	Graphical User Interface
HMI	Human-Machine Interface
H/W	Hardware
ICD	Interface Control Document
IMDD	Instrument Measurement Data Definition
ISP	Instrument Source Packet
LW	Long-Wave
MDS	Measurement Data Stream
MSI	MultiSpectral Imager
PCD	Product Confidence Data
PDD	Product Definition Document
PDGS	Payload Data Ground Segment
SCOE	Spacecraft Check-Out Equipment
SRDB	Spacecraft Reference Data Base
SW	Short-Wave
S/W	Software
TDS	Test Data Set
TOA	Top Of Atmosphere
TW	Total Wave
UV	Ultra-Violet
WGS	World Geodetic System

4. MSI L1 CALIBRATION PRODUCTS

MSI L1 Calibration Products are generated by the MSI L1 Processor.

4.1. TRANSFER MECHANISM

All EarthCARE Products are composed by two physical files:

- One XML for the headers (*filemane*.HDR)
- One binary file for the records containing the data (*filename*.h5)

Both files are located into a folder with the same name (i.e. *filename)*.

4.2. FILE NAMING CONVENTION

The file naming convention for the EarthCARE Products is described in [AD.5].

4.3. DIMENSIONS

Following table contains all dimensions used in the definition of the MSI L1 Calibration products.
"Name" is used in the description of the product datablock below (for brevity).
"Dimension label" is the actual name of the dimension in the NetCDF product.

Table 4-1: MSI NetCDF Dimensions

Name	Description	N Elements	Dimension label
t	Dimension used to define variables depending on the number of samples recorded during the measurement time	Variable	along_track
b	Dimension used to define variables that are band dependant, both VNS and TIR	7	band
VNS_b	Dimension used to define variables that are band dependant, only for VNS	4	VNS_band
TIR_b	Dimension used to define variables that are band dependant, only for TIR	3	TIR_band
pix	Dimension used to define variables that contain arrays of pixels	384	across_track

4.4. SIZE AND FREQUENCY OF TRANSFERS

Following table summarises the sizes and frequency of generation of MSI L1 Calibration products.

Table 4-2: MSI L1 calibration products size and frequency of transfers

MDS type	Size	Frequency of transfer	Comments
MSI_SD1_1B	< 1 MB	Once per day.	
MSI_SD2_1B	< 1 MB	Once per day.	
MSI_DRK_1B	< 1 MB	Once per day.	The along track dimension of this product is used to store several (2) calibration events (VNS CAL and VNS DAY) when they occur in the same frame.
MSI_BBS_1B	< 1 MB	Once per day.	
MSI_TRF_1B	< 1 MB	Once per day.	

4.5. DATA DEFINITION

MSI L1 Calibration Products have different components, but there is a common structure for all of them. In this structure is included the Fixed Product Header and the main Product Header which are identical for all products and so it is described below.

4.6. DATA STRUCTURE

MSI L1 Calibration Products have different components, but there is a common structure for all of them. This structure is presented in the table below.

Table 4-3: L1 Product structure

HeaderData
FixedProductHeader
VariableProductHeader
MainProductHeader
SpecificProductHeader
ScienceData

According to the above structure, the products are physically composed by:

- Headers (FixedProductHeader and VariableProductHeader) included in the XML file
- ScienceData included in the netCDF4/HDF5 binary file (which also contains the headers)

There are three different MSI Calibration Products, sharing this structure. In this structure it is included the Fixed Product Header and the Main Product Header which are identical for all products and so it is described only once below.

4.7. MSI_SD1_1B

This is the MSI Primary Sun Diffuser (VNS) calibration product. It is separated in the four components described below.

4.7.1. MSI_SD1_1B FIXED PRODUCT HEADER

The Fixed Product Header is common for all ECGP products and is defined in Products Definitions Volume 1 [AD.5].

4.7.2. MSI_SD1_1B MAIN PRODUCT HEADER

The Main Product Header for the MSI SD1 Calibration Products is identical to the Main Product Header defined in Products Definitions Volume 1 [AD.5] but with following predefined values specific to MSI SD1 Calibration product:

- fileCategory = "MSI_"
- productType = "SD1_"
- productLevel = "1B"

4.7.3. MSI_SD1_1B SPECIFIC PRODUCT HEADER

The Specific Product Header for the EarthCARE L1 Products follows the specification defined in section 6.1 of [AD.5], which defines following elements:

In case of MSI_SD1_1B, the SpecificProductHeader sub-group contains:

Table 4.4: MSI NOM L1 SPH structure

Group/Field Name	# Dims	Dimensions	Type	Units	Description
InputFileList	0	-	NC_STRING	N/A	String containing the logical file names (without extension) of all input files used by the processor to generate the product.
ConfigurationParameters	0	-	NC_STRING	N/A	String that contains is a copy of the processor configuration file

Group/Field Name	# Dims	Dimensions	Type	Units	Description
QualityStatistics	0	-	NetCDF Group	N/A	This group contains an arbitrary number of quality statistics parameters. See following table

Table 4.5: MSI NOM L1 QualityStatistics group

Field Name	# Dims	Dimensions	Type	Units	Description

4.7.4. MSI_SD1_1B SCIENCE DATA

The Datablock of this product is formatted as NetCDF/HDF5 file and have following fields:

Table 4-6: MSI SD1 L1 Datablock structure

Field Name	#Dims	Dimensions	Type	Units	Description
solar_diffuser	scalar		NC_BYTE	unitless	Always 1
solar_irradiance	2	VNS_b, pix	NC_FLOAT	Irradiance (W/m^2)	Averaged irradiance over all GL whose pointing was "VNSDDIFF1".
solar_irradiance_standard_deviation	2	VNS_b, pix	NC_FLOAT	Irradiance (W/m^2)	Averaged irradiance over all GL whose pointing was "VNSDDIFF1".
valid_ground_lines_count	scalar		NC_INT	unitless	Count of ground lines in solar view for which solar angles were within allowed range.
insufficient_ground_lines_flag	scalar		NC_BYTE	unitless	Warning flag raised if number of contributing GL is too low.
start_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet of first GL whose pointing is "VNSDIFF1".
stop_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Stop time derived from ICU AUX packet of first GL whose pointing is "VNSDIFF1".
normalised_differential_response	2	VNS_b, pix	NC_FLOAT	unitless	Health monitor calculation for detecting unresponsive elements.
normalised_differential_response_high_flag	2	VNS_b, pix	NC_BYTE	unitless	Flag vectors generated by thresholding the NDR arrays.
signal_to_noise	2	VNS_b, pix	NC_FLOAT	unitless	SNR computed during solar diffuser view from statistical measures.
signal_to_noise_low_flag	2	VNS_b, pix	NC_BYTE	unitless	Flag vectors (per pixel) derived from thresholding the solar SNR arrays.
mechanism_recovery_flag	scalar		NC_BYTE	unitless	FLAG indicating mechanism recovery occurred during OBCP.
quality_status	1	VNS_b	NC_BYTE	unitless	Composite overall status indicator for each band. It is "clear" (0) if no issues are detected. When it is non-zero, its value has to be interpreted at bit level: Bit 0: insufficient_ground_lines_flag. Warning flag raised if number of contributing GL is too low. Applies to all bands.

Field Name	#Dims	Dimensions	Type	Units	Description
					Bit 1: mechanism_recovery_flag. Flag indicating mechanism recovery occurred during OBCP. Applies to all bands. Bit 2: normalised_differential_response_high_flag. Flag generated by thresholding the NDR arrays. This is band-specific. This bit will be set if any of the flags in the band array are set, and clear if none of the flags are set. Bit 3: signal_to_noise_low_flag. Flag derived from thresholding the solar SNR arrays. This is band-specific. This bit will be set if any of the flags in the band array are set, and clear if none of the flags are set.
redundant_side_flag	scalar		NC_BYTE	unitless	Redundant or Primary side indicator.
calibration_maintenance_gain	2	VNS_b, pix	NC_FLOAT	unitless	VNS calibration maintenance gain from VNS_RAD_CORR applied by the ECGP (1.0 at start of mission)

4.8. MSI_SD2_1B

This is the MSI Secondary Sun Diffuser (VNS) calibration product. It is separated in the four components described below.

4.8.1. MSI_SD2_1B FIXED PRODUCT HEADER

The Fixed Product Header is common for all ECGP products and is defined in Products Definitions Volume 1 [AD.5].

4.8.2. MSI_SD2_1B MAIN PRODUCT HEADER

The Main Product Header for the MSI SD2 Calibration Products is identical to the Main Product Header defined in Products Definitions Volume 1 [AD.5] but with following predefined values specific to MSI SD2 Calibration product:

- fileCategory = "MSI_"
- productType = "SD2_"
- productLevel = "1B"

4.8.3. MSI_SD2_1B SPECIFIC PRODUCT HEADER

The Specific Product Header for the Calibration MSI SD2 Products is identical to the SD1 Calibration product (see section 4.7.3).

4.8.4. MSI_SD2_1B SCIENCE DATA

The Datablock of this product is formatted as NetCDF/HDF5 file and have the same fields as MSI_SD1_1B (see section 4.7.4).

4.9. MSI_DRK_1B

This is the MSI Dark VNS Calibration Product. It is separated in the four components described below.

4.9.1. MSI_DRK_1B FIXED PRODUCT HEADER

The Fixed Product Header is common for all ECGP products and is defined in Products Definitions Volume 1 [AD.5].

4.9.2. MSI_DRK_1B MAIN PRODUCT HEADER

The Main Product Header for the MSI DRK Calibration Products is identical to the Main Product Header defined in Products Definitions Volume 1 [AD.5] but with following predefined values specific to MSI DRK Calibration product:

- fileCategory = "MSI_"
- productType = "DRK_"
- productLevel = "1B"

4.9.3. MSI_DRK_1B SPECIFIC PRODUCT HEADER

The Specific Product Header for the Calibration MSI DRK Products is identical to the SD1 Calibration product (see section 4.7.3).

4.9.4. MSI_DRK_1B SCIENCE DATA

The Datablock of this product is formatted as NetCDF/HDF5 file and have following fields:

Table 4-7: MSI DRK L1 Datablock structure

Field Name	#Dims	Dimensions	Type	Units	Description
dark_radiance	3	t,VNS_b,pix	NC_FLOAT	VNS Spectral Radiance $W/(m2\ sr\ \mu m)$	Averaged radiance over all GL whose pointing was "VNSDRKOFST"
dark_radiance_standard_deviation	3	t,VNS_b,pix	NC_FLOAT	VNS Spectral Radiance $W/(m2\ sr\ \mu m)$	Standard deviation over all GL whose pointing was "VNSDRKOFST"
VNS_detector_temperature	2	t,VNS_b	NC_FLOAT	Kelvin	Averaged temperature value during dark view.
VNS_detector_temperature_standard_deviation	2	t,VNS_b	NC_FLOAT	Kelvin	RMS uncertainty measured during dark view
VNS_optical_unit_temperature_1	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_optical_unit_temperature_2	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_calibration_unit_temperature_1	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_calibration_unit_temperature_2	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_SWIR2_cold_finger_temperature_1	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_SWIR2_cold_finger_temperature_2	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
VNS_radiator_temperature	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view
front_end_electronics_temperature	1	t	NC_FLOAT	Kelvin	Averaged temperature value during dark view

Field Name	#Dims	Dimensions	Type	Units	Description
valid_ground_lines_count	1	t	NC_INTEGER	unitless	Count of valid ground lines in dark view. Expect 256 minimum.
VNS_DAY_on_board_control_procedure_flag	1	t	NC_BYTE	unitless	Enumerated: 0 - VNS CAL Diff1 1 - VNS CAL Diff2 2 - VNS DAY
start_time	1	t	NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet from first GL whose pointing is "VNSDRKOFST"
stop_time	1	t	NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	End time derived from ICU AUX packet from last GL whose pointing is "VNSDRKOFST"
quality_flag	2	t,VNS_b	NC_BYTE	unitless	If any of the following FDIR flags used to compute statistics is set during the entire view, the this flag is raised: FDIR_VNS_OU_1 FDIR_VNS_OU_2 FDIR_SWIR2_CF_1 FDIR_SWIR2_CF_2 FDIR_VNS_CALU_1 FDIR_VNS_CALU_2 FDIR_FEE
redundant_side_flag	1	t	NC_BYTE	unitless	Redundant or Primary side indicator.
calibration_maintenance_gain	3	t,VNS_b,pix	NC_FLOAT	unitless	VNS calibration maintenance gain from VNS_RAD_CORR applied by the ECGP (1.0 at start of mission)

4.10. MSI_BBS_1B

This is the MSI Black Body and Deep Space (TIR) calibration product. It is separated in the four components described below.

4.10.1. MSI_BBS_1B FIXED PRODUCT HEADER

The Fixed Product Header is common for all ECGP products and is defined in Products Definitions Volume 1 [AD.5].

4.10.2. MSI_BBS_1B MAIN PRODUCT HEADER

The Main Product Header for the MSI BBS Calibration Products is identical to the Main Product Header defined in Products Definitions Volume 1 [AD.5] but with following predefined values specific to MSI BBS Calibration product:

- fileCategory = "MSI_"
- productType = "BBS_"
- productLevel = "1B"

4.10.3. MSI_BBS_1B SPECIFIC PRODUCT HEADER

The Specific Product Header for the Calibration MSI BBS Products is identical to the SD1 Calibration product (see section 4.7.3).

4.10.4. MSI_BBS_1B SCIENCE DATA

The Datablock of this product is formatted as NetCDF/HDF5 file and have following fields:

Table 4-8: MSI BBS L1 Datablock structure

Field Name	#Dims	Dimensions	Type	Units	Description
cold_space_signal	2	TIR_b,pix	NC_FLOAT	ADU	Averaged over all GL whose pointing was "TIRSPCEOFST". No radiometric calibration applied.
cold_space_signal_standard_deviation	2	TIR_b,pix	NC_FLOAT	ADU	Averaged over all GL whose pointing was "TIRSPCEOFST". No radiometric calibration applied.
cold_space_valid_ground_lines_count	scalar		NC_INT	unitless	Count of ground lines which contributed to the statistics (expect 256 minimum)
cold_space_start_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet of first GL whose pointing is "TIRSPCEOFST"
cold_space_stop_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	End time derived from ICU AUX packet of last GL whose pointing is "TIRSPCEOFST"
cold_space_normalised_deviation	2	TIR_b,pix	NC_FLOAT	unitless	Cold-space "signal-to noise" vectors
cold_space_normalised_deviation_high_flag	2	TIR_b,pix	NC_BYTE	unitless	Warning flag vectors computed by thresholding normalised deviation Vectors.
black_body_brightness_temperature	2	TIR_b,pix	NC_FLOAT	Kelvin	Image statistics averaged over all GL whose pointing was "TIRCBLKBD". Full radiometric calibration applied.
black_body_brightness_temperature_standard_deviation	2	TIR_b,pix	NC_FLOAT	Kelvin	Image statistics averaged over all GL whose pointing was "TIRCBLKBD". Full radiometric calibration applied.
black_body_valid_ground_lines_count	scalar		NC_INT	unitless	Count of ground lines which contributed to the statistics (expect 256 minimum)
black_body_start_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet of first GL whose pointing is "TIRCBLKBD"
black_body_stop_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Stop time derived from ICU AUX packet of last GL whose pointing is "TIRCBLKBD"
black_body_temperature_1	scalar		NC_FLOAT	Kelvin	Averaged readings of both LHT08863 and LHT08864 (TIR calibration black body temperatures) acquired during CBB view Accompanied by two standard deviations.
black_body_temperature_2	scalar		NC_FLOAT	Kelvin	
black_body_temperature_1_standard_deviation	scalar		NC_FLOAT	Kelvin	
black_body_temperature_2_standard_deviation	scalar		NC_FLOAT	Kelvin	
black_body_normalised_temperature_difference	2	TIR_b,pix	NC_FLOAT	unitless	Health monitor calculation for detecting unresponsive elements.
black_body_normalised_temperature_difference_high_flag	2	TIR_b,pix	NC_BYTE	unitless	Flags generated by thresholding the normalised temperature difference arrays.

Field Name	#Dims	Dimensions	Type	Units	Description
redundant_side_flag	scalar		NC_BYTE	unitless	Redundant or Primary side indicator.
TIR_mechanism_recovery_flag	scalar		NC_BYTE	unitless	TIR mechanism recovery flag. Health-check diagnostic.
calibration_maintenance_gain	2	TIR_b,pix	NC_FLOAT	unitless	
cold_space_crude_signal	2	TIR_b,pix	NC_FLOAT	ADU	Statistical data (mean and standard deviation within each band) collected from the cold-space view period but based upon TIR data which has NOT been subjected to sensitivity corrections and to which the cold-space mirror (CSM) offset has NOT been applied. Used for diagnostics.
cold_space_crude_signal_standard_deviation	2	TIR_b,pix	NC_FLOAT	ADU	
black_body_signal	2	TIR_b,pix	NC_FLOAT	ADU	Statistical data (mean and standard deviation within each band) collected from the calibration black body (CBB) view period based upon TIR data which has been processed completely except for the application of radiometric calibration. Used for diagnostics
black_body_signal_standard_deviation	2	TIR_b,pix	NC_FLOAT	ADU	
flat_field_status	scalar		NC_INT		0: ok 1: < 5% affected 2: >= 5% affected (this is based on cold_space_normalised_deviation_high_flag which in turn is based on cold_space_normalised_deviation). This status will warn users that data taken after the flat field is applied perhaps is not reliable. The situation might resolve after 16 orbits. If flat_field_status is > 0, ICMF needs to inform users that all data are invalid up to the next TIR calibration.

4.11. MSI_TRF_1B

This is the MSI TIR sensitivity reference parameters calibration product. It is separated in the four components described below.

4.11.1. MSI_TRF_1B FIXED PRODUCT HEADER

The Fixed Product Header is common for all ECGP products and is defined in Products Definitions Volume 1 [AD.5].

4.11.2. MSI_TRF_1B MAIN PRODUCT HEADER

The Main Product Header for the MSI TRF Calibration Products is identical to the Main Product Header defined in Products Definitions Volume 1 [AD.5] but with following predefined values specific to MSI TRF Calibration product:

- fileCategory = "MSI_"
- productType = "TRF_"
- productLevel = "1B"

4.11.3. MSI_TRF_1B SPECIFIC PRODUCT HEADER

The Specific Product Header for the Calibration MSI TRF Products is identical to the SD1 Calibration product (see section 4.7.3).

4.11.4. MSI_TRF_1B SCIENCE DATA

The Datablock of this product is formatted as NetCDF/HDF5 file and have following fields:

Table 4-9: MSI TRF L1 Datablock structure

Field Name	#Dims	Dimensions	Type	Units	Description
cold_space_valid_ground_lines_count	scalar		NC_INT	unitless	Count of ground lines which contributed to the statistics (expect 256 minimum)
cold_space_start_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet of first GL whose pointing is "TIRSPCEOFST"
cold_space_stop_time	scalar		NC_DOUBLE	seconds since 1 Jan 2000 00:00:00	Start time derived from ICU AUX packet of last GL whose pointing is "TIRSPCEOFST"
TIR_detector_temperature	scalar		NC_FLOAT	Kelvin	LHT08872: TIR Detector Temperature
TIR_cover_temperature_1	scalar		NC_FLOAT	Kelvin	LHT08832: TIROU Temp 10 (TIR Cover 1)
TIR_cover_temperature_2	scalar		NC_FLOAT	Kelvin	LHT08833: TIROU Temp 11 (TIR Cover 2)
TIR_reference_blackbody_temperature	scalar		NC_FLOAT	Kelvin	LHT08847: TIROU Temp 9 (Relay Lens Reference BB)
TIR_relay_lens_temperature_1	scalar		NC_FLOAT	Kelvin	LHT08841: TIROU Temp 4 (Relay Lens 1)
TIR_relay_lens_temperature_2	scalar		NC_FLOAT	Kelvin	LHT08842: TIROU Temp 5 (Relay Lens 2)
TIR_bench_temperature_1	scalar		NC_FLOAT	Kelvin	LHT08839: TIROU Temp 2 (TIR Bench 1)
TIR_bench_temperature_2	scalar		NC_FLOAT	Kelvin	LHT08840: TIROU Temp 3 (TIR Bench 2)
TIR_detector_bias_voltage_VFID	scalar		NC_FLOAT	Volts	LHT08580: TIR VFID
TIR_detector_bias_voltage_VSKIM	scalar		NC_FLOAT	Volts	LHT08581: TIR VSKIMMING
TIR_filter_tray_top_temperature	scalar		NC_FLOAT	Kelvin	LHT08844: TIROU Temp 6 (Filter Mask Top)
TIR_filter_tray_bottom_temperature	scalar		NC_FLOAT	Kelvin	LHT08845: TIROU Temp 7 (Filter Mask Bottom)
TIR_mirror_1_temperature	scalar		NC_FLOAT	Kelvin	LHT08846: TIROU Temp 8 (TIR Mirror 1)
front_end_electronics_temperature	scalar		NC_FLOAT	Kelvin	LHT08828: FEE Temperature
redundant_side_flag	scalar		NC_BYTE	unitless	Redundant or Primary side indicator.
calibration_maintenance_gain	2	TIR_b, pix	NC_FLOAT	unitless	TIR calibration maintenance gain from TIR_GAIN_CORR applied by the ECGP (1.0 at start of mission)

END OF DOCUMENT