EUMETSAT

AVHRR Level 1b Product Guide

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Welcome to the AVHRR Level 1b Product Guide. As a potential user of AVHRR Level 1b products, you will find here information to familiarise yourself with the AVHRR/3 instrument, the data processing, end-product contents and format, and potential usage and applications.

A supplement of appendices applicable to all the Product Guides is also available. This contains a product summary and details of generic data, as well as information on the Metop operational orbit, and a list of acronyms and abbreviations.
The supplement is accessible under Document Reference: EUM/OPS-EPS/MAN/08/0034
or electronically via the following Hummingbird link:
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Document Change Record

Version/Date	Section	Description of change
v1 08/09/2004	Full document	First issue of the document.
v2 31/08/2007	Full document	Update to reflect start of Metop/AVHRR Level 1b.
v2A 01/07/2008	Appendix G.5 General	Appendix G.5: - Table added summarising record contents for each product format version. - Table for MDR, items ANGULAR_RELATIONS & EARTH_LOCATIONS: Descriptions amended to also specify that points 5 to 2045 used when using every 20th point. Other general layout improvements and typo corrections.
v2B 17/07/2008	Section 4 Section 6 Section 7 General	Fig. 4-1 updated and note added. In Sec. 4.4.3 "NDVI information" replaced by "vegetation products". LRPT bullet in Sec. 6.1.1 deleted (because LRPT not functional). Table 6-1 row for "NOAA-AVHRR raw data format" deleted. Table 6-5 MDR-1B row: added note on pixel number differences for Metop/NOAA. Third bullet in Sec. 7.1.1 item 1 replaced with new sentence. Sec. 7.1.2 updated. Several typos corrected.
v2C 25/08/2008	Section 4 Section 8	Section 4.1: List of satellites extended. Section 4.1.2: Section and Table 4-2 titles changed from “Scanning…” to “Nominal scanning…”. GAC gap value between pixels corrected from 3.3 to 2.2 km. Figure 4-1 corrected for Calibration output arrow. Section 4.2.2.2: A1 albedo “computed” not “estimated”. Deleted “planned” before Cal/Val activities.
v2D 29/08/2008	Section 4.1	Sentence “The AVHRR/2 version…” brought up to date.
v3 14/09/2009	Section 2 Section 3 Section 4.1.2 Section 5 Section 6.3.4 Section 11	Added reference RD24. Document version numbers updated. Added graphic showing GAC/LAC footprints. EPSView description replaced by brief text on generic tools. (Also minor associated updates to Sec. 2 & 6.) Added description of how to derive radiances from MDR data using factors. Improved equation and its description. In MDR-1B table: Correction to units for Scene_Radiances as given under Description. Also,

Version/Date	Section	Description of change
	General	values of Dim1, Type and Type Size corrected for Frame_Indicator & Time_Code in order to agree with PFS. In following bitfield description tables, updates for Instrument_Invalid_Analog_Word_Flag (totally wrong before), Time_Code, Calibration_Quality. Document restructured – App. F & G renamed as Sec. 10 & 11, and common appendices removed to keep as separate document. Other general typo corrections, and minor text and hyperlink amendments.
v3A 21/01/2011	Section 1 Section 3 General	Added mention of vegetation (NDVI) trial dissemination. Configuration History updates – addition of PPF software versions. Other minor text updates and corrections, and hyperlink updates.

Table of Contents

1 INTRODUCTION

This user guide is intended for users of EPS AVHRR Level 1b products. It provides information about the products available, how to access them, how to extract and interpret the data, and it also aims to help the user in choosing a product for a particular application.

In Appendix A, a full list of EPS products generated at EUMETSAT is given. The products that will be addressed in this guide are:

- AVHRR/3 Level 1b (radiances)

The above products will be generated by the EPS CGS from both Metop and NOAA data. For NOAA AVHRR/3, Global Area Coverage (GAC) data are used.

Note that the Numerical Weather Prediction Satellite Application Facility (NWP SAF) is responsible for the development, distribution and maintenance of the ATOVS and AVHRR Pre-processing Package (AAPP), which allows users to generate equivalent products from AVHRR locally-received data corresponding to both NOAA and Metop platforms.

Concerning higher-level products from AVHRR:

- The Nowcasting SAF (NWC SAF) develops and distributes software to retrieve cloud information at full AVHRR/3 resolution.
- EUMETSAT has started trial dissemination of the Normalised Differential Vegetation Index (NDVI) Level 2 product from AVHRR on Metop.
- The Ocean and Sea Ice SAF (OSI SAF) develops and distributes other interesting products for the oceanographic community, based on AVHRR/3 and MSG data, such as Sea Surface Temperature and Radiative Fluxes products.
- The Land Surface Analysis SAF (LSA SAF) develops and distributes higher-level products from AVHRR and other sensor data catering for the needs of the land meteorological community, including geophysical parameters such as surface albedo, land surface temperature, radiative fluxes, soil moisture, snow cover, fraction of vegetation cover, fraction of absorbed photosynthetic active radiation, and leaf area index.

For further questions not addressed in this guide, on these or other EPS products, you are welcome to access the EUMETSAT Polar System pages on our website www.eumetsat.int, or to contact directly the EUMETSAT User Services Helpdesk. These pages should be the main interface for information on access to all EPS products.

Comprehensive information on the relevant SAFs and their products can also be found on the EUMETSAT website, and the help desks of the relevant SAFs can be accessed directly on:

- NWP SAF: www.nwpsaf.org/
- OSI SAF: www.osi-saf.org/index.php
- NWC SAF: www.nwcsaf.org/
- LSA SAF: http://landsaf.meteo.pt/

2 REFERENCE DOCUMENTS

The following documents have been used to compile the information in this guide. Some of them are referenced within the text, others are provided here for further reading.

2.1 EPS programme documents

[RD11]	EPS Generic Product Format Specification	EPS.GGS.SPE.96167
[RD12]	AVHRR/3 Level 1 Product Format Specification	EPS.MIS.SPE.97231
[RD13]	AVHRR/3 Product Generation Specification	EUM.EPS.SYS.SPE.990004
[RD14]	ATOVS Calibration and Validation Plan	EUM.EPS.SYS.PLN.01.012
[RD15]	EPS Programme Calibration and Validation Overall Plan	EUM.EPS.SYS.PLN.02.004
[RD21]	U-MARF LEO Format Descriptions	EUM/OPS/USR/06/1855
[RD22]	EUMETCast Technical Description	EUM TD 15
[RD23]	EPS Product file naming for EUMETCast	EUM/OPS-EPS-TEN/07/0012
[RD24]	Metop Space to Ground Interface Specification	MO-IF-MMT-SY0001

See www.eumetsat.int for more information on the project.

2.2 SAF documents

See www.nwpsaf.org/ for more information on the NWP SAF project
See www.osi-saf.org for more information on the OSI SAF project.
See www.nwcsaf.org/ for more information on the NWC SAF project.
See http://landsaf.meteo.pt/ for more information on the LSA SAF project.

2.3 Papers, reports and other technical documentation

[RD41]	NOAA KLM User's Guide	www2.ncdc.noaa.gov/docs/klm
[RD42]	The Advanced Very High Resolution Radiometer	Cracknell, A. Taylor and Francis, London, 1997
[RD45]	Manual on the Global Telecommunication System	WMO - No. 386
[RD46]	World Meteorological Organization Manual on Codes	WMO - No. 306
[RD47]	Automatic Adjustment of AVHRR Navigation	P. Bordes et al. J. Atm. Ocean Tech., 9 (1), 15-27, 1992.

3 AVHRR LEVEL 1 PRODUCTS CONFIGURATION HISTORY

Date introduced	Product format version		PFS version	PGS version	Comments
	Major number	Minor number			
19/10/2006	10	0	6.5/7C	5.2/5B	

Table 3-1: AVHRR Level 1 document versions

AVHRR L1 PPF software version	Date introduced on GS1	Comments
4.0	17/07/2007	
4.5.0	17/03/2008	Correction of the surface temperature values used for the cloud detection algorithm. Correct dummy values for signed integers.
5.5.0	16/06/2009	Extension to process the NDVI product.

Table 3-2: AVHRR Level 1 PPF software versions

AVHRR L1 auxiliary files set version	AVHRR L1 auxiliary files	Date introduced on GS1	Comments
P006_R000_PPF_ATOVS1_AUX_20070508	M02/AVHR/xx/AVHR_CAL_xx_M02_20070809130000Z _xxxxxxxxxxxxxxx_20070809000109Z_xxxx_xxxxxxxxxx M02/AVHR/xx/AVHR_THR_xx_M02_20070509070000Z _xxxxxxxxxxxxxxx_20070508000103Z_xxxx_xxxxxxxxxx	22/05/2007	

Table 3-3: AVHRR Level 1 PPF auxiliary parameter file versions

4 AVHRR LEVEL 1B PRODUCTS OVERVIEW

4.1 The AVHRR/3 instrument

The Advanced Very High Resolution Radiometer/3 (AVHRR/3) is a multipurpose imaging instrument used for global monitoring of cloud cover, sea surface temperature, ice, snow and vegetation cover characteristics and is currently flying on NOAA-15, -16, -17, -18, -19 and Metop-A. The AVHRR/2 version 2 of the instrument was flown on NOAA-7 to -14 in a five-channel version. A detailed account of the instrument technical characteristics is given in [RD41], but we will give in the following sections the basic information necessary for understanding and using the product.

4.1.1 Technical description

The AVHRR/3 is a six-channel scanning radiometer providing three solar channels in the visible/near-infrared region and three thermal infrared channels. The AVHRR/3 has two one-micrometre wide channels between 10.3 and 12.5 micrometres. The instrument utilises a 20.32 cm (8 inch) diameter collecting telescope of the reflective Cassegrain type. Cross-track scanning is accomplished by a continuously rotating mirror directly driven by a motor. The three thermal infrared detectors are cooled to 105 kelvin (K) by a two-stage passive radiant cooler. A line synchronisation signal from the scanner is sent to the spacecraft MIRP processor which in turn sends data sample pulses back to the AVHRR.

The spectral channels of AVHRR/3 are not exactly the same as AVHRR/2, and include an additional channel 3a in the near infrared (NIR). AVHRR/3 has six spectral channels between 0.63 and 12.00 micrometres: three in the visible/near infrared and three in the infrared. Channel 3 is a split channel: channel 3a is in the solar spectral region (1.6 μm) whereas channel 3b operates in the infrared around 3.7 μm.

Although AVHRR/3 is a six-channel radiometer, only five channels are transmitted to the ground at any given time. Channels 3a and 3b cannot operate simultaneously. The transition from channel 3a to 3b and vice versa is done by telecommand and reflected in the science data. For Metop-A, channel 3a is operated during the daytime portion of the orbit and channel 3b during the night-time portion.

The data from the six channels are simultaneously sampled at a 40-kHz rate and converted to 10-bit binary form within the instrument. The data samples from each channel are output in a non-continuous burst of 10 space samples, 2048 Earth samples and 10 internal calibration target samples per scan.

The following table summarises the spectral characteristics of AVHRR/3.

Channel	Central wavelength (μm)	Half power points (μm)	Channel noise specifications	
			S/N @ 0.5% reflectance	NEdT @ 300K
1	0.630	0.580 - 0.680	9:1	-
2	0.865	0.725 - 1.000	9:1	-

3a	1.610	1.580 - 1.640	20:1	-
3b	3.740	3.550 - 3.930	-	<0.12 K, 0.0031 mW/(m^2 sr cm^{-1})
4	10.800	10.300 - 11.300	-	<0.12 K, 0.20 mW/(m^2 sr cm^{-1})
5	12.000	11.500 - 12.500	-	<0.12 K, 0.21 mW/(m^2 sr cm^{-1})

Table 4-1: Spectral characteristics of AVHRR/3

4.1.2 Nominal scanning geometry

AVHRR/3 is an across-track scanning system with a scan range of ±55.37° with respect to the nadir direction. The field of view (IFOV) of each channel is approximately 1.3 milliradians (0.0745°) leading to a square instantaneous field of view size of 1.08 km at nadir for a nominal altitude of 833 km. The scanning rate of 360 scans per minute is continuous (1 scan every 1/6 second). There are 2048 Earth views per scan and per channel for a swath width of about ±1447 km (sampling time of 0.025 ms). The sampling angular interval is close to 0.944 milliradians (0.0541°). The distance between two consecutive scans is approximately equal to 1.1 km.

The following table summarises the scanning characteristics.

Characteristics	Value	Unit
Scan direction	East to West (northbound)	-
Scan type	continuous	-
Scan rate	0.025	ms
Sampling interval (duration)	0.1667	s
Sampling interval	0.0541	deg
Pixels/scan	2048	-
Swath	±55.3	deg
Swath width	±1446.58	km
IFOV	0.0745	deg
IFOV type	square	-
IFOV size (nadir)	1.08	km
IFOV size (edge) - across track	6.15	km
IFOV size (edge) - along track	2.27	km
Scan separation	1.1	km

Table 4-2: Nominal scanning characteristics of AVHRR/3

On the NOAA satellites, the on-board processor samples the real-time AVHRR/3 data to produce reduced resolution Global Area Coverage (GAC) data (Figure 4-1). Four out of every five samples along the scan line are used to compute one average value, and the data from only every third scan line are processed. As a result, the spatial resolution of GAC data near the subpoint is actually 1.1 km by 4.4 km with a 2.2 km gap between pixels across the scan line, although generally treated as 4 km resolution. All of the GAC data computed during a complete pass are recorded on board the satellite for transmission to Earth on command. The 10-bit precision of the AVHRR data is retained. The following table summarises the different resolution/grid characteristics of the data.

Characteristics	Value	Unit
Pixels/scan	409	-
Sampling size (nadir)	4.4 (across-track) x 1.1 (along-track)	km
Sampling grid (nadir)	5.5 (across-track) x 3.3 (along-track)	km

Table 4-3: Resolution and grid characteristics of AVHRR/3 GAC data

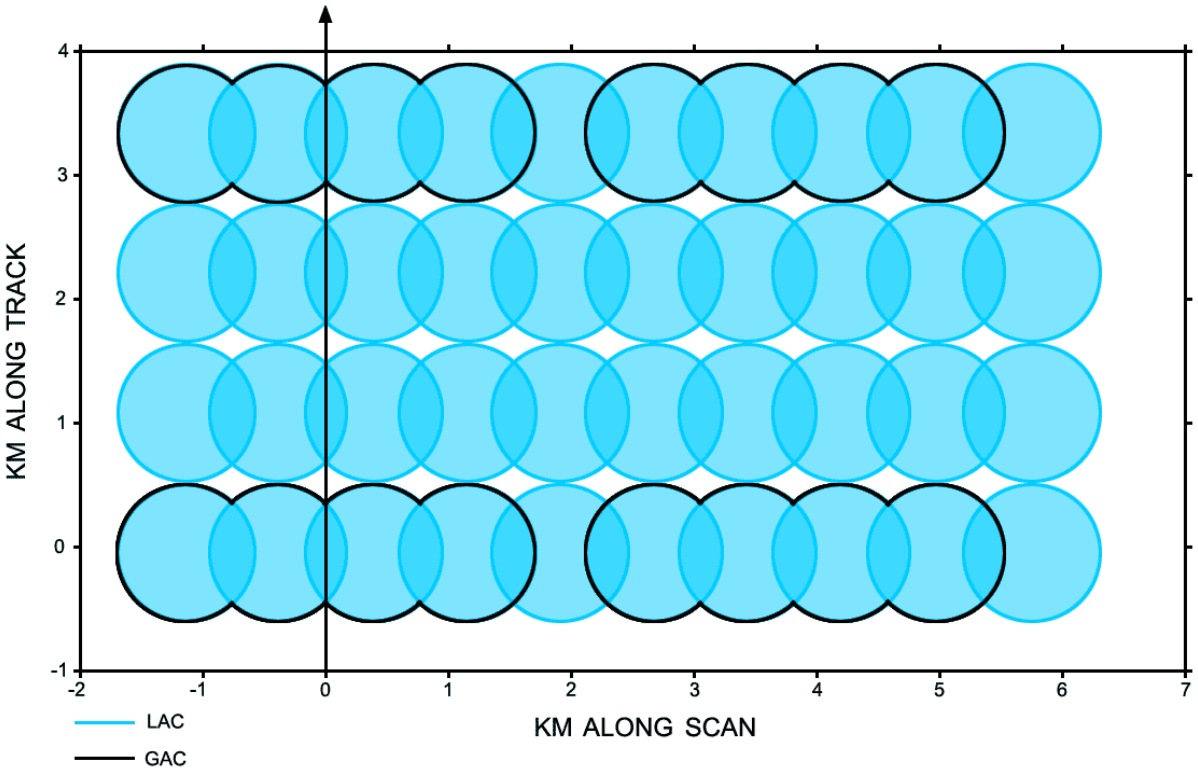


Figure 4-1: Simulated earth-surface footprints for AVHRR/3 showing relation between full resolution data (Local Area Coverage, LAC, in blue) and reduced resolution Global Area Coverage (GAC, black outlines). [Based on NOAA original. Compare with equivalent schematic in Section 4 of the "ATOVS Level 2 Product Guide".]

4.1.3 Instrument calibration

The AVHRR/3 calibration is different for the visible and the IR channels.

4.1.3.1 Visible and near-infrared channels

There is no on-board calibration for the visible channels (channels 1 and 2) and channel 3a. The visible and near-infrared channels of the AVHRR/3 are calibrated prior to launch following a protocol which has evolved over the past two decades, by means of using a calibrated light source and varying the level of illumination as desired for the different channels. At each level of illumination, measurements of the signal issuing from the AVHRR are made, and the mean and standard deviation recorded, and converted to digital counts. Pre-launch calibration results in the form of a simple linear regression relationship between the measured AVHRR signal, expressed in counts, and the albedo of the light source at different levels of illumination are then given.

During the ground processing, the gain and intercept values are selected and applied according to the count values. For AVHRR/3 a dual slope/gain function is used for the visible (channels 1 and 2) and near-infrared (channel 3a) channels to enhance the radiometric resolution at low radiance or reflectance values. For every channel and for every one of the two gain regimes, a set of pre-launch calibration factors (slope and intercept) is provided. It should be noted that the specifications of the split gain ranges are not fixed but may alter from instrument to instrument and during the life time of the instrument.

The AVHRR visible/NIR channels do not have effective on-board calibration, and are known to decrease in response as a function of time, as well as due to launch processes. Pre-launch calibration is carried out to confirm the linearity of the detectors, and to establish baseline calibration coefficients. Post-launch, they will be calibrated against stable surface regions and against other satellites, following various well-established techniques, which constitute what is known as vicarious calibration.

4.1.3.2 Thermal infrared channels

As for the visible channels, a pre-launch calibration is carried out to confirm the linearity of the detectors for different instrument operating temperatures and for the full range of expected Earth target temperatures.

During each in-orbit scan line, the AVHRR views three different types of targets. It first outputs 10 counts when it views cold space, then a single count for each of the 2048 Earth targets (pixels), and finally 10 counts when it views its own internal black body target. The cold space and internal black body target views are used to calibrate the AVHRR, because a radiance value can be independently assigned to each target. The internal black body radiance is estimated from the internal black body temperature, measured by four platinum resistance thermometers (PRTs) embedded in the AVHRR instrument, and the space radiance is computed from pre-launch data.

4.2 Overview of the ground processing and calibration

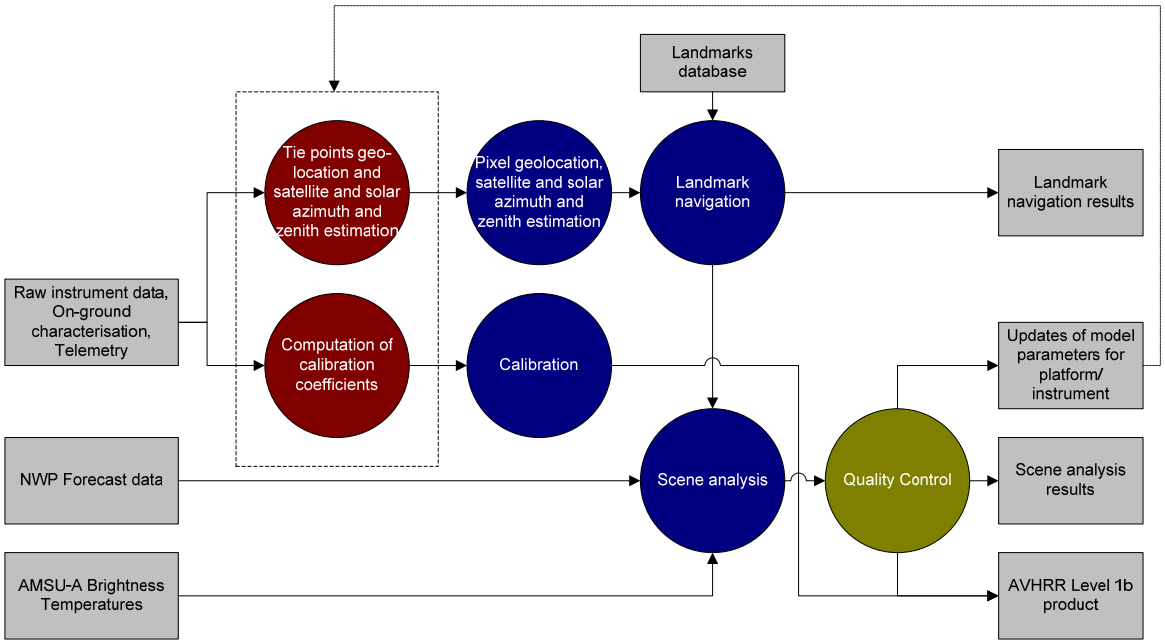
The Level 1 ground processing chain is illustrated in Figure 4-2 below.

The first goal of Level 1 ground processing for AVHRR is the generation of the AVHRR Level 1b product, containing as the main geophysical parameter reflectivity (for channels 1, 2

and 3a) and calibrated radiances (for channels 3, 4 and 5). This processing is data driven and is applied to every science source packet to generate Level 1b products.

Additionally, scenes analysis is performed within the Level 1b processing, with the main goal of assessing cloud contamination for every pixel. This information will be used later on within the processing of ATOVS and IASI Level 2. Only the cloud analysis information is included in the output AVHRR Level 1b product distributed to users. AMSU-A Level 1b data is needed as input to the scenes analysis. In Section 10, the context of the ATOVS, IASI and AVHRR processing chain interactions is provided for information.

The ground processing is applied to data from the AVHRR/3 instruments on both Metop and NOAA satellites. In the case of NOAA, GAC frames are the input raw data flow. These data do not have the same resolution, but the respective output Level 1b products from the EUMETSAT CGS have the same structure, contents and format.



Note: The landmark navigation results are not yet used operationally.

Figure 4-2: Functional overview of the AVHRR Level 1 ground processing chain

4.2.1 Pre-processing

Basic raw data validation checks are applied and the instrument telemetry and other auxiliary data are also validated and related to the input raw data flow.

After that, calibration data need to be processed to retrieve the calibration functions that will allow the Level 1b generation. Concerning the visible and NIR channels, calibration coefficients are calculated based initially on on-ground characterisation information, and later on during the mission lifetime on updated characterisation information from vicarious

calibration. Each pixel count value determines the gain regime and the slope and intercept of the linear regression.

Concerning the calibration for the IR channels, the on-board calibration system is used. Black body temperature measured by the PRT is extracted for every pixel from the AVHRR instrument source packet. Black body radiances are computed from this temperature taking into account the spectral response function of the channel. Average black body estimated radiances and counts, as well as on-ground characterised space radiance and average space counts, provide the two points for linear interpolation to estimate radiances corresponding to each Earth target pixel along the scan line. An additional non-linear correction of this radiance based on pre-launch calibration data is further applied. A minimum of 55 scan lines are necessary to obtain a compete set of calibration coefficients.

Finally, geolocation for tie points along the scan line is performed, as well as their satellite and solar zenith and azimuth angles. Tie point geolocation is estimated by means of a satellite ephemeris model and an instrument scanning model. This first step in the navigation is based on default attitude values, directly after data acquisition.

The calculation of the satellite zenith and azimuth is done by applying a transformation matrix to the Earth fixed satellite position coordinates previously obtained during the tie point geolocation. The solar azimuth and zenith are obtained taking into account the actual solar declination, for which an accurate time stamp for the scan line is previously estimated.

4.2.2 Level 1b processing

4.2.2.1 Generation of the Level 1b product contents

Calibration coefficients are applied to both visible/NIR and IR channels, in order to convert channel count values into reflectivity and radiances, respectively. These are the geophysical parameters which constitute the AVHRR Level 1b products.

Using the tie points geolocation information, each individual pixel is geolocated, following either linear interpolation or Lagrangian interpolation. The same interpolation schemes are used to estimate satellite and solar zenith and azimuth angles for every pixel. This information is also included in the AVHRR Level 1b product.

Using a high resolution coast line data set and the geolocation information estimated above, a surface type is assigned to each pixel. For Metop full resolution data, an automatic adjustment based on landmark position processing is also performed, which will give us also a good assessment of the positioning accuracy, as well as an accurate platform attitude.

4.2.2.2 Scenes analysis

The main functionality of the scenes analysis algorithm is to determine whether a pixel is contaminated by clouds or not. Partially cloudy pixel or pixels covered with semi-transparent clouds will be declared as cloudy. The algorithm also identifies clear pixels which may be covered with snow or ice. In addition, for pixels identified as clear, the surface temperature is determined, and for pixels identified as cloudy the cloud top temperature is computed. The scenes analysis algorithm is based on a threshold technique and works nominally on a pixel-by-pixel basis. The threshold technique compares the image data with thresholds which mark the border between the physical signal (i.e. brightness temperature and reflectance factor) of a pixel without clouds and a pixel containing clouds. The scenes analysis algorithm uses a

prediction, based either on forecast data of the current AVHRR Level 1b scene or on climatological values from a database. Also, spatial information (mean, standard deviation) is used to supplement the scenes analysis process. The threshold technique makes use of the spectral information provided for each pixel with the measurements in all available channels.

Mainly, there are six steps performed in the scenes analysis:

- Step 1: Solar zenith angle check
- Step 2: Channel availability and quality check
- Step 3: Prediction of the clear sky brightness temperature and reflectance
- Step 4: Threshold determination
- Step 5: Scenes type identification
- Step 6: Automatic quality control

In more detail, the different types of cloud detection tests are briefly listed below, where A1 and A2 are respectively the albedo computed from channels 1 and 2, and T3.7, T11 and T12 are respectively the brightness temperatures estimated from channels 3b, 4 and 5.

- T11 test, which reveals low temperature corresponding to medium or high clouds.
- T11-T12 test, applied to detect cirrus clouds.
- T11-T3.7 test (when T3.7 is available and the solar zenith angle is greater than 110°), applied to detect low-water clouds.
- T3.7-T12 test (when T3.7 is available and the solar zenith angle is greater than 110°), applied to detect semi-transparent ice clouds or sub-FOV cold clouds during night-time.
- A2 test (in twilight and daytime situations over coast and sea, without sunglint), applied to detect low clouds which have a greater reflectivity than the sea surface.
- A1 test (in twilight, daytime and sunglint situations over coast, and twilight and daytime situations over land, snow-free conditions), applied to detect low clouds which under snow-free conditions have a higher reflectivity than the underlying land surface.
- T4 spatial coherence test (over sea), applied to detect cloud edges, thin cirrus and small cumulus over sea.

The thresholds for the different tests depend on season, geographical location, daytime, satellite viewing angle and the availability of distinct data sets (e.g., forecast data and/or climatological data).

As output from the scenes type identification, cloud cover information is retrieved and included in the Level 1b product. Retrieval quality information is also included in the Level 1b product. The scenes analysis outputs are forwarded within the EPS CGS to the ATOVS and IASI Level 2 processors.

4.2.3 Post-processing and quality control

This function covers both the radiometric and the geometric quality assessment. The radiometric quality assessment consists of the production of a detailed set of radiometric characteristics of the data for each detector/channel, this for different imaged scenes during the dump (day/night sides, calibration viewing, etc.).

The geometric quality control extracts from the Level 1b data areas corresponding to geographical areas of interest (landmarks), applies the projection using the attached tie-point information and compares this with landmarks extracted from a high-accuracy digital map. The produced information is used to generate detailed quality statistics for analysis purposes. Note that the set of landmarks and statistics produced is different for each instrument chain, as the characteristics of the instrument make a common approach not practical.

Finally, statistics produced by the quality control function are used to perform trend analysis and to derive information on the misalignments between instruments and mis-registration between channels. Updates of the model parameters for the platform/instrument being processed are then estimated and this information allows compensating for slow drifts and changes in these parameters.

4.2.4 Nominal and degraded processing modes

The following table summarises non-nominal processing situations, corresponding to either corrupted/missing Level 0 data, missing auxiliary information and/or instrument ancillary data, missing channels, or invalid calibration information.

Description of anomaly	Influence on processing
Instrument anomalies	
Missing motor telemetry data	No processing
Missing electronics telemetry data	No processing
Missing Channel 1 data	Landmark navigation without NDVI test, scenes analysis without reflectance test over land and with degraded snow/ice detection
Missing Channel 2 data	
Missing Channel 3a data	Scenes analysis with degraded snow/ice test
Missing Channel 3b data	Scenes analysis without relevant brightness temperature difference tests
Missing Channel 4 data	Degraded landmark navigation and scenes analysis without the relevant brightness temperature difference tests
Missing Channel 5 data	
Missing voltage calibrate status	No processing
Missing status of cooler heat, scan motor and/or Earth shield	Degraded Level 1b processing, including scenes analysis
Time sequence	

Bad time field, but it can be inferred from previous good time	Degraded geolocation information and scenes analysis
Bad time field, and it can't be inferred from previous good time	No geolocation information, no angular relations, no scenes analysis
Time discontinuity detected	Degraded geolocation and scenes analysis
Repeated scan times	
Scan time not corrected for clock drift	
Earth location	
No satellite position and velocity	No geolocation, no angular relations, no scenes analysis
Degraded satellite position and velocity	Degraded geolocation, angular relations and scenes analysis
Calibration	
Degraded or incomplete input data for channels 3, 4 and 5 calibration	Use of previous or pre-launch calibration data / Degraded IR radiances and brightness temperatures, landmark navigation and scenes analysis
Navigation	
Degraded orbit ephemeris data	Use of latest available ephemeris file / Degraded geolocation and scenes analysis
No information on Earth location	No geolocation, no angular relations, no scenes analysis
Degraded satellite attitude	Degraded geolocation, scenes analysis

Table 4-4: Summary of non-nominal processing situations

All the situations above are adequately flagged within the Level 1b product. More details on the relevant flag fields are to be found in the product description sections.

An additional non-nominal processing situation is the edge of a dump or possible gaps in a continuous measurement sequence. In that case, the first/last 55 lines of data are used. If a continuous measurement sequence contains less than 55 lines, all the available lines are used for the processing of that sequence, and the calibration cycle contains then less than 55 lines. A degraded calibration for any of these reasons is also flagged within the product.

4.3 AVHRR Level 1b product characteristics and use

4.3.1 General characteristics

Table 4-5 summarises the main characteristics of AVHRR Level 1b products available to users. All products contain quality control and other information about the retrieval and their

use, which are important to know when you choose the product needed for your application. Two Level 1b products are generated, from Metop and from NOAA/GAC data.

Product	Main geophysical parameter	Accuracy	Resolution /grid spacing (nadir)	Swath width	Coverage	Generated
AVHRR Level 1b from Metop	Geolocated reflectivity from visible and NIR channels, and radiances for IR channels / cloud coverage information	Radiometric: 1 K for IR channels / Geolocation: 1 km / Channel to channel mis-registration: <0.1 mrad	1.1 km x 1.1 km / 1.1 km x 1.1 km	2893 km	Global and continuous	EPS CGS
AVHRR Level 1b from NOAA/GAC			4.4 km (across-track) x 1.1 km (along track) / 5.5 km (across-track) x 3.3 km (along track)			

Table 4-5: Summary of the main characteristics of AVHRR/3 Level 1b products

Apart from the main geophysical parameter given for each pixel, navigation information is given for each scan line, as well as angular relations for every navigation point. Calibration data are also appended in the product (slope and intercept) for both visible/NIR and IR channels.

4.3.2 Quality information in the products

A number of quality flags are generated during the Level 1b processing, associated with individual scan lines. The following are the most relevant with respect to data use. A full list and detailed explanation of all flags is given later in the Level 1b spatial averaged products content and format description (Section 11).

- Instrument degradation and/or processing degradation - Boolean flags reporting any possible degradation anywhere in the chain, from the instrument to the end of the processing.
- General quality indicator for a given scan, detecting cases such as gaps, instrument status changes, insufficient data for calibration, Earth location data not available, time sequence anomalies. This flag includes a recommendation to use or not use the scan for further product generation, which is later used in the ATOVS and IASI Level 2 processors.
- The general quality indicator is complemented by a more detailed flag qualifying the reasons for the anomalies detected in the general quality indicator.
- Additionally, instrument telemetry is included in the product as well, so that in the event of instrument anomalies, they can be traced down to the instrument status detailed report.

- Calibration quality summary flag, summarising the IR channels calibration results. This is a bit flag and all bits = 0 indicate a good calibration of the IR channels.
- For products derived from NOAA/GAC data, the presence of channel 3a or 3b can be detected in the GAC frame description within the product. For products from Metop, the corresponding information can be found in the part of the product containing the Digital B telemetry.
- A surface type flag (water, land or mixed) is also appended to every pixel.

4.4 Summary of AVHRR Level 1b product current and potential applications

The main internal use of AVHRR Level 1b product is for further processing in the ATOVS Level 2 and IASI processors in the EUMETSAT CGS. AVHRR/3 radiances and geolocation information included in the AVHRR Level 1b product are passed to the IASI Level 1 processor in order to support IASI navigation and radiative surface analysis. The cloud analysis is further used in the IASI and ATOVS Level 2 processors.

Originally, NOAA designed AVHRR for the following tasks: Channels 1 and 2 were to be used to discern clouds, land-water boundaries, extent of snow and ice, and the inception of snow/ice melting, and to monitor terrestrial vegetation employing the computation of the NDVI; Channels 3, 4, and 5 were to be used to measure the temperature of clouds and the sea surface, and for night-time cloud mapping. Several decades of availability of AVHRR data have proved its usefulness for a range of applications in meteorology, oceanography and terrestrial sciences, extending far beyond these original objectives. Most of these applications imply the derivation of geophysical parameters beyond the contents of the AVHRR Level 1b product (which are basically sensor radiances and cloud information) and that higher-level product derivation is partially covered by products/software generated by the SAFs.

A good reference for the AVHRR instrument is [RD42], which includes a thorough review of all AVHRR applications.

4.4.1 Applications in meteorology

Day and night cloud mapping is the main application of AVHRR data in meteorology, especially at high latitudes where data from geostationary satellites are severely distorted due to Earth curvature. The AVHRR/3 Level 1b contains basic cloud map information necessary for the processing of higher-level ATOVS and IASI products. Additionally, the NWC SAF develops an end-user software package for derivation of a cloud mask from AVHRR images.

Other important applications of AVHRR in meteorology are in combination with information from the ATOVS sensors (HIRS, AMSU-A and MHS) flying on the same platform. Together, these systems provide a suite of infrared and microwave channels that can be used to profile atmospheric temperature and humidity. Such meteorological applications include interpreting cloud top temperatures and heights for predicting and monitoring storms, differentiating ice, water, shadow and other aspects of clouds, deriving polar winds from monitoring cloud motions, water vapour content of the lower atmosphere, and the study and monitoring of tropical cyclones.

Finally, surface radiative fluxes are an essential geophysical parameter for climatological studies which can be derived from AVHRR data. Both the OSI SAF and the LSA SAF generate products containing this information.

4.4.2 Applications in oceanography

Multi-Channel SST (MCSST), computed from channels 4 and 5 of the AVHRR, is the main geophysical parameter of use in AVHRR oceanographic applications.

Infrared AVHRR imagery has also proven very useful in mapping mesoscale ocean features in terms of their SST signatures. Major ocean currents, such as the Gulf Stream, are readily visible by their marked SST gradients. Techniques have been developed for mapping ocean current variability from their signatures in the AVHRR SST imagery. The OSI SAF is developing an operational AVHRR-based global SST product suitable for these purposes.

Another oceanographic application of AVHRR data is in the study of sea ice. Properly filtered for clouds over ice, AVHRR imagery can be used to compute sea ice concentration, type and ice edge location. The OSI SAF develops such a product, based not only on AVHRR imagery, but also on additional passive and microwave sensor information. Finally, a sequence of AVHRR images, either visible or thermal infrared for polar winters, can be used to compute ice motion.

4.4.3 Applications in terrestrial sciences

The AVHRR has evolved into an invaluable resource for studying the land surface. AVHRR's frequent day/night synoptic coverage and high horizontal resolution are features that make the system unique for such applications.

In the area of monitoring terrestrial vegetation, the AVHRR-derived NDVI has proven to be a very robust and useful quantity to monitor vegetation, land cover and climate. The index has been produced and utilised globally and regionally. The NDVI is related to the health of the vegetation growth, and has therefore been used for drought forecasting, crop growth monitoring and to map forest fire fuel potential.

Multi-channel imagery from the AVHRR has also proven to be useful in snow cover mapping. The frequent coverage of the AVHRR is again the prime advantage in being able to distinguish clouds from snow cover with their similar albedo signature. Combined with topographic relief information, snow cover from AVHRR can be converted to snow-water equivalent to give an estimate of the amount of water reserve represented by the winter snow pack.

The LSA SAF develops vegetation products from AVHRR and other sensors, which can be used for the above applications.

5 DATA VIEWING AND READING

Readers for the native EPS format AVHRR Level 1b products are available online at the EUMETSAT website on the Useful Programs & Tools page.

Tools to read HDF formats are TBD, but it is intended that the products can be read using standard HDF libraries. For more information on HDF5 formats in general, see the HDF5 webpages.

6 AVHRR LEVEL 1B PRODUCT FORMATS AND DISSEMINATION

A description of the dissemination means for EPS products and formats is provided in the following paragraphs, focusing down on AVHRR products and their formats.

6.1 EPS products available dissemination means

Note that this section about dissemination means of EPS products in general could be removed when that info is available on the EPS website.

6.1.1 Satellite Direct Broadcast Service

Instrument and ancillary data acquired by the Metop satellites will be broadcast and received by authorised users in real-time via:

- High Resolution Picture Transmission (HRPT) - transmission of data from all Metop instruments in full resolution;

The data will be received by local reception stations. It is the responsibility of the user to procure and install a local reception station. Specification documentation for a EUMETSAT-based HRPT Reference User Station is available for information on the EUMETSAT webpage Metop – AHRPT.

The output format of the EUMETSAT HRPT Reference User Station is Level 0 products in the EPS Native format [RD11], [RD24].

The broadcast data are encrypted. To get authorisation to access the data, users need to register with the EUMETSAT User Services and will receive the data decryption information.

Data from the NOAA payload are also broadcast and received by local users via the HRPT mechanism. For details on the NOAA HRPT system, the reader is referred to the NOAA KLM User's Guide [RD41].

6.1.2 EUMETCast

Global EPS products at different levels will be distributed in near real-time via EUMETSAT's Data Distribution System (EUMETCast). EUMETCast utilises the services of a satellite operator and telecommunications provider to distribute data files using Digital Video Broadcast (DVB) to a wide audience located within the geographical coverage zone which includes most of Europe and certain areas in Africa.

Within the current EUMETCast configuration, the multicast system is based upon a client/server system with the server side implemented at the EUMETCast uplink site (Usingen, Germany) and the client side installed on the individual EUMETCast reception stations. The telecommunications suppliers provide the DVB multicast distribution mechanism. Data/product files are transferred via a dedicated communications line from EUMETSAT to the uplink facility. These files are encoded and transmitted to a geostationary communications satellite for broadcast to user receiving stations. Each receiving station decodes the signal and recreates the data/products according to a defined directory and file name structure. A single reception station can receive any combination of the provided services.

A typical EUMETCast reception station comprises a standard PC with DVB card inserted and a satellite off-set antenna fitted with a digital universal V/H LNB. In addition, users require the multicast client software, which can be obtained via the EUMETSAT User Services.

More detailed information on this service can be found in the EUMETSAT webpage EUMETCast Dissemination Scheme.

Products distributed on EUMETCast can be formatted in a variety of formats, including EPS native format and the WMO formats (BUFR and GRIB).

6.1.3 GTS/RMDCN

A subset of EPS products will be disseminated additionally in near real-time via the Global Telecommunication System (GTS). GTS is the World Meteorological Organization integrated network of point-to-point circuits, and multi-point circuits which interconnect meteorological telecommunication centres. Its purpose is to enable an efficient exchange of meteorological data and products in a timely and reliable way to meet the needs of World, Regional and National Meteorological Centres. The circuits of the GTS are composed of a combination of terrestrial and satellite telecommunication links. Meteorological Telecommunication Centres are responsible for receiving data and relaying them selectively on GTS circuits. The GTS is organised on a three-level basis, namely:

- The Main Telecommunication Network, linking together 3 World meteorological centres and 15 regional telecommunication hubs.
- The Regional Meteorological Telecommunication Networks, consisting of an integrated network of circuits interconnecting meteorological centres in a region, which are complemented by radio broadcasts where necessary. In Europe, the GTS network is supported by the Regional Meteorological Data Communication Network (RMDCN).
- The National Meteorological Telecommunication Networks, which extend the GTS network down to national level.

More detailed information on this service can be found on the WMO website www.wmo.int.

Products distributed on the GTS are in official WMO formats, namely BUFR or GRIB.

6.1.4 EUMETSAT Data Centre

All EPS products and auxiliary data are normally archived and made available to users from the EUMETSAT Data Centre (formerly known as the UMARF or Archive Services) upon request.

The Data Centre can be accessed through the webpage EUMETSAT Data Centre. Access is through a Web interface, the Online Ordering Application, through which the users are able to browse and order products, manage their user profile, retrieve products, documentation and software libraries, get help, etc.

The Data Centre features include geographical and time sub-setting and image preview. EPS products archived in the Data Centre can be accessed in a variety of formats, including EPS native format and HDF5.

6.2 AVHRR products dissemination

Table 6-1 summarises the different dissemination means and formats for all AVHRR products available to users.

Format	Real-Time Direct Broadcast	Near-Real-Time dissemination on EUMETCast (timeliness)	Near-Real-Time dissemination on GTS (timeliness)	EUMETSAT Data Centre retrieval (timeliness)
Metop-AVHRR raw data format	AVHRR HRPT data streams and Metop Admin message	--	--	--
EPS native format	--	AVHRR Level 1b from Metop and NOAA (2 h 15 min)	--	AVHRR Level 0 and AVHRR Level 1b from Metop and NOAA (8-9 h)
HDF5	--	--	--	AVHRR Level 0 and Level 1b from Metop and NOAA (8-9 h)

'Timeliness' *refers to the elapsed time between sensing and dissemination.*

Table 6-1: Summary of dissemination means and formats for AVHRR products

Real-time broadcast of AVHRR raw data is not covered in this guide. It is noted though for information that the raw data streams mentioned in the table above indicate what is broadcast by the platform. Depending on the reception system used (i.e., the HRPT local reception system), different formats of this raw data stream are produced. This depends on the local reception station provider. For Metop HRPT stations, the Reference User Station has been developed to produce EPS Native Level 0 format products.

Although available through the EUMETSAT Data Centre, AVHRR Level 0 products are not considered an end-user product, hence they are not addressed in this guide either.

6.2.1 Near-real-time dissemination

The AVHRR Products disseminated to users in near real-time are:

- AVHRR Level 1b product from Metop, at full AVHRR resolution, with a timeliness of 2 h 15 min from sensing
- AVHRR Level 1b product from NOAA, at GAC resolution, with a timeliness of 2 h 15 min from sensing

The dissemination granularity of the data is 3 minutes.

6.2.2 Archive retrieval

The AVHRR Products available from the EUMETSAT Data Centre via the Online Ordering Application are:

- AVHRR Level 1b product from Metop at full AVHRR resolution in EPS native format or HDF5
- AVHRR Level 1b product from NOAA at GAC resolution in EPS native format or HDF5

The products are archived as full-dump products, but sub-setting capabilities are provided to the user in the retrieval step. The products are available for the users in the EUMETSAT Data Centre 8 to 9 hours after sensing.

6.3 AVHRR EPS native product formats

6.3.1 The EPS native formats

6.3.1.1 General overview of the EPS generic product format

All products in EPS native format are structured and defined according to an EPS Generic Product Format. This format is not AVHRR specific. The general product section breakdown is given, and the following sections will focus on how this generic format is further applied to AVHRR products.

This description is not aimed at supporting the writing of reader software for the AVHRR or other EPS products, because readers and product extraction tools are already available (see Section 5). The intention of this and the following sections is to provide enough information to be able to use such available tools and to interpret the retrieved information.

For users interested in writing their own product readers for one or several AVHRR products in EPS native format, we refer them to the detailed format specifications provided in [RD11] and [RD12].

The general structure of the products is broken down in sections, which contain one or more records of different classes. Every single record is accompanied by a Generic Record Header (GRH), which contains the metadata necessary to uniquely identify the record type and occurrence within the product. The following general structure is followed by all EPS products, where all the sections occur always in the given order.

Header Section, containing metadata applicable to the entire product. The header section may contain two records, the Main Product Header Record (MPHR) and the Secondary Product Header Record (SPHR). This is the only section that contains ASCII records, the rest of the product is in binary.

Pointer Section, containing pointer information to navigate within the product. It consists of a series of Internal Pointer Records (IPR), which include pointers to records within the Global Auxiliary Data, Variable Auxiliary Data and Body Sections that follow.

Global Auxiliary Data Section, containing information on the auxiliary data that have been used or produced during the process of the product and applies to the whole length of the product. There can be zero or more records in this section, and they can be of two classes: Global External Auxiliary Data Record (GEADR), containing an ASCII pointer to the source

of the auxiliary data used, and Global Internal Auxiliary Data Record (GIADR), containing the auxiliary data used itself.

Variable Auxiliary Data Section, containing information on the auxiliary data that have been used or produced during the process of the product and may vary within a product, but with a frequency in any case less than the measurement data itself. There can be zero or more records in this section, and they can be of two classes: Variable External Auxiliary Data Record (VEADR), containing an ASCII pointer to the source of the auxiliary data used, and Variable Internal Auxiliary Data Record (VIADR), containing the auxiliary data used itself.

Body Section, which is usually the main bulk of the product and contains the raw or processed instrument data and associated information. This section contains time-ordered Measurement Data Records (MDR). A particular type of MDR can occur to indicate the location of an unexpected data gap within any product, the Dummy Measurement Data Record (DMDR).

The format of the MPHR, IPRs, GEADR, VEADR and DMDRs is common to all products, while the other records can be of different formats and contents, and identified as of different sub-classes for different products. Every record consists of a series of fields, which can have different data types. See Appendix C for all possible data types.

It is important to note that GEADR and VEADR records are included in the products to support processing configuration control for EUMETSAT at product level. They point to the name of auxiliary data files used in the processing, but they are not of any interest or use to the end-user for the utilisation of the products.

Two types of records deserve special description, because they are key to navigating within the products, namely the GRH and the IPR. Their format and the meaning of their fields are detailed in Appendix D. In particular, IPRs can be used to skip through VEADRs and GEADRs and get to the measurement data of interest to the user.

Table 6-2 gives an example of general structure of the Generic Product Format.

Section	Record Class	Record Subclass	Start Time	Stop Time
HEADER SECTION	MAIN PRODUCT HEADER RECORD		T1	T6
	SECONDARY PRODUCT HEADER RECORD		T1	T6
INTERNAL POINTER SECTION	INTERNAL POINTER RECORD (GEADR Subclass A)		T1	T6
	INTERNAL POINTER RECORD (GEADR Subclass B)		T1	T6
	INTERNAL POINTER RECORD (GIADR Subclass A)		T1	T6
	INTERNAL POINTER RECORD (GIADR Subclass B)		T1	T6
	INTERNAL POINTER RECORD (GIADR Subclass C)		T1	T6
	INTERNAL POINTER RECORD (VEADR Subclass A)		T1	T6
	INTERNAL POINTER RECORD (VEADR Subclass B)		T1	T6
	INTERNAL POINTER RECORD (VEADR Subclass C)		T1	T6
	INTERNAL POINTER RECORD (VIADR Subclass A)		T1	T6
	INTERNAL POINTER RECORD (VIADR Subclass B)		T1	T6
	INTERNAL POINTER RECORD (VIADR Subclass C)		T1	T6
	INTERNAL POINTER RECORD (MDR Subclass A)		T1	T6

	INTERNAL POINTER RECORD (MDR Subclass B)		T1	T6
	INTERNAL POINTER RECORD (MDR DUMMY)		T1	T6
	INTERNAL POINTER RECORD (MDR Subclass A)		T1	T6
	INTERNAL POINTER RECORD (MDR Subclass B)		T1	T6
GLOBAL AUXILIARY DATA SECTION	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T6
	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T6
	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T6
	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T6
	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T6
VARIABLE AUXILIARY DATA SECTION	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T3
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T3	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T5
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T5	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T2
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T2	T4
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T4	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T6
BODY SECTION	MEASUREMENT DATA RECORD	SUBCLASS A	T1	T2
	MEASUREMENT DATA RECORD	SUBCLASS B	T2	T3
	MEASUREMENT DATA RECORD	DUMMY	T3	T4
	MEASUREMENT DATA RECORD	SUBCLASS A	T4	T5
	MEASUREMENT DATA RECORD	SUBCLASS B	T5	T6

Table 6-2: Generalised schematic of the generic product format

6.3.1.2 Granularity of the EPS products

The Full EPS product is produced by processing a dump of data. This is the product size used to archive in the EUMETSAT Data Centre.

In addition, the Regional EPS product is a full product that has been passed through a geographical filter. This may happen, for example, during the retrieval of the product from the Data Centre.

Finally, a Product Dissemination Unit (PDU) is the near-real-time dissemination of the full product, and it is typically of 3 minutes. A PDU is often referred to as product ‘granule’.

The EPS Generic Product Format has been defined to apply to any length of sensing. That means that the same generic format described above applies to a 3-minute duration granule, half an orbit or a full dump of data. The length in time of the product is contained in the MPHR.

6.3.1.3 Product format version control

Every record class and sub-class has an associated record version number contained in its corresponding GRH. In addition, each product has a format version number, which is stored in the MPHR.

6.3.1.4 Product naming convention

File naming convention for EPS products in EPS native format provides a product name that uniquely identifies any product and provides a summary of its contents. The field contents in a product name correspond to those in the MPHR.

<INSTRUMENT_ID>_<PRODUCT_TYPE>_<PROCESSING_LEVEL>_<SPACECRAFT_ID>_
_<SENSING_START>_<SENSING_END>_<PROCESSING_MODE>_<DISPOSITION_MODE>_
<PROCESSING TIME>

Product Name Field / MPHR Field	Description	Size in Characters
INSTRUMENT_ID	Instrument identification	4
PRODUCT_TYPE	Product Type	3
PROCESSING_LEVEL	Processing Level Identification	2
SPACECRAFT_IUD	Spacecraft identification	3
SENSING_START	UTC Time of start of Sensing Data	15
SENSING_END	UTC Time of end of Sensing Data	15
PROCESSING_MODE	Identification of the mode of processing	1
DISPOSITION_MODE	Identification of the type of processing	1
PROCESSING_TIME	UTC time at start of processing for the product	15

Table 6-3: EPS product name fields and their correspondence with MPHR fields

For the AVHRR products, the resulting product file names are as follows:

Product	Product name
AVHRR Level L1b from Metop	AVHR_xxx_1B_Mnn_< ...>
AVHRR Level L1b from NOAA	AVHR_GAC_1B_Nnn_< ...>

Table 6-4: Generic AVHRR Level 1b product names

6.3.2 The AVHRR Level 1b product format

Records to be found in the AVHRR Level 1b products are:

Record Name	Description	Usage	Subclass ID
MPHR	Main Product Header Record	Main product identification details	0
SPHR	Secondary Product Header Record	It contains necessary information to dimension the product (number of lines and navigation points)	0
Necessary IPRs	Internal Product Record Pointers	Necessary to access directly different records in the product	1, 2, ...
GEADRs	Pointers to global auxiliary data file names used in the processing (*)	Not relevant for end-user	not available
GIADR-RADIANCES	Parameters related to radiance conversion and calibration	Relevant for end-user if necessary to retrieve reflectance factors or radiances	1
GIADR-ANALOG	Parameters related to analogue telemetry conversion	Not relevant for end-user	2
VEADRs	Pointers to variable auxiliary data file names used in the processing (*)	Not relevant for end-user	not available
MDR-1B	Same record format for products from Metop and NOAA (but with different numbers of pixels – see below)	Level 1b main product contents (see next sections for more details)	2

Table 6-5: Record types in AVHRR Level 1b product

(*) A full list of GEADRs and VEADRs for the AVHRR Level 1b product is not available at the time of writing this version of the AVHRR Level 1b product guide. IPRs as found in the products can however be used to skip over GEADRs and VEADRs, as those records do not contain any information relevant for the end-user.

These products are organised as successive lines of pixels along track, referenced to by the orbit time that corresponds to that line of pixels. The START/STOP times indicated in the MPHR and the corresponding VIADRs are also referenced with respect to that time.

Each MDR contains data corresponding to one line of pixels. Pixels in one line are given in the direction of scanning: right to left (e.g., East to West for Northbound satellite direction). Data included in each MDR are of several types:

- Measurement data, including five channel radiances, for all the pixels in that line
- Navigation data corresponding to that line

- Calibration coefficients (slope and intercept) to be used for all pixels in that scan line, both for visible and infrared channels
- Cloud information, including the results of the different cloud coverage tests carried out in the scenes analysis
- Generic and specific quality information associated with each MDR. In particular, the flag QUALITY_INDICATOR includes a recommendation to use or not use the corresponding measurements line for further processing. A full list of quality flags and their meaning can be found in Level 1b spatial averaged products content and format description (Section 11).

The number of pixels in an AVHRR Level 1b product line varies for Metop or NOAA data. In the case of Metop products, there are 2048 pixels per line and for NOAA products only 409. The occurrence of a pixel line with respect to the scanning rate is also different. For Metop products, one MDR occurs per instrument scan line. For NOAA products, one MDR occurs every three instrument scan lines. The AVHRR Level 1b product from NOAA is then consistent with the sampling characteristics of the input GAC data, although the format of the Level 1b product is the same as for the Metop-derived products at full AVHRR sampling rate.

Note that several sets of calibration coefficients are provided in the AVHRR/3 Level 1b product, defined as Operational, Test and (for the visible channels) Pre-launch. The coefficients used by the AVHRR/3 processor at EUMETSAT for the scenes analysis are the Operational set, which may consist of the Pre-launch, the Test or a combination of both sets for different mission phases, depending on the status of product validation activities and of the results of future vicarious calibration activities.

To summarise, the occurrence of the different records in the AVHRR Level 1b products is as follows:

Record	Occurrence
MPHR	Once per product
IPRs	Once each per product
GEADRs	Once each per product
GIADR-RADIANCES	Once per product
GIADR-ANALOG	Once per product
VEADRs	Occurs at least once. Re-occurs each time the applicability of the information changes within the product
MDR-1B	Once every instrument scan line for Metop products (full AVHRR sampling rate) Once every 3 instrument scan lines for NOAA products (GAC sampling rate)

Table 6-6: Occurrence of records in AVHRR Level 1b product

See Section 11 for more details on the contents and format of the AVHRR Level 1b products.

6.3.3 Deriving reflectance factors for VIS and NIR channels

The Level 1b products for the AVHRR channels 1, 2 and 3a contain in-band radiances, not counts.

To get the in-band radiances in W m^{-2} sr^{-1} from the array 'SCENE_RADIANCES' in the MDR, the values for channels 1 and 2 have to be divided by 100, and the values of channel 3a by 10000.

To convert scene radiances into target reflectance factors in percent, apply the following formula:

Target reflectance in percent = 100 * π * (scene radiance in W m^{-2} sr^{-1}) / F

where:
F denotes the (channel-specific) solar irradiance in W m^{-2}

The values for F may be found in the GIADR section of the product, viz.:
CH1_SOLAR_FILTERED_IRRADIANCE,
CH2_SOLAR_FILTERED_IRRADIANCE,
CH3A_SOLAR_FILTERED_IRRADIANCE.

If you divide these values (respectively 1399, 2329, 140) by 10, you get F in W m^{-2}. With this knowledge of F, the above equation can then be solved.

6.3.4 Deriving brightness temperatures for IR channels

To get the radiances in m W m^{-2} sr^{-1} cm from the array 'SCENE_RADIANCES' in the MDR, the values for channel 3b have to be divided by 10000, and the values for channels 4 and 5 by 100.

Brightness temperatures can be computed from radiances according to the following equations:

$$T^* = \frac{C_2 . \gamma}{\ln\left(1 + \frac{C_1 . \gamma^3}{R}\right)}$$

$$T = A + B . T^*$$

where:

R = radiance as decoded from the product (mW/(m^2.sr.cm^{-1}))
T* = the brightness temperature (K)
T = corrected brightness temperatures (K)
C1 (constant) = $1.191062.10^{-5}$ (mW/(m^2.sr.cm^{-4}))
C2 (constant) = 1.4387863 (K/cm^{-1})
γ = the channel central wave number (cm^{-1})
A and B are linear correction coefficients
ln is the natural logarithm function

For all instruments, the coefficients can be found in the following file on the EUMETSAT website:

http://www.eumetsat.int/idcplg?IdcService=GET_FILE&dDocName=ZIP_EPS_ATOVS_CALIB_PARS&RevisionSelectionMethod=LatestReleased.

They may also be available in the product as per table below.

Parameter	Location in product
γ	GIADR_RADIANCE.CH{3B,4,5}_CENTRAL_WAVENUMBER
A	GIADR_RADIANCE.CH{3B,4,5}_CONSTANT1
B	GIADR_RADIANCE.CH{3B,4,5}_CONSTANT2_SLOPE

Table 6-7: Location of coefficients for radiance-temperature conversion

6.4 The HDF format

The contents and formats of the individual fields of the AVHRR Level 1b HDF5 products are the same as for the EPS native format. The organisation of the data is different. Typically, the EPS native format presents each scan and corresponding parameters as one complete sequence, stored in a Measurement Data Record (MDR), which is successively repeated until the whole swath is completed. In conversion to HDF5 the measurement values and associated parameters are grouped into separate arrays.

Detailed format descriptions are provided in [RD21]. The products retrieved from the EUMETSAT Data Centre have the same name as the original EPS formatted ones, with the extension appended: '.h5' for HDF5 formatted products, '.nat' for products in the native EPS format. Tools to read HDF formats are TBD, but it is intended that the products can be read using standard HDF libraries. For more information on HDF5 formats in general, see the HDF5 webpages.

7 AVHRR LEVEL 1 PRODUCT PROCESSING ALGORITHMS

The data calibration and retrieval algorithms are documented in the AVHRR Product Generation Specification (PGS) document [RD13]. The operational processing algorithms are summarised below.

7.1 AVHRR Level 1 processing details

7.1.1 Radiances

Radiances are calculated differently depending upon the channel:

1) **IR channel gains** and **offsets** (cold space counts used to calculate the gain) are first determined. The gain is computed using the temperature of the internal black body, the instrument counts from the view of the internal black body, the cold space radiance and the cold space view counts.
   - Readings from multiple thermistors are validated and **averaged** to generate the internal black body temperature, and identified "bad" thermistors can be excluded.
   - A linear correction can be added to the average **black body thermistor temperature**. There are no plans to use this correction unless a calibration problem is found with the thermistors.
   - A quadratic calibration relationship is applied to the signals from channels 3b, 4 and 5.
2) Dual-gain circuitry is employed for the **VIS/NIR channels** 1, 2, and 3a, and these channels also lack an effective on-board radiometric calibration target. There are two sets of gains and intercepts used to convert the measured counts linearly into target reflectance factors. For these channels, pre-launch measurements of gains and intercepts are employed (calibrations are also planned post-launch). From the measured counts, target reflectance factors are computed and converted into radiances. Since this is a fully invertible calculation, we will often refer exclusively to radiances.
3) From the radiances, **brightness temperatures** are computed using the inverse Planck function using the central wavelength of the considered channel.
   - The channel brightness temperatures are corrected by the individual channel response function using **band-correction coefficients** (two coefficients for each channel). This allows the computation using a single Planck function calculation, rather than requiring the convolution of the Planck function across the instrument transmittance function. This saves computational time compared to the full convolution. The same method is employed for the other ATOVS instruments as well, and should not impact Cal/Val.

7.1.2 Geolocation

1) Geolocation is only computed explicitly for every 20th pixel (GAC: every 8th), and then left for the user to interpolate for the remaining pixels between these "tie points".
2) Signals over landmarks are identified, and compared against a fixed database to determine if there is any error (in increments of 1 pixel) along or across track in the

geolocation. (But please note that landmark navigation is currently not in operational use.)

- Landmark processing is carried out before cloud detection. The landmark match-up is attempted using distinct tests. There are four test criteria during daytime and two test criteria during night-time.
- They are designed to function in the presence of clouds by requiring close agreement between measured and expected surface identifications, and thereby rejecting results from suspicious tests.
- Landmark detection cannot work in the case of optically thick clouds covering the whole landmark area being considered.

7.1.3 Scenes analysis

Following geolocation, a "scenes analysis" is carried out to identify **clouds**:

1) A number of thresholds are applied to:
   - individual radiances, looking for unrealistically cold surface temperatures,
   - combinations of radiances (e.g. NDVI) to classify scenes as cloudy or cloud-free,
   - adjacent pixels which are also employed to check for spatial non-uniformity indicative of clouds (over water only).
2) Forecast surface temperature and column humidity data are employed, as well as AMSU-A data when available, for these many tests.
3) Different tests are employed based upon land/coastline/sea (from the coastline database) and day/sunglint (over water only) /night/twilight conditions.
4) Snow and sea ice detection is performed with individual test sequences.

7.1.4 Land/Sea Surface Temperatures

Land Surface Temperature and Sea Surface Temperature are determined using split- or multiple-window techniques depending upon the availability of channel 3b.

7.1.5 Cloud Top Temperature

Cloud Top Temperature is determined directly from channel 4 for cloudy scenes that pass a simple black body threshold test.

8 AVHRR LEVEL 1 PRODUCTS VALIDATION

This section will provide details about what validation methods have been used and description of validation campaigns (if any). Reference will be made to the relevant product quality assessment reports after Commissioning or later on during the mission (in the event of product improvements / processor upgrades).

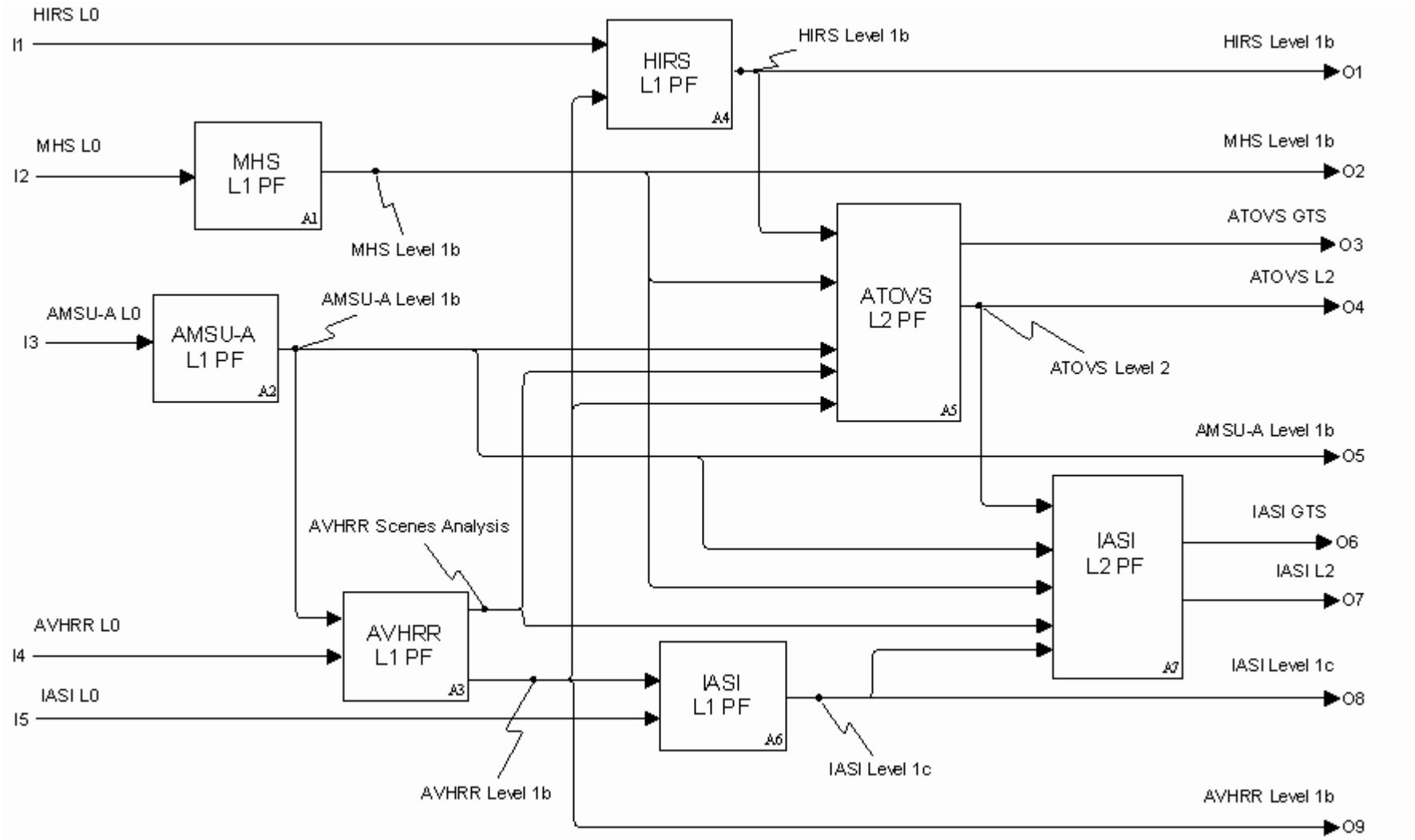
For now, refer to [RD14] for a detailed description of Calibration and Validation activities and methods.

9 AVHRR LEVEL 1 PRODUCTS ROUTINE MONITORING

This section will provide details on AVHRR Level 1 products routine monitoring activities and methods at EUMETSAT. Reference will be made to relevant periodical product quality reports during operations, their contents and explanation.

For now, refer to [RD14] for a detailed description of planned Routine Monitoring activities and methods.

10 ATOVS, IASI AND AVHRR PROCESSING CHAIN INTER-DEPENDENCIES



11 RECORD DESCRIPTION OF THE AVHRR LEVEL 1B PRODUCT

This AVHRR/3 1B description corresponds to the AVHRR/3 PFS [RD12] Issue v7C (PFV 10.0) and to the Generic PFS [RD11] Issue v7D.

Note that the following description is applicable to AVHRR/3 Level 1b products from both Metop and NOAA. In order to be able to generate the record size and offset information in the table describing the MDR-1b record, a number of Earth views and navigation points per scan has been assumed, consistent with the highest possible values corresponding to the Metop full sampling rate and navigation processing. The MDR-1b for the NOAA product will of course be smaller, corresponding to the relevant dimensions of the input GAC data.

These assumed values are given at the end of this section as NE and NP. However, in order to interpret the products, the user must use the correct dimension information for the product contained in the SPHR record, as described below.

In the tables below, coloured items have the following meanings:

Compound data type, which consists of at least two basic or other compound data types. The name of the compound data type is shown first, followed by a list of the items contained within it.

Dimension parameter for variable product fields.

Summary of Product Format Version record contents history

	PFV = 10.0
Record name	**Record version**
mphr	2
sphr	3
giadr-radiance	3
giadr-analog	
mdr-1b	4

If more than one version of a record exists, all versions are described below.

Contents:

- MPHR (name 'mphr', class 1, subclass 0, version 2)
- SPHR (name 'sphr', class 2, subclass 0, version 3)
- GIADR (name 'giadr-radiance', class 5, subclass 1, version 3)
- GIADR (name 'giadr-analog', class 5, subclass 2, version 2)
- MDR (name 'mdr-1b', class 8, subclass 2, version 4)

Certain record types with formats common to all products (IPR, DMDR, GEADR, VEADR) are not included below, since they are not relevant to the average user. If required, details of these records can be found in the Generic PFS [RD11].

11.1 MPHR (name 'mphr', class 1, subclass 0, version 2)

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0
Product Details											
PRODUCT_NAME	Complete name of the product			1	1	1	1	string	67	100	20
PARENT_PRODUCT_NAME_1	Name of the parent product from which this product has been produced. For Level 0 products, this field is filled with lower case x's.			1	1	1	1	string	67	100	120

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PARENT_PRODUCT_NAME_2	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, this field is filled with lower case x's.			1	1	1	1	string	67	100	220
PARENT_PRODUCT_NAME_3	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, this field is filled with lower case x's.			1	1	1	1	string	67	100	320
PARENT_PRODUCT_NAME_4	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, this field is filled with lower case x's.			1	1	1	1	string	67	100	420
INSTRUMENT_ID	Instrument identification			1	1	1	1	enumerated	4	37	520
INSTRUMENT_MODEL	Instrument Model identification			1	1	1	1	enumerated	3	36	557
PRODUCT_TYPE	Product Type			1	1	1	1	enumerated	3	36	593
PROCESSING_LEVEL	Processing Level Identification			1	1	1	1	enumerated	2	35	629
SPACECRAFT_ID	Spacecraft identification			1	1	1	1	enumerated	3	36	664
SENSING_START	UTC Time of start of sensing data in this object (PDU, ROI or Full Product)			1	1	1	1	time	15	48	700
SENSING_END	UTC Time of end of sensing data in			1	1	1	1	time	15	48	748

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	this object (PDU, ROI or Full Product)										
SENSING_START_THEORETICAL	Theoretical UTC Time of start of sensing data in the dump from which this object is derived. This data is the predicted start time at the MPF level.			1	1	1	1	time	15	48	796
SENSING_END_THEORETICAL	Theoretical UTC Time of end of sensing data in the dump from which this object is derived. This data is the predicted end time at the MPF level.			1	1	1	1	time	15	48	844
PROCESSING_CENTRE	Processing Centre Identification			1	1	1	1	enumerated	4	37	892
PROCESSOR_MAJOR_VERSION	Processing chain major version number			1	1	1	1	uinteger	5	38	929
PROCESSOR_MINOR_VERSION	Processing chain minor version number			1	1	1	1	uinteger	5	38	967
FORMAT_MAJOR_VERSION	Dataset Format Major Version number			1	1	1	1	uinteger	5	38	1005
FORMAT_MINOR_VERSION	Dataset Format Minor Version number			1	1	1	1	uinteger	5	38	1043
PROCESSING_TIME_START	UTC time of the processing at start of processing for the product			1	1	1	1	time	15	48	1081
PROCESSING_TIME_END	UTC time of the processing at end of processing for the product			1	1	1	1	time	15	48	1129
PROCESSING_MODE	Identification of the mode of processing			1	1	1	1	enumerated	1	34	1177

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
DISPOSITION_MODE	Identification of the disposition mode			1	1	1	1	enumerated	1	34	1211
RECEIVING_GROUND_STATION	Acquisition Station Identification			1	1	1	1	enumerated	3	36	1245
RECEIVE_TIME_START	UTC time of the reception at CDA for first Data Item			1	1	1	1	time	15	48	1281
RECEIVE_TIME_END	UTC time of the reception at CDA for last Data Item			1	1	1	1	time	15	48	1329
ORBIT_START	Start Orbit Number, counted incrementally since launch			1	1	1	1	uinteger	5	38	1377
ORBIT_END	Stop Orbit Number			1	1	1	1	uinteger	5	38	1415
ACTUAL_PRODUCT_SIZE	Size of the complete product		bytes	1	1	1	1	uinteger	11	44	1453
ASCENDING NODE ORBIT PARAMETERS											
STATE_VECTOR_TIME	Epoch time (in UTC) of the orbital elements and the orbit state vector. this corresponds to the time of crossing the ascending node for ORBIT_START		UTC	1	1	1	1	longtime	18	51	1497
SEMI_MAJOR_AXIS	Semi major axis of orbit at time of the ascending node crossing.		mm	1	1	1	1	integer	11	44	1548
ECCENTRICITY	Orbit eccentricity at time of the ascending node crossing	10^6		1	1	1	1	integer	11	44	1592
INCLINATION	Orbit inclination at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1636
PERIGEE_ARGUMENT	Argument of perigee at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1680
RIGHT_ASCENSION	Right ascension at time of the	10^3	deg	1	1	1	1	integer	11	44	1724

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	ascending node crossing										
MEAN_ANOMALY	Mean anomaly at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1768
X_POSITION	X position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1812
Y_POSITION	Y position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1856
Z_POSITION	Z position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1900
X_VELOCITY	X velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	1944
Y_VELOCITY	Y velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	1988
Z_VELOCITY	Z velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	2032
EARTH_SUN_DISTANCE_RATIO	Earth-Sun distance ratio - ratio of current Earth-Sun distance to Mean Earth-Sun distance			1	1	1	1	integer	11	44	2076
LOCATION_TOLERANCE_RADIAL	Nadir Earth location tolerance radial		m	1	1	1	1	integer	11	44	2120
LOCATION_TOLERANCE_CROSSTRACK	Nadir Earth location tolerance cross-track		m	1	1	1	1	integer	11	44	2164
LOCATION_TOLERANCE_ALONGTRACK	Nadir Earth location tolerance along-track		m	1	1	1	1	integer	11	44	2208
YAW_ERROR	Constant Yaw attitude error	10^3	deg	1	1	1	1	integer	11	44	2252
ROLL_ERROR	Constant Roll attitude error	10^3	deg	1	1	1	1	integer	11	44	2296

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PITCH_ERROR	Constant Pitch attitude error	10^3	deg	1	1	1	1	integer	11	44	2340
LOCATION SUMMARY											
SUBSAT_LATITUDE_START	Latitude of sub-satellite point at start of the data set	10^3	Deg	1	1	1	1	integer	11	44	2384
SUBSAT_LONGITUDE_START	Longitude of sub-satellite point at start of the data set	10^3	Deg	1	1	1	1	integer	11	44	2428
SUBSAT_LATITUDE_END	Latitude of sub-satellite point at end of the data set	10^3	Deg	1	1	1	1	integer	11	44	2472
SUBSAT_LONGITUDE_END	Longitude of sub-satellite point at end of the data set	10^3	Deg	1	1	1	1	integer	11	44	2516
Leap Second Information											
LEAP_SECOND	Occurrence of Leap second within the product. Field is set to -1, 0 or +1 dependent upon occurrence of leap second and direction.			1	1	1	1	integer	2	35	2560
LEAP_SECOND_UTC	UTC time of occurrence of the Leap Second (If no leap second in the product, value is null)			1	1	1	1	time	15	48	2595
Record counts											
TOTAL_RECORDS	Total count of all records in the product			1	1	1	1	uinteger	6	39	2643
TOTAL_MPHR	Total count of all MPHRs in product (should always be 1!)			1	1	1	1	uinteger	6	39	2682
TOTAL_SPHR	Total count of all SPHRs in product (should be 0 or 1 only)			1	1	1	1	uinteger	6	39	2721
TOTAL_IPR	Total count of all IPRs in the			1	1	1	1	uinteger	6	39	2760

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	product										
TOTAL_GEADR	Total count of all GEADRs in the product			1	1	1	1	uinteger	6	39	2799
TOTAL_GIADR	Total count of all GIADRs in the product			1	1	1	1	uinteger	6	39	2838
TOTAL_VEADR	Total count of all VEADRs in the product			1	1	1	1	uinteger	6	39	2877
TOTAL_VIADR	Total count of all VIADRs in the product			1	1	1	1	uinteger	6	39	2916
TOTAL_MDR	Total count of all MDRs in the product			1	1	1	1	uinteger	6	39	2955
Record Based Generic Quality Flags											
COUNT_DEGRADED_INST_MDR	Count of MDRs with degradation due to instrument problems			1	1	1	1	uinteger	6	39	2994
COUNT_DEGRADED_PROC_MDR	Count of MDRs with degradation due to processing problems			1	1	1	1	uinteger	6	39	3033
COUNT_DEGRADED_INST_MDR_BLOCKS	Count of the number of blocks of MDRs degraded due to degraded instrument			1	1	1	1	uinteger	6	39	3072
COUNT_DEGRADED_PROC_MDR_BLOCKS	Count of the number of blocks of MDRs degraded due to degraded processing			1	1	1	1	uinteger	6	39	3111
Time Based Generic Quality Flags											
DURATION_OF_PRODUCT	The duration of the product in milliseconds		ms	1	1	1	1	uinteger	8	41	3150
MILLISECONDS_OF_DATA_PRESENT	The total amount of data present in		ms	1	1	1	1	uinteger	8	41	3191

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	the product										
MILLISECONDS_OF_DATA_MISSING	The total amount of data missing from the product		ms	1	1	1	1	uinteger	8	41	3232
Regional Product Information											
SUBSETTED_PRODUCT	Set when product has been subset (e.g. geographically subset using a region of interest filter). Implies the presence of one or more EUMETSAT Data Centre GIADRs in GAD section for product retrieved from Data Centre.			1	1	1	1	boolean	1	34	3273
											Total: 3307

11.2 SPHR (name 'sphr', class 2, subclass 0, version 3)

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0
QUALITY											
SRC_DATA_QUAL	Flag to specify which combination of auxiliary data is used for the scenes analysis.			1	1	1	1	bitfield (2)	16	49	20
VARIABLE_PARAMETERS											
EARTH_VIEWS_PER_SCANLINE	Number of Earth views per scanline (2048 for Full, 409 for GAC data)			1	1	1	1	integer	5	38	69

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
NAV_SAMPLE_RATE	Rate of sampling the navigation data (angular relation and earth location). For Full data every 40th or 20th Earth view. For GAC data every 8th or 4th Earth view			1	1	1	1	integer	3	36	107
											Total: 143

11.3 GIADR (name 'giadr-radiance', class 5, subclass 1, version 3)

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0
RADIANCE_CONVERSION											
RAMP_CALIBRATION_COEFFICIENT	Ramp/Auto Calibration Indicators Bit Field			1	1	1	1	bitfield (2)	2	2	20
YEAR_RECENT_CALIBRATION	Year of Most Recent Solar Channel Calibration (e.g. 1999)		yr	1	1	1	1	uinteger2	2	2	22
DAY_RECENT_CALIBRATION	Day of Year of Most Recent Solar Channel Calibration (e.g. 365)		day	1	1	1	1	uinteger2	2	2	24
PRIMARY_CALIBRATION_ALGORITHM_ID	Primary Calibration Algorithm ID			1	1	1	1	uinteger2	2	2	26

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PRIMARY_CALIBRATION_ALGORITHM_OPTION	Primary Calibration Algorithm Selected Options			1	1	1	1	bitfield (2)	2	2	28
SECONDARY_CALIBRATION_ALGORITHM_ID	Secondary Calibration Algorithm ID			1	1	1	1	uinteger2	2	2	30
SECONDARY_CALIBRATION_ALGORITHM_OPTION	Secondary Calibration Algorithm Selected Options			1	1	1	1	bitfield (2)	2	2	32
IR_TEMPERATURE1_COEFFICIENT1	IR Target Temp 1 Conversion Coefficient 1	10^2	K	1	1	1	1	integer2	2	2	34
IR_TEMPERATURE1_COEFFICIENT2	IR Target Temp 1 Conversion Coefficient 2	10^5	K/cnt	1	1	1	1	integer2	2	2	36
IR_TEMPERATURE1_COEFFICIENT3	IR Target Temp 1 Conversion Coefficient 3	10^8	K/cnt2	1	1	1	1	integer2	2	2	38
IR_TEMPERATURE1_COEFFICIENT4	IR Target Temp 1 Conversion Coefficient 4	10^11	K/cnt3	1	1	1	1	integer2	2	2	40
IR_TEMPERATURE1_COEFFICIENT5	IR Target Temp 1 Conversion Coefficient 5	10^14	K/cnt4	1	1	1	1	integer2	2	2	42
IR_TEMPERATURE1_COEFFICIENT6	IR Target Temp 1 Conversion	10^17	K/cnt5	1	1	1	1	integer2	2	2	44

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Coefficient 6										
IR_TEMPERATURE2_COEFFICIENT1	IR Target Temp 2 Conversion Coefficient 1	10^2	K	1	1	1	1	integer2	2	2	46
IR_TEMPERATURE2_COEFFICIENT2	IR Target Temp 2 Conversion Coefficient 2	10^5	K/cnt	1	1	1	1	integer2	2	2	48
IR_TEMPERATURE2_COEFFICIENT3	IR Target Temp 2 Conversion Coefficient 3	10^8	K/cnt2	1	1	1	1	integer2	2	2	50
IR_TEMPERATURE2_COEFFICIENT4	IR Target Temp 2 Conversion Coefficient 4	10^11	K/cnt3	1	1	1	1	integer2	2	2	52
IR_TEMPERATURE2_COEFFICIENT5	IR Target Temp 2 Conversion Coefficient 5	10^14	K/cnt4	1	1	1	1	integer2	2	2	54
IR_TEMPERATURE2_COEFFICIENT6	IR Target Temp 2 Conversion Coefficient 6	10^17	K/cnt5	1	1	1	1	integer2	2	2	56
IR_TEMPERATURE3_COEFFICIENT1	IR Target Temp 3 Conversion Coefficient 1	10^2	K	1	1	1	1	integer2	2	2	58
IR_TEMPERATURE3_COEFFICIENT2	IR Target Temp 3 Conversion Coefficient 2	10^5	K/cnt	1	1	1	1	integer2	2	2	60
IR_TEMPERATURE3_COEFFICIENT3	IR Target Temp 3 Conversion	10^8	oK/cnt2	1	1	1	1	integer2	2	2	62

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Coefficient 3										
IR_TEMPERATURE3_COEFFICIENT4	IR Target Temp 3 Conversion Coefficient 4	10^11	K/cnt3	1	1	1	1	integer2	2	2	64
IR_TEMPERATURE3_COEFFICIENT5	IR Target Temp 3 Conversion Coefficient 5	10^14	K/cnt4	1	1	1	1	integer2	2	2	66
IR_TEMPERATURE3_COEFFICIENT6	IR Target Temp 3 Conversion Coefficient 6	10^17	K/cnt5	1	1	1	1	integer2	2	2	68
IR_TEMPERATURE4_COEFFICIENT1	IR Target Temp 4 Conversion Coefficient 1	10^2	K	1	1	1	1	integer2	2	2	70
IR_TEMPERATURE4_COEFFICIENT2	IR Target Temp 4 Conversion Coefficient 2	10^5	K/cnt	1	1	1	1	integer2	2	2	72
IR_TEMPERATURE4_COEFFICIENT3	IR Target Temp 4 Conversion Coefficient 3	10^8	K/cnt2	1	1	1	1	integer2	2	2	74
IR_TEMPERATURE4_COEFFICIENT4	IR Target Temp 4 Conversion Coefficient 4	10^11	K/cnt3	1	1	1	1	integer2	2	2	76
IR_TEMPERATURE4_COEFFICIENT5	IR Target Temp 4 Conversion Coefficient 5	10^14	K/cnt4	1	1	1	1	integer2	2	2	78
IR_TEMPERATURE4_COEFFICIENT6	IR Target Temp 4 Conversion	10^17	K/cnt5	1	1	1	1	integer2	2	2	80

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Coefficient 6										
CH1_SOLAR_FILTERED_IRRADIANCE	Ch 1 Solar Filtered Irradiance in Wavelength	10^1	W/m2	1	1	1	1	integer2	2	2	82
CH1_EQUIVALENT_FILTER_WIDTH	Ch 1 Equivalent Filter Width in Wavelength	10^3	mu_m	1	1	1	1	integer2	2	2	84
CH2_SOLAR_FILTERED_IRRADIANCE	Ch 2 Solar Filtered Irradiance in Wavelength	10^1	W/m2	1	1	1	1	integer2	2	2	86
CH2_EQUIVALENT_FILTER_WIDTH	Ch 2 Equivalent Filter Width in Wavelength	10^3	mu_m	1	1	1	1	integer2	2	2	88
CH3A_SOLAR_FILTERED_IRRADIANCE	Ch 3a Solar Filtered Irradiance in Wavelength	10^1	W/m2	1	1	1	1	integer2	2	2	90
CH3A_EQUIVALENT_FILTER_WIDTH	Ch 3a Equivalent Filter Width in Wavelength	10^3	mu_m	1	1	1	1	integer2	2	2	92
CH3B_CENTRAL_WAVENUMBER	Ch 3b Central Wavenumber	10^2	cm-1	1	1	1	1	integer4	4	4	94
CH3B_CONSTANT1	Ch 3b Constant 1 for band correction	10^5	K	1	1	1	1	integer4	4	4	98
CH3B_CONSTANT2_SLOPE	Ch 3b Constant 2 slope for band correction	10^6	K/ K	1	1	1	1	integer4	4	4	102
CH4_CENTRAL_WAVENUMBER	Ch 4 Central	10^3	cm-1	1	1	1	1	integer4	4	4	106

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Wavenumber										
CH4_CONSTANT1	Ch 4 Constant 1 for band correction	10^5	K	1	1	1	1	integer4	4	4	110
CH4_CONSTANT2_SLOPE	Ch 4 Constant 2 slope for band correction	10^6	K/ K	1	1	1	1	integer4	4	4	114
CH5_CENTRAL_WAVENUMBER	Ch 5 Central Wavenumber	10^3	cm-1	1	1	1	1	integer4	4	4	118
CH5_CONSTANT1	Ch 5 Constant 1 for band correction	10^5	K	1	1	1	1	integer4	4	4	122
CH5_CONSTANT2_SLOPE	Ch 5 Constant 2 slope for band correction	10^6	K/ K	1	1	1	1	integer4	4	4	126
											Total: 130

11.4 GIADR (name 'giadr-analog', class 5, subclass 2, version 2)

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0
A/D_CONVERSION											
PATCH_TEMPERATURE_COEFFICIENT1	Patch Temperature Conversion Coefficient	10^2	K	1	1	1	1	integer2	2	2	20

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PATCH_TEMPERATURE_COEFFICIENT2	Patch Temperature Conversion Coefficient	10^4	K/cnt	1	1	1	1	integer2	2	2	22
PATCH_TEMPERATURE_COEFFICIENT3	Patch Temperature Conversion Coefficient	10^6	K/cnt2	1	1	1	1	integer2	2	2	24
PATCH_TEMPERATURE_COEFFICIENT4	Patch Temperature Conversion Coefficient	10^8	K/cnt3	1	1	1	1	integer2	2	2	26
PATCH_TEMPERATURE_COEFFICIENT5	Patch Temperature Conversion Coefficient	10^10	K/cnt4	1	1	1	1	integer2	2	2	28
PATCH_TEMPERATURE_EXTENDED_COEFFICIENT1	Patch Temperature Extended Conversion Coefficient	10^2	K	1	1	1	1	integer2	2	2	30
PATCH_TEMPERATURE_EXTENDED_COEFFICIENT2	Patch Temperature Extended Conversion Coefficient	10^4	K/cnt	1	1	1	1	integer2	2	2	32
PATCH_TEMPERATURE_EXTENDED_COEFFICIENT3	Patch Temperature Extended Conversion Coefficient	10^6	K/cnt2	1	1	1	1	integer2	2	2	34
PATCH_TEMPERATURE_EXTENDED_COEFFICIENT4	Patch Temperature Extended Conversion Coefficient	10^8	K/cnt3	1	1	1	1	integer2	2	2	36

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PATCH_TEMPERATURE_EXTENDED_COEFFICIENT5	Patch Temperature Extended Conversion Coefficient	10^10	K/cnt4	1	1	1	1	integer2	2	2	38
PATCH_POWER_COEFFICIENT1	Patch Power Conversion Coefficient	10^2	mW	1	1	1	1	integer2	2	2	40
PATCH_POWER_COEFFICIENT2	Patch Power Conversion Coefficient	10^4	mW/cnt	1	1	1	1	integer2	2	2	42
PATCH_POWER_COEFFICIENT3	Patch Power Conversion Coefficient	10^6	mW/cnt2	1	1	1	1	integer2	2	2	44
PATCH_POWER_COEFFICIENT4	Patch Power Conversion Coefficient	10^8	mW/cnt3	1	1	1	1	integer2	2	2	46
PATCH_POWER_COEFFICIENT5	Patch Power Conversion Coefficient	10^10	mW/cnt4	1	1	1	1	integer2	2	2	48
RADIATOR_TEMPERATURE_COEFFICIENT1	Radiator Temperature Conversion Coefficient	10^2	K	1	1	1	1	integer2	2	2	50
RADIATOR_TEMPERATURE_COEFFICIENT2	Radiator Temperature Conversion Coefficient	10^4	K/cnt	1	1	1	1	integer2	2	2	52

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RADIATOR_TEMPERATURE_COEFFICIENT3	Radiator Temperature Conversion Coefficient	10^6	K/cnt2	1	1	1	1	integer2	2	2	54
RADIATOR_TEMPERATURE_COEFFICIENT4	Radiator Temperature Conversion Coefficient	10^8	K/cnt3	1	1	1	1	integer2	2	2	56
RADIATOR_TEMPERATURE_COEFFICIENT5	Radiator Temperature Conversion Coefficient	10^10	K/cnt4	1	1	1	1	integer2	2	2	58
BLACKBODY_TEMPERATURE1_COEFFICIENT1	Blackbody Temperature 1 Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	60
BLACKBODY_TEMPERATURE1_COEFFICIENT2	Blackbody Temperature 1 Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	62
BLACKBODY_TEMPERATURE1_COEFFICIENT3	Blackbody Temperature 1 Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	64
BLACKBODY_TEMPERATURE1_COEFFICIENT4	Blackbody Temperature 1 Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	66

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
BLACKBODY_TEMPERATURE1_COEFFICIENT5	Blackbody Temperature 1 Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	68
BLACKBODY_TEMPERATURE2_COEFFICIENT1	Blackbody Temperature 2 Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	70
BLACKBODY_TEMPERATURE2_COEFFICIENT2	Blackbody Temperature 2 Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	72
BLACKBODY_TEMPERATURE2_COEFFICIENT3	Blackbody Temperature 2 Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	74
BLACKBODY_TEMPERATURE2_COEFFICIENT4	Blackbody Temperature 2 Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	76
BLACKBODY_TEMPERATURE2_COEFFICIENT5	Blackbody Temperature 2 Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	78
BLACKBODY_TEMPERATURE3_COEFFICIENT1	Blackbody Temperature 3 Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	80

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
BLACKBODY_TEMPERATURE3_COEFFICIENT2	Blackbody Temperature 3 Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	82
BLACKBODY_TEMPERATURE3_COEFFICIENT3	Blackbody Temperature 3 Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	84
BLACKBODY_TEMPERATURE3_COEFFICIENT4	Blackbody Temperature 3 Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	86
BLACKBODY_TEMPERATURE3_COEFFICIENT5	Blackbody Temperature 3 Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	88
BLACKBODY_TEMPERATURE4_COEFFICIENT1	Blackbody Temperature 4 Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	90
BLACKBODY_TEMPERATURE4_COEFFICIENT2	Blackbody Temperature 4 Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	92
BLACKBODY_TEMPERATURE4_COEFFICIENT3	Blackbody Temperature 4 Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	94

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
BLACKBODY_TEMPERATURE4_COEFFICIENT4	Blackbody Temperature 4 Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	96
BLACKBODY_TEMPERATURE4_COEFFICIENT5	Blackbody Temperature 4 Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	98
ELECTRONIC_CURRENT_COEFFICIENT1	Electronics Current Conversion Coefficient	10^2	mA	1	1	1	1	integer2	2	2	100
ELECTRONIC_CURRENT_COEFFICIENT2	Electronics Current Conversion Coefficient	10^4	mA/cnt	1	1	1	1	integer2	2	2	102
ELECTRONIC_CURRENT_COEFFICIENT3	Electronics Current Conversion Coefficient	10^6	mA/cnt2	1	1	1	1	integer2	2	2	104
ELECTRONIC_CURRENT_COEFFICIENT4	Electronics Current Conversion Coefficient	10^8	mA/cnt3	1	1	1	1	integer2	2	2	106
ELECTRONIC_CURRENT_COEFFICIENT5	Electronics Current Conversion Coefficient	10^10	mA/cnt4	1	1	1	1	integer2	2	2	108

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
MOTOR_CURRENT_COEFFICIENT1	Motor Current Conversion Coefficient	10^2	mA	1	1	1	1	integer2	2	2	110
MOTOR_CURRENT_COEFFICIENT2	Motor Current Conversion Coefficient	10^4	mA/cnt	1	1	1	1	integer2	2	2	112
MOTOR_CURRENT_COEFFICIENT3	Motor Current Conversion Coefficient	10^6	mA/cnt2	1	1	1	1	integer2	2	2	114
MOTOR_CURRENT_COEFFICIENT4	Motor Current Conversion Coefficient	10^8	mA/cnt3	1	1	1	1	integer2	2	2	116
MOTOR_CURRENT_COEFFICIENT5	Motor Current Conversion Coefficient	10^10	mA/cnt4	1	1	1	1	integer2	2	2	118
EARTH_SHIELD_POSITION_COEFFICIENT1	Earth Shield Position Conversion Coefficient	10^2	V	1	1	1	1	integer2	2	2	120
EARTH_SHIELD_POSITION_COEFFICIENT2	Earth Shield Position Conversion Coefficient	10^4	V/cnt	1	1	1	1	integer2	2	2	122
EARTH_SHIELD_POSITION_COEFFICIENT3	Earth Shield Position Conversion Coefficient	10^6	V/cnt2	1	1	1	1	integer2	2	2	124

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
EARTH_SHIELD_POSITION_COEFFICIENT4	Earth Shield Position Conversion Coefficient	10^8	V/cnt3	1	1	1	1	integer2	2	2	126
EARTH_SHIELD_POSITION_COEFFICIENT5	Earth Shield Position Conversion Coefficient	10^10	V/cnt4	1	1	1	1	integer2	2	2	128
ELECTRONIC_TEMPERATURE_COEFFICIENT1	Electronics Temperature Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	130
ELECTRONIC_TEMPERATURE_COEFFICIENT2	Electronics Temperature Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	132
ELECTRONIC_TEMPERATURE_COEFFICIENT3	Electronics Temperature Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	134
ELECTRONIC_TEMPERATURE_COEFFICIENT4	Electronics Temperature Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	136
ELECTRONIC_TEMPERATURE_COEFFICIENT5	Electronics Temperature Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	138

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
COOLER_HOUSING_TEMPERATURE_COEFFICIENT1	Cooler Housing Temperature Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	140
COOLER_HOUSING_TEMPERATURE_COEFFICIENT2	Cooler Housing Temperature Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	142
COOLER_HOUSING_TEMPERATURE_COEFFICIENT3	Cooler Housing Temperature Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	144
COOLER_HOUSING_TEMPERATURE_COEFFICIENT4	Cooler Housing Temperature Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	146
COOLER_HOUSING_TEMPERATURE_COEFFICIENT5	Cooler Housing Temperature Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	148
BASEPLATE_TEMPERATURE_COEFFICIENT1	Baseplate Temperature Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	150
BASEPLATE_TEMPERATURE_COEFFICIENT2	Baseplate Temperature Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	152

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
BASEPLATE_TEMPERATURE_COEFFICIENT3	Baseplate Temperature Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	154
BASEPLATE_TEMPERATURE_COEFFICIENT4	Baseplate Temperature Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	156
BASEPLATE_TEMPERATURE_COEFFICIENT5	Baseplate Temperature Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	158
MOTOR_HOUSING_TEMPERATURE_COEFFICIENT1	Motor Housing Temperature Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	160
MOTOR_HOUSING_TEMPERATURE_COEFFICIENT2	Motor Housing Temperature Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	162
MOTOR_HOUSING_TEMPERATURE_COEFFICIENT3	Motor Housing Temperature Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	164
MOTOR_HOUSING_TEMPERATURE_COEFFICIENT4	Motor Housing Temperature Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	166

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
MOTOR_HOUSING_TEMPERATURE_COEFFICIENT5	Motor Housing Temperature Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	168
AD_CONVERTER_TEMPERATURE_COEFFICIENT1	A/D Converter Temperature Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	170
AD_CONVERTER_TEMPERATURE_COEFFICIENT2	A/D Converter Temperature Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	172
AD_CONVERTER_TEMPERATURE_COEFFICIENT3	A/D Converter Temperature Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	174
AD_CONVERTER_TEMPERATURE_COEFFICIENT4	A/D Converter Temperature Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	176
AD_CONVERTER_TEMPERATURE_COEFFICIENT5	A/D Converter Temperature Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	178
DETECTOR4_BIAS_VOLTAGE_COEFFICIENT1	Detector #4 Bias Voltage Conversion Coefficient	10^2	V	1	1	1	1	integer2	2	2	180

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
DETECTOR4_BIAS_VOLTAGE_COEFFICIENT2	Detector #4 Bias Voltage Conversion Coefficient	10^4	V/cnt	1	1	1	1	integer2	2	2	182
DETECTOR4_BIAS_VOLTAGE_COEFFICIENT3	Detector #4 Bias Voltage Conversion Coefficient	10^6	V/cnt2	1	1	1	1	integer2	2	2	184
DETECTOR4_BIAS_VOLTAGE_COEFFICIENT4	Detector #4 Bias Voltage Conversion Coefficient	10^8	V/cnt3	1	1	1	1	integer2	2	2	186
DETECTOR4_BIAS_VOLTAGE_COEFFICIENT5	Detector #4 Bias Voltage Conversion Coefficient	10^10	V/cnt4	1	1	1	1	integer2	2	2	188
DETECTOR5_BIAS_VOLTAGE_COEFFICIENT1	Detector #5 Bias Voltage Conversion Coefficient	10^2	V	1	1	1	1	integer2	2	2	190
DETECTOR5_BIAS_VOLTAGE_COEFFICIENT2	Detector #5 Bias Voltage Conversion Coefficient	10^4	V/cnt	1	1	1	1	integer2	2	2	192
DETECTOR5_BIAS_VOLTAGE_COEFFICIENT3	Detector #5 Bias Voltage Conversion Coefficient	10^6	V/cnt2	1	1	1	1	integer2	2	2	194

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
DETECTOR5_BIAS_VOLTAGE_COEFFICIENT4	Detector #5 Bias Voltage Conversion Coefficient	10^8	V/cnt3	1	1	1	1	integer2	2	2	196
DETECTOR5_BIAS_VOLTAGE_COEFFICIENT5	Detector #5 Bias Voltage Conversion Coefficient	10^10	V/cnt4	1	1	1	1	integer2	2	2	198
CH3B_BLACKBODY_VIEW_COEFFICIENT1	Channel 3b Blackbody View Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	200
CH3B_BLACKBODY_VIEW_COEFFICIENT2	Channel 3b Blackbody View Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	202
CH3B_BLACKBODY_VIEW_COEFFICIENT3	Channel 3b Blackbody View Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	204
CH3B_BLACKBODY_VIEW_COEFFICIENT4	Channel 3b Blackbody View Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	206
CH3B_BLACKBODY_VIEW_COEFFICIENT5	Channel 3b Blackbody View Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	208

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
CH4_BLACKBODY_VIEW_COEFFICIENT1	Channel 4 Blackbody View Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	210
CH4_BLACKBODY_VIEW_COEFFICIENT2	Channel 4 Blackbody View Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	212
CH4_BLACKBODY_VIEW_COEFFICIENT3	Channel 4 Blackbody View Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	214
CH4_BLACKBODY_VIEW_COEFFICIENT4	Channel 4 Blackbody View Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	216
CH4_BLACKBODY_VIEW_COEFFICIENT5	Channel 4 Blackbody View Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	218
CH5_BLACKBODY_VIEW_COEFFICIENT1	Channel 5 Blackbody View Conversion Coefficient	10^2	degC	1	1	1	1	integer2	2	2	220
CH5_BLACKBODY_VIEW_COEFFICIENT2	Channel 5 Blackbody View Conversion Coefficient	10^4	degC/cnt	1	1	1	1	integer2	2	2	222

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
CH5_BLACKBODY_VIEW_COEFFICIENT3	Channel 5 Blackbody View Conversion Coefficient	10^6	degC/cnt2	1	1	1	1	integer2	2	2	224
CH5_BLACKBODY_VIEW_COEFFICIENT4	Channel 5 Blackbody View Conversion Coefficient	10^8	degC/cnt3	1	1	1	1	integer2	2	2	226
CH5_BLACKBODY_VIEW_COEFFICIENT5	Channel 5 Blackbody View Conversion Coefficient	10^10	degC/cnt4	1	1	1	1	integer2	2	2	228
REFERENCE_VOLTAGE_COEFFICIENT1	Reference Voltage Conversion Coefficient	10^2	V	1	1	1	1	integer2	2	2	230
REFERENCE_VOLTAGE_COEFFICIENT2	Reference Voltage Conversion Coefficient	10^4	V/cnt	1	1	1	1	integer2	2	2	232
REFERENCE_VOLTAGE_COEFFICIENT3	Reference Voltage Conversion Coefficient	10^6	V/cnt2	1	1	1	1	integer2	2	2	234
REFERENCE_VOLTAGE_COEFFICIENT4	Reference Voltage Conversion Coefficient	10^8	V/cnt3	1	1	1	1	integer2	2	2	236
REFERENCE_VOLTAGE_COEFFICIENT5	Reference Voltage Conversion Coefficient	10^10	V/cnt4	1	1	1	1	integer2	2	2	238

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
											Total: 240

11.5 MDR (name 'mdr-1b', class 8, subclass 2, version 4)

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0
GENERIC_QUALITY_INDICATORS											
DEGRADED_INST_MDR	Quality of MDR has been degraded from nominal due to an instrument degradation			1	1	1	1	boolean	1	1	20
DEGRADED_PROC_MDR	Quality of MDR has been degraded from nominal due to a processing degradation			1	1	1	1	boolean	1	1	21
MEASUREMENT_DATA											
EARTH_VIEWS_PER_SCANLINE	Earth views per scanline, NE		cnt	1	1	1	1	integer2	2	2	22
SCENE_RADIANCES	Scene radiance for channels 1, 2, 3a or 3b, 4 & 5. Channels		See Description	NE	5	1	1	integer2	2	20480	24

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	1,2, 3a in units of W/(m^2.sr). Channels 3b, 4, 5 in units of mW/(m^2.sr.cm^{-1}). Channels 1,2,4 & 5 with scale factor = 2. Channels 3a or 3b with scale factor = 4.										
NAVIGATION_DATA_AT_SCAN_LINE											
TIME_ATTITUDE	Time Associated with Attitude Angles		s	1	1	1	1	uinteger4	4	4	20504
EULER_ANGLE	Euler Angles: Roll, Pitch, Yaw	10^3	deg	3	1	1	1	integer2	2	6	20508
NAVIGATION_STATUS	Navigation Status Bit Field			1	1	1	1	bitfield (4)	4	4	20514
SPACECRAFT_ALTITUDE	Spacecraft Altitude Above Reference Geoid (MSL)	10^1	km	1	1	1	1	uinteger4	4	4	20518
ANGULAR_RELATIONS_FIRST	Angular relationship for the first earth view in scanline	10^2	deg	4	1	1	1	integer2	2	8	20522
ANGULAR_RELATIONS_LAST	Angular relationship for the last earth view in scanline	10^2	deg	4	1	1	1	integer2	2	8	20530
EARTH_LOCATION_FIRST	Earth location for the first earth view in scanline	10^4	deg	2	1	1	1	integer4	4	8	20538

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
EARTH_LOCATION_LAST	Earth location for the last earth view in scanline	10^4	deg	2	1	1	1	integer4	4	8	20546
NUM_NAVIGATION_POINTS	Number of navigation points in angular_relations and earth_locations arrays, NP			1	1	1	1	integer2	2	2	20554
ANGULAR_RELATIONS	Angular relationships: solar zenith angle, satellite zenith angle, solar azimuth angle, satellite azimuth angle (each 40th point, points 25 to 2025; possible reduction to every 20th point, points 5 to 2045)	10^2	deg	4	NP	1	1	integer2	2	824	20556
EARTH_LOCATIONS	Earth Location: latitude, longitude (each 40th point, points 25 to 2025; possible reduction to every 20th point, points 5 to 2045)	10^4	deg	2	NP	1	1	integer4	4	824	21380
QUALITY_INDICATOR	Quality Indicator Bit Field			1	1	1	1	bitfield (4)	4	4	22204
SCAN_LINE_QUALITY	Scan Line Quality			1	1	1	1	bitfield (4)	4	4	22208

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Flags										
CALIBRATION_QUALITY	Calibration Quality Flags			3	1	1	1	bitfield (2)	2	6	22212
COUNT_ERROR_FRAME	Count of Bit Errors in Frame Sync. This field is applicable only to NOAA data. For Metop data it should be defaulted to zero.		cnt	1	1	1	1	uinteger2	2	2	22218
Calibration_Coefficients											
CH123A_CURVE_SLOPE1	Visible Operational calibration curve slope 1 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22220
CH123A_CURVE_INTERCEPT1	Visible Operational calibration curve intercept 1 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22232
CH123A_CURVE_SLOPE2	Visible Operational calibration curve slope 2 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22244
CH123A_CURVE_INTERCEPT2	Visible Operational calibration curve intercept 2 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22256
CH123A_CURVE_INTERCEPTION	Visible Operational calibration		cnt	3	1	1	1	integer4	4	12	22268

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	intersection (ch. 1,2,3a)										
CH123A_TEST_CURVE_SLOPE1	Visible Test calibration curve slope 1 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22280
CH123A_TEST_CURVE_INTERCEPT1	Visible Test calibration curve intercept 1 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22292
CH123A_TEST_CURVE_SLOPE2	Visible Test calibration curve slope 2 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22304
CH123A_TEST_CURVE_INTERCEPT2	Visible Test calibration curve intercept 2 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22316
CH123A_TEST_CURVE_INTERCEPTION	Visible Test calibration intersection (ch. 1,2,3a)		cnt	3	1	1	1	integer4	4	12	22328
CH123A_PRELAUNCH_CURVE_SLOPE1	Visible Prelaunch calibration curve slope 1 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22340
CH123A_PRELAUNCH_CURVE_INTERCEPT1	Visible Prelaunch calibration curve intercept 1 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22352

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
CH123A_PRELAUNCH_CURVE_SLOPE2	Visible Prelaunch calibration curve slope 2 (ch. 1,2,3a)	10^7	%reflectance /cnt	3	1	1	1	integer4	4	12	22364
CH123A_PRELAUNCH_CURVE_INTERCEPT2	Visible Prelaunch calibration curve intercept 2 (ch. 1,2,3a)	10^6	%reflectance	3	1	1	1	integer4	4	12	22376
CH123A_PRELAUNCH_CURVE_INTERCEPTION	Visible Prelaunch calibration intersection (ch. 1,2,3a)		cnt	3	1	1	1	integer4	4	12	22388
CH3B45_SECOND_TERM	IR Operational Calibration Second Order Term (ch. 3b,4,5)	10^9	mW/(m2 sr cm-1)/cnt2	3	1	1	1	integer4	4	12	22400
CH3B45_FIRST_TERM	IR Operational Calibration First Order Term (ch. 3b,4,5)	10^6	mW/(m2 sr cm-1)/cnt	3	1	1	1	integer4	4	12	22412
CH3B45_ZEROTH_TERM	IR Operational Calibration Zero Order Term (ch. 3b,4,5)	10^6	mW/(m2 sr cm-1)	3	1	1	1	integer4	4	12	22424
CH3B45_TEST_SECOND_TERM	IR Test Calibration Second Order Term (ch. 3b,4,5)	10^9	mW/(m2 sr cm-1)/cnt2	3	1	1	1	integer4	4	12	22436
CH3B45_TEST_FIRST_TERM	IR Test Calibration First Order Term (ch.	10^6	mW/(m2 sr cm-1)/cnt	3	1	1	1	integer4	4	12	22448

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	3b,4,5)										
CH3B45_TEST_ZEROTH_TERM	IR Test Calibration Zero Order Term (ch. 3b,4,5)	10^6	mW/(m2 sr cm-1)	3	1	1	1	integer4	4	12	22460
CLOUD_INFORMATION	Cloud Information CCM (Clear/Cloudy/Mixed) Codes			NE	1	1	1	bitfield (2)	2	4096	22472
DIGITAL_A_Telemetry											
FRAME_SYNCHRONISATION	Frame Sync. This field is applicable only to NOAA data. For Metop data the field will be zeroed.			6	1	1	1	uinteger2	2	12	26568
FRAME_INDICATOR	Frame ID. This field is applicable only to NOAA data. For Metop data the all bits will be unset.			2	1	1	1	bitfield (2)	2	4	26580
TIME_CODE	Time Code. This field is applicable only to NOAA data. For Metop data all bits will be unset.			4	1	1	1	bitfield (2)	2	8	26584
RAMP_CALIB	Ramp Calibration (Ch 1-5)		cnt	5	1	1	1	uinteger2	2	10	26592
INTERNAL_TARGET_TEMPERATURE_COUNT	Internal Target		cnt	3	1	1	1	uinteger2	2	6	26602

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Temperature Count Reading (1 - 3) - (Three readings from one of the four platinum resistance thermometers (PRT). A different PRT is sampled for each scan; every fifth scan will contain a reference value of 0 in place of each reading.)										
Digital_B_telemetry											
INSTRUMENT_INVALID_WORD_FLAG	Invalid Word Bit Flags			1	1	1	1	bitfield (2)	2	2	26608
DIGITAL_B_DATA	AVHRR Digital B Data			1	1	1	1	bitfield (2)	2	2	26610
Analog_housekeeping_data											
INSTRUMENT_INVALID_ANALOG_WORD_FLAG	Invalid Word Bit Flags			1	1	1	1	bitfield (4)	4	4	26612
PATCH_TEMPERATURE	Word 1: Patch Temperature			1	1	1	1	uinteger2	2	2	26616
PATCH_EXTENDED_TEMPERATURE	Word 2: Patch Temperature Extended			1	1	1	1	uinteger2	2	2	26618
PATCH_POWER	Word 3: Patch Power			1	1	1	1	uinteger2	2	2	26620

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RADIATOR_TEMPERATURE	Word 4: Radiator Temperature			1	1	1	1	uinteger2	2	2	26622
BLACKBODY_TEMPERATURE1	Word 5: Black Body Temperature 1			1	1	1	1	uinteger2	2	2	26624
BLACKBODY_TEMPERATURE2	Word 6: Black Body Temperature 2			1	1	1	1	uinteger2	2	2	26626
BLACKBODY_TEMPERATURE3	Word 7: Black Body Temperature 3			1	1	1	1	uinteger2	2	2	26628
BLACKBODY_TEMPERATURE4	Word 8: Black Body Temperature 4			1	1	1	1	uinteger2	2	2	26630
ELECTRONIC_CURRENT	Word 9: Electronics Current			1	1	1	1	uinteger2	2	2	26632
MOTOR_CURRENT	Word 10: Motor Current			1	1	1	1	uinteger2	2	2	26634
EARTH_SHIELD_POSITION	Word 11: Earth Shield Position			1	1	1	1	uinteger2	2	2	26636
ELECTRONIC_TEMPERATURE	Word 12: Electronics Temperature			1	1	1	1	uinteger2	2	2	26638
COOLER_HOUSING_TEMPERATURE	Word 13: Cooler Housing Temperature			1	1	1	1	uinteger2	2	2	26640
BASEPLATE_TEMPERATURE	Word 14: Baseplate Temperature			1	1	1	1	uinteger2	2	2	26642
MOTOR_HOUSING_TEMPERATURE	Word 15: Motor Housing Temperature			1	1	1	1	uinteger2	2	2	26644
AD_CONVERTER_TEMPERATURE	Word 16: A/D Converter			1	1	1	1	uinteger2	2	2	26646

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	Temperature										
DETECTOR4_VOLTAGE	Word 17: Detector #4 Bias Voltage			1	1	1	1	uinteger2	2	2	26648
DETECTOR5_VOLTAGE	Word 18: Detector #5 Bias Voltage			1	1	1	1	uinteger2	2	2	26650
CH3_BLACKBODY_VIEW	Word 19: Channel 3b Blackbody View			1	1	1	1	uinteger2	2	2	26652
CH4_BLACKBODY_VIEW	Word 20: Channel 4 Blackbody View			1	1	1	1	uinteger2	2	2	26654
CH5_BLACKBODY_VIEW	Word 21: Channel 5 Blackbody View			1	1	1	1	uinteger2	2	2	26656
REFERENCE_VOLTAGE	Word 22: Reference Voltage			1	1	1	1	uinteger2	2	2	26658
											Total: 26660

Enumeration DISPOSITION_MODE

Value	Name	Description
T	Testing	
O	Operational	
C	Commissioning	

Enumeration INSTRUMENT_ID

Value	Name	Description
AMSA	AMSU-A	
ASCA	ASCAT	
ATOV	ATOVS	instruments: AVHRR/3, HIRS/4, AMSU-A, MHS
AVHR	AVHRR/3	
GOME	GOME	
GRAS	GRAS	
HIRS	HIRS/4	
IASI	IASI	
MHSx	MHS	
NOAA	All NOAA	instruments specific to Level 0 NOAA product
SEMx	SEM	
ADCS	ADCS	
SBUV	SBUV	
xxxx	No specific instrument	
HKTM	VCDU34	data specific to Level 0

Enumeration INSTRUMENT_MODEL

Value	**Name**	**Description**
0	Reserved	
1	Flight Model 1	

2	Flight Model 2	
3	Engineering Model	
4	Protoflight Model	

Enumeration PROCESSING_CENTRE

Value	Name	Description
CGS1		First EUMETSAT EPS Core Ground Segment
CGS2		Second EUMETSAT EPS Core Ground Segment
NSSx		NOAA/NESDIS
RUSx		Reference User Station
DMIx		DMI, Copenhagen (GRAS SAF)
DWDx		DWD, Offenbach (Climate SAF)
FMIx		FMI , Helsinki (Ozone SAF)
IMPx		IMP, Lisbon (Land SAF)
INMx		INM, Madrid (NCW SAF)
MFxx		MF, Lannion (OSI SAF)
UKMO		UKMO, Bracknell (NWP SAF)

Enumeration PROCESSING_LEVEL

Value	Name	Description
00	Level 0	
01	Level 1	

1A	Level 1a	
1B	Level 1b	
1C	Level 1c	
02	Level 2	
03	Level 3	
xx	No Specific Level	

Enumeration PROCESSING_MODE

Value	Name	Description
N	Nominal	NRT processing
B	Backlog Processing	
R	Reprocessing	
V	Validation	

Enumeration PRODUCT_TYPE

Value	Name	Description
ENG		IASI engineering data
GAC		NOAC Global Area Coverage AVHRR data
SND		Sounding Data
SZF		ASCAT calibrated s0 data at full resolution
SZO		ASCAT calibrated s0 data at operational resolution (50 km)
SZR		ASCAT calibrated s0 data at research resolution (25 km)

VER		IASI verification data
xxx		No specific product type specified
AIP		NOAA AIP/SAIP data
TIP		NOAA TIP/STIP data
HRP		HRPT data
LRP		LRPT data

Enumeration RECEIVING_GROUND_STATION

Value	Name	Description
SVL		Svalbard
WAL		Wallops Island, Virginia
FBK		Fairbanks, Alaska
SOC		SOCC (NESDIS Satellite Operations Control Centre), Suitland, Maryland
RUS		Reference User Station

Enumeration SPACECRAFT_ID

Value	Name	Description
xxx		No specific spacecraft
M01		METOP 01
M02		METOP 02
M02		METOP 03
N15		NOAA-K

N16		NOAA-L
N17		NOAA-M
N18		NOAA-N
N19		NOAA-N'

Bitfield DIGITAL_B_DATA

Length 2 bytes

Name	Description	Length
motor telemetry	0=off, 1 =on	1
electronics telemetry	0=off, 1 =on	1
channel 1 status	0 = disable, 1 = enable	1
channel 2 status	0 = disable, 1 = enable	1
channel 3a status	0 = disable, 1 = enable	1
channel 3b status	0 = disable, 1 = enable	1
channel 4 status	0 = disable, 1 = enable	1
channel 5 status	0 = disable, 1 = enable	1
channel 3a_3b select status	0 = 3b, 1 = 3a	1
voltage calibrate status	0 = off, 1 = on	1
cooler heat	0 = off, 1 = on	1
scan motor	0 = low, 1 = high	1
telemetry lock	0 = off, 1 = lock	1
earth shield	0 = disable, 1 = deploy	1

patch control	0 = off, 1 = on	1
Not used		1
Total		16

Bitfield FRAME_INDICATOR

Length 4 bytes

Name	Description	Length
Not Used		6
Sync	0 = internal sysn, 1 = AVHRR sync	1
Frame	DEFAULT TO ZERO (0 = Not an HRPT frame but a GAC frame, 1 = minor frame 1, 2 = minor frame 2, 3 =minor frame 3)	2
Spacecraft addresses		4
Stable	0 = frame stable, 1 = frame resync occurred	1
Input	0 = pseudonoise AVHRR input, 1 = normal AVHRR input	1
Channel Input	0 = AVHRR channel 3b, 1 = AVHRR channel 3a	1
Not used		6
Undefined		10
Total		32

Bitfield INSTRUMENT_INVALID_ANALOG_WORD_FLAG

Length 4 bytes

Name	Description	Length
unused	(zero fill)	9
	For each item below: 0 = associated telemetry item is up-to-date; 1 = associated telemetry item was not updated during most recent telemetry cycle - possibly due to lost frame	
motor current		1
electronics current		1
blackbody temperature, channel 5		1
detector #5 bias voltage		1
blackbody temperature, channel 4		1
blackbody temperature, channel 3b		1
A/D converter temperature		1
black body temperature 4		1
black body temperature 3		1
black body temperature 2		1
black body temperature 1		1
motor housing temperature		1
baseplate temperature		1
electronics temperature		1

cooler housing temperature		1
radiator temperature		1
patch temperature		1
earth shield position		1
patch temperature extended		1
detector #4 bias voltage		1
reference voltage		1
patch power		1
unused	(zero fill)	1
Total		32

Bitfield INSTRUMENT_INVALID_WORD_FLAG

Length 2 bytes

Name	Description	Length
motor/telemetry		1
electronics/telemetry		1
channel 1 status		1
channel 2 status		1
channel 3a status		1
channel 3b status		1
channel 4 status		1
channel 5 status		1

channel 3a/3b select status		1
voltage calibrate status		1
cooler heat		1
scan motor		1
telemetry lock		1
earth shield		1
patch control		1
not used		1
Total		16

Bitfield NAVIGATION_STATUS

Length 4 bytes

Name	Description	Length
Spare	Not used	15
EL_Corrected	Earth location corrected for Euler angles	1
EL_Indicator	Earth location indicator (0 = earth location available, 1 = user ephemeris files older than 24 hours, 2 = no earth location available)	4
SA_Control	Spacecraft attitude control (0 = operating in YGC or NOMINAL mode, 1 = operating in another mode, 2 = attitude exceeds nominal tolerance)	4
A_SMODE	Attitude SMODE (0 = NOMINAL mode, 1 = rate nulling mode, 2 = YGC mode, 3 = search mode, 4 = coast mode)	4
A_MODE	Attitude mode (0 = NOMINAL mode/no test, 1 = yaw axis test in progress, 2 = roll axis test in progress, 3 = pitch axis test in progress)	4
Total		32

Bitfield PRIMARY_CALIBRATION_ALGORITHM_OPTION

Length 2 bytes

Name	Description	Length
Not used		1
Ch 5 resolution	0 = high, 1 = low	1
Ch 5 substitution coefficients	0 = no, 1 = yes	1
Not used		3
Ch 4 resolution	0 = high, 1 = low	1
Ch 4 substitution coefficients	0 = no, 1 = yes	1
Not used		3
Ch 3b resolution	0 = high, 1 = low	1
Ch 3b substitution coefficients	0 = no, 1 = yes	1
Not used		3
Total		16

Bitfield QUALITY_INDICATOR

Length 4 bytes

Name	Description	Length
	do not use scan for product generation	1
	time sequence error detected with this scan	1

	data gap precedes this scan	1
	insufficient data for calibration	1
	earth location data not available	1
	first good time following a clock update (nominally 0)	1
	instrument status changed with this scan	1
	sync lock dropped during this frame - DEFAULT TO ZERO	1
	frame sync word error greater than zero- DEFAULT TO ZERO	1
	frame sync previously dropped lock- DEFAULT TO ZERO	1
	flywheeling detected during this frame- DEFAULT TO ZERO	1
	bit slippage detected during this frame- DEFAULT TO ZERO	1
Not used		11
	TIP parity error detected- DEFAULT TO ZERO	1
	reflected sunlight detected ch 3b (0 = no anomaly; 1 = anomaly; 3 = unsure)	2
	reflected sunlight detected ch 4 (0 = no anomaly; 1 = anomaly; 3 = unsure)	2
	reflected sunlight detected ch 5 (0 = no anomaly; 1 = anomaly; 3 = unsure)	2
	resync occurred on this frame- DEFAULT TO ZERO	1
	pseudo noise occurred on this frame	1
Total		32

Bitfield RAMP_CALIBRATION_COEFFICIENT

Length 2 bytes

Name	Description	Length
Not used		10
CH5	ramp non-linearity for GAC & Full Resolution ch 5	1
CH4	ramp non-linearity for GAC and Full Resolution ch4	1
CH3B	ramp non-linearity for GAC and Full Resolution ch 3b	1
CH3A	ramp non-linearity for GAC and Full Resolution ch 3a	1
CH2	ramp non-linearity for GAC and Full Resolution ch 2	1
CH1	ramp non-linearity for GAC and Full Resolution ch 1	1
Total		16

Bitfield SCAN_LINE_QUALITY

Length 4 bytes

Name	Description	Length
	Not used	8
	Time field is bad but can probably be inferred from the previous good time	1
	Time field is bad and can’t be inferred from the previous good time	1
	This record starts a sequence that is inconsistent with previous times (i.e., there is a time discontinuity). This may or may not be associated with a spacecraft clock update (See bit 26 in QUALITY_INDICATOR Field)	1
	Start of a sequence that apparently repeats scan times that have been previously accepted	1

	Not used	4
	Scan line was not calibrated because of bad time	1
	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	1
	Scan line was not calibrated because of bad or insufficient PRT data	1
	Scan line was calibrated but with marginal PRT data	1
	Some uncalibrated channels on this scan. (See channel indicators.)	1
	Uncalibrated due to instrument mode.	1
	Questionable calibration because of antenna position error of space view	1
	Questionable calibration because of antenna position error of black body	1
	Not earth located because of bad time; earth location fields zero filled	1
	Earth location questionable because of questionable time code. (See time problem flags above.)	1
	Earth location questionable - only marginal agreement with reasonableness check.	1
	Earth location questionable - fails reasonableness check	1
	Earth location questionable because of antenna position check	1
	Not used	3
Total		32

Bitfield SECONDARY_CALIBRATION_ALGORITHM_OPTION

Length 2 bytes

Name	Description	Length
Not used		1

Ch 5 resolution	0 = high, 1 = low	1
Ch 5 substitution coefficients	0 = no, 1 = yes	1
Not used		3
Ch 4 resolution	0 = high, 1 = low	1
Ch 4 substitution coefficients	0 = no, 1 = yes	1
Not used		3
Ch 3b resolution	0 = high, 1 = low	1
Ch 3b substitution coefficients	0 = no, 1 = yes	1
Not used		3
Total		16

Bitfield SRC_DATA_QUAL

Length 2 bytes

Name	Description	Length
Not used		6
NWP_T2M_CHANGE	Availability of NWP T2M is changing during the dump	1
NWP_TCWV_CHANGE	Availability of NWP TCWV is changing during the dump	1
AMSUA_TCWV_CHANGE	Availability of AMSU-A TCWV is changing during the dump	1
NWP_TCWV_MISSING	NWP TCWV is missing	1
AMSUA_TCWV_NWP_T2M_MISSING	AMSU-A TCWV and NWP T2M are missing	1
AMSUA_TCWV_NWP_TCWV_MISSING	AMSU-A TCWV and NWP TCWV are missing	1
AMSUA_TCWV_MISSING	AMSU-A TCWV is missing	1

NWP_T2M_MISSING	NWP T2M is missing	1
NWP_TCWV_NWP_T2M_MISSING	NWP TCWV and NWP T2M are missing	1
AMSUA_TCWV_NWP_TCWV_NWP_T2M_MISSING	AMSU-A TCWV, NWP TCWV, and NWP T2M are missing	1
Total		16

Bitfield TIME_CODE

Length 8 bytes

Name	Description	Length
Not used		6
day	Binary day count	9
0		1
Not used		6
1		1
0		1
1		1
millisecond_msp	Most significant part of binary millisecond of day count	7
Not used		6
millisecond_p	Middle part of binary millisecond of day count	10
Not used		6
millisecond_lsp	Least significant part of binary millisecond of day count	10
Total		64

Bitfield CALIBRATION_QUALITY

Length 2 bytes

Name	Description	Length
	Following 2-byte word is repeated as an array for channels 3b, 4 & 5 respectively.	
Not used		8
calibrated	This channel is not calibrated	1
questionable	This channel is calibrated but questionable	1
bad blackbody	All bad blackbody counts for scan line	1
bad space view	All bad space view counts for scan line	1
zero fill		1
marginal blackbody	Marginal blackbody view counts for this line	1
marginal space view	Marginal space view counts for this line	1
Not used		1
Total		16

Bitfield CLOUD_INFORMATION

Length 2 bytes

Name	Description	Length
Uniformity test a	0=test failed or clear, 1=cloudy	1
Uniformity test b	0 =test failed or cloudy, 1=clear	1
T3-T5 test a	0=test failed or clear, 1=cloudy	1

T3-T5 test b	0 =test failed or cloudy, 1=clear	1
T4-T3 test a	0=test failed or clear, 1=cloudy	1
T4-T3 test b	0 =test failed or cloudy, 1=clear	1
T4-T5 test a	0=test failed or clear, 1=cloudy	1
T4-T5 test b	0 =test failed or cloudy, 1=clear	1
Albedo test a	0=test failed or clear, 1=cloudy or snow/ice covered	1
Albedo test b	0 =test failed or cloudy, 1=clear or snow/ice covered	1
T4 test a	0=test failed or clear, 1=cloudy or snow/ice covered	1
T4 test b	0 =test failed or cloudy, 1=clear or snow/ice covered	1
Number of the test situation	11 different test situations	4
Total		16

Parameters Table

Parameter	Value	Description
NE	2048	Number of earth view per scanline for Full data (highest value)
NP	103	Number of navigation points at a sampling rate of 20 for a Full product (highest value)

Boolean values

Field	value = 0	value = 1
SUBSETTED_PRODUCT	Always set for near real time granule products. For EUMETSAT Data Centre products, set when the product contains a full dump	For EUMETSAT Data Centre products, set when the product contains subset information
DEGRADED_INST_MDR		TBC
DEGRADED_PROC_MDR	TBC TBC	TBC