GRAS Product Guide

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Welcome to the GRAS Product Guide. As a potential user of GRAS products, you will find here information to familiarise you with the GRAS 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
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Document Change Record

Version/Date	Section	Description of change
v1 11/09/2006	Full document	First issue of the document.
v2 31/08/2007	Full document	Update to reflect start of Metop/GRAS.
v2A 14/11/2007	Section 6 Appendices. F,G	Sec. 6.1.1: Added reference after "EPS Native format". Sec. 6.2: Thinned product added to WMO-EUMETCast dissemination in Table 6.1, and to text in Sec. 6.2.1. Timeliness added to WMO row in Table 6.1. App. F,G: First sentence rewritten to be more meaningful for external user.
v2B 18/04/2008	Sections 6,8 Appendices A, B, F, G	Sec. 6,8, App. B: Correction of several typos and hyperlinks. App. A: Acronym PFV added. App. F,G: Table added summarising record contents for each product format version. Other general layout improvements, typo corrections and deletion of duplicate tables.
v2C 28/05/2009	Full document	Document restructured - App. F & G renamed as Sec. 9 & 10, and common appendices removed to keep as separate document. Sec. 2.3: Four references added SCD7,8,9,10. Sec. 3: Configuration history information updated, with addition of Table 3-2 PPF software versions. Sec. 5.1: EPSView description replaced by text on available generic tools. Sec. 8: Added reference to EUMETSAT Product Validation Reports webpage. Sec. 9 &10: Updates to bitfield table contents descriptions for NDF_BITS, ATM_MULTIPATH and SSD_AVAILABILITY to make them correspond to the descriptions in the GRAS Product Format Specification. Various minor editorial updates, correction of typos and hyperlinks.

Table of Contents

1 INTRODUCTION

This document provides a top-level overview of the GRAS instrument and its data processing system, from instrument build to product validation. The document is primarily aimed at those unfamiliar with GRAS. As such the reader is provided with a high-level description of all the relevant components of the GRAS system with references to more detailed information in case this is required.

GRAS products overview provides an overview of the GRAS instrument and the data processing system. The GRAS instrument and basic operating principles are introduced in The GRAS instrument. A short description of the instrument hardware is provided in GRAS hardware, followed by a summary of the Data packet structure and basic instrument operation.

The Level 0 to 1b processor, part of the Core Ground Segment (CGS) located at EUMETSAT in Darmstadt, is described in GRAS system concept and in the Level 0 to 1b data processing. A functional breakdown of the main components of the Level 0 to 1b data processor is given. A summary of the expected product accuracies is provided in Level 1b product summary and an overview of the Level 0, 1a and 1b product formats in GRAS product formats and dissemination. Level 1b to 2 data processing describes the operational Level 2 products produced under the responsibility of the GRAS Meteorology Satellite Application Facility (GRAS SAF). This includes a brief discussion of the GRAS SAF consortium, as well as links to further information.

In GRAS products validation and monitoring a summary of GRAS in-orbit monitoring, verification and validation activities is provided. The overall objectives of in-flight GRAS characterisation, calibration and validation activities are listed in Objectives. GRAS in-orbit instrument verification, carried out under the responsibility of ESA, is discussed in GRAS in-orbit verification. Long-term instrument monitoring activities are briefly discussed in Instrument monitoring. Atmospheric profile verification and validation activities, carried out centrally at EUMETSAT in support of Level 1 validation, are discussed in Validation. Level 2 operational product validation services are provided by the GRAS SAF; these are listed in Validation of GRAS SAF products followed by a brief discussion of the role of the EUMETSAT/ESA Research Announcement of Opportunity in product calibration and validation activities in Scientific activities carried out via the EPS/Metop RAO.

A list of acronyms is provided in Appendix E: Acronyms and Abbeviations**Error! Reference source not found.**.

Acknowledgements

The authors wish to acknowledge the invaluable contributions of the GRAS project team at ESTEC, the GRAS SAF project team, and colleagues at EUMETSAT without whom a successful GRAS flying on Metop would not be possible.

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

[RD1]	EPS End User Requirements Document	EUM.EPS.MIS.REQ.93.001
[RD2]	EPS Core Ground Segment Requirements Documents	EPS.CGS.REQ.95327
[RD3]	EPS Generic Product Format Specification	EPS.GGS.SPE.96167
[RD4]	Metop GRAS Instrument In-Orbit Verification Plan	MO.PL.ESA.GR.0419
[RD5]	GRAS Level 1 Product Generation Function Specification	EPS.SYS.SPE.990010
[RD6]	GRAS Level 1 Product Format Specification	EPS.MIS.SPE.97234
[RD7]	GRAS Requirements Specification	MO.RS.MMT.GR.0001
[RD8]	GRAS Calibration and Validation Plan	EUM/EPS/SYS/PLN/01/013
[RD9]	EPS/Metop Research Announcement of Opportunity	EUM/STG/42/03/DOC/06
[RD10]	U-MARF LEO Format Descriptions	EUM/OPS/USR/06/1855†
[RD11]	EPS Product file naming for EUMETCast	EUM/OPS-EPS-TEN/07/0012
[RD12]	GRAS EPS-PFS Data Reading Introduction	EUM/MET/MAN/06/0267

† Future versions of this document will be available on the EUMETSAT UMARF webpages.

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

2.2 SAF documents

[GS1]	GRAS Meteorology SAF User Requirements	SAF/GRAS/METOFFICE/RQ/URD
[GS2]	GRAS Meteorology SAF Validation Strategy	SAF/GRAS/DMI/RQ/ST
[GS3]	GRAS Meteorology SAF The Radio Occultation Processing Package (ROPP), An Overview	SAF/GRAS/METO/UG/ROPP

2.3 Papers, reports and other technical documentation

[SCD1]	Observing Earth's Atmosphere with Radio Occultation Measurements using GPS	Kursinski, E., G. Hajj, K. Hardy, J. Schofield, R. Linfield *J. Geophys. Res.*, 102, 23429-23465, 1997

[SCD2]	The radio occultation experiment aboard CHAMP: Operational data analysis and validation of vertical atmospheric profiles	Wickert, J., T. Schmidt, G. Beyerle, R. König, Ch. Reigber and N. Jakowski *J. Met. Soc. Japan*, Special issue 'Application of GPS Remote Sensing to Meteorology and Related Fields', 82(1B), 381-395, 2004
[SCD3]	Applications of COSMIC to Meteorology and Climate	Anthes, R., C. Rocken and Y.H. Kuo *Terrestrial*, *Atmospheric and Ocean Sciences*, 11 (1), 115-156, 2000
[SCD4]	World Meteorological Organization Manual on Codes	WMO - No. 306
[SCD5]	NOAA KLM User's Guide	www2.ncdc.noaa.gov/docs/klm
[SCD6]	GRAS Level 1b Product Validation with 1D-Var Retrieval	Marquardt, C., S. Healy, J.-P. Luntama, E. McKernan *EUMETSAT Technical Memorandum* No. 12, Feb 2005
[SCD7]	An introduction to the EUMETSAT polar system	Klaes, K. D., et al. *Bull. Amer. Meteor. Soc.*, 88(7), 1085–1096, doi: 10.1175/BAMS-88-7-1085, 2007
[SCD8]	Prospects of the EPS GRAS mission for operational atmospheric applications	Luntama, J.-P., G. Kirchengast, M. Borsche, U. Foelsche, A. Steiner, S. Healy, A. von Engeln, E. O'Clerigh, and C. Marquardt *Bull. Amer. Meteor. Soc.*, in press, 89(12), 1863-1875, doi: 10.1175/2008BAMS2399.1, 2008
[SCD9]	Smoothing and Differentiation of Data by Simplified Least Squares Procedures	A. Savitzky and Golay, M.J.E *Analytical Chemistry*, Vol. 36, pp. 1627-1639, 1964
[SCD10]	Application Hints for Savitzky-Golay Digital Smoothing Filters	M.U.A. Bromba and H. Ziegler *Analytical Chemistry*, Vol. 53, pp. 1583-1586, 1981

3 GRAS PRODUCTS CONFIGURATION HISTORY

In the following tables the current versions on the operational Ground Segment are shown on a white background.

Date introduced	Product format version		PFS version	PGS version	Comments
	Major number	Minor number			
18/06/2007	10	0	6.6 / v7B	6.4 / v6D	

Table 3-1: GRAS document versions

GRAS software version	Date introduced on GS1	Comments
2.8	21/02/2008	Cal/Val Phase
2.10	15/04/2008	Operational configuration, sensing start time 12:27 UTC
2.11	28/05/2008	Sensing start time 11:48 UTC
2.12	07/11/2008	Sensing start time 05:48 UTC

Table 3-2: GRAS PPF software versions

4 GRAS PRODUCTS OVERVIEW

4.1 The GRAS instrument

The GRAS instrument provides radio occultation measurements in support of the EUMETSAT Polar System (EPS) mission objectives of operational meteorology and climate monitoring. The radio occultation technique was originally used to study the atmospheres of Venus, Mars and other outer planets. Applying this measurement principle to the Earth's atmosphere was made possible with the installation of the GPS satellites.

4.1.1 Measurement principle

GRAS is a radio occultation instrument, using GPS satellite signals in a limb viewing geometry to derive initially bending angle profiles. Further processing of these profiles provides refractivity, temperature, pressure and water vapour profiles. The observation geometry is shown in the following picture.

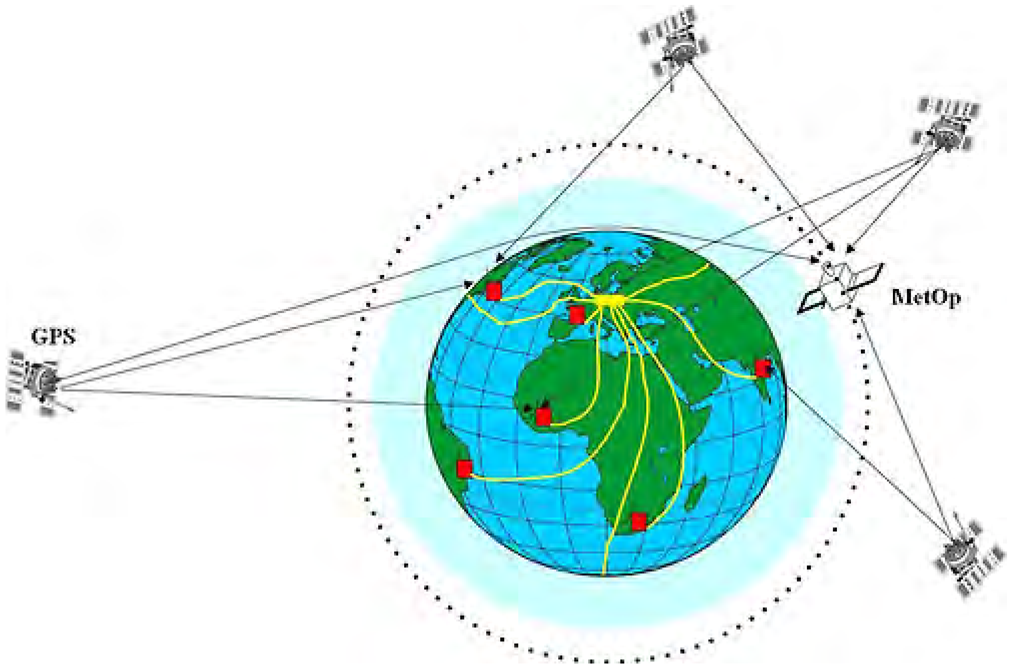

Figure 4-1: GRAS geometry and measurement principle

The GPS signal is refracted away from a straight line as it passes through the atmosphere. The strength of the refraction depends on the atmospheric density which in turn is mainly driven by pressure and temperature, coupled through the hydrostatic equation. Hence, radio occultation provides accurate temperature profiles at altitudes above about 8 km. In the lower parts of the troposphere, water vapour also affects the refraction of the ray, thus information on the water vapour is also provided here.

The processing also requires precise knowledge on the GPS and Metop orbits. The accurate GPS orbits are provided by a Ground Support Network (GSN), indicated by the red squares in the picture above. The Metop precise orbit is determined within the EUMETSAT processing.

For further information, please refer to the following articles: [SCD1], [SCD2], [SCD3].

4.1.2 GRAS hardware

Several papers and ESA bulletins provide information on the Metop satellite and the GRAS instrument, e.g. [SCD7], [SCD8], ESA Bull. No. [102], [127]. Please refer to these publications for further information.

4.1.3 Data packet structure and basic instrument operation

GRAS tracks setting and rising GPS satellites; it uses three independent antenna/receiver chains to track these satellites:

- Zenith: used for real-time navigation, up to 8 GPS satellites simultaneously
- Velocity: used for rising occultations, up to 2 GPS satellites simultaneously
- Anti-Velocity: used for setting occultations, up to 2 GPS satellites simultaneously

The instrument has three operating modes:

- STANDBY: initial mode of instrument. Instrument is initialised with the almanac data of the GPS satellites constellation. No measurements are taken.
- NAVIGATION: Initially, the instrument uses the previously uploaded almanac data and an initial position, velocity and time to determine which GPS satellites it shall acquire and track. Based on these satellites, a navigation solution is calculated and the instrument continues to update its current position. Data packets are generated from the zenith antenna.
- OCCULTATION: In addition to navigation mode, GRAS acquires and tracks satellites on the velocity and anti-velocity antenna. Data packets containing navigation and occultation data are generated.

Generally, the pseudo-noise code is tracked for navigation while the carrier phase is tracked to allow for atmospheric demodulation. The main measurement data provided by GRAS are:

- L1/L2 carrier phase
- L1/L2 code phase
- L1/L2 P code phase
- L1 C/A, L1/L2 P amplitude measurements

Additionally, ancillary data is provided for e.g. ephemeris, instrument monitoring.

The instrument provides the following raw packets:

- GPS
- Extended Navigation
- Temperature and Voltage
- Noise
- Gain & Histogram
- Tracking State
- Raw Sampling
- Single Frequency Carrier
- Dual Frequency Carrier
- C/A Code Phase

- C/A, P1, P2 Code Phase
- Navigation Data Frame Dump

These will be pre-structured and run through the measurement reassembly to provide instrument products:

- GPS
- Position, Velocity and Time
- Temperature and Voltage
- Amplitude and Noise
- Tracking State
- Carrier Phase
- Code Phase
- Navigation Data Bits

GRAS operates in two tracking states: closed-loop and open loop (called raw sampling). For closed-loop tracking, the carrier phase is phase locked to the received GPS signal. For open loop tracking, carrier phase is measured relative to an on-board Doppler model. Default for closed-loop tracking is 50 Hz, and 1 kHz for open loop tracking. Tracking data is provided from about 80 km down to the surface. Switching between closed and open loop is generally performed automatically based on the tracking of the P code; once this is lost, open loop tracking will start.

4.2 GRAS system concept

The Product Generation Facility (PGF) interacts with the Core Ground Segment (CGS) M&C functionality by means of the Product Generation Environment (PGE). The PGE provides the means by which the PGF acquires satellite and instrument data downlinked via the Command and Data Acquisition (CDA). The actual processing is performed by the Product Processing Facility (PPF) with the data provided by the PGF.

The PGE also provides the means by which data from the GRAS GSN is provided to the PGF and subsequently the PPF. Furthermore, the PGF acquires information from the GRAS/Metop POD service and the Metop satellite orbital services via the PGE.

Inputs:

GRAS source packets	Correspond to the raw output data provided by the instrument as CCSDS source packets. These packets contain the GRAS measurement data in measurement data packets and housekeeping data in ancillary data packets.
Instrument characterisation data	Contain instrument characterisation data to be used for correcting the impact of the instrument and spacecraft hardware on the observation data.
GSN status and configuration data	Contain characterisation of the location and hardware of the fiducial stations of the GRAS GSN, and characterisation data of the currently operational GPS satellites.
GSN products	Contains products from the GRAS Ground Support Network (GSN).
Flight dynamics	Metop manoeuvre information, Metop CoM (centre of mass)

information	position vector in the spacecraft reference coordinate frame as a function of time.
NWP data	NWP data about the surface level meteorological parameters at the fiducial stations.

Outputs:

Level 0 data	Correspond to the Level 0 products [RD3]
Level 1a data	Correspond to the Level 1a products [RD6]
Level 1b data	Correspond to the Level 1b products [RD6]
Occultation table	Contains predicted GRAS measurements.
Reporting/Quality Information	Corresponds to the compiled reporting information produced by the GRAS PGF that is transferred to the reporting function of the CGS. This information includes all quality information required by the Quality Control function of the CGS.
Monitoring Information	Contains all regular monitoring information on the PGF, providing the G/S M&C function with the information on the status of the instrument, data, processing functions, processing platforms, links, etc.

Controls:

Ground Segment Commands	This data stream corresponds to the transfer of commands generated by the G/S and controls the operation of the GRAS PGF. Note: these influence only the way the processing is done and are not related to any instrument/platform commands.

Services:

Generic PGE services	PGE provides the PGF with all services that are needed for interference-free operations.

4.3 GRAS data processing

4.3.1 Level 0 to 1b data processing

The central processing facility, located at EUMETSAT headquarters in Darmstadt, is responsible for the processing of all GRAS data up to Level 1b, and delivers Level 0, Level 1a and Level 1b products to the user community. This Level 0 to 1b processing is carried out within the Core Ground Segment (CGS) by the GRAS PPF which converts raw instrument data (Level 0 data stream) into time-stamped, geolocated bending angles. Level 0, 1a and Level 1b data products, product quality and monitoring information are also generated by the CGS.

4.3.1.1 Receive and validate Level 0 and auxiliary data

The receive-and-validate function, in addition to the generic checks identified in the [RD2] EPS Core Ground Segment Requirements Documents, performs the instrument-specific acceptance and checking of the input data. Its purpose is to accept the Level 0 data and to perform all checks required for validation of the input data before passing them to the algorithmic functions. This functionality correlates Level 0 data with auxiliary data and also produces reporting statistics.

4.3.1.2 Process Level 0 to Level 1a

Level 1a processing consists of:

- GRAS measurement data pre-processing
- Measurement identification
- Instrument corrections
- Level 1a products quality check and formatting

The Level 1a processing function ingests GRAS CCSDS packets. Each CCSDS packet consists of GRAS navigation data and ancillary and measurement data from several occultations. The Level 1a processing function rearranges the GRAS CCSDS packets and pre-processes them to generate complete sequences of raw measurement data. The raw measurement data sequences are reassembled into carrier phase, amplitude, noise and code phase data.

The Level 1a processing performs the identification of the measured occultations and the navigation data sequences by using the occultation and navigation identification codes from the occultation tables, and the header information in the GRAS navigation, ancillary and measurement data. The measurement identification includes identification of the antenna and receiving chain (i.e. RFCU and GEU) for each observation.

The Level 1a processing function ingests the GPS Precise Orbit Determination (POD) products provided by the GSN via the PGE. GPS POD products are used together with the on-board navigation solution included in the GRAS ancillary data to determine the incidence angle of the incoming GPS transmissions in the instrument correction function.

The Level 1a PPF uses the data from the GRAS Instrument Characterisation Database to determine the instrument correction parameters to remove the impact of the instrument on the measurement data. The phase and group delays caused by the receiving antennas, RF components and electronics are removed, and amplitude measurements are corrected for the variations of the antenna gain pattern and variations in the gain in the RF components and electronics due to temperature variations. All instrument correction functions are user selectable. The contents and the format of the GRAS Instrument Characterisation Database is provided in [RD5]. The C/A and P code phase measurements are not converted into pseudo-ranges in the Level 1a processing. However, they are corrected for the Differential Code Bias (DCB) caused by the transmitting GPS satellite and by the receiver. The corrected code phase measurements by the GRAS zenith antenna are provided to the GRAS/Metop NRT POD.

Finally, the Level 1a PPF collects all Level 1a products including the GRAS GSN and GRAS/Metop NRT POD products, performs quality checks, and formats all the products. Further information is available at [RD5].

A functional decomposition of the GRAS L1a processor is shown in the following figure.

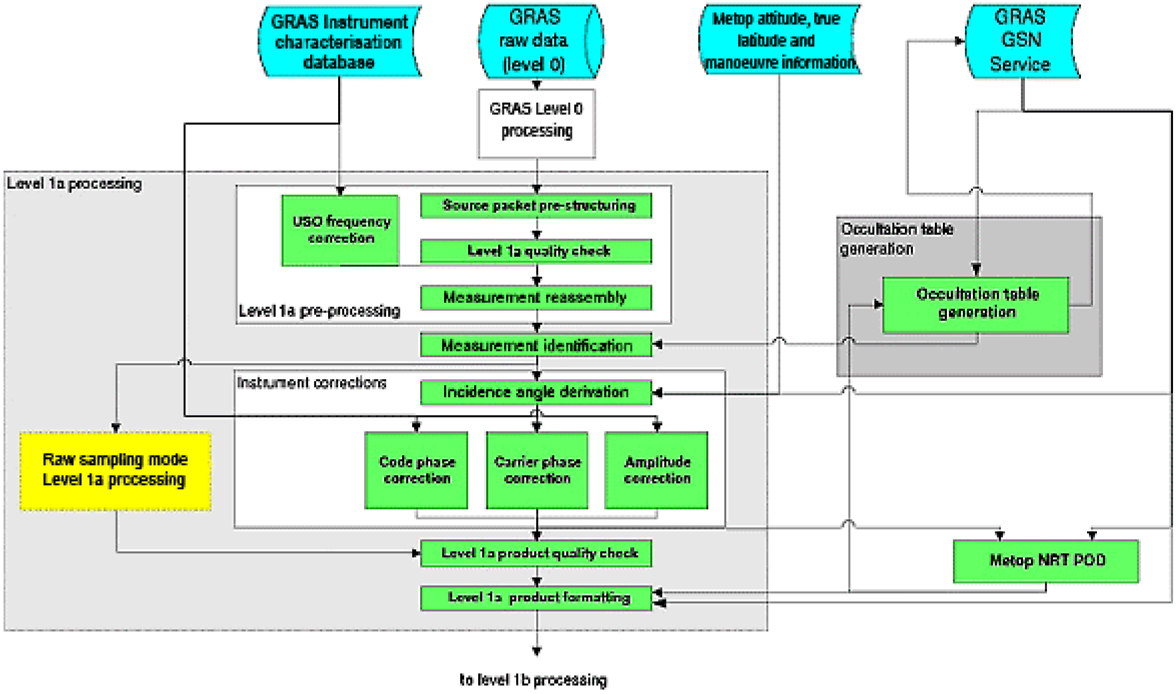

Figure 4-2: Level 0 to Level 1a processing steps

4.3.1.3 Process Level 1a to Level 1b

The Level 1b processing function calculates the bending angle and the impact parameter from the instrument-corrected occultation measurement data.

The Level 1b processing function performs occultation isolation to combine GRAS data for each occultation with the auxiliary data required to retrieve the bending angle profile. The pivot GPS satellite and the fiducial station supporting differencing schemes (for clock correction) have to be selected before all auxiliary data for each occultation can be filtered.

The Level 1b PPF performs several corrections to the measurement data before the actual bending angle retrieval is performed. The phase residual, which is to a good approximation the phase delay introduced by the atmosphere, is calculated by removing the geometrical distance between the transmitter and receiver antennas from the measured phase. This requires determination of the true reception and transmission times and interpolation of the satellite state vectors into these times. The corrections for relativistic effects are mostly included into the synchronisation of the measurement time stamps with the reference time provided by the GRAS GSN because the relativistic effects are included in the clock offset estimates calculated in the GPS and GRAS/Metop NRT POD. The only relativistic effect not included in the clock offset estimates is the variation in the apparent velocity of light because of the gravitational field of the Earth (Shapiro effect). This effect is taken into account in the determination of the transmission time and geometric path removal.

After the removal of the geometric path the measured phase residual is still wrapped around 2π. The unwrapping of the phase is combined in this algorithm.

After the relativity correction a cycle slip detection and correction function is applied to the phase residual data.

The Level 1b PPF corrects the data provided by the Level 1a function for clock drifts on board the GPS satellite and, if necessary, the GRAS instrument. The Level 1b processing function obtains, via the PGE, for each of the ground stations supporting differencing the Sounding Support Data (SSD). GSN also provides an estimate of the Tropospheric Zenith Delay (TZD) for each fiducial station and local surface level meteorological observations (if available). TZD has to be mapped to the elevation of the occulting and pivot GPS satellites by the Level 1b PPF.

Correction technique	**Applicability**
No differencing (ND)	All clocks in the observation system are considered sufficiently stable and no clock correction is required. Clock biases are removed by using bias estimates from POD.
Single differencing 1 (SD1)	GPS clock is considered stable and only the impact of the GRAS clock instability is corrected for. The differencing is performed between links A and D in the figure below.
Single differencing 2 (SD2)	GRAS clock is considered stable and the impact of the GPS clock instability is corrected for (current baseline scenario). The differencing is performed between links A and B in the figure below.
Double differencing 1 (DD1)	All observation system clock errors are corrected for (GPS, GRAS, fiducial stations). The differencing is performed between all measurement links in the figure below.
Double differencing 2 (DD2)	Similar to DD1, but two ground stations are used. One station tracks the occulting GPS satellite (GPS-1 in figure below) and the other tracks the pivot satellite (GPS-2 in figure below). The advantage is that neither station has to have visibility to both GPS satellites. The disadvantage is that the ground station clock errors are not removed.

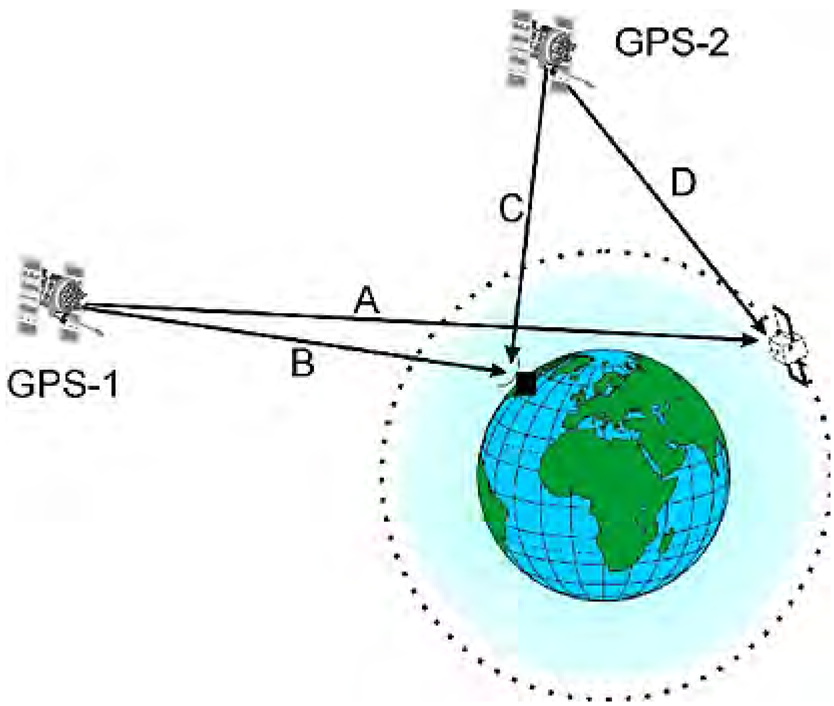

Figure 4-3: Measurement links used for clock corrections

The baseline scenario for the GRAS PPF is clock correction with SD2. DD1 and DD2 are considered as fall-back options in the case that SD2 cannot provide good product accuracy. ND and SD1 are optional differencing methods that may be applied depending on the GPS clock characteristics. The use of additional GPS satellites in the clock correction will introduce noise on the bending angle, thus ND will be used if the GRAS clock is found to be stable enough. The actual applied clock correction can be found in the Level 1b data products.

In deriving the total bending angle, the Level 1b processing function assumes a locally spherical atmosphere. The errors introduced by this assumption are reduced by applying a correction for the Earth's oblateness. The Level 1b processing function computes correction parameters for this purpose.

The derived phases of the occultation data are corrupted by high-frequency noise. The Level 1b processing function therefore low-pass filters the derived phase data. The filtering function is based on Savitzky-Golay (see [SCD9], [SCD10]).

The Level 1b processing function computes the Doppler shift (as a time derivative) for the phase residual observations in the occultation. It retrieves the bending angle as a function of the impact parameter by using the Geometrical Optics (GO) approximation. Additionally, Wave Optics (WO) processing is applied to parts of the measurement, using phases and amplitudes to derive a bending angle profile. GO is applied to the whole measured profile and WO to the lower part of the profile to detect and remove the impact of atmospheric multipath.

The frequency-independent neutral bending angle is computed by correcting for ionospheric dispersion, by applying a linear combination of the bending angles at two frequencies. Bending angle bias is calculated and a correction is applied if necessary. The Level 1b processing function also derives the total electron content (TEC) along the ray path. Error characterisation is performed for all Level 1b products. For the raw sampling mode the Level 1b processing algorithm is to be defined.

Further information is available at [RD5]. A functional decomposition of the GRAS L1a processor is shown in the following figure.

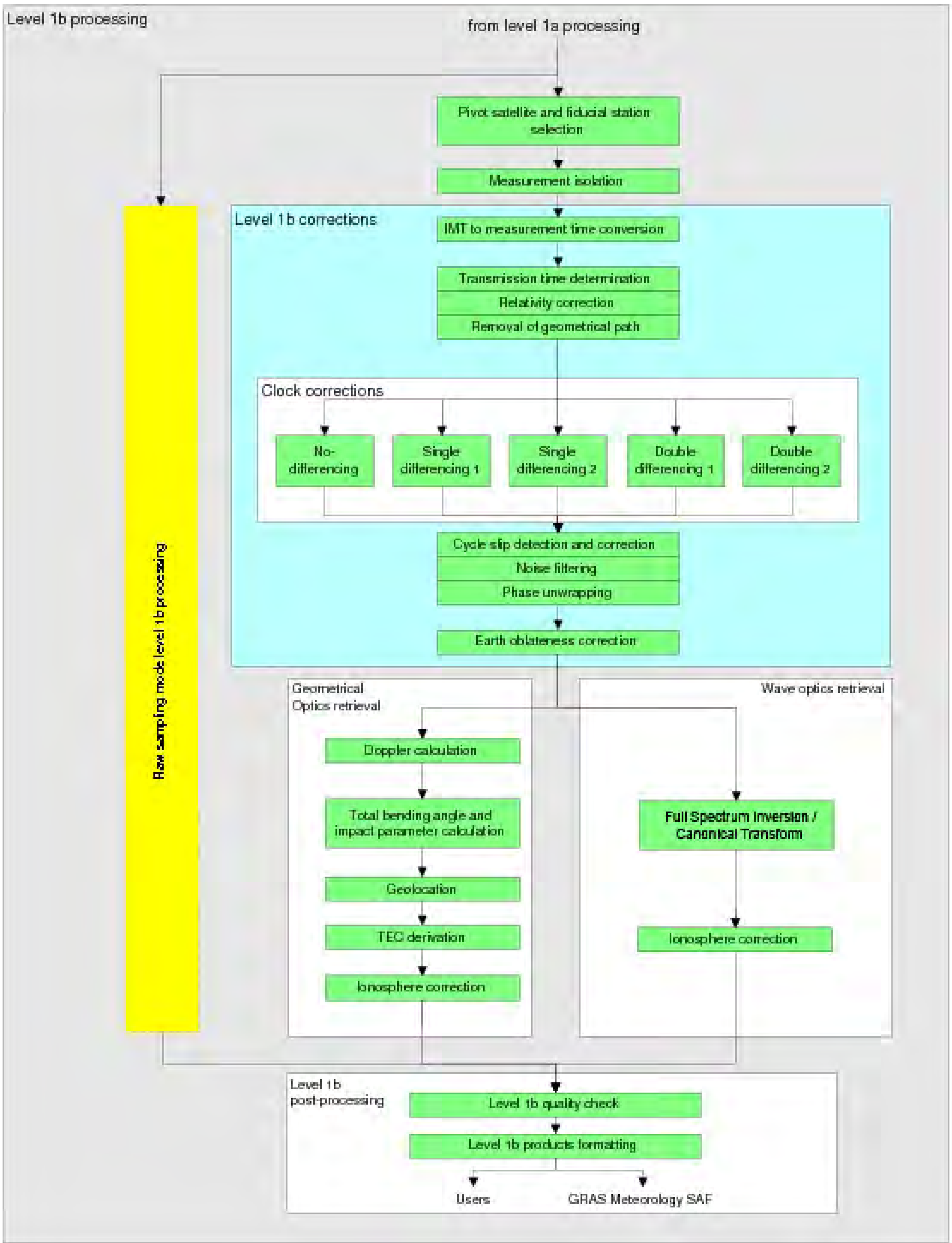

Figure 4-4: Level 1a to Level 1b processing steps

4.3.1.4 Occultation table generation

The Occultation Table Generation function produces a table containing all occultations and navigation measurements theoretically visible for the GRAS receiver for a time period of 24-36 hours. The table includes the pseudo random noise (PRN) code numbers of the occulting GPS satellites and the PRN numbers of the GPS satellites visible for the GRAS zenith antenna (GZA). An occultation and navigation measurement identification number is applied to each measurement.

Occultation table generation is based on predicted GPS and Metop orbits provided by the GSN and GRAS/Metop POD, respectively.

4.3.2 Level 1b product summary

A summary of the expected 1b products and their corresponding relative errors is given in the table below.

Parameter	Performance
No. of occultations / day	> 500
Measurement range	1 - 80 km
Bending angle error	< 1.0 µrad or 0.4% (whichever is larger)
Sampling rate	50 Hz (closed-loop), 1 kHz (open loop)
Timeliness	2 h 15 min

Table 4-1: Expected GRAS Level 1b products and performance

4.3.3 GRAS SAF Level 1b to 2 data processing

The responsibility for extraction of meteorological or geophysical (Level 2) products from GRAS lies with the GRAS Meteorology Satellite Application Facility (GRAS SAF) [GRAS SAF]. The development of the GRAS SAF was started in 1999 and is coordinated by the Danish Meteorological Institute (DMI) in Copenhagen. The GRAS SAF consortium comprises:

- Danish Meteorological Institute (DMI), host institute, Denmark
- Met Office, UK
- Institut D'Estudis Espacials de Catalunya, Spain
- ECMWF, UK (new partner in the CDOP phase)

As part of the distributed element of the EUMETSAT Applications Ground Segment, the GRAS SAF provides operational services to end-users, e.g. real-time or off-line product services, data management and related user services, including coordination of and support to relevant research and development. The SAF Visiting Scientist Programme allows involvement of scientific experts external to the SAF Consortium.

The GRAS SAF produces two different Level 2 products; one is provided in Near Real Time (NRT) [see NRT product], the other within 30 days [see offline product]. For further information on the products etc., please refer to the GRAS SAF website.

5 DATA VIEWING AND READING

Readers for the native EPS format GRAS 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.

Software capable of reading the WMO formats is available from a variety of sources, including ECMWF.

A description of how to read, plot and convert EPS format into NetCDF using Python is given in *GRAS EPS-PFS Data Reading Introduction* [RD12] which may be downloaded as a PDF.

6 GRAS PRODUCT FORMATS AND DISSEMINATION

A description of the dissemination means for EPS products and formats is provided in the following paragraphs, focusing down on GRAS 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 [RD3].

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 [SCD5].

6.1.2 EUMETCast

Global EPS products at different processing levels are 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 on 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 (e.g. BUFR and GRIB).

6.1.3 GTS/RMDCN

A subset of EPS products is disseminated additionally in near real-time via the Global Telecommunication System (GTS). The 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, e.g. BUFR or GRIB.

6.1.4 UMARF

All EPS products and auxiliary data are normally archived and made available to users from the EUMETSAT Unified Meteorological Archive and Retrieval Facility (UMARF) upon request.

The UMARF can be accessed through the EUMETSAT webpage Archive Services. Access is through a web interface through which the users are able to browse and order products, manage their user profile, retrieve products, documentation and software libraries, get help, etc.

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

6.2 GRAS products dissemination

Table 6.1 summarises the different dissemination means and formats for all GRAS Level 1 products available to users.

Format	Real-Time Direct Broadcast	Near-Real-Time dissemination on EUMETCast (timeliness)	Near-Real-Time dissemination on GTS (timeliness)	UMARF retrieval (timeliness)
Metop raw data format	GRAS HRPT raw data stream and Metop Admin message	--	--	--
EPS native format	--	GRAS Level 1b (2 h 15 min)	--	GRAS Level 1a (8-9 h) GRAS Level 1b (8-9 h)
HDF	--	--	--	(TBC)
WMO (BUFR)	--	GRAS Level 1b (2 h 15 min) GRAS Level 1b (thinned) (2 h 15 min)	GRAS Level 1b (thinned) (2 h 15 min)	--

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

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

Note: The BUFR thinned data on GTS is much smaller in quantity than the full data on EUMETCast.

Real-time broadcast of GRAS 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 UMARF, GRAS Level 0 products are not considered as an end-user product, hence they are not addressed in this guide either.

6.2.1 Near real-time dissemination

The GRAS Level 1 Products disseminated to users in near real-time are:

- GRAS Level 1b products (full + thinned), with a timeliness of 2 h 15 min from sensing

The dissemination granularity for Level 1 data covers one to several occultations within a time window of about 3 minutes.

6.2.2 Archive retrieval

The GRAS Level 1 & 2 Products available from the UMARF are:

- GRAS Level 1a
- GRAS Level 1b
- GRAS Level 2 (from GRAS SAF)

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

6.3 GRAS EPS product format

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 GRAS specific. The general product section breakdown is given, and the following sections will focus on how this generic format is further applied to GRAS products.

This description is not aimed at supporting the writing of reader software for the GRAS 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 GRAS products in EPS native format, we refer them to the detailed format specifications provided in [RD6].

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 processing 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. Note: not used for GRAS.

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. Note: VEADR not used for GRAS.

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.

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

Section	**RECORD CLASS**	**RECORD SUBCLASS**	**START TIME**	**STOP TIME**
HEADER SECTION	MAIN PRODUCT HEADER RECORD SECONDARY PRODUCT HEADER RECORD		T1 T1	T6 T6
INTERNAL POINTER SECTION	INTERNAL POINTER RECORD (GEADR Subclass A) INTERNAL POINTER RECORD (GEADR Subclass B) INTERNAL POINTER RECORD (GIADR Subclass A) INTERNAL POINTER RECORD (GIADR Subclass B)		T1 T1 T1 T1 T1 T1 T1 T1	T6 T6 T6 T6 T6 T6 T6 T6

Section	RECORD CLASS	RECORD SUBCLASS	START TIME	STOP TIME
	INTERNAL POINTER RECORD (GIADR Subclass C) INTERNAL POINTER RECORD (VEADR Subclass A) INTERNAL POINTER RECORD (VEADR Subclass B) INTERNAL POINTER RECORD (VEADR Subclass C) INTERNAL POINTER RECORD (VIADR Subclass A) INTERNAL POINTER RECORD (VIADR Subclass B) INTERNAL POINTER RECORD (VIADR Subclass C) INTERNAL POINTER RECORD (MDR Subclass A) INTERNAL POINTER RECORD (MDR Subclass B) INTERNAL POINTER RECORD (MDR DUMMY) INTERNAL POINTER RECORD (MDR Subclass A) INTERNAL POINTER RECORD (MDR Subclass B)		T1 T1 T1 T1 T1 T1 T1 T1	T6 T6 T6 T6 T6 T6 T6 T6
GLOBAL AUXILIARY DATA SECTION	GLOBAL INTERNAL AUXILIARY DATA RECORD GLOBAL INTERNAL AUXILIARY DATA RECORD GLOBAL INTERNAL AUXILIARY DATA RECORD GLOBAL INTERNAL AUXILIARY DATA RECORD GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS A SUBCLASS B SUBCLASS A SUBCLASS B SUBCLASS C	T1 T1 T1 T1 T1	T6 T6 T6 T6 T6
VARIABLE AUXILIARY DATA SECTION	VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY	SUBCLASS A SUBCLASS B SUBCLASS B SUBCLASS C SUBCLASS C SUBCLASS A SUBCLASS A SUBCLASS A	T1 T1 T3 T1 T5 T1 T2 T4	T6 T3 T6 T5 T6 T2 T4 T6

Section	RECORD CLASS	RECORD SUBCLASS	START TIME	STOP TIME
	DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B SUBCLASS C	T1 T1	T6 T6
BODY SECTION	MEASUREMENT DATA RECORD MEASUREMENT DATA RECORD MEASUREMENT DATA RECORD MEASUREMENT DATA RECORD MEASUREMENT DATA RECORD	SUBCLASS A SUBCLASS B DUMMY SUBCLASS A SUBCLASS B	T1 T2 T3 T4 T5	T2 T3 T4 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 UMARF.

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 UMARF.

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

The 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_ID	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 GRAS products, the resulting product file names are as follows:

Product	Product name
GRAS Level 1a	GRAS_xxx_1A_Mnn_< ...>
GRAS Level 1b	GRAS_xxx_1B_Mnn_< ...>

Table 6-4: Generic GRAS product names

6.3.2 GRAS Level 1a products

GRAS Level 1a products (see [RD5]) contain reformatted raw instrument data along with all supplementary data needed for further processing, including geolocation and quality flags. The full information is available in Section 9.

Section	Record class	Record subclasses / Remarks
Header	MPHR	
	SPHR	
Pointer	IPR	(One per target class)
Global Aux Data	GEADR	None for GRAS
	GIADR	None for GRAS
Variable Aux Data	VIADR	Occulting GPS NRT orbit arc Earth orientation parameters Tropospheric delay product Ground station clock bias estimate Ground station clock offset estimates Sounding support measurements GPS tracking data Occultation table GSN quality report Metop NRT orbit arc Metop attitude data Metop clock offset estimates
Body	MDR	Information generally on a per PDU basis, see MDR-1a-… in Section 9.14 etc. (Granularity: generally one per PDU)

Table 6-5: Generalised format of GRAS Level 1a products

Typical product size for one full orbit is about 250 MB.

6.3.3 GRAS Level 1b products

GRAS Level 1b products (see [RD5]) contain information on a per occultation basis, along with auxiliary information such as geolocation, quality flags, etc. The full information is available in Section 10.

Section	Record class	Record subclasses / Remarks
Header	MPHR	
	SPHR	(same as in Level 1a product)
Pointer	IPR	One per target class
Global Aux Data	GEADR	as defined [RD3]
	GIADR	as defined [RD3]
Variable Aux Data	VIADR	GPS orbit arc Occulting GPS clock bias estimate

		Tropospheric delay products for fiducial stations Clock offset estimates for fiducial stations Metop NRT orbit arc Metop clock bias estimation Earth orientation parameters Metop attitude information
Body	MDR	Information on a per occultation basis, see MDR-1b in Section 10.11 (Granularity: one per occultation)

Table 6-6: Generalised format of GRAS Level 1b products

Typical product size for one full orbit is about 180 MB.

6.4 The HDF format

The contents and formats of the individual fields of the GRAS-2 Level 1b HDF5 products are the same as for the EPS native format.

Detailed format descriptions are provided in [RD10]. The products retrieved from the UMARF 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.

6.5 The WMO formats

The GRAS Level 1b products available in WMO (BUFR) format are summarised in the table below.

Product	Bulletin header	Originating station	Descriptor sequence
GRAS Level 1b	N/A	N/A	3-10-026 [Descriptor 3-10-026 is the standard for radio occultation data.]
GRAS Level 1b thinned	IEGXii (ii from 01 to 89) [ii is incremented for successive occultations ending in the same minute.]	EUMP	3-10-026

Table 6-7: GRAS Level 1b products available in WMO (BUFR) format

The full format description of these products is available in the WMO Manual on Codes [SCD4].

The names of the GRAS Level 1b products distributed on EUMETCast are specified in [RD11]. They follow the pattern:

gras_yyyymmdd_hhmmss_metopa_nnnnn_eps_o[_thn].l1_bufr

where:

yyyymmdd	stands for the UTC year, month, day of the data end sensing time
hhmmss	stands for the UTC hour, minute, second of the data end sensing time
nnnnn	is the orbit number
_thn	denotes a thinned product

GRAS vertical profiles regularly contain several thousand samples because the instrument samples at a frequency of 50 Hz and an occultation can often last more than 60 seconds. The GTS is currently not able to cope with the resulting large BUFR files, hence a thinned BUFR product is generated and distributed only on GTS. The thinning reduces the number of vertical levels to currently 247, using a simple linear interpolation in log(bending angle). The same thinning algorithm is also used at the GRAS SAF to thin Level 2 products.

There will be one occultation per GTS bulletin, and the GTS data will not be compressed. The full data on EUMETCast may have multiple occultations within a BUFR message and will be compressed.

7 GRAS PRODUCTS PROCESSING ALGORITHMS

This section will be completed later. For now, please refer to the Product Generation Function Specifications [RD5].

8 GRAS PRODUCTS VALIDATION AND MONITORING

For more recent information, please check for relevant documents on the EUMETSAT webpage Product Validation Reports.

8.1 Objectives

The overall objective of the GRAS characterisation, calibration and validation activities is to ensure that, after the commissioning phase and thereafter during the mission lifetime, the GRAS instrument achieves its expected performance with respect to the GRAS requirements specification [RD7], and that the products satisfy the EPS end-user requirements specified in [RD1]. A further objective is that the GRAS product accuracy will continuously improve as far as possible to satisfy the evolving state-of-the-art user requirements. The following specific objectives determine the product Cal/Val activities for GRAS:

- full verification of instrument performance through monitoring of the GRAS instrument
- calibration and characterisation of the GRAS instrument taking into account possible long-term changes in instrument performance in-flight
- provision of confidence-checked and verified GRAS Level 1 products
- provision of validated GRAS Level 1b products
- revision of product generation processing algorithms and required data sets, to ensure that the products first meet, and then exceed, user expectations.

It can be expected that corrections to the GRAS processing will periodically require a reprocessing of the complete data set during routine operations to ensure the consistency of the long-term data record.

8.2 GRAS in-orbit verification

GRAS In-Orbit Verification (GRAS IOV) has been carried out under the responsibility of the European Space Agency (ESA). GRAS passed the test review board on 23 January 2007 and the hardware is considered operational. The primary objective of GRAS IOV was to verify that the instrument meets its functional and performance requirements. This has been achieved by exercising specific instrument operations, first via manual commanding and then using dedicated test timelines, and by analysis of raw data from the S bands using dedicated test tools. Demonstration of this nominal instrument performance is a prerequisite for successful GRAS IOV and Commissioning Phase Hand-over Reviews. In addition, GRAS IOV activities provide significant input to the planning of commissioning phase and routine operations. The specific functional and performance tests carried out during IOV are fully detailed in [RD4].

8.3 Instrument monitoring

Verification of the correct functioning of the GRAS instrument requires continuous instrument monitoring activities. These activities start during the commissioning phase, specifically during in-orbit verification of the instrument function and performance, and continue during the remainder of the commissioning phase (which partly ends with a Product Validation Board review) and during routine operations [RD4]. Furthermore, instrument characteristics might change during the GRAS lifetime, e.g. caused by software upgrades.

Operational instrument monitoring is performed in the Cal/Val Facility (CVF) at EUMETSAT, a dedicated calibration and validation network for all Metop instruments, as part of the calibration and validation activities. GRAS-specific parameters (such as tracking state and number of tracked occultations) are monitored to assure the instrument's health. A very basic instrument monitoring is also performed by the Quality Control Facility within the Core Ground Segment at EUMETSAT.

8.4 Validation

A general overview of the GRAS calibration and validation activities is given in [RD8]. Validation can be separated into two parts, the so-called Precise Orbit Determination (POD) and the profile validation.

8.4.1 Precise Orbit Determination validation

The data processing requires accurate knowledge of the GPS and Metop satellite positions and velocities.

GPS satellite positions and velocities are provided by the Ground Support Network (GSN), a service that provides GPS state vectors, clock offset estimates and ground-based measurements from a network of globally distributed fiducial stations. This service is provided by ESA/ESOC. The accuracy of the GPS orbits provided by the GSN is validated by comparing them to International GNSS Service (IGS) orbits. Additionally, the timeliness and completeness of the GSN data is monitored.

Metop satellite positions are calculated based on the GRAS navigation measurements and the GSN data in near real-time. Validation of this calculated orbit is done in the CVF within a batch process, using the ESOC Navigation Package for Earth Observation Satellites (NAPEOS) software. Additionally, several further validation approaches are performed/planned:

- Navigation measurements covering dedicated time periods are provided to external partners, and the orbits calculated at these partner institutions are compared to the in-house ones.
- Navigation measurements provided by other radio occultation instruments can be run through the in-house processing and compared to the external orbits.
- The in-house Flight Dynamics Facility provides less accurate Metop orbits which should agree within the error bounds.
- The GRAS receiver provides a less accurate on-board solution which should agree within the error bounds.

8.4.2 Atmospheric profile validation

For a good description of the validation strategy for GRAS see EUMETSAT Technical Memorandum 12 [SCD6].

Level 1b profiles as provided by GRAS contain, among other parameters, bending angle over impact parameters. These bending angles represent the main measurements that are assimilated at NWP centres. (Note: NWP centres might also choose to assimilate refractivity profiles as provided by the GRAS SAF.) Except for other radio occultation instruments, bending angles are generally not measured, thus a continuous, operational validation of these profiles is problematic. Hence the core validation process is based on a one-dimensional variational assimilation (1DVar) approach. This provides bending angles along with robust statistics for the GRAS validation. Additionally, temperature, pressure and humidity profiles (which present the main information that is extracted from radio occultation measurements by NWP centre assimilation) are provided by the 1DVar. The availability of these profiles allows further validation of the GRAS measurements by comparing them to instruments providing these profiles, such as radiosondes or Lidar. Hence, the validation is partly based on the variables which are of main interest to the NWP centres.

8.4.2.1 1DVar validation

The tool for these activities is the Radio Occultation Processing Package (ROPP) software tool [GS3]. It uses a 1DVar approach to derive temperature, water vapour and pressure profiles from bending angles; background information is taken generally from the ECMWF. A so-called forward model maps the atmospheric state (ECMWF profiles) onto measurement state (bending angle profiles), hence validation can be performed in measurement space and in atmospheric state space for all available occultations.

Routine instrument monitoring and validation are based on the 1DVar output:

- "Noise characteristics" statistics: although not a direct 1DVar product, these are required as input and are monitored.
- "Convergence and Cost" statistics: output of the 1DVar processing giving information on assumed input errors.
- "Observation minus Background" statistics: performed in measurement space, showing the difference between the forward propagated ECMWF background state and the actual GRAS measurement.
- "Observation minus Solution" statistics: performed in measurement space, showing the difference between the forward propagated 1DVar solution and the actual GRAS measurement.

8.4.2.2 Radio occultation instrument validation

This validation is performed continuously by collocating GRAS measurements with other available external radio occultation missions. Possible missions are the COSMIC constellation, see e.g. [SCD3], or the CHAMP mission [SCD2]. Direct validation of bending angles is possible with this approach, but it also allows the EUMETSAT processing to be validated by using raw measurements from these external missions, running them through the POD and the profile generation, and validating the generated profiles with the external ones. Note that this validation will not allow all GRAS measurements to be accommodated since it relies on collocation.

8.4.2.3 Radiosonde validation

Radiosondes provide temperature, pressure and humidity profiles. These could be used to generate a refractivity and bending angle profile for validation. Although, as mentioned above, the 1DVar output can also be used to validate directly in atmospheric parameter space, note that this validation will not allow all GRAS measurements to be accommodated since it relies on collocation.

8.4.2.4 Lidar validation

Lidar instruments generally provide temperature profiles in the upper atmosphere. These can be used for temperature validation. Note that this validation will not allow all GRAS measurements to be accommodated since it relies on collocation.

8.5 Validation of GRAS SAF products

As noted above, validation of GRAS SAF products is under the responsibility of the GRAS SAF itself. The validation activities planned by the GRAS SAF are described in detail at [GS1], [GS2]. They comprise:

- system performance: observation delay, availability, data quality assessment using NWP profiles
- product validation: global statistics with respect to NWP (separation into land/sea, latitude bands, regions, rising/setting)
- validation using other measurements: such as radiosondes, other radio occultations
- validation campaigns: high resolution radiosondes, lidars

Validation results from these activities, and also the diagnostic quantities produced in the generation of Level 2 products, provide valuable feedback to the Level 1 validation activities. Similarly, Level 1 verification and validation activities provide necessary input to the GRAS SAF validation activities.

8.6 Scientific activities carried out via the EPS/Metop RAO

An EPS/Metop Research Announcement of Opportunity (RAO) to be coordinated by EUMETSAT and ESA was started. The primary objectives of the Announcement of Opportunity are:

- stimulating relevant research in all domains of Earth Sciences, and structured dialogue and interactions between the selected investigators and the EUMETSAT operational users;
- identifying support to calibration and validation activities, complementing and enhancing calibration and validation activities planned by EUMETSAT;
- investigation of innovative research algorithms and demonstration of new geophysical products and of their relevance to research.

Several selected RAOs provide scientific support to GRAS calibration and validation activities. Further details can be found in the *EPS/Metop Research Announcement of Opportunity* [RD9].

9 RECORD DESCRIPTION OF THE GRAS LEVEL 1A PRODUCTS

This GRAS 1a description corresponds to the GRAS Level 1 PFS [RD6] Issue v7B and the Generic PFS [RD3] Issue v7B.

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

(yellow)	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.
(green)	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
viadr-1a-gps-pod	3
viadr-1a-eop	5
viadr-1a-tzd	3
viadr-1a-gps-clock	3
viadr-1a-station-clock	3
viadr-1a-ssd	3
viadr-1a-occultation-table	3
viadr-1a-gsn-quality-report	3

viadr-1a-metop-pod	3
viadr-1a-metop-attitude	3
viadr-1a-metop-clock	3
mdr-1a-onboard-navigation	3
mdr-1a-gain	3
mdr-1a-temperature	3
mdr-1a-tracking-state	3
mdr-1a-ephemeris	3
mdr-1a-occ-noise	3
mdr-1a-zenith-noise	3
mdr-1a-occultation-data	4
mdr-1a-navigation-data	4
mdr-1a-nav-frame	3
mdr-1a-gras-monitoring	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 1, version 3)
- VIADR (name 'viadr-1a-gps-pod', class 7, subclass 1, version 3)
- VIADR (name 'viadr-1a-eop', class 7, subclass 2, version 5)
- VIADR (name 'viadr-1a-tzd', class 7, subclass 3, version 3)
- VIADR (name 'viadr-1a-gps-clock', class 7, subclass 4, version 3)

- VIADR (name 'viadr-1a-station-clock', class 7, subclass 5, version 3)
- VIADR (name 'viadr-1a-ssd', class 7, subclass 6, version 3)
- VIADR (name 'viadr-1a-occultation-table', class 7, subclass 8, version 3)
- VIADR (name 'viadr-1a-gsn-quality-report', class 7, subclass 9, version 3)
- VIADR (name 'viadr-1a-metop-pod', class 7, subclass 10, version 3)
- VIADR (name 'viadr-1a-metop-attitude', class 7, subclass 11, version 3)
- VIADR (name 'viadr-1a-metop-clock', class 7, subclass 12, version 3)
- MDR (name 'mdr-1a-onboard-navigation', class 8, subclass 1, version 3)
- MDR (name 'mdr-1a-gain', class 8, subclass 2, version 3)
- MDR (name 'mdr-1a-temperature', class 8, subclass 3, version 3)
- MDR (name 'mdr-1a-tracking-state', class 8, subclass 4, version 3)
- MDR (name 'mdr-1a-ephemeris', class 8, subclass 5, version 3)
- MDR (name 'mdr-1a-occ-noise', class 8, subclass 6, version 3)
- MDR (name 'mdr-1a-zenith-noise', class 8, subclass 7, version 3)
- MDR (name 'mdr-1a-occultation-data', class 8, subclass 8, version 4)
- MDR (name 'mdr-1a-navigation-data', class 8, subclass 9, version 4)
- MDR (name 'mdr-1a-nav-frame', class 8, subclass 10, version 3)
- MDR (name 'mdr-1a-gras-monitoring', class 8, subclass 11, 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 [RD3].

Note: An entry of 'var' in the 'Field size' or 'Offset' columns below indicates that the entry cannot be specified exactly because of variable dimensions. To compute field sizes and offsets, please see the PFS for more detailed information.

9.1 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
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			1	1	1	1	string	67	100	420

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	appropriate, this field is filled with lower case x's.										
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 this object (PDU, ROI or Full Product)			1	1	1	1	time	15	48	748
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

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
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
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		UTC	1	1	1	1	longtime	18	51	1497

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	elements and the orbit state vector. this corresponds to the time of crossing the ascending node for ORBIT_START										
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 ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1724
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	10^3	m/s	1	1	1	1	integer	11	44	1944

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	node										
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
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

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
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 product			1	1	1	1	uinteger	6	39	2760
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			1	1	1	1	uinteger	6	39	2916

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	product										
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 the product		ms	1	1	1	1	uinteger	8	41	3191
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 UMARF			1	1	1	1	boolean	1	34	3273

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	GIADRs in GAD section for product retrieved from UMARF.										
											Total: 3307

9.2 SPHR (name 'sphr', class 2, 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
GOBS_VER	Gras Onboard Software version number			1	1	1	1	string	40	73	20
GRAS_ID	GRAS instrument identification			1	1	1	1	enumerated	3	36	93
EARTH_MODEL_ID	Earth model identification			1	1	1	1	enumerated	3	36	129
METOP_MANOEUVRE_FLAG	Metop manoeuvre flag			1	1	1	1	boolean	1	34	165
METOP_MANOEUVRE_START	Start time of the manoeuvre		s	1	1	1	1	longtime	18	51	199
METOP_MANOEUVRE_END	End time of the manoeuvre		s	1	1	1	1	longtime	18	51	250
MANOEUVRE_IMP_END	Time from the end of the manoeuvre after which the manoeuvre does not any more affect the MDRs		s	1	1	1	1	integer	10	43	301
											Total: 344

9.3 VIADR (name 'viadr-1a-gps-pod', class 7, 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
GPS_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time sample interval used in solution		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_SATELLITES	Number of GPS satellites, N			1	1	1	1	uinteger1	1	1	40
GPS_ID	GPS satellite identification			N	1	1	1	uinteger1	1	var	41
POSITION_UNCERTAINTY_X	Satellite position x uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
POSITION_UNCERTAINTY_Y	Satellite position x uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
POSITION_UNCERTAINTY_Z	Satellite position z uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
VELOCITY_UNCERTAINTY_X	Satellite velocity x uncertainty	10^6	m/s	N	1	1	1	integer8	8	var	var
VELOCITY_UNCERTAINTY_Y	Satellite velocity y uncertainty	10^6	m/s	N	1	1	1	integer8	8	var	var
VELOCITY_UNCERTAINTY_Z	Satellite velocity z uncertainty	10^6	m/s	N	1	1	1	integer8	8	var	var
CLOCK_OFFSET_UNCERTAINTY	Satellite transmitter clock offset uncertainty	10^9	s	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
CLOCK_DRIFT_UNCERTAINTY	Satellite transmitter clock rate of change uncertainty	10^9	s/s	N	1	1	1	integer8	8	var	var
NUMBER_OF_EPOCHS	Number of epochs for each GPS satellite, M			N	1	1	1	uinteger2	2	var	var
GPS_ORBIT_ARC				M	N	1	1	GPS_STATE_VECTOR	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
SATELLITE_POSITION_X	Satellite position x at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Y	Satellite position y at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Z	Satellite position z at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_X	Satellite velocity v_x at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Y	Satellite velocity v_y at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Z	Satellite velocity v_z at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
CLOCK_OFFSET	Clock offset	10^9	s	1	1	1	1	integer8	8	8	
CLOCK_DRIFT	Satellite transmitter clock rate of change	10^9	s/s	1	1	1	1	integer8	8	8	
											Total: var

9.4 VIADR (name 'viadr-1a-eop', class 7, subclass 2, version 5)

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
NUM_EPOCHS	Number of EOP epochs, N			1	1	1	1	integer2	2	2	20
Earth_Orientation_Parameters											
EPOCH	Start time of the record validity	10^9	s	N	1	1	1	uinteger8	8	var	22
X_POLE	x-pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
Y_POLE	y-pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DUT1	UT1-UTC	10^6	s	N	1	1	1	integer8	8	var	var
EOP_STATUS	Final or predicted EOP products			N	1	1	1	boolean	1	var	var
D_psi	Celestial pole offset in longitude	10^6	arcsec	N	1	1	1	integer8	8	var	var
D_eps	Celestial pole offset in obliquity	10^6	arcsec	N	1	1	1	integer8	8	var	var
DX_POLE	Uncertainty in X-Pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DY_POLE	Uncertainty in Y-Pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DLOD	Uncertainty in Length of day (LOD)	10^6	s	N	1	1	1	integer8	8	var	var
											Total: var

9.5 VIADR (name 'viadr-1a-tzd', class 7, subclass 3, 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
Tropospheric_delay_product											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
STATION_NUMBER	Number of stations in interval			1	1	1	1	uinteger2	2	2	36
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	38
TROPOS_NUMBER_PARAMETERS	Number of tropospheric parameters for the stations			1	1	1	1	uinteger2	2	2	39
TROPOS_ESTIMATE_INTERVAL	Estimation interval	10^6	s	1	1	1	1	uinteger8	8	8	41
NUMBER_OF_STATIONS	Number of fiducial stations, M			1	1	1	1	uinteger2	2	2	49
STATION_ID	Ground station identification			M	1	1	1	string	4	var	51
NUM_EPOCHS	Number of epochs, T			M	1	1	1	uinteger2	2	var	var
STATION_TZD_ESTIMATES				T	M	1	1	TROP_DELAY	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
MEASURED_SURFACE_PRESSURE	Measured surface pressure at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
MEASURED_SURFACE_TEMPERATURE	Measured surface temperature at the station location	10^3	K	1	1	1	1	uinteger8	8	8	
MEASURED_PARTIAL_WV_PRESSURE	Measured partial pressure of	10^3	mbar	1	1	1	1	uinteger8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	the water vapour at surface at the station location										
NWP_SURFACE_PRESSURE	NWP surface pressure at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
NWP_SURFACE_TEMPERATURE	NWP surface temperature at the station location	10^3	K	1	1	1	1	uinteger8	8	8	
NWP_PARTIAL_WV_PRESSURE	Partial pressure of the water vapour at surface at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
TROP0S_ZENITH_DELAY	Zenith tropospheric delay estimate from the GSN	10^6	m	1	1	1	1	uinteger8	8	8	
TROPOS_ZENITH_DELAY_UNCERTAINTY	Uncertainty in zenith tropospheric delay estimate	10^6	m	1	1	1	1	integer8	8	8	
											Total: var

9.6 VIADR (name 'viadr-1a-gps-clock', class 7, subclass 4, 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
GPS_clock_bias_estimates											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time sample interval used in solution		s	1	1	1	1	uinteger2	2	2	36
GPS_NUMBER	Number of satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_SATELLITES	Number of GPS satellites, M			1	1	1	1	uinteger1	1	1	40
GPS_ID	GPS satellite identification			M	1	1	1	uinteger1	1	var	41
CLOCK_QUALITY	Quality indicator for each GPS satellite			M	1	1	1	uinteger8	8	var	var
NUM_EPOCHS	Number of clock solution epochs, N			M	1	1	1	integer2	2	var	var
GPS_CLOCK_OFFSETS				N	M	1	1	GPS_CLOCKS	16	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
GPS_CLOCK_OFFSET	Clock offset estimate	10^20	s	1	1	1	1	integer8	8	8	
											Total: var

9.7 VIADR (name 'viadr-1a-station-clock', class 7, subclass 5, 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
Ground_station_clock_offset_estimates											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
ESTIMATE_INTERVAL	Estimation interval for clock bias		s	1	1	1	1	uinteger2	2	2	36
STATION_NUMBER	Number of stations in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_STATIONS	Number of fiducial stations, M			1	1	1	1	uinteger1	1	1	40
STATION_ID	Ground station identification			M	1	1	1	string	4	var	41
CLOCK_QUALITY	Quality indicator for each station			M	1	1	1	uinteger8	8	var	var
NUM_EPOCHS	Number of epochs, E			M	1	1	1	uinteger2	2	var	var
STATION_CLOCK_OFFSETS				E	M	1	1	STATION_CLOCKS	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
STATION_CLOCK_OFFSET	Clock offset	10^20	s	1	1	1	1	integer8	8	8	
STATION_CLOCK_DRIFT	Clock drift	10^9	s/s	1	1	1	1	integer8	8	8	
STATION_POSITION_MEASUREMENT_X	Position of measurement point x (ECI)	10^6	m	1	1	1	1	integer8	8	8	
STATION_POSITION_MEASUREMENT_Y	Position of measurement point y (ECI)	10^6	m	1	1	1	1	integer8	8	8	
STATION_POSITION_MEASUREMENT_Z	Position of measurement point z (ECI)	10^6	m	1	1	1	1	integer8	8	8	
STATION_VELOCITY_X	Velocity v_x of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
STATION_VELOCITY_Y	Velocity v_y of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
STATION_VELOCITY_Z	Velocity v_z of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
											Total: var

9.8 VIADR (name 'viadr-1a-ssd', class 7, subclass 6, 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
Sounding_support_measurements											
MEASUREMENT_START	Start time of measurement arc	10^6	s	1	1	1	1	uinteger8	8	8	20
MEASUREMENT_END	End time of measurement arc	10^6	s	1	1	1	1	uinteger8	8	8	28

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
MEASUREMENT_SAMPLE_INTERVAL	Sampling interval used in tracking		s	1	1	1	1	uinteger1	1	1	36
NUMBER_OF_OCCULTATIONS	Number of occultations, J			1	1	1	1	uinteger1	1	1	37
OCCULTATION_ID	Occultation identification			J	1	1	1	string	32	var	38
NUMBER_OF_STATIONS	Number of stations capable of supporting this occultation, K			J	1	1	1	uinteger1	1	var	var
STATION_ID	Ground station identification			K	J	1	1	string	4	var	var
NUM_GPS	Number of GPS satellites measured by the station, P			K	J	1	1	uinteger1	1	var	var
GPS_ID	GPS PRN number			P	K	J	1	uinteger1	1	var	var
GPS_TYPE	Occulting or pivot satellite			P	K	J	1	boolean	1	var	var
PIVOT_REC	Pivot satellite recommendation 1st, 2nd,...			P	K	J	1	uinteger1	1	var	var
NUM_EPOCHS	Number of SSD epochs, S			P	K	J	1	uinteger1	1	var	var
GPS_SSD_DATA				S	P	K	J	SSD_SAMPLE	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
C1	C/A code pseudorange		m	1	1	1	1	uinteger8	8	8	
L1C1	C/A-based carrier phase at L1	10^6	cycles	1	1	1	1	uinteger8	8	8	
P1	Y1-codeless pseudorange at L1	10^6	m	1	1	1	1	uinteger8	8	8	
L1P1	Y1-codeless-based phase at L1	10^6	cycles	1	1	1	1	uinteger8	8	8	
P2	Y2-codeless pseudorange at L2	10^6	m	1	1	1	1	uinteger8	8	8	
L2P2	Y2-codeless-based phase at L2	10^6	cycles	1	1	1	1	uinteger8	8	8	
S1	SNR in L1	10^3	dB	1	1	1	1	integer8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
S2	SNR in L2	10^3	dB	1	1	1	1	integer8	8	8	
											Total: var

9.9 VIADR (name 'viadr-1a-occultation-table', class 7, subclass 8, 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
Occultation_table											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
TABLE_ID	Table id number			1	1	1	1	uinteger4	4	4	36
Measurement_characterisation_(for_each_predicted_measurement)											
NUMBER_OF_MEASUREMENTS	Number of predicted measurements, N			1	1	1	1	uinteger2	2	2	40
MEASUREMENT_ID	Id number of the predicted measurement			N	1	1	1	string	32	var	42
MEASUREMENT_START	Measurement start time	10^6	s	N	1	1	1	uinteger8	8	var	var
MEASUREMENT_END	Measurement end time	10^6	s	N	1	1	1	uinteger8	8	var	var
MEASUREMENT_DURATION	Length of the measurement		s	N	1	1	1	uinteger2	2	var	var
GPS_ID	Measured GPS PRN number			N	1	1	1	uinteger1	1	var	var
MEASUREMENT_TYPE	Raisin/setting/navigation			N	1	1	1	enumerated	1	var	var
INCIDENCE_AZIMUTH	Azimuth angle of the incoming	10^3	deg	N	1	1	1	integer4	4	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	ray										
INCIDENCE_ELEVATION	Elevation angle of the incoming ray	10^3	deg	N	1	1	1	integer4	4	var	var
GEOLOCATION_SLTH_START	SLTH start value used for geolocation	10^3	m	N	1	1	1	integer4	4	var	var
GEOLOCATION_SLTH_END	SLTH end value used for geolocation	10^3	m	N	1	1	1	integer4	4	var	var
PRED_START_LAT	Predicted start latitude of the measurement	10^3	degree	N	1	1	1	integer4	4	var	var
PRED_START_LONG	Predicted start longitude of the measurement	10^3	degree	N	1	1	1	integer4	4	var	var
PRED_END_LAT	Predicted end latitude of the measurement	10^3	degree	N	1	1	1	integer4	4	var	var
PRED_END_LONG	Predicted end longitude of the measurement	10^3	degree	N	1	1	1	integer4	4	var	var
Metop_state_vector_(once_per_occultation_table)											
METOP_SAMPLE_INTERVAL	Time sample interval of the state vectors		s	1	1	1	1	uinteger2	2	2	var
NUMBER_OF_METOP_EPOCHS	Number of state vector epochs, M			1	1	1	1	uinteger2	2	2	var
EPOCH_TIME	Time stamp in reference time	10^6	s	M	1	1	1	integer8	8	var	var
SATELLITE_POSITION_X	Satellite position x at epoch time	10^6	m	M	1	1	1	integer8	8	var	var
SATELLITE_POSITION_Y	Satellite position y at epoch time	10^6	m	M	1	1	1	integer8	8	var	var
SATELLITE_POSITION_Z	Satellite position z at epoch time	10^6	m	M	1	1	1	integer8	8	var	var
SATELLITE_VELOCITY_X	Satellite velocity x at epoch time	10^6	m/s	M	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
SATELLITE_VELOCITY_Y	Satellite velocity y at epoch time	10^6	m/s	M	1	1	1	integer8	8	var	var
SATELLITE_VELOCITY_Z	Satellite velocity z at epoch time	10^6	m/s	M	1	1	1	integer8	8	var	var
GPS_state_vector_(once_per_occultation_table)											
GPS_SAMPLE_INTERVAL	Time sample interval of the state vectors		s	1	1	1	1	uinteger2	2	2	var
NUMBER_OF_GPS	Number of GPS satellites, G			1	1	1	1	uinteger1	1	1	var
GPS_ID_STATE	GPS PRN number			G	1	1	1	uinteger1	1	var	var
NUMBER_OF_GPS_EPOCHS	Number of state vector epochs, E			G	1	1	1	uinteger2	2	var	var
STATE_VECTOR				E	G	1	1	GPS_STATE_SHORT	56	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
SATELLITE_POSITION_X	Satellite position x at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Y	Satellite position y at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Z	Satellite position z at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_X	Satellite velocity v_x at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Y	Satellite velocity v_y at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Z	Satellite velocity v_z at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
											Total: var

9.10 VIADR (name 'viadr-1a-gsn-quality-report', class 7, subclass 9, 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
GSN_Quality_report											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
GENERATION_TIME	File generation time	10^9	s	1	1	1	1	uinteger8	8	8	36
PAST_TIME_START	Start time of the past data	10^9	s	1	1	1	1	uinteger8	8	8	44
PAST_TIME_END	End time of the past data	10^9	s	1	1	1	1	uinteger8	8	8	52
GLOBAL_SA	Global SA setting of the GPS system			1	1	1	1	boolean	1	1	60
SA_CHANGE_EPOCH	Epoch of the global SA status change	10^9	s	1	1	1	1	uinteger8	8	8	61
STAT_NUM_GPS	Number of GPS satellites that status information is provided for, A			1	1	1	1	uinteger1	1	1	69
STAT_GPS_ID	GPS PRN number			A	1	1	1	uinteger1	1	var	70
GPS_MANOEUVRE_EPOCHS	Number of manoeuvre epochs for the GPS satellite, B			A	1	1	1	uinteger2	2	var	var
GPS_MANOEUVRE_START	Start time of the GPS manoeuvre	10^9	s	B	A	1	1	uinteger8	8	var	var
GPS_MANOEUVRE_END	End time of the GPS manoeuvre	10^9	s	B	A	1	1	uinteger8	8	var	var
GPS_ECLIPSE_EPOCHS	Number of eclipse epochs for the GPS satellite, L			A	1	1	1	uinteger2	2	var	var
GPS_ECLIPSE_START	Start time of the GPS eclipse	10^9	s	L	A	1	1	uinteger8	8	var	var
GPS_ECLIPSE_END	End time of the GPS eclipse	10^9	s	L	A	1	1	uinteger8	8	var	var
GPS_SA_EPOCHS	Number of Selective Availability (SA) epochs for the GPS satellite, M			A	1	1	1	uinteger2	2	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
GPS_SA_STATUS	SA status of the GPS satellite			M	A	1	1	boolean	1	var	var
GPS_SA_EPOCH	Epoch of the SA status change	10^9	s	M	A	1	1	uinteger8	8	var	var
STAT_NUM_STATIONS	Number of fiducial stations that status information is provided for, C			1	1	1	1	uinteger1	1	1	var
STAT_STATION_ID	Station ID			C	1	1	1	string	4	var	var
STAT_OUTAGE_EPOCHS	Number of station outage epochs, D			C	1	1	1	uinteger2	2	var	var
OUTAGE_PAST_START	Start time of the past outage of the station	10^9	s	D	C	1	1	uinteger8	8	var	var
OUTAGE_PAST_END	End time of the past outage of the station	10^9	s	D	C	1	1	uinteger8	8	var	var
STAT_PLANNED_OUTAGE_EPOCHS	Number of station planned outage epochs, N			C	1	1	1	uinteger2	2	var	var
OUTAGE_PLANNED_START	Start time of the planned outage of the station	10^9	s	N	C	1	1	uinteger8	8	var	var
OUTAGE_PLANNED_END	End time of the planned outage of the station	10^9	s	N	C	1	1	uinteger8	8	var	var
NUM_PERIOD_ORB_QUALITY	Number of periods that the orbit quality is provided, E			1	1	1	1	uinteger2	2	2	var
ORB_COMPARISON_START	Start time of the orbit comparison	10^9	s	E	1	1	1	uinteger8	8	var	var
ORB_COMPARISON_END	End time of the orbit comparison	10^9	s	E	1	1	1	uinteger8	8	var	var
ORB_REF_FILE_NAME	Name of the reference file			E	1	1	1	string	88	var	var
ORB_OVERALL_RMS	Overall RMS difference	10^6	m	E	1	1	1	integer4	4	var	var
ORB_OVERALL_WRMS	Weighted overall RMS difference	10^6	m	E	1	1	1	integer4	4	var	var
NUM_GPS_ORB_QUALITY	Number of GPS satellites that the orbit quality information is provided for, F			E	1	1	1	uinteger1	1	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
ORB_GPS_ID	GPS PRN number			F	E	1	1	uinteger1	1	var	var
ORB_ALONG_RMS	RMS difference along track	10^6	m	F	E	1	1	integer4	4	var	var
ORB_CROSS_RMS	RMS difference cross track	10^6	m	F	E	1	1	integer4	4	var	var
ORB_RADIAL_RMS	RMS difference radial	10^6	m	F	E	1	1	integer4	4	var	var
NUM_PERIOD_CLOCK_QUALITY	Number of periods that the clock quality is provided, G			1	1	1	1	uinteger2	2	2	var
CLOCK_COMPARISON_START	Start time of the clock comparison	10^9	s	G	1	1	1	uinteger8	8	var	var
CLOCK_ORB_COMPARISON_END	End time of the clock comparison	10^9	s	G	1	1	1	uinteger8	8	var	var
CLOCK_REF_FILE_NAME	Name of the reference file			G	1	1	1	string	88	var	var
CLOCK_AVERAGE_RMS	Average RMS	10^15	s	G	1	1	1	integer8	8	var	var
CLOCK_AVERAGE_STDEV	Average standard deviation	10^15	s	G	1	1	1	integer8	8	var	var
NUM_GPS_CLOCK_QUALITY	Number of GPS satellites that the clock quality is provided for, H			G	1	1	1	uinteger1	1	var	var
CLOCK_GPS_ID	GPS PRN number			H	G	1	1	uinteger1	1	var	var
CLOCK_GPS_RMS	RMS clock difference	10^15	s	H	G	1	1	integer8	8	var	var
CLOCK_GPS_STDEV	Standard deviation of the clock difference	10^15	s	H	G	1	1	integer8	8	var	var
NUM_STATION_CLOCK_QUALITY	Number of fiducial stations that the clock quality is provided for, K			G	1	1	1	uinteger1	1	var	var
CLOCK_FID_GPS_ID	Fiducial station ID			K	G	1	1	string	4	var	var
CLOCK_FID_RMS	RMS clock difference	10^15	s	K	G	1	1	integer8	8	var	var
CLOCK_FID_STDEV	Standard deviation of the clock difference	10^15	s	K	G	1	1	integer8	8	var	var
											Total: var

9.11 VIADR (name 'viadr-1a-metop-pod', class 7, subclass 10, 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
Metop_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time sample interval used in solution		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of GPS satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
POSITION_UNCERTAINTY_X	Satellite position x uncertainty	10^6	m	1	1	1	1	integer8	8	8	40
POSITION_UNCERTAINTY_Y	Satellite position y uncertainty	10^6	m	1	1	1	1	integer8	8	8	48
POSITION_UNCERTAINTY_Z	Satellite position z uncertainty	10^6	m	1	1	1	1	integer8	8	8	56
VELOCITY_UNCERTAINTY_X	Satellite velocity x uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	64
VELOCITY_UNCERTAINTY_Y	Satellite velocity y uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	72
VELOCITY_UNCERTAINTY_Z	Satellite velocity z uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	80
NUMBER_OF_EPOCHS	Number of solution epochs, N			1	1	1	1	uinteger4	4	4	88
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	92
SATELLITE_POSITION_X	Satellite position x at epoch time	10^6	m	N	1	1	1	integer8	8	var	var
SATELLITE_POSITION_Y	Satellite position y at epoch time	10^6	m	N	1	1	1	integer8	8	var	var
SATELLITE_POSITION_Z	Satellite position z at epoch time	10^6	m	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
SATELLITE_VELOCITY_X	Satellite velocity x at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
SATELLITE_VELOCITY_Y	Satellite velocity y at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
SATELLITE_VELOCITY_Z	Satellite velocity z at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
											Total: var

9.12 VIADR (name 'viadr-1a-metop-attitude', class 7, subclass 11, 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
Metop_attitude											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
NUMBER_OF_EPOCHS	Number of attitude data epochs, N			1	1	1	1	uinteger4	4	4	36
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	40
METOP_STEERING_MODE	Metop steering mode indicator			N	1	1	1	enumerated	1	var	var
METOP_MISPOINTING_ROLL	Mispointing angle Dh	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_PITCH	Mispointing angles Dx	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_YAW	Mispointing angles Dz	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_TRUE_LATITUDE	Metop true latitude angle	10^3	deg	N	1	1	1	integer8	8	var	var
											Total: var

9.13 VIADR (name 'viadr-1a-metop-clock', class 7, subclass 12, 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
Metop_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time sample interval used in solution		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of GPS satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
CLOCK_OFFSET_UNCERTAINTY	Satellite transmitter clock offset uncertainty	10^9	s	1	1	1	1	integer8	8	8	40
CLOCK_DRIFT_UNCERTAINTY	Satellite transmitter clock rate of change uncertainty	10^9	s/s	1	1	1	1	integer8	8	8	48
NUMBER_OF_EPOCHS	Number of solution epochs, N			1	1	1	1	uinteger4	4	4	56
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	60
CLOCK_OFFSET	Clock offset estimate	10^20	s	N	1	1	1	integer8	8	var	var
CLOCK_DRIFT	Satellite transmitter clock rate of change	10^20	s/s	N	1	1	1	integer8	8	var	var
											Total: var

9.14 MDR (name 'mdr-1a-onboard-navigation', class 8, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
GRAS_MODE	Navigation or occultation mode			1	1	1	1	boolean	1	1	38
NUMBER_OF_SAMPLES	Number of data samples, N			1	1	1	1	uinteger4	4	4	39
TIME_IMT	IMT time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	43
TIME_UTC_GRAS	UTC_GRAS time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	var
TIME_OBT	OBT time stamp of the sample	10^6	s	N	1	1	1	longtime	8	var	var
ONBOARD_NAV_SOLUTION	Onboard navigation solution method			N	1	1	1	enumerated	1	var	var
POS_X	Position vector x	10^6	m	N	1	1	1	integer8	8	var	var
POS_Y	Position vector y	10^6	m	N	1	1	1	integer8	8	var	var
POS_Z	Position vector z	10^6	m	N	1	1	1	integer8	8	var	var
VEL_X	Velocity vector x	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_Y	Velocity vector y	10^6	m	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
VEL_Z	Velocity vector z	10^6	m	N	1	1	1	integer8	8	var	var
											Total: var

9.15 MDR (name 'mdr-1a-gain', class 8, subclass 2, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_SAMPLES	Number of data samples, N			1	1	1	1	uinteger4	4	4	38
TIME_IMT	IMT time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	42
ZALS	GZA AGC loop status			N	1	1	1	enumerated	1	var	var
ZHIMT	GZA instrument measurement time of the histogram	10^9	s	N	1	1	1	uinteger8	8	var	var
ZHIST	GZA DISC histogram			N	7	1	1	integer2	2	var	var
ZGCIMT	GZA instrument measurement time of the last	10^9	s	N	1	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	change in gain										
ZANA	GZA receiver channel analogue gain setting			N	1	1	1	enumerated	1	var	var
ZDIG	GZA receiver channel digital gain setting			N	1	1	1	bitfield (6)	6	var	var
VALS	GVA AGC loop status			N	1	1	1	enumerated	1	var	var
VHIMT	GVA instrument measurement time of the histogram	10^9	s	N	1	1	1	uinteger8	8	var	var
VHIST	GVA DISC histogram			N	7	1	1	integer2	2	var	var
VGCIMT	GVA instrument measurement time of the last change in gain	10^9	s	N	1	1	1	uinteger8	8	var	var
VANA	GVA receiver channel analogue gain setting			N	1	1	1	enumerated	1	var	var
VDIG	GVA receiver channel digital gain setting			N	1	1	1	bitfield (6)	6	var	var
AVALS	GAVA AGC loop status			N	1	1	1	enumerated	1	var	var
AVHIMT	GAVA instrument measurement time of the histogram	10^9	s	N	1	1	1	uinteger8	8	var	var
AVHIST	GAVA DISC histogram			N	7	1	1	integer2	2	var	var
AVGCIMT	GAVA instrument measurement time of the last change in gain	10^9	s	N	1	1	1	uinteger8	8	var	var
AVANA	GAVA receiver channel analogue gain setting			N	1	1	1	enumerated	1	var	var
AVDIG	GAVA receiver channel digital gain setting			N	1	1	1	bitfield (6)	6	var	var
											Total: var

9.16 MDR (name 'mdr-1a-temperature', class 8, subclass 3, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_SAMPLES	Number of data samples, N			1	1	1	1	uinteger4	4	4	38
TIME_OBT	OBT time stamp of the sample		s	N	1	1	1	longtime	8	var	42
GEU_STS	GEU status register			N	1	1	1	bitfield (1)	1	var	var
USO_TIM	On-board time of last USO oven switch on or off	10^6	s	N	1	1	1	time	6	var	var
ZAT	Zenith antenna temperature	10^3	degC	N	1	1	1	integer8	8	var	var
VAT	Velocity antenna temperature	10^3	degC	N	1	1	1	integer8	8	var	var
AVAT	Anti-velocity antenna temperature	10^3	degC	N	1	1	1	integer8	8	var	var
RZT	Zenith RFCU temperature	10^3	degC	N	1	1	1	integer8	8	var	var
RVT	Velocity RFCU temperature	10^3	degC	N	1	1	1	integer8	8	var	var
RAVT	Anti-velocity RFCU temperature	10^3	degC	N	1	1	1	integer8	8	var	var
GEUT	GEU temperature	10^3	degC	N	1	1	1	integer8	8	var	var
ISACT	ISAC temperature	10^3	degC	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
USOIT	USO internal temperature	10^3	degC	N	1	1	1	integer8	8	var	var
USOET	USO external temperature	10^3	degC	N	1	1	1	integer8	8	var	var
DBUPV	DBU power voltage	10^3	V	N	1	1	1	uinteger8	8	var	var
TSV	Thermistor supply voltage	10^3	V	N	1	1	1	uinteger8	8	var	var
FGT	FG temperature	10^3	degC	N	1	1	1	integer8	8	var	var
USOG	USO ground	10^3	V	N	1	1	1	integer8	8	var	var
D5V	Digital 5 V	10^3	V	N	1	1	1	uinteger8	8	var	var
											Total: var

9.17 MDR (name 'mdr-1a-tracking-state', class 8, subclass 4, 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
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
TRACKING_STATE_DATA											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_SAMPLES	Number of data samples, N			1	1	1	1	uinteger4	4	4	38

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
TIME_IMT	IMT time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	42
CODE_STATUS	Codeless or coded tracking mode			N	1	1	1	boolean	1	var	var
CH0_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH0_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH0_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH1_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH1_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH1_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH2_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH2_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH2_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH3_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH3_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH3_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH4_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH4_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH4_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH5_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH5_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH5_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH6_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH6_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
CH6_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH7_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH7_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH7_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH8_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH8_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH8_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH9_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH9_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH9_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH10_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH10_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH10_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
CH11_SATELLITE_IDENTIFIER	Identifier of the tracked GPS satellite			N	1	1	1	uinteger1	1	var	var
CH11_TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
CH11_IMT	Time of the tracking state change	10^9	s	N	1	1	1	uinteger8	8	var	var
											Total: var

9.18 MDR (name 'mdr-1a-ephemeris', class 8, subclass 5, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_SATELLITES	Number of GPS satellites, N			1	1	1	1	uinteger1	1	1	38
GPS_ID	GPS satellite identification			N	1	1	1	uinteger1	1	var	39
NUMBER_OF_SAMPLES	Number of data samples, M			N	1	1	1	uinteger4	4	var	var
TIME_OBT	OBT time stamp of the sample		s	M	N	1	1	longtime	8	var	var
A_FLAG	Alert flag			M	N	1	1	boolean	1	var	var
AS_FLAG	Anti-spoofing flag			M	N	1	1	boolean	1	var	var
C2	Codes on L2 channel			M	N	1	1	enumerated	1	var	var
SVA	SV accuracy			M	N	1	1	uinteger1	1	var	var
D2	Data flag for L2 on P-code			M	N	1	1	boolean	1	var	var
CF	Curve fit interval			M	N	1	1	boolean	1	var	var
WN	Week number			M	N	1	1	uinteger2	2	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
NH	GPS navigation data health summary			M	N	1	1	boolean	1	var	var
SH	GPS signal health			M	N	1	1	enumerated	1	var	var
IODC	Issue of data (Clock)			M	N	1	1	uinteger2	2	var	var
A_F0	SV clock correction polynomial constant			M	N	1	1	integer4	4	var	var
A_F1	SV clock correction polynomial constant			M	N	1	1	integer2	2	var	var
A_F2	SV clock correction polynomial constant			M	N	1	1	integer2	2	var	var
T_GD	Estimated group delay differential			M	N	1	1	integer2	2	var	var
T_OC	Clock data reference time			M	N	1	1	integer2	2	var	var
C_RS	Amplitude of the sine harmonic correction term to the orbit radius			M	N	1	1	integer2	2	var	var
DELTA_N	Mean motion diff. From computed value			M	N	1	1	integer2	2	var	var
M_0	Mean anomaly at reference time			M	N	1	1	integer4	4	var	var
C_UC	Amplitude of the cosine harmonic correction term to the argument of latitude			M	N	1	1	integer2	2	var	var
E	Eccentricity			M	N	1	1	integer4	4	var	var
C_US	Amplitude of the sine harmonic correction term to the argument of latitude			M	N	1	1	integer2	2	var	var
SQRT_A	Square root of the semi-major axis			M	N	1	1	uinteger4	4	var	var
T_OE	Reference time ephemeris			M	N	1	1	uinteger4	4	var	var
C_IC	Amplitude of the cosine harmonic correction term to the angle of inclination			M	N	1	1	integer2	2	var	var
OMEGA_0	Longitude of ascending node of orbit plane at weekly epoch			M	N	1	1	integer4	4	var	var
C_IS	Amplitude of the sine harmonic correction term			M	N	1	1	integer2	2	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	to the angle of inclination										
I_0	Inclination angle at reference time			M	N	1	1	integer4	4	var	var
C_RC	Amplitude of the cosine harmonic correction term to the orbit radius			M	N	1	1	integer2	2	var	var
OMEGA	Argument of perigee			M	N	1	1	integer4	4	var	var
OMEGA_DOT	Rate of right ascension			M	N	1	1	integer4	4	var	var
IODE	Issue of data (Ephemeris)			M	N	1	1	uinteger1	1	var	var
I_DOT	Rate of inclination angle			M	N	1	1	integer2	2	var	var
ASAT	GPS identifier of satellite from which the UTC and ionosphere parameters are acquired			M	N	1	1	uinteger1	1	var	var
A1	Polynomial constant			M	N	1	1	integer4	4	var	var
A0	Polynomial constant			M	N	1	1	integer4	4	var	var
DELTA_T_LS	Delta time due to leap seconds			M	N	1	1	integer1	1	var	var
T_OT	Reference time for UTC data			M	N	1	1	uinteger1	1	var	var
WN_T	UTC reference week number			M	N	1	1	uinteger1	1	var	var
WN_LSF	UTC reference week number			M	N	1	1	integer1	1	var	var
DN	Day number			M	N	1	1	integer1	1	var	var
DELTA_T_LSF	Delta time due to leap seconds			M	N	1	1	integer1	1	var	var
ALPHA_0	Ionosphere parameter			M	N	1	1	integer1	1	var	var
ALPHA_1	Ionosphere parameter			M	N	1	1	integer1	1	var	var
ALPHA_2	Ionosphere parameter			M	N	1	1	integer1	1	var	var
ALPHA_3	Ionosphere parameter			M	N	1	1	integer1	1	var	var
BETA_0	Ionosphere parameter			M	N	1	1	integer1	1	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
BETA_1	Ionosphere parameter			M	N	1	1	integer1	1	var	var
BETA_2	Ionosphere parameter			M	N	1	1	integer1	1	var	var
BETA_3	Ionosphere parameter			M	N	1	1	integer1	1	var	var
											Total: var

9.19 MDR (name 'mdr-1a-occ-noise', class 8, subclass 6, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_PACKETS	Number of measurement packets, M			1	1	1	1	uinteger4	4	4	38
TIME_IMT_PACKET	IMT time stamp of the packet	10^9	s	M	1	1	1	uinteger8	8	var	42
DT	Integration time	10^9	s	M	1	1	1	uinteger4	4	var	var
NUMBER_OF_SAMPLES	Number of measurement samples, N			M	1	1	1	uinteger4	4	var	var
TIME_IMT_SAMPLE	IMT time stamp of the sample	10^9	s	N	M	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
GAVA_L1_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L1_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L2_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L2_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L1_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L1_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L2_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L2_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L1_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L1_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L2_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GAVA_L2_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L1_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L1_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L2_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GVA_L2_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
L1_NOISE_GAVA	L1 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
L2_NOISE_GAVA	L2 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
L1_NOISE_GVA	L1 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
L2_NOISE_GVA	L2 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
											Total: var

9.20 MDR (name 'mdr-1a-zenith-noise', class 8, subclass 7, 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
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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_PACKETS	Number of measurement packets, M			1	1	1	1	uinteger4	4	4	38
TIME_IMT	IMT time stamp of the packet	10^9	s	M	1	1	1	uinteger8	8	var	42
DT	Integration time	10^9	s	M	1	1	1	uinteger4	4	var	var
NUMBER_OF_SAMPLES	Number of measurement samples, N			M	1	1	1	uinteger4	4	var	var
TIME_IMT_SAMPLE	IMT time stamp of the sample	10^9	s	N	M	1	1	uinteger8	8	var	var
GZA_L1_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L1_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L2_I_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L2_I_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L1_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L1_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
GZA_L2_Q_M	Normalised signal level detector count			N	M	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
GZA_L2_Q_S	Normalised signal level detector count			N	M	1	1	integer8	8	var	var
L1_NOISE	L1 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
L2_NOISE	L2 noise estimate	10^9	dB	N	M	1	1	integer8	8	var	var
											Total: var

9.21 MDR (name 'mdr-1a-occultation-data', class 8, subclass 8, 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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
PRED_START_EPOCH	Predicted start epoch of the measurement from	10^9	s	1	1	1	1	uinteger8	8	8	38

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	occultation table										
PRED_END_EPOCH	Predicted end epoch of the measurement from occultation table	10^9	s	1	1	1	1	uinteger8	8	8	46
MEASUREMENT_ID	Measurement identification			1	1	1	1	string	32	32	54
ID_FAILED	Measurement identification failed			1	1	1	1	boolean	1	1	86
MEASUREMENT_LENGTH	Measurement length		s	1	1	1	1	uinteger2	2	2	87
GRAS_MODE	Navigation or occultation mode			1	1	1	1	boolean	1	1	89
MEASUREMENT_TYPE	Rising, setting, or navigation			1	1	1	1	enumerated	1	1	90
GRAS_CHANNEL_ID	GRAS channel identification			1	1	1	1	enumerated	1	1	91
GPS_OCC_ID	Occulting GPS identification			1	1	1	1	uinteger1	1	1	92
GPS_HW_DELAY	Estimated GPS hardware group delay	10^15	s	1	1	1	1	integer8	8	8	93
GPS_HW_COR_CA	GPS hardware delay correction for CA code phase	10^9	chips	1	1	1	1	integer8	8	8	101
GPS_HW_COR_P1	GPS hardware delay correction for P1 code phase	10^9	chips	1	1	1	1	integer8	8	8	109
GPS_HW_COR_P2	GPS hardware delay correction for P2 code phase	10^9	chips	1	1	1	1	integer8	8	8	117
USO_FREQUENCY	Nominal USO frequency used in the processing	10^9	Hz	1	1	1	1	uinteger8	8	8	125
ANTENNA_REF_POINT_X	Antenna reference point position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	133

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
ANTENNA_REF_POINT_Y	Antenna reference point position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	141
ANTENNA_REF_POINT_Z	Antenna reference point position vector z in SR frame	10^6	m	1	1	1	1	integer8	8	8	149
METOP_COM_VECT_X	Metop CoM position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	157
METOP_COM_VECT_Y	Metop CoM position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	165
METOP_COM_VECT_Z	Metop CoM position vector z in SR frame	10^6	m	1	1	1	1	integer8	8	8	173
CYCLE_SLIP_LIMIT	Lower height limit for cycle slip detection and correction	10^6	m	1	1	1	1	integer8	8	8	181
Q_ANA	Analogue AGC active during measurement			1	1	1	1	boolean	1	1	189
INSTRUMENT_STABLE	USO oven temperature has been stabilized after switch on			1	1	1	1	boolean	1	1	190
USO_TEMPERATURE_START	USO oven temperature at the beginning of the measurement	10^3	degC	1	1	1	1	integer4	4	4	191
USO_TEMPERATURE_END	USO oven temperature at the end of the measurement	10^3	degC	1	1	1	1	integer4	4	4	195
USO_TEMPERATURE_CHANGE	USO oven temperature change during occultation	10^3	degC	1	1	1	1	integer4	4	4	199
METOP_MANOEUVRE	This MDR is affected by a Metop manoeuvre			1	1	1	1	boolean	1	1	203

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
METOP_STEERING_MODE	Metop steering mode during the measurement			1	1	1	1	enumerated	1	1	204
GPS_MANOEUVRE_FLAG	GPS manoeuvre flag			1	1	1	1	boolean	1	1	205
GPS_MANOEUVRE_TIME	Time of the GPS manoeuvre	10^6	s	1	1	1	1	uinteger8	8	8	206
GPS_ECLIPTING	GPS eclipsing			1	1	1	1	boolean	1	1	214
ECLIPSE_TIME	Time of the eclipse	10^6	s	1	1	1	1	uinteger8	8	8	215
L1_CA_AMP_LOW	Number of times when L1-C/A amplitude level is below the specified threshold, T1			1	1	1	1	uinteger2	2	2	223
L1_CA_AMP_LOW_TIME	IMT time stamps corresponding to the times when the amplitude is below threshold	10^9	s	T1	1	1	1	uinteger8	8	var	225
L1_P1_AMP_LOW	Number of times when L1-P1 amplitude level is below the specified threshold, T2			1	1	1	1	uinteger2	2	2	var
L1_P1_AMP_LOW_TIME	IMT time stamps corresponding to the times when the amplitude is below threshold	10^9	s	T2	1	1	1	uinteger8	8	var	var
L2_P2_AMP_LOW	Number of times when L2-P2 amplitude level is below the specified threshold, T3			1	1	1	1	uinteger2	2	2	var
L2_P2_AMP_LOW_TIME	IMT time stamps corresponding to the times when the amplitude is below threshold	10^9	s	T3	1	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L1_CA_NOISE_FLAG	L1-C/A noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L1_P1_NOISE_FLAG	L1-P1 noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L2_P2_NOISE_FLAG	L2-P2 noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L1_CA_PSEUDORANGE_FLAG	L1-C/A pseudorange outside the threshold			1	1	1	1	boolean	1	1	var
L1_P1_PSEUDORANGE_FLAG	L1-P1 pseudorange outside threshold			1	1	1	1	boolean	1	1	var
L2_P2_PSEUDORANGE_FLAG	L2-P2 pseudorange outside the threshold			1	1	1	1	boolean	1	1	var
L2_NOT_TRACKED	Tracking state 15 was not achieved during measurement			1	1	1	1	boolean	1	1	var
MEASUREMENT_INCOMPLETE	Part of the measurement data time sequence missing			1	1	1	1	boolean	1	1	var
RS_DATA_MISSING	Raw sampling mode data missing			1	1	1	1	boolean	1	1	var
ATTITUDE_MISSING	Metop mispointing angles data not available			1	1	1	1	boolean	1	1	var
LOCAL_MULTIPATH	Incidence angle in the high local multipath risk directions			1	1	1	1	boolean	1	1	var
LOCAL_MULTIPATH_SOURCE	Possible source of local multipath based on incidence			1	1	1	1	bitfield (2)	2	2	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	angles										
TELEMETRY_IN_RANGE	All telemetry data in within the specified range			1	1	1	1	bitfield (3)	3	3	var
SA_FLAG	SA flag			1	1	1	1	boolean	1	1	var
NUMBER_OF_SAMPLES	Number of measurement samples, N			1	1	1	1	uinteger4	4	4	var
TIME_IMT	IMT time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	var
TIME_IMT_SAMPLE	IMT time since the measurement start	10^9	s	N	1	1	1	uinteger8	8	var	var
TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
MEASUREMENT_PACKET_TYPE	Type of the measurement packet of the sample (SF,DF,RS)			N	1	1	1	enumerated	1	var	var
SECONDARY_PACKET_TYPE	Type of the measurement packet of the sample (SF,DF,RS) in case of two parallel packet types			N	1	1	1	enumerated	1	var	var
POS_GPS_X	Position vector x of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
POS_GPS_Y	Position vector y of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
POS_GPS_Z	Position vector z of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
VEL_GPS_X	Velocity vector x of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
VEL_GPS_Y	Velocity vector y of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_GPS_Z	Velocity vector z of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_X	Position vector x of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_Y	Position vector y of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_Z	Position vector z of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
VEL_METOP_OBN_X	Velocity vector x of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_METOP_OBN_Y	Velocity vector y of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_METOP_OBN_Z	Velocity vector z of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var
L1_CA_PHASE_MDID	L1-C/A carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L1_P1_PHASE_MDID	L1-P1 carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L2_P2_PHASE_MDID	L2-P2 carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L1_CA_AMPLITUDE_MDID	L1-C/A amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_P1_AMPLITUDE_MDID	L1-P1 amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var
L2_P2_AMPLITUDE_MDID	L2-P2 amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RAY_ZENITH_ANGLE	Incoming ray zenith angle from the antenna normal	10^3	deg	N	1	1	1	uinteger8	8	var	var
RAY_AZIMUTH_ANGLE	Incoming ray azimuth angle	10^3	deg	N	1	1	1	uinteger8	8	var	var
ANTENNA_PHASE_CORRECTION_L1_CA	Antenna carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_PHASE_CORRECTION_L1_P1	Antenna carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_PHASE_CORRECTION_L2_P2	Antenna carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
RFCU_PHASE_CORRECTION_L1_CA	RFCU carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var
RFCU_PHASE_CORRECTION_L1_P1	RFCU carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
RFCU_PHASE_CORRECTION_L2_P2	RFCU carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L1_CA	GEU carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L1_P1	GEU carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L2_P2	GEU carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L1_CA	Antenna amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L1_P1	Antenna amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L2_P2	Antenna amplitude correction	10^9		N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	for L2-P2										
RFCU_AMPLITUDE_CORRECTION_L1_CA	RFCU amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
RFCU_AMPLITUDE_CORRECTION_L1_P1	RFCU amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var
RFCU_AMPLITUDE_CORRECTION_L2_P2	RFCU amplitude correction for L2-P2	10^9		N	1	1	1	integer8	8	var	var
GEU_AMPLITUDE_CORRECTION_L1_CA	GEU amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
GEU_AMPLITUDE_CORRECTION_L1_P1	GEU amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var
GEU_AMPLITUDE_CORRECTION_L2_P2	GEU amplitude correction for L2-P2	10^9		N	1	1	1	integer8	8	var	var
USO_FREQUENCY_CORRECTION	USO frequency correction	10^9	Hz	N	1	1	1	integer8	8	var	var
USO_FREQUENCY_COMP	USO frequency after the correction	10^9	Hz	N	1	1	1	integer8	8	var	var
L1_CA_PHASE	L1-C/A carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_P1_PHASE	L1-P1 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L2_P2_PHASE	L2-P2 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_CA_AMPLITUDE	L1-C/A amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_P1_AMPLITUDE	L1-P1 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L2_P2_AMPLITUDE	L2-P2 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_NOISE	L1 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
L2_NOISE	L2 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
NUMBER_OF_SAMPLES_CP	Number of code phase measurement samples, M			1	1	1	1	uinteger4	4	4	var
TIME_IMT_CP	IMT time stamp of the sample	10^9	s	M	1	1	1	uinteger8	8	var	var
TIME_IMT_SAMPLE_CP	IMT time since the measurement start	10^9	s	M	1	1	1	uinteger8	8	var	var
ANA	Analogue gain setting value		dB	M	1	1	1	integer2	2	var	var
L1_CA_CODE_PHASE_MDID	L1-C/A code phase uncorrected	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_P1_CODE_PHASE_MDID	L1-P1 code phase uncorrected	10^9	chips	M	1	1	1	uinteger8	8	var	var
L2_P2_CODE_PHASE_MDID	L2-P2 code phase uncorrected	10^9	chips	M	1	1	1	uinteger8	8	var	var
RFCU_CP_CORRECTION_L1_CA	RFCU code phase correction for L1-C/A	10^9	chips	M	1	1	1	integer8	8	var	var
RFCU_CP_CORRECTION_L1_P1	RFCU code phase correction for L1-P1	10^9	chips	M	1	1	1	integer8	8	var	var
RFCU_CP_CORRECTION_L2_P2	RFCU code phase correction for L2-P2	10^9	chips	M	1	1	1	integer8	8	var	var
GEU_CP_CORRECTION_L1_CA	GEU code phase correction for L1-C/A	10^9	chips	M	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
GEU_CP_CORRECTION_L1_P1	GEU code phase correction for L1-P1	10^9	chips	M	1	1	1	integer8	8	var	var
GEU_CP_CORRECTION_L2_P2	GEU code phase correction for L2-P2	10^9	chips	M	1	1	1	integer8	8	var	var
L1_CA_CODE_PHASE	L1-C/A code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_P1_CODE_PHASE	L1-P1 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L2_P2_CODE_PHASE	L2-P2 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_CA_PSEUDORANGE	L1-C/A pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
L1_P1_PSEUDORANGE	L1-P1 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
L2_P2_PSEUDORANGE	L2-P2 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
NUMBER_OF_SAMPLES_RS	Number of samples in a raw sampling mode, K			1	1	1	1	uinteger8	8	8	var
TIME_IMT_SAMPLE_RS	IMT time stamp of the sample	10^9	s	K	1	1	1	uinteger8	8	var	var
P_1_RS	L1 NCO phase of first sample			K	1	1	1	integer8	8	var	var
F1_1_RS	L1 NCO frequency setting for L1 carrier during sequence 1 in this packet			K	1	1	1	integer4	4	var	var
TINT1_RS	Total integration time from			K	1	1	1	uinteger4	4	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	IMT when F1_1 is valid until F2_1 is set										
F2_1_RS	L1 NCO frequency setting for L1 carrier during sequence 2 in this packet			K	1	1	1	integer4	4	var	var
TINT2_RS	Total integration time from IMT+TINT1 when F2_1 is valid until the last measurement of the packet			K	1	1	1	uinteger4	4	var	var
IQ_CA_EXP_RS	Exponent of I/Q samples			K	1	1	1	uinteger2	2	var	var
I_CA_RS	I sample of L1 carrier amplitude in terms of normalised counts of the C/A punctual correlation value			K	1	1	1	integer2	2	var	var
Q_CA_RS	Q sample of L1 carrier amplitude in terms of normalised counts of the C/A punctual correlation value			K	1	1	1	integer2	2	var	var
L1_PHASE_RS	L1 carrier phase after instrument correction	10^9	m	K	1	1	1	integer8	8	var	var
L1_AMPLITUDE_RS	L1 amplitude after instrument correction	10^9	dBV	K	1	1	1	integer8	8	var	var
L1_NOISE_RS	L1 noise estimate	10^9	dB	K	1	1	1	integer8	8	var	var
											Total: var

9.22 MDR (name 'mdr-1a-navigation-data', class 8, subclass 9, 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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
PRED_START_EPOCH	Predicted start epoch of the measurement from occultation table	10^6	s	1	1	1	1	uinteger8	8	8	38
PRED_END_EPOCH	Predicted end epoch of the measurement from occultation table	10^6	s	1	1	1	1	uinteger8	8	8	46
MEASUREMENT_ID	Measurement identification			1	1	1	1	string	32	32	54
ID_FAILED	Measurement identification failed			1	1	1	1	boolean	1	1	86
MEASUREMENT_LENGTH	Measurement length		s	1	1	1	1	uinteger2	2	2	87
GRAS_MODE	Navigation or occultation			1	1	1	1	boolean	1	1	89

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	mode										
MEASUREMENT_TYPE	Rising, setting, or navigation			1	1	1	1	enumerated	1	1	90
GRAS_CHANNEL_ID	GRAS channel identification			1	1	1	1	enumerated	1	1	91
GPS_ID	GPS identification			1	1	1	1	uinteger1	1	1	92
GPS_HW_DELAY	Estimated GPS hardware group delay	10^15	s	1	1	1	1	integer8	8	8	93
GPS_HW_COR_CA	GPS hardware delay correction for CA code phase	10^9	chips	1	1	1	1	integer8	8	8	101
GPS_HW_COR_P1	GPS hardware delay correction for P1 code phase	10^9	chips	1	1	1	1	integer8	8	8	109
GPS_HW_COR_P2	GPS hardware delay correction for P2 code phase	10^9	chips	1	1	1	1	integer8	8	8	117
USO_FREQUENCY	Nominal USO frequency used in the processing	10^9	Hz	1	1	1	1	uinteger8	8	8	125
ANTENNA_REF_POINT_X	Antenna reference point position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	133
ANTENNA_REF_POINT_Y	Antenna reference point position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	141
ANTENNA_REF_POINT_Z	Antenna reference point position vector z in SR frame	10^6	m	1	1	1	1	integer8	8	8	149
METOP_COM_VECT_X	Metop CoM position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	157
METOP_COM_VECT_Y	Metop CoM position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	165
METOP_COM_VECT_Z	Metop CoM position vector z	10^6	m	1	1	1	1	integer8	8	8	173

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	in SR frame										
Q_ANA	Analogue AGC active during measurement			1	1	1	1	boolean	1	1	181
INSTRUMENT_STABLE	USO oven temperature has been stabilized after switch on			1	1	1	1	boolean	1	1	182
USO_TEMPERATURE_START	USO oven temperature at the beginning of the measurement	10^3	degC	1	1	1	1	integer4	4	4	183
USO_TEMPERATURE_END	USO oven temperature at the end of the measurement	10^3	degC	1	1	1	1	integer4	4	4	187
USO_TEMPERATURE_CHANGE	USO oven temperature change during measurement	10^3	degC	1	1	1	1	integer4	4	4	191
METOP_MANOEUVRE	This MDR is affected by a Metop manoeuvre			1	1	1	1	boolean	1	1	195
METOP_STEERING_MODE	Metop steering mode during the measurement			1	1	1	1	enumerated	1	1	196
GPS_MANOEUVRE_FLAG	Measured GPS manoeuvre flag			1	1	1	1	boolean	1	1	197
GPS_MANOEUVRE_TIME	Time of the GPS manoeuvre	10^6	s	1	1	1	1	uinteger8	8	8	198
GPS_ECLIPTING	Measured GPS eclipsing			1	1	1	1	boolean	1	1	206
ECLIPSE_TIME	Time of the eclipse	10^6	s	1	1	1	1	uinteger8	8	8	207
L1_CA_AMP_LOW	Number of times when L1-C/A amplitude level is below the specified threshold, T1			1	1	1	1	uinteger2	2	2	215
L1_CA_AMP_LOW_TIME	IMT time stamps	10^9	s	T1	1	1	1	uinteger8	8	var	217

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	corresponding to the times when the amplitude is below threshold										
L1_P1_AMP_LOW	Number of times when L1-P1 amplitude level is below the specified threshold, T2			1	1	1	1	uinteger2	2	2	var
L1_P1_AMP_LOW_TIME	IMT time stamps corresponding to the times when the amplitude is below threshold	10^9	s	T2	1	1	1	uinteger8	8	var	var
L2_P2_AMP_LOW	Number of times when L2-P2 amplitude level is below the specified threshold, T3			1	1	1	1	uinteger2	2	2	var
L2_P2_AMP_LOW_TIME	IMT time stamps corresponding to the times when the amplitude is below threshold	10^9	s	T3	1	1	1	uinteger8	8	var	var
L1_CA_NOISE_FLAG	L1-C/A noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L1_P1_NOISE_FLAG	L2-P2 noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L2_P2_NOISE_FLAG	L2-Y noise level compared to a threshold			1	1	1	1	boolean	1	1	var
L1_CA_PSEUDORANGE_FLAG	L1-C/A pseudorange outside the threshold			1	1	1	1	boolean	1	1	var
L1_P1_PSEUDORANGE_FLAG	L2-P2 pseudorange outside threshold			1	1	1	1	boolean	1	1	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L2_P2_PSEUDORANGE_FLAG	L2-Y pseudorange outside the threshold			1	1	1	1	boolean	1	1	var
L2_NOT_TRACKED	Tracking state 15 was not achieved during measurement			1	1	1	1	boolean	1	1	var
MEASUREMENT_INCOMPLETE	Part of the measurement data time sequence missing			1	1	1	1	boolean	1	1	var
ATTITUDE_MISSING	Metop mispointing angles data not available			1	1	1	1	boolean	1	1	var
LOCAL_MULTIPATH	Incidence angle in the high local multipath risk directions			1	1	1	1	boolean	1	1	var
LOCAL_MULTIPATH_SOURCE	Possible source of local multipath based on incidence angles			1	1	1	1	bitfield (2)	2	2	var
TELEMETRY_IN_RANGE	All telemetry data in within the specified range			1	1	1	1	bitfield (3)	3	3	var
SA_FLAG	SA flag			1	1	1	1	boolean	1	1	var
NUMBER_OF_SAMPLES	Number of measurement samples, N			1	1	1	1	uinteger4	4	4	var
TIME_IMT	IMT time stamp of the sample	10^9	s	N	1	1	1	uinteger8	8	var	var
TIME_IMT_SAMPLE	IMT time since the measurement start	10^9	s	N	1	1	1	uinteger8	8	var	var
TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
MEASUREMENT_PACKET_TYPE	Type of the measurement			N	1	1	1	enumerated	1	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	packet of the sample (SF,DF,RS)										
SECONDARY_PACKET_TYPE	Type of the measurement packet of the sample (SF,DF,RS) in case of two parallel packet types			N	1	1	1	enumerated	1	var	var
POS_GPS_X	Position vector x of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
POS_GPS_Y	Position vector y of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
POS_GPS_Z	Position vector z of the GPS CoM	10^6	m	N	1	1	1	integer8	8	var	var
VEL_GPS_X	Velocity vector x of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_GPS_Y	Velocity vector y of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_GPS_Z	Velocity vector z of the GPS CoM	10^6	m/s	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_X	Position vector x of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_Y	Position vector y of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
POS_METOP_OBN_Z	Position vector z of Metop from GOBS	10^6	m	N	1	1	1	integer8	8	var	var
VEL_METOP_OBN_X	Velocity vector x of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
VEL_METOP_OBN_Y	Velocity vector y of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var
VEL_METOP_OBN_Z	Velocity vector z of Metop from GOBS	10^6	m/s	N	1	1	1	integer8	8	var	var
L1_CA_PHASE_MDID	L1-C/A carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L1_P1_PHASE_MDID	L1-P1 carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L2_P2_PHASE_MDID	L2-P2 carrier phase uncorrected	10^9	cycles	N	1	1	1	integer8	8	var	var
L1_CA_AMPLITUDE_MDID	L1-C/A amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_P1_AMPLITUDE_MDID	L1-P1 amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var
L2_P2_AMPLITUDE_MDID	L2-P2 amplitude uncorrected	10^9	dBV	N	1	1	1	integer8	8	var	var
RAY_ZENITH_ANGLE	Incoming ray zenith angle from the antenna normal	10^3	deg	N	1	1	1	uinteger8	8	var	var
RAY_AZIMUTH_ANGLE	Incoming ray azimuth angle	10^3	deg	N	1	1	1	uinteger8	8	var	var
ANTENNA_PHASE_CORRECTION_L1_CA	Antenna carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_PHASE_CORRECTION_L1_P1	Antenna carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_PHASE_CORRECTION_L2_P2	Antenna carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
RFCU_PHASE_CORRECTION_L1_CA	RFCU carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RFCU_PHASE_CORRECTION_L1_P1	RFCU carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
RFCU_PHASE_CORRECTION_L2_P2	RFCU carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L1_CA	GEU carrier phase correction for L1-C/A	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L1_P1	GEU carrier phase correction for L1-P1	10^9	m	N	1	1	1	integer8	8	var	var
GEU_PHASE_CORRECTION_L2_P2	GEU carrier phase correction for L2-P2	10^9	m	N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L1_CA	Antenna amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L1_P1	Antenna amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var
ANTENNA_AMPLITUDE_CORRECTION_L2_P2	Antenna amplitude correction for L2-P2	10^9		N	1	1	1	integer8	8	var	var
RFCU_AMPLITUDE_CORRECTION_L1_CA	RFCU amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
RFCU_AMPLITUDE_CORRECTION_L1_P1	RFCU amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var
RFCU_AMPLITUDE_CORRECTION_L2_P2	RFCU amplitude correction for L2-P2	10^9		N	1	1	1	integer8	8	var	var
GEU_AMPLITUDE_CORRECTION_L1_CA	GEU amplitude correction for L1-C/A	10^9		N	1	1	1	integer8	8	var	var
GEU_AMPLITUDE_CORRECTION_L1_P1	GEU amplitude correction for L1-P1	10^9		N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
GEU_AMPLITUDE_CORRECTION_L2_P2	GEU amplitude correction for L2-P2	10^9		N	1	1	1	integer8	8	var	var
USO_FREQUENCY_CORRECTION	USO frequency correction	10^9	Hz	N	1	1	1	integer8	8	var	var
USO_FREQUENCY_COMP	USO frequency after the correction	10^9	Hz	N	1	1	1	integer8	8	var	var
L1_CA_PHASE	L1-C/A carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_P1_PHASE	L1-P1 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L2_P2_PHASE	L2-P2 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_CA_AMPLITUDE	L1-C/A amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_P1_AMPLITUDE	L1-P1 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L2_P2_AMPLITUDE	L2-P2 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_NOISE	L1 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
L2_NOISE	L2 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
NUMBER_OF_SAMPLES_CP	Number of code phase measurement samples, M			1	1	1	1	uinteger4	4	4	var
TIME_IMT_CP	IMT time stamp of the sample	10^9	s	M	1	1	1	uinteger8	8	var	var
TIME_IMT_SAMPLE_CP	IMT time since the measurement start	10^9	s	M	1	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
ANA	Analogue gain setting value		dB	M	1	1	1	integer2	2	var	var
L1_CA_CODE_PHASE	L1-C/A code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_P1_CODE_PHASE	L1-P1 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L2_P2_CODE_PHASE	L2-P2 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_CA_PSEUDORANGE	L1-C/A pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
L1_P1_PSEUDORANGE	L1-P1 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
L2_P2_PSEUDORANGE	L2-P2 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
RFCU_CP_CORRECTION_L1_CA	RFCU code phase correction for L1-C/A	10^9	chips	M	1	1	1	integer8	8	var	var
RFCU_CP_CORRECTION_L1_P1	RFCU code phase correction for L1-P1	10^9	chips	M	1	1	1	integer8	8	var	var
RFCU_CP_CORRECTION_L2_P2	RFCU code phase correction for L2-P2	10^9	chips	M	1	1	1	integer8	8	var	var
GEU_CP_CORRECTION_L1_CA	GEU code phase correction for L1-C/A	10^9	chips	M	1	1	1	integer8	8	var	var
GEU_CP_CORRECTION_L1_P1	GEU code phase correction for L1-P1	10^9	chips	M	1	1	1	integer8	8	var	var
GEU_CP_CORRECTION_L2_P2	GEU code phase correction for L2-P2	10^9	chips	M	1	1	1	integer8	8	var	var
L1_CA_CODE_PHASE_MDID	L1-C/A code phase	10^9	chips	M	1	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	uncorrected										
L1_P1_CODE_PHASE_MDID	L1-P1 code phase uncorrected	10^9	chips	M	1	1	1	uinteger8	8	var	var
L2_P2_CODE_PHASE_MDID	L2-P2 code phase uncorrected	10^9	chips	M	1	1	1	uinteger8	8	var	var
											Total: var

9.23 MDR (name 'mdr-1a-nav-frame', class 8, subclass 10, 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
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											
START_EPOCH	Epoch of the MDR start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the MDR end	10^9	s	1	1	1	1	uinteger8	8	8	30
GPS_ID	GPS identification			1	1	1	1	uinteger1	1	1	38
GRAS_CHANNEL_ID	GRAS channel identification			1	1	1	1	enumerated	1	1	39
NUMBER_OF_SAMPLES	Number of packets, N			1	1	1	1	uinteger2	2	2	40

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
TIME_IMT	IMT time stamp of the bit string	10^9	s	N	1	1	1	uinteger8	8	var	42
UNUSED_BITS	Number of unused bits in the last 16-bit words of the packet			N	1	1	1	uinteger1	1	var	var
NUMBER_OF_BIT_STRINGS	Number of navigation data bit strings in a packet, M			N	1	1	1	uinteger4	4	var	var
NDF_BITS	Navigation message data bit string			M	N	1	1	bitfield (8)	8	var	var
											Total: var

9.24 MDR (name 'mdr-1a-gras-monitoring', class 8, subclass 11, 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
GRAS_Monitoring											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
NUMBER_OF_EPOCHS	Number of monitoring data epochs, N			1	1	1	1	uinteger4	4	4	38
TIME_IMT	IMT time stamp of the samples	10^9	s	N	1	1	1	uinteger8	8	var	42

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
ENGINEERING_PARAMETER_1	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_2	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_3	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_4	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_5	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_6	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_7	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_8	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_9	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_10	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
											Total: var

Enumeration DISPOSITION_MODE

Value	Name	Description
T	Testing	
O	Operational	
C	Commissioning	

Enumeration EARTH_MODEL_ID

Value	Name	Description
0	Not used	
1	WGS84 ellipsoid model	

Enumeration GRAS_CHANNEL_ID

Value	Name	Description
0	Zenith chain 0	
1	Zenith chain 1	
2	Zenith chain 2	
3	Zenith chain 3	
4	Zenith chain 4	
5	Zenith chain 5	
6	Zenith chain 6	
7	Zenith chain 7	
8	Velocity chain 8	

9	Velocity chain 9	
10	Anti-velocity chain 10	
11	Anti-velocity chain 11	

Enumeration GRAS_ID

Value	Name	Description
0	Not used	
1	GRAS 1	
2	GRAS 2	
3	GRAS 3	

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 MEASUREMENT_TYPE

Value	Name	Description
0	Rising	Rising occultation
1	Setting	Setting occultation
2	Navigation	Navigation measurement
3	Spare	

Enumeration METOP_STEERING_MODE

Value	Name	Description
0	Rate Reduction Mode	
1	Coarse Acquisition Mode	
2	Fine Acquisition Mode 1	
3	Fine Acquisition Mode 2	
4	Fine Acquisition Mode 3	
5	Operational Mode	
6	Fine Pointing Mode	
7	Yaw Steering Mode	
8	Orbit Control Mode	
9	Fine Control Mode	
10	Safe Mode	

Enumeration PROCESSING_CENTRE

Value	Name	Description
CGS1		First EUMETSAT EPS Core Ground Segment
CGS2		Second EUMETSAT EPS Core Ground Segment
CGS3		Third 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'

Enumeration AVALS

Value	Name	Description
0	Inside window	
1	Above windows	
2	Below window	
3	Automatic gain control disabled	

Enumeration AVANA

Value	Name	Description
5	0	Analogue Gain Setting values obtained from the AGGA
9	-5	
6	-10	
10	-15	

Enumeration C2

Value	Name	Description
0	Reserved	
1	P code ON	
2	CA code ON	

Enumeration MEASUREMENT_PACKET_TYPE

Value	Name	Description
0	Not packet	
1	DF	Double Frequency
2	SF	Single Frequency
3	RS	Raw Sampling
4	Spare	

Enumeration ONBOARD_NAV_SOLUTION

Value	Name	Description
0	Not navigation solution	
1	Propagated initial settings	
2	First-fix	
4	Calculated with least square	
5	Calculated with Kalman filter	
7	Invalid navigation solution	An invalid navigation solution will be indicated if least square is used and less than 4 satellites are in the field-of-view of the zenith antenna. The reported navigation solution will be the propagated one.

Enumeration SECONDARY_PACKET_TYPE

Value	Name	Description
0	Not packet	
1	DF	Double Frequency
2	SF	Single Frequency
3	RS	Raw Sampling
4	Spare	

Enumeration SH

Value	Name	Description
0	All signals OK	
1	All signals weak	
2	All signals dead	
3	All signals have no data modulation	
4	L1P signal weak	
5	L1P signal dead	
6	L1P signal has no data modulation	
7	L2P signal weak	
8	L2P signal dead	
9	L2P signal has no data modulation	
10	L1C signal weak	
11	L1C signal dead	

12	L1C signal has no data modulation	
13	L2C signal weak	
14	L2C signal dead	
15	L2C signal has no data modulation	
16	L1 and L2P signal weak	
17	L1 and L2P signal dead	
18	L1 and L2P signal has no data modulation	
19	L1 and L2C signal weak	
20	L1 and L2C signal dead	
21	L1 and L2C signal has no data modulation	
22	L1 signal weak	
23	L1 signal dead	
24	L1 signal has no data modulation	
25	L2 signal weak	
26	L2 signal dead	
27	L2 signal has no data modulation	
28	SV is temporarily out	Do not use this SV during current pass
29	SV will be temporarily out	Use with caution
30	Spare	
31	More than one combination would be required to describe anomalies	

Enumeration VALS

Value	Name	Description
0	Inside window	
1	Above windows	
2	Below window	
3	Automatic gain control disabled	

Enumeration VANA

Value	Name	Description
5	0	Analogue Gain Setting values obtained from the AGGA
9	-5	
6	-10	
10	-15	

Enumeration ZALS

Value	Name	Description
0	Inside window	
1	Above windows	
2	Below window	
3	Automatic gain control disabled	

Enumeration ZANA

Value	Name	Description
5	0	Analogue Gain Setting values obtained from the AGGA
9	-5	
6	-10	
10	-15	

Bitfield LOCAL_MULTIPATH_SOURCE

Length 2 bytes

Name	Description	Length
Spare		13
ASCAT_ANT_RF_in_the_FOV	0=outside FOV, 1=inside FOV	1
ASCAT_ANT_RA_in_the_FOV	0=outside FOV, 1=inside FOV	1
Metop_solar_panel_in_the_FOV	0=outside FOV, 1=inside FOV	1
Total		16

Bitfield TELEMETRY_IN_RANGE

Length 3 bytes

Name	Description	Length
Spare		3
Digital_5_V	0 - Within range 1 - Outside range	1
USO_ground	0 - Within range 1 - Outside range	1

FG_thermistor	0 - Within range 1 - Outside range	1
Thermistor_supply_voltage	0 - Within range 1 - Outside range	1
DBU_power_voltage	0 - Within range 1 - Outside range	1
USO_external_thermistor	0 - Within range 1 - Outside range	1
USO_internal_thermistor	0 - Within range 1 - Outside range	1
ISAC_thermistor	0 - Within range 1 - Outside range	1
GEU_thermistor	0 - Within range 1 - Outside range	1
Anti_velocity_RFCU_thermistor	0 - Within range 1 - Outside range	1
Velocity_RFCU_thermistor	0 - Within range 1 - Outside range	1
Zenith_RFCU_thermistor	0 - Within range 1 - Outside range	1
Anti_velocity_antenna_thermistor	0 - Within range 1 - Outside range	1
Velocity_antenna_thermistor	0 - Within range 1 - Outside range	1
Zenith_antenna_thermistor	0 - Within range 1 - Outside range	1
ENDP_Velocity_Z	0 - Within range 1 - Outside range	1
ENDP_Velocity_Y	0 - Within range 1 - Outside range	1
ENDP_Velocity_X	0 - Within range 1 - Outside range	1
ENDP_Position_Z	0 - Within range 1 - Outside range	1
ENDP_Position_Y	0 - Within range 1 - Outside range	1
ENDP_Position_X	0 - Within range 1 - Outside range	1
Total		24

Bitfield AVDIG

Length 6 bytes

Name	Description	Length
CCT_5		8
CCT_4		8
CCT_3		8
CCT_2		8
CCT_1		8
CCT_0		8
Total		48

Bitfield CH0_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1

undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH10_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1

undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH11_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1

undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH1_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1

undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH2_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1

L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH3_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1

C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH4_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1

C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH5_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1

Acquisition_and_tracking_ended		1
Total		16

Bitfield CH6_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1

Total		16

Bitfield CH7_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH8_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield CH9_TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield GEU_STS

Length 1 bytes

Name	Description	Length
RFCU_Velocity_chain_RFCU_status	0=off, 1=on	1
RFCU_Zenith_chain_RFCU_status	0=off, 1=on	1
RFCU_Anti_velocity_chain_RFCU_status	0=off, 1=on	1
USO_Oven_Relay_Status	0=off, 1=on	1
SC_Frequency_Generator_PLL_LOCK_status	0=off, 1=on	1
LO_Frequency_Generator_PLL_LOCK_status	0=off, 1=on	1
Not_used		2
Total		8

Bitfield NDF_BITS

Length 8 bytes

Name	Description	Length
NDF bits	Navigation Data Frame bits as received from the GPS satellite (optional)	64
Total		64

Bitfield TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1
undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Bitfield VDIG

Length 6 bytes

Name	Description	Length
CCT_5		8
CCT_4		8
CCT_3		8
CCT_2		8
CCT_1		8
CCT_0		8
Total		48

Bitfield ZDIG

Length 6 bytes

Name	Description	Length
CCT_5		8
CCT_4		8
CCT_3		8
CCT_2		8
CCT_1		8
CCT_0		8
Total		48

10 RECORD DESCRIPTION OF THE GRAS LEVEL 1B PRODUCTS

This GRAS 1a description corresponds to the GRAS Level 1 PFS [RD6] Issue v7B and the Generic PFS [RD3] Issue v7B.

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

- (yellow) 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.
- (green) 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
viadr-1b-gps-pod	3
viadr-1b-gps-clock	3
viadr-1b-tzd	3
viadr-1b-station-clock	3
viadr-1b-metop-pod	3
viadr-1b-metop-clock	3
viadr-1b-eop	5
viadr-1b-metop-attitude	3

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 1, version 3)
- VIADR (name 'viadr-1b-gps-pod', class 7, subclass 21, version 3)
- VIADR (name 'viadr-1b-gps-clock', class 7, subclass 22, version 3)
- VIADR (name 'viadr-1b-tzd', class 7, subclass 23, version 3)
- VIADR (name 'viadr-1b-station-clock', class 7, subclass 24, version 3)
- VIADR (name 'viadr-1b-metop-pod', class 7, subclass 25, version 3)
- VIADR (name 'viadr-1b-metop-clock', class 7, subclass 26, version 3)
- VIADR (name 'viadr-1b-eop', class 7, subclass 27, version 5)
- VIADR (name 'viadr-1b-metop-attitude', class 7, subclass 28, version 3)
- MDR (name 'mdr-1b', class 8, subclass 20, 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 [RD3].

Note: An entry of 'var' in the 'Field size' or 'Offset' columns below indicates that the entry cannot be specified exactly because of variable dimensions. To compute field sizes and offsets, please see the PFS [RD6] for more detailed information.

10.1 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
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			1	1	1	1	string	67	100	420

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	appropriate, this field is filled with lower case x's.										
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 this object (PDU, ROI or Full Product)			1	1	1	1	time	15	48	748
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

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
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
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		UTC	1	1	1	1	longtime	18	51	1497

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	elements and the orbit state vector. this corresponds to the time of crossing the ascending node for ORBIT_START										
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 ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1724
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	10^3	m/s	1	1	1	1	integer	11	44	1944

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	node										
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
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

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
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 product			1	1	1	1	uinteger	6	39	2760
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			1	1	1	1	uinteger	6	39	2916

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	product										
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 the product		ms	1	1	1	1	uinteger	8	41	3191
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 UMARF			1	1	1	1	boolean	1	34	3273

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	GIADRs in GAD section for product retrieved from UMARF.										
											Total: 3307

10.2 SPHR (name 'sphr', class 2, 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
GOBS_VER	Gras Onboard Software version number			1	1	1	1	string	40	73	20
GRAS_ID	GRAS instrument identification			1	1	1	1	enumerated	3	36	93
EARTH_MODEL_ID	Earth model identification			1	1	1	1	enumerated	3	36	129
METOP_MANOEUVRE_FLAG	Metop manoeuvre flag			1	1	1	1	boolean	1	34	165
METOP_MANOEUVRE_START	Start time of the manoeuvre		s	1	1	1	1	longtime	18	51	199
METOP_MANOEUVRE_END	End time of the manoeuvre		s	1	1	1	1	longtime	18	51	250
MANOEUVRE_IMP_END	Time from the end of the manoeuvre after which the manoeuvre does not any more affect the MDRs		s	1	1	1	1	integer	10	43	301
											Total: 344

10.3 VIADR (name 'viadr-1b-gps-pod', class 7, subclass 21, 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
Occulting_GPS_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time interval of the state vector samples		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of satellites used in the POD solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_SATELLITES	Number of GPS satellites, N			1	1	1	1	uinteger1	1	1	40
GPS_ID	GPS satellite identification			N	1	1	1	uinteger1	1	var	41
X_POSITION_UNCERTAINTY	Satellite position x coordinate uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
Y_POSITION_UNCERTAINTY	Satellite position y coordinate uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
Z_POSITION_UNCERTAINTY	Satellite position z coordinate uncertainty	10^6	m	N	1	1	1	integer8	8	var	var
X_VELOCITY_UNCERTAINTY	Satellite velocity x uncertainty	10^6	m/s	N	1	1	1	integer8	8	var	var
Y_VELOCITY_UNCERTAINTY	Satellite velocity y	10^6	m/s	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	uncertainty										
Z_VELOCITY_UNCERTAINTY	Satellite velocity z uncertainty	10^6	m/s	N	1	1	1	integer8	8	var	var
CLOCK_OFFSET_UNCERTAINTY	Satellite transmitter clock offset uncertainty	10^9	s	N	1	1	1	integer8	8	var	var
CLOCK_DRIFT_UNCERTAINTY	Satellite transmitter clock rate of change uncertainty	10^9	s/s	N	1	1	1	integer8	8	var	var
NUMBER_OF_EPOCHS	Number of epochs for each GPS satellite, M			N	1	1	1	uinteger2	2	var	var
GPS_ORBIT_ARC				M	N	1	1	GPS_STATE_VECTOR	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
SATELLITE_POSITION_X	Satellite position x at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Y	Satellite position y at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_POSITION_Z	Satellite position z at epoch time	10^6	m	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_X	Satellite velocity v_x at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Y	Satellite velocity v_y at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
SATELLITE_VELOCITY_Z	Satellite velocity v_z at epoch time	10^6	m/s	1	1	1	1	integer8	8	8	
CLOCK_OFFSET	Clock offset	10^9	s	1	1	1	1	integer8	8	8	
CLOCK_DRIFT	Satellite transmitter clock rate	10^9	s/s	1	1	1	1	integer8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	of change										
											Total: var

10.4 VIADR (name 'viadr-1b-gps-clock', class 7, subclass 22, 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
GPS_clock_bias_estimates											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time interval of the clock offset samples		s	1	1	1	1	uinteger2	2	2	36
GPS_NUMBER	Number of satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_SATELLITES	Number of GPS satellites, M			1	1	1	1	uinteger1	1	1	40
GPS_ID	GPS satellite identification			M	1	1	1	uinteger1	1	var	41
CLOCK_QUALITY	Quality indicator for each GPS satellite			M	1	1	1	uinteger8	8	var	var
NUM_EPOCHS	Number of clock solution epochs, N			M	1	1	1	integer2	2	var	var
GPS_CLOCK_OFFSETS				N	M	1	1	GPS_CLOCKS	16	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
GPS_CLOCK_OFFSET	Clock offset estimate	10^20	s	1	1	1	1	integer8	8	8	

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

10.5 VIADR (name 'viadr-1b-tzd', class 7, subclass 23, 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
Tropospheric_delay_product											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
STATION_NUMBER	Number of stations in interval			1	1	1	1	uinteger2	2	2	36
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	38
TROPOS_NUMBER_PARAMETERS	Number of tropospheric parameters for the stations			1	1	1	1	uinteger2	2	2	39
TROPOS_ESTIMATE_INTERVAL	Estimation interval	10^6	s	1	1	1	1	uinteger8	8	8	41
NUMBER_OF_STATIONS	Number of fiducial stations, M			1	1	1	1	uinteger2	2	2	49
STATION_ID	Ground station identification			M	1	1	1	string	4	var	51
NUM_EPOCHS	Number of epochs, T			M	1	1	1	uinteger2	2	var	var
STATION_TZD_ESTIMATES				T	M	1	1	TROP_DELAY	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
MEASURED_SURFACE_PRESSURE	Measured surface pressure at	10^3	mbar	1	1	1	1	uinteger8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	the station location										
MEASURED_SURFACE_TEMPERATURE	Measured surface temperature at the station location	10^3	K	1	1	1	1	uinteger8	8	8	
MEASURED_PARTIAL_WV_PRESSURE	Measured partial pressure of the water vapour at surface at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
NWP_SURFACE_PRESSURE	NWP surface pressure at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
NWP_SURFACE_TEMPERATURE	NWP surface temperature at the station location	10^3	K	1	1	1	1	uinteger8	8	8	
NWP_PARTIAL_WV_PRESSURE	Partial pressure of the water vapour at surface at the station location	10^3	mbar	1	1	1	1	uinteger8	8	8	
TROP0S_ZENITH_DELAY	Zenith tropospheric delay estimate from the GSN	10^6	m	1	1	1	1	uinteger8	8	8	
TROPOS_ZENITH_DELAY_UNCERTAINTY	Uncertainty in zenith tropospheric delay estimate	10^6	m	1	1	1	1	integer8	8	8	
											Total: var

10.6 VIADR (name 'viadr-1b-station-clock', class 7, subclass 24, 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

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
Ground_station_clock_bias_estimates											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
ESTIMATE_INTERVAL	Estimation interval for clock bias		s	1	1	1	1	uinteger2	2	2	36
STATION_NUMBER	Number of stations in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
NUMBER_OF_STATIONS	Number of fiducial stations, M			1	1	1	1	uinteger1	1	1	40
STATION_ID	Ground station identification			M	1	1	1	string	4	var	41
CLOCK_QUALITY	Quality indicator for each station			M	1	1	1	uinteger8	8	var	var
NUM_EPOCHS	Number of epochs, E			M	1	1	1	uinteger2	2	var	var
STATION_CLOCK_OFFSETS				E	M	1	1	STATION_CLOCKS	72	var	var
EPOCH_TIME	Time stamp in reference time	10^9	s	1	1	1	1	uinteger8	8	8	
STATION_CLOCK_OFFSET	Clock offset	10^20	s	1	1	1	1	integer8	8	8	
STATION_CLOCK_DRIFT	Clock drift	10^9	s/s	1	1	1	1	integer8	8	8	
STATION_POSITION_MEASUREMENT_X	Position of measurement point x (ECI)	10^6	m	1	1	1	1	integer8	8	8	

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
STATION_POSITION_MEASUREMENT_Y	Position of measurement point y (ECI)	10^6	m	1	1	1	1	integer8	8	8	
STATION_POSITION_MEASUREMENT_Z	Position of measurement point z (ECI)	10^6	m	1	1	1	1	integer8	8	8	
STATION_VELOCITY_X	Velocity v_x of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
STATION_VELOCITY_Y	Velocity v_y of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
STATION_VELOCITY_Z	Velocity v_z of the measurement point (ECI)	10^6	m/s	1	1	1	1	integer8	8	8	
											Total: var

10.7 VIADR (name 'viadr-1b-metop-pod', class 7, subclass 25, 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
Metop_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time interval of the state vector samples		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of GPS satellites used in POD solution			1	1	1	1	uinteger1	1	1	38

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
X_POSITION_UNCERTAINTY	Satellite position x coordinate uncertainty	10^6	m	1	1	1	1	integer8	8	8	40
Y_POSITION_UNCERTAINTY	Satellite position y coordinate uncertainty	10^6	m	1	1	1	1	integer8	8	8	48
Z_POSITION_UNCERTAINTY	Satellite position z coordinate uncertainty	10^6	m	1	1	1	1	integer8	8	8	56
X_VELOCITY_UNCERTAINTY	Satellite velocity x uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	64
Y_VELOCITY_UNCERTAINTY	Satellite velocity y uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	72
Z_VELOCITY_UNCERTAINTY	Satellite velocity z uncertainty	10^6	m/s	1	1	1	1	integer8	8	8	80
NUMBER_OF_EPOCHS	Number of solution epochs, N			1	1	1	1	uinteger4	4	4	88
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	92
METOP_POSITION_X	Satellite position x vector	10^6	m	N	1	1	1	integer8	8	var	var
METOP_POSITION_Y	Satellite position y vector	10^6	m	N	1	1	1	integer8	8	var	var
METOP_POSITION_Z	Satellite position z vector	10^6	m	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_X	Satellite velocity x at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_Y	Satellite velocity y at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_Z	Satellite velocity z at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
											Total: var

10.8 VIADR (name 'viadr-1b-metop-clock', class 7, subclass 26, 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
Metop_NRT_orbit_arc											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
SAMPLE_INTERVAL	Time interval of the clock offset samples		s	1	1	1	1	uinteger2	2	2	36
NUMBER_SATELLITE	Number of GPS satellites in solution			1	1	1	1	uinteger1	1	1	38
PRODUCT_TYPE	NRT or enhanced POD product			1	1	1	1	enumerated	1	1	39
CLOCK_OFFSET_UNCERTAINTY	Satellite transmitter clock offset uncertainty	10^9	s	1	1	1	1	integer8	8	8	40
CLOCK_DRIFT_UNCERTAINTY	Satellite transmitter clock rate of change uncertainty	10^9	s/s	1	1	1	1	integer8	8	8	48
NUMBER_OF_EPOCHS	Number of solution epochs, N			1	1	1	1	uinteger4	4	4	56
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	60
CLOCK_OFFSET	Clock offset estimate	10^20	s	N	1	1	1	integer8	8	var	var
CLOCK_DRIFT	Satellite transmitter clock rate of change	10^20	s/s	N	1	1	1	integer8	8	var	var
											Total: var

10.9 VIADR (name 'viadr-1b-eop', class 7, subclass 27, version 5)

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
NUM_EPOCHS	Number of EOP epochs, N			1	1	1	1	integer2	2	2	20
Earth_Orientation_Parameters											
EPOCH	Start time of the record validity	10^9	s	N	1	1	1	uinteger8	8	var	22
X_POLE	x-pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
Y_POLE	y-pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DUT1	UT1-UTC	10^6	s	N	1	1	1	integer8	8	var	var
EOP_STATUS	Final or predicted EOP products			N	1	1	1	boolean	1	var	var
D_psi	Celestial pole offset in longitude	10^6	arcsec	N	1	1	1	integer8	8	var	var
D_eps	Celestial pole offset in obliquity	10^6	arcsec	N	1	1	1	integer8	8	var	var
DX_POLE	Uncertainty in X-Pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DY_POLE	Uncertainty in Y-Pole	10^6	arcsec	N	1	1	1	integer8	8	var	var
DLOD	Uncertainty in Length of day (LOD)	10^6	s	N	1	1	1	integer8	8	var	var
											Total: var

10.10 VIADR (name 'viadr-1b-metop-attitude', class 7, subclass 28, 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
Metop_attitude											
START_VALIDITY	Start time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	20

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
END_VALIDITY	End time of the record validity	10^9	s	1	1	1	1	uinteger8	8	8	28
NUMBER_OF_EPOCHS	Number of attitude data epochs, N			1	1	1	1	uinteger4	4	4	36
EPOCH_TIME	Time stamp in reference time	10^9	s	N	1	1	1	uinteger8	8	var	40
METOP_STEERING_MODE	Metop steering mode indicator			N	1	1	1	enumerated	1	var	var
METOP_MISPOINTING_ROLL	Mispointing angle Dh	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_PITCH	Mispointing angles Dx	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_YAW	Mispointing angles Dz	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_TRUE_LATITUDE	Metop true latitude angle	10^3	deg	N	1	1	1	integer8	8	var	var
											Total: var

10.11 MDR (name 'mdr-1b', class 8, subclass 20, 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											
START_EPOCH	Epoch of the measurement start	10^9	s	1	1	1	1	uinteger8	8	8	22

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
END_EPOCH	Epoch of the measurement end	10^9	s	1	1	1	1	uinteger8	8	8	30
PRED_START_EPOCH	Predicted start epoch of the measurement from occultation table	10^6	s	1	1	1	1	uinteger8	8	8	38
PRED_END_EPOCH	Predicted end epoch of the measurement from occultation table	10^6	s	1	1	1	1	uinteger8	8	8	46
PRED_START_LAT	Predicted start latitude of the measurement	10^3	degree	1	1	1	1	integer8	8	8	54
PRED_START_LONG	Predicted start longitude of the measurement	10^3	degree	1	1	1	1	integer8	8	8	62
PRED_END_LAT	Predicted end latitude of the measurement	10^3	degree	1	1	1	1	integer8	8	8	70
PRED_END_LONG	Predicted end longitude of the measurement	10^3	degree	1	1	1	1	integer8	8	8	78
MEASUREMENT_ID	Measurement identification			1	1	1	1	string	32	32	86
ID_FAILED	Measurement identification failed			1	1	1	1	boolean	1	1	118
MEASUREMENT_LENGTH	Measurement length		s	1	1	1	1	uinteger2	2	2	119
GRAS_MODE	Navigation or occultation mode			1	1	1	1	boolean	1	1	121
MEASUREMENT_TYPE	Rising, setting, or navigation			1	1	1	1	enumerated	1	1	122
GRAS_CHANNEL_ID	GRAS channel identification			1	1	1	1	enumerated	1	1	123
GPS_OCC_ID	Occulting GPS identification			1	1	1	1	uinteger1	1	1	124
OCC_GPS_HW_DELAY	Estimated GPS hardware group delay	10^15	s	1	1	1	1	integer8	8	8	125
OCC_GPS_HW_COR_CA	GPS hardware delay correction for CA code phase	10^9	chips	1	1	1	1	integer8	8	8	133
OCC_GPS_HW_COR_P1	GPS hardware delay correction for P1 code phase	10^9	chips	1	1	1	1	integer8	8	8	141

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
OCC_GPS_HW_COR_P2	GPS hardware delay correction for P2 code phase	10^9	chips	1	1	1	1	integer8	8	8	149
GPS_PIV_ID	Pivot GPS identification			1	1	1	1	uinteger1	1	1	157
PIV_GPS_HW_DELAY	Estimated GPS hardware group delay	10^15	s	1	1	1	1	integer8	8	8	158
PIV_GPS_HW_COR_CA	GPS hardware delay correction for CA code phase	10^9	chips	1	1	1	1	integer8	8	8	166
PIV_GPS_HW_COR_P1	GPS hardware delay correction for P1 code phase	10^9	chips	1	1	1	1	integer8	8	8	174
PIV_GPS_HW_COR_P2	GPS hardware delay correction for P2 code phase	10^9	chips	1	1	1	1	integer8	8	8	182
FID_ID_DD1	Reference fiducial station identification for DD1			1	1	1	1	string	4	4	190
FID_ID_DD2	Second reference fiducial station identification for DD2			1	1	1	1	string	4	4	194
LOW_PIV_GZA_SD1	Pivot satellite elevation from GZA is below threshold in SD1 processing			1	1	1	1	boolean	1	1	198
LOW_OCC_FID_SD2	Occulting GPS satellite elevation from fiducial station is below threshold in SD2 processing			1	1	1	1	boolean	1	1	199
LOW_PIV_GZA_DD1	Pivot satellite elevation from GZA is below threshold in DD1 processing			1	1	1	1	boolean	1	1	200
LOW_PIV_FID_DD1	Pivot satellite elevation from fiducial station is below threshold in DD1 processing			1	1	1	1	boolean	1	1	201
LOW_OCC_FID_DD1	Occulting GPS satellite elevation from fiducial station is below			1	1	1	1	boolean	1	1	202

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	threshold in DD1 processing										
LOW_PIV_GZA_DD2	Pivot satellite elevation from GZA is below threshold in DD2 processing			1	1	1	1	boolean	1	1	203
LOW_PIV_FID_DD2	Pivot satellite elevation from fiducial station is below threshold in DD2 processing			1	1	1	1	boolean	1	1	204
LOW_OCC_FID_DD2	Occulting GPS satellite elevation from fiducial station is below threshold in DD2 processing			1	1	1	1	boolean	1	1	205
MEAN_OCCULTATION_RAY_TANGENT_LAT	Mean latitude of the ray tangent point	10^3	degree	1	1	1	1	integer8	8	8	206
MEAN_OCCULTATION_RAY_TANGENT_LONG	Mean longitude of the ray tangent point	10^3	degree	1	1	1	1	integer8	8	8	214
USO_FREQUENCY	Nominal USO frequency used in the processing	10^9	Hz	1	1	1	1	uinteger8	8	8	222
ANTENNA_REF_POINT_X	Antenna reference point position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	230
ANTENNA_REF_POINT_Y	Antenna reference point position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	238
ANTENNA_REF_POINT_Z	Antenna reference point position vector z in SR frame	10^6	m	1	1	1	1	integer8	8	8	246
METOP_COM_VECT_X	Metop CoM position vector x in SR frame	10^6	m	1	1	1	1	integer8	8	8	254
METOP_COM_VECT_Y	Metop CoM position vector y in SR frame	10^6	m	1	1	1	1	integer8	8	8	262
METOP_COM_VECT_Z	Metop CoM position vector z in SR	10^6	m	1	1	1	1	integer8	8	8	270

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	frame										
Q_ANA	Analogue AGC active during measurement			1	1	1	1	boolean	1	1	278
INSTRUMENT_STABLE	USO oven temperature has been stabilized after switch on			1	1	1	1	boolean	1	1	279
USO_TEMPERATURE_START	USO oven temperature at the beginning of the measurement	10^3	degC	1	1	1	1	integer4	4	4	280
USO_TEMPERATURE_END	USO oven temperature at the end of the measurement	10^3	degC	1	1	1	1	integer4	4	4	284
USO_TEMPERATURE_CHANGE	USO oven temperature change during occultation	10^3	degC	1	1	1	1	integer4	4	4	288
METOP_MANOEUVRE	This MDR is affected by a Metop manoeuvre			1	1	1	1	boolean	1	1	292
METOP_STEERING_MODE	Metop steering mode during the measurement			1	1	1	1	enumerated	1	1	293
L1_CA_AMP_LOW	Number of times when L1-C/A amplitude level is below the specified threshold			1	1	1	1	uinteger2	2	2	294
L1_CA_AMP_TIME	Epoch corresponding to the maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^6	s	1	1	1	1	integer8	8	8	296
L1_CA_IMPACT_LIMIT	Maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^9	m	1	1	1	1	integer8	8	8	304

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L1_P1_AMP_LOW	Number of times when L1-P1 amplitude level is below the specified threshold			1	1	1	1	uinteger2	2	2	312
L1_P1_AMP_TIME	Epoch corresponding to the maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^6	s	1	1	1	1	integer8	8	8	314
L1_P1_IMPACT_LIMIT	Maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^9	m	1	1	1	1	integer8	8	8	322
L2_P2_AMP_LOW	Number of times when L2-P2 amplitude level is below the specified threshold			1	1	1	1	uinteger2	2	2	330
L2_P2_AMP_TIME	Epoch corresponding to the maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^6	s	1	1	1	1	integer8	8	8	332
L2_P2_IMPACT_LIMIT	Maximum impact parameter height before the amplitude has been below threshold (from the top of the atmosphere)	10^9	m	1	1	1	1	integer8	8	8	340
L1_CA_NOISE_FLAG	L1-C/A noise level compared to a threshold			1	1	1	1	boolean	1	1	348
L1_P1_NOISE_FLAG	L1-P1 noise level compared to a threshold			1	1	1	1	boolean	1	1	349

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L2_P2_NOISE_FLAG	L2-P2 noise level compared to a threshold			1	1	1	1	boolean	1	1	350
L1_CA_PSEUDORANGE_FLAG	L1-C/A pseudorange outside the threshold			1	1	1	1	boolean	1	1	351
L1_P1_PSEUDORANGE_FLAG	L1-P1 pseudorange outside threshold			1	1	1	1	boolean	1	1	352
L2_P2_PSEUDORANGE_FLAG	L2-P2 pseudorange outside the threshold			1	1	1	1	boolean	1	1	353
USO_TEMP_NOMINAL	USO temperature outside threshold			1	1	1	1	boolean	1	1	354
USO_TEMP_DRIFT_NOMINAL	USO temperature drift outside threshold			1	1	1	1	boolean	1	1	355
L2_NOT_TRACKED	Tracking state 15 was not achieved during measurement			1	1	1	1	boolean	1	1	356
MEASUREMENT_INCOMPLETE	Part of the measurement data time sequence missing			1	1	1	1	boolean	1	1	357
ATTITUDE_MISSING	Metop mispointing angles data not available			1	1	1	1	boolean	1	1	358
RS_DATA_MISSING	Raw sampling mode data missing			1	1	1	1	boolean	1	1	359
LOCAL_MULTIPATH	Incidence angle in the high local multipath risk directions			1	1	1	1	boolean	1	1	360
LOCAL_MULTIPATH_SOURCE	Possible source of local multipath based on incidence angles			1	1	1	1	bitfield (2)	2	2	361
TELEMETRY_IN_RANGE	All telemetry data is within the specified range			1	1	1	1	bitfield (3)	3	3	363
SA_FLAG	Selective Availability flag			1	1	1	1	boolean	1	1	366
A_FLAG	Alert flag			1	1	1	1	boolean	1	1	367

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
AS_FLAG	Anti-spoofing flag			1	1	1	1	boolean	1	1	368
PHASE_L1	Phase residual L1 quality			1	1	1	1	boolean	1	1	369
PHASE_L2	Phase residual L2 quality			1	1	1	1	boolean	1	1	370
DOPPLER_L1	Doppler residual L1 quality			1	1	1	1	boolean	1	1	371
DOPPLER_L2	Doppler residual L2 quality			1	1	1	1	boolean	1	1	372
DOPPLER_RATE_L1	Doppler rate L1 quality			1	1	1	1	boolean	1	1	373
DOPPLER_RATE_L2	Doppler rate L2 quality			1	1	1	1	boolean	1	1	374
DOPPLER_ACC_L1	Doppler acceleration L1 quality			1	1	1	1	boolean	1	1	375
DOPPLER_ACC_L2	Doppler acceleration L2 quality			1	1	1	1	boolean	1	1	376
TEC_QUALITY	TEC quality			1	1	1	1	boolean	1	1	377
TEC_DRIFT	TEC drift quality			1	1	1	1	boolean	1	1	378
TEC_ACC	TEC acceleration quality			1	1	1	1	boolean	1	1	379
BENDING_L1	Bending angle L1 quality			1	1	1	1	boolean	1	1	380
BENDING_L2	Bending angle L2 quality			1	1	1	1	boolean	1	1	381
NEUTRAL_BENDING	Ionosphere corrected bending angle quality			1	1	1	1	boolean	1	1	382
IMPACT_L1	Impact parameter L1 quality			1	1	1	1	boolean	1	1	383
IMPACT_L2	Impact parameter L2 quality			1	1	1	1	boolean	1	1	384
L1_CA_STRAT	L1-CA noise level in stratosphere			1	1	1	1	boolean	1	1	385
L1_P1_STR	L1-P1 noise level in stratosphere			1	1	1	1	boolean	1	1	386
L2_P2_STRAT	L2-P2 noise level in stratosphere			1	1	1	1	boolean	1	1	387
L1_CA_TROP	L1-CA noise level in troposphere			1	1	1	1	boolean	1	1	388
L1_P1_TROP	L1-P1 noise level in troposphere			1	1	1	1	boolean	1	1	389

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L2_P2_TROP	L2-P2 noise level in troposphere			1	1	1	1	boolean	1	1	390
PGE	Probability of Gross Error	10^2		1	1	1	1	uinteger2	2	2	391
ONBOARD_NAV_SOLUTION	Onboard navigation solution method			1	1	1	1	enumerated	1	1	393
SELECTED_CLOCK_CORRECTION_METHOD	Selected clock correction differencing method (ND/SD1/SD2/DD1/DD2)			1	1	1	1	enumerated	1	1	394
CLOCK_CORRECTION_FALLBACK_MODE	Selected clock correction not possible and a fallback mode has been activated			1	1	1	1	bitfield (1)	1	1	395
SSD_AVAILABILITY	Availability of the SSD data			1	1	1	1	bitfield (2)	2	2	396
BE_FLAG	Bias estimation on/off			1	1	1	1	boolean	1	1	398
BE_TYPE	BBE or FBE			1	1	1	1	boolean	1	1	399
BE_MODEL	Atmospheric model used in bias estimation			1	1	1	1	enumerated	1	1	400
BE_HEIGHT	Bias estimation height	10^6	m	1	1	1	1	integer8	8	8	401
BE_WINDOW	Bias estimation window half aperture	10^6	m	1	1	1	1	integer8	8	8	409
BE_BIAS_ESTIMATE	Bias error estimate (note: unit depends on the BE type)	10^9	rad or m/s	1	1	1	1	integer8	8	8	417
LOCAL_CURVATURE_X	Local radius vector of curvature x	10^6	m	1	1	1	1	integer8	8	8	425
LOCAL_CURVATURE_Y	Local radius vector of curvature y	10^6	m	1	1	1	1	integer8	8	8	433
LOCAL_CURVATURE_Z	Local radius vector of curvature z	10^6	m	1	1	1	1	integer8	8	8	441
COORDINATES_OF_CENTRE_REFRACTION_X	Coordinate x of the local centre of refraction	10^6	m	1	1	1	1	integer8	8	8	449
COORDINATES_OF_CENTRE_REFRACTION_Y	Coordinate y of the local centre of refraction	10^6	m	1	1	1	1	integer8	8	8	457

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
COORDINATES_OF_CENTRE_REFRACTION_Z	Coordinate z of the local centre of refraction	10^6	m	1	1	1	1	integer8	8	8	465
OCCULTING_GPS_MANOEUVRE	Occulting GPS manoeuvre flag			1	1	1	1	boolean	1	1	473
GPS_MANOEUVRE_TIME	Time of the occulting GPS manoeuvre	10^6	s	1	1	1	1	uinteger8	8	8	474
GPS_ECLIPTING	Occulting GPS eclipsing			1	1	1	1	boolean	1	1	482
ECLIPSE_TIME	Time of the eclipse	10^6	s	1	1	1	1	uinteger8	8	8	483
GPS_NAV_HEALTH	GPS navigation data health summary			1	1	1	1	boolean	1	1	491
GPS_SH	GPS signal health information			1	1	1	1	enumerated	1	1	492
MEAN_AZIMUTH_INCOMING_RAY	Mean azimuth of the incoming ray to GRAS	10^3	degree	1	1	1	1	integer8	8	8	493
MEAN_AZIMUTH_OUTGOING_RAY	Mean azimuth of the outgoing ray from GPS	10^3	degree	1	1	1	1	integer8	8	8	501
RECEIVER_ANALOG_GAIN	receiver channel analogue gain setting			1	1	1	1	enumerated	1	1	509
RECEIVER_DIGITAL_GAIN	receiver channel digital gain setting			1	1	1	1	bitfield (6)	6	6	510
TEC_METHOD	TEC determination method			1	1	1	1	enumerated	1	1	516
ERROR_COVARIANCE_ID	Error covariance matrix reference identification			1	1	1	1	integer2	2	2	517
MAX_SLTH	Maximum straight line tangent height	10^6	m	1	1	1	1	integer8	8	8	519
MIN_SLTH	Minimum straight line tangent height	10^6	m	1	1	1	1	integer8	8	8	527
LAT_STRAIGHT_PATH_HIGH	Latitude of the straight path at 80 km	10^3	degree	1	1	1	1	integer4	4	4	535
LONG_STRAIGHT_PATH_HIGH	Longitude of the straight path at 80 km	10^3	degree	1	1	1	1	integer4	4	4	539

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
LAT_STRAIGHT_PATH_LOW	Latitude of the straight path at lowest height	10^3	degree	1	1	1	1	integer4	4	4	543
LONG_STRAIGHT_PATH_LOW	Longitude of the straight path at lowest height	10^3	degree	1	1	1	1	integer4	4	4	547
LAT_STRAIGHT_PATH_MID	Latitude of the straight path at user definable impact parameter value	10^3	degree	1	1	1	1	integer4	4	4	551
LONG_STRAIGHT_PATH_MID	Longitude of the straight path at user definable impact parameter value	10^3	degree	1	1	1	1	integer4	4	4	555
CYCLE_SLIP_LIMIT	Lower height limit for cycle slip detection and correction	10^6	m	1	1	1	1	integer8	8	8	559
CYCLE_SLIP_FLAG_CL_OCC	Number of detected and corrected cycle slips in closed loop mode in occultation data			1	1	1	1	integer2	2	2	567
CYCLE_SLIP_FLAG_RS	Number of detected and corrected cycle slips in raw sampling mode			1	1	1	1	integer2	2	2	569
CYCLE_SLIP_FLAG_CL_PIV	Number of detected and corrected cycle slips in closed loop mode in pivot GPS data			1	1	1	1	integer2	2	2	571
WO_CHARACTERISATION	Characterisation of the WO method			1	1	1	1	bitfield (4)	4	4	573
ATM_MULTIPATH	Atmospheric mutltipath flag			1	1	1	1	bitfield (4)	4	4	577
WO_START	Starting height of WO processing	10^6	m	1	1	1	1	integer8	8	8	581
WO_END	Ending height of WO processing	10^6	m	1	1	1	1	integer8	8	8	589
WO_HEIGHT_STEP	WO height step	10^6	m	1	1	1	1	integer8	8	8	597
BP_PLANES	Number of BP planes considered			1	1	1	1	integer2	2	2	605
BP_LOCATION	Location of the BP plane	10^6	m	1	1	1	1	integer8	8	8	607

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
DELTA_UTC_REF	Time difference between UTC time and GSN reference time at the reference time of the first GO measurement sample	10^9	s	1	1	1	1	integer8	8	8	615
NUMBER_OF_SAMPLES	Number of observation samples, N			1	1	1	1	uinteger4	4	4	623
TIME_REF	Reference time of the sample	10^9	s	N	1	1	1	uinteger8	8	var	627
TIME_UTC	UTC time of the sample	10^9	s	N	1	1	1	uinteger8	8	var	var
TIME_START_OCCULTATION	Time from the beginning of the occultation	10^9	s	N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_1	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_2	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_3	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_4	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_5	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_6	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_7	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_8	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
ENGINEERING_PARAMETER_9	Engineering parameter for in-flight	10^9		N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
	monitoring of GRAS status										
ENGINEERING_PARAMETER_10	Engineering parameter for in-flight monitoring of GRAS status	10^9		N	1	1	1	integer8	8	var	var
TRACKING_STATE	Tracking state			N	1	1	1	bitfield (2)	2	var	var
SLTH	Straight line tangent height	10^3	m	N	1	1	1	integer4	4	var	var
LAT_RAY_TANGENT_L1	Latitude of the ray tangent point for L1	10^3	degree	N	1	1	1	integer4	4	var	var
LAT_RAY_TANGENT_L2	Latitude of the ray tangent point for L2	10^3	degree	N	1	1	1	integer4	4	var	var
LAT_RAY_TANGENT_LC	Latitude of the ray tangent point for LC	10^3	degree	N	1	1	1	integer4	4	var	var
LONG_RAY_TANGENT_L1	Longitude of the ray tangent point for L1	10^3	degree	N	1	1	1	integer4	4	var	var
LONG_RAY_TANGENT_L2	Longitude of the ray tangent point for L2	10^3	degree	N	1	1	1	integer4	4	var	var
LONG_RAY_TANGENT_LC	Longitude of the ray tangent point for LC	10^3	degree	N	1	1	1	integer4	4	var	var
OCCULTING_GPS_POSITION_X	Occulting GPS position vector x	10^6	m	N	1	1	1	integer8	8	var	var
OCCULTING_GPS_POSITION_Y	Occulting GPS position vector y	10^6	m	N	1	1	1	integer8	8	var	var
OCCULTING_GPS_POSITION_Z	Occulting GPS position vector z	10^6	m	N	1	1	1	integer8	8	var	var
OCCULTING_GPS_VELOCITY_X	Occulting GPS velocity vector x	10^6	m/s	N	1	1	1	integer8	8	var	var
OCCULTING_GPS_VELOCITY_Y	Occulting GPS velocity vector y	10^6	m/s	N	1	1	1	integer8	8	var	var
OCCULTING_GPS_VELOCITY_Z	Occulting GPS velocity vector z	10^6	m/s	N	1	1	1	integer8	8	var	var
METOP_POSITION_X	Satellite position x vector	10^6	m	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
METOP_POSITION_Y	Satellite position y vector	10^6	m	N	1	1	1	integer8	8	var	var
METOP_POSITION_Z	Satellite position z vector	10^6	m	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_X	Satellite velocity x at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_Y	Satellite velocity y at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
METOP_VELOCITY_Z	Satellite velocity z at epoch time	10^6	m/s	N	1	1	1	integer8	8	var	var
PIVOT_GPS_POSITION_X	Pivot GPS position vector x	10^6	m	N	1	1	1	integer8	8	var	var
PIVOT_GPS_POSITION_Y	Pivot GPS position vector y	10^6	m	N	1	1	1	integer8	8	var	var
PIVOT_GPS_POSITION_Z	Pivot GPS position vector z	10^6	m	N	1	1	1	integer8	8	var	var
PIVOT_GPS_VELOCITY_X	Pivot GPS velocity vector x	10^6	m/s	N	1	1	1	integer8	8	var	var
PIVOT_GPS_VELOCITY_Y	Pivot GPS velocity vector y	10^6	m/s	N	1	1	1	integer8	8	var	var
PIVOT_GPS_VELOCITY_Z	Pivot GPS velocity vector z	10^6	m/s	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_POSITION_X	Fiducial station 1 position vector x	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_POSITION_Y	Fiducial station 1 position vector y	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_POSITION_Z	Fiducial station 1 position vector z	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_VELOCITY_X	Fiducial station 1 velocity vector x	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_VELOCITY_Y	Fiducial station 1 velocity vector y	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT1_VELOCITY_Z	Fiducial station 1 velocity vector z	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT2_POSITION_X	Fiducial station 2 position vector x	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT2_POSITION_Y	Fiducial station 2 position vector y	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT2_POSITION_Z	Fiducial station 2 position vector z	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT2_VELOCITY_X	Fiducial station 2 velocity vector x	10^6	m	N	1	1	1	integer8	8	var	var
FIDUCIAL_STAT2_VELOCITY_Y	Fiducial station 2 velocity vector y	10^6	m	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
FIDUCIAL_STAT2_VELOCITY_Z	Fiducial station 2 velocity vector z	10^6	m	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_ROLL	Mispointing angle Dh	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_PITCH	Mispointing angles Dx	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_MISPOINTING_YAW	Mispointing angles Dz	10^3	deg	N	1	1	1	integer8	8	var	var
METOP_TRUE_LATITUDE	Metop true latitude angle	10^3	deg	N	1	1	1	integer8	8	var	var
USO_FREQUENCY_CORRECTION	USO frequency correction	10^9	Hz	N	1	1	1	integer8	8	var	var
USO_FREQUENCY_COMP	USO frequency after the correction	10^9	Hz	N	1	1	1	uinteger8	8	var	var
L1_CA_PHASE	L1-C/A carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_P1_PHASE	L1-P1 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L2_P2_PHASE	L2-P2 carrier phase after instrument correction	10^6	m	N	1	1	1	integer8	8	var	var
L1_CA_AMPLITUDE	L1-C/A amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_P1_AMPLITUDE	L1-P1 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L2_P2_AMPLITUDE	L2-P2 amplitude after instrument correction	10^9	dBV	N	1	1	1	integer8	8	var	var
L1_NOISE	L1 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
L2_NOISE	L2 noise estimate	10^9	dB	N	1	1	1	integer8	8	var	var
RESIDUAL_PHASE_DELAY_L1	Residual phase delay L1	10^9	m	N	1	1	1	integer8	8	var	var
RESIDUAL_PHASE_DELAY_L2	Residual phase delay L2	10^9	m	N	1	1	1	integer8	8	var	var
RESIDUAL_DOPPLER_SHIFT_L1	Residual Doppler shift L1	10^9	m/s	N	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
RESIDUAL_DOPPLER_SHIFT_L2	Residual Doppler shift L2	10^9	m/s	N	1	1	1	integer8	8	var	var
GO_BENDING_ANGLE_L1	GO Bending angle L1	10^9	rad	N	1	1	1	integer8	8	var	var
GO_BENDING_ANGLE_L2	GO Bending angle L2	10^9	rad	N	1	1	1	integer8	8	var	var
GO_IMPACT_PARAMETE_L1	GO Impact parameter L1	10^9	m	N	1	1	1	integer8	8	var	var
GO_IMPACT_PARAMETE_L2	GO Impact parameter L2	10^9	m	N	1	1	1	integer8	8	var	var
IONOSPHERIC_CORRECTED_GO_BENDING	GO Ionospheric corrected bending angle	10^9	rad	N	1	1	1	integer8	8	var	var
TEC	Total electron content along the ray path	10^9	TECU	N	1	1	1	integer8	8	var	var
GO_APPROXIMATE_L1_RAY_HEIGHT	GO Impact parameter L1 - local radius of the curvature	10^9	m	N	1	1	1	integer8	8	var	var
NUMBER_OF_SAMPLES_CP	Number of code phase measurement samples, M			1	1	1	1	uinteger4	4	4	var
TIME_REF_CP	Reference time of the sample	10^9	s	M	1	1	1	uinteger8	8	var	var
TIME_UTC_CP	UTC time of the sample	10^9	s	M	1	1	1	uinteger8	8	var	var
TIME_START_OCCULTATION_CP	Time from the beginning of the occultation	10^9	s	M	1	1	1	integer8	8	var	var
L1_CA_CODE_PHASE	L1-C/A code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_P1_CODE_PHASE	L1-P1 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L2_P2_CODE_PHASE	L2-P2 code phase after instrument correction	10^9	chips	M	1	1	1	uinteger8	8	var	var
L1_CA_PSEUDORANGE	L1-C/A pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
L1_P1_PSEUDORANGE	L1-P1 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
L2_P2_PSEUDORANGE	L2-P2 pseudorange after instrument correction	10^9	m	M	1	1	1	uinteger8	8	var	var
NUMBER_OF_SAMPLES_WO	Number of samples in the Wave Optics processing, W			1	1	1	1	uinteger4	4	4	var
TIME_REF_WO	Reference time of the WO sample	10^9	s	W	1	1	1	uinteger8	8	var	var
TIME_UTC_WO	UTC time of the WO sample	10^9	s	W	1	1	1	uinteger8	8	var	var
BP_HEIGHT	Height in BP plane	10^6	m	W	1	1	1	integer8	8	var	var
WO_L1_CA_AMPLITUDE	L1 C/A amplitude in BP plane	10^9	dBV	W	1	1	1	integer8	8	var	var
WO_L1_P_AMPLITUDE	L1 P amplitude in BP plane	10^9	dBV	W	1	1	1	integer8	8	var	var
WO_L2_P_AMPLITUDE	L2 P amplitude in BP plane	10^9	dBV	W	1	1	1	integer8	8	var	var
WO_RESIDUAL_PHASE_DELAY_L1	Residual phase delay L1 in BP plane	10^9	m	W	1	1	1	integer8	8	var	var
WO_RESIDUAL_PHASE_DELAY_L2	Residual phase delay L2 in BP plane	10^9	m	W	1	1	1	integer8	8	var	var
WO_RESIDUAL_DOPPLER_SHIFT_L1	Residual Doppler shift L1 in BP plane	10^9	m/s	W	1	1	1	integer8	8	var	var
WO_RESIDUAL_DOPPLER_SHIFT_L2	Residual Doppler shift L2 in BP plane	10^9	m/s	W	1	1	1	integer8	8	var	var
WO_BENDING_ANGLE_L1	WO Bending angle L1	10^9	rad	W	1	1	1	integer8	8	var	var
WO_BENDING_ANGLE_L2	WO Bending angle L2	10^9	rad	W	1	1	1	integer8	8	var	var
WO_IMPACT_PARAMETE_L1	WO Impact parameter L1	10^9	m	W	1	1	1	integer8	8	var	var
WO_IMPACT_PARAMETE_L2	WO Impact parameter L2	10^9	m	W	1	1	1	integer8	8	var	var
IONOSPHERIC_CORRECTED_WO_BENDING	WO Ionosphere corrected bending angle	10^9	rad	W	1	1	1	integer8	8	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
WO_APPROXIMATE_L1_RAY_HEIGHT	WO Impact parameter L1 - local radius of the curvature	10^9	m	W	1	1	1	integer8	8	var	var
NUMBER_OF_SAMPLES_RS	Number of samples in a raw sampling mode, K			1	1	1	1	uinteger4	4	4	var
TIME_IMT_RS	IMT time stamp of the sample	10^9	s	K	1	1	1	uinteger8	8	var	var
TIME_UTC_GRAS_RS	UTC_GRAS time stamp of the sample	10^9	s	K	1	1	1	uinteger8	8	var	var
TIME_OBT_RS	OBT time stamp of the sample		s	K	1	1	1	longtime	8	var	var
TIME_REF_RS	Reference time of the sample	10^9	s	K	1	1	1	integer8	8	var	var
P_1_RS	L1 NCO phase of first sample			K	1	1	1	integer8	8	var	var
F1_1_RS	L1 NCO frequency setting for L1 carrier during sequence 1 in this packet			K	1	1	1	integer4	4	var	var
TINT1_RS	Total integration time from IMT when F1_1 is valid until F2_1 is set			K	1	1	1	uinteger4	4	var	var
F2_1_RS	L1 NCO frequency setting for L1 carrier during sequence 2 in this packet			K	1	1	1	integer4	4	var	var
TINT2_RS	Total integration time from IMT+TINT1 when F2_1 is valid until the last measurement of the packet			K	1	1	1	uinteger4	4	var	var
IQ_CA_EXP_RS	Exponent of I/Q samples			K	1	1	1	uinteger2	2	var	var
I_CA_RS	I sample of L1 carrier amplitude in terms of normalised counts of the C/A punctual correlation value			K	1	1	1	integer2	2	var	var

Name	Description	Scaling factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type size	Field size	Offset
Q_CA_RS	Q sample of L1 carrier amplitude in terms of normalised counts of the C/A punctual correlation value			K	1	1	1	integer2	2	var	var
L1_PHASE_RS	L1 carrier phase after instrument correction	10^9	deg	K	1	1	1	integer8	8	var	var
L1_AMPLITUDE_RS	L1 amplitude after instrument correction	10^9	dBV	K	1	1	1	integer8	8	var	var
L1_NOISE_RS	L1 noise estimate	10^9	dB	K	1	1	1	integer8	8	var	var
											Total: var

Enumeration BE_MODEL

Value	Name	Description
0	MSISE90	Baseline
1	NRLMSISE00	Updated model from MSISE90
2	Spare	

Enumeration DISPOSITION_MODE

Value	Name	Description
T	Testing	
O	Operational	
C	Commissioning	

Enumeration EARTH_MODEL_ID

Value	Name	Description
0	Not used	
1	WGS84 ellipsoid model	

Enumeration GPS_SH

Value	Name	Description
0	All signals OK	
1	All signals weak	

2	All signals dead	
3	All signals have no data modulation	
4	L1P signal weak	
5	L1P signal dead	
6	L1P signal has no data modulation	
7	L2P signal weak	
8	L2P signal dead	
9	L2P signal has no data modulation	
10	L1C signal weak	
11	L1C signal dead	
12	L1C signal has no data modulation	
13	L2C signal weak	
14	L2C signal dead	
15	L2C signal has no data modulation	
16	L1 and L2P signal weak	
17	L1 and L2P signal dead	
18	L1 and L2P signal has no data modulation	
19	L1 and L2C signal weak	
20	L1 and L2C signal dead	
21	L1 and L2C signal has no data modulation	
22	L1 signal weak	
23	L1 signal dead	
24	L1 signal has no data modulation	

25	L2 signal weak	
26	L2 signal dead	
27	L2 signal has no data modulation	
28	SV is temporarily out	Do not use this SV during current pass
29	SV will be temporarily out	Use with caution
30	Spare	
31	More than one combination would be required to describe anomalies	

Enumeration GRAS_CHANNEL_ID

Value	Name	Description
0	Zenith chain 0	
1	Zenith chain 1	
2	Zenith chain 2	
3	Zenith chain 3	
4	Zenith chain 4	
5	Zenith chain 5	
6	Zenith chain 6	
7	Zenith chain 7	
8	Velocity chain 8	
9	Velocity chain 9	
10	Anti-velocity chain 10	
11	Anti-velocity chain 11	

Enumeration GRAS_ID

Value	Name	Description
0	Not used	
1	GRAS 1	
2	GRAS 2	
3	GRAS 3	

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 MEASUREMENT_TYPE

Value	Name	Description
0	Rising	Rising occultation
1	Setting	Setting occultation
2	Navigation	Navigation measurement
3	Spare	

Enumeration METOP_STEERING_MODE

Value	Name	Description
0	Rate Reduction Mode	
1	Coarse Acquisition Mode	
2	Fine Acquisition Mode 1	
3	Fine Acquisition Mode 2	
4	Fine Acquisition Mode 3	
5	Operational Mode	
6	Fine Pointing Mode	
7	Yaw Steering Mode	
8	Orbit Control Mode	
9	Fine Control Mode	
10	Safe Mode	

Enumeration ONBOARD_NAV_SOLUTION

Value	Name	Description
0	Not navigation solution	
1	Propagated initial settings	
2	First-fix	
4	Calculated with least square	
5	Calculated with Kalman filter	
7	Invalid navigation solution	An invalid navigation solution will be indicated if least square is used

		and less than 4 satellites are in the field-of-view of the zenith antenna. The reported navigation solution will be the propagated one.

Enumeration PROCESSING_CENTRE

Value	Name	Description
CGS1		First EUMETSAT EPS Core Ground Segment
CGS2		Second EUMETSAT EPS Core Ground Segment
CGS3		Third 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 RECEIVER_ANALOG_GAIN

Value	Name	Description
5	0	Analogue Gain Setting values obtained from the AGGA
9	-5	
6	-10	
10	-15	

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 SELECTED_CLOCK_CORRECTION_METHOD

Value	Name	Description
0	ND	No differencing
1	SD1	Single differencing 1
2	SD2	Single differencing 2
3	DD1	Double differencing 1
4	DD2	Double differencing 2

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'

Enumeration TEC_METHOD

Value	Name	Description
0	TEC at level 1a	
1	TEC at level 1b	
2	Spare	

Bitfield ATM_MULTIPATH

Length 4 bytes

Name	Description	Length
unused		30
Atmospheric_multipath_in_troposphere	0 = Atmospheric multipath has not been detected 1 = Atmospheric multipath detected	1
Atmospheric_multipath_in_stratosphere	0 = Atmospheric multipath has not been detected 1 = Atmospheric multipath detected	1
Total		32

Bitfield CLOCK_CORRECTION_FALLBACK_MODE

Length 1 bytes

Name	Description	Length
Spare		2
ND_failed	No clock correction	1
SD1__ND	0=no, 1=mode change performed	1

SD2__SD1	0=no, 1=mode change performed	1
DD1__SD2	0=no, 1=mode change performed	1
DD2__DD1	0=no, 1=mode change performed	1
Fallback_mode	0=not activated, 1=activated	1
Total		8

Bitfield LOCAL_MULTIPATH_SOURCE

Length 2 bytes

Name	Description	Length
Spare		13
ASCAT_ANT_RF_in_the_FOV	0=outside FOV, 1=inside FOV	1
ASCAT_ANT_RA_in_the_FOV	0=outside FOV, 1=inside FOV	1
Metop_solar_panel_in_the_FOV	0=outside FOV, 1=inside FOV	1
Total		16

Bitfield RECEIVER_DIGITAL_GAIN

Length 6 bytes

Name	Description	Length
CCT_5		8
CCT_4		8
CCT_3		8
CCT_2		8

CCT_1		8
CCT_0		8
Total		48

Bitfield SSD_AVAILABILITY

Length 2 bytes

Name	Description	Length
Spare		10
Station 2 TZD estimate	0 = available, 1 = not available or error too large	1
Station 1 TZD estimate	0 = available, 1 = not available or error too large	1
Station_characterisation_data_for_station_2	0 = available, 1 = not available	1
Station_characterisation_data_for_station_1	0 = available, 1 = not available	1
SSD_fiducial_station_2	0 = available, 1 = not available	1
SSD_fiducial_station_1	0 = available, 1 = not available	1
Total		16

Bitfield TELEMETRY_IN_RANGE

Length 3 bytes

Name	Description	Length
Spare		3
Digital_5_V	0 - Within range 1 - Outside range	1
USO_ground	0 - Within range 1 - Outside range	1

FG_thermistor	0 - Within range 1 - Outside range	1
Thermistor_supply_voltage	0 - Within range 1 - Outside range	1
DBU_power_voltage	0 - Within range 1 - Outside range	1
USO_external_thermistor	0 - Within range 1 - Outside range	1
USO_internal_thermistor	0 - Within range 1 - Outside range	1
ISAC_thermistor	0 - Within range 1 - Outside range	1
GEU_thermistor	0 - Within range 1 - Outside range	1
Anti_velocity_RFCU_thermistor	0 - Within range 1 - Outside range	1
Velocity_RFCU_thermistor	0 - Within range 1 - Outside range	1
Zenith_RFCU_thermistor	0 - Within range 1 - Outside range	1
Anti_velocity_antenna_thermistor	0 - Within range 1 - Outside range	1
Velocity_antenna_thermistor	0 - Within range 1 - Outside range	1
Zenith_antenna_thermistor	0 - Within range 1 - Outside range	1
ENDP_Velocity_Z	0 - Within range 1 - Outside range	1
ENDP_Velocity_Y	0 - Within range 1 - Outside range	1
ENDP_Velocity_X	0 - Within range 1 - Outside range	1
ENDP_Position_Z	0 - Within range 1 - Outside range	1
ENDP_Position_Y	0 - Within range 1 - Outside range	1
ENDP_Position_X	0 - Within range 1 - Outside range	1
Total		24

Bitfield WO_CHARACTERISATION

Length 4 bytes

Name	Description	Length
Spare		27
Phase_Matching	0=GOPM method has not been applied, 1=GOPM method has been applied	1
Full_Spectrum_Inversion	0=FSI method has not been applied, 1=FSI method has been applied	1
Canonical_Transform_2	0 =CT2 method has not been applied, 1=CT2 method has been applied	1
Canonical_Transform	0=CT method has not been applied, 1=CT method has been applied	1
Back_Propagation	0=BP method has not been applied, 1=BP method has been applied	1
Total		32

Bitfield TRACKING_STATE

Length 2 bytes

Name	Description	Length
P_code_and_L2_carrier_tracking,_highest_tracking_state		1
P_code_tracking		1
P_code_acquisition		1
undefined		1
undefined		1
undefined		1
Single_carrier_frequency_tracking_at_10_ms		1
Single_carrier_frequency_tracking_at_1_ms		1

undefined		1
undefined		1
undefined		1
undefined		1
L1_carrier_lock_check		1
C/A_code_lock_check		1
C/A_code_acquisition		1
Acquisition_and_tracking_ended		1
Total		16

Supplement of Product Guide Common Appendices

The following sections comprise appendices containing information that is relevant for all the EPS Product Guides.

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APPENDIX A SUMMARY OF ALL EPS PRODUCTS

In this annex, we summarise all EPS products generated at EUMETSAT or the SAFs up to Level 2.

The following is a definition of the different product levels, as understood in the EPS context:

Level 0: Raw data after restoration of the chronological data sequence for each instrument, i.e. after demultiplexing of the data by instrument, removal of any data overlap due to the data dump procedure and relevant quality checks. Raw instrument data information (telemetry packets) is maintained during this process.

Level 1a: Instrument data in full resolution with radiometric and geometric (i.e. Earth location) calibration computed and appended but not applied.

Level 1b: Calibrated, Earth-located and quality-controlled product, expressed as radiance or brightness temperature, in the original pixel location, and packaged with needed ancillary, engineering and auxiliary data.

Level 1c: In the case of the IASI spectra, Level 1b data after application of the apodisation function and addition of co-registered AVHRR radiance analysis.

Level 2: Earth-located values converted to geophysical parameters, at the same spatial and temporal sampling as the Level 1b or Level 1c data.

Level 3: Gridded point geophysical products on a multi-pass basis.

It is understood that the average user is interested in products of Level 1b and higher. Details on Level 0 and Level 1a products will thus not be provided in this summary.

Concerning Level 3 and higher, the SAFs generate a variety of both products and software, based not only on Metop or NOAA data, but on many other satellite data and conventional observations. For a complete and updated list of these high-level products, it is best to check the EUMETSAT SAF page from www.eumetsat.int or the specific SAF pages which are linked from there.

In the following table, NRT and ARC stand for Near Real Time and Archive respectively. When the archive is specifically the EUMETSAT archive, ARC is replaced in the table by EUMDC (= EUMETSAT Data Centre (formerly UMARF)).

Note that the following table is not complete for all products.

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
Metop	AVHR_xxx_1B_Mnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K (μ wave & IR channels) Geolocation: <1 km Channel to Channel Misregistration: ≤ 0.1 mrad	1447 km (2048 Earth view samples)	Square IFOV: 0.0745 deg, equivalent to 1.08x1.08 km at nadir	N/A	1.08 km across track at nadir, 1.1 km along track	N/A
Metop	HIRS_xxx_1B_Mnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K (IR channels) Albedo: 10^{-2} digits not affected by rounding	1080.35 km (56 Earth view samples)	Circular IFOV: 0.69 deg, equivalent to 10.0 km at nadir	N/A	10.0 km across track at nadir, 42.15 km along track	N/A
Metop	AMSA_xxx_1B_Mnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K	1026 km (30 Earth view samples)	Circular IFOV: 3.3 deg, equivalent to 47.63 km at nadir	N/A	47.63 km across track at nadir, 52.69 km along track	N/A
Metop	MHSx_xxx_1B_Mnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K	1077.68 km (90 Earth view samples)	Circular IFOV: 1.1 deg, equivalent to 15.88 km at nadir	N/A	15.88 km across track at nadir, 17.56 km along track	N/A
NOAA	AVHR_GAC_1B_Nnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K (μ wave & IR channels) Geolocation: <1 km Channel to Channel Misregistration: ≤ 0.1 mrad	1447 km (409 Earth view samples)	1.1 (along-track) x 4.4 (across-track) km at nadir (NOAA/GAC resolution)	N/A	3.3 (along-track) x 4.4 (across-track) km at nadir (NOAA/GAC sampling)	N/A

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
NOAA	HIRS_xxx_1B_Nnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K (IR channels) Albedo: 10^{-2} digits not affected by rounding	1080.35 km (56 Earth view samples)	Circular IFOV: 0.69 deg, equivalent to 10.0 km at nadir	N/A	10.0 km across track at nadir, 42.15 km along track	N/A
NOAA	AMSA_xxx_1B_Nnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K	1026 km (30 Earth view samples)	Circular IFOV: 3.3 deg, equivalent to 47.63 km at nadir	N/A	47.63 km across track at nadir, 52.69 km along track	N/A
NOAA	MHSx_xxx_1B_Nnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K	1077.68 km (90 Earth view samples)	Circular IFOV: 1.1 deg, equivalent to 15.88 km at nadir	N/A	15.88 km across track at nadir, 17.56 km along track	N/A
Metop	IASI_xxx_1B_Nnn	1b	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m						
Metop	GRAS_xxx_1B_Mnn	1b	Bending angle	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 µrad or 0.4% (whichever is larger)				<1000 km (mean distance between individual soundings over 12 h time window)	Surface to 80 km
Metop	GOME_xxx_1B_Mnn	1b		EPS CGS	Global	NRT&EUMDC	2 h 15 m	Geolocation: Barycentres of each FOV shall be positioned no worse than 0.06° of the scan mirror TBD (46.435° scan angle)				Instrument Footprint	N/A
Metop	ASCA_SZO_1B_Mnn	1b	ASCAT σ_0 (normalised	EPS CGS	Global	NRT&EUMDC	2 h 15 m	Radiometric accuracy:	Double swath of	50x50 km	N/A	25 km (21 nodes)	N/A

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
			backscatter) triplets					0.5 db peak-to-peak Radiometric resolution: 2 - 5% Geolocation: 4 km	550 km with a gap around satellite track of 700 km				
Metop	ASCA_SZR_1B_Mnn	1b	ASCAT σ_0 (normalised backscatter) triplets	EPS CGS	Global	NRT&EUMDC	2 h 15 m	Radiometric accuracy: 0.5 db peak-to-peak Radiometric resolution: 4 - 11% Geolocation: 4 km	Double swath of 550 km with a gap around satellite track of 700 km	(25-34)x(25-34) km	N/A	12.5 km (41 nodes)	N/A
Metop	ASCA_ FUL _1B_Mnn	1b	ASCAT σ_0 (normalised backscatter) individual values	EPS CGS	Global	EUMDC	2 h 15 m	Radiometric accuracy: 0.5 db peak-to-peak Geolocation: 4 km	Double swath of 550 km with a gap around satellite track of 700 km	Instrument resolution (approx 20x10 km)	N/A	Instrument sampling (256 values along each antenna footprint)	N/A
Metop	IASI_xxx_1C_Mnn	1c	Radiances	EPS CGS	Global	NRT&EUMDC	2 h 15 m	1 K (IR channels)		Instrument FOV	N/A	Instrument FOV	N/A
Metop	ATOV_SND_02_Mnn	2	Atmospheric temperature	EPS CGS	Global	NRT&EUMDC	3 h	1.7 K Troposphere 2 K Stratosphere	1080.35 km	N/A	N/A	HIRS/4 instrument horizontal sampling grid: 56 pixels per scan and 42.15 km	Typically 40 Pressure levels
			Atmospheric water vapour					20%					Typically 15 Pressure levels

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
			Surface emissivity					n/a (not a retrieved parameter)				scan separation	N/A
			Surface Temperature					0.6 K					N/A
			Fractional cloud cover					5-10%					N/A
			Cloud Top Temperature					1-2 K					N/A
			Cloud Top Pressure					50 hPa					N/A
			Tropopause height					50 hPa					N/A
			Cloud Liquid Water Content					0.04 mm					N/A
			Total Column Precipitable Water					5%					N/A
NOAA	ATOV_SND_02_Nnn	2	Atmospheric temperature	EPS CGS	Global	NRT&EUMDC	3 h	1.7 K Troposphere 2 K Stratosphere	1080.35 km	N/A	N/A	HIRS/4 instrument horizontal sampling grid: 56 pixels per scan and 42.15 km scan separation	Typically 40 Pressure levels
			Atmospheric water vapour					20%					Typically 15 Pressure levels
			Surface emissivity					n/a (not a retrieved parameter)					N/A
			Surface Temperature					0.6 K					N/A
			Fractional cloud cover					5-10%					N/A

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
			Cloud Top Temperature					1-2 K					N/A
			Cloud Top Pressure					50 hPa					N/A
			Tropopause height					50 hPa					N/A
			Cloud Liquid Water Content					0.04 mm					N/A
			Total Column Precipitable Water					5%					N/A
Metop	Reduced ATOVS Level 2 product from Metop (TBD name)	2	Atmospheric temperature	EPS CGS	Global	NRT&EUMDC	3 h	1.7 K Troposphere 2 K Stratosphere				Every 4th HIRS/4 FOV and every 2nd HIRS/4 scan line	Pressure levels for atmospheric temperature and water vapour profiles: every 4th level of the full product
			Atmospheric water vapour					20%					
			Surface Temperature					0.6 K					N/A
NOAA	Reduced ATOVS Level 2 product from Metop (TBD name)	2	Atmospheric temperature	EPS CGS	Global	NRT&EUMDC	3 h	1.7 K Troposphere 2 K Stratosphere				Every 4th HIRS/4 FOV and every 2nd HIRS/4 scan line	Pressure levels for atmospheric temperature and water vapour profiles: every 4th level of the full product
			Atmospheric					20%					

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
			water vapour										
			Surface Temperature					0.6 K					N/A
Metop	IASI_SND_02_Mnn	2	Atmospheric temperature	EPS CGS	Global	NRT&EUMDC	3 h	1 K Troposphere 2 K Stratosphere				IASI FOV	40 Pressure levels to 1 hPa
			Rel Humidity: 10%					Rel Humidity: 10%				IASI FOV	20 Pressure levels to 10 hPa
			Cloud Cover: 10%<10% (climate)					Cloud Cover: 10% <10% (climate)				IASI FOV	N/A
			Cloud Top Temperature: 2K					Cloud Top Temperature: 2 K				IASI FOV	N/A
			Cloud Top Height: 300m					Cloud Top Height: 300m				IASI FOV	N/A
			Trace gases					Trace gases: CH4 <20% N2O <20% CO <10%				250 km	N/A
Metop	Near Surface Wind Vector	2		Ocean & Sea Ice SAF	Global	NRT	3 h	2 m/s (vector components)				nominal: 50 km research: 25 km	N/A
Metop/ NOAA	Cloud Type (including Fog)	2		Nowcasting SAF	Regional	Software	15 min	N/A				Full AVHRR Resolution	N/A
Metop	Total Ozone from GOME	2		Ozone Monitoring SAF	Global	NRT	3 h	<5%				250 km	N/A
Metop/	Total Ozone from	2		Ozone	Global	NRT	3 h					HIRS/4 FOV	N/A

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
NOAA	HIRS			Monitoring SAF									
Metop	Ozone Profiles	2		Ozone Monitoring SAF	Global	NRT	3 h	<15% at pressures <30 hPa <50% at pressure >30 hPa				250 km	7 km at pressures <30 hPa <10 km at pressures >30 hPa
Metop	Aerosol Index	2		Ozone Monitoring SAF	Global	NRT	3 h					250 km	
Metop	Trace Gases (note use of IASI not planned)	2		Ozone Monitoring SAF	Global	Offline	3 h	<50% trace gases include ClO, BrO, SO2 and NO2				250 km	N/A
Metop	Ozone Profiles	2		Ozone Monitoring SAF	Global	Offline	3 h	<15% at pressures <30 hPa <50% at pressure >30 hPa				250 km	7 km at pressures <30 hPa <10 km at pressures >30 hPa
Metop	Temperature, Humidity and Pressure Profiles	2		GRAS Meteorology SAF	Global	NRT	3 h	Temperature: 2 K Troposphere 1 K Stratosphere				<1000 km (mean distance between individual soundings over 12 h time window)	30 Pressure levels 500 hPa to 10 hPa
								Rel Humidity: 10% or 0.2 g/kg (whichever is larger)				<1000 km (mean distance between individual	20 Pressure levels to 300 hPa

SATELLITE	PRODUCT NAME	LEVEL	MAIN GEOPHYSICAL /ENG PARAMETER	PRODUCER	COVERAGE	DISSEMINATION	NRT TIMELINESS	ACCURACY	SWATH WIDTH	H-RESOLUTION	V-RESOLUTION	H-samp	V-samp
												soundings over 12 h time window)	
Metop	Temperature, Humidity and Pressure Profiles	2		GRAS Meteorology SAF	Global	Offline	3 h	Temperature: 2 K Troposphere 1 K Stratosphere				<1000 km (mean distance between individual soundings over 12 h time window)	30 Pressure levels 500 to 10 hPa
								Rel Humidity: 10% or 0.2 g/kg (whichever is larger)				<1000 km (mean distance between individual soundings over 12 h time window)	20 Pressure levels to 300 hPa
Metop/ NOAA	Aerosol	2		Land Surface Analysis SAF	Global	NRT	12 h	<50%				1 km	
Metop/ NOAA	Land Surface Temperature	2		Land Surface Analysis SAF	Global	NRT	6 h	4 K				1 km	N/A
Metop/ MSG/ NOAA	Land Surface Temperature	2		Land Surface Analysis SAF	Global	NRT	6 h	4 K				3 km	N/A
Metop/ NOAA	N. Europe Snow Cover	2		Land Surface Analysis SAF	Regional	NRT	1 d	5%				1 km	N/A
Metop/ MSG/ NOAA	Vegetation Index	2		Land Surface Analysis SAF	Regional	Offline	1 d	N/A				1 km	N/A

APPENDIX B METOP OPERATIONAL ORBIT

B.1 Metop orbit basic parameters

The orbit parameters for the operational baseline mean orbit, with respect to the inertial Mean-of-Date System J2000.0, are given below. The orbit propagation is carried out with a geopotential model GEM10B of order 36 and degree 36, with lunisolar perturbations and a medium air drag model MSIS 77.

The repeatability cycle is 29 days/412 orbits and the Mean Local Solar Time at ascending node is 21 h 30 min. As the right column in the table shows, this orbit is almost equivalent to a 5 days/71 orbits repeat cycle.

Mean Element		Baseline 29 days/412 revs orbit	Value for a 5 days/71 revs orbit
Semi-Major Axis	a	7,195,605.347 m	7,197,939.000 m
Eccentricity	e	0.001165	0.001165
Inclination	i	98.702198°	98.704663°
Right Ascension of Ascending Node	Ω	62.4731° + 0.98564735° * N where: N = number of Julian days from 1 Jan 2000	62.4731° + 0.98564735° * N where: N = number of Julian days from 1 Jan 2000
Argument of Perigee	ω	90.0°	90.0°
Mean Anomaly	M	270.133359°	270.133359°

B.2 Metop attitude law

The Metop nominal attitude is the **Local Normal Pointing** (LNP) law augmented by the **Yaw Steering Mode** (YSM).

LNP forces the satellite to point to the local normal direction (which for an oblate planet like the Earth is generally different from the direction towards the Earth centre).

Additionally to LNP, the satellite platform slowly moves about its centre of mass with a slow rocking motion about all three axes (X or pitch, Y or roll, Z or yaw) with the largest oscillation amplitude being on the yaw axis. This is the concept of **yaw steering**.

B.2.1 Metop yaw steering law

Yaw steering angles are modulated on board to compensate for the apparent drift of the sub-satellite point due to Earth rotation. Use of the yaw steering law is beneficial to those instruments with swaths significantly extending sideways (e.g. ASCAT). The amplitude of the rotation about each angle is effected on board (and modelled on-ground), first computing the angle amplitude and then applying the three rotations as follows:

Angular Coefficients:

In the reference frame selected for the Metop CFI Software (positive X pointing away from solar panel, positive Y towards the flight direction, positive Z towards outer space) the signs in front of C_X and C_Y in the following equations are negative.

$$C_X = -e_e{}^2 \left(\frac{a_e}{a}\right) \frac{\sin^2(i)}{2}$$ Pitch

$$C_Y = -e_e{}^2 \left(\frac{a_e}{a}\right) \sin(i)\cos(i)$$ Roll

$$C_Z = \frac{k \cos(i-\pi/2)}{1 + k \sin(i-\pi/2)}$$ Yaw

where:

- a_e = semi-major axis of the Earth reference ellipsoid (km)
- a = mean semi-major axis of the Metop reference orbit (km)
- e_e = eccentricity of the Earth reference ellipsoid
- i = mean inclination of the Metop orbit (radians)
- k = (ω_e /ω_n) with ω_e Earth angular velocity (radians/s) and ω_n Metop angular velocity along its reference orbit (radians/s)

In the spacecraft reference frame (positive X pointing from spacecraft centre of mass to solar panel, positive Y opposite to flight direction, positive Z towards outer space) the signs of C_X and C_Y are positive. In this case the numerical value for C_X is positive for Metop and the value for C_Y is negative:

$$C_X = +e_e{}^2 \left(\frac{a_e}{a}\right) \frac{\sin^2(i)}{2}$$ Pitch

$$C_Y = +e_e{}^2 \left(\frac{a_e}{a}\right) \sin(i)\cos(i)$$ Roll

$$C_Z = \frac{k \cos(i-\pi/2)}{1 + k \sin(i-\pi/2)}$$ Yaw

In the spacecraft reference frame and with the Metop mission reference orbit data, the maximum amplitudes are:

C_X	Pitch maximum amplitude (radians):	+0.002899
C_Y	Roll maximum amplitude (radians):	–0.00089
C_Z	Yaw maximum amplitude (radians):	+0.068766

In the Metop CFI Software reference frame the signs of C_X and C_Y are swapped with respect to the signs of the numerical values obtained in the Metop spacecraft reference frame. The C_Z sign is unaffected by the choice of attitude reference frame.

Steering Angles:

$$\eta = C_X \sin(2PSO)$$ η: pitch steering angle

$$\xi = C_Y \sin(PSO)$$ ξ: roll steering angle

$$\zeta = C_Z \cos(PSO)\left(1 - \frac{(C_Z \cos(PSO))^2}{3}\right)$$ ς: yaw steering angle

where:

PSO ("Position sur l'Orbite", in radians) is the angle measured in the satellite orbital plane from the latest ascending node to the current satellite position along the orbit.

B.3 Metop orbit and attitude propagation

B.3.1 Orbit propagation

The main concepts are already explained above in B.1.

The average operational values for maximum propagation error (in metres) after 48 hours are:

in radial direction:	6-7 m
in along-track direction:	50-60 m
in cross-track direction:	8-10 m

which are well below (i.e. better than) the required values.

B.3.2 Metop attitude propagation

The Metop attitude control system is a closed-loop one, therefore no attitude prediction is performed on ground. Our reference attitude is the LNP+YSM law (see above, B.2). Telemetry from sun sensors, earth sensors and gyros is processed on ground to check that attitude deviations from the LNP+YSM reference values stay within certain mission-defined thresholds. Deviations of less than 0.02° in pitch, roll and yaw are routinely observed.

APPENDIX C DATA TYPES USED BY THE GENERIC EPS FORMAT

C.1 Basic data types

Type ID	Type	Size	Range	Comments
Integers				
byte	Signed Byte	1 byte	-128…127	"Two's Complement" coding convention for negative values Range calculated: -2^{n-1} to $+2^{n-1}-1$, where n is the length of the integer in bits
u-byte	Unsigned Byte	1 byte	0…255	Range calculated: 0 to $+2^{n}-1$ where n is the length of the integer in bits
enumerated	Enumerated Byte	1 byte	256 flag states	May only contain a value from a set of specified integer values, each of which is associated with a named concept, e.g. a set of error codes. When this field type is defined, the possible integer values and associated names are completely specified.
boolean	Boolean Byte	1 byte	False/True	Specific enumerated integer type which takes only 2 possible values: when all bits are zeroed, it denotes 'FALSE', otherwise, if any bit is set (i.e. its value is different from zero), it denotes 'TRUE'.
integer2	Signed 2-byte Integer	2 bytes	-32768…32767	"Two's Complement" coding convention for negative values Range calculated: -2^{n-1} to $+2^{n-1}-1$, where n is the length of the integer in bits
u-integer2	Unsigned 2-byte Integer	2 bytes	0…65535	Range calculated: 0 to $+2^{n}-1$ where n is the length of the integer in bits
integer4	Signed 4-byte Integer	4 bytes	-2147483648…2147483647	"Two's Complement" coding convention for negative values

Type ID	Type	Size	Range	Comments
				Range calculated: -2^{n-1} to $+2^{n-1}-1$, where n is the length of the integer in bits
u-integer4	Unsigned 4-byte Integer	4 bytes	0…4294967295	Range calculated: 0 to $+2^{n}-1$ where n is the length of the integer in bits
integer8	Signed 8-byte Integer	8 bytes	-9223372036854775808 …9223372036854775807	"Two's Complement" coding convention for negative values Range calculated: -2^{n-1} to $+2^{n-1}-1$, where n is the length of the integer in bits
u-integer8	Unsigned 8-byte Integer	8 bytes	0…18446744073709551615	Range calculated: 0 to $+2^{n}-1$ where n is the length of the integer in bits
Bit Strings				
Bit String	bitst(n)	1 bit per element	n/a	A bit string is encoded as follows: bn-1…b0 , where bi is the ith bit in the string and n is the length in bits of the bit string, with bn-1 being the most significant bit. The value of n shall always be a multiple of 8 ensuring that a bit string is always a full number of bytes in size.
Character Strings				
Standard Character String	char(length)	1 byte per character	n/a	Can only contain upper case letters [A…Z], numbers [0…9] and the underscore character (_). The number of characters in a character string is determined by the **length** parameter e.g. CHAR(8) is an 8 character string.
Enumerated Character String	e-char(length)	1 byte per character	n/a	Same properties as standard character string except that it can only contain one of a set of specified string values, and may also include the lower case "x" character (used as whitespace padding).
Extended Character	x-char(length)	1 byte per	n/a	Same properties as standard character string except that it may also contain space character, the newline character (\n), the equals sign (=)

Type ID	Type	Size	Range	Comments
String		character		and the plus (+) and minus (-) signs. Only found in ASCII records.
Time formats				
Generalised Time	general time	15 bytes	n/a	This is a char(15) data type with a specific format **YYYYMMDDHHMMSSZ**, Z indicates Zulu or UTC time. If a field has a type of general time but no time is applicable, then the field should be filled with the string for "no applicable time", which is a string of 14 lower case 'x' characters terminated by the ASCII character 'Z', e.g., **xxxxxxxxxxxxxxZ**
Long Generalised Time	long general time	18 bytes	n/a	This is a char(18) data type with a specific format **YYYYMMDDHHMMSSmmmZ**, Z indicates Zulu or UTC time. If a field has a type of long general time but no time is applicable, then the field should be filled with the string for "no applicable time", which is a string of 17 lower case 'x' characters terminated by the ASCII character 'Z', e.g., **xxxxxxxxxxxxxxxxxZ**

C.2 Compound data types

Type ID	Type	Size (bytes)	Components
Integers - Variable Scale Factors The EPS product format specification does not allow “real” data types to be present in a product. Instead, real values are encoded into integer format using a fixed scaling factor that is specified in the format specification tables. However, there may be some values that vary too much to be efficiently encoded into an integer value with a fixed scaling factor. If these are single values, they may be encoded into a compound that includes a scaling factor and the integer value as described in this section. If these values are an array of values, they are more easily presented by an array of bytes containing the variable scaling factors followed by an array of integer data types. The real value is calculated by dividing the integer value by the scaling factor expressed as a power of ten.			
Variable Scale Factor Byte	V-BYTE	2	byte + byte
Variable Scale Factor Unsigned Byte	VU-BYTE	2	byte + u-byte
Variable Scale Factor Integer-2	V-INTEGER2	3	byte + integer2
Variable Scale Factor Unsigned Integer-2	VU-INTEGER2	3	byte + u-integer2
Variable Scale Factor Integer-4	V-INTEGER4	5	byte + integer4
Variable Scale Factor Unsigned Integer-4	VU-INTEGER4	5	byte + u-integer4
Variable Scale Factor Integer-8	V-INTEGER8	9	byte + integer8
Variable Scale Factor Unsigned Integer-8	VU-INTEGER8	9	byte + u-integer8

Type ID	Type	Size (bytes)	Components
Time formats CCSDS Day Segmented (CDS) time represents the day since epoch (1 January 2000 starting with 0). The CDS time is UTC-based and takes into account leap second corrections.			
Short CDS Time	short cds time	6	u-integer2 + u-integer4 (Encodes the day since epoch in the first 2 bytes and the number of milliseconds since the beginning of the day in the day in its last 4 bytes)
Long CDS Time	long cds time	8	u-integer2 + u-integer4 + u-integer2 (Encodes the day since epoch in the first 2 bytes, the number of milliseconds since the beginning of the day in its next 4 bytes, and the number of microseconds since the last millisecond in its last 2 bytes)

APPENDIX D FORMAT AND CONTENTS OF THE GRH AND IPR

D.1 Generic Record Header

Field	Description	Type	Size (bytes)	Offset (bytes)
RECORD_CLASS	Class of Record	enumerated	1	0
INSTRUMENT_GROUP	Defining group for record subclasses	enumerated	1	1
RECORD_SUBCLASS	Subclass of this record class	enumerated	1	2
RECORD_SUBCLASS_VERSION	Version of this particular format of the record case	enumerated	1	3
RECORD_SIZE	Total size of the record case (including this header)	u-integer4	4	4
RECORD_START_TIME	Start Time for this record - context will depend on record class	short cds time	6	8
RECORD_STOP_TIME	Stop Time for this record - context will depend on record class	short cds time	6	14
			Total	20

D.1.1 RECORD_CLASS enumerated values

Index	Record Class	Acronym
0	Reserved	
1	Main Product Header Record	MPHR
2	Secondary Product Header Record	SPHR

3	Internal Pointer Record	IPR
4	Global External Auxiliary Data Record	GEADR
5	Global Internal Auxiliary Data Record	GIADR
6	Variable External Auxiliary Data Record	VEADR
7	Variable Internal Auxiliary Data Record	VIADR
8	Measurement Data Record	MDR

D.1.2 INSTRUMENT_GROUP enumerated values

Index	Defining Group
0	GENERIC (no specific instrument)
1	AMSU-A
2	ASCAT
3	ATOVS instruments (AVHRR/3, HIRS/4, AMSU-A, MHS)
4	AVHRR/3
5	GOME
6	GRAS
7	HIRS/4
8	IASI (except IASI L2 products)
9	MHS

10	SEM
11	ADCS
12	SBUV
13	DUMMY
14	ARCHIVE (Note: Only used in GIADRs. A GIADR with INSTRUMENT_GROUP of archive contains only descriptive information and is not processed.)
15	IASI_L2 (used for IASI L2 products only)

D.1.3 RECORD_SUBCLASS values

This is determined by the Instrument Group and shall vary from instrument to instrument and also, if necessary, from processing level to processing level. The record subclasses are defined in the instrument-specific sections of this document.

D.1.4 RECORD_SUBCLASS_VERSION values

This is the version number of the record subclass. Any update to the format of the record subclass will result in the increment of the subclass version number.

D.1.5 RECORD_SIZE values

This field contains the total size of the record subclass (including the GRH) in bytes.

D.1.6 Definitions of RECORD_START_TIME and RECORD_STOP_TIME values

Record Class	Record Start Time	Record Stop Time
Main Product Header Record	RECORD_START_TIME of the first MDR in the product	RECORD_STOP_TIME of the last MDR in the product
Secondary Product Header Record	RECORD_START_TIME of the first MDR in the product	RECORD_STOP_TIME of the last MDR in the product
Internal Pointer Record	RECORD_START_TIME of the first MDR in the product	RECORD_STOP_TIME of the last MDR in the product
Global External Auxiliary Data Record	RECORD_START_TIME of the first MDR in the product	RECORD_STOP_TIME of the last MDR in the product
Global Internal Auxiliary Data Record	RECORD_START_TIME of the first MDR in the product	RECORD_STOP_TIME of the last MDR in the product
Variable External Auxiliary Data Record	The RECORD_START_TIME of the first MDR for which this data applies.	The RECORD_STOP_TIME of the last MDR for which this data was applied.
Variable Internal Auxiliary Data Record	The RECORD_START_TIME of the first MDR for which this data applies.	The RECORD_STOP_TIME of the last MDR for which this data was applied.
Measurement Data Record	Usually the “sensing time” of the first measurement in the record, but see individual PFSs for local definitions	Usually the “sensing time” of the last measurement in the record, but see individual PFSs for local definitions

D.2 Generic Internal Pointer Record

Field	Description	Type	Size (bytes)	Offset (bytes)
TARGET_RECORD_CLASS	Class of target record as derived from the GRH of the target record	enumerated	1	0
TARGET_INSTRUMENT_GROUP	Defining group for target record subclass as derived from the GRH of the target record	enumerated	1	1
TARGET_RECORD_SUBCLASS	Subclass of target record class as derived from the GRH of the target record	enumerated	1	2
TARGET_RECORD_OFFSET	Offset of target record from start of product	u-integer4	4	3
			Total	7

The meaning of the TARGET_RECORD_CLASS, TARGET_INSTRUMENT_GROUP and TARGET_RECORD_SUBCLASS values correspond to those of the RECORD_CLASS, INSTRUMENT_GROUP and RECORD_SUBCLASS in the GRH above, respectively.

The TARGET_RECORD_OFFSET is given in bytes.

APPENDIX E ACRONYMS AND ABBREVIATIONS

1DVar	One dimensional variational assimilation
AAI	Absorbing Aerosol Index
AAPP	ATOVS and AVHRR Pre-processing Package
ADC	Analogue Digital Converter
AMSU	Advanced Microwave Sounding Unit
ANX	Ascending Node Crossing
AOD	Aerosol Optical Depth
ASCAT	Advanced SCATterometer
ASCII	American Standard Code for Information Interchange
ATOVS	Advanced TIROS-N Operational Vertical Sounder
AU	Astronomical Unit
AVHRR	Advanced Very High Resolution Radiometer
BEAT	Basic Envisat Atmospheric Toolbox
BSDF	Bi-directional Scattering Distribution Function
BU	Binary Unit
BUFR	Binary Universal Form for the Representation of meteorological data
C/A	Coarse Acquisition
CAL	Calibration function of EPS
CATGAS	Calibration Apparatus for Trace Gas Absorption Spectroscopy
CCSDS	Consultative Committee for Space Data Systems [recommends data standards]
CDA	Command and Data Acquisition (station)
CFI	Customer Furnished Item
CGS	Core Ground Segment
CGSRD	Core Ground Segment Requirements Document
CIE	Commission Internationale de L’Eclairage/International Commission on Illumination
CM SAF	Climate Monitoring Satellite Application Facility
CMDL	Climate Monitoring and Diagnostics Laboratory
CU	Calibration Unit of the GOME-2 instrument
CVF	Cal/Val Facility at EUMETSAT
DBS	Direct Broadcast Service
DIAL	Differential Absorption Lidar

DISORT	Discrete Ordinate Radiative Transfer model
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
DMDR	Dummy Main Data Record
DMI	Danmarks Meteorologiske Institut
DOAS	Differential Optical Absorption Spectroscopy
DVB	Digital Video Broadcast
DWD	Deutscher Wetterdienst
EARS	EUMETSAT Advanced Retransmission Service
EASOE	European Arctic Stratospheric Ozone Experiment
ECMWF	European Centre for Medium-Range Weather Forecasts
ENVISAT	ENVIronmental SATellite
EOS	Earth Observing System
EPS	EUMETSAT Polar System
EPTOMS	Earth Probe TOMS
ERS	European Remote Sensing (satellite)
ESA	European Space Agency
ESOC	European Space Operations Centre (Darmstadt, Germany)
ESTEC	European Space Technology Centre (Noordwijk, NL)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites (Darmstadt, Germany)
EURD	End User Requirements Document
FIR	Finite Impulse Response
FM	Flight Model.
FMI	Finnish Meteorological Institute or Ilmatieteen Laitos
FOV	Field Of View
FPA	Focal Plane Assembly
FRTM	Fast Radiative Transfer Model
FTIR	Fourier Transform InfraRed
FWHM	Full Width at Half Maximum
GAC	Global Area Coverage (data)
GAW	Global Atmosphere Watch (WMO programme)
GDP	GOME Data Processor (ERS-2)
GEADR	Global External Auxiliary Data Record
GEU	GRAS Electronics Unit
GIADR	Global Internal Auxiliary Data Record
GMF	Geophysical Model Function
GNSS	Global Navigation Satellite System

GOME	Global Ozone Monitoring Experiment
GPS	Global Positioning System
GRH	Generic Record Header
GRIB	Numerical weather prediction data in grid point form, expressed in binary
G/S	Ground Segment
GSN	Ground Support Network
GTL	GOME TimeLine
GTS	Global Telecommunication System
GTT	GOME Timeline Table
GZA	GRAS Zenith Antenna
HCL	Hollow Cathode Lamp
HDF	Hierarchical Data Format
HIRS	High Resolution Infrared Radiation Sounder
HK	Housekeeping
HNMS	Hellenic National Meteorological Service, Greece
HRPT	High Resolution Picture Transmission
IASI	Infrared Atmospheric Sounding Interferometer
ICU	Instrument Control Unit
ID	Identification
IFE	Institut für Fernerkundung der Universität Bremen (D)
IFOV	Instantaneous Field Of View
IIS	Integrated Imaging Subsystem
IPR	Internal Pointer Record
IR	InfraRed
ISCCP	International Satellite Cloud Climatology Project
IT	Integration Time
ITSC	International TOVS Study Conference
KMI	Koninklijk Meteorologisch Instituut van België / Institut Royal Météorologique de Belgique
KNMI	Koninklijk Nederlands Meteorologisch Instituut (De Bilt, NL)
LAP	Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki
LED	Light Emitting Diode
LIDORT	Linearised Discrete Ordinate Radiative Transfer Model
LNB	Low-Noise Block Converter
LNP	Local Normal Pointing
LRPT	Low Resolution Picture Transmission

LSA SAF	Land Surface Analysis Satellite Application Facility
LUT	Look-Up Table
M&C	Monitoring and Control
MDR	Main Data Record
MDR	Measurement Data Record
Metop	METeorological OPerational (satellite)
MF	Météo-France
MHS	Microwave Humidity Sounder
MIPAS	Michelson Interferometer for Passive Atmospheric Sounding
MIRP	Manipulated Information Rate Processor (for high data rate AVHRR)
MLER	Minimum Lambert Equivalent Reflectivity
MLST	Mean Local Solar Time
MME	Müller Matrix Element
MPF	Mission Planning Facility
MPHR	Main Product Header Record
NASA	National Aeronautics and Space Administration
NDSC	Network for the Detection of Stratospheric Change
NDVI	Normalised Difference Vegetation Index
NIR	Near InfraRed
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRT	Near Real Time
NWC SAF	Satellite Application Facility on support to Nowcasting and Very Short-Range Forecasting
NWP	Numerical Weather Prediction
NWP SAF	Numerical Weather Prediction Satellite Application Facility
O3M SAF	Ozone & Atmospheric Chemistry Monitoring Satellite Application Facility
OBCT	On-Board Clock Time
OMI	Ozone Monitoring Instrument
OMPS	Ozone Mapping and Profiler Suite
OSI SAF	Ocean and Sea Ice Satellite Application Facility
PCD	Product Confidence Data
PDU	Product Dissemination Unit
PFS	Product Format Specification
PFV	Product Format Version
PG	Power Gain

PGE	Product Generation Environment	*Note: In the context of the EPS Product Guides and the PGS and PFS documents, the abbreviations PGE & PGF are defined as indicated here, but they may have different meanings in other, more recent, documents.*
PGF	Product Generation Function	
PGS	Product Generation (function) Specification	
PLLO	Phase-Locked Loop Oscillator	
PLM	PayLoad Module	
PMC	Payload Module Control	
PMD	Polarisation Measurement Device	
POD	Precise Orbit Determination	
PPF	Product Processing Facility of the EPS CGS	
PPG	Pixel-to-Pixel Gain	
PQE	Product Quality Evaluation	
PRN	Pseudo Random Noise code [of GPS satellite]	
PRT	Platinum Resistance Thermometer	
PSF	Points Spread Function	
PSO	Position sur l'Orbite	
PU	Polarisation Unit	
RAO	Research Announcement of Opportunity	
RD	Reference Document	
RFCU	Radio Frequency Conditioning Unit	
RMDCN	Regional Meteorological Data Communication Network	
RMS	Root Mean Square	
ROPP	Radio Occultation Processing Package	
RTM	Radiative Transfer Model	
SAA	Southern Atlantic Anomaly	
SAF	Satellite Application Facility	
SAO	Smithsonian Astrophysical Observatory (Cambridge, USA)	
SBT	Satellite Binary Time	
SBUV	Solar Backscatter Ultra-Violet Experiment	
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Cartography	
SEM	Space Environment Monitor	
SESAME	Second European Stratospheric Arctic and Mid-latitude Experiment	
SLS	Spectral Light Source	
SMR	Sun Mean Reference	
SOT	SOlar calibration Timeline	
SPA	Sensor Performance Assessment	
SPHR	Secondary Product Header Record	

SRON	Space Research Organisation of the Netherlands (Utrecht, NL)
SSD	Sounding Support Data
SSST	Single Space Segment Team
SST	Sea Surface Temperature
SVM	SerVice Module
SZA	Solar Zenith Angle
TBC	To Be Confirmed
TBD	To Be Defined
TIROS	Television and InfraRed Operational Satellites
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
TPD	Technisch Physische Dienst (Delft, NL)
TZD	Tropospheric Zenith Delay
UMARF	Unified Meteorological Archive and Retrieval Facility
UTC	Universal Time Coordinated
UTC	Universal Time Clock
UV	UltraViolet
VEADR	Variable External Auxiliary Data Record
VERA	VErsatile Retrieval Algorithm
VIADR	Variable Internal Auxiliary Data Record
VIS	Visible
WLS	White Light Source
WMO	World Meteorological Organization
WOUDC	World Ozone and Ultraviolet Data Centre
YSM	Yaw Steering Mode