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Swarm Level 2 Processing System

Product specification for L2 Products and Auxiliary Products

British Geological Survey (BGS)
National Space Institute – DTU Space (DTU)
Delft Institute of Earth Observation and Space Systems (DEOS)
Helmholtz Centre Potsdam - German Research Centre for Geosciences (GFZ)
Eidgenössische Technische Hochschule Zürich (ETH)
Institut de Physique du Globe de Paris (IPGP)

with additional contributions from

NASA Goddard Space Flight Center (GSFC)
University of Colorado (CIRES)
Charles University Prague (CUP)

Prepared:		Checked:	
Guram Kervalishvili	Date 2021-02-25	Bernhard Fluche	Date 2021-02-25
Scientist		Project Manager	

Approved:

Claudia Stolle	Date 2021-02-25
Team Leader	

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List of TBDs

RID	Section(s)	Actor	Due Date
None			

1 Introduction

1.1 Purpose

This document specifies the Swarm Level 2 products and auxiliary products.

This document is a constituent of the design definition file and is provided in response to the requirement of the Deliverable Item List, SW-LI-ESA-GS-0176, DIL-ID Sys-8.

1.2 Scope

The *Swarm* Level 1b data products are the corrected and formatted output from each of the three *Swarm* satellites. By a complex assimilation of these individual satellite measurements into one set of products for the satellite constellation, the *Swarm* Level 2 Processor ensures a very significant improvement of the quality of the final scientific data products.

This document specifies the intermediate and final data products, the auxiliary products of the *Swarm* Level 2 Processor, and the Quick look reports of L1b data. The definition and justification of Swarm Level 2 data and auxiliary products are documented in [AD-1] and [AD-2] of the ESA Swarm study under ESA contract no. 20969/07/NL/JA.

Originally, the document was proposed to be named “Product specification for Level 2 Products, Quick Look products and Auxiliary Data Products”. It was agreed during the PDGS to L2PS ICD Clarification Meeting on 15-10-2010 that Quick Look reports are included in the L2 products; and that the title of this document will be modified to “Product Specification for Level 2 products and Auxiliary Products”.

1.3 Document structure

The document is structured in the following way:

- The document starts with an overview of applicable and reference documents, and a table of abbreviations in chapter 2.
- The Swarm science objectives are represented in chapter 3.
- Chapter 4 recalls the product structure and format.
- Product specifications are provided in chapter 5. After a comprehensive overview of the different products, each product is specified in detail.

1.4 Online version

An online version in the form of a website called “Swarm Product Data Handbook” is available for information on Swarm, which is also includes the information from this document:

http://swarm-wiki.spacecenter.dk/mediawiki-1.21.1/index.php/Main_Page

The Swarm Product Data Handbook provides a detailed description of the Swarm Level 1b and Swarm Level 2 products including supporting information distributed to the Swarm users.

2 Applicable and Reference Documentation

2.1 Applicable Documents

[AD-1] PDD – Product Definition Document (SWL2_SPT_PDD)

[AD-2] LPM – List and Description of Auxiliary Data and Prior Models Needed (SWL2-SPT-LPM)

[AD-3] ADD – Architecture Design Document (SWL2_SPT_ADD)

[AD-4] SWRD – Software Requirement Document (SWL2_SPT_SWRD)

[AD-5] Swarm Level 1b Product Definition (SW-RS-DSC-SY-0007)

[AD-6] Swarm Level 0 Product Format, Doc. No: SWARM-GSEG-EOPG-05-001, ESA ESTEC, Noordwijk, The Netherlands

[AD-7] Earth Explorer File Format Standards Doc. No: PE-TN-ESA-GS-0001 ESA ESTEC, Noordwijk, The Netherlands

[AD-8] Tailoring of File Format Standards to Swarm Mission Doc. No: SW-TN-ESA-GS-0074 ESA ESTEC, Noordwijk, The Netherlands

[AD-9] Preparation of the Swarm Level 2 Data Processing, Final Report Doc. No: SWL2-SPT-FR

[AD-10] Statement of work (SoW) for the Development of the Swarm Level 2 Algorithms and Associated Level 2 Processing Facility, Doc. No: SW-SW-ESA-GS-0179

[AD-11] L2 CAT-2 Processors Auxiliary Data Providers to Swarm PDGS Interface Control Document, Doc ID: SWAM-GSEG-EOPG-IC-011-0004

2.2 Reference Documents

[RD-1] Swarm Level 1b Processor Characterisation and Calibration Data Base Doc. No: SW-TN-DSC-SY-0005 National Space Institute, Technical University of Denmark

[RD-2] Swarm Level 1b Processor Algorithms Doc. No: SW-RS-DSC-SY-0002 National Space Institute, Technical University of Denmark

[RD-3] Finlay, C. C. et al., International Geomagnetic Reference Field – the eleventh generation, Geophys. J. Int., 183, 1216-1230, doi: 10.1111/j.1365-246X.2010.04804.x., 2010

[RD-4] Olsen, N., H. Lühr, T. J. Sabaka, M. Mandea, M. Rother, L. Tøffner-Clausen and S. Choi, CHAOS—a model of the Earth's magnetic field derived from CHAMP, Ørsted, and SAC-C magnetic satellite data, Geophys. J. Int., 166, doi: 10.1111/j.1365-246X.2006.02959.x, 2006

[RD-5] http://core2.gsfc.nasa.gov/CM/

[RD-6] Wardinski, I., Continuous Covariant Constrained-end-points field model (C3FM) published online at www.gfz-potsdam.de/pb2/pb23/Models/index.html, 2007

[RD-7] Lesur, V., I. Wardinski, M. Rother, and M. Mandea, GRIMM - The GFZ Reference Internal Magnetic Model based on vector satellite and observatory data, Geophys. J. Int., doi:10.1111/j.1365-246X.2008.03724.x, 2008

[RD-8] Maus, S., M. Rother, C. Stolle, W. Mai, S. Choi, H. Lühr, D. Cooke, and C. Roth, Third generation of the Potsdam Magnetic Model of the Earth (POMME), Geochem. Geophys. Geosyst., 7, Q07008, doi:10.1029/2006GC001269, 2006

[RD-9] Maus, S., H. Lühr, M. Rother, K. Hemant, G. Balasis, P. Ritter, and C. Stolle, Fifth-generation lithospheric magnetic field model from CHAMP satellite measurements, Geochem. Geophys Geosyst., 8, Q05013, doi:10.1029/2006GC00152, 2007

[RD-10] Kuvshinov, A., and N. Olsen, A global model of mantle conductivity derived from 5 years of CHAMP, Ørsted, and SAC-C magnetic data, *Geophys. Res. Lett.*, 33, L18301, doi:10.1029/2006GL027083.3, 2006

[RD-11] Maus, S., Rother, M., Hemant, K., Stolle, C., Lühr, H., Kuvshinov, A., and Olsen, N., Earth's lithospheric magnetic field determined to spherical harmonic degree 90 from CHAMP satellite measurements, Geophys. J. Int., 164, 319–330, doi: 10.1111/j.1365-246X.2005.02833.x, 2006

[RD-12] Manoj C., A. Kuvshinov, S. Maus and H. Lühr, Ocean circulation generated magnetic signals, Earth, Planets and Space, 58, 429-437, 2006

[RD-13] Olsen, N., T. J. Sabaka, and F. Lowes: New Parameterization of External and Induced Fields in Geomagnetic Field Modeling, and a Candidate Model for IGRF 2005, Earth, Planets and Space, 57, 1141-1149, 2005

[RD-14] Lühr, H.; Maus, S.: Solar cycle dependence of quiet-time magnetospheric currents and a model of their near-Earth magnetic fields. Earth Planets and Space, 62 (No. 10), 843-848, 2010

[RD-15] Olsen, N., Sabaka, T. J. and Gaya-Pique, L. R., Study of an Improved Comprehensive Magnetic Field Inversion Analysis for Swarm. Final report to ESA study with contract number 19690/06/NL/CB

[RD-16] Swarm Level 0 Products, doc. no: SW.IF.EAD.GS.00017, EADS Astrium, Friedrichshafen, Germany

2.3 Abbreviations

Acronym	*Description*
ACC	Accelerometer
ADC	Analogue to Digital Converter
ADD	Architecture Design Document
APDF	Archiving and Payload Data Facility
AOCS	Attitude & Orbit Control Subsystem
ANGARA	Analysis of Non-Gravitational Accelerations due to Radiation and Aerodynamics
ASM	Absolute Scalar Magnetometer
AMPS	Average Magnetic field and Polar current System
BGS	British Geological Survey

Acronym	*Description*
CCDB	Characterisation and Calibration Data Base
CDC	Compact Detector Coil
CDR	Critical Design Review
CI	Comprehensive Inversion
CoG	Center of Gravity
CSC	Compact Spherical Coil
CRC	Cycle Redundancy Code
CRF	Common Reference Frame
DCG	Document Contents Guidelines
DS	Data Set
DSD	Data Set Description
DSR	Data Set Records
DNSC	Danish National Space Center (now DTU Space)
DTU	Technical University of Denmark
EADS	European Aeronautic Defence and Space
EEF	Earth Explorer Format
	Eastward Electric Field
EESS	End-to-End System Simulator
EFI	Electric Field Instrument
EPS	Electrical Power Subsystem ITRF
ESA	European Space Agency
eu	engineering unit
FAC	Field-Aligned Current
GFZ	GeoForschungsZentrum, Potsdam, germany
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPSR	GPS/GNSS Receiver
GS	Ground Segment
HWM	Horizontal Wind Model
ICRS	International Celestial Reference System
ICGFM	International Center for Global Earth Models

Acronym	*Description*
IERS	International Earth Rotation Service
IGRF	International Geomagnetic Reference Field
IGS	International GNSS Service
IPGP	Institut de Physique du Globe de Paris, France
IPIR	Ionospheric Plasma IRregularities characterised by the Swarm satellites
IRI	International Reference Ionosphere
ITRF	International Terrestrial Reference Frame
ISP	Instrument Source Packet
ITRS	International Terrestrial Reference System
JPL	Jet Propulsion Laboratory
KO	Kick-Off
LDA	Local Data Archive
LP	Langmuir Probe
L2PS	Level 2 Processing System
MSIS	Mass Spectrometer and Incoherent Scatter
MOD	Medium precision Orbit Determination
MPH	Main Product Header
MPPF	Mission Performance & Planning System
NEC	North-East-Centre reference frame
N/A	Not Applicable
NRL	Naval Research Laboratory
PC	Polar Cap index
PDGS	Payload Data Ground Segment
PDS	Payload Data Segment
PPS	Pulse per Second
POD	Precise Orbit Determination
S/C	Spacecraft
SCARF	Satellite Constellation Application and Research Facility
SMART	Swarm Magnetic and Atmospheric Research Team
SOW	Statement of Work
SPH	Specific Product Header

Acronym	*Description*
SRD	System Requirements Document
STR	Star Tracker
SV	Secular Variation
TBC	To Be Confirmed
TBD	To Be Defined
TCF	Temporal Calibration File
TII	Thermal Ion Imager
uc	unsigned character
UTC	Universal Time Coordinated
VFM	Vector Field Magnetometer

3 The Swarm Science Objectives

According to ESA SP-1279(6) "Swarm – The Earth Magnetic Field and Environment Explorer, Report for Mission Selection", the five research objectives of the *Swarm* mission are:

O1: Studies of core dynamics, geodynamo processes, and core-mantle interaction

O2: Mapping of the lithospheric magnetisation and its geological interpretation

O3: Determination of the 3-D electrical conductivity of the mantle

O4: Investigation of electric currents flowing in the magnetosphere and ionosphere

O5: Magnetic Forcing of the Upper Atmosphere

During the ESA *Swarm* study "Preparation of the *Swarm* Level 2 Data Processing" [AD-9] advanced models for the various contributions to the Earth's magnetic field have been identified as Level 2 products. In particular, the Comprehensive Inversion (CI) providing mathematical descriptions of the various geomagnetic field contributions is required. In order to derive the best model for each of the various contributions to the geomagnetic field, it is necessary to co-estimate or correct for various other parts to the field. As an example, fields from magnetospheric and ionospheric currents and their Earth-induced counterparts have to be considered when modelling the internal part of the field. If a typical user of magnetic field models relies only on standard models, he/she may not be able to take full advantage of the constellation measurements and thus miss the advantages offered by *Swarm*. This clearly argues for advanced *Swarm* Level 2 magnetic field models.

Also the other science objectives, for instance determination of the electrical conductivity of the mantle, require data products with a good description of the time-space structure of the external (magnetospheric) field and its Earth-induced counterpart.

How the products are attributed to the Swarm Science Objectives is described in Table 5-1and Table 5-2.

4 Structure of product files

This section describes the general structure of the Level 2 product files, which is derived from and similar as described for the Level 1b product format description in [AD-5].

4.1 General Structure of products

The structure of the products produced for delivery to the PDGS follows the requirements of [AD-7] as represented in Figure 4.1 below.

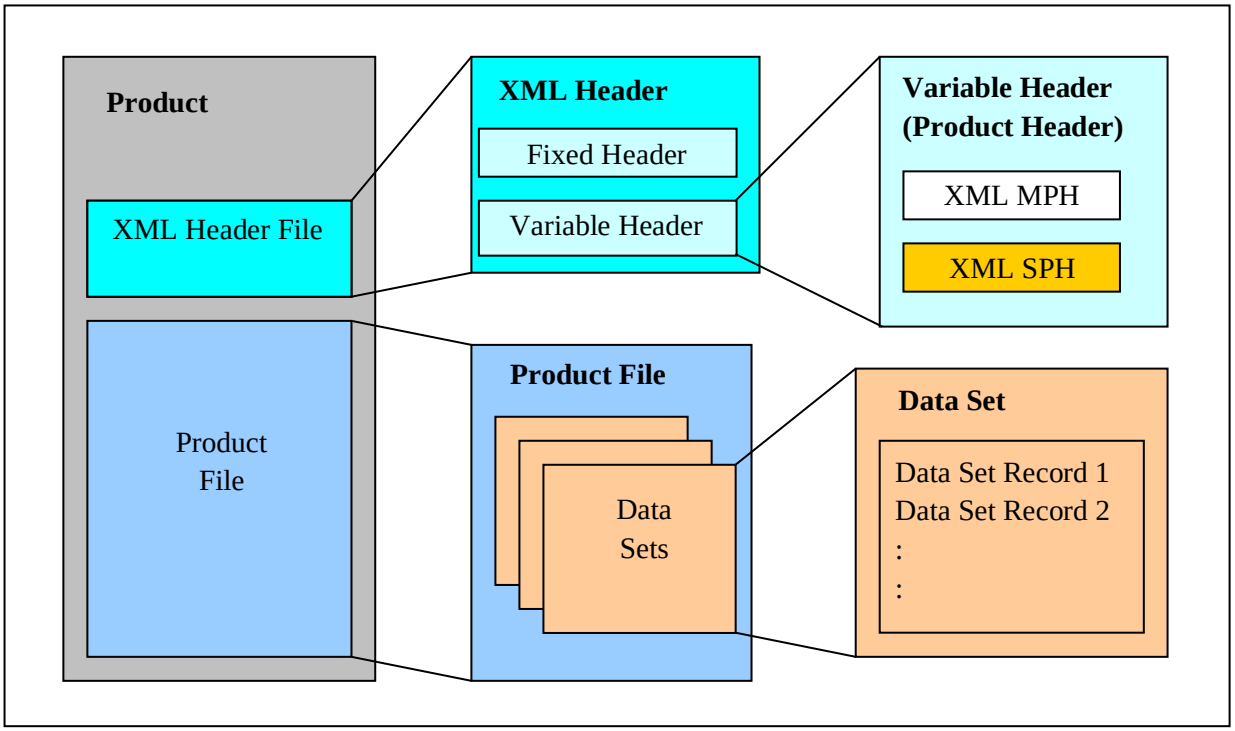

Figure 4.1 General Product Structure

Each product is composed of two physical files:

- XML Header file with extension .HDR
- Product file with an extension depending on the product (see section 5.3)

The XML Header file is an ASCII file containing data information that users can easily access for identifying the product without needs to look inside the product file.

It consists of

- Fixed Header, a common header for all files in the Swarm Ground Segment
- Variable Header, including
  - Main Product Header (MPH) containing general information.
  - Specific Product Header (SPH) containing product specific information. The Specific Product Header will also contain references to auxiliary and/or input files relevant for the specific product.

The product file is the real product containing the processing results.

4.2 XML Header File

The XML Header file contains information identifying the product.

The Fixed Header (hereafter called Standard Swarm Header) is the common header for all files in the Swarm Ground Segment, which means it is applied to all files flowing amongst the sub-systems composing the PDGS.

The format of the Standard Swarm Header is under ESA responsibility and is specified in [AD-7] and [AD-8].

The Variable Header (hereafter called Product Header) is the header with format and content depending on the file type and kind of product.

The next sub-paragraphs specify the content of these headers.

4.2.1 Level 2 Products Fixed Header (Standard Swarm Header)

The Standard Swarm Header is completely ASCII and based on XML syntax and conventions proposed in [AD-7].

Table 4-1: Level 2 Fixed Header

Field #	Description	Units		Format
1	File_Name	Tag		
	Product file name (without extension) (see Section 4.4)			55*uc
2	File_Description	Tag		
	Description such as mid column in Table 5-1 - Table 5-3 (For CAT-2 AUX products, allowed entries are described in [AD-11].)			x*uc
3	Notes	Tag		
	This field will be empty.			

Field #	Description	Units		Format
4	Mission	Tag		
	Will be “Swarm”.			5*uc
5	File_Class	Tag		
	Type of processing; character 9 – 18 in the file name (see Section 4.4), this can be: OPER = Routine operations RPRO = Reprocessing			4*uc
6	File_Type	Tag		
	Product name, first column in Table 5-1- Table 5-3			10*uc
7	Validity_Period	Tag		
7.1	Validity_Start	Tag		
	Start time of validity period UTC=yyyy-mm-ddThh:mm:ss			23*uc
7.2	Validity_Stop	Tag		
	Stop time of validity period UTC=yyyy-mm-ddThh:mm:ss			23*uc
8.	File_Version	Tag		
	Version number of the product Start with 0001 and increases by one if following product versions are generated.			%04d
9.	Source	Tag		
9.1	System	Tag		
	Name of the Ground Segment component: L2PS: for CAT_1 products APDF: for CAT-2 products			4*uc
9.2	Creator	Tag		
	Name of Level 2 processor , such as *CI* for comprehensive inversion, or *IBI* for bubble index, *SwarmLevel2Create* for CAT-1 AUX products, *ADF Preprocessor* for CAT-2 AUX products.			x*uc
9.3	Creator_Version	Tag		

Field #	Description	Units		Format
	Version of Level 2 processor VV.rr			5*uc
9.4	Creation_Date	Tag		
	Date of file creation: UTC=yyyy-mm-ddThh:mm:ss			23*uc

4.2.2 Level 2 Products Variable Header (Product Header)

The XML Variable Header (hereafter called Product Header) for the Level 2 products is composed by:

- an XML Main Product Header (XML MPH), and
- an XML Specific Product Header (XML SPH)

Each header is completely ASCII and based on XML syntax and conventions proposed in the [AD-7].

The following sections describe the MPH and SPH for Level 2, Cat-1 Auxiliary products, and Cat-2 Auxiliary products AUX_LIT_2F, AUX_COR_2F and AUX_IGR_2F. MPH and SPH for all other CAT-2 AUX products are described in [AD-11].

4.2.2.1 XML Main Product Header (XML MPH)

The Main Product Header (MPH) has the following format – very similar to the Level 0 and Level 1b Main Product Header ([AD-5],[AD-6]), see also [AD-8]:

Table 4-2 Level 2 Main Product Header (MPH)

Field #	Description	Units		Format
1	MPH	Tag		
Following fields 1.1 – 1.9 are valid for all L2, Cat-1 Auxiliary products, and Cat-2 AUX_LIT_2F, AUX_COR_2F and AUX_IGR_2F Auxiliary products (not for other Cat-2 Auxiliary products)				
1.1	Product	Tag		
	Product file name (without extension) (see Section 4.4)			55*uc
1.2	Product_Format	Tag		
	Format of the Product file: CDF, PDF or ASCII			5*uc
1.3	Proc_Stage_Code	Tag		
	character 9 – 18 in the file name (see Section 4.4), this can be: OPER = Routine operations			4*uc

Field #	Description	Units		Format
	RPRO = Reprocessing			
1.3	Ref_Doc	Tag		
	Reference Document describing the product, shall be *SW-DS-DTU-GS-0001*			17*uc
Data Processing Information				
1.4	Proc_Center	Tag		
	Processing Center ID code: BGS = British Geological Survey DEOS = DEOS DTU = DTU Space ETH = Eidgenössische Technische Hochschule GFZ = GeoForschungsZentrum Potsdam IPGP = Institut de Physique du Globe de Paris PDGS = Payload Data Ground Segment			4*uc
1.5	Proc_Time	Tag		
	Processing Time, UTC (Product Generation Time) UTC=yyyy-mm-dd Thh:mm:ss.uuuuuu			30*uc
1.6	Software_Version	Tag		
	Processor Name and software version number *ProcessorName*/VV.rr *(Processor name* as tag 9.2 of Fixed header)			x*uc
Product Confidence Data Information				
1.7	Product_Err	Tag		
	Product Error Flag. Set to 0 if product is fully ok, non-zero if any problems or errors are present			uc
Product Size Information				
1.8	Tot_Size	Tag		
	unit=”bytes”	Attribute		

Field #	Description	Units		Format
	Total size of product	bytes		%+021d
1.9	CRC	Tag		
	Cyclic Redundancy Code computed as overall value of all records of the Measurement Data Set. Will be set to "-0000000001" if not computed.			%+011d

4.2.2.2 XML Specific Product Header (XML SPH)

The formats of the Specific Product Headers (SPHs) are described. The SPHs are separately described for Level-2 Products (Cat-1 and Cat-2) and for CAT-1 AUX products. The SPH for CAT-1 AUX products applies also to the CAT-2 AUX products AUX_IGR_2F, AUX_COR_2F and AUX_LIT_2F. The SPH's for all other CAT-2 AUX products are described in [AD-11].

Table 4-3 Level 2 Specific Product Header (SPH) – For L2 Cat-1 and L2 Cat-2 products

Following fields 1.1 – 1.6 are valid for L2 Cat-1 products				
Field #	**Description**	**Units**		**Format**
1	SPH	Tag		
1.1	SPH_Descriptor	Tag		
	Product Name, first column of Tables 5.1 – 5.3			10*uc
1.2	Original_Filename	Tag		
	Name of original files, e.g, "*.SP3" for GPS orbit files			x*uc
Information on Time of Data				
1.3	Sensing_Time_Interval	Tag		
1.3.1	Sensing_Start	Tag		
	Start time in UTC of sensing data UTC=yyyy-mm-ddThh:mm:ss.uuuuuu			30*uc
1.3.2	Sensing_Stop	Tag		
	Stop time in UTC of sensing data UTC=yyyy-mm-ddThh:mm:ss.uuuuuu			30*uc

Product Confidence Section – various information on the quality of the product, such as number of missing or erroneous ISPs (Instrument Source Packets) and number of rejected or suspicious samples.				
1.4	Product_Confidence_Data	Tag		
1.4.1	Quality_Indicator	Tag		
	General product quality indicator, 000 if best quality is expected, 001 if the quality is acceptable.			%03d
List of Input files				
1.5	List_of_Input_File_Names	Tag		
	count=”n”	Attribute		
This part is repeated n *times, one for each input file*				
1.5.i	File_Name			*uc
	Name of processor input file *i*			
List of Output files				
1.6	List_of_Output_File_Names	Tag		
	count=”n”	Attribute		
This part is repeated n *times, one for each output file*				
1.6.i	File_Name			*uc
	Name of processor output file *i*			
Following fields 1.1 – 1.5 are valid for L2 Cat-2 products				
Field #	**Description**	**Units**		**Format**
1	SPH	Tag		
1.1	SPH_Descriptor	Tag		
	Product Name, first column of Tables 5.1 – 5.3			10*uc
Information on Time of Data				
1.2	Orbit_Information	Tag		
1.2.1	Sensing_Start	Tag		

	Start time in UTC of sensing data UTC=yyyy-mm-ddThh:mm:ss.uuuuuu			30*uc
1.2.2	Sensing_Stop	Tag		
	Stop time in UTC of sensing data UTC=yyyy-mm-ddThh:mm:ss.uuuuuu			30*uc
Information on manoeuvre				
1.3	Maneuver_Information	Tag		
	count=”n”	Attribute		
1.3.*i*	Maneuver_Id *i*=1, ..., n	Tag		
	The i^{th}, distinct maneuver identification code [RD-16]			%03d
Product Confidence Section – various information on the quality of the product, such as number of missing or erroneous ISPs (Instrument Source Packets) and number of rejected or suspicious samples.				
1.4	Product_Confidence_Data	Tag		
1.4.1	Quality_Indicator	Tag		
	General product quality indicator **FAC_TMS_F and FACx_TMS_2F:** 000 no problems at all occurred 001 quality_indicators is 001 in the L1b header of one of the MAGx_LR_1B 010 Flags(1) or Flags(2) is/are larger than 0 (data gaps occurred) 100 if one or all of Flags(3...8) are larger than 0 (problems with auxiliary data for magnetospheric field calculation occurred); And combinations of quality indicators **IBIxTMS_2F:** 000 no problems at all occurred 001 quality_indicators is 001 in the L1b header of one of the MAGx_LR_1B or EFIx_PL_1B 010 all of the Bubble_Index within the output are -1 (unanalyzable) **TECxTMS_2F:** 000 no problems at all occurred			%03d

	001 L1b header of one of the MODx_SC_1B or GPSx_RO_1B quality_indicators is 001 010 daily average of Relative_STEC_RMS or daily average of DCB_Error is larger than 2 TECU **EFFxTMS_2F:** 000: no problems at all occurred 001: L1b header of one of the MAGx_LR_1B quality indicators is 001 010: Flags(4) is larger than 0 (data gap prevented processing)			
List of input files				
1.5	List_of_DSDs	Tag		
	count=”n”	Attribute		
This part is repeated n *times, one for each input file*				
1.5.i	DSD	Tag		
	Data Set *i* descriptor, *i* = 1,2,…,n			
1.5.*i*.1	Data_Set_Name	Tag		
	Product name (see Table 5-2 Final Level 2 products)			10*uc
1.5.*i*.2	Data_Set_Type	Tag		
	Type of Data Set: M – measurement R – reference			uc
1.5.*i*.3	File_Name	Tag		
	Name of Input File (without extension)			55*uc
1.5.*i*.4	Data_Set_Offset	Tag		
	unit=”bytes” Offset (in bytes) of first byte of first DS record within Product File. Only used if Data_Set_Type = “M”, otherwise set to zeros.	Attribute		%+021d
1.5.*i*.5	Data_Set_Size	Tag		
	unit=”bytes”	Attribute		

	Total number of bytes in DS Only used if Data_Set_Type = "M", otherwise set to zeros.			%+021d
1.5.*i*.6	Num_of_Records	Tag		
	Number of Data Set records. Only used if Data_Set_Type = "M", otherwise set to zeros.			%+011d
1.5.*i*.7	Record_Size	Tag		
	unit="bytes" Size of Data Set records If variable set to –0000000001 Only used if Data_Set_Type = "M", otherwise set to zeros.	Attribute		%+011d
1.5.*i*.8	Byte_Order	Tag		
	Byte ordering information. 3210 → Big-endian 0123 → Little-endian Only used if Data_Set_Type = "M", otherwise set to "0000".			4*uc

Table 4-4 Level 2 Specific Product Header (SPH) – For CAT-1 AUX products and for AUX_IGR_2F, AUX_COR_2F and AUX_LIT_2F

Field #	**Description**	**Units**		**Format**
1	SPH	Tag		
1.1	SPH_Descriptor	Tag		
	Product Name, first column of Tables 5.1 – 5.3			10*uc
Information on Time of Data				
1.2	Validity_Time_Interval	Tag		
1.2.1	Validity_Start	Tag		
	Start time in UTC of sensing data UTC=yyyy-mm-dd Thh:mm:ss.uuuuuu			33*uc
1.2.2	Validity_Stop	Tag		

	Stop time in UTC of sensing data UTC=yyyy-mm-dd Thh:mm:ss.uuuuuu			33*uc
Product Confidence Section – various information on the quality of the product, such as number of missing or erroneous ISPs (Instrument Source Packets) and number of rejected or suspicious samples.				
1.4	Product_Confidence_Data	Tag		
1.4.1	Quality_Indicator	Tag		
	Generel product quality indicator, 000 if best quality is expected. A different number than 000, if problems occurred during processing.			%03d
Originator information				
1.5	Source	Tag		
1.5.1	Original_Filename	Tag		
	Name of the original file before reformatting Examples: AUX_KP__2_ : kp*yyyy*.wdc AUX_DST_2_ : dst*yyyymm*.ig2 AUX_F10_2_ : DAILYPLT.OBS AUX_IMF_2_ : omni2_h0_mrg1hr_*yyyymmdd*_v01.cdf AUX_OBS_2_ : *yyyy*.min (if only obsyyyymmddqmin.min files as input) *yyyy.wdc (if only obs*yyyy*.wdc as input) wdc_mixed (if obsyyyymmddqmin.min and obs*yyyy*.wdc as input) AUX_COR_2_ : *freely chosen by the chain* AUX_LIT_2_ : *freely chosen by the chain* AUX_IGR_2_ : igrf12coeffs.txt AUX_COR_2F : *as for AUX_COR_2_* AUX_LIT_2F : *as for AUX_LIT_2_* AUX_IGR_2F : *as for AUX_IGR_2_* with *yyyy*=year, *mm*=month and *dd*=day			x*uc
1.5.2	Creator_Date	Tag		
	Date of creation of the original file UTC=yyyy-mm-ddThh:mm:ss			23*uc
1.5.3	Creator	Tag		

	Name of the external facility creating the original file, e.g., AUX_KP__2_ : Niemegk observatory AUX_DST_2_ : WDC Kyoto AUX_F10_2_ : NGDC NOAA AUX_IMF_2_ : NASA AUX_OBS_2_ : INTERMAGNET and WDC Edinburgh AUX_COR_2_ : GFZ AUX_LIT_2_ : IPGP AUX_IGR_2_ : IAGA AUX_COR_2F : *as for AUX_COR_2_* AUX_LIT_2F : *as for AUX_LIT_2_* AUX_IGR_2F : *as for AUX_IGR_2_*			x*uc

4.2.3 Input Files

Input files to the Level 2 Processor (Level 1b and auxiliary products) used in the generation of the products are specified in the specific product header (section 4.2.2.2).

4.3 Product File Formats

The L2 and Auxiliary Product File consist of data sets with specific formats that have been agreed during the SCARF Technical Meeting 2 on February 22/23, 2010. Five different formats exist:

- ASCII Listing (SHC format)
- ASCII Listing (SP3 format)
- ASCII Listing (XML)
- ASCII Listing (others)
- CDF-format
- PDF-files

The following section describes the format categories in more detail. The format category for the individual products is provided in Table 5-1 – Table 5-3.

4.3.1 ASCII Listing (SHC format)

All core and lithosphere magnetic field model products (final and intermediate) obey the SHC format. Missing data values are marked with `NaN`.

The Gauss coefficients g and h of spherical harmonic models are given as snapshots at different time instants. A static field (i.e. the high-degree lithospheric field) is given as one snapshot; the core field is provided as a series of snapshot models.

Each file contains one or more blocks. Each of these blocks describes a certain range of Gauss coefficients with the same description of time dependence (i.e. either static, linear time dependent, cubic splines, or order-6 splines, or others).

Each block contains a header part and a coefficient part of length K = N_max*(N_max+2) – (N_min-1)*(N_min+1) lines with the Gauss coefficients stored row-wise in natural order (g_1^0, g_1^1, h_1^1, g_2^0 g_2^1 h_2^1, …). The first column of this coefficient part contains spherical harmonic degree n, the second contains spherical harmonic order m. Non-negative values of the order refer to the Gauss coefficients g_n^m while negative orders indicate the Gauss coefficients h_n^m. Rows 3 to `N_times+2` of this coefficient part contains the Gauss coefficients of the `N_times` snapshot models, provided at the time instants `t` (given in decimal years).

Such a series of snapshot models is sufficient to completely describe a model if its time dependence is constant, a Taylor expansion in time, or a piecewise linear varying spline (order 2 spline).

In the case of a time dependence described by splines of order larger than 2 (e.g. cubic splines, i.e. spline of order 4), additional information is needed to reconstruct the time dependence from the `N_times` snapshot models. Within SCARF, following format applies: providing `spline_order` snapshot models for each knot interval (i.e. an "oversampling" of the model), indicated by the value `N_step` (which is equal to `spline_order-1` in this case). This is explained in Table 4-5 SHA format used in SCARF. Every `N_step` value of time t (in decimal years) are the spline knots, and therefore `N_step = spline_order - 1`.. It is possible to read the whole block using space-delimited free format read instructions.

# Comment line part. An arbitrary number of comment lines, each starting with '#',						
# may be added before or after each block						
N_min	N_max	N_times	spline_order	N_step =spline_order -1	Start validity time (*optional*)	Stop validity time (*optional*)
		t(1)	t(2)	t(3)	…	t(N_times)
N_min	0	g(1)	g(2)			g(N_times)
N_min	1	g(1)	g(2)			g(N_times)
N_min	-1	h(1)	h(2)			h(N_times)
n	m	g(1)	g(2)			g(N_times)
n	-m	h(1)	h(2)			h(N_times)
N_max	N_max	g(1)	g(2)			g(N_times)
N_max	-N_max	h(1)	h(2)			h(N_times)

Table 4-5 SHA format used in SCARF. Every `N_step` value of time `t` (in decimal years) are the spline knots, and therefore `N_step = spline_order - 1`.

Table 4-6 Has become obsolete. Deleted.

4.3.2 ASCII Listing (SP3 format)

The National Geodetic Survey Standard GPS Format SP3 is a specific format which is applied to represent ephemeris and other orbit characteristics of satellites.

The format is described and discussed in detail in http://www.ngs.noaa.gov/orbits/sp3_docu.txt . All times in a SP3 files refer to GPS time.

4.3.3 ASCII Listing (XML format)

Has become obsolete. Deleted.

Table 4-7 Has become obsolete. Deleted.

4.3.4 ASCII Listing (others)

Products that are given in standardized formats are represented as ASCII listing. Formats for Euler angles Mantle conductivity and ionospheric field products are described below. Other products may have different ASCII formats, which are described in respective tables of sections 5.7 - 5.14.

4.3.4.1 Format for Euler Angle Products (MSW_EUL)

Euler angles are represented in the reference frame described in Fig 5.2 and Eqs. (5.4)-(5.7) of [RD-15]. Following 3 comment lines, each line presents one time instant. After the time stamp the lines consist of 9 values; 3 Euler angles (in degree) for each of the 3 Swarm satellites. Quality indicators for the Euler angle estimation are part of internal product validation reports (MSW_VALi2C, MSW_VALi2D).

```
# Header line
# Header line
# MD2000 SW-A(alpha) SW-A(beta) SW-A(gamma) SW-B(alpha) SW-B(beta) SW-B(gamma) SW-C(alpha) SW-C(beta) SW-C(gamma)
 -534.00  -0.478881   0.968858   -0.171713    0.224457   -0.120588   -0.342825    0.617217   0.830820    0.865270
 -504.00  -0.478882   0.968854   -0.171712    0.224457   -0.120592   -0.342825    0.617209   0.830820    0.865277
  ...
```

Table 4-8 Format example of Euler Angle products MSW_EUL

4.3.4.2 Format for mantle conductivity products (MIN_1DM, MIN_3DM, MCR_1DM, MCR_3DM)

The format for products `MIN_1DM_2_`, `MIN_3DM_2a`, `MIN_3DM_2b` and corresponding intermediate products is described as follows:

```
# Arbitrary number of comment lines starting with # sign
N_layer   N_theta   N_phi
theta_b   phi_b
<layer_1>
<layer_2>
<layer_3>
...
<layer_Nlayer>
```

where

`N_layer` is the number of layers;

`N_theta` is the number of colatitude nodes. Colatitude of the first node is `90.0/real(N_theta)`. Step in colatitude is `180.0/real(N_theta)`, index increases from North to South;

`N_phi` is the number of longitude nodes. Longitude of the first node is `180.0/real(N_phi)`. Step in colatitude is `360.0/real(N_phi)`, index increases from West to East;

`theta_b, phi_b` are the geographic colatitude and longitude of the North pole in degrees. For example, if (theta_b,phi_b)= (0.00, 00.00) the coordinate system used in this file coincides with geographic. If (theta_b,phi_b)= (9.92,287.78) the coordinate system used in this file coincides with dipolar IGRF11 at epoch 2010.0.

Each <layer_k> block consists of:

```
k r_k sigma0_k 3Dflag
[sigma_k]
```

where
k is the number of layer. Layers are numbered from surface to bottom, starting from 1;

r_k is the radius of the outer boundary of the k-th layer in kilometers. For Earth, r_1 should be 6371.2.

sigma0_k is the conductivity in the k-th layer (Siemens per meter)

3Dflag if it equals to 1; the k-th layer is laterally homogeneous (1-D) with conductivity sigma0_k. No 3-D conductivity is stored, and next block <layer_k+1> immediately follows; if it equals to 3, the k-th layer is laterally heterogeneous (3-D). Array sigma_k is expected in the next N_theta lines

sigma_k is an array containing the conductivity distribution in the k-th layer. It is present only if corresponding 3Dflag is 3. Each line corresponds to one colatitude, ordered north to south, each column to one longitude ordered eastwards. Unit is S/m.

Additional notes: If the conductivity model is only 1-D, without any lateral heterogeneities, values assigned to N_theta, N_phi, theta_b, and phi_b do not influence the model definition, and are in principle arbitrary. For consistency in reading, they should be included in the file with safe values (N_theta,N_phi)= (1,1), and (theta_b,phi_b)= (0.00, 00.00). Similarily, for 3-D layers, where sigma_k is given, the corresponding sigma0_k doesn't influence the model definition, and can be arbitrary. It can be used to store any auxiliary conductivity value related to the given layer (i.e., background 1-D value, arithmetic or geometric average of conductivity etc.) but shouldn't be relied upon.

The format for products MCR_1DM_2_ and MCR_1DM_2_ and corresponding intermediate products is described as follows:

The files are in ASCII format with LF control character used for newline (unix style), and arbitrary number of spaces used as variable separator in a line. General structure of the files is as follows:

```
# Arbitrary number of comment lines starting with # sign
N_periods N_theta   N_phi   3Dflag
<block_1>
<block_2>
<block_3>
...
<block_N_periods>
```

where

N_periods is the number of periods;

N_theta is the number of colatitude nodes. Colatitude of the first node is 90.0/real(N_theta). Step in colatitude is 180.0/real(N_theta), index increases from North to South;

N_phi is the number of longitude nodes. Longitude of the first node is 180.0/real(N_phi). Step in colatitude is 360.0/real(N_phi), index increases from West to East;

3Dflag equals to 1 for global 1D responses, or equals to 3 if we 2-D maps of C-responses are provided

Each <block_k> block consists of:
k T_k ReC0_k ImC0_k Err0_k Coh20_k

[ReC3D_k]
[ImC3D_k]
[Err3D_k]
[Coh23D_k]

where
k is the index of period. Ordering of periods is arbitrary.

T_k is the k-th period in days.

ReC0_k is the real part of C response at period T_k in kilometers.

ImC0_k is the imaginary part of C response at period T_k in kilometers.

Err0_k is the uncertainty of C response estimation at period T_k in kilometers.

Coh20_k is the squared coherence at period T_k (dimensionless).

ReC3D_k is an array of real parts of local C responses on a N_theta x N_phi grid at period T_k in kilometers. Each line corresponds to one colatitude, ordered north to south, each column to one longitude ordered eastwards. It is present only if 3Dflag equals to 3.

ImC3D_k is an array of imaginary parts of local C responses on a N_theta x N_phi grid at period T_k in kilometers. Each line corresponds to one colatitude, ordered north to south, each column to one longitude ordered eastwards. It is present only if 3Dflag equals to 3.

Err3D_k is an array of uncertainty estimates of local C responses on a N_theta x N_phi grid at period T_k in kilometers. Each line corresponds to one colatitude, ordered north to south, each column to one longitude ordered eastwards. It is present only if 3Dflag equals to 3.

Coh23D_k is an array of squared coherencies on a N_theta x N_phi grid at period T_k. Each line corresponds to one colatitude, ordered north to south, each column to one longitude ordered eastwards. It is present only if 3Dflag equals to 3.

Additional notes:
If the responses are 1-D, values assigned to N_theta, N_phi do not influence the response definition, and are in principle arbitrary. For consistency in reading,
they should be included in the file with safe values (N_theta,N_phi)= (1,1).

Similarly, for 2-D maps of responses, where `ReC3D_k(:,:),ImC3D_k(:,:), dC3D_k(:,:)` and `Coh23D_k(:,:)` are given, the corresponding `ReC0_k, ImC0_k, dC0_k, Coh20_k` don't influence the responses definition, and can be arbitrary. It can be used to store any auxiliary responses/uncertainty etc. values related to the given period (i.e. arithmetic mean or median etc.) but shouldn't be relied upon.

4.3.4.3 Format for ionospheric field products (MIO_SHA)

The primary ionospheric field scalar potential is expressed as follows:

For $a < r < a + h$:

$$V(r,\theta_d,\varphi_d,t,t_m) = (1 + N \cdot F_{10.7}) \sum_{s=smin}^{smax} \sum_{p=pmin}^{pmax} \sum_{n=1}^{nmax} \sum_{m=0}^{mmax} a \left(\frac{r}{a}\right)^n P_n^m(\theta_d) \left\{ \left[q_{nsp}^{m(c)} \cos m\varphi_d + s_{nsp}^{m(c)} \sin m\varphi_d \right] \cos\left(\omega_s st + \omega_p pt_m\right) + \left[q_{nsp}^{m(s)} \cos m\varphi_d + s_{nsp}^{m(s)} \sin m\varphi_d \right] \sin\left(\omega_s st + \omega_p pt_m\right) \right\} \quad (1)$$

For $r > a + h$:

$$V(r,\theta_d,\varphi_d,t,t_m) = (1 + N \cdot F_{10.7}) \sum_{s=smin}^{smax} \sum_{p=pmin}^{pmax} \sum_{n=1}^{nmax} \sum_{m=0}^{mmax} a \left(\frac{a}{r}\right)^{n+1} P_n^m(\theta_d) \left\{ \left[g_{nsp}^{m(c)} \cos m\varphi_d + h_{nsp}^{m(c)} \sin m\varphi_d \right] \cos\left(\omega_s st + \omega_p pt_m\right) + \left[g_{nsp}^{m(s)} \cos m\varphi_d + h_{nsp}^{m(s)} \sin m\varphi_d \right] \sin\left(\omega_s st + \omega_p pt_m\right) \right\} \quad (2)$$

where

- r, θ_d and φ_d are the radius, dipole colatitude and longitude based on a location of the Northern dipole at co-latitude θ_{NGP} and longitude φ_{NGP}
- t, t_m are the time of the year counted from January 1, 00 UT, and the magnetic universal time (MUT)
- $a = 6371.2$ km is the radius at the Earth's surface, $h = 110$ km is the altitude of the ionospheric current system
- $P_n^m(\theta_d)$ is the Schmidt semi-normalized Legendre functions
- $\omega_s = 2\pi$ rads/yr and $\omega_p = 2\pi/24$ rads/hr are the fundamental seasonal and diurnal angular frequencies
- $q_{nsp}^{m(c,s)}$, $s_{nsp}^{m(c,s)}$ are the (real) Gauss coefficients for $a < r < a + h$
- $g_{nsp}^{m(c,s)}$, $h_{nsp}^{m(c,s)}$ are the (real) Gauss coefficients for $a + h < r$
- $nmax, mmax$ are the maximum degree and order of the Gauss coefficients
- $pmin, pmax$ are the minimum and maximum diurnal wavenumbers
- $smin, smax$ are the minimum and maximum seasonal wavenumbers
- $F_{10.7}$ is solar flux in units of $10^{-22} Wm^{-2} Hz^{-1}$
- N is the Wolf ratio in units of $1/(10^{-22} Wm^{-2} Hz^{-1})$.

Magnetic universal time (in hours) is given by $t_m = (180 - \varphi_{d,s})/15$ with $\varphi_{d,s}$ as dipole longitude of the subsolar point.

The coefficients describing the primary field above and below the ionosphere are related according to

$$g_{nsp}^{m(c,s)} = -\frac{n}{n+1}\left(\frac{a+h}{a}\right)^{2n+1} q_{nsp}^{m(c,s)} \quad (3)$$

The secondary (induced) ionospheric field scalar potential is expressed using equation (2) but with another set of Gauss coefficients, $g'^{m(c,s)}_{nsp}$, $h'^{m(c,s)}_{nsp}$, for all $r > a$.

The MIO product contains a header of arbitrary length (these header lines start with #), a line containing information about model parameterization

```
nmax mmax pmin pmax smin smax theta_NGP phi_NGP h N
```

(where theta_NGP and phi_NGP are co-latitude and longitude of the Northern dipole in degrees, h is the altitude of the ionospheric current sheet in km, and N is the Wolf ratio that indicates the dependence of the currents on solar flux F10.7), followed by the SH model of the primary field coefficients below the ionosphere, $q_{nsp}^{m(c,s)}$, $s_{nsp}^{m(c,s)}$ and the model of the secondary field coefficients, $g'^{m(c,s)}_{nsp}$, $h'^{m(c,s)}_{nsp}$.

The general structure of all MIO_SHA product files is as follows:

```
# Header
# Header
nmax mmax pmin pmax smin smax theta_NGP phi_NGP h N
```

1	0	$q^{0(c)}_{1,smin,pmin}$	$q^{0(s)}_{1,smin,pmin}$	…	$q^{0(c)}_{1,smax,pmax}$	$q^{0(s)}_{1,smax,pmax}$	
1	1	$q^{1(c)}_{1,smin,pmin}$	$q^{1(s)}_{1,smin,pmin}$	…	$q^{1(c)}_{1,smax,pmax}$	$q^{1(s)}_{1,smax,pmax}$	
1	−1	$s^{1(c)}_{1,smin,pmin}$	$s^{1(s)}_{1,smin,pmin}$	…	$s^{1(c)}_{1,smax,pmax}$	$s^{1(s)}_{1,smax,pmax}$	
2	0	$q^{0(c)}_{2,smin,pmin}$	$q^{0(s)}_{2,smin,pmin}$	…	$q^{0(c)}_{2,smax,pmax}$	$q^{0(s)}_{2,smax,pmax}$	
2	1	$q^{1(c)}_{2,smin,pmin}$	$q^{1(s)}_{2,smin,pmin}$	…	$q^{1(c)}_{2,smax,pmax}$	$q^{1(s)}_{2,smax,pmax}$	
2	−1	$s^{1(c)}_{2,smin,pmin}$	$s^{1(s)}_{2,smin,pmin}$	…	$s^{1(c)}_{2,smax,pmax}$	$s^{1(s)}_{2,smax,pmax}$	
2	2	$q^{2(c)}_{2,smin,pmin}$	$q^{2(s)}_{2,smin,pmin}$	…	$q^{2(c)}_{2,smax,pmax}$	$q^{2(s)}_{2,smax,pmax}$	
2	−2	$s^{2(c)}_{2,smin,pmin}$	$s^{2(s)}_{2,smin,pmin}$	…	$s^{2(c)}_{2,smax,pmax}$	$s^{2(s)}_{2,smax,pmax}$	
…							
1	0	$g'^{0(c)}_{1,smin,pmin}$	$g'^{0(s)}_{1,smin,pmin}$	…	$g'^{0(c)}_{1,smax,pmax}$	$g'^{0(s)}_{1,smax,pmax}$	
1	1	$g'^{1(c)}_{1,smin,pmin}$	$g'^{1(s)}_{1,smin,pmin}$	…	$g'^{1(c)}_{1,smax,pmax}$	$g'^{1(s)}_{1,smax,pmax}$	
1	−1	$h'^{1(c)}_{1,smin,pmin}$	$h'^{1(s)}_{1,smin,pmin}$	…	$h'^{1(c)}_{1,smax,pmax}$	$h'^{1(s)}_{1,smax,pmax}$	
2	0	$g'^{0(c)}_{2,smin,pmin}$	$g'^{0(s)}_{2,smin,pmin}$	…	$g'^{0(c)}_{2,smax,pmax}$	$g'^{0(s)}_{2,smax,pmax}$	
2	1	$g'^{1(c)}_{2,smin,pmin}$	$g'^{1(s)}_{2,smin,pmin}$	…	$g'^{1(c)}_{2,smax,pmax}$	$g'^{1(s)}_{2,smax,pmax}$	
2	−1	$h'^{1(c)}_{2,smin,pmin}$	$h'^{1(s)}_{2,smin,pmin}$	…	$h'^{1(c)}_{2,smax,pmax}$	$h'^{1(s)}_{2,smax,pmax}$	
2	2	$g'^{2(c)}_{2,smin,pmin}$	$g'^{2(s)}_{2,smin,pmin}$	…	$g'^{2(c)}_{2,smax,pmax}$	$g'^{2(s)}_{2,smax,pmax}$	
2	−2	$h'^{2(c)}_{2,smin,pmin}$	$h'^{2(s)}_{2,smin,pmin}$	…	$h'^{2(c)}_{2,smax,pmax}$	$h'^{2(s)}_{2,smax,pmax}$	
…							

Each of the two models (describing the primary, resp. secondary, field) is stored as a $N_{nm} \times (2N_{sp})$ block of coefficients, where

$N_{nm} = mmax(mmax + 2) + (nmax - mmax)(2mmax + 1)$
$N_{sp} = (pmax - pmin + 1)(smax - smin + 1)$

The first two columns contain the n, m values for each series of $2N_{sp}$ coefficients; negative m values indicate that the line is that of $\sin m\varphi_d$ coefficients. Coefficients are stored by iterating on s, p in that order (same as in equations (1) and (2)), i.e. p is nested within s such that in each line

$$n, m, q^{m(c)}_{n,smin,pmin}\ q^{m(s)}_{n,smin,pmin}\ q^{m(c)}_{n,smin,pmin+1}\ q^{m(s)}_{n,smin,pmin+1} q^{m(c)}_{n,smin,pmin+2}\ q^{m(s)}_{n,smin,pmin+2} \cdots$$
$$q^{m(c)}_{n,smin,pmax}\ q^{m(s)}_{n,smin,pmax} q^{m(c)}_{n,smin+1,pmin}\ q^{m(s)}_{n,smin+1,pmin} \cdots q^{m(c)}_{n,smax,pmax}\ q^{m(s)}_{n,smax,pmax}$$

4.3.5 CDF format

The CDF format is applied for many L1b products. The data volume will be minimized with gzip applied to each variable separately, rather than to the whole file content. This allows a faster access to single variables, if needed. Missing data values are marked with `NaN`.

CDF time variables are given in CDF epoch. The CDF epoch is defined in UTC and as the number of milliseconds since 01-Jan-0000 00:00:00.000. The CDF epoch unit is `ms` (milliseconds).

As of September 2011, CDF library version 3.3 is required to read all CDF files described in the document.

The number and content of the variables are provided in detail in appropriate sections 0 - 5.14.

4.3.6 PDF reports

Validation and Quick look reports are provided in PDF format.

4.4 File Names

The file names of each **Level 2 product** is defined in [AD-8], that is:

```
MM_CCCC_TTTTTTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvvv.HDR

MM_CCCC_TTTTTTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvvv.EXT
```

where the meaning of the elements composing the file name is described in section 4 of [AD-8] and are:

`MM` = `SW` (Mission ID)

`CCCC` = `OPER` or `RPRO` (for "Operational" or "Reprocessing")

`TTTTTTTTTT` = Product name, as defined in section 5.1

`yyyymmddThhmmss` = validity start time
(e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000)

`YYYYMMDDTHHMMSS` = validity stop time

`vvvv` = version number

`EXT` = Product extension, as defined in section 5.3

The validity start and end time is similar to the description in section 4.1.5.3 "*Shape 1, Context 3: Validity Period with respect to Time of Contents Relevance*" in [AD-8] where it is also stated: "As validity time

values may have greater precision than a second, all validity start times shall be round down and all validity stop times shall be rounded up. “

For example, in case of the MCO_SHA_2D Level 2 product the names are:

```
SW_OPER_MCO_SHA_2D_20120924T075728_20130228T230231_0001.HDR

SW_OPER_MCO_SHA_2D_20120924T075728_20130228T230231_0001.shc
```

The file with the extension .HDR is the XML Header file and the file with the extension `.DBL` is the Level 2 product file. Both files will be zipped together into one file with the extension `.ZIP`.

For some products, such as lithospheric field products, a validity time is not applicable, because the lithospheric field is regarded as time-invariant. For such cases, the consortium has proposed following convention for validity start and stop time: `00000000T000000_99999999T999999`.

5 Specification of Level 2 Products and Auxiliary Products

This chapter starts with the description of the product name convention in section 5.1 and the product classification in section 5.2. The chapter follows on with a product overview (section 5.3) and then specifies each product in detail (section 5.4 ff.).

5.1 Product name convention

According to [AD-8], Swarm product names consist of 10 digits, which are subdivided into two sub-fields as follows: TTTTTTTTTT = FFFFDDDDDD, where FFFF = File Category and DDDDDD = Semantic Descriptor.

For Level 2 products FFFF = FFFx. FFF describes the product type (e.g., MCO – Magnetic Core Field, AUX – Auxiliary Product), and x = _ if the product is derived from (available for) the satellite constellation, and x = A, B or C, respectively for Swarm A, Swarm B or Swarm C, if single satellite products are derived.

For Level 2 products DDDDDD = DDDy2z. DDD provides a description which is specific for each product, for example TMS for time series or SHA for spherical harmonics. y = i for intermediate products and y = _ when final products are concerned.

The last two digits describe the product level [AD-8]. Therefore digit 9 is always 2, identifying the product as a Level 2 product.

The last digit z indicates the origin or the purpose of the product. This applies especially when different chains lead to the same science product. This last digit z can be:

C	Derived from Comprehensive Inversion
D	Derived from dedicated chain
F	Fast Track product
E	Extended, only applied for extended lithospheric field maps (MLI_SHA_2E)
_	Only one chain has been indentified to lead to this product type
a	Product derived from candidate chain a (only applied for mantle conductivity products – derived in the frequency domain)
b	Product derived from candidate chain b (only applied for mantle conductivity products – derived in the time domain)

For example, the intermediate product of the spherical harmonic model of the core field derived from CI is named MCO_SHAi2C, and the final product of the spherical harmonic model of the core field derived from dedicated inversion is named MCO_SHA_2D. The product of Eastward Electric Field derived from Swarm C is called EEFCTMS_2F. The Auxiliary data product for the KP index is called AUX_KP__2_.

5.2 Product classification

Different product types exist in the Level 2 processor.

5.2.1 Level 2 products

Three Categories have been defined in [AD-10]. Each Level 2 product is attributed to one of these categories.

CAT-1: Complex algorithms contributing to the generation of a Level 2 product of the various sources of the Earth's magnetic field, of thermospheric products, and for Precise Orbit determination. The generation of CAT-1 products require interaction with experienced scientists. The products will be processed by SCARF, and will be distributed by ESA.

CAT-2: Algorithms leading to a Level 2 product with minimum delay with respect to the generation of the corresponding Level 1b data. The generation of CAT-2 products is designed to run automatically. The CAT-2 products will be generated and distributed by ESA.

Intermediate and final products

Some Level 2 products are further characterized by product types. These are:

- **Intermediate products** are Level 2 products which are independently validated before their release to final Level 2 products. Intermediate products are delivered to PDGS together with an **intermediate validation report**. An intermediate validation report exists to each chain that submit an intermediate product. The intermediate validation report product name is `FFF_VALi2z`, e.g., `MCO_VALi2C`.

- **Final Level 2 products** are validated intermediate products or products which are released on Fast Track including internal quality check (Fast Track Products). Only Final products are distributed to the end users.

Candidate products

For all magnetic field products and the 3D-mantle conductivity product two or three different candidates can be identified reaching to the same product quantity. For all magnetic field products, the candidates are derived in the Comprehensive Inversion Chain or in Dedicated Inversion Chains or as Fast Track products. This identification is indicated by the last character in the product name `C`, `D` or `F` (see also section 5.1).

In the case of 3D mantle conductivity model, the two candidates differ in that they are derived in the frequency domain or in the time domain. This differentiation, `a` or `b`, is indicated by the last character in the product name.

All other products have only one candidate.

Fast Track products

Fast Track products have no intermediate stage. The validation is performed by means of an internal quality check in the algorithms of each of these products, and the quality of the product is provided, e.g., by a quality flag. Fast Track products are released without a validation report.

Three CAT-1 magnetic products will be derived on Fast Track (Euler angles, core field model, magnetospheric model). All CAT-2 products are Fast Track products. For all Fast Track products, the last letter of the product name is `F` (see section 5.1).

Final validation reports
For non-Fast Track products a validation report is required when releasing the intermediate products to the final product stage. A final validation report is provided for each product chain, e.g., `MCO_VAL_2D`, for the final validation report for the dedicated chain for the core field model. The input of the final validation report is the intermediate product, the intermediate validation report and auxiliary products.

The intercomparison between products of two chains in one product family (e.g., `MCO_SHA_2D` and `MCO_SHA_2C`), will be released in one validation report called, e.g, `MCO_VAL_2_`.

Validation report products exist for following product families: Euler angles, core field models, lithospheric field models, ionospheric models, magnetosphere models, 1D-mantle conductivity (mantle conductivity model and C-response), 3D-mantle conductivity (mantle conductivity model and C-response maps), precise orbit determination and thermospheric winds and density.

Final validation reports are Final Level 2 products. **Auxiliary products**
Auxiliary products are necessary prior or during processing of high precision Swarm Level 2 products but do not result from the Swarm L0 or L1b processor. Auxiliary products are further classified in auxiliary models and auxiliary data.

For auxiliary products that are needed in CAT-1 as well as in CAT-2 chains, two different products are defined. The acquisition of auxiliary products for CAT-2 products lies in the responsibility of PDGS in the course of the mission. The name of all CAT-2 auxiliary products end with the letter `F` – Fast track.

5.2.3 Level 2 product selection
All Level 2 Cat-1 Fast-Track, Quick-Look, Orbit Determination, and Upper Atmosphere products (see Table 5-2) will be transferred from the product creator (L2PS) to PDGS at ESA for immediate dissemination to the user community.

Level 2 Cat-1 magnetic products (all non Fast-Track magnetic field model and mantle conductivity products, see Table 5-2) are subject to independent validation by BGS. The validation reports together with the model products are further subject to an independent review performed by the product creator (L2PS), external experts and the Agency. Based on this review, accepted Level 2 products will be transferred from BGS to PDGS for dissemination to the user community.

All Level 2 Cat-2 products are produced and distributed by PDGS and are not subject to external validation.

5.3 Product overview
This section provides an overview about all L2 products, intermediate (Table 5-1), final (Table 5-2), and auxiliary products (Table 5-3). Each product is described in more detail in sections 5.4 - 5.14. Please note that in Table 5-3 the column “Extension” is only present for conformance with Table 5-1 and Table 5-2 and it only contains "DBL".

Table 5-1 Intermediate Level 2 products

Science Objective	*Product Name*	*Description*	*Format*	*Extension*
	MSW_EULi2C	**CAT-1:** Euler angles for all satellites	ASCII listing	.txt

Science Objective	*Product Name*	*Description*	*Format*	*Extension*
All, Needed for L1b processing	`MSW_VALi2C`	Intermediate validation report	PDF report	.pdf
	`MSW_EULi2D`	**CAT-1:** Euler angles for all satellites	ASCII listing	.txt
	`MSW_VALi2D`	Intermediate validation report	PDF report	.pdf
O1: Core Field	`MCO_SHAi2C`	**CAT-1:** Spherical harmonic model of the main (core) field and its temporal variation	ASCII listing (SHC)	.shc
	`MCO_VALi2C`	Intermediate validation report	PDF report	.pdf
	`MCO_SHAi2D`	**CAT-1:** Spherical harmonic model of the main (core) field and its temporal variation	ASCII listing (SHC)	.shc
	`MCO_VALi2D`	Intermediate validation report	PDF report	.pdf
O2: Lithospheric Field	`MLI_SHAi2C`	**CAT-1:** Spherical harmonic model of the lithospheric field	ASCII listing (SHC)	.shc
	`MLI_VALi2C`	Intermediate validation report	PDF report	.pdf
	`MLI_SHAi2D`	**CAT-1:** Spherical harmonic model of the lithospheric field.	ASCII listing (SHC)	.shc
	`MLI_VALi2D`	Intermediate validation report	PDF report	.pdf
	`MLI_SHAi2E`	**CAT-1:** Extended spherical harmonic model of the lithospheric field	ASCII listing (SHC)	.shc
	`MLI_VALi2E`	Intermediate validation report	PDF report	.pdf
O3: Mantle Conductivity	`Q3D_CI_i2_`	**CAT-1:** Q-matrix of 3D mantle conductivity including oceans	ASCII listing	.txt
	`MIN_1DMi2_`	**CAT-1:** 1D model of mantle conductivity	ASCII listing	.txt
	`MI1_VALi2_`	Intermediate validation report	PDF report	.pdf
	`MIN_3DMi2a`	**CAT-1:** 3D model of mantle conductivity (frequency domain)	ASCII listing	.txt
	`MIN_3DMi2b`	**CAT-1:** 3D model of mantle conductivity (time domain)	ASCII listing	.txt
	`MI3_VALi2_`	Intermediate validation report	PDF report	.pdf
	`MCR_1DMi2_`	**CAT-1:** 1D C-response	ASCII listing	.txt
	`MC1_VALi2_`	Intermediate validation report	PDF report	.pdf
	`MCR_3DMi2_`	**CAT-1:** 3D C-response maps	ASCII listing	.txt
	`MC3_VALi2_`	Intermediate validation report	PDF report	.pdf
O4: External Current Systems	`MMA_SHAi2C`	**CAT-1:** Spherical harmonic model of the large-scale magnetospheric field and its Earth-induced counterpart	CDF	.cdf
	`MMA_VALi2C`	Intermediate validation report	PDF report	.pdf

Science Objective	*Product Name*	*Description*	*Format*	*Extension*
	MIO_SHAi2C	**CAT-1:** Spherical harmonic model of the daily geomagnetic variation at middle latitudes (Sq and low latitudes – EEJ)	ASCII listing	.txt
	MIO_VALi2C	Intermediate validation report	PDF report	.pdf
	MIO_SHAi2D	**CAT-1:** Spherical harmonic model of the daily geomagnetic variation at middle latitudes (Sq and low latitudes – EEJ)	ASCII listing	.txt
	MIO_VALi2D	Intermediate validation report	PDF report	.pdf
Accelerometry	**ACCxDISi2_**	CAT-1: List of disturbances in accelerometer data	CDF	.cdf
	ACCx_FMi2_	CAT-1: Time series of non-gravitational accelerations from force models	CDF	.cdf

O=Science Objective

Table 5-2 Final Level 2 products

Science Objective	*Name*	*Description*	*Format*	*Extension*
All. Needed for L1b processing	**MSW_EUL_2C**	**CAT-1:** Euler angles describing transformation from STR-CRF to VFM frame for satellites A, B, and C	ASCII listing	.txt
	MSW_EUL_2D	**CAT-1:** Euler angles describing transformation from STR-CRF to VFM frame for satellites A, B, and C	ASCII listing	.txt
	MSW_VAL_2C	**CAT-1:** Validation report about Euler angles	PDF	.pdf
	MSW_VAL_2D	**CAT-1:** Validation report about Euler angles	PDF	.pdf
	MSW_VAL_2_	**CAT-1:** Validation report about Euler angles	PDF	.pdf
	MSW_EUL_2F	**CAT-1:** Euler angles describing transformation from STR-CRF to VFM frame for satellites A, B, and C	ASCII listing	.txt
O1: Core Field	**MCO_SHA_2C**	**CAT-1:** Spherical harmonic model of the main (core) field and its temporal variation	ASCII listing (SHC)	.shc
	MCO_SHA_2D	**CAT-1:** Spherical harmonic model of the main (core) field and its temporal variation	ASCII listing (SHC)	.shc
	MCO_VAL_2C	**CAT-1:** Validation report on core magnetic field	PDF	.pdf
	MCO_VAL_2D	**CAT-1:** Validation report on core magnetic field	PDF	.pdf

Science Objective	*Name*	*Description*	*Format*	*Extension*
	MCO_VAL_2_	**CAT-1:** Validation report on core magnetic field	PDF	.pdf
	MCO_SHA_2F	**CAT-1:** Spherical harmonic model of the main (core) field and its temporal variation	ASCII listing (SHC)	.shc
O2: Lithospheric Field	MLI_SHA_2C	**CAT-1:** Spherical harmonic model of the lithospheric field	ASCII listing (SHC)	.shc
	MLI_SHA_2D	**CAT-1:** Spherical harmonic model of the lithospheric field	ASCII listing (SHC)	.shc
	MLI_SHA_2E	**CAT-1:** Extended spherical harmonic model of the lithospheric field	ASCII listing (SHC)	.shc
	MLI_VAL_2C	**CAT-1:** Validation report on lithospheric field	PDF	.pdf
	MLI_VAL_2D	**CAT-1:** Validation report on lithospheric field	PDF	.pdf
	MLI_VAL_2E	**CAT-1:** Validation report on lithospheric field	PDF	.pdf
	MLI_VAL_2_	**CAT-1:** Validation report on lithospheric field	PDF	.pdf
O3: Mantle Conductivity	MIN_1DM_2_	**CAT-1:** 1D model of mantle conductivity	ASCII listing	.txt
	MIN_3DM_2a	**CAT-1:** 3D model of mantle conductivity (frequency domain)	ASCII listing	.txt
	MIN_3DM_2b	**CAT-1:** 3D model of mantle conductivity (time domain)	ASCII listing	.txt
	MCR_1DM_2_	**CAT-1:** 1D C-response maps	ASCII listing	.txt
	MCR_3DM_2_	**CAT-1:** 3D C-response maps	ASCII listing	.txt
	MI1_VAL_2_	**CAT-1:** Validation report on 1D mantle conductivity	PDF	.pdf
	MI3_VAL_2_	**CAT-1:** Validation report on 3D mantle conductivity	PDF	.pdf
	MC1_VAL_2_	**CAT-1:** Validation report on 1D C-response	PDF	.pdf
	MC3_VAL_2_	**CAT-1:** Validation report on 3D C-response	PDF	.pdf
O4: External Current Systems	MMA_SHA_2C	**CAT-1:** Spherical harmonic model of the large-scale magnetospheric field and its Earth-induced counterpart	CDF	.cdf
	MMA_VAL_2C	**CAT-1:** Validation report magnetospheric magnetic model	PDF	.pdf
	MMA_SHA_2F	**CAT-1:** Spherical harmonic model of the large-scale magnetospheric field and its Earth-induced counterpart	CDF	.cdf

Science Objective	*Name*	*Description*	*Format*	*Extension*
	MIO_SHA_2C	**CAT-1:** Spherical harmonic model of the daily geomagnetic variation at middle latitudes (Sq and low latitudes (EEJ)	ASCII listing	.txt
	MIO_SHA_2D	**CAT-1:** Spherical harmonic model of the daily geomagnetic variation at middle latitudes (Sq and low latitudes (EEJ)	ASCII listing	.txt
	MIO_VAL_2C	**CAT-1:** Validation report on ionospheric magnetic model	PDF	.pdf
	MIO_VAL_2D	**CAT-1:** Validation report on ionospheric magnetic model	PDF	.pdf
	MIO_VAL_2_	**CAT-1:** Validation report on ionospheric magnetic model	PDF	.pdf
	IBIxTMS_2F	**CAT-2:** Ionospheric bubble index	CDF	.cdf
	TECxTMS_2F	**CAT-2:** Time series of the ionospheric total electron content	CDF	.cdf
	FAC_TMS_2F	**CAT-2:** Time series of field-aligned currents	CDF	.cdf
	FACxTMS_2F	**CAT-2:** Time series of field-aligned currents	CDF	.cdf
	EEFxTMS_2F	Dayside equatorial electric field	CDF	.cdf
	IPDxIRR_2F	Time series of characteristics of the plasma density and plasma irregularities (IPIR)	CDF	.cdf
	MIO_SHA_2E	An empirical model of the Average Magnetic field and Polar current System (AMPS)	ASCII	.txt
Precise Orbit Determination	SP3xCOM_2_	**CAT-1:** time series of position and velocity of the center of mass of each satellite (reduced-dynamic POD)	ASCII listing (SP3)	.sp3
	SP3xKIN_2_	**CAT-1:** time series of position of the center of mass of each satellite (kinematic POD)	ASCII listing (SP3)	.sp3
	SP3xVAL_2_	**CAT-1:** Validation report for SP3xCOM_2_	PDF	.pdf
	ACCxPOD_2_	**CAT-1:** Time series of non-gravitational accelerations estimated by POD	CDF	.cdf
Accelerometry	ACCxCAL_2_	**CAT-1:** Corrected and calibrated accelerometer observations	CDF	.cdf
	ACCxVAL_2_	**CAT-1:** Validation report for ACCxCAL_2_	PDF	.pdf
O5: Magnetic Forcing of the Upper Atmosphere	ACCx_AE_2_	**CAT-1:** Time series of calibrated and pre-processed accelerometer observations and of aerodynamic accelerations	CDF	.cdf
	DNSxACC_2_	**CAT-1:** time series of neutral thermospheric density and wind speed from precise orbit determination and accelerometer data	CDF	.cdf

Science Objective	*Name*	*Description*	*Format*	*Extension*
	DNSxPOD_2_	**CAT-1:** time series of neutral thermospheric density from precise orbit determination data only	CDF	.cdf
	TDAxVAL_2_	**CAT-1:** Validation report for DNSxACC_2_	PDF	.pdf
	DNSxVAL_2_	**CAT-1:** Validation report for DNSxPOD_2_	PDF	.pdf
Quick Look Reports	**MAG_QL__2_**	Quick Look of magnetic field products MAGx_LR_1B	PDF	.pdf
	EFI_QL__2_	Quick Look of EFIx_PL_1B	PDF	.pdf

O=Science Objective

Table 5-3 Auxiliary data and model

Product Name	*Description*	*Format*	*Extension*
AUX_KP__2_	Planetary index of geomagnetic activity	ASCII listing	.DBL
AUX_DST_2_	Equivalent equatorial magnetic disturbances index	ASCII listing	.DBL
AUX_F10_2_	Index of daily solar radio flux	ASCII listing	.DBL
AUX_IMF_2_	Interplanetary magnetic field, 3-componenet magnetic field, solar wind density and velocity	CDF	.DBL
AUX_KP__2F	Planetary index of geomagnetic activity	ASCII listing	.DBL
AUX_DST_2F	Equivalent equatorial magnetic disturbances index	ASCII listing	.DBL
AUX_F10_2F	Index of daily solar radio flux	ASCII listing	.DBL
AUX_IMF_2F	Interplanetary magnetic field, 3-componenet magnetic field	ASCII listing	.DBL
AUX_SWV_2F	Solar wind density and velocity	ASCII listing	.DBL
AUX_IRZ_2F	12 month smoothed sunspot number	ASCII listing	.DBL
AUX_APX_2F	Apex magnetic coordinates[1]	ASCII listing	.DBL
AUX_GPSEPH	GPS ephemeris[1]	ASCII listing (SP3)	.DBL
AUX_USLEAP	Leap second information[1]	ASCII listing	.DBL
AUX_DCB_2F	GPS satellite differential code biases	ASCII listing	.DBL
AUX_OBS_2_	Hourly Geomagnetic observatory data; 3-component magnetic field at INTERMAGNET and other magnetic observatories	ASCII listing	.DBL

[1] Used internally by operational processor, product is specified in [AD-11].

Product Name	*Description*	*Format*	*Extension*
AUX_OBSM2_	1 minute geomagnetic observatory data; 3-component magnetic field at INTERMAGNET and other magnetic observatories	ASCII listing	.DBL
AUX_OBSS2_	1 second geomagnetic observatory data; 3-component magnetic field at INTERMAGNET and other magnetic observatories	ASCII listing	.DBL
AUX_IGR_2_	IGRF (International Geomagnetic Reference Field) latest generation, model of the Earth's core magnetic field.	ASCII listing (SHC)	.DBL
AUX_COR_2_	Model for the core magnetic field	ASCII listing (SHC)	.DBL
AUX_LIT_2_	Model for the lithospheric magnetic field	ASCII listing (SHC)	.DBL
AUX_IGR_2F	IGRF (International Geomagnetic Reference Field) latest generation, model of the Earth's core magnetic field.	ASCII listing (SHC)	.DBL
AUX_COR_2F	Model for the core magnetic field	ASCII listing (SHC)	.DBL
AUX_LIT_2F	Model for the lithospheric magnetic field	ASCII listing (SHC)	.DBL
AUX_PMF_2F	Magnetospheric model	ASCII listing	.DBL
AUX_PSM_2F	Coefficients to transform from Solar Magnetic (SM) to geographic coordinates for computing the external magnetic field	ASCII listing	.DBL
AUX_PGM_2F	Coefficients to transform from Geocentric Solar Magnetospheric (GSM) to geographic coordinates for computing the external magnetic field	ASCII listing	.DBL
AUX_MTI_2_	Model of magnetic signals of major tidal constituents	ASCII listing	.DBL
AUX_MCM_2_	A priory radially-symmetric (1D) model of mantle conductivity	ASCII listing	.DBL
AUX_OCM_2_	2D model of surface conductance	ASCII listing	.DBL

5.4 Euler Angles

5.4.1 Intermediate Level 2 Candidate Products

Product identifier	**MSW_EULi2C**
Definition	3 sets of Euler angles, one set for each satellite
Input Data	MAGx_LR_1R, AUX_DST_2_, AUX_KP__2_, AUX_F10_2_, Q3D_CI_i2_
Input Time Span	All available quiet time observations from the mission
Spatial representation	N/A
Time representation	time series (snapshots)
Units	Degree
Resolution	10^{-6}
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfit provided in validation report
Data volume	~1 kB

Product identifier	MSW_EULi2C
Data format	ASCII listing (section 4.3.4.1)
Output Data	For each satellite A, B, and C: Euler angles, type 1-2-3
Output time span	As input
Update rate	First after 1 year, updated every year
Latency	1.5 months
Notes	

Product identifier	MSW_VALi2C
Definition	Intermediate validation report for Euler angle determination from CI
Input Data	MSW_EULi2C
Data volume	< 1 MB
Data format	PDF format
Output Data	PDF file
Latency	Same as for MSW_EULi2C
Notes	

Product identifier	MSW_EULi2D
Definition	3 sets of Euler angles, one set for each satellite.
Input Data	MAGx_LR_1B (x=[A,B,C]), AUX_IGR_2_, AUX_COR_2_, AUX_LIT_2_, AUX_DST_2_, AUX_KP__2_, AUX_IMF_2_ ; optional: MMA_SHAi2C, MMA_SHA_2F, MIN_1DMi2_
Input Time Span	1 year to full mission, but limited to quiet periods passing the selection
Spatial representation	N/A
Time representation	Time series (snapshots) for the three Euler Angle sets, he time is given in MJD 2000.0 midnight
Units	Degree for Euler Angles, Days, Fraction for leading MJD
Resolution	10^{-6} for the Euler Angles, 0.01for MJD
Uncertainty	See notes in this table, otherwise refer to product quality report
Quality indicator	e.g. RMS error or histograms in product quality report
Data volume	~1 kB
Data format	ASCII table (section 4.3.4)
Output Data	For each satellite A, B, and C: three Euler angles, type 1-2-3 preceded by time in MJD
Output time span	Same as input, resolution N/A (adaptive to data)
Update rate	First after 1 year, updated every year.

Product identifier	MSW_EULi2D
Latency	6 weeks
Notes	See also Notes in MSW_VAL_2D. If possible, results of three different segmentation windows sizes (i.e. for 5, 10 and 20 days -- the decision to apply for three window sizes and the definitive sizes will depend on data quality) will be, together with the scatter of the time series, used to assess stability and validity of the Euler Angles.

5.4.2 Final Level 2 Products

Product identifier	MSW_VALi2D
Definition	Intermediate validation report for Euler angle determination from Dedicated Core
Input Data	MSW_EULi2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MSW_EULi2D
Latency	Same as for MSW_EULi2D
Notes	If possible, results of three different segmentation windows sizes (i.e. for 5, 10 and 20 days, the decision to apply for three window sizes and the definitive sizes will depend on data quality) will be, together with the scatter of the time series internally and in conjunction with previous results, used to assess stability and validity of the Euler Angles.

Product identifier	MSW_VAL_2C
Definition	Validation report for Euler angle determination
Input Data	MSW_EULi2C, MSW_VALi2C
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as MSW_EUL_2C
Latency	1 month
Notes	

Product identifier	MSW_VAL_2D
Definition	Validation report for Euler angle determination
Input Data	MSW_EULi2D, MSW_VALi2D

Product identifier	MSW_VAL_2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as MSW_EUL_2D
Latency	1 month
Notes	If possible, results of three different segmentation windows sizes (i.e. for 5, 10 and 20 days, the decision to apply for three window sizes and the definitive sizes will depend on data quality) will be, together with the scatter of the time series internally and in conjunction with previous results, used to assess stability and validity of the Euler Angles.

Product identifier	MSW_VAL_2_
Definition	Comparison validation report for Euler angle determinations
Input Data	MSW_EULi2C, MSW_EULi2D, MSW_VAL_2C, MSW_VAL_2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Each time both, MSW_EUL_2C and MSW_EUL_2D have been released
Latency	1 month
Notes	

Product identifier	MSW_EUL_2C
Definition	3 sets of Euler angles, one set for each satellite
Input Data	MSW_EULi2C, MSW_VAL_2_
Input Time Span	As for MSW_EULi2C
Spatial representation	As for MSW_EULi2C
Time representation	As for MSW_EULi2C
Units	As for MSW_EULi2C
Resolution	As for MSW_EULi2C
Uncertainty	As for MSW_EULi2C
Quality indicator	As for MSW_EULi2C
Data volume	As for MSW_EULi2C
Data format	As for MSW_EULi2C

Product identifier	MSW_EUL_2C
Output Data	As for MSW_EULi2C
Output time span	As for MSW_EULi2C
Update rate	As for MSW_EULi2C
Latency	As for MSW_EULi2C
Notes	

Product identifier	MSW_EUL_2D
Definition	3 sets of Euler angles, one set for each satellite.
Input Data	MSW_EULi2D, MSW_VAL_2_
Input Time Span	Same as for MSW_EULi2D
Spatial representation	Same as for MSW_EULi2D
Time representation	Same as for MSW_EULi2D
Units	Same as for MSW_EULi2D
Precision	Same as for MSW_EULi2D
Quality indicator	Same as for MSW_EULi2D
Data volume	Same as for MSW_EULi2D
Data format	Same as for MSW_EULi2D
Output Data	Same as for MSW_EULi2D
Output time span and resolution	Same as for MSW_EULi2D
Update rate	Same as for MSW_EULi2D
Latency	Same as for MSW_EULi2D
Notes	

Product identifier	MSW_EUL_2F
Definition	3 sets of Euler angles, one set for each satellite.
Input Data	MAGx_LR_1B(x=[A,B,C]), AUX_IGR_2_, AUX_COR_2_, AUX_LIT_2_, AUX_DST_2_, AUX_KP__2_, AUX_IMF_2_ ; optional: MMA_SHAi2C, MMA_SHA_2F, MIN_1DMi2_
Input Time Span	At least 4 months
Spatial representation	N/A
Time representation	Time series (snapshots) for the three Euler Angle sets, he time is given in MJD 2000.0 midnight

Product identifier	MSW_EUL_2F
Units	Degree for Euler Angles, Days. Fraction for leading MJD
Resolution	10^{-6} for the Euler Angles, 0.01 for MJD
Uncertainty	See Notes in this table, otherwise refer to product quality report
Quality indicator	E.g. RMS error or histograms provided in the product quality report.
Data volume	~1 kB
Data format	ASCII table (section 4.3.4)
Output Data	For each satellite A, B, and C: Euler angles, type 1-2-3 preceded by time in MJD
Output time span	Same as input, resolution N/A (adaptive to data)
Update rate	3 months
Latency	2 weeks
Notes	See also Notes in MSW_VAL_2D. If possible, results of three different segmentation windows sizes (i.e. for 5, 10 and 20 days -- the decision to apply for three window sizes and the definitive sizes will depend on data quality) will be, together with the scatter of the time series internally and in conjunction with previous results, used to assess stability and validity of the Euler Angles.

5.5 Core Field Models

5.5.1 Intermediate Level 2 Candidate Products

Product identifier	MCO_SHAi2C
Definition	Spherical harmonic model of the main (core) field and its temporal variation
Input Data	Same as MSW_EULi2C
Input Time Span	Same as MSW_EULi2C
Spatial representation	Spherical Harmonics up to degree 18
Time representation	Snapshot models, based on order 5 splines with 6 months knots spacing
Units	nT
Resolution	1 pT
Uncertainty	Refer to quality report
Quality indicator	Statistics of data misfit provided in validation report
Data volume	~10 kB
Data format	ASCII table (SHC, see section 4.3.1)
Output Data	Gauss coefficients
Output time span	As input time span but with some extrapolations
Update rate	Same as MSW_EULi2C
Latency	Same as MSW_EULi2C

Product identifier	MCO_SHAi2C
Notes	

Product identifier	MCO_VALi2C
Definition	Intermediate validation report for core field from CI
Input Data	MCO_SHAi2C
Data volume	< 1 MB
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MCO_SHAi2C
Latency	Same as for MCO_SHAi2C
Notes	

Product identifier	MCO_SHAi2D
Definition	Spherical harmonic model of the core field and its temporal variation
Input Data	MAGx_LR_1B]), (x=[A,B,C]), AUX_IGR_2_, AUX_COR_2_, AUX_LIT_2_, AUX_DST_2_, AUX_KP__2_, AUX_IMF_2_ ; optional: MMA_SHAi2C, MMA_SHA_2F, MIN_1DMi2_
Input Time Span	Nominal minimum of 1 year up to the full Swarm data span.
Spatial representation	Spherical Harmonics up to degree 18
Time representation	Snapshot models (corresponding to 1/2 year knot separation and order 6 splines)
Units	nT
Resolution	1 pT
Uncertainty	Refer to quality report
Quality indicator	Statistics of data misfit, power spectra etc. provided in validation report
Data volume	~10 kB
Data format	ASCII table (SHC, see section 4.3.1)
Output data	Gauss coefficients
Output time span	Time span same as for input.
Update rate	1 per year
Latency	6 weeks
Notes	Latency may be increased if data quality has to be investigated.

Product identifier	MCO_VALi2D
Definition	Intermediate validation report for dedicated core field
Input Data	MCO_SHAi2C
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MCO_SHAi2D
Latency	Same as for MCO_SHAi2D
Notes	

5.5.2 Final Level 2 Products

Product identifier	MCO_VAL_2C
Definition	Validation report for core field model from CI chain
Input Data	MCO_SHAiC, MCO_VALi2C, AUX_OBS_2_, AUX_IGR_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MCO_SHA_2C
Latency	1 month
Notes	

Product identifier	MCO_VAL_2D
Definition	Validation report for core field model from dedicated chain
Input Data	MCO_SHAi2D, MCO_VALi2D, AUX_OBS_2_, AUX_IGR_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MCO_SHA_2D
Latency	1 month
Notes	

Product identifier	MCO_VAL_2_
Definition	Comparative validation report for core field models
Input Data	MCO_SHA_2C, MCO_SHA_2D, MCO_VAL_2C, MCO_VAL_2D, AUX_OBS_2_, AUX_IGR_2_

Product identifier	MCO_VAL_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Each time both, MCO_SHA_2C and MCO_SHA_2D have been released
Latency	1 month
Notes	

Product identifier	MCO_SHA_2C
Definition	Spherical harmonic model of the main (core) field and its temporal variation
Input Data	MCO_SHAi2C, MCO_VAL_2_
Input Time Span	Same as for MCO_SHAi2C
Spatial representation	Same as for MCO_SHAi2C
Time representation	Same as for MCO_SHAi2C
Units	Same as for MCO_SHAi2C
Resolution	Same as for MCO_SHAi2C
Uncertainty	Same as for MCO_SHAi2C
Quality indicator	Same as for MCO_SHAi2C
Data volume	Same as for MCO_SHAi2C
Data format	Same as for MCO_SHAi2C
Output Data	Same as for MCO_SHAi2C
Output time span	Same as for MCO_SHAi2C
Update rate	Same as for MCO_SHAi2C
Latency	Same as for MCO_SHAi2C
Notes	

Product identifier	MCO_SHA_2D
Definition	Spherical harmonic model of the core field
Input Data	MCO_SHAi2D, MCO_VAL_2_
Input Time Span	As for MCO_SHAi2D
Spatial representation	As for MCO_SHAi2D
Time representation	As for MCO_SHAi2D
Units	As for MCO_SHAi2D
Resolution	As for MCO_SHAi2D
Uncertainty	As for MCO_SHAi2D

Product identifier	MCO_SHA_2D
Quality indicator	As for MCO_SHAi2D
Data volume	As for MCO_SHAi2D
Data format	As for MCO_SHAi2D
Output Data	As for MCO_SHAi2D
Output time span	As for MCO_SHAi2D
Update rate	As for MCO_SHAi2D
Latency	As for MCO_SHAi2D
Notes	The model accuracy strongly depends on the LT offset between satellite C and the A,B satellite pair.

Product identifier	MCO_SHA_2F
Definition	Spherical harmonic model of the main (core) field and its temporal variation
Input Data	MAGx_LR_1B (x=[A,B,C]), AUX_IGR_2_, AUX_COR_2_, AUX_LIT_2_, AUX_DST_2_, AUX_KP__2_, AUX_IMF_2_ ; optional: MMA_SHAi2C, MMA_SHA_2F, MIN_1DMi2_
Input Time Span	Minimum of 4 months
Spatial representation	Spherical Harmonics up to degree 18
Time representation	Snapshot models
Units	nT
Resolution	1 pT
Uncertainty	Refere to quality report
Quality indicator	Statistics of data misfit, power spectra etc. provided in validation report
Data volume	~10 kB
Data format	ASCII table (SHC, see section 4.3.4)
Output Data	Gauss coefficients
Output time span and resolution	Time span: Minimum 4 months Time resolution: corresponding to 3 month knots separation and order 2 splines
Update rate	First after 4 month, afterwards update is three months (if granted by data quality).
Latency	1 week
Notes	Assumed updated rate is three month

5.6 Lithospheric Field Models

5.6.1 Intermediate Level 2 Candidate Products

Product identifier	MLI_SHAi2C
Definition	Spherical harmonic model of the lithospheric field
Input Data	Same as MSW_EULi2C
Input Time Span	Same as MSW_EULi2C
Spatial representation	Spherical Harmonics from degree 16 to 150
Time representation	Snapshot
Units	nT
Resolution	1 pT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfits provided in validation report
Data volume	~0.5 MB
Data format	ASCII table (SHC, see section 4.3.1)
Output Data	Gauss coefficients
Output time span	N/A (lithospheric field is considered constant over the analysed time range)
Update rate	Same as MSW_EULi2C
Latency	Same as MSW_EULi2C
Notes	

Product identifier	MLI_VALi2C
Definition	Intermediate validation report for litospheric field from CI
Input Data	MLI_SHAi2C
Data volume	< 1 MB
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MLI_SHAi2C
Latency	Same as for MLI_SHAi2C
Notes	

Product identifier	MLI_SHAi2D
Definition	Spherical harmonic model of the lithospheric field
Input Data	MAGx_LR_1B, AUX_KP__2_, AUX_DST_2_, AUX_F10_2_, AUX_IMF_2_, AUX_MTI_2_, AUX_LIT_2_, AUX_COR_2_, IBIxTMS_2_, MCO_SHAi2D, MCO_SHA_2F, MMA_SHAi2C, MMA_SHA_2F, MCO_SHAi2C, MIO_SHAi2C, MIO_SHAi2D, MSW_EULi2C, MSW_EULi2D

Product identifier	MLI_SHAi2D
Input Time Span	One to four years of full Swarm data set.
Spatial representation	Spherical Harmonics from degree 16 to 150
Time representation	Snapshot
Units	nT
Resolution	1 pT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfits provided in validation report
Data volume	~0.5 MB
Data format	ASCII table (SHC, see section 4.3.1)
Output Data	Gauss coefficients
Output time span	N/A (lithospheric field is considered constant over the analysed time range)
Update rate	One model every year
Latency	One month
Notes	

Product identifier	MLI_VALi2D
Definition	Intermediate validation report for dedicated litospheric field
Input Data	MLI_SHAi2D
Data volume	< 100 Mb per report
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MLI_SHAi2D
Latency	Same as for MLI_SHAi2D
Notes	

Product identifier	MLI_SHAi2E
Definition	Map of the lithospheric field from the Revised Spherical Cap Harmonic analysis (R-SCHA) Dedicated Lithospheric Inversion, expressed in terms of high degree Spherical Harmonics
Input Data	MAGx_LR_1B, AUX_KP__2_, AUX_DST_2_, AUX_F10_2_, AUX_IMF_2_, AUX_MTI_2_, AUX_LIT_2_, AUX_COR_2_, IBIxTMS_2_, MCO_SHAi2D, MCO_SHA_2F, MMA_SHAi2C, MMA_SHA_2F, MCO_SHAi2C, MIO_SHAi2C, MIO_SHAi2D, MSW_EULi2C, MSW_EULi2D
Input Time Span	Same as MLI_SHAi2D
Spatial representation	Spherical harmonics from degree 16 to 200

Product identifier	MLI_SHAi2E
Time representation	Snapshot
Units	nT
Resolution	1 pT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfits provided in validation report
Data volume	~3MB
Data format	ASCII table (SHC, see section 4.3.1)
Output Data	Gauss coefficients
Output time span	N/A (lithospheric field is considered constant over the analysed time range)
Update rate	One model every year
Latency	One month
Notes	The product has the same format as the other lithospheric field models, but at a higher SH degree to be used for mapping purpose only. SH Gauss coefficients are here a mean to store the map, but the product itself is a map. The map should not be computed at altitudes lower than the minimum altitude of Swarm measurements

5.6.2 Final Level 2 Products

Product identifier	MLI_VALi2E
Definition	Intermediate validation report for dedicated litospheric field with revised spherical cap harmonics
Input Data	MLI_SHAi2E
Data volume	< 100 Mb per report
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MLI_SHAi2E
Latency	Same as for MLI_SHAi2E
Notes	

Product identifier	MLI_VAL_2C
Definition	Validation report for lithospheric field model from CI chain
Input Data	MLI_SHAi2C, MLI_VALi2C, AUX_LIT_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file

Product identifier	MLI_VAL_2C
Update rate	Same as for MLI_SHA_2C
Latency	1 month
Notes	

Product identifier	MLI_VAL_2D
Definition	Validation report for lithospheric field model from dedicated
Input Data	MLI_SHAi2D, MLI_VALi2D, AUX_LIT_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MLI_SHA_2D
Latency	1 month
Notes	

Product identifier	MLI_VAL_2E
Definition	Validation report for lithospheric field model
Input Data	MLI_SHAi2E, MLI_VALi2E, AUX_LIT_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MLI_SHA_2E
Latency	1 month
Notes	

Product identifier	MLI_VAL_2_
Definition	Comparison validation report for lithospheric field model
Input Data	MLI_SHA_2C, MLI_SHA_2D, MLI_SHA_2E, MLI_VAL_2C, MLI_VAL_2D, MLI_VAL_2E, AUX_LIT_2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Each time both, MLI_SHA_2C , MLI_SHA_2D and MLI_SHA_2D have been released
Latency	1 month
Notes	

Product identifier	MLI_SHA_2C
Definition	Spherical harmonic model of the lithospheric field
Input Data	MLI_SHAi2C, MLI_VAL_2_
Input Time Span	Same as MLI_SHAi2C
Spatial representation	Same as MLI_SHAi2C
Time representation	Same as MLI_SHAi2C
Units	Same as MLI_SHAi2C
Resolution	Same as MLI_SHAi2C
Uncertainty	Same as MLI_SHAi2C
Quality indicator	Same as MLI_SHAi2C
Data volume	Same as MLI_SHAi2C
Data format	Same as MLI_SHAi2C
Output Data	Same as MLI_SHAi2C
Output time span	Same as MLI_SHAi2C
Update rate	Same as MLI_SHAi2C
Latency	Same as MLI_SHAi2C
Notes	

Product identifier	MLI_SHA_2D
Definition	Spherical harmonic model of the lithospheric field
Input Data	MLI_SHAi2D, MLI_VAL_2_
Input Time Span	Same as MLI_SHAi2D
Spatial representation	Same as MLI_SHAi2D
Time representation	Same as MLI_SHAi2D
Units	Same as MLI_SHAi2D
Resolution	Same as MLI_SHAi2D
Uncertainty	Same as MLI_SHAi2D
Quality indicator	Same as MLI_SHAi2D
Data volume	Same as MLI_SHAi2D
Data format	Same as MLI_SHAi2D
Output Data	Same as MLI_SHAi2D
Output time span	Same as MLI_SHAi2D
Update rate	Same as MLI_SHAi2D
Latency	Same as MLI_SHAi2D

Product identifier	MLI_SHA_2D
Notes	

Product identifier	MLI_SHA_2E
Definition	Final map of the lithospheric field from the Revised Spherical Cap Harmonic analysis (R-SCHA) Dedicated Lithospheric Inversion, expressed in terms of high degree Spherical Harmonics
Input Data	MLI_SHAi2E, MLI_VAL_2_
Input Time Span	Same as MLI_SHAi2E
Spatial representation	Same as MLI_SHAi2E
Time representation	Same as MLI_SHAi2E
Units	Same as MLI_SHAi2E
Resolution	Same as MLI_SHAi2E
Uncertainty	Same as MLI_SHAi2E
Quality indicator	Same as MLI_SHAi2E
Data volume	Same as MLI_SHAi2E
Data format	Same as MLI_SHAi2E
Output Data	Same as MLI_SHAi2E
Output time span	Same as MLI_SHAi2E
Update rate	Same as MLI_SHAi2E
Latency	Same as MLI_SHAi2E
Notes	Same as MLI_SHAi2E

5.7 Mantle Conductivity

5.7.1 Intermediate Level 2 Products

Product identifier	Q3D_CI_i2_
Definition	Q-matrix of 3-D mantle conductivity model including oceans
Input Data	AUX_OCM_2_, AUX_MCM_2, MIN_1DMi2_, MIN_3DMi2a, MIN_3DMi2b
Input Time Span	N/A
Spatial representation	Spherical harmonic (SH) expansion in dipolar coordinates.
Time representation	Four time harmonics (at periods of 24, 12, 8 and 6 hours)
Units	dimensionless
Resolution	10^{-5}
Uncertainty	N/A
Quality indicator	N/A
Data volume	500 Mb

Product identifier	**Q3D_CI_i2_**

Data format	The files are in ASCII format with LF control character used for newline (unix style), and arbitrary number of spaces used as variable separator in a line. General structure of the files is as follows:
	
	`# Arbitrary number of comment lines starting with # sign`
	`N_periods N_max M_max`
	
	`<block_1>`
	`<block_2>`
	`<block_3>`
	`...`
	`<block_N_periods>`
	
	where
	`N_periods` is a number of periods
	`N_max` is a maximum degree of spherical harmonic expansion (SHE) of the external field
	`M_max` is a maximum order of SHE of the external field
	
	Each `<block_k>` block consists of:
	`T_k`
	`# Comment line with degrees and orders of SHE of internal field`
	
	Then matrix(array) of dimension [M_max*(M_max + 2) +(N_max-M_max)*(2*M_max+1)]x[N_max*(N_max+2)] follows which columns are:
	
	`<Columns 1 - 2>: degree and order of SHE of external field`
	`<Columns 3 – N_max*(N_max+2)+1>: elements of Q-matrix`
	
	where `T_k` is the k-th period in days.

Output Data	Transfer function connecting induced and inducing SH expansion coefficients
Output time span	N/A
Update rate	First version 1 year after launch updated when required
Latency	N/A
Notes	

Product identifier	**MIN_1DMi2_**
Definition	1-D model of mantle conductivity
Input Data	MMA_SHAi2C, AUX_OCM_2_, AUX_MCM_2
Input Time Span	2 years
Spatial representation	Conductivity distribution with respect to depth (1-D layered model of the Earth)
Time representation	N/A

Product identifier	MIN_1DMi2_
Units	Kilometers (for layer radii), Siemens per meter (for conductivities)
Resolution	N/A
Uncertainty	Refer to product quality report
Quality indicator	N/A
Data volume	A few Kb
Data format	ASCII listing (section 4.3.4.2)
Output Data	Conductivities within the layer, and radii of the top of the layer
Output time span	N/A
Update rate	First version after 2 years, update every year
Latency	1 months
Notes	This 1-D model is foreseen as the output of the 1-D frequency domain inversion

Product identifier	MI1_VALi2_
Definition	Intermediate validation report for 1-D model of mantle conductivity
Input Data	MIN_1DMi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MIN_1DMi2_
Latency	Same as for MIN_1DMi2_
Notes	

Product identifier	MIN_3DMi2a
Definition	3-D model of mantle conductivity (frequency domain)
Input Data	MMA_SHAi2C, AUX_OCM_2_, AUX_MCM_2
Input Time Span	> 2 years
Spatial representation	3-D grid, laterally regular, radially irregular
Time representation	N/A
Units	Kilometers (for layer radii), Siemens per meter (for conductivities)
Resolution	N/A
Uncertainty	Refer to product quality report
Quality indicator	N/A
Data volume	A few Mb
Data format	ASCII listing (section 4.3.4.2)

Product identifier	MIN_3DMi2a
Output Data	Conductivities in cells of a 3-D grid
Output time span	N/A
Update rate	First version after 2 years, updates every year
Latency	4 months
Notes	This 3-D model is foreseen as the output of the 3-D frequency domain inversion

Product identifier	MIN_3DMi2b
Definition	3-D model of mantle conductivity (time domain)
Input Data	MMA_SHAi2C, AUX_OCM_2_, AUX_MCM_2
Input Time Span	> 2 years
Spatial representation	3-D grid, laterally regular, radially irregular
Time representation	N/A
Units	Kilometers (for layer radii), Siemens per meter (for conductivities)
Resolution	N/A
Uncertainty	Refer to product quality report
Quality indicator	N/A
Data volume	A few Mb
Data format	ASCII listing (section 4.3.4.2)
Output Data	Conductivities in cells of a 3-D grid
Output time span	N/A
Update rate	First version after 2 years, updates every year
Latency	4 months
Notes	This 3-D model is foreseen as the output of the 3-D time domain inversion

Product identifier	MI3_VALi2_
Definition	Intermediate validation report for 3-D model of mantle conductivity candidate a and b
Input Data	MIN_3DMi2a, MIN_3DMi2b
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as for MIN_3DMi2a
Latency	Same as for MIN_3DMi2a
Notes	

Product identifier	MCR_1DMi2_
Definition	Global 1D C-responses
Input Data	MMA_SHAi2C, AUX_OCM_2_, AUX_MCM_2
Input Time Span	2 year
Spatial representation	N/A
Time representation	N/A
Units	km
Resolution	N/A
Uncertainty	For periods between 4-15 days the relative error should be less than 30 %
Quality indicator	Uncertainties and squared coherencies coming from signal processing
Data volume	A few Kb
Data format	ASCII listing (section 4.3.4.2)
Output Data	C-responses (real and imaginary parts), their uncertainties and squared coherences on a set of periods
Output time span and resolution	N/A
Update rate	Same as MIN_1DMi2_
Latency	Same as MIN_1DMi2_
Notes	These responses are foreseen as the by-product of the 1-D frequency domain inversion

Product identifier	MC1_VALi2_
Definition	Intermediate validation report for 1-D maps of C-responses
Input Data	MCR_1DMi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as MCR_1DMi2_
Latency	Same as MCR_1DMi2_
Notes	

Product identifier	MCR_3DMi2_
Definition	3-D maps of C-responses
Input Data	MMA_SHAi2C, AUX_OCM_2_, AUX_MCM_2_
Input Time Span	4 years
Spatial representation	2-D (lon, lat) grid

Product identifier	MCR_3DMi2_
Time representation	N/A
Units	km
Resolution	N/A
Uncertainty	For periods between 4-15 days the relative error should be less than 30 %
Quality indicator	Uncertainties and squared coherencies coming from signal processing
Data volume	A few Mb
Data format	ASCII listing (section 4.3.4.2)
Output Data	C-responses (real and imaginary parts), their uncertainties and squared coherences on 2-D (lon, lat) grid on a set of periods
Output time span and resolution	N/A
Update rate	Same as MIN_3DMi2a
Latency	Same as MIN_3DMi2a
Notes	These responses are foreseen as the by-product of the 3-D frequency domain inversion

Product identifier	MC3_VALi2_
Definition	Intermediate validation report for 3-D maps of C-responses
Input Data	MCR_3DMi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as MCR_3DMi2_
Latency	Same as MCR_3DMi2_
Notes	

5.7.2 Final Level 2 Products

Product identifier	MI1_VAL_2_
Definition	Validation report for 1D mantle conductivity
Input Data	MIN_1DMi2_, MI1_VALi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MIN_1DM_2_,
Latency	1 month
Notes	

Product identifier	MI3_VAL_2_
Definition	Validation report for 3D mantle conductivity, candidate product a and b and intercomparison between a and b
Input Data	MIN_3DMi2a, MIN_3DMi2b, MI3_VALi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Each time when both, MIN_3DM_2a and MIN_3DM_2b are released
Latency	1 month
Notes	

Product identifier	MC1_VAL_2_
Definition	Validation report for 1D C-response
Input Data	MCR_1DMi2_, MC1_VALi2_
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MCR_1DM_2_
Latency	1 month
Notes	

Product identifier	MC3_VAL_2_
Definition	Validation report for 3D C-response
Input Data	MCR_3DMi2_, MC3_VALi2
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MCR_3DM_2_
Latency	1 month
Notes	

Product identifier	MIN_1DM_2_
Definition	1-D model of mantle conductivity

Product identifier	MIN_1DM_2_
Input Data	MIN_1DMi2_, MC1_VAL_2_
Input Time Span	As for MIN_1DMi2_
Spatial representation	As for MIN_1DMi2_
Time representation	As for MIN_1DMi2_
Units	As for MIN_1DMi2_
Resolution	As for MIN_1DMi2_
Uncertainty	As for MIN_1DMi2_
Quality indicator	As for MIN_1DMi2_
Data volume	As for MIN_1DMi2_
Data format	As for MIN_1DMi2_
Output Data	As for MIN_1DMi2_
Output time span	As for MIN_1DMi2_
Update rate	As for MIN_1DMi2_
Latency	As for MIN_1DMi2_
Notes	As for MIN_1DMi2_

Product identifier	MIN_3DM_2a
Definition	3-D model of mantle conductivity (frequency domain)
Input Data	MIN_3DMi2a, MC3_VAL_2_
Input Time Span	As for MIN_3DMi2a
Spatial representation	As for MIN_3DMi2a
Time representation	As for MIN_3DMi2a
Units	As for MIN_3DMi2a
Resolution	As for MIN_3DMi2a
Uncertainty	As for MIN_3DMi2a
Quality indicator	As for MIN_3DMi2a
Data volume	As for MIN_3DMi2a
Data format	As for MIN_3DMi2a
Output Data	As for MIN_3DMi2a
Output time span	As for MIN_3DMi2a
Update rate	As for MIN_3DMi2a
Latency	As for MIN_3DMi2a
Notes	As for MIN_3DMi2a

Product identifier	MIN_3DM_2b
Definition	3-D model of mantle conductivity (frequency domain)
Input Data	MIN_3DMi2b, MC3_VAL_2_
Input Time Span	As for MIN_3DMi2b
Spatial representation	As for MIN_3DMi2b
Time representation	As for MIN_3DMi2b
Units	As for MIN_3DMi2b
Resolution	As for MIN_3DMi2b
Uncertainty	As for MIN_1DMi2b
Quality indicator	As for MIN_3DMi2b
Data volume	As for MIN_3DMi2b
Data format	As for MIN_3DMi2b
Output Data	As for MIN_3DMi2b
Output time span	As for MIN_3DMi2b
Update rate	As for MIN_3DMi2b
Latency	As for MIN_3DMi2b
Notes	As for MIN_3DMi2b

Product identifier	MCR_1DM_2_
Definition	Global 1D C-responses
Input Data	MCR_1DMi2_, MC1_VAL_2_
Input Time Span	As for MCR_1DMi2_
Spatial representation	As for MCR_1DMi2_
Time representation	As for MCR_1DMi2_
Units	As for MCR_1DMi2_
Resolution	As for MIN_1DMi2_
Uncertainty	As for MIN_1DMi2_
Quality indicator	As for MCR_1DMi2_
Data volume	As for MCR_1DMi2_
Data format	As for MCR_1DMi2_
Output Data	As for MCR_1DMi2_
Output time span and resolution	As for MCR_1DMi2_
Update rate	As for MCR_1DMi2_
Latency	As for MCR_1DMi2_
Notes	

Product identifier	MCR_3DM_2_
Definition	2-D maps of C-responses
Input Data	MCR_3DMi2_, MC3_VAL_2_
Input Time Span	As for MCR_3DMi2_
Spatial representation	As for MCR_3DMi2_
Time representation	As for MCR_3DMi2_
Units	As for MCR_3DMi2_
Resolution	As for MCR_3DMi2_
Uncertainty	As for MCR_3DMi2_
Quality indicator	As for MCR_3DMi2_
Data volume	As for MCR_3DMi2_
Data format	As for MCR_3DMi2_
Output Data	As for MCR_3DMi2_
Output time span	As for MCR_3DMi2_
Update rate	As for MCR_3DMi2_
Latency	As for MCR_3DMi2_
Notes	

5.8 External Field and Current Systems

5.8.1 Intermediate Level 2 Candidate Products

Product identifier	MMA_SHAi2C
Definition	Spherical harmonic representation of the large scale magnetospheric field and of its induced counterpart
Input Data	Same as MSW_EULi2C
Input Time Span	Same as MSW_EULi2C
Spatial representation	Spherical Harmonics of degree and order at least 1 for the external field and of degree and order at least 5 for its Earth induced counterpart
Time representation	Time series
Units	nT
Resolution	≤ 1 pT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfit provided in the validation report
Data volume	~2 MB/year
Data format	CDF variables

Product identifier	MMA_SHAi2C

Various temporal resolutions may be employed for various external and internal coefficients, hence a number of CDF variable groups are used to store external (named "...qs_N") respectively internal (named "...gh_N") coefficients. Note: the temporal resolutions for the various groups of external and internal coefficients are usually not identical.

Name	Type	Dim	Unit	Contents
t_qs_1	CDF_EPOCH	1	ms	Time instants of external Gauss coefficients q (cosine) and s (sine)
qs_1	CDF_DOUBLE	1	nT	External Gauss coefficients q (cosine) and s (sine) in dipole frame corresponding to time instants t_qs_1
dqs_1	CDF_DOUBLE	1	nT	Formal error estimate for qs_1
nm_qs_1	CDF_INT2	1	-	First column: vector of spherical harmonic degrees of the coefficients qs_1. Second column: vector of spherical harmonic orders. Nonnegative values denote coefficients q (cosine) while negative values denote coefficients s (sine)
t_qs_2	CDF_EPOCH	1	ms	Time instants of external Gauss coefficients q (cosine) and s (sine)
qs_2	CDF_DOUBLE	2	nT	External Gauss coefficients q (cosine) and s (sine) in dipole frame corresponding to time instants t_qs_2
dqs_2	CDF_DOUBLE	2	nT	Formal error estimate for qs_2

Product identifier	MMA_SHAi2C				
	nm_qs_2	CDF_INT2	2	-	First column: vector of spherical harmonic degrees of the coefficients qs_2. Second column: vector of spherical harmonic orders. Nonnegative values denote coefficients q (cosine) while negative values denote coefficients s (sine)
	t_gh_1	CDF_EPOCH	1	ms	Time instants of induced Gauss coefficients g (cosine) and h (sine)
	gh_1	CDF_DOUBLE	1	nT	Internal induced Gauss coefficients g (cosine) and h (sine) in dipole frame
	dgh_1	CDF_DOUBLE	1	nT	Formal error estimate for gh_1
	nm_gh_1	CDF_INT2	1	-	First column: vector of spherical harmonic degrees of the coefficients gh_1. Second column: vector of spherical harmonic orders. Nonnegative values denote coefficients g (cosine) while negative values denote coefficients h (sine)
	t_gh_2	CDF_EPOCH	1	ms	Time instants of induced Gauss coefficients g (cosine) and h (sine)
	gh_2	CDF_DOUBLE	2	nT	Internal induced Gauss coefficients g (cosine) and h (sine) in dipole frame
	dgh_2	CDF_DOUBLE	2	nT	Formal error estimate for gh_2

Product identifier	MMA_SHAi2C				
	nm_gh_2	CDF_INT2	2	-	First column: vector of spherical harmonic degrees of the coefficients gh_2. Second column: vector of spherical harmonic orders. Nonnegative values denote coefficients g (cosine) while negative values denote coefficients h (sine)
	t_qual	CDF_EPOCH	1	ms	Time instants of quality information (rms, n_data, and q_flag).
	rms	CDF_DOUBLE	2	nT	Root-mean-square difference between models and input data (after processing to subtract non-magnetospheric sources) in dipole frame, for the time instants indicated by t_qual First column: RMS difference in radial direction. Second column: RMS difference in theta direction. Third column: RMS difference in phi direction.

Product identifier	MMA_SHAi2C
	n_data | CDF_UINT2 | 2 | - | Number of data used at each time-instant from each satellite. First column: Number of data from SWARM A. Second column: Number of data from SWARM B. Third column: Number of data from SWARM C.
Output Data	Time series of external and induced SH coefficients in dipole coordinate frame; root-mean-square differences between (processed) input data and models; number of data from each satellite used for each model; quality flag.
Output time span	Time span as input
Update rate	Same as MSW_EULi2C
Latency	Same as MSW_EULi2C
Notes	

Product identifier	MMA_VALi2C
Definition	Intermediate validation report for ionospheric fields from CI
Input Data	MMA_SHAi2C
Data volume	< 1 MB
Data format	PDF format
Output Data	PDF file
Update rate	Same as MMA_SHAi2C
Latency	Same as MMA_SHAi2C
Notes	

Product identifier	MIO_SHAi2C
Definition	Spherical harmonic representation of the daily geomagnetic variations at mid and low latitudes (Sq and EEJ) and of its induced counterpart
Input Data	Same as MSW_EULi2C
Input Time Span	Same as MSW_EULi2C
Spatial representation	Spherical Harmonics up to degree 60 and order 12 in dipole coordinates
Time representation	Fourier Series, seasonal and daily periodicity
Units	nT

Product identifier	MIO_SHAi2C
Resolution	1 pT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfit provided in the validation report
Data volume	~130 kB
Data format	ASCII listing (section 4.3.4.3)
Output Data	Coefficients of SH model in dipole coordinates, with seasonal and diurnal periodicity
Output time span	N/A
Update rate	Same as MSW_EULi2C
Latency	Same as MSW_EULi2C
Notes	

Product identifier	MIO_VALi2C
Definition	Intermediate validation report for ionospheric fields from CI
Input Data	MIO_SHAi2C
Data volume	< 1 MB
Data format	PDF format
Output Data	PDF file
Update rate	Same as MIO_SHAi2C
Latency	Same as MIO_SHAi2C
Notes	

Product identifier	MIO_SHAi2D
Definition	Spherical harmonic representation of the daily geomagnetic variations at mid and low latitudes (Sq and EEJ) and its induced counterpart
Input Data	MAGx_LR_1B, AUX_KP__2_, AUX_DST_2_, AUX_F10_2_, AUX_IMF_2, AUX_COR_2_, AUX_OBS_2_, AUX_LIT_2_, AUX_IGR_2_, MCO_SHA_2F, MCO_SHAi2D, MLI_SHAi2D, MCO_SHAi2C, MLI_SHAi2C, MMA_SHAi2C, MMA_SHA_2F, Q3D_CI_i2_
Input Time Span	3 months to 1 year, to be confirmed and aligned to update rate
Spatial representation	Spherical Harmonics up to degree 60 and order 12 in dipole coordinates
Time representation	Fourier Series, seasonal and daily periodicity
Units	nT
Resolution	1 fT
Uncertainty	Refer to product quality report
Quality indicator	Statistics of data misfits provided in the validation report
Data volume	~ 3.5 Mo

Product identifier	MIO_SHAi2D
Data format	ASCII listing (section 4.3.4.3)
Output Data	Coefficients of SH model in dipole coordinates, with seasonal and diurnal periodicity
Output time span	N/A
Update rate	First after 6 months, 1 year, and update every year.
Latency	1.5 month
Notes	

5.8.2 Final Level 2 Products

Product identifier	MIO_VALi2D
Definition	Intermediate validation report for ionospheric fields from dedicated chain
Input Data	MIO_SHAi2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Same as MIO_SHAi2D
Latency	Same as MIO_SHAi2D
Notes	

Product identifier	MMA_VAL_2C
Definition	Validation report for magnetospheric field model from CI chain
Input Data	MMA_SHAi2C, MMA_SHA_2F, MMA_VALi2C
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MMA_SHA_2C
Latency	1 month
Notes	

Product identifier	MMA_SHA_2C
Definition	Spherical harmonic representation of the large scale magnetospheric field and of its induced counterpart
Input Data	MMA_SHAi2C, MMA_VAL_2_
Input Time Span	As for MMA_SHAi2C
Spatial representation	As for MMA_SHAi2C

Product identifier	MMA_SHA_2C
Time representation	As for MMA_SHAi2C
Units	As for MMA_SHAi2C
Resolution	As for MMA_SHAi2C
Uncertainty	As for MMA_SHAi2C
Quality indicator	As for MMA_SHAi2C
Data volume	As for MMA_SHAi2C
Data format	As for MMA_SHAi2C
Output Data	As for MMA_SHAi2C
Output time span	As for MMA_SHAi2C
Update rate	As for MMA_SHAi2C
Latency	As for MMA_SHAi2C
Notes	

Product identifier	MMA_SHA_2F
Definition	Spherical harmonic representation of the large scale magnetospheric field and its induced counterpart
Input Data	MAGx_LR_1B, AUX_IGR_2_, AUX_COR_2_, MCO_SHA_2F, MCO_SHA_2C, MCO_SHA_2D, AUX_LIT_2_, MLI_SHA_2C, MIO_SHA_2C, AUX_F10_2_, AUX_IMF_2F, AUX_DST_2_, AUX_KP__2_, AUX_OBS_2_
Input Time Span	Full Swarm data set covering at least 30 days
Spatial representation	Degree 1 spherical Harmonics for the external and internally induced fields
Time representation	Snapshot values 1.5 hours apart.
Units	See variable 'Units' in 'Data format', below.
Resolution	See variable 'Type' in 'Data format', below.
Uncertainty	Overall uncertainty will include contributions from uncertainties in the Input Data, which are not calculated here. Estimates of the uncertainty resulting from the modeling process after the Input Data has been processed can be obtained from the 'rms' output variable.
Quality indicator	Root-mean-square difference between model and (processed) input data; number of data used per model; quality flag.
Data volume	~5 MB/year
Data format	**CDF Variables**

Name	Type	Dim	Unit	Contents
t_qs	CDF_EPOCH	1	ms	Time instants (CDFEPOCH) of external Gauss coefficients q (cosine) and s (sine)
qs_geo	CDF_DOUBLE	2	nT	External Gauss coefficients q (cosine) and s (sine) in Geographic frame

Product identifier	**MMA_SHA_2F**					
		qs_sm	CDF_DOUBLE	2	nT	External Gauss coefficients q (cosine) and s (sine) in Solar Magnetic frame
		nm_qs	CDF_INT2	2	-	First column: vector of spherical harmonic degrees of the coefficients qs_geo and qs_sm. Nonnegative values denote coefficients q (cosine) while negative values denote coefficients s (sine) Second column: vector of spherical harmonic orders
		t_gh	CDF_EPOCH	1	ms	Time instants (CDFEPOCH) of induced Gauss coefficients g (cosine) and h (sine)
		gh_geo	CDF_DOUBLE	2	nT	Internal induced Gauss coefficients g (cosine) and h (sine) in Geographic frame
		gh_sm	CDF_DOUBLE	2	nT	Internal induced Gauss coefficients g (cosine) and h (sine) in Solar Magnetic frame
		nm_gh	CDF_INT2	2	-	First column: vector of spherical harmonic degrees of the coefficients gh_geo and gh_sm. Nonnegative values denote coefficients g (cosine) while negative values denote coefficients h (sine) Second column: vector of spherical harmonic orders
		t_qual	CDF_EPOCH	1	ms	Time instants (CDFEPOCH) of quality information (rms, n_data, and q_flag).

Product identifier	MMA_SHA_2F					
		rms	CDF_DOUBLE	2	nT	Root-mean-square difference between models and input data (after processing to subtract non-magnetospheric sources) in geographic frame. First column: RMS difference in radial direction. Second column: RMS difference in theta direction. Third column: RMS difference in phi direction.
		n_data	CDF_UINT2	2	-	Number of data used at each time-instant from each satellite. First column: Number of data from SWARM A. Second column: Number of data from SWARM B. Third column: Number of data from SWARM C.

Product identifier	**MMA_SHA_2F**					
		q_flag	CDF_UINT1	1	-	Product quality flag. Value of zero indicates good quality / no issues. The meaning of individual bits are described below: Bit Set if 1 Input time-series is shorter than 1-year filter used to separate internal and external coefficients. This is unavoidable at the start of the mission. 2 Internal/external separation filter has at least one bad/missing datum. This is not necessarily serious (check n_data, above and bits 3 and 4, below). 3 total n_data for this model is < 90% of the expected maximum available. 4 Internal/external separation filter has at least one bad/missing datum amongst the most recent (five) where it is most sensitive. Example: decimal '9' means bits '1' and '4' set.
Output Data	Time series of external and induced SH coefficients in Solar Magnetic and Geographic coordinate frames; root-mean-square differences between (processed) input data and models; number of data from each satellite used for each model; quality flag.					
Output time span	1 day					
Update rate	Daily					
Latency	< 1 day					
Notes						

Product identifier	MIO_VAL_2C
Definition	Validation report for ionospheric field model from CI chain
Input Data	MIO_SHAi2C, MIO_VALi2C
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MIO_SHA_2C
Latency	1 month
Notes	

Product identifier	MIO_VAL_2D
Definition	Validation report for ionospheric field model from dedicated chain
Input Data	MIO_SHAi2D, MIO_VALi2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	As for MIO_SHA_2D
Latency	1 month
Notes	

Product identifier	MIO_VAL_2_
Definition	Comparison validation report for ionospheric field model
Input Data	MIO_SHA_2C, MIO_SHA_2D, MIO_VAL_2C, MIO_VAL_2D
Data volume	< 1 Mb per day
Data format	PDF format
Output Data	PDF file
Update rate	Each time when both, MIO_SHA_2C and MIO_SHA_2D are released.
Latency	1 month
Notes	

Product identifier	MIO_SHA_2C
Definition	Spherical harmonic representation of the daily geomagnetic variations at mid and low latitudes (Sq and EEJ)
Input Data	MIO_SHAi2C, MIO_VAL_2_
Input Time Span	Same as MIO_SHAi2C

Product identifier	MIO_SHA_2C
Spatial representation	Same as MIO_SHAi2C
Time representation	Same as MIO_SHAi2C
Units	Same as MIO_SHAi2C
Resolution	Same as MIO_SHAi2C
Uncertainty	Same as MIO_SHAi2C
Quality indicator	Same as MIO_SHAi2C
Data volume	Same as MIO_SHAi2C
Data format	Same as MIO_SHAi2C
Output Data	Same as MIO_SHAi2C
Output time span	Same as MIO_SHAi2C
Update rate	Same as MIO_SHAi2C
Latency	Same as MIO_SHAi2C
Notes	

Product identifier	MIO_SHA_2D
Definition	Spherical harmonic representation of the daily geomagnetic variations at mid and low latitudes (Sq and EEJ)
Input Data	MIO_SHAi2D, MIO_VAL_2_
Input Time Span	Same as MIO_SHAi2D
Spatial representation	Same as MIO_SHAi2D
Time representation	Same as MIO_SHAi2D
Units	Same as MIO_SHAi2D
Resolution	Same as MIO_SHAi2D
Uncertainty	Same as MIO_SHAi2D
Quality indicator	Same as MIO_SHAi2D
Data volume	Same as MIO_SHAi2D
Data format	Same as MIO_SHAi2D
Output Data	Same as MIO_SHAi2D
Output time span	Same as MIO_SHAi2D

Product identifier	IBIxTMS_2F
Definition	Ionospheric bubble index
Input Data	MAGx_LR_1B, EFIx_PL_1B, Satellite positions, Time stamps (UTC) AUX_IGR_2F, AUX_COR_2F, AUX_LIT_2F, AUX_PMF_2F, AUX_F10_2F, AUX_DST_2F, AUX_IMF_2F, AUX_SWV_2F, AUX_PSM_2F, AUX_PGM_2F

<table>
<tr><td>Product identifier</td><td>IBIxTMS_2F</td></tr>
<tr><td>Input Time Span</td><td>3 days</td></tr>
<tr><td>Spatial representation</td><td>One index per data point (characterising whether the magnetic observation is affected by bubble or not.)</td></tr>
<tr><td>Time representation</td><td>1s time series</td></tr>
<tr><td>Units</td><td>N/A</td></tr>
<tr><td>Resolution</td><td>N/A</td></tr>
<tr><td>Uncertainty</td><td>N/A</td></tr>
<tr><td>Quality indicator</td><td>Flags_Bubble:
0 Quiet
1 Confirmed plasma bubble
2 Unconfirmed plasma bubble
4 Large peak in unfiltered magnetic field residuals
8 Time gap
16 Too many peaks in filtered magnetic field residuals
32 Outside equatorial orbit segment or invalid latitude/local time

Flags_B, Flags_F and Flags_q provided in [AD-5].</td></tr>
<tr><td>Data volume</td><td>~4 MB/day/satellite</td></tr>
<tr><td>Data format</td><td>Swarm L2 CAT-2 IBI Product CDF Output Specification

Variables
<table>
<tr><th>Variable Name</th><th>Description</th><th>Type</th><th>Units</th></tr>
<tr><td>Timestamp</td><td>Time stamp in UTC</td><td>CDF_EPOCH</td><td>ms</td></tr>
<tr><td>Latitude</td><td>Geographic latitude</td><td>CDF_DOUBLE</td><td>degree</td></tr>
<tr><td>Longitude</td><td>Geographic longitude</td><td>CDF_DOUBLE</td><td>degree</td></tr>
<tr><td>Radius</td><td>Geographic radius</td><td>CDF_DOUBLE</td><td>m</td></tr>
<tr><td>Bubble_Index</td><td>Plasma Bubble Index
0 Quiet
1 Bubble
-1 Not analyzed</td><td>CDF_INT2</td><td>No unit</td></tr>
<tr><td>Bubble_Probability</td><td>Detection probability of the plasma bubble
(in steps of 0.2; 0-not probable, 1-very probable)</td><td>CDF_DOUBLE</td><td>No unit</td></tr>
<tr><td>Flags_Bubble</td><td>Flags related to the plasma bubble index</td><td>CDF_UINT1</td><td>No unit</td></tr>
</table></td></tr>
</table>

Product identifier	IBIxTMS_2F
	Flags_F: Flags_F passed through from MAGx_L1_B; CDF_UINT1; No unit Flags_B: Flags_B passed through from MAGx_L1_B; CDF_UINT1; No unit Flags_q: Flags_q passed through from MAGx_L1_B; CDF_UINT1; No unit
Output Data	time stamps, positions, Bubble Index, Bubble probability, flags
Output time span	1 day
Latency	6 min
Update rate	1 per day
Notes	

Product identifier	TECxTMS_2F
Definition	Time series of the ionospheric total electron content
Input Data	GPS RINEX observation and navigation files (GPSX_RO_1B) Swarm satellite ephemeris (MODX_SC_1B) GPS and Swarm satellite ephemeris (AUX_GPSEPH) GPS transmitter biases(AUX_DCB_2F) Leap seconds (AUX_USLEAP)
Input Time Span	3 days
Spatial representation	Line representation of GPS –Swarm link
Time representation	1-s time series for TEC and 1 day for DCB
Units	TECU (10^{16} electrons/m^2)
Resolution	1E-8 TECU
Uncertainty	2 TECU
Quality indicator	Relative_STEC_RMS (RMS deviation between code and carrier phases) and DCB_Error
Data volume	~4 MB / day / satellite
Data format	**Variables** Timestamp: Time stamp in UTC; CDF_EPOCH; ms Latitude: Geographic latitude; CDF_DOUBLE; degree Longitude: Geographic longitude; CDF_DOUBLE; degree

Product identifier	**TECxTMS_2F**

Radius	Geographic radius	CDF_DOUBLE	km
GPS_Position	X-,Y-,Z-coordinates (WGS84) of the GPS satellite	CDF_DOUBLE	km
LEO_Position	X-,Y-,Z-coordinates (WGS84) of the LEO satellite	CDF_DOUBLE	m
PRN	GPS satellite PRN	CDF_UINT2	No Unit
L1	GPS L1 carrier phase observation	CDF_DOUBLE	m
L2	GPS L2 carrier phase observation	CDF_DOUBLE	m
P1	GPS P1 code phase observation	CDF_DOUBLE	m
P2	GPS P2 code phase observation	CDF_DOUBLE	m
S1	GPS signal-to-noise ratio or raw signal strength on L1	CDF_DOUBLE	No Unit
S2	GPS signal-to-noise ratio or raw signal strength on L2	CDF_DOUBLE	No Unit
Absolute_STEC	Absolute slant TEC	CDF_DOUBLE	TECU
Absolute-VTEC	Absolute vertical TEC	CDF_DOUBLE	TECU
Elevation-Angle	Elevation angle	CDF_DOUBLE	degree
Relative_STEC	Relative slant TEC	CDF_DOUBLE	TECU
Relative_STEC_RMS	Root mean square error of relative slant TEC	CDF_DOUBLE	TECU
DCB	GPS receiver differential code bias	CDF_DOUBLE	TECU
DCB_Error	Error of the GPS receiver differential code bias	CDF_DOUBLE	TECU

Output Data	time stamps, positions, PRN, L1, L2, P1, P2, S1, S2, TEC, RMS, DCB, DCB_Error
Output time span	1 day
Latency	6 min
Update rate	1 per day
Notes	The cadence of the TECxTMS_2F data has changed from 10-s (0.1 Hz) to 1-s (1 Hz) at: • 2014-07-14 06:42:59 for Swarm A • 2014-07-14 06:06:46 for Swarm B

Product identifier	TECxTMS_2F
	• 2014-07-14 08:15:59 for Swarm C It is recommended to use absolute VTEC data with corresponding elevation angles of the GPS rays of at least 50°.

Product identifier	FAC_TMS_2F
Definition	Time series of field aligned current density and radial currents density along the orbit. Field-aligned current density is derived by the multiplication of the radial current density with the inclination angle of the geomagnetic field. The field-aligned current density can only be calculated at high latitudes, where the magnetic field is well inclined, i.e. $I > 30°$ (except near the magnetic equator). At lower latitudes, the times series has no values (NaN). The radial current density can be provided along the whole orbit, except for latitudes $\theta > 86°$. Scale size >150 km.
Input Data	MAGA_LR_1B, MAGC_LR_1B, Time stamps (UTC) AUX_IGR_2F, AUX_COR_2F, AUX_LIT_2F, AUX_PMF_2F, AUX_F10_2F, AUX_DST_2F, AUX_IMF_2F, AUX_SWV_2F, AUX_PSM_2F, AUX_PGM_2F
Input Time Span	3 days
Spatial representation	Current density estimates along entire orbits at positions between SwA and SwC
Time representation	Time series of current density, Δt=1sec
Units	Current density: µA/m^2
Resolution	Current density: 1E-6 µA/m^2
Uncertainty	50 nA/m^2 for periods 10s to 90min on top of constant bias of <200nA/m^2, for latitudes below 80°, gradually degrading between 80° to 86°, no values beyond 86°
Quality indicator	**Flags:** **There are 10 digits reserved in this flag:** If the satellite is inside the region where FAC and/or IRC can in principle be calculated than digits 9 and 10 are both 0. If the satellite was outside this region than digit 9 or 10 is 1. (In this case, FAC and/or IRC value is NaN). Digit 9 and 10 can never be 1 for the same measurement. Digit 1 to 8 report about different problems that occur during the processing. All of them provide a fall back solutions. They can have values N=1-4, indicating the number of affected quad points. **About NANs:** The FAC and/or IRC value is always NAN, when digit 9 or 10 is 1. When digit 9 and 10 are both 0, but the FAC/IRC value is NaN, the reason for NaN is unknown.

Product identifier	FAC_TMS_2F

The provided digits 1-8 do not inform about possible reasons for NaN. They provide information on the expected quality of the results. Digits 1-8 can be different to 0 irrespective of the values of digits 9 and 10.

Digit-Nr.	Value	Meaning
1	0/N	interpolated data (data gap)
2	0/N	Data is in filter tuning range due to larger data gap before and/or after the gap
3	0/N	no EST data were available because no `AUX_DST_2F` was available for magnetospheric field calculation; instead default value is used
4	0/N	no IST data were available because no `AUX_DST_2F` was available for magnetospheric field calculation; instead default value is used
5	0/N	no Aux data `AUX_F10_2F` available for magnetospheric field calculation; instead default value is used
6	0/N	no Aux data (`AUX_IMF_2F`) available for magnetospheric field calculation; instead default value is used
7	0/N	no *Em* data (merging electric field) was available because either `AUX_IMF_2F or AUX_SWV_2F` were not available for magnetospheric field calculation; instead default value is used.
8	0/N	No magnetospheric field coefficients (`Aux_PMF_2F or Aux_PSM_2F or Aux_PGM_2F`) available; magnetospheric field is set to 0; resulting FACs are slightly less reliable.
9	**0/1**	**`IRC`=*NaN* and `FAC`=*NaN* because latitude |θ| >86° near geogr. pole**
10	**0/1**	**`FAC`=*NaN* because inclination |*I*| < 30° near magn. equator**

<table>
<tr><th>Product identifier</th><th>FAC_TMS_2F</th></tr>
<tr><td></td><td>Flags_B, Flags_F and Flags_q are handed through from Level 1b processing [AD-5]. For each current estimate the flag values of the measurement points involved were added. Accordingly, the digits of these flags have values of N=0-4, corresponding to the number of (measurements involved in the FAC/IRC estimate (quad points) that have been affected.</td></tr>
<tr><td>Data volume</td><td>5 MB per day</td></tr>
<tr><td>Data format</td><td>
<table>
<tr><th>Variable Name</th><th>Data Type</th><th>Descriptions</th><th>Units</th></tr>
<tr><td>Timestamp</td><td>CDF_EPOCH</td><td>Time, UTC</td><td>milli-seconds</td></tr>
<tr><td>Latitude</td><td>CDF_DOUBLE</td><td>Position in ITRF, Latitude</td><td>degrees</td></tr>
<tr><td>Longitude</td><td>CDF_DOUBLE</td><td>Position in ITRF, Longitude</td><td>degrees</td></tr>
<tr><td>Radius</td><td>CDF_DOUBLE</td><td>Position in ITRF, Radius</td><td>m</td></tr>
<tr><td>IRC</td><td>CDF_DOUBLE</td><td>Ionospheric radial current (IRC)</td><td>$\mu A/m^2$</td></tr>
<tr><td>IRC_Error</td><td>CDF_DOUBLE</td><td>uncertainty of IRC</td><td>$\mu A/m^2$</td></tr>
<tr><td>FAC</td><td>CDF_DOUBLE</td><td>Field-aligned current (FAC)</td><td>$\mu A/m^2$</td></tr>
<tr><td>FAC_Error</td><td>CDF_DOUBLE</td><td>uncertainty of FAC</td><td>$\mu A/m^2$</td></tr>
<tr><td>Flags</td><td>CDF_UINT4</td><td>Flags characterizing the product quality (processing flags)</td><td>-</td></tr>
<tr><td>Flags_F</td><td>CDF_UINT4</td><td>Flags_F passed through from L1b and accumulated for quad points</td><td>-</td></tr>
<tr><td>Flags_B</td><td>CDF_UINT4</td><td>Flags_B passed through from L1b and accumulated for quad points</td><td>-</td></tr>
<tr><td>Flags_q</td><td>CDF_UINT4</td><td>Flags_q passed through from L1b and accumulated for quad points</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>Output Data</td><td>time stamps, positions, radial current density, field-aligned current density, quality flags</td></tr>
</table>

Product identifier	**FAC_TMS_2F**
Output time span	1day
Update rate	1 per day
Latency	10 min
Notes	

Product identifier	**FACxTMS_2F**
Definition	Time series of field-aligned current density and radial currents density along the orbit from single satellite measurements. Field-aligned current density is derived by the magnetic field in the MFA frame. No FACs will be estimated for cases with Vx < 1.5 km/s (near the magnetic equator). The FAC values at these current positions will be set to *NaN*. The radial current density, i.e. FAC multiplied by the inclination of the magnetic field, can be provided along the whole orbit. Scale size >7.5 km.
Input Data	MAGx_LR_1B, Satellite positions, Time stamps (UTC) AUX_IGR_2F, AUX_COR_2F, AUX_LIT_2F, AUX_PMF_2F, AUX_F10_2F, AUX_DST_2F, AUX_IMF_2F, AUX_SWV_2F, AUX_PSM_2F, AUX_PGM_2F
Input Time Span	3 days
Spatial representation	Current density estimates along entire orbits at positions of SwA, SwB, and SwC.
Time representation	Time series of current density, Δt=1sec
Units	Current density: μA/m^2
Resolution	Current density: 1E-6 μA/m^2
Uncertainty	less than FAC_TMS_2F, 70 nA/m^2 on top of constant bias of <200nA/m^2, for latitudes below 80°, gradually degrading between 80° to 86°, no values beyond 86°
Quality indicator	**Flags** same as for FAC_TMS_2F but N=1-2
Data volume	5MB per day, per satellite
Data format	Same as for FAC_TMS_2F
Output Data	time stamps, positions, radial current density, field-aligned current density, quality flags
Output time span	1day
Latency	10 min
Update rate	1 per day
Notes	

<table>
<tr><td>Product identifier</td><td>EEFxTMS_2F</td></tr>
<tr><td>Definition</td><td>Dayside equatorial electric field</td></tr>
<tr><td>Input Data</td><td>MAGx_LR_1B, MCO_SHA_2X</td></tr>
<tr><td>Input Time Span</td><td>Every dayside equator crossing ±20 minutes</td></tr>
<tr><td>Spatial representation</td><td>One longitude/latitude pair (on the magnetic equator) for each output value</td></tr>
<tr><td>Time representation</td><td>Single values at time of dayside equator crossing</td></tr>
<tr><td>Units</td><td>V/m</td></tr>
<tr><td>Resolution</td><td>0.1 mV/m</td></tr>
<tr><td>Uncertainty</td><td>0.1 mV/m</td></tr>
<tr><td>Quality indicator</td><td>Relative error between modeled and observed current profile</td></tr>
<tr><td>Data volume</td><td>< 2 kB</td></tr>
<tr><td>Data format</td><td>CDF
<table>
<tr><th>Variable Name</th><th>Type</th><th>Description</th><th>Units</th></tr>
<tr><td>Timestamp</td><td>CDF_EPOCH</td><td>Timestamp of the EEF measurement (time of satellite crossing of magnetic equator)</td><td>Milliseconds</td></tr>
<tr><td>Longitude</td><td>CDF_DOUBLE</td><td>Geographic longitude of the Swarm satellite crossing of the magnetic equator</td><td>Degrees</td></tr>
<tr><td>Latitude</td><td>CDF_DOUBLE</td><td>Geographic latitude of the Swarm satellite crossing of the magnetic equator</td><td>Degrees</td></tr>
<tr><td>EEF</td><td>CDF_DOUBLE</td><td>Equatorial eastward electric field estimate</td><td>mV/m</td></tr>
<tr><td>EEJ</td><td>CDF_DOUBLE</td><td>Height-integrated latitude profile of equatorial eastward current estimate (length 81)</td><td>mA/m</td></tr>
<tr><td>RelErr</td><td>CDF_DOUBLE</td><td>Relative error between modelled and observed equatorial electrojet current</td><td>N/A</td></tr>
<tr><td>Flags</td><td>CDF_UINT2</td><td>Value describing the quality of the EEF estimate. Also contains identification information for Swarm satellite (A, B, C)</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Output Data</td><td>Longitude, latitude, time, EEF value, quality-indicator, flags</td></tr>
</table>

Product identifier	EEFxTMS_2F
Output time span	Continuous for entire mission. One value for each day-side equator crossing (90 minute sampling for day-night local time orbits, 45 minutes for dawn-dusk orbits)
Update rate	One output file per day
Latency	30 hours
Notes	The EEJ vector has length 81 and corresponds to QD latitudes ranging from -20° to +20° in steps of 0.5°. So for example, the corresponding QD latitude vector could be constructed using the following MATLAB syntax: qdvec = [-20:0.5:20].

Product identifier	IPDxIRR_2F
Definition	Time series of characteristics of the plasma density and plasma irregularities along the orbit from single satellite measurements. Time series of local plasma conditions, including background density and total electron content. Data related to geomagnetic regions in the ionosphere. Indication of severity of plasma irregularities for ground-based users provided.
Input Data	EFI_LP_1B, TECxTMS_2F, AOBxFAC_2F, IBIxTMS_2F PCP – Polar Cap Products
Input Time Span	3 days
Spatial representation	Data provided along entire orbits at positions of SwA, SwB, and SwC
Time representation	1 second time series (the electron density data are downsampled to 1 second resolution; the timestamp of the electron density and TEC data are rounded to the nearest integer UTC seconds)
Units	See data format table
Resolution	Temporal data resolution of 1 second, density variations estimated at 0.5 second resolution
Uncertainty	N/A
Quality indicator	Quality flags are handed through from Level 1b and Level 2 processing which is used as input data
Data volume	ca. 10 MB per day, per satellite
Data format	CDF
Output Data	CDF file with time series

Variable Name	Data Type	Descriptions	Units
Timestamp	CDF_EPOCH	Time, UTC	milliseconds
Latitude	CDF_DOUBLE	Position in ITRF, Latitude	degrees

Product identifier	**IPDxIRR_2F**			
	Longitude	CDF_DOUBLE	Position in ITRF, Longitude	degrees
	Radius	CDF_DOUBLE	Position in ITRF, Radius	m
	Ne	CDF_DOUBLE	Plasma density; directly copied from the Langmuir probe files	cm^{-3}
	Background Ne	CDF_DOUBLE	Background density; calculated from Ne using a percentile filter	cm^{-3}
	Foreground Ne	CDF_DOUBLE	Foreground density; calculated from Ne using a percentile filter	cm^{-3}
	Te	CDF_DOUBLE	Electron temperature; directly copied from the Langmuir probe files	K
	PCP_flag	CDF_INT4	The polar cap patch flag	-
	Grad_Ne@100km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 27 data points for the 2 Hz electron density data	cm^{-3}/m
	Grad_Ne@50km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 13 data points for the 2 Hz electron density data	cm^{-3}/m
	Grad_Ne@50km	CDF_DOUBLE	The electron density gradient in a running window calculated via linear regression over 5 data points for the 2 Hz electron density data	cm^{-3}/m
	Grad_Ne@PCP_edge	CDF_DOUBLE	The linear electron density gradient calculated over the edges of a patch; non-zero only at the edges of polar cap patches	cm^{-3}/m

Product identifier	IPDxIRR_2F			
	ROD	CDF_DOUBLE	Rate Of change of Density	cm^{-3}/s
	RODI10s	CDF_DOUBLE	Rate Of change of Density Index (RODI) is the standard deviation of ROD over 10 seconds	cm^{-3}/s
	RODI20s	CDF_DOUBLE	Rate Of Density Index (RODI) is the standard deviation of ROD over 20 seconds	cm^{-3}/s
	delta_Ne10s	CDF_DOUBLE	Derived by subtracting Ne by its median filtered value in 10 seconds; indicates the electron density fluctuations smaller than 75 km	cm^{-3}
	delta_Ne20s	CDF_DOUBLE	Derived by subtracting Ne by its median filtered value in 20 seconds; indicates the electron density fluctuations smaller than 150 km	cm^{-3}
	delta_Ne40s	CDF_DOUBLE	Derived by subtracting Ne by its median filtered value in 40 seconds; indicates the electron density fluctuations smaller than 300 km	cm^{-3}
	num_GPS_satellites	CDF_INT4	Total number of tracked GPS satellites above 20 degrees	-
	mVTEC	CDF_DOUBLE	Median of VTEC from all available GPS satellites above 30 degrees	TECU
	mROT	CDF_DOUBLE	Median of Rate Of TEC (ROT) from all available GPS satellites above 30 degrees	TECU/s
	mROTI10s	CDF_DOUBLE	Median of Rate Of TEC Index (ROTI) from all available GPS satellites above 30 degrees. The ROTI of each satellite is the standard deviation of ROT over 10 seconds	TECU/s

Product identifier	**IPDxIRR_2F**			
	mROTI20s	CDF_DOUBLE	Median of Rate Of TEC Index (ROTI) from all available GPS satellites above 30 degrees. The ROTI of each satellite is the standard deviation of ROT over 20 seconds	TECU/s
	IBI_flag	CDF_INT4	Plasma Bubble Index, copied from the level-2 Ionospheric Bubble Index product, IBIxTMS_2F	-
	Ionopshere_region_ flag	CDF_INT4	0: equator, 1: mid-latitudes; 2: auroral oval; 3: polar cap	-
	IPIR_index	CDF_INT4	0-3 low, 4-5 medium, and > 6 high level of fluctuations in the ionospheric plasma density	-
	Ne_quality_flag	CDF_INT4	Quality flag for the Ne data and the derived data from Ne, e.g., background density, foreground density etc. It is a mixture of the LP and TII QFlags. It is calculated as LP_QFLAG*1000 + TII_QFLAG	-
	TEC_STD	CDF_DOUBLE	Standard deviation of VTEC from GPS satellites	TECU
Output time span	1day			
Update rate	1 per day			
Latency	10 min			
Notes	The meanings of the PCP_flag are as follows: 0 if the plasma density measurement occurred outside a polar cap patch. 1 if the plasma density measurement occurred at one of the edges of a polar cap patch (no plasma velocity measurements are available). 2 if the plasma density measurement occurred at the leading edge of a polar cap patch. 3 if the plasma density measurement occurred at the trailing edge of a polar cap patch. 4 if the plasma density measurement occurred inside a polar cap patch proper. When no ion drift data is available, the leading and trailing edges cannot be distinguished. In this case the polar cap patch flag is set to 4 throughout the patch proper and to 1 throughout both edges.			

Product identifier	MIO_SHA_2E
Definition	An empirical model of the Average Magnetic field and Polar current System (AMPS). See: - forward code at doi: 10.5281/zenodo.1182931 - science paper at doi: 10.1029/2018JA025387
Input Data	Swarm magnetic field (MAG-L) measurements, CHAMP magnetic field measurements, model predictions of core, lithospheric and large-scale magnetospheric (including Earth-induced) contributions, taken by the CHAOS geomagnetic field model, OMNI solar wind measurements, F10.7 index
Input Time Span	Entire Swarm mission + entire CHAMP mission
Spatial representation	Spherical harmonic expansion in QD/modified apex coordinates, with degree up to 45/65 for poloidal/toroidal magnetic field parts. Spherical harmonic order (in MLT) up to 3
Time representation	Time dependence contained in parametrization in terms of external parameters: 20 min average solar wind speed and interplanetary magnetic field, dipole tilt angle, and F10.7 index
Units	Magnetic field in nT, horizontal sheet current density in mA/m, vertical current density in µA/m2
Resolution	0.1 nT, 1 mA/m, 0.01 µA/m2
Uncertainty	See doi: 10.1029/2018JA025387
Quality indicator	N/A
Data volume	218 kB
Data format	ASCII
Output Data	Spherical harmonic coefficient
Output time span	Model is based on data from entire CHAMP and Swarm missions, but it is in principle valid for any time when solar wind data was available
Update rate	Yearly (to be confirmed)
Latency	2 months, due to update rate of OMNI data and computation time
Notes	

5.9 Precise Orbit Determination Products

5.9.1 Final Level 2 Products

Product identifier	SP3xCOM_2_
Definition	Time series of dynamic position and velocity of the center of mass of each satellite in the ITRF (Earth-fixed) frame
Input Data	GPSA_RO_1B, GPSB_RO_1B, GPSC_RO_1B STRAATT_1B, STRBATT_1B, STRCATT_1B MODA_SC_1B, MODB_SC_1B, MODC_SC_1B SC_xDYN_1B External data from IGS, IERS, CODE

Product identifier	SP3xCOM_2_
Input Time Span	30 hr (daily batches with overlap)
Spatial representation	N/A
Time representation	GPS time (seconds – s), time step = 10 s
Units	km for position, dm/s for velocity
Resolution	1 ps for time, mm for position, 0.1 μm/s for velocity
Uncertainty	10 cm 3D for position
Quality indicator	Validation report **SP3xVAL_2_**
Data volume	< 2 Megabyte (MB) per satellite per day
Data format	SP3c (section 4.3.2)
Output Data	SP3c file
Output time span	24 hr
Update rate	Daily
Latency	21 days
Notes	Central 24 hr of input time span will be selected for SP3 product Quality report will be provided as separate Level 2 product

Product identifier	SP3xKIN_2_
Definition	Time series of kinematic position of the center of mass of each satellite in the ITRF (Earth-fixed) frame
Input Data	GPSA_RO_1B, GPSB_RO_1B, GPSC_RO_1B STRAATT_1B, STRBATT_1B, STRCATT_1B MODA_SC_1B, MODB_SC_1B, MODC_SC_1B SC_xDYN_1B External data from IGS, IERS, CODE
Input Time Span	30 hr (daily batches with overlap)
Spatial representation	N/A
Time representation	GPS time (seconds – s), observation epochs
Units	km for position, dm/s for velocity
Resolution	1 ps for time, mm for position, 0.1 μm/s for velocity
Uncertainty	10 cm 3D for position
Quality indicator	Validation report **SP3xVAL_2_**
Data volume	< 15 Megabyte (MB) per satellite per day
Data format	SP3c
Output Data	SP3c file
Output time span	24 hr

Product identifier	**SP3xKIN_2_**
Update rate	Daily
Latency	21 days
Notes	Central 24 hr of input time span will be selected for SP3 product Quality report will be provided as separate Level 2 product

Product identifier	**SP3xVAL_2_**
Definition	Validation report for precise orbit solutions SP3xCOM_2_ and SP3xKIN_2_
Input Data	SP3xCOM_2_ and SP3xKIN_2_ ILRS Swarm tracking data Diagnostic and statistical output from orbit determination process
Input Time Span	30 hr
Data volume	< 20 Mb per satellite per day
Data format	PDF format
Output Data	PDF file
Output time span	24 hr
Update rate	1 day
Latency	21 per day
Notes	30 hr time input time span includes overlaps between consecutive orbit solutions

Product identifier	**ACCxPOD_2_**
Definition	Time series of non-gravitational and aerodynamic accelerations obtained by POD
Input Data	GPSx_RO_1B, STRxATT_1B, SC_xDYN_1B, External data from CODE
Input Time Span	30 hr (daily batches with overlap)
Spatial representation	N/A
Time representation	UTC (seconds – s), time step = 30 sec
Units	m/s^2
Resolution	64 bit double precision floating point number format
Uncertainty	10^{-7} m/s^2 variance for along-track and cross-track directions
Quality indicator	Validation report **DNSxVAL_2_**
Data volume	< 10 Kb per satellite per day
Data format	CDF

Field name	**Type**	**Dimension**	**Unit**	**Contents**
time	CDF_EPOCH	1	ms	Observation time

Product identifier	ACCxPOD_2_					
		acc_pod	CDF_REAL8	3	m/s^2	Estimated non-gravitational accelerations (X,Y,Z)
		acc_pod_aero	CDF_REAL8	3	m/s^2	Estimated aerodynamic accelerations (X,Y,Z)
		validity_flag_tot	CDF_INT8	1	-	Flag for variable "acc_pod", 0 = nominal data, 1 = anomalous data
		validity_flag	CDF_INT8	1	-	Flag for variable "acc_pod_aero", 0 = nominal data, 1 = anomalous data
Output Data	CDF file with time series of accelerations					
Output time span	24 hr					
Update rate	1 month					
Latency	21 days					
Notes	The total non-gravitational acceleration (variable "acc_pod") is used for calibrating the accelerometer data (in product "ACCxCAL_2"), whereas the aerodynamic acceleration (variable "acc_pod_aero") is used for the calculation of thermosphere density (in product "DNSxPOD_2").					

5.10 Magnetic Forcing of the Upper Atmosphere

5.10.1 Intermediate Level 2 Products

Product identifier	ACCxDISi2_				
Definition	List of disturbances in accelerometer data				
Input Data	ACCx_PR_1B, ACCx_FMi2_				
Input time span	Variable				
Spatial representation	N/A				
Time representation	UTC				
Units	m/s^2				
Resolution	64 bit double precision floating point format				
Quality indicator	Validation report ACCxVAL_2_				
Data volume	~10 kB / day				
Data format	CDF				
	Field name	**Type**	**Dimension**	**Unit**	**Contents**
	time	CDF_EPOCH	1	ms	Disturbance time in UTC

Product identifier	**ACCxDISi2_**				
	type	CDF_REAL8	1	N/A	Type of disturbance
	duration	CDF_REAL8	1	s	Duration of disturbance
	mag_lin	CDF_REAL8	3	m/s^2	Magnitude of disturbance in linear accelerations
	mag_ang	CDF_REAL8	3	m/s^2	Magnitude of disturbance in angular accelerations
Output data	CDF file with list of disturbances in accelerometer data				
Output time span	Variable				
Update rate	Every 3 months				
Latency	1 month				
Notes	All accelerations are provided in the CRF (x-direction is roughly along-track, y-direction is roughly cross-track, z-direction is roughly nadir)				

Product identifier	**ACCx_FMi2_**				
Definition	Time series of non-gravitational acceleration from force models				
Input data	MODx_SC_1B, STRxATT_1B, AUX_KP__2F , AUX_F10_2F				
Input time span	24 hr				
Spatial representation	N/A				
Time representation	UTC (seconds – s), time step = 10 sec				
Units	m/s^2				
Resolution	64 bit double precision floating point format				
Quality indicator	Validation report ACCxVAL_2_				
Data volume	1.5 MB / day				
Data format	CDF				
	Field name	**Type**	**Dimension**	**Unit**	**Contents**
	time	CDF_EPOCH	1	ms	Epoch of observation
	a_total	CDF_REAL8	3	m/s2	Total non-gravitational acceleration
	a_aero	CDF_REAL8	3	m/s^2	Aerodynamic acceleration
	a_solar	CDF_REAL8	3	m/s^2	Solar radiation pressure acceleration

Product identifier	**ACCx_FMi2_**				
	a_albedo	CDF_REAL8	3	m/s^2	Earth albedo radiation pressure acceleration
	a_infrared	CDF_REAL8	3	m/s^2	Earth infrared radiation pressure acceleration
Output data	CDF file with non-gravitational acceleration from force models				
Output time span	24 hr				
Update rate	daily				
Latency	21 days				
Notes	All accelerations are provided in the CRF (x-direction is roughly along-track, y-direction is roughly cross-track, z-direction is roughly nadir)				

5.10.2 Final Level 2 Products

Product identifier	**ACCxCAL_2_**
Definition	Time series of corrected and calibrated acceleration, including all corrections and calibration parameters
Input Data	ACCx_PR_1B, ACCxPOD_2_, ACCxDISi2_, SC_xDYN_1B, ACCx_PR_1B
Input Time Span	24 hours
Spatial representation	Three-dimensional time series along satellite orbit
Time representation	UTC
Units	m/s^2 for accelerations, unitless for scale factors and flags
Resolution	64 bit double precision floating point format
Quality indicator	Validation report ACCxVAL_2_ Global attribute "DAILY_QUALITY_INDEX" of Type CDF_REAL, which ranges from 1.0 (good data quality) to 5.0 (bad data quality)
Data volume	15 MB per day
Data format	CDF

Field name	**Type**	**Dimension**	**Unit**	**Contents**
time	CDF_EPOCH	1	ms	Epoch of observation (UTC)
a_cal	CDF_REAL8	3	m/s^2	Calibrated linear acceleration (X,Y,Z)
a_stp	CDF_REAL8	3	m/s^2	Step correction for linear accelerations

Product identifier	**ACCxCAL_2_**					
		a_tmp	CDF_REAL8	3	m/s^2	Temperature correction for linear accelerations
		a_gg	CDF_REAL8	3	m/s^2	Gravity gradient correction for linear accelerations
		a_aa	CDF_REAL8	3	m/s^2	Angular acceleration correction for linear accelerations
		a_ca	CDF_REAL8	3	m/s^2	Centrifugal acceleration correction for linear accelerations
		s	CDF_REAL8	3	N/A	Scale factor (time series) for linear accelerations
		b	CDF_REAL8	3	m/s^2	Bias for linear accelerations
		spike_index	CDF_REAL8	3	m/s^2	Vector indicating per axis the size of artificial spikes in linear accelerations
		flag_cor	CDF_UINT4	1	N/A	Flag indicating which corrections are applied
		flag_val	CDF_UINT4	1	N/A	Flag indicating if data is valid
		flag_thr	CDF_UINT4	1	N/A	Flag indicating if thruster activations
Output Data	CDF file with corrected and calibrated accelerations from the accelerometer, all corrections and calibration parameters, and flags; sampling rate is 1 Hz (accelerations are at original measurement epochs)					
Output time span	1 day					
Update rate	3 months					
Latency	1 month					

Product identifier	**ACCxCAL_2_**
Notes	All accelerations are provided in the CRF (x-direction is roughly along-track, y-direction is roughly cross-track, z-direction is roughly nadir) Calibration was performed against non-gravitational accelerations from POD that are contained in product ACCxPOD_2_ Early versions of this product will contain only along-track acceleration data

Product identifier	**ACCx_AE_2_**
Definition	Time series of calibrated accelerometer data, pre-processed to represent external non-gravitational forces and aerodynamic accelerations
Input Data	SC_xDYN_1B, STRxATT_1B, SP3xCOM_2_, ACCxCAL_2_, ACCxPOD_2_, AUX_F10_2_, AUX_KP__2_ External data from IERS
Input Time Span	24 hr
Spatial representation	Time-series along satellite track, altitude (m), latitude (deg), longitude (deg) and local solar time (hours) available based on MODX_SC_1B
Time representation	UTC (seconds – s), nominally with 10 s time step
Units	nm/s^2 for accelerations, s for time, m for altitude, degrees for latitude, longitude, hours for local solar time
Resolution	64 bit double precision floating point number format
Uncertainty	N/A
Quality indicator	Validation report **TDAxVAL_2_**
Data volume	< 10 Mbyte per satellite per day
Data format	CDF

Field name	**Type**	**Dimension**	**Unit**	**Contents**
time	CDF_EPOCH	1	ms	Observation time
acc_total_obs	CDF_REAL8	1	m/s^2	Non-gravitational acceleration from accelerometer and GPS receiver (X ≈ along-track)
acc_aero_obs	CDF_REAL8	1	m/s^2	Aerodynamic accelerations (X ≈ along-track)

Output Data	CDF file with time series
Output time span	24 hr
Update rate	3 months

Product identifier	**ACCx_AE_2_**
Latency	1 month
Notes	The applied accelerometer bias and scale factors are available in the metadata.

Product identifier	**ACCxVAL_2_**
Definition	Validation report for measured, modeled and POD accelerations ACCxCAL_2_, ACCx_FMi2_ and ACCxPOD_2_
Input Data	ACCxDISi2_, ACCxCAL_2_, ACCxPOD_2_, ACCx_FMi2_
Input Time Span	Variable
Data volume	1 – 10 MB / day
Output Data	PDF file
Output time span	Variable
Update rate	3 months
Latency	1 month

Product identifier	**DNSxACC_2_**
Definition	Thermospheric density at the satellite location estimated from calibrated non-gravitational accelerations (ACCx_AE_2_) that are based on precise orbit determination and accelerometer data
Input Data	STRxATT_1B, SC_xDYN_1B, ACCx_AE_2_, SP3_COM__2, AUX_IER_2_, AUX_AER_2_, AUX_F10_2_, AUX_KP__2_ External data from IERS
Input Time Span	24 hr
Spatial representation	Time-series along satellite track, altitude (m), latitude (deg), longitude (deg) and local solar time (hours) available based on MODX_SC_1B
Time representation	UTC (seconds – s), nominally with 10 s time step
Units	kg/m^3 for density, m/s for wind speed
Resolution	64 bit double precision floating point number format
Uncertainty	30% of variance from models for neutral density
Quality indicator	Validation report **TDAxVAL_2_**
Data volume	< 15 Mbyte per satellite per day
Data format	CDF

Field name	**Type**	**Dimension**	**Unit**	**Contents**
time	CDF_EPOCH	1	ms	Observation time

<table>
<tr><td>Product identifier</td><td>DNSxACC_2_
<table>
<tr><td>altitude</td><td>CDF_REAL8</td><td>1</td><td>m</td><td>Observation altitude</td></tr>
<tr><td>latitude</td><td>CDF_REAL8</td><td>1</td><td>deg</td><td>Observation geodetic latitude</td></tr>
<tr><td>longitude</td><td>CDF_REAL8</td><td>1</td><td>deg</td><td>Observation geodetic longitude</td></tr>
<tr><td>local_solar_time</td><td>CDF_REAL8</td><td>1</td><td>hours</td><td>Observation local solar time</td></tr>
<tr><td>density</td><td>CDF_REAL8</td><td>1</td><td>kg/m^3</td><td>Thermospheric neutral density</td></tr>
</table></td></tr>
<tr><td>Output Data</td><td>CDF file with time series</td></tr>
<tr><td>Output time span</td><td>24 hr</td></tr>
<tr><td>Update rate</td><td>3 months</td></tr>
<tr><td>Latency</td><td>1 month</td></tr>
<tr><td>Notes</td><td>None</td></tr>
</table>

<table>
<tr><td>Product identifier</td><td>DNSxPOD_2_</td></tr>
<tr><td>Definition</td><td>Thermospheric density at the satellite location along with auxiliary parameters (altitude, latitude, longitude and local solar time). Derived from non-gravitational accelerations based on precise orbit determination data only (ACCxPOD_2_).</td></tr>
<tr><td>Input Data</td><td>MODx_SC_1B, STRxATT_1B, SC_xDYN_1B, ACCxPOD_2_</td></tr>
<tr><td>Input Time Span</td><td>24 hr</td></tr>
<tr><td>Spatial representation</td><td>Time-series along satellite track, altitude (m), latitude (deg), longitude (deg) and local solar time (hours) available based on MODx_SC_1B</td></tr>
<tr><td>Time representation</td><td>UTC (seconds – s), nominally with 30 s time step, as well as orbital averages</td></tr>
<tr><td>Units</td><td>kg/m^3 for density</td></tr>
<tr><td>Resolution</td><td>64 bit double precision floating point number format</td></tr>
<tr><td>Uncertainty</td><td>30% of variance from models for neutral density</td></tr>
<tr><td>Quality indicator</td><td>Validation report DNSxVAL_2_</td></tr>
<tr><td>Data volume</td><td>< 160 Kbyte per satellite per day</td></tr>
<tr><td>Data format</td><td>CDF
<table>
<tr><th>Field name</th><th>Type</th><th>Dimension</th><th>Unit</th><th>Contents</th></tr>
<tr><td>time</td><td>CDF_EPOCH</td><td>1</td><td>ms</td><td>Time of observation</td></tr>
</table></td></tr>
</table>

Product identifier	**DNSxPOD_2_**					
		density	CDF_REAL8	1	kg/m^3	Density derived from GPS accelerations
		density_orbitmean	CDF_REAL8	1	kg/m^3	Orbit-average of density derived from GPS accelerations
		validity_flag	CDF_INT1	1	-	Flag: 0 = nominal data, 1 = anomalous data
		altitude	CDF_REAL8	1	m	Altitude
		latitude	CDF_REAL8	1	deg	Geodetic latitude
		longitude	CDF_REAL8	1	deg	Geodetic longitude
		local_solar_time	CDF_REAL8	1	hours	Local solar time
Output Data	CDF file with time series					
Output time span	24 hr					
Update rate	1 month					
Latency	21 days					
Notes	The density_orbitmean field contains the mean density, taken over one orbital period, for each time step. The orbital period in seconds is provided as metadata in the CDF file. At high altitude and low solar activity, the errors inherent in the radiation pressure model and acceleration determination using GPS data can become significant compared to the magnitude of the acceleration signal. This can result in large density errors and even negative densities. Users are advised to use the orbit mean densities in those conditions. At high altitude and low solar activity, the errors inherent in the radiation pressure model and acceleration determination using GPS data can become significant compared to the magnitude of the acceleration signal. This can result in large density errors and even negative densities. Users are advised to use the orbit mean densities in those conditions.					

Product identifier	**TDAxVAL_2_**
Definition	Validation report for thermospheric densities and winds DNSxACC_2_
Input Data	DNSxACC_2_, ACCx_AE_2_, ACCxCAL_2_, ACCxPOD_2_
Input Time Span	24 hr
Data volume	< 20 Mb per satellite per day
Data format	PDF format

Product identifier	TDAxVAL_2_
Output Data	PDF file
Output time span	24 hr
Update rate	3 months
Latency	1 month
Notes	Associated with ACCxCAL_2_, ACCxPOD_2_, ACCx_AE_2_ and DNSxACC_2_

Product identifier	DNSxVAL_2_
Definition	Validation report showing plots of GPS-derived accelerations ACCxPOD_2_, as well as for thermosphere density and orbit-average thermosphere density, derived from these accelerations. Flagged data are included and marked in the plots.
Input Data	DNSxPOD_2_, ACCxPOD_2_
Input Time Span	24 hr
Data volume	< 20 Mb per satellite per day
Data format	PDF format
Output Data	PDF file
Output time span	24 hr
Update rate	1 day
Latency	21 days
Notes	Associated with DNSxPOD_2, ACCxPOD_2_

5.11 Gravity Field Products

5.11.1 Final Level 2 Products

Product identifier	EGF_SHA_2_
Definition	Monthly gravity field of the Earth
Input Data	GPSA_RO_1B, GPSB_RO_1B, GPSC_RO_1B, STRAATT_1B, STRBATT_1B, STRCATT_1B
Input Time Span	1 calendar month
Spatial representation	Spherical harmonic coefficients
Time representation	Monthly average of Earth's gravity field, i.e. with an implicit epoch located at the middle of the calendar month
Units	See output data
Resolution	12 significant digits in scientific notation

Product identifier	EGF_SHA_2_
Uncertainty	Typically 1-2 mm geoid height or 1-2 cm Equivalent Water Height discrepancy w.r.t. GRACE over land areas during low solar activity periods, considering Gaussian smoothing with 750km spherical cap radius
Quality indicator	RMS over ocean areas that are 6 degrees away from coast lines, after removing long-term trend, annual and semi-annual variations estimated from monthly un-weighted averages of numerous GRACE models (AIUB02, CSR05, GRGS03, ITSG14, GFZ05a, JPL05 and TNJ01)
Data volume	20 Kb
Data format	ASCII file with Stokes Coefficients following the ICGEM-format (http://icgem.gfz-potsdam.de/ICGEM-Format-2011.pdf)
Output Data	Degree, order, cosine coefficient, sine coefficient (columns 5 and 6 set to zero)
Output time span	1 calendar month
Update rate	Quarterly
Latency	5 months
Notes	- Stokes coefficients available up to degree 40 - No smoothing applied - GRACE comparison indicates that there is little useful geophysical signal above roughly degree 12, i.e. it suggest the signal-to-noise ratio drops below 1 at those degrees and above - Further product details in Swarm ITT1.1 TN-01

5.12 Quick Look reports for L1b products

Product identifier	MAG_QL__2_
Definition	Quick-look report for L1b magnetic data
Input Data	MAGx_LR_1B, AUX_IGR_2_, AUX_COR_2F, AUX_COR_2_
Input Time Span	24 hr
Spatial representation	N/A
Time representation	N/A
Units	N/A
Precision	N/A
Quality indicator	N/A
Data volume	< 1 Mb/day
Data format	PDF format
Output Data	PDF file

Product identifier	MAG_QL__2_
Output time span and resolution	daily and mission-to-date
Update rate	daily
Latency	target is < 1 day on normal week days
Notes	May be developed as an online tool for operation at MPPF

5.13 Auxiliary data

Product identifier	EFI_QL__2_
Definition	Quick-look report for L1b plasma data
Input Data	EFIx_PL_1B
Input Time Span	24 hr
Spatial representation	N/A
Time representation	N/A
Units	N/A
Precision	N/A
Quality indicator	N/A
Data volume	<1 Mb/day
Data format	PDF format
Output Data	PDF file
Output time span and resolution	daily and mission-to-date
Update rate	daily
Latency	target is < 1 day on normal week days
Notes	May be developed as an online tool for operation at MPPF

Product identifier	AUX_KP__2_
Definition	**Kp** – Planetary three-hourly index of geomagnetic activity recorded at 13 mid-latitude ground-based observatories and corresponding ap series
Application	MSW_EULi2_C, MSW_EULi2_D, MSW_EUL_2F, MCO_SHAi2C, MCO_SHAi2D, MCO_SHA_2F, MLI_SHAi2C, MLI_SHAi2D, MIO_SHAi2C, MIO_SHAi2D, DNSxACC_2_, WP16000
Spatial representation	1 value describing the global state
Time representation	Time series in UT (3-hours average: 0-3h, 3-6h, 6-9h, 9-12h, 12-15h, 15-18h, 18-21h, 21-24h)
Units	Kp: Unitless, ap: nT
Resolution	Kp indices range in 28 steps from 0 (quiet) to 9 (greatly disturbed) with fractional parts expressed in thirds of a unit. A Kp-value equal to 27, for example, means 2 and 2/3 or 3-; a

Product identifier	**AUX_KP__2_**
	Kp-value equal to 30 means 3 and 0/3 or 3 exactly; and a Kp-value equal to 33 means 3 and 1/3 or 3+.
Uncertainty	N/A
Quality indicator	Not provided

Data format	ASCII listing
	`# Three-hours indices Kp and ap`
	`# created @ 2010-12-06 04:40:01`
	`#`
	`MJD2000 Kp ap`
	`-365.9375 3 2`
	`-364.8125 27 12`
	`-364.6875 10 4`
	`...`
	
	Format description:
	
	• File starts with a number of header lines all starting with #
	• Followed by one 1 line for description of column variables
	• Afterwards each line is formatted as follows:
	
	Column Format Description
	====== ====== ===========
	1-11 f11.4 MJD2000 centered at the three-hours time interval (0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21, 21-24 UT)
	12-14 i3 3-hourly Kp index
	15-18 i4 3-hourly ap index

Data volume	27 kB / year
Update rate	2 updates per month
Latency	few days to one months
Data source	GFZ (based on information from http://www.gfz-potsdam.de/en/kp-index/)
Notes	

Product identifier	**AUX_KP__2F**
Definition	**Kp** – Planetary three-hourly index of geomagnetic activity recorded at 13 mid-latitude ground-based observatories.
Application	EEFxTMS_2F
Spatial representation	1 value describing the global state
Time representation	Time series (3-hours average: 0-3h, 3-6h, 6-9h, 9-12h, 12-15h, 15-18h, 18-21h, 21-24h)
Units	unitless
Resolution	Kp indices range in 28 steps from 0 (quiet) to 9 (greatly disturbed) with fractional parts expressed in thirds of a unit. A Kp-value equal to 27, for example, means 2 and 2/3 or 3-; a Kp-value equal to 30 means 3 and 0/3 or 3 exactly; and a Kp-value equal to 33 means 3 and 1/3 or 3+.
Uncertainty	N/A
Quality indicator	N/A

Product identifier	**AUX_KP__2F**
Data volume	27 kB / year
Data format	ASCII table; 11 1 12421 22017 31313171320 35 7 6 2 5 5 6 5 7 50.21 11 1 22421 32020 71010171717 35 7 7 3 4 4 6 6 6 50.21 11 1 32421 41313 71317232730 43 5 5 3 5 6 9 12 15 80.42 11 1 42421 51727171717202013 44 6 12 6 6 6 7 7 5 70.31 11 1 52421 6 3 0 013131013 13 20 2 0 0 5 5 4 5 5 30.10 11 1 62421 72313 3 7 3132750 42 9 5 2 3 2 5 12 48 110.63 11 1 72421 85733333023233733 81 67 18 18 15 9 9 22 18 221.15 11 1 82421 92723233033272730 66 12 9 9 15 18 12 12 15 130.73 … Format description file wdc_fmt.doc: Column Format Description ====== ====== =========== 1- 2 i2 yy, last two digits of year 3- 4 i2 mm, month (1-12) 5- 6 i2 dd, day of month (1-31) 7-10 i4 Bartels solar rotation number - a sequence of 27-day intervals counted continuously from February 8, 1832 11-12 i2 Number of day within the Bartels 27-day cycle 13-28 8i2 3-hourly Kp indices (0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21, 21-24 UT) 29-31 i3 Daily Kp sum, expressed to the nearest third of a unit (supplied only for tradition, use Ap scientific purposes!) 32-55 8i3 3-hourly ap indices (0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21, 21-24 UT) 56-58 i3 Ap equivalent daily amplitude - the arithmetic mean of the day's eight ap values 59-61 f3.1 Cp or Planetary Daily Character Figure - a qualitative Estimate of overall level of magnetic activity for the day determined from the sum of the eight ap amplitudes. Cp ranges, in steps of one-tenth, from 0 (quiet) to 2.5 (highly disturbed) 62-62 i1 C9 - a conversion of the 0 to 2.5 range of the Cp index to one digit between 0 and 9 63-65 i3 International Sunspot Number. Records contain * Zurich number through December 31, 1980 * International Brussels number thereafter 66-70 f5.1 Ottawa 10.7 cm Solar Radio Flux adjusted to 1 AU - measured at 1700 UT daily and expressed in units of 10^-22 W/m^2/Hz. Observations began on February 14, 1947. From that date through December 31, 1973, the fluxes given here do not reflect the revisions Ottawa made in 1966. 71-71 i1 Flux Qualifier 0: indicates flux required no adjustment; 1: indicates flux required adjustment for burst in progress at time of measurement; 2: indicates a flux approximated by either

Product identifier	AUX_KP__2F
	interpolation or extrapolation; 3: indicates no observation. (The last three fields in columns 63-71 are optional. If all three or one of them are missing a new line starts after the last record.)
Latency	< 3 hours
Update rate	3 hours
Data source	http://www-app3.gfz-potsdam.de/kp_index/qlyymm.wdc data format: ftp://ftp.gfz-potsdam.de/pub/home/obs/kp-ap/wdc/wdc_fmt.doc , Adolf-Schmidt-Observatory for Geomagnetism Niemegk, Helmholtz Center Potsdam, German Research Centre for Geosciences, GFZ, Potsdam, Germany.
Notes	The 3 hourly KP index values are published with a delay between 1 and 3 hours with respect to the hour of the day. All the three hours KP index values of the day not yet available at the time of the download are filled with "99". E.g downloading the data after the 7.30 p.m a possible value of the Kp index is 1710102010999999. Please note that all the 8 i2 value have been filled. 13-28 8i2 3-hourly Kp indices (0-3, 3-6, 6-9, 9-12, 12-15,15-18, 18-21, 21-24 UT) The Kp daily sum is computed only in case the three hourly KP index covering the whole day are available (all 8 i2 different from "99"). In case of lack of data the Kp daily sum is not computed and the related 3 columns are filled white space. E.g " " 29-31 i3 Daily Kp sum, expressed to the nearest third of a unit (supplied only for tradition, use Ap scientific purposes!) The 3 hourly Ap index are computed together with the Kp index so the related column will be filled with the Ap values only if the Kp related to the same 3 hour column is available. E.g downloading the data after the 7 p.m a possible value of the Ap index is " 6 4 4 7 4". The value not already computed will remain empty, i.e. filled with spaces. 32-55 8i3 3-hourly ap indices (0-3, 3-6, 6-9, 9-12, 12-15,15-18, 18-21, 21-24 UT)

Product identifier	AUX_DST_2_
Definition	**Dst** – Equivalent equatorial magnetic disturbance indices derived from hourly scaling of low-latitude horizontal magnetic variation. Dst is directly related to the intensity of the magnetospheric ring current. **Est** – Part of the magnetic disturbance which is attributed to external currents (ring current) **Ist** – Part of the magnetic disturbance which is attributed to induced currents in the Earth
Application	MSW_EULi2_C, MSW_EULi2_D, MSW_EUL_2F, MCO_SHAi2C, MCO_SHAi2D, MCO_SHA_2F, MLI_SHAi2C, MLI_SHAi2D, MIO_SHAi2C, MIO_SHAi2D, WP16000
Spatial representation	1 value describing the global state
Time representation	Time series (1-hour average)
Units	nT
Resolution	1 pT
Uncertainty	N/A
Quality indicator	Not provided

Product identifier	**AUX_DST_2_**
Data volume	45 kB / year

Data format	ASCII table;
	`# Expanded and assembled Dst, Est and Ist, Zero Mean`
	`# created @ 2011-10-24 00:10:00`
	`#`
	`#  MJD2000  Dst  Est  Ist Flag`
	`-364.97917 -7.000 -8.994 1.994 D`
	`-364.93750 -4.000 -6.877 2.877 D`
	`-364.89583 -4.000 -6.873 2.873 D`
	`-364.85417 -8.000 -9.745 1.745 D`
	`-364.81250 -8.000 -9.770 1.770 D`
	`-364.77083 -5.000 -7.626 2.626 D`
	`-364.72917 -4.000 -6.895 2.895 D`
	`-364.68750 -1.000 -4.725 3.725 D`
	`-364.64583 3.000 -1.821 4.821 D`
	`…..`
	
	Format description:
	
	`Lines 1-3: header information`
	`Line 4: description of column variables`
	
	`Each line from Line 5 onward:`
	
	`Column Format Description`
	`====== ====== ===========`
	`1-12 f12.5 MJD2000 centered at the averaging`
	`time interval (1 hour)`
	`13-22 f10.3 1 hour averaged Dst index`
	`23-32 f10.3 1 hour averaged Est index`
	`33-42 f10.3 1 hour averaged Ist index`
	`43-47 4x,a1 D – Definitive, P – Preliminary`

Update rate	daily
Latency	real time (< 1 day) definitive (up to several years)
Data source	GFZ (based on information from http://swdcwww.kugi.kyoto-u.ac.jp/dstdir/index.html)
Notes	Explanation see, e.g., [RD-13]

Product identifier	**AUX_DST_2F**
Definition	**Dst** – Equivalent equatorial magnetic disturbance indices derived from hourly scaling of low-latitude horizontal magnetic variation. Dst is directly related to the intensity of the magnetospheric ring current.
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F, EEFxTMS_2F
Spatial representation	1 value describing the global state
Time representation	Time series (1-hour average)
Units	nT
Resolution	1.0
Uncertainty	Not provided

<table>
<tr><td>Product identifier</td><td>AUX_DST_2F</td></tr>
<tr><td>Quality indicator</td><td>Not provided</td></tr>
<tr><td>Data volume</td><td>45 kB / year</td></tr>
<tr><td>Data format</td><td>ASCII listing (others)
The format of the file is given in http://wdc.kugi.kyoto-u.ac.jp/dstae/format/dstformat.html.

<table>
<tr><th colspan="3">RECORD FORMAT (LENGTH: 120 BYTE FIXED)</th></tr>
<tr><th>COLUMN</th><th>FORMAT</th><th>SHORT DESCRIPTION</th></tr>
<tr><td>1-3</td><td>A3</td><td>Index name 'DST'</td></tr>
<tr><td>4-5</td><td>I2</td><td>The last two digits of the year</td></tr>
<tr><td>6-7</td><td>I2</td><td>Month</td></tr>
<tr><td>8</td><td>A1</td><td>'*' for index</td></tr>
<tr><td>9-10</td><td>I2</td><td>Date</td></tr>
<tr><td>11-12</td><td>A2</td><td>All spaces or may be "RR" for quick look</td></tr>
<tr><td>13</td><td>A1</td><td>'X' (for index)</td></tr>
<tr><td>14</td><td>A1</td><td>Version (0: quicklook, 1: provisional, 2: final, 3 and up: corrected final or may be space)</td></tr>
<tr><td>15-16</td><td>I2</td><td>Top two digits of the year (19 or space for 19XX, 20 from 2000)</td></tr>
<tr><td>17-20</td><td>I4</td><td>Base value, unit 100 nT</td></tr>
<tr><td>21-116</td><td>24I4</td><td>24 hourly values, 4 digit number, unit 1 nT, value 9999 for the missing data.
First data is for the first hour of the day, and Last data is for the last hour of the day.</td></tr>
<tr><td>117-120</td><td>I4</td><td>Daily mean value, unit 1 nT.
Value 9999 for the missing data.</td></tr>
</table>
</td></tr>
<tr><td>Latency</td><td>< 1 day</td></tr>
<tr><td>Update rate</td><td>< 1 day</td></tr>
<tr><td>Data source</td><td>We can get the appropriate amount of data from Kyoto World Data Center using the following script.
<pre>
==
url='http://wdc.kugi.kyoto-u.ac.jp/cgi-bin/dstae-cgi?'
SCent=20
STens=0
SYear=2
SMonth=01
ECent=20
ETens=1
EYear=1
EMonth=01
Image='GIF'
COLOR='COLOR'
AE=0
Dst=0
</pre>
</td></tr>
</table>

Product identifier	**AUX_DST_2F**
	Output='DST' Out='WDC' Email='bla@bla.de' output='test.txt' # original URL: # http://wdc.kugi.kyoto-u.ac.jp/cgi-bin/dstae-cgi?SCent=20&STens=1&SYear=1&SMonth=05&ECent=20&ETens=1&EYear=1&EMonth=06&Image+Type=GIF&COLOR=COLOR&AE+Sensitivity=0&Dst+Sensitivity=0&Output=DST&Out+format=WDC&Email=bla%40bla.de wget "http://wdc.kugi.kyoto-u.ac.jp/cgi-bin/dstae-cgi?SCent=$SCent&STens=$STens&SYear=$SYear&SMonth=$SMonth&ECent=$ECent&ETens=$ETens&EYear=$EYear&EMonth=$EMonth&Image+Type=$Image&COLOR=$COLOR&AE+Sensitivity=$AE&Dst+Sensitivity=$Dst&Output=$Output&Out+format=$out&Email=$Email" -O $output What we need to input to the script is as follows: (1) Scent*100+STens*10+SYear= *Start year* (2) SMonth= *Start month* (3) ECent*100+ETens*10+EYear= *End year* (4) EMonth= *End month* Then, the script creates an output file named 'text.txt'
Notes	Preliminary Dst

Product identifier	**AUX_F10_2_**
Definition	**F10.7**: daily measure of the solar radio flux per unit frequency at a wavelength of 10.7 cm
Application	CI, MSW_EULi2D, MSW_EULi2F, MCO_SHAi2F, MLI_SHAi2C, MLI_SHAi2D, MIO_SHAi2D, DNSxACC_2_, WP16000
Spatial representation	One value for global state
Time representation	Time series (1 day average)
Units	10^{-22} $Js^{-1}m^{-2}Hz^{-1}$
Resolution	0.1
Uncertainty	N/A
Quality indicator	Not provided
Data volume	32 kB / year
Data format	ASCII listing (others) # Assembled daily observed values of solar flux F10.7 # obtained from ftp.ngdc.noaa.gov/STP/SOLAR DATA/SOLAR RADIO/FLUX/Penticton Observed/daily/DAILYPLT.OBS # on 17-Mar-2011 09:56:45 by program get_F107.m # MD2000 F10.7 in units of [$10e^{-22}$ W m^{-2} Hz^{-1}] -729.5 101.6 -728.5 101.0 -727.5 101.1 -726.5 90.7 -725.5 89.3

Product identifier	**AUX_F10_2_**
	-724.5 87.0 -723.5 84.9 -722.5 82.2 -721.5 81.6 -720.5 80.7 -719.5 84.8 -718.5 95.8 -717.5 90.4 … Format description: Lines 1-4: header information Line 5: description of column variables Each line from Line 6 onward: Column Format Description ====== ====== =========== 1-08 f8.1 MJD2000 centered at noon 9-15 f7.1 F10.7 value ('*' if missing data)
Latency	< 10 days
Update rate	1 week
Data source	DTU based on information from ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SOLAR_RADIO/FLUX/Penticton_Observed/
Notes	

Product identifier	**AUX_F10_2F**
Definition	**F10.7**: daily measure of the solar radio flux per unit frequency at a wavelength of 10.7 cm
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F, EEFxTMS_2F, AUX_PMF_2F
Spatial representation	One value for global state
Time representation	Time series (1 day average)
Units	10^{-22} $Wm^{-2}Hz^{-1}$
Resolution	0.1
Uncertainty	Not provided
Quality indicator	Not provided
Data volume	< 1 MB
Data format	The format of the data is described in the header of each data file. Ex.> :Product: Daily Solar Data quar_DSD.txt :Issued: 2025 UT 07 Jul 2011 # # Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center # Please send comments and suggestions to SWPC.Webmaster@noaa.gov # # Quarterly Daily Solar Data # # Sunspot Stanford GOES15 # Radio SESC Area Solar X-Ray ------ Flares ------

Product identifier	**AUX_F10_2F**

	<pre># Flux Sunspot 10E-6 New Mean Bkgd X-Ray Optical
	# Date 10.7cm Number Hemis. Regions Field Flux C M X S 1 2 3
	#---
	2011 04 01 109 62 330 1 -999 B2.3 2 0 0 1 0 0 0
	2011 04 02 108 66 280 0 -999 B2.2 0 0 0 1 0 0 0
	2011 04 03 114 70 290 0 -999 B3.9 0 0 0 0 0 0 0
	2011 04 04 113 83 340 1 -999 B3.3 0 0 0 1 0 0 0
	2011 04 05 109 65 380 0 -999 B2.8 0 0 0 0 0 0 0
	2011 04 06 117 56 230 1 -999 B3.1 3 0 0 0 0 0 0</pre>
	Format description:
	Header lines of non-data information, header line starting with : or #, then 1 line per daily data.
	
	See also ftp://ftp.sec.noaa.gov/pub/indices/old_indices/README

Latency	1 day
Update rate	daily
Data source	ftp://ftp.sec.noaa.gov/pub/indices/old_indices/ . The file names in the directory are as described below. (1) From 1994 to the previous year (i.e. to 2010 as of June 2011): *yyyy*_DSD.txt (where *yyyy* signifies a year). (2) In the current year (i.e. in 2011 as of June 2011): *yyyyQq*_DSD.txt (where *yyyy* signifies a year and *q* the quarter of a year).
Notes	

Product identifier	**AUX_IMF_2_**
Definition	The Interplanetary Magnetic Field (IMF)
Application	MSW_EULi2D, MSW_EUL_2F, MCO_SHAi2D, MCO_SHA_2F, MLI_SHAi2D, MIO_SHAi2D
Spatial representation	Value of the IMF propagated to the Earth magnetosphere (1 global value per time stamp), provided in GSE and GSM format
Time representation	Time series (1 hour averages)
Units	nT for IMF, km/s for solar wind speed
Resolution	0.1 nT for IMF, 1 km/s for solar wind speed
Uncertainty	Not provided
Quality indicator	Sigma B; sigma v
Data format	CDF

Variable Name	**Description**	**Type**	**Units**
Epoch	Epoch Time	CDF_EPOCH	
YR	Year	CDF_INT4	
Day	Decimal Day (JAN 1=1)	CDF_INT4	
HR	Decimal Hour	CDF_INT4	
Rot#	Bartels Rotation Number	CDF_INT4	
IMF	ID for IMF spacecraft	CDF_INT4	
PLS	ID for SW Plasma spacecraft	CDF_INT4	
IMF_PTS	# fine time scale IMF points	CDF_INT4	
PLS_PTS	# fine time scale plasma points	CDF_INT4	
ABS_B	Field Magnitude Avg.	CDF_REAL4	nT
F	Magnitude of avg. field vector	CDF_REAL4	nT

Product identifier	**AUX_IMF_2_**			
	THETA_AV	Lat. Angle of AV.	CDF_REAL4	Deg
	PHI_AV	Long. Angle of AV.	CDF_REAL4	Deg
	BX_GSE	Bx, GSE	CDF_REAL4	nT
	BY_GSE	By, GSE	CDF_REAL4	nT
	BZ_GSE	Bz, GSE	CDF_REAL4	nT
	BY_GSM	By, GSM	CDF_REAL4	nT
	BZ_GSM	Bz, GSM	CDF_REAL4	nT
	SIGMA-ABS_B	sigma-ABS_B	CDF_REAL4	nT
	SIGMA-B	sigma-B	CDF_REAL4	nT
	SIGMA-Bx	sigma-Bx	CDF_REAL4	nT
	SIGMA-By	sigma-By	CDF_REAL4	nT
	SIGMA-Bz	sigma-Bz	CDF_REAL4	nT
	T	Plasma temperature	CDF_REAL4	K
	N	Ion density	CDF_REAL4	cm^{-3}
	V	Flow speed	CDF_REAL4	km/s
	PHI-V	Flow longitude	CDF_REAL4	Deg
	THETA-V	Flow latitude	CDF_REAL4	Deg
	Ratio	Alpha/prot. ratio	CDF_REAL4	
	Pressure	Flow pressure	CDF_REAL4	nPa
	SIGMA-T	sigma-T	CDF_REAL4	K
	SIGMA-N	sigma-n	CDF_REAL4	cm^{-3}
	SIGMA-V	sigma-V	CDF_REAL4	Km/s
	SIGMA-PHI-V	sigma-phi-V	CDF_REAL4	Deg
	SIGMA-THETA-V	sigma-theta-V	CDF_REAL4	Deg
	SIGMA-ratio	sigma-ratio	CDF_REAL4	
	E	Electric Field	CDF_REAL4	mV/m
	Beta	Plasma beta	CDF_REAL4	
	Mach_num	Alfen mach number	CDF_REAL4	
	Mgs_mach_num	Magnetosonic mach number	CDF_REAL4	
	PR-FLX_1	PROT Flux > 1 MEV	CDF_REAL8	$(cm^2\ ster\ s)^{-1}$
	PR-FLX_2	PROT Flux > 2 MEV	CDF_REAL4	$(cm^2\ ster\ s)^{-1}$
	PR-FLX_4	PROT Flux > 4 MEV	CDF_REAL4	$(cm^2\ ster\ s)^{-1}$
	PR-FLX_10	PROT Flux >10 MEV	CDF_REAL4	$(cm^2\ ster\ s)^{-1}$
	PR-FLX_30	PROT Flux >30 MEV	CDF_REAL4	$(cm^2\ ster\ s)^{-1}$
	PR-FLX_60	PROT Flux >60 MEV	CDF_REAL4	$(cm^2\ ster\ s)^{-1}$
	MFLX (6=No,1=All,-1=n/a)	M'SPH Flux Flag	CDF_INT4	
	R	Sunspot number (daily)	CDF_INT4	
	F10_INDEX	F10.7 index (daily)	CDF_REAL4	
	KP	Kp*10 (3-h)	CDF_INT4	
	DST	Dst Index (1-h)	CDF_INT4	nT
	AE	AE-index (1-h)	CDF_INT4	nT
	AP_INDEX	ap-index (3-h)	CDF_INT4	nT
	AL_INDEX	AL-index (1-h)	CDF_INT4	nT
	AU_INDEX	AU-index (1-h)	CDF_INT4	nT
	PC_N_INDEX	PC(N) index	CDF_REAL4	
Data volume	2.2 MB / year			
Latency	~ 1 month			
Update rate	~ 1 month			
Data source	DTU based on information from ftp://cdaweb.gsfc.nasa.gov/pub/istp/omni2/yyyy/omni2_h0_mrg1hr_yyyymmdd_v01.cdf with `yyyy` =year, `mm` = month, `dd` =day			
Notes	For detailed description of the data see http://omniweb.gsfc.nasa.gov/html/omni2_doc.html			

Product identifier	**AUX_IMF_2F**
Definition	**The Interplanetary Magnetic Field (IMF)** is described by the three component of the solar IMF provided in GSM coordinates.
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F
Spatial representation	Values at the L1 point (equilibrium between sun's and Earth's gravity force)
Time representation	Time series (1 h averages)
Units	nT for IMF
Resolution	< 0.1 nT
Uncertainty	Not provided
Quality indicator	S is the status of the data (0 nominal data, 1-8 bad data, 9 no data).
Data volume	~65 kB / month

Data format	Example file format for IMF 1h values (yyymm_ace_mag_1h.txt):
	`:Product: 201102_ace_mag_1h.txt`
	`:Issued: 2011 Feb 21 1010 UT`
	`# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center`
	`# Please send comments and suggestions to SWPC.Webmaster@noaa.gov`
	`#`
	`# Magnetometer values are in GSM coordinates.`
	`#`
	`# Units: Bx, By, Bz, Bt in nT`
	`# Units: Latitude degrees +/- 90.0`
	`# Units: Longitude degrees 0.0 - 360.0`
	`# Status(S): 0 = nominal data, 1 to 8 = bad data record, 9 = no data`
	`# Missing data values: -999.9`
	`# Source: ACE Satellite - Magnetometer`
	`#`
	`# Hourly Averaged Real-time Interplanetary Magnetic Field Values`
	`#`
	`# Modified Seconds`
	`# UT Date Time Julian of the ---------- GSM Coordinates -------`
	`--------`
	`# YR MO DA HHMM Day Day S Bx By Bz Bt Lat.`
	`Long.`
	`#----------`
	`--------`
	`2011 02 01 0000 55593 0 0 6.7 -3.5 -2.5 8.0 -18.2`
	`332.3`
	`2011 02 01 0100 55593 3600 0 0.1 3.4 -2.7 4.4 -38.2`
	`87.8`
	`2011 02 01 0200 55593 7200 0 -5.4 0.9 1.4 5.6 14.1`
	`170.6`
	`2011 02 01 0300 55593 10800 0 2.3 -4.9 0.8 5.5 8.9`
	`295.0`
	`2011 02 01 0400 55593 14400 0 3.4 -3.0 -8.3 9.5 -61.6`
	`318.6`
	…
	Format description:
	`header lines of non-data information, header line starting with : or #, then 1 line per 1 hourly data.`
	`B is in GSM coordinates.`
	`The format is '(i4,2i3,2x,2i2,2i8,i5,6f8.1)'.`

Product identifier	**AUX_IMF_2F**
	See also ftp://ftp.sec.noaa.gov/pub/lists/ace2/README
Update rate	Hourly data files are updated at 10 minutes past the hour.
Latency	10 min
Data source	ftp://ftp.sec.noaa.gov/pub/lists/ace2/ in this directory file is named: yyyymm_ace_mag_1h.txt Space Weather Prediction Center, NOAA
Notes	

Product identifier	**AUX_SWV_2F**
Definition	**Solar wind velocity**
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F
Spatial representation	Values at the L1 point (equilibrium between sun's and Earth's gravity force)
Time representation	Time series (1 h averages)
Units	km/s for solar wind velocity
Resolution	1 km/s
Uncertainty	Not provided
Quality indicator	S is the status of the data (0 nominal data, 1-8 bad data, 9 no data).
Data volume	~55 kB / month

Data format	Example file format for 1h solar wind parameters (yyyymm_ace_swepam_1h.txt):
	`:Product: 201102_ace_swepam_1h.txt`
	`:Issued: 2011 Feb 21 1010 UT`
	`# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center`
	`# Please send comments and suggestions to SWPC.Webmaster@noaa.gov`
	`#`
	`# Units: Proton density p/cc`
	`# Units: Bulk speed km/s`
	`# Units: Ion tempeture degrees K`
	`# Status(S): 0 = nominal data, 1 to 8 = bad data record, 9 = no data`
	`# Missing data values: Density and Speed = -9999.9, Temp. = -1.00e+05`
	`# Source: ACE Satellite - Solar Wind Electron Proton Alpha Monitor`
	`#`
	`#  Hourly Averaged Real-time Bulk Parameters of the Solar Wind Plasma`
	`#`
	`#  Modified Seconds  Solar Wind`
	`# UT Date  Time  Julian  of the  Proton  Bulk  Ion`
	`# YR MO DA  HHMM  Day  Day  S  Density  Speed  Temperature`
	`#----------`
	`2011 02 01  0000  55593  0  0  1.5  303.3  1.02e+05`
	`2011 02 01  0100  55593  3600  0  2.7  330.4  1.24e+05`
	`2011 02 01  0200  55593  7200  0  7.6  370.0  1.17e+05`
	`2011 02 01  0300  55593  10800  0  18.2  364.6  5.29e+04`
	`2011 02 01  0400  55593  14400  0  9.3  353.0  6.17e+04`
	…
	Format description:
	`Header lines of non-data information, header line starting with : or #, then 1 line per 1 hour data.`
	`The format is '(i4,2i3,2x,2i2,2i8,i5,2f11.2,e13.2E2)'`

Product identifier	**AUX_SWV_2F**
	See also ftp://ftp.sec.noaa.gov/pub/lists/ace2/README
Update rate	Hourly data files are updated at 10 minutes past the hour.
Latency	10 min
Data source	ftp://ftp.sec.noaa.gov/pub/lists/ace2/ in this directory file is named: yyyymm_ace_swepam_1h.txt Space Weather Prediction Center, NOAA
Notes	

Product identifier	**AUX_IRZ_2F**
Definition	**Ig/R12** – 12 month smoothed sunspot number
Application	EEFxTMS_2F
Spatial representation	1 value describing the global state
Time representation	Time series in 1 month steps
Units	unitless
Resolution	Sunspot number is given to 1 decimal point
Uncertainty	N/A
Quality indicator	N/A
Data volume	< 10 kB / year

Data format	ASCII table;
	`10,06,2011,`
	
	`1,1958,12,2013,`
	
	`165.7,`
	`164.6,164.3,165.6,166.6,167.2,167.7,167.6,166.5,165.4,164.1,162.3,161.2`
	`160.6,159.1,156.4,153.1,149.4,146.0,143.9,143.2,141.3,138.7,136.4,133.7`
	`131.0,129.1,128.1,127.3,125.2,122.3,117.3,111.0,105.6,101.3,97.0,92.2`
	`87.6,83.3,78.4,73.1,68.6,63.5,58.8,55.9,54.7,53.7,52.5,51.3`
	`49.4,46.3,43.2,41.4,40.5,39.6,38.4,36.8,34.4,31.9,30.3,28.6`
	…
	`138.3,137.3,137.6,138.6,136.8,140.2,140.6,141.8,142.2,139.7,139.4,140.0,`
	`141.3`
	
	`200.1,`
	`199.0,200.9,201.3,196.8,191.4,186.8,185.2,184.9,183.8,182.2,180.7,180.5,`
	`178.6,176.9,174.5,169.2,165.1,161.4,155.8,151.3,146.3,141.1,137.2,132.5,`
	`128.9,125.0,121.6,119.6,117.0,113.9,108.4,101.9, 97.2, 92.6, 87.2, 82.9,`
	` 80.2, 74.8, 68.9, 64.3, 60.1, 55.8, 53.1, 52.5, 52.3, 51.4, 50.5, 48.7,`
	` 45.2, 41.8, 39.8, 39.4, 39.2, 38.3, 36.8, 34.9, 32.7, 30.8, 30.0, 29.8,`
	…
	` 74.2, 75.8, 76.5, 76.3, 76.8, 78.0, 77.8, 76.8, 76.4, 76.2, 76.8, 77.2,`
	` 76.9`
	
	`Format description:`
	
	`First line: day, month, year of the last update of this file,`
	`separated by comma and line closed with comma`
	`Second line: blank`

Product identifier	AUX_IRZ_2F
	Third line: start month, start year, end month, end year, separated by comma and line closed with comma Fourth line: blank **First block** (IG index): Line 1: monthly mean for the month preceding the start month followed by comma Following lines: Monthly values separated by comma or line break; some values may contain whitespace after the comma Last Line: monthly mean for the month after the end month Blank line separates first and second block **Second block** (RZ, sunspot number): Line 1: monthly mean for the month preceding the start month followed by comma Following lines: Monthly values separated by comma or line break; some values may contain whitespace after the comma Last Line: monthly mean for the month after the end month A negative Rz index means that the given index is the 13-months-running mean of the solar radio flux (F10.7). The close correlation between (Rz)12 and (F10.7)12 is used to derive the (Rz)12 indices. An IG index of -111 indicates that no IG values are available for the time period. In this case a correlation function between (IG)12 and (Rz)12 is used to obtain (IG)12. See also ftp://nssdcftp.gsfc.nasa.gov/models/ionospheric/iri/iri2012/00readme.txt or ftp://nssdcftp.gsfc.nasa.gov/models/ionospheric/iri/iri2012/irifun.for
Latency	Monthly
Update rate	Monthly
Data source	ftp://nssdcftp.gsfc.nasa.gov/models/ionospheric/iri/iri2012/ig_rz.dat
Notes	

Product identifier	AUX_DCB_2F
Definition	GPS satellite differential code biases (dcb)
Application	TECxTMS_2F
Spatial representation	Ordered by satellite number
Time representation	1 value/day
Units	m
Resolution	0.001 ns
Uncertainty	Not provided
Quality indicator	Value for root mean scatter (RMS) of the daily solution
Data volume	~170 kB/day

Product identifier	**AUX_DCB_2F**

Data format	ASCII listing (others)
	Example of dcb for day 1 of year 2008 'igsg0010.08i':
	…
	`DCB values in nanoseconds, reference is Sum_of_SatDCBs = 0  COMMENT`
	`DIFFERENTIAL CODE BIASES                                  START OF AUX DATA`
	`    01    -3.381     0.024                                  PRN / BIAS / RMS`
	`    02     5.561     0.022                                  PRN / BIAS / RMS`
	`    03    -2.884     0.029                                  PRN / BIAS / RMS`
	`    04    -1.670     0.029                                  PRN / BIAS / RMS`
	`    05    -3.015     0.046                                  PRN / BIAS / RMS`
	`    06    -2.499     0.017                                  PRN / BIAS / RMS`
	`    07    -4.369     0.035                                  PRN / BIAS / RMS`
	`    08    -2.979     0.032                                  PRN / BIAS / RMS`
	`    09    -2.112     0.014                                  PRN / BIAS / RMS`
	`    10    -3.982     0.060                                  PRN / BIAS / RMS`
	`    11     2.015     0.018                                  PRN / BIAS / RMS`
	`    12     2.162     0.039                                  PRN / BIAS / RMS`
	`    13     1.655     0.044                                  PRN / BIAS / RMS`
	`    14     0.257     0.007                                  PRN / BIAS / RMS`
	…
	
	See also ftp://cddis.gsfc.nasa.gov/pub/reports/formats/ionex1.pdf

Latency	3-9 hours
Update rate	Daily
Data source	ftp://cddis.gsfc.nasa.gov/pub/gps/products/ionex/, NASA Goddard Space Flight Center
Notes	

Product identifier	**AUX_OBS_2_**
Definition	**Geomagnetic Observatory Data** are hourly means of the three components of the Earth's magnetic field measured at magnetic observatories, in geocentric (North-East-Centred) coordinates..
Application	Comprehensive Inversion chain products, MIO_SHAi2D, MMA_SHA_2F, MCO_VAL_2_, MIO_VAL_2_
Spatial representation	Values at about one hundred magnetic observatories at the Earth's surface
Time representation	Time series (1 hour averages)
Units	nT
Resolution	0.1nT
Quality indicator	5.13.1.1.1 The 'Quality' channel identifies data as INTERMAGNET 'Quasi-definitive' (available within three months) or 'Definitive' (available after about one year). See http://www.intermagnet.org/faqs-eng.php for details.
Data volume	< 150Mb/yr

Data format	ASCII listing (others)
	`Example:`
	`#Observatory hourly mean values selected from WDC Edinburgh/INTERMAGNET`
	`#File created on   6  2 2012`
	`#obs  gc_lat    long      rad yyyy mm dd  UT N=-Btheta   E=Bphi    C=-Br`
	`#########################################################################`
	`#AAE1`

Product identifier	**AUX_OBS_2_**
	AAE1 8.974 38.767 6380.055 1998 1 1 0.5 35961.0 NaN 968.0 AAE1 8.974 38.767 6380.055 1998 1 1 1.5 35960.0 746.0 968.0 .... AAE1 8.974 38.767 6380.055 1998 12 31 22.5 35987.0 758.0 1036.0 AAE1 8.974 38.767 6380.055 1998 12 31 23.5 35988.0 756.0 1036.0 #ABK0 ABK0 68.218 18.817 6360.064 1998 1 1 0.5 11466.0 966.0 51282.0 ABK0 68.218 18.817 6360.064 1998 1 1 1.5 11467.0 965.0 51281.0 .... Format description: Variable number of header lines each starting with '#'. Note, embedded header lines expected, such as introducing a next station (see example above) Missing value flag = NaN Column Format Description ====== ====== =========== 1-4 s4 3-letter IAGA code, followed by digit 5-12 f8.3 geocentric latitude (degrees) 13-20 f8.3 geocentric longitude (degrees) 21-39 f9.3 radius (km) 30-34 i5 year 35-37 i3 month 38-40 i3 day 41-45 f5.1 UT (hours) 46-54 f9.1 North (-B_theta) component (nT) 55-63 f9.1 East (B_phi) component (nT) 64-72 f9.1 Centered (-B_r) component (nT)
Update rate	Every 3 months
Latency	3 months for quasi-definitive – 1-2 years for definitive
Availability	BGS
Notes	

Product identifier	**AUX_OBSM2_**
Definition	**Geomagnetic Observatory Data** are 1 minute means of the three components of the Earth's magnetic field measured at magnetic observatories, in geocentric (North-East-Centred) coordinates..
Application	Comprehensive Inversion chain products, MIO_SHAi2D, MMA_SHA_2F, MCO_VAL_2_, MIO_VAL_2_
Spatial representation	Values at about one hundred magnetic observatories at the Earth's surface
Time representation	Time series (1 minute averages)
Units	nT
Resolution	0.1nT
Quality indicator	The 'Quality' channel identifies data as INTERMAGNET 'Quasi-definitive' (available within three months) or 'Definitive' (available after about one year). See http://www.intermagnet.org/faqs-eng.php for details.
Data volume	< 3Mb/day

<table>
<tr><th>Product identifier</th><th>AUX_OBSM2_</th></tr>
<tr><td>Data format</td><td>CDF
<table>
<tr><th>Field name</th><th>Type</th><th>Unit</th><th>Contents</th></tr>
<tr><td>IAGA_code</td><td>CDF_CHAR</td><td>-</td><td>IAGA three letter observatory identification code associated with datum</td></tr>
<tr><td>Quality</td><td>CDF_CHAR</td><td>-</td><td>Data quality: D for definitive and Q for quasi-definitive</td></tr>
<tr><td>Timestamp</td><td>CDF_EPOCH</td><td>-</td><td>Date and time</td></tr>
<tr><td>Longitude</td><td>CDF_DOUBLE</td><td>deg</td><td>Longitude</td></tr>
<tr><td>Latitude</td><td>CDF_DOUBLE</td><td>deg</td><td>Geocentric latitude</td></tr>
<tr><td>Radius</td><td>CDF_DOUBLE</td><td>m</td><td>Radius</td></tr>
<tr><td>B_NEC</td><td>CDF_DOUBLE</td><td>nT</td><td>Geocentric-north, east, and geocentric-down component of magnetic field. NaN values are used as placeholders for missing data</td></tr>
</table></td></tr>
<tr><td>Update rate</td><td>Daily</td></tr>
<tr><td>Latency</td><td>4-days, 1-, 3-, 6-months, 1-, 2- and 4-years</td></tr>
<tr><td>Availability</td><td>BGS</td></tr>
<tr><td>Notes</td><td></td></tr>
</table>

<table>
<tr><th>Product identifier</th><th>AUX_OBSS2_</th></tr>
<tr><td>Definition</td><td>Geomagnetic Observatory Data are 1 second values of the three components of the Earth’s magnetic field measured at magnetic observatories, in geocentric (North-East-Centred) coordinates..</td></tr>
<tr><td>Application</td><td>Comprehensive Inversion chain products, MIO_SHAi2D, MMA_SHA_2F, MCO_VAL_2_, MIO_VAL_2_</td></tr>
<tr><td>Spatial representation</td><td>Values at about one hundred magnetic observatories at the Earth’s surface</td></tr>
<tr><td>Time representation</td><td>Time series (1 second values)</td></tr>
<tr><td>Units</td><td>nT</td></tr>
<tr><td>Resolution</td><td>0.01nT</td></tr>
<tr><td>Quality indicator</td><td>The ‘Quality’ channel identifies data as INTERMAGNET ‘Quasi-definitive’ (available within three months) or ‘Definitive’ (available after about one year). See http://www.intermagnet.org/faqs-eng.php for details.</td></tr>
<tr><td>Data volume</td><td>< 50Mb/day</td></tr>
<tr><td>Data format</td><td>CDF
<table>
<tr><th>Field name</th><th>Type</th><th>Unit</th><th>Contents</th></tr>
<tr><td>IAGA_code</td><td>CDF_CHAR</td><td>-</td><td>IAGA three letter observatory identification code associated with datum</td></tr>
<tr><td>Quality</td><td>CDF_CHAR</td><td>-</td><td>Data quality: D for definitive and Q for quasi-definitive</td></tr>
<tr><td>Timestamp</td><td>CDF_EPOCH</td><td>-</td><td>Date and time</td></tr>
<tr><td>Longitude</td><td>CDF_DOUBLE</td><td>deg</td><td>Longitude</td></tr>
<tr><td>Latitude</td><td>CDF_DOUBLE</td><td>deg</td><td>Geocentric latitude</td></tr>
<tr><td>Radius</td><td>CDF_DOUBLE</td><td>m</td><td>Radius</td></tr>
</table></td></tr>
</table>

Product identifier	AUX_OBSS2_			
	B_NEC	CDF_DOUBLE	nT	Geocentric-north, east, and geocentric-down component of magnetic field. NaN values are used as placeholders for missing data
Update rate	Daily			
Latency	4-days, 1-, 3-, 6-months, 1-, 2- and 4-years			
Availability	BGS			
Notes				

5.14 Auxiliary models

5.14.1 Magnetic field models

Product identifier	AUX_IGR_2_
Definition	**IGRF (International Geomagnetic Reference Field)** latest (11th) generation is a continuous model of the Earth's main magnetic field. It is based on data from permanent observatories and from land, airborne, marine and satellite surveys (CHAMP, Ørsted). [RD-3] IGRF11 is valid for dates from 1900.0 to 2015.0. Values for dates before 1945.0 and after 2005.0 are preliminary, otherwise the values are definitive.
Application	MSW_SHA_2C, MSW_SHA_2D, MSW_SHA_2F, MCO_SHA_2C, MCO_SHA_2D, MCO_SHA_2F, MLI_SHA_2C, MMA_SHA_2C, MMA_SHA_2D, MIO_SHA_2C, MIO_SHA_2D, WP16000
Spatial representation	Spherical harmonics (degree 13)
Time representation	Coefficients for snap shot SH models 5 yrs apart; linear interpolation recommended, prediction of linear Secular Variation
Units	nT
Resolution	N/A
Uncertainty	Modelled field uncertainty ~20nT [RD-3]
Quality indicator	N/A
Data format	ASCII listing (SHC format); See section 4.3.1
Data volume	36 kB
Update rate	5 years
Data source	DTU based on information from http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html
Notes	A predictive model is required to estimate near-real time magnetic field observations from the satellite measurements. The IGRF is actually the only predictive model expected to be available at the launch time of *Swarm*. However, IGRF is known to provide not sufficiently accurate results for precise magnetic field modelling studies. It is anticipated to replace the IGRF by models known to produce higher quality results as soon as they are available also for predictions. This model will be contained in AUX_COR_2_.

Product identifier	AUX_IGR_2F
Definition	**IGRF (International Geomagnetic Reference Field)** latest (11th) generation is a continuous model of the Earth's main magnetic field. It is based on data from permanent

Product identifier	AUX_IGR_2F
	observatories and from land, airborne, marine and satellite surveys (CHAMP, Ørsted). [RD-3] IGRF11 is valid for dates from 1900.0 to 2015.0. Values for dates before 1945.0 and after 2005.0 are preliminary, otherwise the values are definitive.
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonics (degree 13)
Time representation	Coefficients for snap shot SH models 5 yrs apart; linear interpolation recommended, prediction by linear Secular Variation
Units	nT
Resolution	N/A
Uncertainty	Modelled field uncertainty ~20nT [RD-3]
Quality indicator	N/A
Data format	ASCII listing (SHC format); See section 4.3.1 .
Data volume	36 kB
Update rate	5 years
Latency	N/A
Data source	The content of AUX_IGR_2_ is copied to AUX_IGR_2F every time, when a new version of AUX_IGR_2_ is available.
Notes	

Product identifier	AUX_COR_2_
Definition	Sperical harmonic model of the core magnetic field
Application	MSW_SHA_2D, MSW_SHA_2F, MCO_SHA_2D, MCO_SHA_2F, MLI_SHA_2C, MMA_SHA_2D, MIO_SHA_2D
Spatial representation	Spherical harmonics up to degree 20
Time representation	Snapshot models
Units	nT
Resolution	1pT
Uncertainty	< 10 nT
Quality indicator	N/A
Output data format	ASCII listing (SHC format); See section 4.3.1 .
Data volume	~10 kB
Update rate	Depending on the choice of model (see Notes below).
Data source	GFZ
Notes	During the operational phase, each chain will use the auxiliary core field model most suitable to the chain. This model might be updated with new Swarm data. This model might have prediction capability. (During the test phase, the CHAOS-3 model is set here to specify the format of the product.)

Product identifier	AUX_COR_2F
Definition	Model for the core magnetic field

Product identifier	AUX_COR_2F
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonics up to degree 20
Time representation	Snapshot models
Units	nT
Resolution	1pT
Uncertainty	< 10 nT
Quality indicator	N/A
Output data format	ASCII listing (SHC format); See section 4.3.1.
Data volume	~10 kB
Update rate	Once per 5 years (see also section 5 in [AD-11])
Data source	See below.
Notes	The content and the format of the product file will be copied from AUX_COR_2_ . (see also section 3.15 in [AD-11])

Product identifier	AUX_LIT_2_
Definition	The applied lithospheric field model is required to describe as accurately as possible the magnetic field of the Earth's lithosphere. At present, we assume the MF7 to be a suitable model for this purpose. MF7 is a lithospheric model which is based on 3 years (2008-2010) of CHAMP scalar and vector magnetic field observations.
Application	MSW_SHA_2D, MSW_SHA_2F, MCO_SHA_2D, MCO_SHA_2F, MLI_SHA_2C, MMA_SHA_2D, MIO_SHA_2D
Spatial representation	Spherical harmonic degree 130 corresponding to ~300 km
Time representation	N/A
Units	nT
Resolution	N/A
Uncertainty	Modeled field uncertainty ≤1nT [RD-9]
Quality indicator	N/A
Data format	ASCII table (SHC, see section 4.3.1)
Data volume	< 10kB
Update rate	~1 years
Latency	N/A
Data source	IPGP based on information from http://geomag.org/models/MF7.html
Notes	Presently, the lithospheric model is described by MF7. It is anticipated to use the most accurate lithospheric model available during the *Swarm* mission.

Product identifier	AUX_LIT_2F
Definition	The applied lithospheric field model is required to describe as accurately as possible the magnetic field of the Earth's lithosphere. At present, we assume the MF7 to be a suitable model for this purpose. MF7 is a lithospheric model, which is based on 3 years (2008-2010) of CHAMP scalar and vector magnetic field observations.
Application	IBIxTMS_2F, FACxTMS_2F, FAC_TMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonic degree 130 corresponding to ~300 km
Time representation	N/A
Units	nT

Product identifier	**AUX_LIT_2F**
Resolution	N/A
Uncertainty	Modelled field uncertainty ≤1nT [RD-9]
Quality indicator	N/A
Data format	ASCII table (SHC, see section 4.3.1)
Data volume	400 kB
Update rate	~1 years
Latency	N/A
Data source	http://geomag.org/models/MF7.html
Notes	Presently, the lithospheric model is described by MF7. It is anticipated to use the most accurate lithospheric model available during the *Swarm* mission.

Product identifier	**AUX_MTI_2_**
Definition	Magnetic signals of major (8) tidal constituents (tides)
Application	Correction of magnetic field measurements for ocean tidal signals
Spatial representation	Spherical harmonic coefficients (real and imaginary parts) of the magnetic potential
Time representation	Time harmonics specific for each tide
Units	nT
Resolution	Up to spherical harmonic degree 45
Accuracy	Of the order of 10 %
Quality indicator	N/A

Data format	ASCII listing (others)
	
	`# Arbitrary number of comment lines starting with # sign`
	`8`
	`T_1  T_2  T_3 .... T_8`
	
	Then matrix(array) of dimension [45*(45+2)]x18 follows which columns are:
	
	`<Columns  1 - 2>:  degree and order of spherical harmonic`
	`<Columns  3 - 4>:  real and imaginary parts of SHC of the potential for K2 tide`
	`<Columns  5 - 6>:  real and imaginary parts of SHC of the potential for S2 tide`
	`<Columns  7 - 8>:  real and imaginary parts of SHC of the potential for M2 tide`
	`<Columns  9 -10>:  real and imaginary parts of SHC of the potential for N2 tide`
	`<Columns 11 -12>:  real and imaginary parts of SHC of the potential for K1 tide`
	`<Columns 13 -14>:  real and imaginary parts of SHC of the potential for P1 tide`
	`<Columns 15 -16>:  real and imaginary parts of SHC of the potential for O1 tide`
	`<Columns 17 -18>:  real and imaginary parts of SHC of the potential for Q2 tide`

Product identifier	AUX_MTI_2_
	Here `8` is the number of tidal constituents, and `T_1, T_2, ..., T_8` are the periods of the tidal constituents (in days) in ascending order
Data volume	A few Mb
Update rate	N/A
Data source	ETH
Notes	The predicted magnetic signals from 8 major tides were validated on CHAMP magnetic field residuals in producing the MF4 crustal field model (see Figure 2 of [RD-11])

5.14.2 Mantle conductivity model

Product identifier	AUX_MCM_2_
Definition	Auxiliary (preliminary) mantle conductivity model
Application	Mantle conductivity chains
Spatial representation	Conductivity distribution with respect to depth (1-D layered model of the Earth)
Time representation	N/A
Units	Kilometers (for layer radii), Siemens per meter (for conductivities)
Resolution	Variable radial resolution from 0.5 km (near surface) to > 120 km (lower mantle)
Accuracy	N/A
Quality indicator	N/A
Data format	As for MIN_1DMi2_
Data volume	A few Kb
Update rate	N/A
Data source	ETH
Notes	1-D Mantle conductivity model based on joint inversion of CHAMP, Oersted, and SAC-C satellite data [RD-10]

5.14.3 Surface conductance models

Product identifier	AUX_OCM_2_
Definition	Surface conductance map in dipolar coordinates
Application	Mantle conductivity chains
Spatial representation	2-D grid
Time representation	N/A
Units	Siemens
Resolution	1x1 degree
Accuracy	N/A
Quality indicator	N/A
Data format	As for MIN_1DMi2_ **Additional information:** The product is compatible with the ASCII format designed for storage of conductivity models, assuming: - only one heterogeneous layer is used (`N_layers = 1, 3DFlag_1 = 3`)

Product identifier	AUX_OCM_2_
	- conductance values are stored in Siemens (instead of conductivity in S/m)
Data volume	A few Mb
Update rate	N/A
Data source	ETH
Notes	Surface conductance map based on continental topography, ocean bathymetry, salinity, temperature, pressure, and thickness of sediments [RD-12]

5.14.4 Magnetospheric models

Product identifier	AUX_PMF_2F
Definition	Model of spherical harmonic coefficients of the external, magnetospheric field
Application	FACxTMS_2F, FAC_TMS_2F, IBIxTMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonics to degree 2
Time representation	N/A
Units	nT
Resolution	N/A
Uncertainty	~ 5 nT [RD-14]
Quality indicator	N/A
Data format	`AUX_PMF_2F` has the following format, as defined by the originator and available at http://geomag.org/models/Pomme6/pomme-6.1.cof: Line 1: epoch header Line 2: epoch year Line 3: data range header Line 4: 2 columns (start year, end year) Line 5: IMF-By header Line 6: 2 columns of floating point Line 7: Em header Line 8: 1 column of floating point Line 9: 3 columns of floating point Line 10: F10.7 correlated header Line 11: 1 column floating point Line 12: 3 columns floating point Line 13: 5 columns floating point Line 14: Est/Ist header Line 15: 1 column floating point Line 16: SM-External header Line 17: 1 column floating point Line 18: 3 columns floating point Line 19: 5 columns floating point Line 20: GSM-External header Line 21: 1 column floating point Line 22: 3 columns floating point Line 23: 5 columns floating point Lines 24-25: header

Product identifier	AUX_PMF_2F
	Line 26: 4 columns integer (degree static field, degree 1st derive, degree 2nd derive before epoch, degree 2nd derive after epoch) Lines 27-28: header Lines 29-180: 10 columns (degree n (integer), order m (integer), 8 floating point coefficients) Lines 181-8673: 4 columns (degree n integer, order m integer, 2 floating point coefficients) **Epoch:** **2005.0** **Data-range:** **2000.5 2009.7** **IMF-By correlated fields in GSM (f1,1 * IMF-By * Y1,1 and f1,-1 * IMF-By * Y1,-1):** **0.0732 -0.2635** **Em-correlated fields in GSM (fn,m * (Em_eff-0.5) * Yn,m):** **1** **1.3828 0 0** **F10.7-correlated fields in SM (fn,m * (F107a-120) * Yn,m):** **2** **0.0803 0 0** **0 -0.0024 0.0001 0 0** **Est/Ist correlated fields in SM (f1,0 * Est * Y1,0 and f1,0 * Ist * Y1,0_intern** **0.8681** **SM-External field:** **2** **5.4291 0 0** **0 -0.9469 0.9038 0 0** **GSM-External field:** **2** **8.3148 0.0943 0.4332** **0.1297 -0.6767 -1.2871 -0.0047 0.5217** Internal field: Degree: static 1st-deriv 2nd-deriv-before-epoch 2nd-deriv-after-epoch 130 16 16 16 n m g_lm h_lm gd hd gdd- hdd- gdd+ hdd+ --- 1 0 -29553.9685 0.0000 12.1671 0.0000 0.0496 0.0000 -0.2509 0.0000 ... where the coefficients written in red boldfaces are really used for the calculation of magnetospheric fields.
Data volume	300 kB
Update rate	N/A (time independent)
Latency	N/A
Data source	http://geomag.org/models/Pomme6/pomme-6.1.cof
Notes	The initially used magnetospheric field model is the POMME-6. It is anticipated to use the best quality version of the magnetospheric field model available during the *Swarm* mission.

Product identifier	AUX_PSM_2F
Definition	Coefficients to transform from Solar Magnetic (SM) to geographic coordinates for computing the external magnetic field
Application	FACxTMS_2F, FAC_TMS_2F, IBIxTMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonics to degree 3
Time representation	Temporal degree 6
Units	N/A

Product identifier	**AUX_PSM_2F**
Resolution	N/A
Uncertainty	N/A
Quality indicator	N/A
Data format	ASCII listing defined by originator Line 1: header information Line 2: 2 columns (spatial and temporal degrees of expansion) Lines 3-4: header Lines 5-1083: 5 columns of data (degree n, SM order m, geographic order m, daily index, coefficient) Example: expansion degrees: SM spatial, daily variation 3 6 n, m_SM, m_GEO, dailyindx, coeff 1 0 0 -6 -0.00000 1 0 0 -5 0.00000 1 0 0 -4 -0.00000 1 0 0 -3 0.00000 1 0 0 -2 -0.00000 1 0 0 -1 0.00000 1 0 0 0 0.98282 ...
Data volume	< 50 kB
Latency	N/A
Update rate	N/A
Data source	http://geomag.org/models/Pomme6/sm2geo_coeff_3_6
Notes	The initially used magnetospheric field model is the POMME-6. It is anticipated to use the best quality version of the magnetospheric field model available during the *Swarm* mission.

Product identifier	**AUX_PGM_2F**
Definition	Coefficients to transform from Geocentric Solar Magnetospheric (GSM) to geographic coordinates for computing the external magnetic field
Application	FACxTMS_2F, FAC_TMS_2F, IBIxTMS_2F, EEFxTMS_2F
Spatial representation	Spherical harmonics to degree 3
Time representation	Temporal degree 6
Units	N/A
Resolution	N/A
Uncertainty	N/A
Quality indicator	N/A
Data format	ASCII listing defined by originator Line 1: header Line 2: 3 columns (spatial, daily, and annual degrees of expansion) Lines 3-4: header

Product identifier	**AUX_PGM_2F**
	Lines 5-1083: 17 columns of data (degree n, GSM order m, geographic order m, daily index, 13 columns of coefficients) Example: expansion degrees: GSM spatial, daily variation, annual variation 3 6 6 n m_GSM m_GEO, dailyindx, annualindx --> 1 0 0 -6 -0.00000 0.00000 -0.00000 0.00000 -0.00000 0.00000 -0.00000 0.00000 -0.00000 -0.00000 -0.00000 1 0 0 -5 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 -0.00000 -0.00000 -0.00000 -0.00000 1 0 0 -4 0.00000 0.00000 0.00000 0.00000 0.00001 0.00000 0.00008 -0.00000 0.00003 0.00000 0.00000 0.00000 0.00000 1 0 0 -3 -0.00000 -0.00000 -0.00000 -0.00002 -0.00003 0.00004 -0.00002 0.00041 0.00001 0.00004 0.00000 0.00000 0.00000 ...
Data volume	< 200 kB
Latency	N/A
Update rate	N/A
Data source	http://geomag.org/models/Pomme6/gsm2geo_coeff_3_6
Notes	The initially used magnetospheric field model is the POMME-6. It is anticipated to use the best quality version of the magnetospheric field model available during the *Swarm* mission.