

IASI Level 2: Product Format Specification

Doc.No. : EPS.MIS.SPE.980760
Issue : v9B e-signed
Date : 8 June 2017

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Document Change Record

Issue / Revision	Date	DCN. No	Changed Pages / Paragraphs
2.0	25/5/99		First Issue
2 Draft B	23/07/99		Addressed RIDs
3 Draft A	30/06/00	EUM.EPS.SYS.DCN.034	<ul style="list-style-type: none"> • Incorporate change in EPS Generic Product Specification, Issue 3 and incorporate responses to IFCT Comments miniRIDs.
4 Draft A	15/11/00		<ul style="list-style-type: none"> • Add section on GTS products • Simplified document layout • Editorial changes • Updated Product Record tables in Annex
4 Draft B	29/06/01		LEO/C/TP <ul style="list-style-type: none"> • Removed GTS section (covered by PGS document) • Removed information redundant with GPFS • Updated text to describe changes in Annex • Removed information redundant with Annex • Added record subclass definitions • Updated occurrence information section
4 Draft C	28/05/01		LEO/C/TP <ul style="list-style-type: none"> • Removed requirement in Level 1a SPHR section • Updated all sections in line with GPFS changes • Removed items redundant with GPFS
5.0	01/06/01		CGS PDR Issue <ul style="list-style-type: none"> • Major reworking of Level 1b product format definitions in line with PGS updates
5.1	13/06/01		Revised issue for CGS PDR <ul style="list-style-type: none"> • Updated signature table
6.0	13/06/02	EUM.EPS.SYS.DCR.02.128	<ul style="list-style-type: none"> • Removed Product Conventions Document [AD-3] as an AD. Relevant information now in [AD-1] • Updated template • Modified MDR to allow for variable sized data area to contain information such as covariance matrix • Added FLG_STER to determine what information is stored in MDR.COVARIANC_MATRIX • Moved ADR fields into MDR. Deleted ADR definition • VEADR and GEADR definitions updated in line with GPFS update • See also list of updates in Annex • No contents defined for SPHR – record removed from product
6.1	20/09/02	EUM.EPS.SYS.DCR.	<ul style="list-style-type: none"> • Updated Occurrence table

Issue / Revision	Date	DCN. No	Changed Pages / Paragraphs
		02.174	<ul style="list-style-type: none"> Removed TBC from Section 3.6.1.1 and used 10x compression as an example for product sizing purposes. Clarified text. Added table of cloud phase codes - Table 3. Updated signature table names Added Section 5 Record Format Version Control See also DCR of annex for changes
	10/02/03	EUM.EPS.SYS.DCR.03.043	<ul style="list-style-type: none"> Changed INSTRUMENT_GROUP from IASI to IASI_L2
6.2	12/03/04	EUM.EPS.SYS.DCR.04.011	<ul style="list-style-type: none"> Added Section 3.6.2 Variance and Covariance Matrix Data Deleted redundant Section 3.6.1.1 COVARIANCE_MATRIX Updated Record Subclass Version Numbers See also DCR in Annex
6.3	08/09/06	EUM.EPS.SYS.DCR.06.0317	<ul style="list-style-type: none"> Changes to MDR fields as detailed in DCR in the Annex
6.4	30/04/08	EUM_AB_DCR_EU_M_58	<ul style="list-style-type: none"> Annex: GIADR, record SURFACE_EMISSIVITY_WAVELENGTHS, Type Size 2 (hard coded) corrected to 4 (via formula). Field Size and Offset also automatically corrected.
v7A	12/08/08		<p>Migrated into Hummingbird. Body contents copied into standard template. Editorial updates – formatting etc. Signature table updated.</p>
v7B	10/09/08		<ul style="list-style-type: none"> Added Appendix A with hyperlink referring to Annex. Deleted sentence in Section 1.1 referring to reference AD-3 (replaced by AD-1 – see issue 6.0 update comment). Editorial edits – typos, standardisation, use of auto referencing for document and section references.
v8	10/03/09	ODT_DCR_16	<ul style="list-style-type: none"> Added a row to table 3 (Cloud Phase codes) as per ODT_DCR_16
v8A	29/04/10	ODT_DCR_155	<ul style="list-style-type: none"> Added record subclass info.
V9	23/10/14		<ul style="list-style-type: none"> Signature table updated. Issued with release of IASI L2 v6 PPF updates. Section 3.3.1 Subclass descriptions added Section 3.5.1 Record subclasses added Section 3.5.1 Description and formula for Error Data added.
V9A	09/06/16		<ul style="list-style-type: none"> Update after release of IASI L2 PPFv6.2 Details use of ERROR_DATA and quality indicator QI_FG_xxx Explains how to reconstruct full land surface emissivity spectra
V9B	08/06/17		<ul style="list-style-type: none"> Update after release of IASI L2 PPFv6.3

<i>Issue / Revision</i>	<i>Date</i>	<i>DCN. No</i>	<i>Changed Pages / Paragraphs</i>
			<ul style="list-style-type: none">• Section 3.5.6 "Brescia-SO2 fields" added• Section 3.5.7 "FLG_DUSTCLD flag" added• Section 3.5.5: document reference updated

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1 INTRODUCTION

1.1 Purpose and Scope

This document is the Infrared Atmospheric Sounding Interferometer (IASI) Level 2 Product Format Specification.

The generic product format specification used by this document is defined in the EPS Generic Product Format Specification [AD 2].

1.2 Structure of the Document

The document is organised in the following sections, including the introduction:

<i>Section</i>	<i>Contents</i>
1	is this section, the scope of the document.
2 and 3	Describes the instrument-specific and level-specific records required for the Level 2 product.
4	Details the occurrence rates of the records within the product.
5	Provides a history of version numbers for the records defined within the document.
Appendix A	Links to detailed tables describing the record formats.

1.3 Applicable Documents

<i>No.</i>	<i>Document Title</i>	<i>Reference</i>
AD 1	EPS Generic Product Format Specification	EPS/GGS/SPE/96167
AD 2	EPS Ground Segment IASI Level 2 Product Generation Specification	EPS/SYS/SPE/990013

2 IASI LEVEL 2 EPS PRODUCT FORMAT

2.1 Form

The product format for the IASI Level 2 product is based on the generic product format as described in [AD 2]. This document details the instrument-specific and level-specific additions required for the IASI Level 2 product.

2.2 Generic Record Header Fields

All generic record header fields of the instrument/level specific records defined in this document shall have an INSTRUMENT_GROUP value of IASI_L2 [AD 1].

3 LEVEL 2 RECORDS

3.1 Secondary Product Header Record

There is no SPHR defined for the IASI L2 product.

3.2 Global and Variable External Auxiliary Data Records

There are no GEADRs or VEADRs defined for the IASI Level 2 product.

3.3 Global Internal Auxiliary Data Record

There is one subclass of GIADR for the Level 2 product. This is detailed in the Annex to this document.

3.3.1 Record Subclasses

<i>Subclass</i>	<i>Description</i>	<i>Subclass ID</i>
GIADR	Pressure levels for temperature, humidity and ozone retrievals. Number of state-vector PCs. Layer height for CO, HNO ₃ and O ₃ . Plume heights for SO ₂ .	1

Table 1: GIADR Subclasses

3.4 Variable Internal Auxiliary Data Record

There is no VIADR defined for Level 2 products.

3.5 Measurement Data Record

There is one subclass of MDR for the Level 2 product. The MDR is detailed in the Annex to this document.

3.5.1 Record Subclasses

<i>Subclass</i>	<i>Description</i>	<i>Subclass ID</i>
MDR	IASI L2 sounding product	1

Table 2: MDR Subclasses

3.5.2 Fields

The settings of MDR fields not described within this document are to be found in [AD 2].

3.5.3 ERROR_DATA

The decoding and utilisation of the ERROR_DATA field requires auxiliary information contained in the auxiliary dataset COF_STV. You will find this dataset on the EUMETSAT website together with the technical documentation.

The fields TEMPERATURE_ERROR, WATER-VAPOUR_ERROR and OZONE_ERROR store the upper triangular part of the retrieval error covariance matrices for temperature (ATMOSPHERIC_TEMPERATURE), water-vapour (ATMOSPHERIC_WATER_VAPOUR) and ozone (ATMOSPHERIC_OZONE) fields respectively, in row major order. These retrieval error covariance matrices correspond to the principal component (PC) score representation in which the profiles are retrieved [AD 2]. Each entry is stored as a bitst(32), which represents the value as a big endian IEEE 754 single-precision binary floating-point number (binary32). To obtain the retrieval error covariance matrices corresponding to the pressure level grid in which the profiles are provided in the product, it

is therefore necessary first to build the full symmetric PC space retrieval error covariance matrices from the upper triangular part and then to expand to pressure level space using the state-vector principal components (eigenvectors), which are available in the COF_STV static auxiliary dataset. Each of the components (temperature, water-vapour and ozone) uses a different number of eigenvectors for the PC score representation, these numbers are provided in the GIADR record of the product in these fields:

- NUM_TEMPERATURE_PCS (NPCT)
- NUM_WATER_VAPOUR_PCS (NPCW)
- NUM_OZONE_PCS (NPCO)

The upper triangular parts of the retrieval error covariance matrices which are stored in the error data therefore have the following number of entries, respectively:

- $NPCT * (NPCT + 1) / 2$
- $NPCW * (NPCW + 1) / 2$
- $NPCO * (NPCO + 1) / 2$

To illustrate how the full symmetric matrix is built from the upper triangular part stored in row major order we consider a case where $NPCx(n)$ equals 3 and the $n*(n+1)/2$ stored entries are as follows:

- $v_1, v_2, v_3, v_4, v_5, v_6$

In this case the retrieval error covariance matrix in PC space (S_{PC}) would be given by this formula:

$$S_{PC} = \begin{bmatrix} v_1 & v_2 & v_3 \\ v_2 & v_4 & v_5 \\ v_3 & v_5 & v_6 \end{bmatrix} \quad \text{Equation 1}$$

For any of the three error components we obtain the N times N retrieval error covariance matrix S_{SV} in pressure level space from the n times n retrieval error covariance matrix in PC space by pre and post multiplication with the N times n matrix of eigenvectors, as follows:

$$S_{SV} = VS_{PC}V^T \quad \text{Equation 2}$$

The averaging kernels in atmospheric PC space, A_{PC} , can be computed with this formula:

$$A_{PC} = I - S_{PC}S_x^{-1} \quad \text{Equation 3}$$

From which the averaging kernels in the pressure grid space can be derived as follows:

$$A_{SV} = VA_{PC}V^T \quad \text{Equation 4}$$

where:

I	is the identity matrix
S_{PC}	is the retrieval error covariance matrix in atmospheric PC space as per Equation 1
S_x	is the background error covariance matrix provided in the COF_STV auxiliary dataset. /COF_STV/T_covariance for temperature /COF_STV/W_covariance for water-vapour /COF_STV/O_covariance for ozone
V	Are the atmospheric eigenvectors provided in the COF_STV auxiliary dataset. /COF_STV/T_eigenvectors for temperature /COF_STV/W_eigenvectors for water-vapour /COF_STV/O_eigenvectors for ozone Even if more eigenvectors are provided, only the first n should be used for the expansion.

Note: The unit of the retrieval error covariance matrix in pressure level spaces is K^2 for temperature and $\log(\text{ppmv})^2$ for water vapour and ozone.

3.5.4 Quality indicators of the first-guess products

There are four first guess “all-sky” products:

- FG_ATMOSPHERIC_TEMPERATURE
- FG_ATMOSPHERIC_WATER_VAPOUR
- FG_ATMOSPHERIC_OZONE
- FG_SURFACE_TEMPERATURE .

These are provided with quality indicators (FG_QI_XXX) which relate to the expected precision of the temperature, water-vapour, ozone, and surface temperature retrievals. The following table summarises the interpretation of the respective quality indicators:

<i>Quality indicator</i>	<i>Interpretation</i>	<i>Unit</i>
FG_QI_ATMOSPHERIC_TEMPERATURE	Retrieval error estimate of the surface air temperature	K
FG_QI_ATMOSPHERIC_WATER_VAPOUR	Retrieval error estimate of the surface air humidity	K [dew point]
FG_QI_ATMOSPHERIC_OZONE	Scalar value typically ranging between 0 and 10. Lower values indicate lower expected errors of the ozone profile.	-
FG_QI_SURFACE_TEMPERATURE	Retrieval error estimate of the surface skin temperature	K

3.5.5 Land surface emissivity

The field SURFACE_EMISSIVITY contains the surface emissivity retrieved over continental surface and provided in selected channels over. The number of channels and the wavelength at which the surface emissivity are provided is these fields in the GIADR:

- NUM_SURFACE_EMISSIVITY_WAVELENGTHS
- SURFACE_EMISSIVITY_WAVELENGTHS .

It is possible to construct the full emissivity spectrum for all 8461 IASI channels using a base of emissivity eigenvectors, as defined in the Global Infrared Land Surface Emissivity Database established at the University of Wisconsin. For details, see cimss.ssec.wisc.edu/iremim/. This can be performed with the following equation:

$$\boldsymbol{\varepsilon} = \boldsymbol{\Omega}(\tilde{\boldsymbol{\Omega}}^T \tilde{\boldsymbol{\Omega}})^{-1} \tilde{\boldsymbol{\Omega}}^T (\tilde{\boldsymbol{\varepsilon}} - \langle \tilde{\boldsymbol{\varepsilon}} \rangle) + \langle \boldsymbol{\varepsilon} \rangle$$

Equation 5

where:

$\boldsymbol{\varepsilon}$	is the land surface emissivity spectra on all IASI channels
$\tilde{\boldsymbol{\varepsilon}}$	is the land surface emissivity spectra in the selected channels for L2 products
$\langle \boldsymbol{\varepsilon} \rangle$	is the average emissivity in all IASI channels, available in the COF_EMS auxiliary dataset: /COF_EMS/mean
$\langle \tilde{\boldsymbol{\varepsilon}} \rangle$	is the average emissivity in the channels subset
$\boldsymbol{\Omega}$	is the eigenvector defined on all the IASI channels, available in the COF_EMS auxiliary dataset: /COF_EMS/eigenvector
$\tilde{\boldsymbol{\Omega}}$	is the eigenvectors defined on the IASI channels subset

3.5.6 EUMETSAT AC SAF CO product (FORLI-CO)

The product fields of the FORLI-CO group are explained and detailed in a dedicated product format specification document: SAF/O3M/ULB/PUM/001, available on AC SAF website (<http://acsaf.org>) or alternatively on EUMETSAT website in the technical documents section pertaining to the IASI Sounding Products and in the corresponding product navigator.

3.5.7 EUMETSAT AC SAF SO₂ product (BRESCIA-SO₂)

The product fields of the BRESCIA-SO₂ group are explained and detailed in a dedicated product format specification document: SAF/AC/ULB/PUM/002, available on AC SAF website (<http://acsaf.org>) or on the EUMETSAT website technical documents page. The document is here: DATA/TECHNICAL DOCUMENTS/METOP/NOAA Global Data Services (GDS)/GDS-Metop IASI Sounding Products

3.5.8 FLG_DUSTCLD flag

The field FLG_DUSTCLD contains an indicator that provides a pseudo-quantitative information of the dust load in the IASI pixels. The values typically range between 0 and 10, but can reach higher values in exceptional dust outbreaks. The presence of dust is suspected when the index is greater than approximately two.

4 OCCURRENCE INFORMATION

There is one IASI scan every eight seconds [AD 2].

<i>Record</i>	<i>Occurrence</i>
MCHR	Once per product
SPHR	No SPHR defined
GEADR	Once per product
GIADR	Once per product
VEADR	As required
MDR	Every scan

Table 3: Record occurrence rates

5 RECORD FORMAT VERSION CONTROL

This section provides version numbers for the records defined within this document.

<i>Record Subclass</i>	<i>Format Version Number</i>	<i>Issue Defined</i>
GIADR	4	9
	3	6.2
	2	6.1
	1	6.0 (CDR)
MDR	4	9
	3	6.2
	2	6.1
	1	6.0 (CDR)

Table 4: Record Format Version Numbers

APPENDIX A: DETAILED SPECIFICATION OF IASI LEVEL 2 DATA RECORDS

In the Annex that follows this page, you will find detailed format specifications for all the Variable Internal and Measurement Data Records in IASI Level 2 products:

- GIADR
- MDR

This annex is available as a separate spreadsheet with this EUMETSAT document reference:

EPS.MIS.SPE.980760.ANX

This Document	
Title	IASI LEVEL 2 PRODUCT FORMAT SPECIFICATION TABLES
Reference Number	EPS/MIS/SPE/980760

Revision	
Issue 4 Draft B	Corrected VIADR-2 size calculation
	Updated spreadsheet layout
	Moved generic SPHR fields into the MPHR
	Added INTEGRATED_OZONE field to MDR-2
Issue 4 Draft C	Updates to MDR and ADR
	Decreased array size of compressed covariance matrix stored in ADR
	Updated ADR flags section - removed FLG_FGVAL, added FLG_NWPBAD, changed type of FLG_PRECHC to bistst(24)
	Renamed worksheet tabs
	Updated REC_HEAD size to 24 bytes
Issue 5 Revision 0	Issue for CGS PDR
Issue 5 Revision 1	Revised Issue for CGS PDR
	Removed empty VIADR record definition
Issue 5 Rev 2	Moved ADR fields into MDR
Issue 6 Rev 0	Corrected GIADR.PRESSURE_LEVELS_OZONE to 10 x 2 wide levels. (Was 45 levels)
	Corrected MDR.SURFACE_EMISSIVITY to 20 wavelengths (from 15)
	Corrected descriptive text for MDR.INTEGRATED_OZONE. Levels becomes layers
	Deleted following MDR fields: FLG_CLDRET, FLG_FGSUPAD, FLG_FGSUPSAT, FLG_FRTM, FLG_IASIGEO, FLG_INTCLR, FLG_PRECHC
	Changed types of following MDR fields: FLG_FINCHC, FLG_FRCSEL, FLG_IASIBAD, FLG_INITIA
	Added following MDR fields: FLG_STER, MATRIX_DATA_SIZES
	Changed definition, use and size of MDR.COVARANCE_MATRIX
	Added field GIADR.SURFACE_EMISSIVITY_WAVELENGTHS
	Updated trace gas units in MDR from ppmv to kg.m ⁻²
	Added field MDR.NUMBER_CLOUD_FORMATIONS
	Field MDR.EULER_ANGLES replaced by MDR.ATTITUDE_ANGLES containing attitude angles
	Added fields in GIADR: NUM_PRESSURE_LEVELS_TEMP, NUM_PRESSURE_LEVELS_HUMIDITY, NUM_PRESSURE_LEVELS_OZONE
	Deleted SPHR. No contents defined for this record.
	Removed MPHR flags FLG_ATOVBAD, FLG_AMSUBAD and FLG_MHSBAD as per ASPI RID 0103

Issue 6 Rev 1	EUM.EPS.SYS.DCR.02.174
	Maximum number of Pressure Levels for Water Vapour profiles increased from 45 to 90 (MDR and Parameters)
	Maximum number of Pressure Levels for Temperature profiles increased from 45 to 90 (MDR and Parameters)
	Added NUM_SURFACE_EMISSIVITY_WAVELENGTHS to GIADR
	MDR.ATMOSPHERIC_TEMPERATURE made variable length
	MDR.ATMOSPHERIC_WATER_VAPOUR made variable length array
	MDR.ATMOSPHERIC_OZONE made variable length array
	MDR.SURFACE_EMISSIVITY made variable length array
	GIADR.PRESSURE_LEVELS_TEMP made variable length array
	GIADR.PRESSURE_LEVELS_HUMIDITY made variable length array
	GIADR.PRESSURE_LEVELS_OZONE made variable length array
	GIADR.SURFACE_EMISSIVITY_WAVELENGTHSP made variable length array
	Colour coding added to variable arrays and array size parameters to allow easier cross-checking
	MDR.ATMOSPHERIC_WATER_VAPOUR units changed from ppmv to kg/kg (compatible with ATOVS) and scale factor increased from 0 to 5
	MDR.INTEGRATED_OZONE units changed from ppmv to kg/m ²
	MDR.CLOUD_PHASE data type changed from u-integer2 to enumerated
	MDR.TIME_ATTITUDE made unsigned data type (ATOVS)
	MDR.ATTITUDE_ANGLES scale factor increased from 0 to 3, and data type changed from integer4 to integer2 (ATOVS)
	MDR.NAVIGATION_STATUS changed from bitst(16) to bitst(32) as defined in main text
	MDR.EARTH_LOCATION scale factor increased from 3 to 4 and data type changed from integer2 to integer4
	MDR.SPACECRAFT_ALTITUDE made unsigned data type
	MDR.ANGULAR_RELATION scale factor changed from 3 to 2
	MDR.FLG_SUPADI data type changed from u-byte to enumerated (PGS)
	MDR.FLG_SUPSAT data type changed from u-byte to enumerated (PGS)
	MDR scale factors and units marked as NA (not applicable) where appropriate
	Typical values for M and N added to parameters to allow typical MDR size to be calculated (assumes 10x compression of matrix)
	MDR.MATRIX_DATA_SIZES array increased to allow 120 values of M,N to accommodate compression technique that does not produce consistently sized compressed matrices
	All offset calculations updated as necessary

	Add scaling factors to the trace gas fields in the MDR: CO2: 3 O3 (all fractional and total column): 7 N2O: 7 CO: 7 CH4: 5
Issue 6 Rev 2	EUM.EPS.SYS.DCR.04.011
	GIADR: PRESSURE_LEVELS_TEMP changed data type to u-integer4
	GIADR: PRESSURE_LEVELS_HUMIDITY changed data type to u-integer4
	GIADR: PRESSURE_LEVELS_OZONE changed data type to u-integer4
	MDR: Added SURFACE_PRESSURE field
	Compounds: Added WAVELET_COEFF compound
	MDR: Renamed field MATRIX_DATA_SIZES to DATA_SIZES
	MDR: Renamed field COVARIANCE_MATRIX to ERROR_DATA
	MDR: Changed array size of DATA_SIZES to 1
	MDR: Changed array size of FLG_STER to 1
	MDR: Added format definitions of ERROR_DATA based on setting of FLG_STER
	Parameters: Updated definitions of M and N
	MDR: FLG_RETBOU data type changed from bist(144) to bitst(256)
	MDR: ATMOSPHERIC_WATER_VAPOUR changed SF to 6 and data type to u-integer4
	MDR: FLG_IASICLD changed data type to bitst(8)
	MDR: FLG_CLDTST changed data type to bitst(8)
	MDR: Deleted FLG_ATOVINS
	MDR: Changed CLOUD_TOP_PRESSURE data type to u-integer4
	MDR: SURFACE_EMISSIVITY changed SF to 4 and data type to u-integer4
	MDR: INSTRUMENT_MODE flag description updated to indicate content source
Issue 6 Rev 3	EUM.EPS.SYS.DCR.06.0317
	Changes to the following MDR fields:
	ATMOSPHERIC_OZONE scale factor changed from 7 to 6
	INTEGRATED_OZONE scale factor changed from 7 to 6
	INTEGRATED_N2O scale factor changed from 7 to 6
	INTEGRATED_CH4 scale factor changed from 5 to 6

	INTEGRATED_N2O - typo fixed in field name (INEGRATED_N2O changed to INTEGRATED_N2O)
Issue 6 Rev 4	EUM_AB_DCR_EUM_58
	GIADR, record SURFACE_EMISSIVITY_WAVELENGTHS, Type Size 2 (hard coded) corrected to 4 (via formula). Field Size and Offset also automatically corrected.
Version 7A 12/08/08	Migrated into Hummingbird. Contents identical with issue 6.4.
Version 7B 10/09/08	No changes to annex.
Version 8 10/03/09	ODT_DCR_16
	MDR: CLOUD_PHASE description updated with addition of '255 = undefined'
Version 9 12/11/13	New format for IASI L2 PPF version 6

Doc Ref: EPS.MIS.SPE.980760.ANX
IASI Level 2 Product Format Specification - Annex
Worksheet: GIADR

FIELD	DESCRIPTION	SF	UNITS	DIM1	DIM2	DIM3	TYPE	TYPE SIZE	FIELD SIZE	OFFSET
RECORD_HEADER	Generic record header	0		1	1	1	REC_HEAD	20	20	0
GIADR CONTENTS										
NUM_PRESSURE_LEVELS_TEMP	Number of pressure levels for temperature profile retrieval (NLT)	0	NA	1	1	1	u-byte	1	1	20
PRESSURE_LEVELS_TEMP	Pressure levels on which retrieved temperature profiles are given	2	Pa	NLT	1	1	u-integer4	4	404	21
NUM_PRESSURE_LEVELS_HUMIDITY	Number of pressure levels for humidity profile retrieval (NLQ)	0	NA	1	1	1	u-byte	1	1	425
PRESSURE_LEVELS_HUMIDITY	Pressure levels on which retrieved humidity profiles are given	2	Pa	NLQ	1	1	u-integer4	4	404	426
NUM_PRESSURE_LEVELS_OZONE	Number of pressure levels for ozone profile retrieval (NLO)	0	NA	1	1	1	u-byte	1	1	830
PRESSURE_LEVELS_OZONE	Pressure levels on which retrieved ozone profiles are given	2	Pa	NLO	1	1	u-integer4	4	404	831
NUM_SURFACE_EMISSIVITY_WAVELENGT HS	Number of wavelengths for surface emissivity retrieval (NEW)	0	NA	1	1	1	u-byte	1	1	1235
SURFACE_EMISSIVITY_WAVELENGTHS	Wavelengths for surface emissivity	4	µm	NEW	1	1	u-integer4	4	48	1236
ERROR_DATA										1284
NUM_TEMPERATURE_PCS	Number of principal components for temperature in the ERROR_DATA (NPCT)	0	NA	1	1	1	u-byte	1	1	1284
NUM_WATER_VAPOUR_PCS	Number of principal components for water-vapour in the ERROR_DATA (NPCW)	0	NA	1	1	1	u-byte	1	1	1285
NUM_OZONE_PCS	Number of principal components for ozone in the ERROR_DATA (NPCO)	0	NA	1	1	1	u-byte	1	1	1286
FORLI										1287
FORLI_NUM_LAYERS_CO	Number of partial layers for CO (NL_CO)	0	NA	1	1	1	u-byte	1	1	1287
FORLI_LAYER_HEIGHTS_CO	CO partial layer heights	0	m	NL_CO	1	1	u-integer2	2	38	1288
FORLI_NUM_LAYERS_HNO3	Number of partial layers for HNO3 (NL_HNO3)	0	NA	1	1	1	u-byte	1	1	1326
FORLI_LAYER_HEIGHTS_HNO3	HNO3 partial layer heights	0	m	NL_HN O3	1	1	u-integer2	2	38	1327
FORLI_NUM_LAYERS_O3	Number of partial layers for O3 (NL_O3)	0	NA	1	1	1	u-byte	1	1	1365
FORLI_LAYER_HEIGHTS_O3	O3 partial layer heights	0	m	NL_O3	1	1	u-integer2	2	80	1366
BRESCIA										1446
BRESCIA_NUM_ALTITUDES_SO2	Number of estimated SO2 plume heights (NL_SO2)	0	NA	1	1	1	u-byte	1	1	1446
BRESCIA_ALTITUDES_SO2	Estimated SO2 plume heights	0	m	NL_SO2	1	1	u-integer2	2	10	1447
										1457

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FIELD	DESCRIPTION	SF	UNITS	DIM1	DIM2	DIM3	TYPE	TYPE SIZE	FIELD SIZE	OFFSET
RECORD_HEADER	Generic record header	NA	NA	1	1	1	REC_HEAD	20	20	0
GENERIC QUALITY INDICATORS										20
DEGRADED_INST_MDR	Quality of MDR has been degraded from nominal due to an instrument degradation	NA	NA	1	1	1	boolean	1	1	20
DEGRADED_PROC_MDR	Quality of MDR has been degraded from nominal due to a processing degradation	NA	NA	1	1	1	boolean	1	1	21
First guess profiles										22
FG_ATMOSPHERIC_TEMPERATURE	A-priori temperature profile (for 120 FOV with up to 101 vertical levels)	2	K	NLT	120	1	u-integer2	2	24240	22
FG_ATMOSPHERIC_WATER_VAPOUR	A-priori water vapour profile (for 30 EFOV with up to 101 vertical levels)	7	kg/kg	NLQ	120	1	u-integer4	4	48480	24262
FG_ATMOSPHERIC_OZONE	A-priori ozone profile (for 30 EFOV with up to 101 vertical levels)	8	kg/kg	NLO	120	1	u-integer2	2	24240	72742
FG_SURFACE_TEMPERATURE	A-priori surface skin temperature	2	K	120	1	1	u-integer2	2	240	96982
FG_QI_ATMOSPHERIC_TEMPERATURE	Quality indicator for a-priori temperature profile	1	NA	120	1	1	u-byte	1	120	97222
FG_QI_ATMOSPHERIC_WATER_VAPOUR	Quality indicator for a-priori water vapour profile	1	NA	120	1	1	u-byte	1	120	97342
FG_QI_ATMOSPHERIC_OZONE	Quality indicator for a-priori ozone profile	1	NA	120	1	1	u-byte	1	120	97462
FG_QI_SURFACE_TEMPERATURE	Quality indicator for a-priori surface skin temperature	1	NA	120	1	1	u-byte	1	120	97582
MEASUREMENT DATA										97702
ATMOSPHERIC_TEMPERATURE	Temperature (for 120 IFOV with up to 101 vertical levels)	2	K	NLT	120	1	u-integer2	2	24240	97702
ATMOSPHERIC_WATER_VAPOUR	Water vapour (for 120 IFOV with up to 101 vertical levels)	7	kg/kg	NLQ	120	1	u-integer4	4	48480	121942
ATMOSPHERIC_OZONE	Ozone (for 120 IFOV with up to 101 vertical levels)	8	kg/kg	NLO	120	1	u-integer2	2	24240	170422
SURFACE_TEMPERATURE	Surface temperature (for 120 IFOV)	2	K	120	1	1	u-integer2	2	240	194662
INTEGRATED_WATER_VAPOUR	Integrated water vapour (for 120 IFOV)	2	kg.m ⁻²	120	1	1	u-integer2	2	240	194902
INTEGRATED_OZONE	Integrated ozone (for 120 IFOV)	6	kg.m ⁻²	120	1	1	u-integer2	2	240	195142
INTEGRATED_N2O	Integrated N2O (for 120 IFOV)	6	kg.m ⁻²	120	1	1	u-integer2	2	240	195382
INTEGRATED_CO	Integrated CO (for 120 IFOV)	7	kg.m ⁻²	120	1	1	u-integer2	2	240	195622
INTEGRATED_CH4	Integrated CH4 (for 120 IFOV)	6	kg.m ⁻²	120	1	1	u-integer2	2	240	195862
INTEGRATED_CO2	Integrated CO2 (for 120 IFOV)	3	kg.m ⁻²	120	1	1	u-integer2	2	240	196102
SURFACE_EMISSIVITY	Surface emissivity (for 120 IFOV with up to 20 wavelengths)	4	NA	NEW	120	1	u-integer2	2	2880	196342
NUMBER_CLOUD_FORMATIONS	Number of cloud formations in IFOV	0	NA	120	1	1	u-byte	1	120	199222
FRACTIONAL_CLOUD_COVER	Fractional cloud cover (for 120 IFOV with up to 3 cloud formations)	2	%	3	120	1	u-integer2	2	720	199342
CLOUD_TOP_TEMPERATURE	Cloud top temperature (for 120 IFOV with up to 3 cloud formations)	2	K	3	120	1	u-integer2	2	720	200062
CLOUD_TOP_PRESSURE	Cloud top pressure (for 120 IFOV with up to 3 cloud formations)	0	Pa	3	120	1	u-integer4	4	1440	200782
CLOUD_PHASE	Cloud Phase (for 120 IFOV with up to 3 cloud formations) (0 = no cloud, 1 = liquid, 2 = ice, 3 = mixed, 255 = undefined)	0	NA	3	120	1	enumerated	1	360	202222

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SURFACE_PRESSURE	Surface pressure	0	Pa	120	1	1	u-integer4	4	480	202582
INSTRUMENT										203062
INSTRUMENT_MODE	Instrument mode. This is a copy of the MDR-1C flag GEPSIasiMode as defined in the IASI L1 PFS.	0	NA	1	1	1	enumerated	1	1	203062
NAVIGATION DATA AT SCAN LINE										203063
SPACECRAFT_ALTITUDE	Spacecraft Altitude Above Reference Geoid (MSL)	1	km	1	1	1	u-integer4	4	4	203063
NAVIGATION DATA AT IFOV										203067
ANGULAR_RELATION	Angular relationships: solar zenith angle, satellite zenith angle, solar azimuth angle, satellite azimuth angle for 120 IFOV	2	deg	4	120	1	integer2	2	960	203067
EARTH_LOCATION	Earth Location: latitude, longitude of surface footprint (for 120 IFOV)	4	deg	2	120	1	integer4	4	960	204027
PROCESSING AND QUALITY FLAGS										204987
FLG_AMSUBAD	Availability and quality of AMSU measurements	NA	NA	120	1	1	enumerated	1	120	204987
FLG_AVHRRBAD	Availability and quality of AVHRR measurements	NA	NA	120	1	1	enumerated	1	120	205107
FLG_CLDFRM	Origin of characterisation of the cloud formations	NA	NA	120	1	1	bitst(8)	1	120	205227
FLG_CLDNES	Cloudiness assessment summary	NA	NA	120	1	1	enumerated	1	120	205347
FLG_CLDTST	Details of cloud tests executed and their results	NA	NA	120	1	1	bitst(16)	2	240	205467
FLG_DAYNIT	Discrimination between day and night	NA	NA	120	1	1	enumerated	1	120	205707
FLG_DUSTCLD	Indicates presence of dust clouds in the IFOV	1	NA	120	1	1	u-byte	1	120	205827
FLG_FGCHECK	Check that geophysical parameters from the first guess are within bounds	NA	NA	120	1	1	bitst(16)	2	240	205947
FLG_IASIBAD	Availability and quality of IASI L1 measurements	NA	NA	120	1	1	enumerated	1	120	206187
FLG_INITIA	Indicates the measurements used in the first guess retrieval	NA	NA	120	1	1	bitst(8)	1	120	206307
FLG_ITCONV	Convergence and acceptance of the OEM result	NA	NA	120	1	1	enumerated	1	120	206427
FLG_LANSEA	Specifies surface type	NA	NA	120	1	1	enumerated	1	120	206547
FLG_MHSBAD	Availability and quality of MHS measurements	NA	NA	120	1	1	enumerated	1	120	206667
FLG_NUMIT	Number of iterations in the OEM	0	NA	120	1	1	u-byte	1	120	206787
FLG_NWPBAD	Availability and quality of NWP data	NA	NA	120	1	1	enumerated	1	120	206907
FLG_PHYSCHECK	Indicates potential corrections for superadiabatic and supersaturation conditions	NA	NA	120	1	1	bitst(8)	1	120	207027
FLG_RETCHECK	Check that geophysical parameters from the OEM are within bounds	NA	NA	120	1	1	bitst(16)	2	240	207147
FLG_SATMAN	Indication of satellite manoeuvre	NA	NA	120	1	1	enumerated	1	120	207387
FLG_SUNGLNT	Identification of sun glint	NA	NA	120	1	1	enumerated	1	120	207507
FLG_THICIR	Thin cirrus cloud test	NA	NA	120	1	1	enumerated	1	120	207627
ERROR_DATA										207747
NERR	Number of error data records for current scan line	0	NA	1	1	1	u-byte	1	1	207747
ERROR_DATA_INDEX	Index of the error data record corresponding to the IFOVs in the line (=255 if N/A)	NA	NA	120	1	1	u-byte	1	120	207748
TEMPERATURE_ERROR	Retrieval error covariance matrix for temperature in principal component domain	NA	NA	NERRT	NERR	1	bitst(32)	4	98400	207868

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WATER_VAPOUR_ERROR	Retrieval error covariance matrix for water-vapour in principal component domain	NA	NA	NERRW	NERR	1	bitst(32)	4	25200	306268
OZONE_ERROR	Retrieval error covariance matrix for ozone in principal component domain	NA	NA	NERRO	NERR	1	bitst(32)	4	9360	331468
FORLI_GENERAL										
SURFACE_Z	Altitude of surface	0	m	120	1	1	integer2	2	240	340828
FORLI_CO										
CO_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	341068
CO_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	341188
CO_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	341668
CO_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	341788
CO_NBR	Number of CO profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	341908
CO_CP_AIR	Air partial columns on each retrieved layer	-20	molecules /cm ²	NL_CO	CO_NBR	1	u-integer2	2	1900	341909
CO_CP_CO_A	A-priori partial columns for CO en each retrieved layer	-13	molecules /cm ²	NL_CO	CO_NBR	1	u-integer2	2	1900	343809
CO_X_CO	Scaling vector multiplying the <i>a-priori</i> CO vector in order to define the retrieved CO vector.	NA	NA	NL_CO	CO_NBR	1	vu-integer2	3	2850	345709
CO_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_CO	CO_NBR	1	v-integer4	5	2500	348559
CO_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_CO	CO_NBR	1	v-integer4	5	70000	351059
FORLI_HNO3										
HNO3_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	421059
HNO3_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	421179
HNO3_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	421659
HNO3_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	421779
HNO3_NBR	Number of HNO3 profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	421899
HNO3_CP_AIR	Air partial columns on each retrieved layer	-20	molecules /cm ²	NL_HNO3	HNO3_NBR	1	u-integer2	2	0	421900
HNO3_CP_HNO3_A	A-priori partial columns for HNO3 in each retrieved layer	-11	molecules /cm ²	NL_HNO3	HNO3_NBR	1	u-integer2	2	0	421900
HNO3_X_HNO3	Scaling vector multiplying the <i>a-priori</i> HNO3 vector in order to define the retrieved HNO3 vector.	NA	NA	NL_HNO3	HNO3_NBR	1	vu-integer2	3	0	421900
HNO3_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_HNO3	HNO3_NBR	1	v-integer4	5	0	421900
HNO3_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_HNO3	HNO3_NBR	1	v-integer4	5	0	421900
FORLI_O3										
O3_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	421900
O3_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	422020
O3_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	422500
O3_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	422620
O3_NBR	Number of O3 profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	422740
O3_CP_AIR	Air partial columns on each retrieved layer	-20	molecules /cm ²	NL_O3	O3_NBR	1	u-integer2	2	0	422741

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O3_CP_O3_A	A-priori partial columns for O3 en each retrieved layer	-14	molecules /cm2	NL_O3	O3_NBR	1	u-integer2	2	0	422741
O3_X_O3	Scaling vector multiplying the <i>a-priori</i> O3 vector in order to define the retrieved O3 vector.	NA	NA	NL_O3	O3_NBR	1	vu-integer2	3	0	422741
O3_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_O3	O3_NBR	1	v-integer4	5	0	422741
O3_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_O3	O3_NBR	1	v-integer4	5	0	422741
BRESCIA_SO2										
SO2_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	422741
SO2_COL_AT_ALTITUDES	SO2 column for a plume at different estimated altitudes	1	DU	NL_SO2	120	1	u-integer2	2	1200	422861
SO2_ALTITUDE	Retrieved plume altitude	0	m	120	1	1	u-integer2	2	240	424061
SO2_COL	SO2 column at the retrieved plume altitude from an OEM approach	1	DU	120	1	1	u-integer2	2	240	424301
SO2_BT_DIFFERENCE	Indicative brightness temperature difference	2	K	120	1	1	integer2	2	240	424541

Field Type	Size in Bytes
bitst(8)	1
boolean	1
byte	1
char(1)	1
e-char(1)	1
enumerated	1
u-byte	1
bitst(16)	2
char(2)	2
e-char(2)	2
integer2	2
u-integer2	2
bitst(24)	3
char(3)	3
e-char(3)	3
vu-integer2	3
bitst(32)	4
char(4)	4
integer4	4
u-integer4	4
v-integer4	5
vu-integer4	5
short cds time	6
integer8	8
long cds time	8
u-integer8	8
general time	15
bitst(144)	18
REC_HEAD	20
bitst(256)	32
char(40)	40
char(88)	88

NOTE: Table must be sorted into ascending order

Parameter	Typical value	Description
HNO3_NBR	0	Number of HNO3 retrievals in scan line (variable per line, value provided in MDR)
O3_NBR	0	Number of O3 retrievals in scan line (variable per line, value provided in MDR)
NL_SO2	5	Number of estimated SO2 plume heights (GIADR :: BRESCIA_NUM_ALTITUDES_SO2)
NPCO	10	Number of principal components for ozone in the ERROR_DATA (GIADR :: NUM_OZONE_PCS)
NEVA_CO	10	Maximum number of eigenvectors for the CO sensitivity matrix = round(NL_CO/2)
NEVA_HNO3	10	Maximum number of eigenvectors for the HNO3 sensitivity matrix = round(NL_HNO3/2)
NEW	12	Number of wavelengths for Emissivities (GIADR :: NUM_SURFACE_EMISSIVITY_WAVELENGTH)
NPCW	18	Number of principal components for water-vapour in the ERROR_DATA (GIADR :NUM_WATER_VAPOUR_PCS)
NL_CO	19	Number of partial layers for CO (GIADR :: FORLI_NUM_LAYERS_CO)
NL_HNO3	19	Number of partial layers for HNO3 (GIADR :: FORLI_NUM_LAYERS_HNO3)
NEVA_O3	20	Maximum number of eigenvectors for the O3 sensitivity matrix = round(NL_O3/2)
NPCT	28	Number of principal components for temperature in the ERROR_DATA (GIADR :: NUM_TEMPERATURE_PCS)
NERR	30	Number of error data records in scan line (variable per line, value provided in MDR)
NL_O3	40	Number of partial layers for O3 (GIADR :: FORLI_NUM_LAYERS_O3)
CO_NBR	50	Number of CO retrievals in scan line (variable per line, value provided in MDR)
NERRO	78	Number of elements in the ozone error record = NPCO*(NPCO+1)/2
NLO	101	Number of pressure Levels for ozone profiles (GIADR :: NUM_PRESSURE_LEVELS_OZONE)
NLQ	101	Number of Pressure Levels for Water Vapour profiles (GIADR :: NUM_PRESSURE_LEVELS_HUMIDITY)
NLT	101	Number of Pressure Levels for Temperature profiles (GIADR, NUM_PRESSURE_LEVELS_TEMP)
NERRW	210	Number of elements in the water-vapour error record = NPCW*(NPCW+1)/2
NEVE_CO	280	Maximum number of elements in the CO sensitivity matrix eigenvectors = NEVA_CO * NL_CO
NEVE_HNO3	400	Maximum number of elements in the HNO3 sensitivity matrix eigenvectors = NEVA_HNO3 * NL_HNO3
NERRT	820	Number of elements in the temperature error record = NPCT*(NPCT+1)/2
NEVE_O3	936	Maximum number of elements in the O3 sensitivity matrix eigenvectors = NEVA_O3 * NL_O3