IASI Level 2: Product Guide

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Document Change Record

Issue / Revision	*DCN No.*	*Changed Pages / Paragraphs*
V3		The updates relate to the new PPF version 6. Revised list of reference documents and publications.
V3A		Updated/repaired offsets in the MDR tables
V3B		Completed formatting for TSS document standards. Compiled new reference tables lists. Responded to board requests for changes to document.
V3C		Kept most recent change records upfront, moved the historical in Annex. Fixed typos. Updates to reflect products changes with v6.2 Explains how to construct averaging kernels and land surface emissivity.
V3D		Updates for the v6.3 • SO_2 partial columns • flg_dustclld • L2PCore SST v00.2 • format description cleaning
V3E		Change to availabiltiy information of EARS-IASI L2. Also, updated reference to HDF5, replacing it with netCDF as official format for reformatting on Data Centre queries.

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1 INTRODUCTION

This user guide is intended to support the users of EUMETSAT Polar System (EPS) IASI Level 2 products. It provides information about the products available, how to access them, how to extract and interpret the data and use the processing and quality flags. This manual also provides product information to help the user choose a product for a particular application.

1.1 Scope

These EPS products will be addressed in this guide:

IASI Level 2 full product

- Temperature profiles
- Humidity profiles
- Ozone profiles
- CO profiles
- SO_2 partial colums
- Surface temperature
- Land surface emissivity
- Fractional cloud cover
- Cloud top temperature
- Cloud top pressure
- Cloud phase
- Dust index
- Total column N_2O
- Total column CH_4
- Total column CO_2
- Error covariance matrix
- Processing and quality flags

IASI Level 2 GTS product

- Temperature profiles
- Humidity profiles
- Surface temperature

IASI Level 2Pcore product

- Skin sea surface temperature
- Uncertainty estimates
- Quality levels and flags
- Wind speed

The products listed above are generated by the EPS Core Ground Segment from IASI instruments on board the Metop platforms. EUMETSAT generates Level 2 from IASI Level 1c products, which are also generated and distributed to users. If you are interested in IASI Level 1c radiance products, see the IASI Level 1 Product Guide for these products processing, formats, dissemination means and applications.

For further questions about EPS Products that are not addressed in this guide, please see the EUMETSAT Polar System pages on our website www.eumetsat.int, or contact the EUMETSAT

User Services Helpdesk ops@eumetsat.int. These pages should be the main interface for updated information on access to all EPS products.

Comprehensive information on the SAF and their products and activities can also be found on the EUMETSAT website and on the relevant SAF webpage. See http://acsaf.org and www.osi-saf.org.

1.2 Reference Documents

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

No.	*Document Title*	*Reference*
RD 1	EPS End User Requirements Document	EUM.EPS.MIS.REQ.93.001
RD 2	EPS Generic Product Format Specification	EPS/GGS/SPE/96167
RD 3	IASI Level 1 Product Format Specification	EUM.EPS.SYS.SPE.990003
RD 4	IASI Level 2 Product Format Specification	EPS.MIS.SPE.980760
RD 5	IASI Instrument Specification	IA-SP-1000-201-CNE
RD 6	Spécification Technique de Besoin du logiciel opérationnel IASI	IA-SB-2100-9462-CNE
RD 7	Dossier de définition des algorithmes IASI	IA-DF-0000-2006-CNE
RD 8	IASI Level 2 Product Generation Specification	EPS.SYS.SPE.990013
RD 9	EPS Programme Calibration and Validation Overall Plan	EUM.EPS.SYS.PLN.02.004
RD 10	U-MARF LEO Format Descriptions	EUM/OPS/USR/06/1855
RD 11	EUMETCast Technical Description	EUM TD 15
RD 12	EPS System Requirements Document	EUM.EPS.SYS.REQ.93001
RD 13	EPS Products for GTS Distribution	EUM.EPS.SYS.TEN.02.008
RD 14	EPS Product file naming for EUMETCast	EUM/OPS-EPS-TEN/07/0012
RD 15	BUFR Descriptors for IASI Level 2 Data	EUM/OPS/TEN/07/2410
RD 16	IASI L2 PPF version 6, validation report	EUM/TSS/REP/14/7743
RD 17	IASI L2 PPF version 6.2, validation report	EUM/RSP/REP/16/857500
RD 18	IASI L2 PPF version 6.3, validation report	EUM/RSP/REP/17/922945
RD 19	Metop Space to Ground Interface Specification	MO-IF-MMT-SY0001
RD 20	Single Sensor Error Statistic Scheme for IASI Level 2 Sea Surface Temperature	EUM/MET/DOC/11/0142
RD 21	Validation of IASI L2Pcore sea surface temperature	EUM/MET/DOC/10/0472
RD 22	EPS Product Validation Report: IASI L1 PCC	EUM/OPS-EPS/REP/10/0148
RD 23	Validation of the NN-based cloud detection tests for IASI	EUM/MET/TEN/10/0343
RD 24	Validation of the CO_2-slicing and the chi2 method for IASI using the AVHRR visual analysis from Brockmann Consult	EUM/MET/TEN/10/0237
RD 25	Assessment of the chi-square method for cloud top pressure and equivalent cloud amount retrievals with measurements from IASI	EUM/MET/TEN/09/0688
RD 26	The piece-wise linear regression	Hultberg et August, ITSC-19, EUM/RSP/TEN/13/723383
RD 27	BUFR Descriptors for IASI Level 2 Data	EUM/OPS/TEN/07/2410

1.3 SAF documents

These documents can be found on http://acsaf.org or on http://www.eumetsat.int.

No.	*Document Title*	*Reference*
RD 28	Fast Optimal Retrieval on Layers for IASI: Algorithm Theoretical Basis Document	SAF/O3M/ULB/FORLI_ATBD
RD 29	IASI Brescia SO2 : Algorithm Theoretical Basis Document	SAF/O3M/ULB/BresciaSO2_ATBD
RD 30	Near real-time IASI CO: Product User Manual	SAF/O3M/ULB/PUM/001
RD 31	Near real-time IASI SO_2: Product User Manual	SAF/AC/ULB/PUM/002

See also www.nwpsaf.eu for more information on the NWP SAF project

1.4 GHRSST documents

No.	*Document Title*	*Reference*
RD 32	The Recommended GHRSST Data Specification Revision 2.0	www.ghrsst.org/modules/documents/documents/GDS2.0_TechnicalSpecifications_v2.0.pdf

1.5 Applicable Papers, Reports and other Technical Documentation

No.	*Document Title*	*Reference*
AD 1	Manual on the Global Telecommunication System	WMO - No. 386
AD 2	World MO Manual on Codes	WMO - No. 306
AD 3	Hyperspectral earth observation from IASI: Five years of accomplishments.	Hilton et al. 2012, Bulletin of the American Meteorological Society, 93, 347–370, DOI: 10.1175/BAMS-D-11-00027.1.
AD 4	IASI on Metop-A: Operational Level 2 retrievals after five years in orbit	T. August et al, JQSRT, 113 (11), 1340-1371, doi:10.1016/j.jqsrt.2012.02.028, 2012.
AD 5	Global land surface emissivity retrieved from satellite ultraspectral IR measurements	D. Zhou et al, IEEE Trans. Geosci. Remote Sens., 49, 1277--1290, doi:10.1109/TGRS.2010.2051036, 2011
AD 6	Technical Note: An assessment of the accuracy of the RTTOV fast radiative transfer model using IASI data	Matricardi, Atmos. Chem. Phys., 9, 6899-6913, 2009
AD 7	Assessing the impact of radiometric noise on IASI performances	U. Amato, V. Cuomo and C. Serio *Int. J. Remote Sensing*, vol. 16, N°15, 2927-2938,
AD 8	The information content of clear sky IASI radiance and their potential for numerical weather prediction	P. Prunet, J.-N. Thepaut, V. Casse *QJRMS*, 124, pp 211-241, 1998
AD 9	The GEISA system in 1996 : toward an operational tool for the second generation vertical sounders radiance simulation	N. Jacquinet-Husson et al. *JSQRT*, 59, N°3-5, 511-527, 1998
AD 10	The effects of nonlinearity on analysis and retrieval errors	J.R. Eyre *UKMO Forecasting Research Technical Report* N°252
AD 11	Assimilation of carbon monoxide measured from satellite in a three-dimensional chemistry-transport model	C. Clerbaux, J. Hadji-Lazaro, D. Hauglustaine, G. Mégie, B. Khattatov and J.F. Lamarque J. *Geophys. Res.*, 106, D14,15, 385-394, 2001

No.	Document Title	Reference
AD 12	Channel selection methods for Infrared Atmospheric Sounding Interferometer radiances	F. Rabier, N. Fourrié, D. Chafaï and P. Prunet Q.*J. R. Meteorol. Soc*., 128,1011-1027, 2002
AD 13	Balloon-borne calibrated spectroradiometer for atmospheric nadir sounding	Y. Té, P. Jeseck, C. Camy Peyret, S. Payan, G. Perron and G. Aubertin *Applied Optics*, Vol 41, N°30, 6431-6441, 2002
AD 14	Retrieval of CO from nadir remote-sensing measurements in the infrared by use of four different inversion algorithms	C. Clerbaux, J. Hadji-Lazaro, S. Payan, C. Camy-Peyret, J. Wang, D.P. Edwards and M. Lo *Applied Optics*, Vol. 41,N° 33, 7068-7078, 2002
AD 15	First satellite ozone distributions retrieved from nadir high-resolution infrared spectra	S. Turquety, J. Hadji-Lazaro and C. Clerbaux Geophys. Res. Lett., Vol.29,N°24,2198, 2002
AD 16	Simulation of uplooking and downlooking high-resolution radiance spectra with two different radiative transfer model	R. Rizzi, M. Matricardi and F. Miskolczi Applied Optics,41,6, 940-956, 2002
AD 17	The feasibility of monitoring CO2 from high resolution infrared sounders	A. Chédin, R. Saunders, A. Hollingworth, N. Scott, M. Matricardi, J. Etcheto, C. Clerbaux, R. Armante, C. Crevoisier *J. Geophysical. Research*, Vol. 108, N° D2, 4064-4083, 2003
AD 18	Spectroscopic measurements of halocarbons and hydrohalocarbons by satellite-borne remote sensors	P.F. Coheur, C. Clerbaux and R. Rolin *J. Geophysical Research*., Vol. 108,N° D4,4130, 2003
AD 19	Classification of IASI inhomogeneous scenes using co-located AVHRR data	Phillips, P., P. Schlüssel Proc. SPIE, 5979, 29-41, 2005
AD 20	Technical note: Analytical estimation of the optimal parameters for EOF retrievals of the IASI Level 2 Product Processing Facility and its application using AIRS and ECMWF data	Calbet, X., P. Schlüssel *Atmos. Chem. Phys*., 6, 831-846, 2006
AD 21	An introduction to the EUMETSAT Polar System	Klaes, K.D., M. Cohen, Y. Buhler, P. Schlüssel, R. Munro, J.-P. Luntama, A. Von Engeln, E. Ó. Clerigh, H. Bonekamp, J. Ackermann, J. Schmetz *Bulletin of the American Meteorological Society*, 88, 1085-1096, doi:10.1175/BAMS.88.7.1085, 2007.
AD 22	Sensitivity of analysis error covariance to the mis-specification of background error covariance	Eyre and Hilton, Q. J. R. Meteorol. Soc., 139, 524-533, doi: 10.1002/qj.1979, 2013
AD 23	Toward improved validation of satellite sea surface skin temperature measurements for climate research	Donlon, C.J., P.J. Minnett, C. Gentemann, T.J. Nightingale, I.J.Barton, B. Ward, and M.J. Murray *J. Climate,* 15**,** 353–369, 2002
AD 24	Diurnal signals in satellite sea surface temperature measurements	Gentemann, C.L., C.J. Donlon, A. Stuart-Menteth, and F.J. Wentz *Geophys. Res. Let.*, 30, 3, 1140
AD 25	Diurnal warm-layer events in the western Mediterranean and European shelf seas	Merchant C. J., M.J. Filipiak, P. Le Borgne, H. Roquet, Autret Emmanuelle, J-F. Piolle, S. Lavender *Geophys. Res. Let.*, 2008, 35
AD 26	Observations of the oceanic thermal skin in the Atlantic Ocean	Donlon, C.J. and I.S. Robinson, *Journ. Geophys. Res.*, 102, C8, 1997
AD 27	A numerical study of the effects of anomalous North Atlantic atmospheric conditions on the infrared measurement of sea surface temperature	Minnett, P., *J. Geophysical Research*, 91, C7, 1986

No.	***Document Title***	***Reference***
AD 28	Operational SST retrieval from METOP/AVHRR validation report	Le Borgne, P., G. Legendre, A. Marsouin, and S. Pere, *Ocean and Sea-Ice SAF CDOP report*, Version 2.0, July 2008
AD 29	FORLI radiative transfer and retrieval code for IASI	Hurmtans et al, JQSRT, 113, 1391-1408, doi:10.1016/j.jqsrt.2012.02.036, 2012
AD 30	Monitoring of atmospheric composition using the thermal infrared IASI/MetOp sounder	Clerbaux et al, Atmos. Chem. Phys., 9, 6041-6054, 2009.
AD 31	Measurements of total and tropospheric ozone from IASI: comparison with correlative satellite, ground-based and ozonesonde observations	Boynard et al, Atmos. Chem. Phys., 9, 6255-6271, 2009.
AD 32	Carbon monoxide distributions from the IASI/METOP mission: evaluation with other space-borne remote sensors	George et al, Atmos. Chem. Phys., 9, 8317-8330, 2009
AD 33	A unified approach to aerosol remote sensing and type specification in the infrared	Clarisse et al, Atmos. Chem. Phys., 13, 2195-2221, doi:10.5194/acp-13-2195-2013, 2013
AD 34	The MACC reanalysis: an 8-year data set of atmospheric composition	Atmos. Chem. Phys., 13, 4073-4109, doi:10.5194/acp-13-4073-2013, 2013
AD 35	The 2007-2011 evolution of tropical methane in the mid-troposphere as seen from space by MetOp-A/IAS	Crevoisier et al, Atmos. Chem. Phys., 13, 4279-4289, doi:10.5194/acp-13-4279-2013, 2013.
AD 36	The Concordiasi field experiment over Antarctica: first results from innovative atmospheric measurements	Rabier et al, Bull. Amer. Meteor. Soc., 94, ES17-ES20, doi http://dx.doi.org/10.1175/BAMS-D-12-00005.1, 2013
AD 37	Equatorial total column of nitrous oxide as measured by IASI on MetOp-A: implications for transport processes	Ricaud et al, Atmos. Chem. Phys., 9, 3947-3956, 2009
AD 38	Retrieval of desert dust aerosol vertical profiles from IASI measurements in the TIR atmospheric window	Vandenbusche et al, Atmos. Meas. Tech., 6(10), 2577-2591, doi:10.5194/amt-6-2577-2013, 2013.
AD 39	Tracking and quantifying volcanic SO2 with IASI, the September 2007 eruption at Jebel at Tair	Clarisse et al., ACP 2008, doi:10.5194/acp-8-7723-2008
AD 40	Retrieval of sulphur dioxide from the infrared atmospheric sounding interferometer (IASI)	Clarisse et al., Atmos. Meas. Tech., 5, 581-594, doi:10.5194/amt-5-581-2012, 2012.
AD 41	The 2011 Nabro eruption, a SO2 plume height analysis using IASI measurements	Clarisse et al., Atmos. Chem. Phys., 14, 3095-3111, doi:10.5194/acp-14-3095-2014, 2014.
AD 42	Retrieval of near-surface sulfur dioxide (SO2) concentrations at a global scale using IASI satellite observations	Baudouin et al, AMT 2016, doi:10.5194/amt-9-721-2016
AD 43	A unified approach to infrared aerosol remote sensing and type specification	Clarisse et al., 2013, doi:10.5194/acp-13-2195-2013, 2013

1.6 Acronyms and Definitions Used in this Document

Acronym	*Meaning*
AC SAF	Atmospheric Composition monitoring SAF
GHRSST	Group for High-Resolution Sea Surface Temperature
IASI	Infrared Atmospheric Sounding Interferometer
IFOV	Instantaneous Field of View
MDR	Measurement Data Record
NWP	Numerical Weather Prediction
NWP SAF	Numerical Weather Prediction SAF
OEM	Optimal Estimation Method
OmC	Observed minus Calculated brightness temperature
OSI SAF	Ocean and Sea-Ice SAF
PWLR	Piece-Wise Linear Regression
SAF	Satellite Application Facility
SSES	Single Sensor Error Statistics

2 IASI LEVEL 2 PRODUCTS CONFIGURATION HISTORY

In the following table the current versions on the operational ground segment are shown on a white background.

Date introduced	*Product format version*		*PFS version [RD 4]*	*PGS version [RD 8]*	*Comments*
	Major number	*Minor number*			
19/10/2006	10	0	6.5	5.3	
10/09/2008	10	0	V.7B/v8	5.6/V.7	
30/09/2014	11	0	V9	V8	
20/06/2017	11	0	V9B	V8D	

Table 1: IASI Level 2 document versions

IASI L2 PPF software version	*Date on GS1*	*Comments*
4.0	27/11/2007	
4.2	29/04/2008	
4.3	12/08/2008	
4.3.1	20/10/2008	
4.3.2	21/01/2009	
4.3.3	29/03/2010	
5.0.6	14/09/2010	• Sensing start time 13:14:57 UTC • Improved Temperature profiles and CO and O3 total columns and CO and N_2O produced for pixels 3 and 4.
5.1	02/12/2010	Sensing start time 10:59:57 UTC Production and dissemination of cloudy T, q retrievals.
5.1.1	14/03/2011	CO and N_2O are disseminated for the four pixels.
5.2.1	20/10/2011	• Sensing start time 9:59:59 UTC (orbit #25952) • Improved cloud screening for cloudy T, q retrievals • Fixed polar cloud-top pressure retrievals • Changed RTM to RTTOV-10
5.3	28/02/2012	• Implementation of alternative method (chi square) for retrieval of cloud properties in cases where the CO2 slicing fails. • An additional cloud test has been implemented based on the relative in homogeneity of the AVHRR channel 4 and 5 within the IASI FOV. • The result of the new cloud test is available in the product in bit 7 of FLG_IASICLD, but is not taken into account for the selection of cloud free pixels for retrieval

IASI L2 PPF software version	*Date on GS1*	*Comments*
6.0.5	30/09/2014	• Deployment of a new IASI L2 processor including the following major changes: • Synergistic nearly all-sky retrievals with IASI and collocated AMSU/MHS measurements • Provision of the full retrieval error covariance matrix for OEM retrievals (clear-sky only) • Simplified cloudiness flagging • Provision of ozone profiles with averaging kernels • Provision of CO profiles with averaging kernels
6.0.6	04/11/2014	• Fix for a bug that was causing alarms during the external calibration events.
6.1.1	24/09/2015	• Improvement of the Land Surface Temperature: the bias introduced with the version 6.0 has been removed • New FORLI-CO library • Correction the of the Cloud Fraction format • Metop-C readiness completed
6.2.2	02/06/2016	• New first guess: the PWLR3 is replacing the PWLR. Better quality and no stripping in the temperature retrieval anymore. • New FORLI-CO library including the concise CO quality flag • Increase of the upper limit of the integrated CO product
6.3.2	20/06/2017	• Deployment of the new Brescia SO_2 product, made of 5 partial columns + quality information • Deployment of the new Dust Index product (FLG_DUSTCLD) • Enhancement of the Quality Classification Scheme of the L2P core IASI SST product (yield increase, especially at high latitude) • Addition of two new experimental fields to the L2P core IASI SST product: 1) the dust index and the cloud signal "obs – calc" • Fix the encoding bug of the BDIV flag in the CO product

Table 2: IASI Level 2 PPF software versions

	Quality levels				*Match-up data set period*	*Date introduce in the Ground Segment*
	2	***3***	***4***	***5***		
Metop-A						
Bias (K)	–0.24	–0.46	–0.39	–0.34	04/2010 – 09/2010	14/03/2011
Std (K)	0.42	0.35	0.36	0.41		
Bias (K)	–0.31	–0.34	-0.34	–0.14	09/2010 – 03/2011	29/09/2011
Std (K)	0.36	0.25	0.30	0.32		
Bias (K)	–0.37	–0.37	–0.42	–0.25	04/2011 – 03/2012	16/07/2012
Std (K)	0.41	0.31	0.39	0.36		
Bias (K)	–0.27	–0.27	–0.17	–0.09	03/2014 – 08/2014	30/09/2014
Std (K)	0.52	0.46	0.40	0.33		
Bias (K)	-0.75	-0.25	-0.01	0.09	12/2016 – 01/2017	20/06/2017
Std (K)	1.18	0.68	0.49	0.41		
Metop-B						
Bias (K)	–0.28	–0.34	–0.18	–0.08	03/2014 – 08/2014	30/09/2014
Std (K)	0.46	0.41	0.39	0.35		
Bias (K)	-0.71	-0.32	-0.05	0.07	12/2016 – 01/2017	20/06/2017
Std (K)	1.21	0.67	0.48	0.39		

Table 3: IASI L2P Core SST Single Sensor Error Statistics updates.

3 IASI LEVEL 2 PRODUCTS OVERVIEW

3.1 The IASI instrument

The Infrared Atmospheric Sounding Interferometer is composed of a Fourier transform spectrometer (IASI) and an associated Integrated Imaging Subsystem (IIS). The Fourier transform spectrometer provides infrared spectra with high resolution between 645 and 2760 cm^{-1} (3.6 µm to 15.5 µm). The IIS consists of a broad-band radiometer with a high spatial resolution. However, the IIS information is only used for co-registration with the Advanced Very High Resolution Radiometer (AVHRR).

The main goal of the IASI mission is to provide atmospheric emission spectra to derive temperature and humidity profiles with high vertical resolution and accuracy. Additionally, it is used for the determination of trace gases such as ozone, nitrous oxide, carbon dioxide and methane, as well as land- and sea surface temperature and emissivity and cloud properties.

3.1.1 IASI Level 2 processing and data usage

The IASI Level 2 processing foresees not only the usage of the IASI Level 1c radiance spectra but also of the ATOVS measurements namely AMSU-A L1b, AVHRR L1B, MHS Level 1b. Additionally, the IASI L2 processing makes usage of NWP data. The mapping of ATOVS measurements onto the IASI Instantaneous Field Of Views (IFOVs) is therefore an essential part of the processing. In the following section the IASI sampling and the synchronisation and collocation with the ATOVS instruments is discussed before the L2 processing itself is introduced in Section 3.2.

3.1.2 Sampling characteristics of IASI and collocation with ATOVS

IASI is an across-track scanning system with scan range of ±48° 20´, symmetrically with respect to the nadir direction. A nominal scan line covers 30 scan positions towards the Earth and two calibration views. One calibration view is into deep space, the other observes the internal black body. The scan starts on the left side with respect to the flight direction of the spacecraft.

The elementary (or effective) field of view (EFOV) is the useful field of view at each scan position. Each EFOV consists of a 2 × 2 matrix of so-called instantaneous fields of view (IFOV). Each IFOV has a diameter of 14.65 Millirad (mrad) , which corresponds to a ground resolution of 12 km at nadir and a satellite altitude of 819 km. The 2 × 2 matrix is centred on the viewing direction. The instrument points spread function (PSF) is defined as the horizontal sensitivity within an IFOV. The IFOV diameter (D = 14.65 mrad) is defined so that the integral of the PSF over this circular area is larger than 95 %. The non-uniformity within the inner 80 % of the IFOV (D=11.72 mrad) is not larger than ± 5 %. The IIS field of view is defined by a square area of 59.63 × 59.63 mrad, consisting of 64 × 64 pixels and covering the same area as the IASI EFOV.

The instrument scans in a step and stare modus. Each interferogram is acquired within 151 ms. The 30 Earth interferograms per scan line are taken in equally spaced time intervals every 8/37 second so that a synchronisation with AMSU is reached. Figure 1 summarises the synchronisation of IASI with the ATOVS instruments AMSU and MHS.

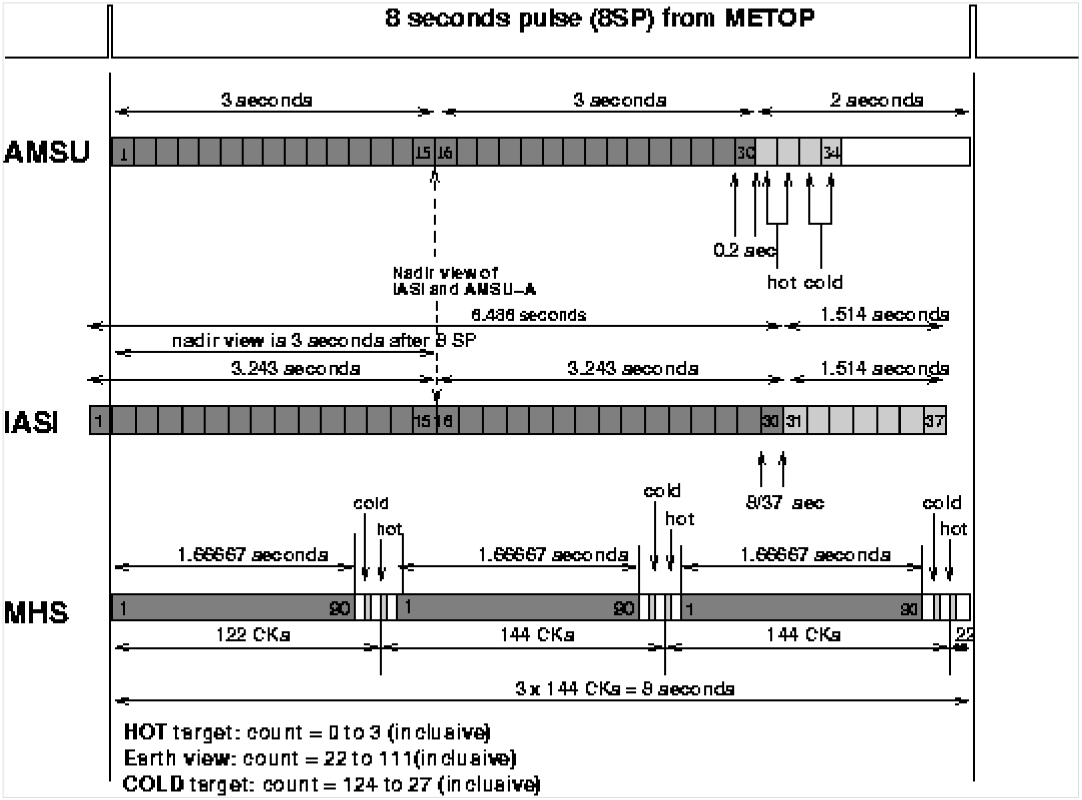

Figure 1: Synchronisation of IASI, AMSU-A and MHS

Characteristics	***Value***	***Unit***
Scan type	step and stare	–
Scan rate	8	second
Stare interval	151	ms
Step interval	8/37	second
Number of Earth scans / line - EFOV	30	–
Swath	±48.333	degree
Swath width	±1100	km
IFOV - shape at nadir	circular	–
IFOV - size at nadir	12	km
IFOV - size at edge of scan line across track	39	km
IFOV - size at edge of scan line along track	20	km

Table 4 : IASI Scanning Characteristics

Within the IASI Level 2 processing, the measurements from the ATOVS instruments and the ATOVS L2 products are used. The collocation between IASI and the ATOVS instruments is shown in the following figures.

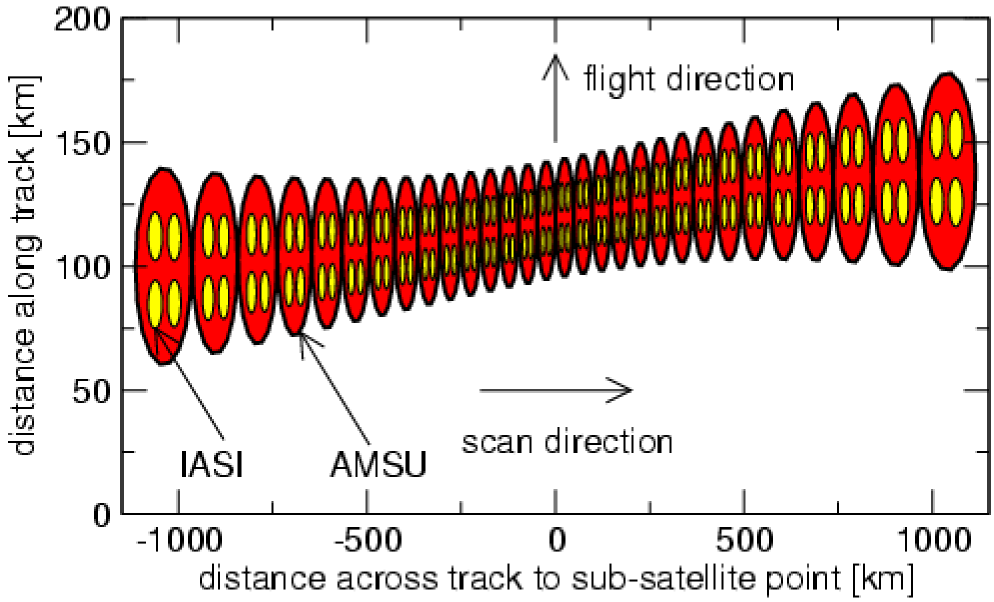

Figure 2 : Collocation of IASI (yellow) and AMSU (red). The distance along and across-track is given in km.

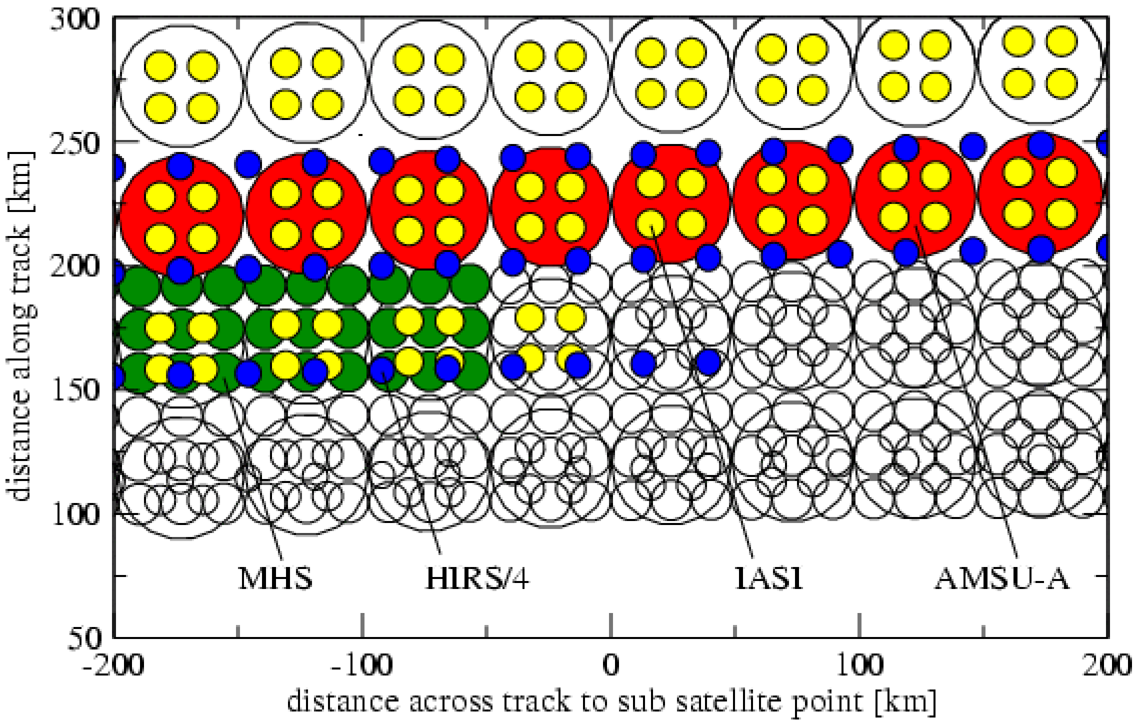

Figure 3 : The collocation between IASI (yellow), AMSU (red), MHS (green) and HIRS (blue) is shown for four scan lines near nadir

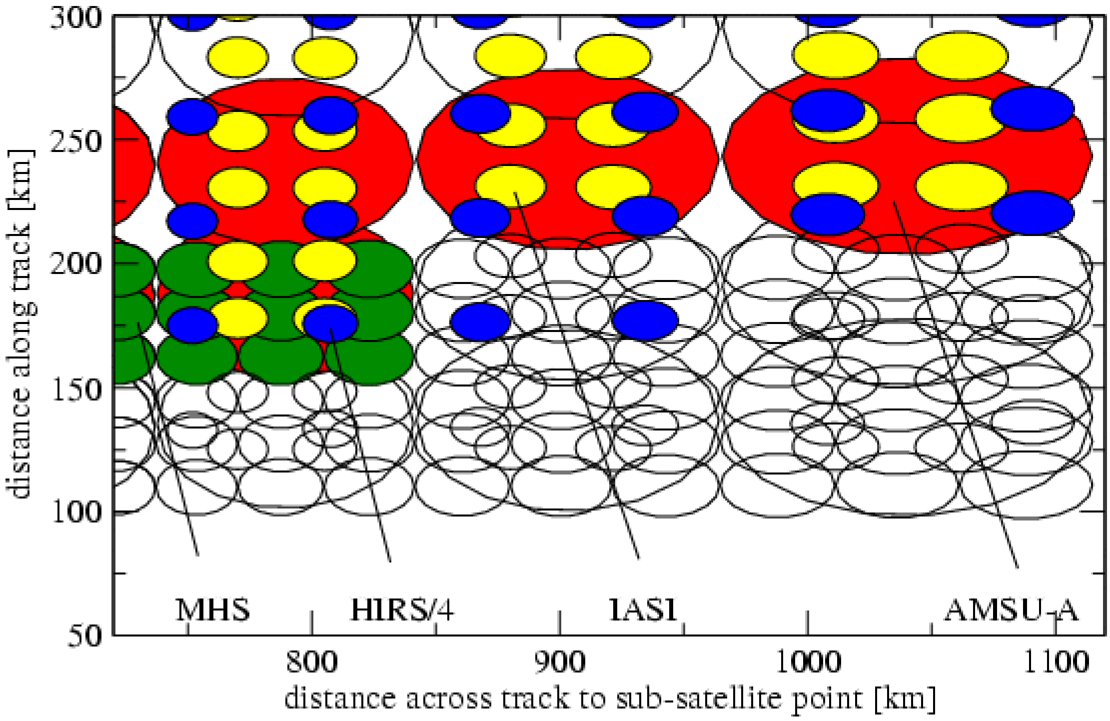

Figure 4 : The collocation between IASI (yellow), AMSU (red), MHS (green) and HIRS (blue) is shown at the end of the IASI scan line

3.2 Overview of the Level 2 processing

The objective of the IASI Level 2 ground processing is the derivation of geophysical parameters from the radiance measurements. The following parameters are derived during IASI Level 2 processing:

- Temperature profiles
- Humidity profiles (and integrated water-vapour total column)
- Ozone profiles (and integrated ozone total column)
- CO profiles (and integrated carbon monoxide total column)
- SO_2 partial columns
- Surface temperature
- Surface emissivity
- Fractional cloud cover
- Cloud top temperature
- Cloud top pressure
- Cloud phase
- Dust index
- Total column N_2O
- Total column CH_4
- Total column CO_2
- Error covariance
- Processing and quality flags

The nominal input of IASI Level 2 processor consists of the following products:

- IASI L1c products
- AMSU L1b products
- MHS L1b products
- AVHRR cloud mask
- NWP forecast data (only for clouds detection)

The following sections provide an overview of the IASI Level 2 processing.

3.2.1 IASI Level 2 pre-processing

Before any collocation and further processing, the validity of the input data is checked by comparison against validity bounds and evaluation of their respective quality flags. The input data consist of the AMSU and MHS Level 1B, the AVHRR cloud mask, the IASI Level 1c radiance spectra, navigation and viewing information as well as the NWP forecast data. The availability of the respective data for processing and their quality are reflected in the following flags:

- FLG_MHSBAD
- FLG_AVHBAD
- FLG_IASIBAD
- FLG_NWPBAD

During the pre-processing phase, the geolocation is extracted from L1C data for individual IASI IFOVs. The topography and surface type (land/water) within the IASI IFOV are extracted from a Land-Sea database and a Digital Elevation Model (DEM). The flag *FLG_LANSEA* summarises the topography and the surface type (land/water). When collocated microwave auxiliary measurements are available, open water and sea-ice can be distinguished and the surface state is reflected in the *FLG_LANSEA*.

The AVHRR information used in the IASI L2 PPF is the cloud fraction integrated in the IASI footprint embedded in the IASI L1c products. The AVHRR radiance cluster analyses, also present in the IASI L1c products, is used in subsequent functions to evaluated the homogeneity of the scenes as input information for cloud detection.

The IASI L1c radiances are transformed in principle components for each of the three bands separately. This has the advantage of removing part of the random noise and of compressing the information present in the IASI L1c measurements in a smaller number of elements —typically 300 PCS as compared to 8461 channels.

3.2.2 First-guess all-sky T, WV, and O_3 retrievals

A statistical method—PWLR[3] (Piece-Wise Linear Regression-cube), explained in [RD 26]—is then applied using the input measurements available: IASI and AMSU/MHS, or IASI only if microwave data are not available. It provides estimates of the temperature, water-vapour and ozone profiles in all-sky conditions—clear and cloudy scenes as well as surface skin temperature and surface emissivity.

The PWLR[3] retrievals serve as "first guess" to the optimal estimation method, described in Section 3.2.2. These are stored in the IASI L2 products with the following labels:

- FG_ATMOSPHERIC_TEMPERATURE
- FG_ATMOSPHERIC_WATER_VAPOUR
- FG_ATMOSPHERIC_OZONE

The method also returns quality indicators (QI) for each of these parameters, available in the products under the labels:

- FG_QI_ATMOSPHERIC_TEMPERATURE
- FG_QI_ATMOSPHERIC_WATER_VAPOUR
- FG_QI_ATMOSPHERIC_OZONE

In the nominal mode using microwave measurements in addition to IASI, the yield is approximately 95 %. Validation results show that the method is relatively robust to cloud contamination with errors in temperature below or around 1 K throughout the troposphere and errors in water-vapour between 1 and 1.5 g/kg on average in the lower troposphere [RD 16] In the absence of microwave information, the retrievals in only IR-mode are obviously more sensitive to cloud contamination and lead to lower yield. The measurements used in this first guess retrieval are summarised in the flag *FLG_INITIA*.

3.2.3 IASI Level 2 cloud products

3.2.3.1 Cloud detection

The cloud detection is performed with three concurrent cloud detection methods using AVHRR collocated cloud mask, the NWP forecasts and IASI measurements. In the NWP test, window channels radiances simulated with weather forecasts and the radiative transfer RTTOV [AD 6] are compared to the actual IASI observations in these channels. Large differences betray the presence of a cloud in the IASI field of view. The AVHRR test directly used the integrated cloud fraction embedded in the IASI L1C data computed with the AVHRR cloud mask within the IASI IFOV. IASI pixels with AVHRR cloud fractions exceeding a configurable threshold are flagged cloudy. The third test applies artificial neural networks to IASI radiances and AVHRR cluster information (mean value and variance) to classify the scenes into cloud-free; partly cloudy and fully cloudy. The details of the tests executed and the outcome are recorded in *FLG_CLDTST*. The test names are in Table 5.

Test name	***Type of test***	***Measurements used***
NWP	Window channel test	IASI; NWP forecast,
AVHRR	Integrated fractional cloud coverage	AVHRR cloud-mask
ANN	non-linear classification	IASI and AVHRR measurements

Table 5 : IASI Level 2 cloud detection tests

If all tests conclude that there is an absence of clouds, the IFOV is declared cloud-free with high confidence. If a cloud is detected by at least one of the tests, a cloud characterisation is attempted. See Section 3.2.3.2 for an explanation of this characterization. Where no clouds could be confirmed with confidence, the IASI IFOV is treated as a clear pixel. However, it is flagged as clear pixel with potential faint cloud contamination. This is reflected in the cloud summary *FLG_CLDNES*. Future implementations could include implementation of thin cirrus cloud detection and aerosol dust detection. Corresponding place-holders flags have been created in the IASI L2 products which remain set to the *default unavailable* value in the current version.

3.2.3.2 Determination of cloud top height and fractional cloud cover

This part of the processor has not been changed in Version 6. See the document [AD 4] for more details on the algorithm and validation results.

If clouds are detected in the field of view, the CO_2-slicing and Chi² methods are used to estimate the fractional cloud cover and the cloud top pressure for the IASI IFOVs. The success of the methods depends on the contrast between cloud and surface signals being greater than instrument noise, as long as IASI-measured radiance is provided in the input to the algorithm.

The CO_2 slicing algorithm is based upon a fixed, pre-selected number of CO_2 channels and a reference channel. The effective cloud amount is estimated from the radiance within a window channel combined with the use of the previously-retrieved cloud top pressure. If the cloud top pressure estimated from a particular CO_2 channel together with the reference channel does not support an estimate of the effective cloud amount in the interval [0, 1], and based on the radiance in the window channel, then that CO_2 channel is excluded from the initial set of pre-selected channels. The algorithm fails for those IFOVs where all the pre-selected CO_2 channels are excluded as a consequence of this test. The cloud top pressure estimates from the individual CO_2 channels passing the test are analysed in order to find out those CO_2 channels whose estimates belong to the most populated class. The weighted mean of these cloud top pressure estimates is the retrieved cloud top pressure. If the retrieved cloud top pressure value is greater than 570 hPa—lower down in the atmosphere—and the forecast temperature profile shows a temperature inversion in the lower troposphere, then the retrieved cloud top pressure is calculated simply as the weighted mean of those estimates below the base of the inversion. The Chi² is described in [RD 24] and [RD 25].

In these IASI L2 Version 6 products, only the cloud characterisation comes from the exploitation of IASI measurements, through the CO_2-slicing and Chi² methods. No combination with AVHRR fractional cloud cover and cloud-top temperature is performed for the current version of the algorithm.

The fractional cloud cover, the cloud top height, the cloud top temperature, and the number of cloud formations are part of the Measurement Data Record (MDR), which contains the following:

- FRACTIONAL_CLOUD_COVER,
- CLOUD_TOP_TEMPERATURE,
- CLOUD_TOP_PRESSURE and
- NUMBER_CLOUD_FORMATIONS.

In this algorithm version, the number of cloud formations does not exceed one.

Additionally, the cloud phase is estimated for cloudy IASI IFOVs by evaluation of the infrared window regions between 8 μm to 9 μm and 11 μm to 12 μm. The cloud phase is part of the CLOUD_PHASE in the MDR.

A summary based on information from the previous cloud detection tests is generated. The fractional cloud cover is evaluated against thresholds and used to determine the category the IFOV falls under:

- clear with high confidence (cloudiness class Q1)
- presumably clear (cloudiness class Q2)
- partly cloudy (cloudiness class Q3)
- cloudy (cloudiness class Q4).

The Table 6 describes how the IFOVs are distributed into the four cloudiness categories according to the results of i) the cloud detection test and ii) the cloud top height and fractional cloud cover.

<table>
<tr><th>ANN</th><th>NWP</th><th>AVHRR</th><th>Cloud parameters</th><th>FLG_CLDNES Class</th><th>Retrieval</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>No cloud</td><td>Q1</td><td>FG-PWLR[3] + OEM</td></tr>
<tr><td rowspan="2">0
:
1</td><td rowspan="2">0
:
1</td><td rowspan="2">1
:
0</td><td>No cloud or
ECA<25% | CTP>750hPa</td><td>Q2</td><td>FG-PWLR[3] + OEM</td></tr>
<tr><td>ECA>25% and CTP<750hPa</td><td rowspan="2">Q3</td><td rowspan="2">FG-PWLR[3]</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">1</td><td rowspan="2">1</td><td>ECA<80%</td></tr>
<tr><td>ECA>80%</td><td>Q4</td><td>FG-PWLR[3]</td></tr>
</table>

Table 6: Logic table describing the distribution of the IFOVs into the 4 cloudiness classes of the FLG_CLDNES flag.

This is summarised in the flag *FLG_CLDNES*. The results of the cloud detection and the origin of the height assignment are summarised in the cloud flags *FLG_CLDTST* and *FLG_CLDFRM.*

The following retrieval steps are invoked for cloud-free IFOVs only—those pixels where *FLG_CLDNES* is one or two.

3.2.3.3 Evaluation of the dust load in the IFOV

The dust index introduced in the version 6.3 implements the method developed by L. Clarisse (Université Libre de Bruxelles). It is a unitless indicator providing a pseudo-quantitative information of the dust load in the IASI pixels. As such, it is not a physical quantitative characterisation of the dust content and nature. The values typically range between 0 and 10, can reach higher values in exceptional dust outbreaks. The presence of dust is suspected when the index is greater than approximately two. The dust index can be read from the flag *FLG_DUSTCLD*.

3.2.4 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 the surface emissivity are provided at is provided in the GIADR, in the fields `NUM_SURFACE_EMISSIVITY_WAVELENGTHS` and `SURFACE_EMISSIVITY_WAVELENGTHS`.

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

$$\boldsymbol{\varepsilon} = \boldsymbol{\Omega}\left(\tilde{\boldsymbol{\Omega}}^T\tilde{\boldsymbol{\Omega}}\right)^{-1}\tilde{\boldsymbol{\Omega}}^T\left(\tilde{\boldsymbol{\varepsilon}} - \langle\tilde{\boldsymbol{\varepsilon}}\rangle\right) + \langle\boldsymbol{\varepsilon}\rangle \quad \textit{Equation 1}$$

where:

ε	is the land surface emissivity spectra on all IASI channels
$\tilde{\varepsilon}$	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

3.2.5 Optimal estimation retrieval of temperature, humidity and ozone

An optimal estimation retrieval of temperature, humidity and ozone profiles is attempted in cloud-free as per *FLG_CLDNES* (when equal to 1 or 2). The profiles and surface parameters from the statistical retrieval are used as "first guess" to this iterative retrieval. This process is described in Section 3.2.2. They are verified against validity bounds. Values that are "out of bounds" of the first retrieval are replaced by climatology data and the status is captured in *FLG_FGCHECK*. They are then passed into the Fast Radiative Transfer Model (FRTM) to calculate the synthetic IASI radiance spectra and Jacobians, which are a matrix of the partial derivatives of the measurements with respect to the profiles and surface parameters. Information which is not part of the retrievals but needed as input for the FRTM—like trace gas profiles—is taken from the climatological background.

If the residuals computed between IASI observations and the calculated radiances using the "first guess" exceed a configurable threshold, an undetected cloud is suspected and the optimal estimation is aborted. This is reflected in the flag *FLG_ITCONV*.

The state vector is then adjusted iteratively such as to minimise the following cost function:

$$J = (x - x_a)^T . S_x^{-1} . (x - x_a) + (F(x) - y)^T . S_y^{-1} . (F(x) - y)$$

In this equation, the second term on the right-hand side translates how well the observations $\boldsymbol{y}$ can be fitted with the simulated radiances using this state vector $\boldsymbol{x}$ and the forward model $\boldsymbol{F(x)}$. The error is normalised by the expected instrument and model errors and error covariances $\boldsymbol{S_y}$. The first term of the right-hand side accounts for how much the state vector departs from the a priori background knowledge of the state vector $\boldsymbol{x_a}$ and its associated error covariance $\boldsymbol{S_x}$. The background a priori state vector is set to the first guess. The background covariance matrix is a static matrix configuring the IASI L2 PPF, which was computed off-line with PWLR retrievals and correlative NWP analysis from ECMWF. The convergence is reached when the norm of the gradient of the cost function approaches zero. If convergence has not been achieved within a configurable maximum number of iterations, the state vector may still be accepted if the radiance residuals (F(x)-y) are small enough. The result of the convergence and acceptance is given by *FLG_ITCONV*. The number of iterations is in *FLG_NUMIT*.

This algorithm provides temperature, humidity, and ozone profiles as well as the skin surface temperature. These parameters are checked against validity bounds. These bounds are indicated by *FLG_RETCHECK*. In addition to the sounding profiles, the OEM allows the estimation of the retrieval error covariance matrix. These errors are described in the section ERROR_DATA of the IASI L2 Product Format Specifications. The averaging kernels can be derived from the full error covariance matrix. The yield with the OEM, which completes the all-sky statistical retrievals, varies between 20 % and 30 % and are limited to clear or presumably clear IASI IFOVs. The validation of Version 6 of the IASI L2 data showed that the OEM slightly improves the precision as compared to the first guess retrievals in clear sky [RD 16].

3.2.6 Derivation of Single Sensor Error Statistics for the IASI SST L2Pcore product

The most significant part of the GHRSST L2P specification is the Single Sensor Error Statistics (SSES). These are observational error estimates provided at pixel level as a bias and standard deviation.

Each observation is assigned a quality level from 0 to 5, where 0 is missing data, 1 is bad data (such as cloud), 2 is the worst useable data, and 5 is the best quality, as given in Table 9. Quality levels for this product have been defined by stratifying against observed minus calculated bringhtness temperature.

The SSES bias and standard deviation are then calculated for each quality level by analysing differences between satellite SSTs collocated with drifting buoys in a matchup database that uses six months' worth of data. The SSES bias and standard deviations are provided to the processor for each quality level within a Look-up Table (LUT). The LUT is updated every six months to a year. For more details, see [RD 16] and [RD 20].

3.2.7 N_2O, CH_4 and CO_2

The total columns of N_2O, CH_4 and CO_2 are retrieved with artificial neural networks trained with synthetic radiances (using RTTOV) and a collection of trace gas profiles from the MOZART model. They are generated in a Demonstrational mode and have not been validated. Work is on-going to upgrade the retrieval algorithms, starting with the methane.

3.2.8 FORLI-CO

Since the release of the IASI L2 processor version 6, profiles of carbon monoxide are retrieved, while only the total column had been provided until the IASI L2 PPF version 5. This is performed with the FORLI-CO library developed at ULB (Belgium) and LATMOS (France) and integrated into the IASI L2 operational processor. This generates the EUMETSAT AC SAF IASI CO product.

For the description of the FORLI-CO products, see the corresponding user manual [RD 28]. The corresponding algorithm description is detailed in [RD 30] and products validation is documented in [AD 29], [AD 30], [AD 31], [AD 32].

3.2.9 BRESCIA-SO_2

The IASI L2 PPF version 6.3 includes a new product: the SO_2 product. It consists of 5 partial columns determined assuming 5 different altitudes for the SO_2 plume. They are provided together with quality information. The retrieval is performed with the BRESCIA-SO_2 algorithm developed at ULB (Belgium) and LATMOS (France), and forms the EUMTSAT AC SAF IASI SO2 product.

For the description of the BRESCIA-SO_2 products, see the corresponding user manual [RD 29]. The corresponding algorithm description is detailed in [RD 31] and product validation is documented [AD 39], [AD 40], [AD 41], [AD 42].

3.3 IASI Level 2 product characteristics

3.3.1 General

Table 7 summarises the requirements for the IASI Level 2 products with respect to product accuracy, sampling and timeliness as they can be found in the EPS End User Requirements Document [RD 1].

Product	*Accuracy*	*Sampling*	*Timeliness*
Temperature	1 K (2 K stratosphere)	IFOV	3 hours
Relative humidity	10 %	IFOV	3 hours
Cloud cover	10 %	IFOV	3 hours
Cloud top temperature	2 K	IFOV	3 hours
Cloud top height	300 m	IFOV	3 hours
Integrated CH_4	less than 20 %	250 km	3 hours
Integrated N_2O	less than 20 %	250 km	3 hours
Integrated CO	less than 10 %	250 km	3 hours

Table 7: Requirements for IASI Level 2 products

3.3.2 Vertical resolution of the temperature and humidity profiles

Users should consider carefully the definition of the IASI temperature and humidity profile products required for their particular application. The IASI sounding products represent thermodynamic states of deep atmospheric layers at variable depths, due to the integrating nature of the radiation measurements at the top of the atmosphere. The maximum number of independent pieces of information determined in the temperature profile is 14, with a maximum of 10 pieces for the moisture profile—but these numbers vary with the atmospheric situation. In summary, the true vertical resolution of the retrieved profiles is lower than the vertical grid defined in the products. Profiles retrieved from such radiance measurements are smoothed versions, where the smoothing functions are the averaging kernels.

An example of a set of averaging kernels for temperature and humidity is shown in Figure: 1. Two things can be seen: the vertical extent over which a particular kernel averages, and the amplitude, which shows how sharply a kernel peaks at a particular height. Higher amplitudes indicate more information about the corresponding layer. For example, an amplitude of one would indicate perfect measurements at a distinct level; however, this is purely hypothetical and does not exist. Nevertheless, the retrieved profiles are represented on a fine vertical grid for the reason that the averaging kernels vary with atmospheric situation. Consequently, the vertical resolution and the centre altitudes of the resolved layers vary also. The actual variation is not known *a priori*, so the retrieval is performed on a fixed, fine pressure grid and the smoothing is represented by the *a posteriori* error covariance matrix, which is part of the product and represented on the same pressure grid. The off-diagonal elements of the covariance matrix describe the inter-relationship between the state-vector elements and provide information about the actual vertical resolution.

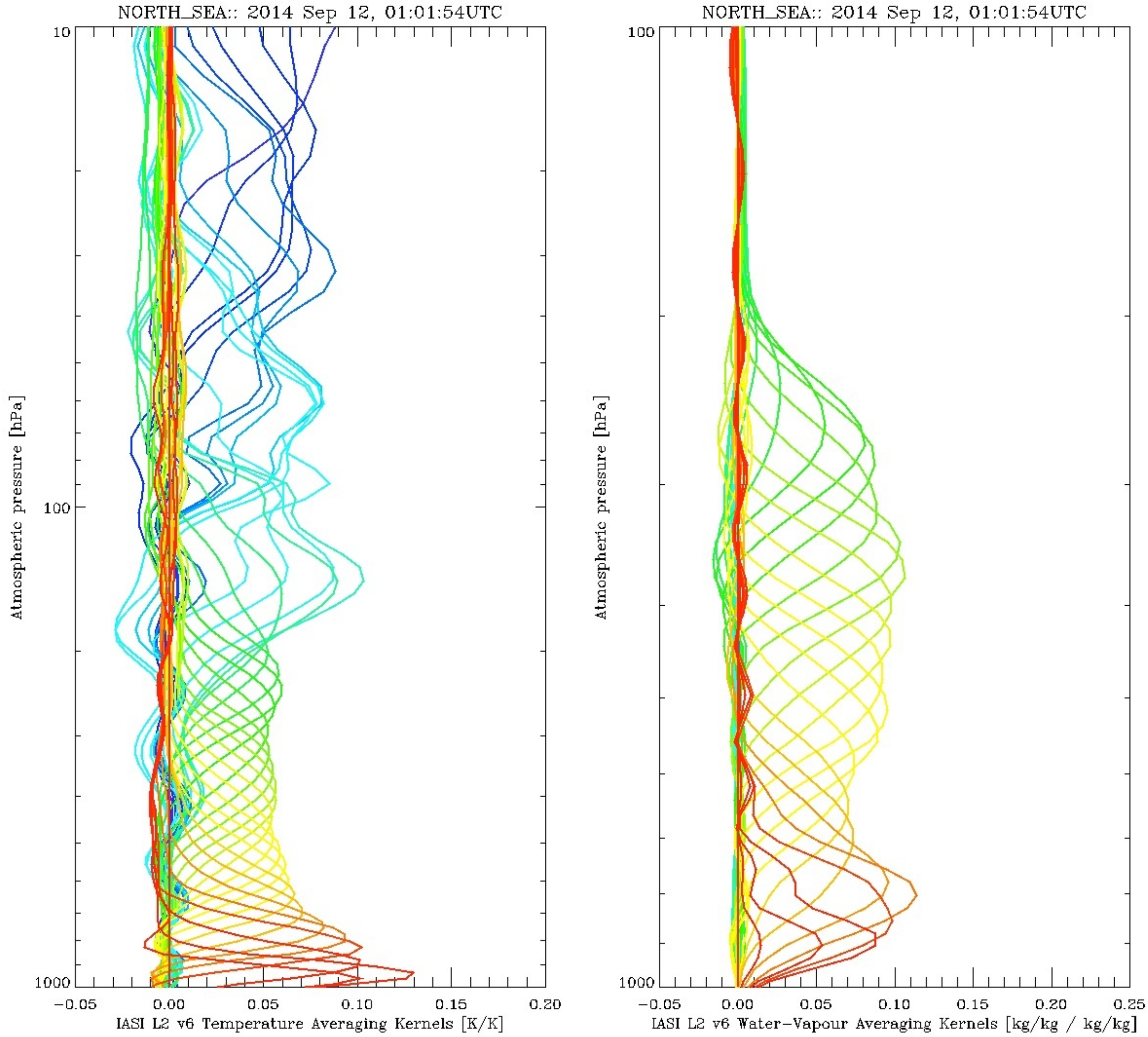

Figure: 1: Averaging kernels for temperature (left) and water-vapour (right) profiles for a mid-lattitude ocean sample taken on 12/09/2014.

3.3.3 Instrument mode and navigation information

The instrument mode is indicated by the IASI Level 1c flag GEPSIasiMode. The flag indicates whether the instrument is operated in normal scan mode or external calibration mode.

The navigation information is given at IFOV level. Information about the satellite's roll, pitch and yaw angles are given by *ATTITUDE_ANGLES*, the time in seconds associated with it is given in *TIME_ATTITUDE*. The spacecraft's altitude is given in the *SPACECRAFT_ALTITTUDE* the variable All values are given in km. The bit string *NAVIGATION_STATUS* contains further detailed information about the navigational status.

3.3.4 Quality and processing information in the product

A number of quality and processing information flags are generated during the Level 2 processing. These flags are distributed as part of the IASI Level 2 product and are associated with individual IFOVs. Table 8 contains the description of the IASI Level 2 processing and quality flags. The possible values and the conditions are described individually in Section 8 of this document. The flags do not only indicate the quality and completeness of the IASI L1c product—they also indicate the choices made in the IASI Level 2 processing.

Flag name	*Description*
FLG_AMSUBAD	Availability and quality of AMSU measurements
FLG_AVHRRBAD	Availability and quality of AVHRR measurements
FLG_CLDFRM	Origin of characterisation of the cloud formations
FLG_CLDNES	Cloudiness assessment summary
FLG_CLDTST	Details of cloud tests exectued and their results
FLG_DAYNIT	Discrimination between day and night
FLG_DUSTCLD	Indicates dust contamination
FLG_FGCHECK	Check that geophysical parameters from the first guess are within bounds
FLG_IASIBAD	Availability and quality of IASI L1 measurements
FLG_INITIA	Indicates the measurements used in the first guess retrieval
FLG_ITCONV	Convergence and acceptance of the OEM result
FLG_LANSEA	Specifies surface type
FLG_MHSBAD	Availability and quality of MHS measurements
FLG_NUMIT	Number of iterations in the OEM
FLG_NWPBAD	Availability and quality of NWP data
FLG_PHYSCHECK	Indicates potential corrections for superadiabatic and supersaturation conditions
FLG_RETCHECK	Check that geophysical parameters from the OEM are within bounds
FLG_SATMAN	Indication of satellite manouevre
FLG_SUNGLNT	Identification of sun glint
FLG_THICIR	Thin cirrus cloud test

Table 8 : IASI Level 2 processing and quality flags

A detailed explanation on the format is given later in the Level 2 EPS format description found in Section 8 of this document. Further details can be found in RD 4 and RD 8

3.4 IASI Level 2Pcore SST product

In addition to the surface temperature provided by the IASI L2 product, the IASI L2Pcore dataset provides the same SST, following the GHRSST specification. The SST retrieval is performed and provided by the IASI L2 processor. The IASI L2P is referred to as 'core' as it does not contain all the auxiliary information (including sea-ice, aerosol, SST background) as specified in a full GHRSST L2P file. These are the main constituents of the IASI L2Pcore SST: skin sea surface temperature, uncertainty estimates (SSES), quality levels and flags, and wind speed. The L2PCore is monitored and augmented at the OSI SAF to form the final IASI L2P SST product.

The IASI SST is representative of the temperature of the upper 20 micrometres of the ocean surface. Ocean and atmospheric models in general use a sub-skin or foundation SST (representing the same measurement at night-time) to be able to characterise the overall heat capacity of the ocean. The skin SST is usually cooler than the sub-skin SST by around 0.17 K at high wind speeds [AD 23], although during daylight hours in regions of high insulation and low wind speed this is reversed and the skin

SST can become several degrees warmer than the foundationSST. See [AD24], [AD25], and [AD 24]. The wind speed is included in the products.

Moreover, the GHRSST Data Specification [RD 32] defines quantities referred to as Single Sensor Error Statistics (SSES). These comprise a bias and standard deviation between comparisons of night-time satellite and *in situ* drifting buoy SSTs collocated within a matchup dataset. The SSES provides uncertainty estimates for the IASI SST observations grouped into quality levels ranging from two (worst useable quality) to five (best quality). The thresholds between each quality level are determined using "the observed minus calculated brightness temperature" (OmC)predicted with the PWLR[3] retrieval function. The OmC retrieval was trained off-line with calculated brightness temperatures computed using the radiative transfert model of the IASI L2 processor (RTTOV).

Table 9 shows the quality levels 0 to 5 based on the thresholds of OmC. A look-up table of SSES bias and standard deviations for each quality level is computed from a 6-month match-up dataset and used to update the operational processor configuration twice a year. These regular updates do not affect the SST values, only the quality information assigned to them. The quality levels are included in the products.

Level	*Data quality*	*Integrated water vapour*	*IASI L2 PPF flags*	*Comment*
0	No data	–	Flg_lansea eq 1 or no SST data.	No data available, or over land.
1	Bad	–	Flg_lansea eq 0. $\|OmC\| \geq 3$	Sea only. Not provided
2	First useable quality	3.5+	Flg_lansea eq 0. $2<\|OmC\| < 3$	Sea only.
3	Fair	1.5 to 2.5	Flg_lansea eq 0. $1<\|OmC\| < 2$	Sea only.
4	Good	2.5 to 3.5	Flg_lansea eq 0. $0.5<\|OmC\| < 1$	Sea only.
5	Best quality	0 to 1.5	Flg_lansea eq 0. $\|OmC\| < 0.5$	Sea only.

Table 9: IASI- integrated water vapour thresholds for each SSES quality level

3.5 Summary of IASI Level 2 product applications

The summary is not available for this issue of the user guide.

3.6 Products status of IASI L2 product

Table 10 presents the products status of each IASI L2 parameter, with the methodology used to retrieve them.

Parameter	*Algorithm*	*Status*
Cloud detection	NWP, AVHRR, ANN	Operational
Cloud fraction & height	CO_2-slicing, Chi^2	Operational
Cloud phase	BT difference	Demonstrational
Dust Index	Regression	Operational
T profiles	OEM (clear-sky)	Operational
q profiles	OEM (clear-sky)	Operational
O_3 profiles	OEM (clear-sky)	Pre-Operational
SST / LST	OEM (clear-sky)	Operational
T profiles	$PWLR^3$ (all-sky)	Operational
q profiles	$PWLR^3$ (all-sky)	Operational
O_3 profiles	$PWLR^3$ (all-sky)	Pre-Operational
SST / LST	$PWLR^3$ (all-sky)	Operational
Emissivity	EOF	Pre-Operational
O_3 total column	OEM	Operational
CO profiles	FORLI-CO	Operational
CO total column	FORLI-CO	Operational
SO_2 partial columns	BRESCIA-SO_2	Demonstrational[1]
N_2O, CH_4, CO_2 total columns	ANN	Demonstrational

Table 10: IASI L2 product status summary

[1] The SO_2 is expected to receive operational status by end 2017

4 DATA VIEWING AND READING

4.1 Generic tools for data reading

Readers for the native EPS format IASI Level 2 products are available online at the EUMETSAT website. See the Data: Data Delivery: Support S/W & Tools page.

Note: You must download the IDL reader for use with all EPS products. Download it online or contact the EUMETSAT help desk to get this reader.

Software capable of reading the WMO formats is available from a variety of sources, including the European Centre for Medium-Range Weather Forecasts (ECMWF) web page.

4.2 Generic netCDF tools

The IASI L2Pcore SST is produced in netCDF format, in accordance with the GDS 2.0. The IASI L2 products, which are also referenced as IASI Sounding –SND products, can also be ordered in a netCDF format from the archive centre. These two products can be read with standard netCDF readers. For more information on netCDF and generic readers, please see the web page:

www.unidata.ucar.edu/software/netcdf/.

5 IASI LEVEL 2 PRODUCT FORMATS AND DISSEMINATION

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

5.1 EPS Products available dissemination means

5.1.1 EUMETCast

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

Within the current EUMETCast configuration, the multicast system is based upon a client/server system with the server side implemented at the EUMETCast uplink site (Usingen, Germany) and the client side installed on the individual EUMETCast reception stations. The telecommunications suppliers provide the DVB-S2 multicast distribution mechanism. Data/product files are transferred via a dedicated communications line from EUMETSAT to the uplink facility. These files are encoded and transmitted to a geostationary communications satellite for broadcast to user receiving stations. Each receiving station decodes the signal and recreates the data/products according to a defined directory and file name structure. A single reception station can receive any combination of the provided services.

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

More detailed information on this service can be found in the EUMETSAT webpage:

www.eumetsat.int/ Data/EUMETSAT Data Centre

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

5.1.2 GTS/RMDCN

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

- The Main Telecommunication Network, linking three world meteorological centres and 15 regional telecommunication hubs.

- The Regional Meteorological Telecommunication Networks, consisting of an integrated network of circuits interconnecting meteorological centres in a region, which are complemented by radio broadcasts where necessary. In Europe, the GTS network is supported by the Regional Meteorological Data Communication Network (RMDCN).
- The National Meteorological Telecommunication Networks, which extends the GTS network to the national level.

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

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

5.1.3 EUMETSAT Data Centre

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

www.eumetsat.int /Quick Links/Data Registration

Access is through a web interface, through which the users are able to browse and order products, manage their user profile, retrieve products, get documentation and software libraries, and get specific user help. The Data Centre features include geographical and time sub-setting and image preview. EPS products archived in the Data Centre can be accessed in a variety of formats, including EPS native format and HDF5.

5.2 IASI products dissemination

Table 11 summarises the different dissemination means and formats for all IASI Level 2 products. The timeliness of the product delivery is noted in parenthesis and refers to the elapsed time between sensing and dissemination.

Format	*Real-Time Direct Broadcast*	*Near-Real-Time on EUMETCast*	*Near-Real-Time on GTS*	*EUMETSAT Data Centre retrieval*	*FTP Access*
EPS native format	–	–	–	IASI Level 2 (8 to 9 hours)	–
HDF5	EARS-IASI L2	PWLR[3] retrievals + quality indicators and cloud signal Available within 30' from sensing	–		–
NetCDF	–	–	–	IASI Level 2 (8 to 9 hours)	–
WMO (BUFR)	–	IASI Level 2 products (less than 2 hours)	(less than 2hours)	–	–

Table 11: Summary of dissemination means and formats for IASI Level 2 products.

5.2.1 Near-real-time dissemination

The Global IASI Level 2 products are disseminated to users in near real-time with a time lapse of two hours from sensing to delivery. The data are disseminated in WMO (BUFR) format, as per Section 0 below.

5.2.2 EARS IASI L2 Regional Service

The Regional IASI L2 products are generated from regional dumps at direct broadcast stations. The regional dumps are centralised for processing to higher livels before dissemination. The regional IASI L2 products are generated with the EARS-IASI service, whose coverage is shown in Figure 5. They are retrieved with the same methodology used for the first-guess statistical retrieval. The regional EARS-IASI L2 are available within 30 minutes from sensing and are disseminated on EUMETCast in HDF5 format. The README file description in Figure 6 details this format.

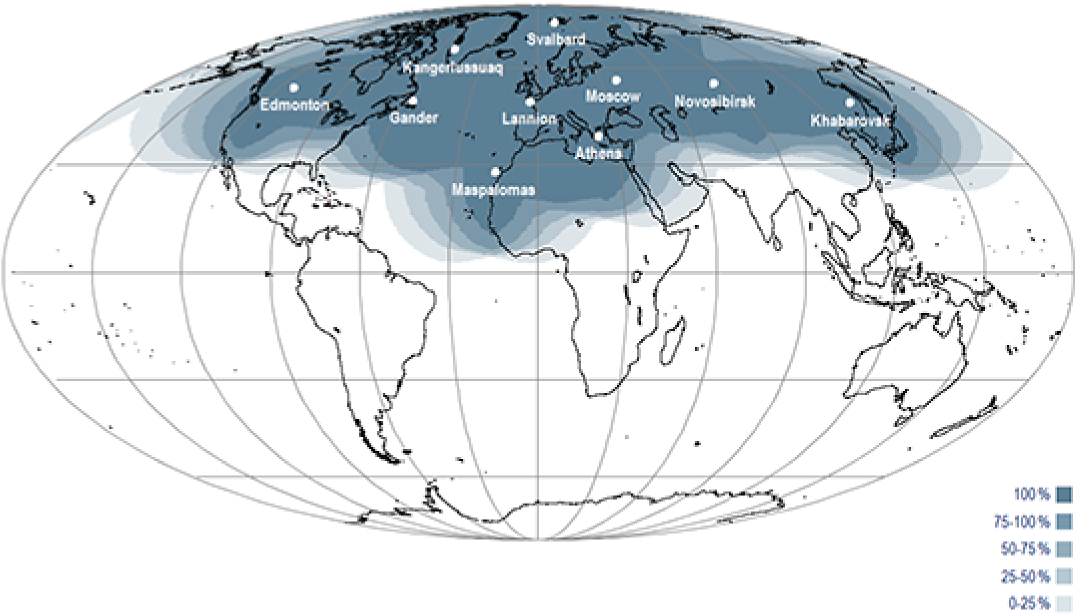

Figure 5: EARS IASI regional service coverage

Content of the PW3 Files disseminated on EUMETCast in HDF5 format   Updated 29 June 2017

PW3 Files contain geophysical parameters retrieved from IASI and, when available, collocated AMSU and MHS measurements from the Metop-A and Metop-B satellites. The retrieval algorithm is the PWLR^3, standing for Piece-Wise Linear Regression Cube. The method combines the measurements from all IASI individual fields of view (IFOV) to perform retrievels in each IASI IFOV individually.

The retrieved parameters are Temperature, Water-vapour, Ozone, Surface temperature, the surface pressure and surface emissivity. They come along with contextual and auxiliary information, e.g. geolocation, viewing and solar angles, quality indicators etc. Fill values, i.e. unavailable data, are encoded with all bits set.

```
The format is HDF5 and data are structured as follows:
   AMSU            STRUCT    -> AMSU related information (quality & availability)
   INFO            STRUCT    -> TBW
   L1C             STRUCT    -> Auxiliary information (lat/lon, angles etc.)
   MAPS            STRUCT    -> Static surface information from atlases, e.g. elevation, land fraction
   MHS             STRUCT    -> MHS related information (quality & availability)
   PWLR            STRUCT    -> Retrieved geohpysical parameters and quality indicators
Group AMSU
   FLG_AMSUBAD     -> 0=good AMSU could be collocated   1=Bad or missing AMSU data, no AMSU collocated data used
Group INFO
    OmC            STRUCT    -> Predicted OBS-CALC assuming clear-sky [Kelvin] in selected window channels;
                                relates to cloud signal
    MDIST          STRUCT    -> Average distance to observations classes [internal diagnostic parameter,
                                not for product users]
Group L1C
   LATITUDE         STRUCT    -> Latitude of the pixel centre  [ degrees ; -90 .. 90 ]
   LONGITUDE        STRUCT    -> Longitude of the pixel centre [ degrees ; -180 .. 180 ]
   SATAZIMUTH       STRUCT    -> Satellite azimuth angle [degrees]
   SATZENITH        STRUCT    -> Satellite zenith angle [degrees]
   SENSINGTIME_DAY  STRUCT    -> Sensing date, day since 01 January 2000
   SENSINGTIME_MSEC STRUCT    -> Sensing time in milliseconds in the sensing date
   SUNAZIMUTH       STRUCT    -> Solar azimuth angle [degrees]
   SUNZENITH        STRUCT    -> Solar zenith angle [degrees]
   LANDFRACTION     STRUCT    -> land fraction as computed with AVHRR collocated data (copied across from IASI L1C)
```

```
Group MAPS
   HEIGHT          STRUCT    -> average surface elevation within the field of view (m)
   HEIGHTSTD       STRUCT    -> stddev of the elevation within the field of view (m)

Group MHS
   FLG_MHSBAD     -> 0=good MHS could be collocated   1=Bad or missing MHS data, no MHS collocated data used

Group PWLR
   E               STRUCT    -> surface emissivity in 10 channels {217, 726, 1124, 1721, 2239, 2683, 4317, 5420,
                                6722, 8231 with first channel ID = 0}
   O               STRUCT    -> Ozone profile [137 atmospheric levels + surface air] (kg/kg)
   OC              STRUCT    -> Ozone total column (kg/m2)
   P               STRUCT    -> Pressure grid [137 atmospheric levels + surface pressure] (hPa)
   QE              STRUCT    -> Quality indicator for emissivity
   QO              STRUCT    -> Quality indicator for ozone (~average uncertainties along the profile in Dew point T)
   QP              STRUCT    -> Quality indicator for surface pressure (~ uncertainties in hPa)
   QT              STRUCT    -> Quality indicator for temperature (~uncertainty estimates of surface air temperature, in K)
   QTS             STRUCT    -> Quality indicator for skin surface temperature (~uncertainties in K)
   QW              STRUCT    -> Quality indicator for water-vapour (~uncertainty estimates of surface air water-vapour,
                                in Dew point temperature )
   T               STRUCT    -> Temperature profile [137 atmospheric levels + surface air] (K)
   TS              STRUCT    -> Surface temperature (K)
   W               STRUCT    -> Water-vapour profile [137 atmospheric levels + surface air] (kg/kg)
   WC              STRUCT    -> Water-vapour total column (mm)
```

Figure 6: Content of the PW3 Files

5.2.3 Archive retrieval

The IASI Level 2 products available from the EUMETSAT Data Centre are archived as full-dump products, but sub-setting capabilities are provided to the user in the retrieval process. The products in the EUMETSAT Data Centre are available to users for eight to nine hours after sensing, either in EPS native format or in NetCDF format.

5.2.4 FTP dissemination

The IASI Level 2Pcore SST products will be available on FTP. Access to the FTP server requires user registration via the EUMETSAT Earth Observation Portal:

www.eumetsat.int/Home/Main/DataAccess/EOPortal

5.3 IASI EPS native product formats

5.3.1 The EPS native formats

5.3.1.1 General overview of the EPS generic product format

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

This description is not aimed at supporting the writing of reader software for the IASI or other EPS products, because readers and product extraction tools are already available. See Section 4. The intention of this and the following sections is to provide enough information to be able to use such available tools and to interpret the retrieved information.

For users interested in writing their own product readers for one or several IASI products in EPS native format, we refer them to the detailed format specifications provided in [RD 2] and [RD 4].

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

Header Section	Contains metadata applicable to the entire product. The header section may contain two records, the Main Product Header Record (MPHR) and the Secondary Product Header Record (SPHR).

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

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

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

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

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

The format of the MPHR, IPRs, GEADR, VEADR and DMDRs is common to all products, while the other records can be of different formats and contents. Sub-classes have an instrument-specific content and format. Every record consists of a series of fields, which can have different data types.

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

Two types of records deserve special description because they are key to navigatioin within the products: GRH and the IPR. Their format and the meaning of their fields are detailed in Section 8.

Table 12 that follows lays out the general structure of the Generic Product Format.

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

Section	*Record Class*	*Record Subclass*	*Start Time*	*Stop Time*
	GLOBAL INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T6
VARIABLE AUXILIARY DATA SECTION	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T3
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T3	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T5
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T5	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T1	T2
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T2	T4
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS A	T4	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS B	T1	T6
	VARIABLE INTERNAL AUXILIARY DATA RECORD	SUBCLASS C	T1	T6
BODY SECTION	MEASUREMENT DATA RECORD	SUBCLASS A	T1	T2
	MEASUREMENT DATA RECORD	SUBCLASS B	T2	T3
	MEASUREMENT DATA RECORD	DUMMY	T3	T4
	MEASUREMENT DATA RECORD	SUBCLASS A	T4	T5
	MEASUREMENT DATA RECORD	SUBCLASS B	T5	T6

Table 12 : Generalised schematic of the generic product format

5.3.1.2 Granularity of the EPS products

The Full EPS product is produced by processing a so-called granule of data. One granule contains 3 minutes of instrument data and one granule of IASI data, therefore 22 or 23 IASI scan lines. This is the product size which is also used to archive the data in the EUMETSAT Data Centre. The length in time of the product is contained in the MPHR.

5.3.1.3 Product format version control

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

5.3.1.4 Product naming convention

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

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

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

Table 13 : EPS product name fields and their correspondence with MPHR fields

For the IASI Level 2 product, the resulting product file names are as follows:

Product	*Product name*
IASI Level 2	IASI_SND_02_Mnn_<...>

5.3.2 The IASI Level 2 product formats

Table 14 lists the records to be found in IASI Level 2 products:

Record Name	*Description*	*Usage*	*Subclass ID*
MPHR	Main Product Header Record	Main product identification details	0
GEADR	Global External Auxiliary Data Record	Global auxiliary data set used for the generation of the IASI L2 product not written into the product	0
GIADR	Global Internal Auxiliary Data Record	Pressure levels for temperature, humidity and ozone profiles	0
VEADR	Variable External Auxiliary Data Record	Variable auxiliary data set used for the generation of the IASI L2 product not written into the product	0
MDR	Measurement Data Record Level 2	IASI Level 2 products, processing and quality information	0

Table 14 : Records found in the IASI L2 format

The IASI Level 2 products are organised as successive scan lines. Each IASI Level 1 MDR product contains one IASI scan line. The IFOV within one scan line are referenced to by the geolocation. The START/STOP timeshare is indicated in the MPHR. The occurrence of the different records in the Level 2 products is as follows:

Record	*Occurrence*
MPHR	Once per product
GEADR	Once per product
GIADR	Once per product
VEADR	As required
MDR	Once per scan line

Table 15 : Occurrence of the different records in the IASI L2 product

See Section 8 for complete descriptions of the contents and EPS format of the IASI Level 2 products.

5.4 The netCDF format

The EUMETSAT Data Centre offers the possibility to reformat the native EPS IASI products in netCDF when the archive request is performed. NetCDF formatted products that are retrieved this way are named exactly like the EPS formatted products, as described in Section 5.2 above but are given an *.nc* extension. The products can be read using standard netCDF libraries. For more information on netCDF formats in general, see the netCDF Group homepage.

5.5 The WMO formats

The IASI Level 2 products are available in WMO (BUFR) format for near-real time dissemination. This format is described in the dedicated document [RD 27].

The full format description of these products is available in the WMO Manual on Codes. See [AD 2].

The names of the IASI Level 2 products distributed on EUMETCast are specified in [RD 14]. They follow this pattern:

iasi_yyyymmdd_hhmmss_metopa_nnnnn_eps_o_<product code>.l2_bufr

where:

yyyymmdd	the UTC year, month, day of the data start sensing time	
hhmmss	the UTC hour, minute, second of the data start sensing time	
nnnnn	the orbit number	
product code		
	twt	atmospheric temperature and water vapour
	twt_err	Retrieval error covariance estimate for temperature and water-vapour profiles
	ozo	atmospheric ozone profiles and full error covariance estimate
	co	CO profiles and averaging kernels
	trg	trace gases
	ems	Emissivity
	clp	cloud parameters

6 IASI LEVEL 2 PRODUCTS PROCESSING ALGORITHMS

The detailed IASI Level 2 processing and algorithm description can be found in the reference document [RD 8].

7 IASI LEVEL 2 PRODUCTS VALIDATION AND MONITORING

7.1 General Considerations

A number of algorithms were modified or introduced with the release of the IASI L2 processor v6, seeking improvements in the atmospheric sounding in the lower tropospheric, i.e. for temperature and especially humidity, and enhancements of existing products (e.g. increased yield with retrievals in cloudy IFOVs, provision of full CO and O_3 profiles, provision of the full error estimates…). The validation of these new IASI Level 2 products has been conducted with in-house products assessment and through cooperation with external partners who performed an independent evaluation of the products. The retrieved geophysical parameters have been compared to numerical model fields (forecasts and analysis), to in-situ measurements (e.g. buoys, radiosondes, drop sondes), to ground-based instruments (land surface temperature radiometer, Brewer and Dobson instruments for the total column O3, GPS-RO and microwave radiometer total column water-vapour measurements, Lidar atmospheric profilers etc.) and to other satellite products. A comprehensive validation report capturing the main results for each products assessment has been published:

EPS Product Validation Report: IASI L2 PPF [RD 16] and [RD 17].

Long-term monitoring and validation will be continued to characterise further the various IASI L2 product components and to verify the temporal consistency of these products. For products that remained unchanged in this Version 6, which are the cloud detection and products, please see [AD 4] for a summary of the related validation methodology and results.

The version 6.3 of the IASI L2 processor adds two new products, the SO_2 partial columns and the dust index. The EUMETSAT AC SAF IASI SO2 products are retrieved with the BRECIA-SO2 library developed at ULB/LATMOS and provided within the AC SAF, who is responsible for its validation and monitoring. Specific information can be found in the dedicated papers for the SO_2 ([AD 39], [AD 40], [AD 41], [AD 42]). The dust index implements the retrieval algorithm after Clarisse et al., 2013, [AD 43]. More information on the qualification of the v6.3 can be found in the validation report of the IASI L2 processor version 6.3 [RD 18].

7.2 IASI L2Pcore SST product

First results can be found in the IASI L2 PPF V.6 surface temperature validation report [RD 16]. In addition, a validation report that focuses on the sea surface temperature has been prepared [RD 21]. This presents validation results of IASI SSTs compared to drifting buoy SSTs and colocated AVHRR SSTs. The IASI SSTs have bias below 0.1 K compared to drifting buoys, with standard deviation of ~0.3 K for the best quality classes. Three-way error statistics give these error estimations:

- IASI SSTs have an error of approximately 0.30 K
- AVHRR SSTs to have an error of approximately 0.17 K
- the error on the drifting buoy SSTs to be approximately 0.20 K

The two validation reports are available on the EUMETSAT website. See this web page:

http://www.eumetsat.int Main/DataProducts/Resources

For monitoring, the IASI L2Pcore, SSTs are collocated with the OSI-SAF Metop/AVHRR *in situ* dataset [AD 28] on a monthly basis. This multi-matchup dataset is used to analyse the biases and standard deviations of IASI SST differences compared to drifting-buoy SSTs. This ensures consistency in the results, and allows for quick identification of any problems.

The quality classification scheme of the IASI L2Pcore SST product has been updated in the verion 6.3 of the IASI L2 processor. The validation of this new quality stratification, as well as the comparaison with the previous one can be found in the validation report of the versiob 6.3 [RD 18].

8 RECORD DESCRIPTION OF THE IASI LEVEL 2 PRODUCTS

This IASI L2 description corresponds to the IASI Level 2 PFS, Version 9, [RD 4] which is PFV 11.0 and to the Generic PFS [RD 2], Version 7E.

To be able to generate the record size and offset information in the table describing the MDR record, a number of in-principle configurable parameters such as pressure levels, state vector dimension, and wavelet levels need to be set. These assumed typical values are given at the end of this section in the parameter tables. Some of these values may differ from those given in the IASI Level 2 PFS, which contains nominal maximum values. However, to correctly interpret the products the user must use the correct dimension information for the product as contained in the GIADR and other records. These are highlighted in green in the tables that follow.

Also in these product tables that follow, these colours have the following meanings:

(pale yellow)	Indicates a compound data type, which consists of at least two basic or other compound data types. The name of the compound data type is shown first, followed by a list of the items contained within it.
(yellow)	Variable product fields with dimensions defined in the GIADR
(orange)	Variable product fields with dimensions derived from the GIADR and a parameter defined in the PFS
(green)	Variable product fields with dimensions defined in the product MDR

8.1 Summary of Product Format Version record contents history

PFV = 11.0

Record name	*Record version*
mphr	2
giadr	4
mdr	4

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

8.2 Tables that follow:

- MPHR (name 'mphr', class 1, subclass 0, version 2)
- GIADR (name 'giadr', class 5, subclass 1, version 4)
- MDR (name 'mdr', class 8, subclass 1, version 4)

Certain record types with formats common to all products (IPR, DMDR, GEADR, VEADR) are not included below, since they are not relevant to the average user. If required, details of these records can be found in the Generic PFS [RD 2].

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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
RECORD_HEADER	Generic Record Header			1	1	1	1	REC_HEAD	20	20	0

Product Details

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
PRODUCT_NAME	Complete name of the product			1	1	1	1	string	67	100	20
PARENT_PRODUCT_NAME_1	Name of the parent product from which this product has been produced. For Level 0 products, this field filled with lower case x's.			1	1	1	1	string	67	100	120
PARENT_PRODUCT_NAME_2	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, field is filled with lower-case x's.			1	1	1	1	string	67	100	220
PARENT_PRODUCT_NAME_3	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, field is filled with lower case x's.			1	1	1	1	string	67	100	320
PARENT_PRODUCT_NAME_4	Name of the parent product from which this product has been produced. For Level 0 products or products for which this is not appropriate, field is filled with lower case x's.			1	1	1	1	string	67	100	420
INSTRUMENT_ID	Instrument identification			1	1	1	1	enumerated	4	37	520
INSTRUMENT_MODEL	Instrument Model identification			1	1	1	1	enumerated	3	36	557
PRODUCT_TYPE	Product Type			1	1	1	1	enumerated	3	36	593
PROCESSING_LEVEL	Processing Level Identification			1	1	1	1	enumerated	2	35	629
SPACECRAFT_ID	Spacecraft identification			1	1	1	1	enumerated	3	36	664

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
SENSING_START	UTC Time of start of sensing data in this object (PDU, ROI or Full Product)			1	1	1	1	time	15	48	700
SENSING_END	UTC Time of end of sensing data in this object (PDU, ROI or Full Product)			1	1	1	1	time	15	48	748
SENSING_START_THEORETICAL	Theoretical UTC Time of start of sensing data in the dump from which this object is derived. This data is the predicted start time at the MPF level.			1	1	1	1	time	15	48	796
SENSING_END_THEORETICAL	Theoretical UTC Time of end of sensing data in the dump from which this object is derived. This data is predicted end time at MPF level.			1	1	1	1	time	15	48	844
PROCESSING_CENTRE	Processing Centre Identification			1	1	1	1	enumerated	4	37	892
PROCESSOR_MAJOR_VERSION	Processing chain major version number			1	1	1	1	uinteger	5	38	929
PROCESSOR_MINOR_VERSION	Processing chain minor version number			1	1	1	1	uinteger	5	38	967
FORMAT_MAJOR_VERSION	Data set Format Major Version number			1	1	1	1	uinteger	5	38	1005
FORMAT_MINOR_VERSION	Data set Format Minor Version number			1	1	1	1	uinteger	5	38	1043
PROCESSING_TIME_START	UTC time of the processing at start of processing for the product			1	1	1	1	time	15	48	1081
PROCESSING_TIME_END	UTC time of the processing at end of processing for the product			1	1	1	1	time	15	48	1129
PROCESSING_MODE	Identification of the mode of processing			1	1	1	1	enumerated	1	34	1177
DISPOSITION_MODE	Identification of the disposition mode			1	1	1	1	enumerated	1	34	1211
RECEIVING_GROUND_STATION	Acquisition Station Identification			1	1	1	1	enumerated	3	36	1245

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
RECEIVE_TIME_START	UTC time of the reception at CDA for first Data Item			1	1	1	1	time	15	48	1281
RECEIVE_TIME_END	UTC time of the reception at CDA for last Data Item			1	1	1	1	time	15	48	1329
ORBIT_START	Start Orbit Number, counted incrementally since launch			1	1	1	1	uinteger	5	38	1377
ORBIT_END	Stop Orbit Number			1	1	1	1	uinteger	5	38	1415
ACTUAL_PRODUCT_SIZE	Size of the complete product		bytes	1	1	1	1	uinteger	11	44	1453

Ascending Node Orbit Parameters

Name	Description	Scaling Factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type Size	Field size	Offset
STATE_VECTOR_TIME	Epoch time (in UTC) of the orbital elements and the orbit state vector. this corresponds to the time of crossing the ascending node for ORBIT_START		UTC	1	1	1	1	longtime	18	51	1497
SEMI_MAJOR_AXIS	Semi major axis of orbit at time of the ascending node crossing.		mm	1	1	1	1	integer	11	44	1548
ECCENTRICITY	Orbit eccentricity at time of the ascending node crossing	10^6		1	1	1	1	integer	11	44	1592
INCLINATION	Orbit inclination at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1636
PERIGEE_ARGUMENT	Argument of perigee at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1680
RIGHT_ASCENSION	Right ascension at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1724
MEAN_ANOMALY	Mean anomaly at time of the ascending node crossing	10^3	deg	1	1	1	1	integer	11	44	1768
X_POSITION	X position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1812
Y_POSITION	Y position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1856
Z_POSITION	Z position of the orbit state vector in the orbit frame at ascending node	10^3	m	1	1	1	1	integer	11	44	1900
X_VELOCITY	X velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	1944
Y_VELOCITY	Y velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	1988
Z_VELOCITY	Z velocity of the orbit state vector in the orbit frame at ascending node	10^3	m/s	1	1	1	1	integer	11	44	2032

Ascending Node Orbit Parameters

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
EARTH_SUN_DISTANCE_RATIO	Earth-Sun distance ratio - ratio of current Earth-Sun distance to Mean Earth-Sun distance			1	1	1	1	integer	11	44	2076
LOCATION_TOLERANCE_RADIAL	Nadir Earth location tolerance radial		m	1	1	1	1	integer	11	44	2120
LOCATION_TOLERANCE_CROSSTRACK	Nadir Earth location tolerance cross-track		m	1	1	1	1	integer	11	44	2164
LOCATION_TOLERANCE_ALONGTRACK	Nadir Earth location tolerance along-track		m	1	1	1	1	integer	11	44	2208
YAW_ERROR	Constant Yaw attitude error	10^3	degree	1	1	1	1	integer	11	44	2252
ROLL_ERROR	Constant Roll attitude error	10^3	degree	1	1	1	1	integer	11	44	2296

LOCATION SUMMARY

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
SUBSAT_LATITUDE_START	Latitude of sub-satellite point at start of the data set	10^3	Deg	1	1	1	1	integer	11	44	2384
SUBSAT_LONGITUDE_START	Longitude of sub-satellite point at start of the data set	10^3	Deg	1	1	1	1	integer	11	44	2428
SUBSAT_LATITUDE_END	Latitude of sub-satellite point at end of the data set	10^3	Deg	1	1	1	1	integer	11	44	2472
SUBSAT_LONGITUDE_END	Longitude of sub-satellite point at end of the data set	10^3	Deg	1	1	1	1	integer	11	44	2516

LEAP SECOND INFORMATION

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
LEAP_SECOND	Occurrence of Leap second within the product. Field is set to -1, 0 or +1 dependent upon occurrence of leap second and direction.			1	1	1	1	integer	2	35	2560
LEAP_SECOND_UTC	UTC time of occurrence of the Leap Second (If no leap second in the product, value is null)			1	1	1	1	time	15	48	2595

RECORD COUNTS

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
TOTAL_RECORDS	Total count of all records in the product			1	1	1	1	uinteger	6	39	2643
TOTAL_MPHR	Total count of all MPHRs in product (should always be 1!)			1	1	1	1	uinteger	6	39	2682
TOTAL_SPHR	Total count of all SPHRs in product (should be 0 or 1 only)			1	1	1	1	uinteger	6	39	2721
TOTAL_IPR	Total count of all IPRs in the product			1	1	1	1	uinteger	6	39	2760
TOTAL_GEADR	Total count of all GEADRs in the product			1	1	1	1	uinteger	6	39	2799
TOTAL_GIADR	Total count of all GIADRs in the product			1	1	1	1	uinteger	6	39	2838
TOTAL_VEADR	Total count of all VEADRs in the product			1	1	1	1	uinteger	6	39	2877
TOTAL_VIADR	Total count of all VIADRs in the product			1	1	1	1	uinteger	6	39	2916
TOTAL_MDR	Total count of all MDRs in the product			1	1	1	1	uinteger	6	39	2955

RECORD-BASED GENERIC QUALITY FLAGS

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
COUNT_DEGRADED_INST_MDR	Count of MDRs with degradation due to instrument problems			1	1	1	1	uinteger	6	39	2994
COUNT_DEGRADED_PROC_MDR	Count of MDRs with degradation due to processing problems			1	1	1	1	uinteger	6	39	3033
COUNT_DEGRADED_INST_MDR_BLOCKS	Count of the number of blocks of MDRs degraded due to degraded instrument			1	1	1	1	uinteger	6	39	3072
COUNT_DEGRADED_PROC_MDR_BLOCKS	Count of the number of blocks of MDRs degraded due to degraded processing			1	1	1	1	uinteger	6	39	3111

TIME-BASED GENERIC QUALITY FLAGS

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
DURATION_OF_PRODUCT	The duration of the product in milliseconds		ms	1	1	1	1	uinteger	8	41	3150
MILLISECONDS_OF_DATA_PRESENT	The total amount of data present in the product		ms	1	1	1	1	uinteger	8	41	3191
MILLISECONDS_OF_DATA_MISSING	The total amount of data missing from the product		ms	1	1	1	1	uinteger	8	41	3232

REGIONAL PRODUCT INFORMATION

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Dim4*	*Type*	*Type Size*	*Field size*	*Offset*
SUBSETTED_PRODUCT	Set when product has been subset (e.g. geographically subset using a region of interest filter). Implies the presence of one or more EUMETSAT Data Centre GIADRs in GAD section for product retrieved from Data Centre.			1	1	1	1	boolean	1	34	3273
										Total:	**3307**

8.4 GIADR (name 'giadr', class 5, subclass 1, version 4)

Name	*Description*	*Scaling Factor*	*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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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 layers, defined by 2 pressure levels each, on which retrieved ozone profiles are given	2	Pa	NLO	1	1	u-integer4	4	404	831
NUM_SURFACE_EMISSIVITY_WAVELENGTHS	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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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_HNO3	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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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
									Total:	**1457**

8.5 MDR (name 'mdr', class 8, subclass 1, version 4)

Name	*Description*	*Scaling Factor*	*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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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 and up to 2 temperatures)	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 N20 (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
SURFACE_PRESSURE	Surface pressure	0	Pa	120	1	1	u-integer4	4	480	202582

INSTRUMENT

Name	Description	Scaling Factor	Units	Dim1	Dim2	Dim3	Type	Type Size	Field size	Offset
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	74302

NAVIGATION DATA AT SCAN LINE

Name	Description	Scaling Factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type Size	Field size	Offset
TIME_ALTITUDE	Time Associated with Attitude Angles		s	1	1	1	1	uinteger4	4	4	74303
ATTITUDE_ANGLES	Attitude Angles: Roll, Pitch, Yaw	10^3	degree	3	1	1	1	integer2	2	6	74307
NAVIGATION_STATUS	Navigation Status Bit Field			1	1	1	1	bitfield (4)	4	4	74313
SPACECRAFT_ALTITUDE	Spacecraft Altitude Above Reference Geoid (MSL)	1	km	1	1	1		u-integer4	4	4	74317

NAVIGATION DATA AT IFOV

Name	Description	Scaling Factor	Units	Dim1	Dim2	Dim3	Dim4	Type	Type Size	Field size	Offset
ANGULAR_RELATION	Angular relationships: solar zenith angle, satellite zenith angle, solar azimuth angle, satellite azimuth angle for 120 IFOV	2	degree	4	120	1		integer2	2	960	74321
EARTH_LOCATION	Earth Location: latitude, longitude of surface footprint (for 120 IFOV)	4	degree	2	120	1		integer4	4	960	75281

PROCESSING AND QUALITY FLAG

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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 exectued 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 manouevre	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

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
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	48720	207868
WATER_VAPOUR_ERROR	Retrieval error covariance matrix for water-vapour in principal component domain	NA	NA	NERRW	NERR	1	bitst(32)	4	20520	256588
OZONE_ERROR	Retrieval error covariance matrix for ozone in principal component domain	NA	NA	NERRO	NERR	1	bitst(32)	4	6600	277108

FORLI GENERAL

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
SURFACE_Z	Altitude of surface	0	m	120	1	1	integer2	2	240	283708

FORLI-CO

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
CO_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	283948
CO_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	284068
CO_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	284548
CO_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	284668
CO_NBR	Number of CO profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	284788
CO_CP_AIR	Air partial columns on each retrieved layer	–20	molecules/cm^2	NL_CO	CO_NBR	1	u-integer2	2	1900	284789
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	286689
CO_X_CO	Scaling vector multiplying the a-priori CO vector in order to define the retrieved CO vector.	NA	NA	NL_CO	CO_NBR	1	vu-integer2	3	2850	288589
CO_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_CO	CO_NBR	1	v-integer4	5	2500	291439
CO_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_CO	CO_NBR	1	v-integer4	5	47500	293939

FORLI- HNO3

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
HNO3_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	341439
HNO3_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	341559
HNO3_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	342039
HNO3_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	342159
HNO3_NBR	Number of HNO3 profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	342279
HNO3_CP_AIR	Air partial columns on each retrieved layer	-20	molecules/cm2	NL_HNO3	HNO3_NBR	1	u-integer2	2	0	342280
HNO3_CP_HNO3_A	A-priori partial columns for HNO3 in each retrieved layer	-11	molecules/cm2	NL_HNO3	HNO3_NBR	1	u-integer2	2	0	342280
HNO3_X_HNO3	Scaling vector multiplying the a-priori HNO3 vector in order to define the retrieved HNO3 vector.	NA	NA	NL_HNO3	HNO3_NBR	1	vu-integer2	3	0	342280
HNO3_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_HNO3	HNO3_NBR	1	v-integer4	5	0	342280
HNO3_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_HNO3	HNO3_NBR	1	v-integer4	5	0	342280

FORLI-O3

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
O3_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	342280
O3_BDIV	Retrieval flags	NA	NA	120	1	1	bitst(32)	4	480	342400
O3_NPCA	Number of vectors describing the characterization matrices	0	NA	120	1	1	u-byte	1	120	342880
O3_NFITLAYERS	Number of layers actually retrieved	0	NA	120	1	1	u-byte	1	120	343000
O3_NBR	Number of O3 profiles retrieved in scanline	0	NA	1	1	1	u-byte	1	1	343120
O3_CP_AIR	Air partial columns on each retrieved layer	–20	molecules/cm²	NL_O3	O3_NBR	1	u-integer2	2	0	343121
O3_CP_O3_A	A-priori partial columns for O3 in each retrieved layer	–14	molecules/cm²	NL_O3	O3_NBR	1	u-integer2	2	0	343121
O3_X_O3	Scaling vector multiplying the a-priori O3 vector in order to define the retrieved O3 vector.	NA	NA	NL_O3	O3_NBR	1	vu-integer2	3	0	343121
O3_H_EIGENVALUES	Main eigenvalues of the sensitivity matrix	NA	NA	NEVA_O3	O3_NBR	1	v-integer4	5	0	343121
O3_H_EIGENVECTORS	Main eigenvectors of the sensitivity matrix	NA	NA	NEVE_O3	O3_NBR	1	v-integer4	5	0	343121

BRESCIA SO2

Name	*Description*	*Scaling Factor*	*Units*	*Dim1*	*Dim2*	*Dim3*	*Type*	*Type Size*	*Field size*	*Offset*
SO2_QFLAG	General retrieval quality flag	NA	NA	120	1	1	enumerated	1	120	343121
SO2_COL_AT_ALTITUDES	SO2 column for a plume at different estimated altitudes	1	DU	NL_SO2	120	1	u-integer2	2	1200	343241
SO2_ALTITUDE	Retrieved plume altitude	0	m	120	1	1	u-integer2	2	240	344441
SO2_COL	SO2 column at the retrieved plume altitude from an OEM approach	1	DU	120	1	1	u-integer2	2	240	344681
SO2_BT_DIFFERENCE	Indicative brightness temperature difference	2	K	120	1	1	integer2	2	240	344921
									Total:	1457

8.6 Parameters Table

Parameter	*Value*	*Description*
NEW	12	Number of wavelengths for Emissivities (GIADR :: NUM_SURFACE_EMISSIVITY_WAVELENGTH)
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)
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)
NL_O3	40	Number of partial layers for O3 (GIADR :: FORLI_NUM_LAYERS_O3)
NL_SO2	5	Number of estimated SO2 plume heights (GIADR :: BRESCIA_NUM_ALTITUDES_SO2)
NPCT	28	Number of principal components for temperature in the ERROR_DATA (GIADR :: NUM_TEMPERATURE_PCS)
NPCW	18	Number of principal components for water-vapour in the ERROR_DATA (GIADR :: NUM_WATER_VAPOUR_PCS)
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)
NEVE_CO	190	Maximum number of elements in the CO sensitivity matrix eigenvectors = NEVA_CO * NL_CO
NEVA_HNO3	10	Maximum number of eigenvectors for the HNO3 sensitivity matrix = round(NL_HNO3/2)
NEVE_HNO3	190	Maximum number of elements in the HNO3 sensitivity matrix eigenvectors = NEVA_HNO3 * NL_HNO3
NEVA_O3	20	Maximum number of eigenvectors for the O3 sensitivity matrix = round(NL_O3/2)
NEVE_O3	800	Maximum number of elements in the O3 sensitivity matrix eigenvectors = NEVA_O3 * NL_O3
NERRT	406	Number of elements in the temperature error record = NPCT*(NPCT+1)/2
NERRW	171	Number of elements in the water-vapour error record = NPCW*(NPCW+1)/2
NERRO	55	Number of elements in the ozone error record = NPCO*(NPCO+1)/2
NERR	30	Number of error data records in scan line (variable per line, value provided in MDR)
CO_NBR	50	Number of CO retrievals in scan line (variable per line, value provided in MDR)
HNO3_NBR	50	Number of HNO3 retrievals in scan line (variable per line, value provided in MDR)
O3_NBR	50	Number of O3 retrievals in scan line (variable per line, value provided in MDR)

The following flags are of type enumerated, u-byte, or bit string. The types enumerated and u-byte always consist of 1 byte, while the number of bits per bit string can vary but are always a multiple of 8. The convention adopted below when numbering bits streams is to refer to the least significant bit as 1, as per the IASI Level 2 Product Generation Specification [RD 8].

Table 16 contains the size of bit strings that can be found in the IASI L2 product:

Number of Bits	*Number of Bytes*
8	1
16	2
24	3
32	4
256	32

Table 16 : IASI L2 Bit Strings

Any individual bit in the bit string may be set to zero or one. By default all bits are set to zero. In the The following tables describe the conditions under which the bits are set to 1 in the column witht he heading *Meaning*. If the size of the bit string is larger than the number of used bits, the unused bits are set to zero.

Value	*Description*
T	Testing
O	Operational
C	Commissioning

Table 17 : DISPOSITION_MODE values definition

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

Table 18 : INSTRUMENT_ID values definition

Value	*Description*
N/A	TBD

Table 19 : INSTRUMENT_MODE values definition

Value	*Description*
0	Reserved
1	Flight Model 1
2	Flight Model 2
3	Engineering Model
4	Protoflight Model

Table 20 : INSTRUMENT_MODEL values definition

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

Table 21 : PROCESSING_CENTRE values definition

Value	*Name*
00	Level 0
01	Level 1
1A	Level 1a
1B	Level 1b
1C	Level 1c
02	Level 2
03	Level 3
xx	No Specific Level

Table 22 : PROCESSING LEVEL values definition

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

Table 23 : PROCESSING MODE values definition

Value	*Description*
ENG	IASI engineering data
GAC	NOAC Global Area Coverage AVHRR data
SND	Sounding Data
SZF	ASCAT calibrated s0 data at full resolution
SZO	ASCAT calibrated s0 data at operational resolution (50 km)
SZR	ASCAT calibrated s0 data at research resolution (25 km)
VER	IASI verification data
xxx	No specific product type specified
AIP	NOAA AIP/SAIP data
TIP	NOAA TIP/STIP data
HRP	HRPT data
LRP	LRPT data

Table 24 : PRODUCT_TYPE values definition

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

Table 25 : PRODUCT_TYPE values definition

Value	*Description*
xxx	No specific spacecraft
M01	METOP 01
M02	METOP 02
M02	METOP 03
N15	NOAA-K
N16	NOAA-L
N17	NOAA-M
N18	NOAA-N
N19	NOAA-N'

Table 26 : SPACECRAFT_ID values definition

FLG_AMSUBAD	**Availability of AMSU products**	**Enumerated, 1 Byte**

Value	*Meaning*
0	The expected AMSU measurements are available, of good quality and collocated with IASI for processing.
1	AMSU-A data are available but of degraded quality (according to AMSU L1 flags or QC tests) and not used for processing.
2	No coincident (time and space) AMSU measurements available for processing.

Table 27 : AMSUBAD Flag Enumeration Key

FLG_AVHRRBAD	**Availability of AMSU products**	**Enumerated, 1 Byte**

Value	*Meaning*
0	The expected AVHRR radiance analyses are available and of good quality for processing.
1	The radiance clusters are available but of degraded quality (according to IASI L1c flags or QC tests) and not used for processing.
2	No radiance clusters available for processing.
0	The expected AVHRR radiance analyses are available and of good quality for processing.

Table 28 : AVHRRBAD Flag Enumeration Key

Bitfield: FLG_ CLDFRM	**Cloud retrieval algorithm**	**Bit string, length: 1 Byte**

Bit number and Value	*Meaning*
0 (all Bits set to 0)	No cloud products retrieved
Bit 1 = 1	Height assignment performed with NWP forecasts
Bit 2 = 1	Height assignment performed with statistical first guess retrieval
Bit 3 = 1	Cloud products retrieved with the CO_2-slicing
Bit 4 = 1	Cloud products retrieved with the χ^2 method
Bits 5-8	Spare

Table 29 : Bitfield Enumeration FLG_ CLDFRM

FLG_ CLDNES	**Cloudiness summary**	**Enumerated, 1 Byte**

Value	*Meaning*
1	The IASI IFOV is clear
2	The IASI IFOV is processed as cloud-free but small cloud contamination possible
3	The IASI IFOV is partially covered by clouds
4	High or full cloud coverage

Table 30 : CLDNES Enumeration Key

Bitfield: FLG_CLDTST	**Details of cloud tests executed and results**	**Bit string, length: 2 Bytes**

Bit number and Value	*Meaning*
0 (all Bits set to 0)	No cloud products retrieved
Bit 1 = 1	IASI NWP cloud test executed
Bit 2 = 1	IASI NWP cloud test indicates a cloud
Bit 3 = 1	AMSU cloud test executed
Bit 4 = 1	AMSU cloud test indicates a cloud
Bit 5 = 1	AVHRR integrated cloud fraction assessed
Bit 6 = 1	AVHRR integrated cloud fraction indicates a cloud
Bit 7 = 1	IASI-AVHRR ANN cloud test executed
Bit 8 = 1	IASI-AVHRR ANN cloud test indicates a cloud
Bit 9 = 1	AVHRR heterogeneity test executed
Bit 10 = 1	AVHRR heterogeneity test indicates a cloud
Bit 11 = 1	IASI cloud optical thickness computed
Bit 12 = 1	IASI cloud optical thickness indicates a cloud
Bit 13 = 1	Spare
Bit 14 = 1	Spare
Bit 15 = 1	Spare
Bit 16 = 1	Spare

Table 31 : Bitfield Enumeration FLG_ CLDTST

FLG_DAYNIT	**Day-Night**	**Enumerated, 1 Byte**

Value	*Meaning*
0	Day
1	Night
2	Twilight

Table 32 : FLG_DAYNIT Enumeration Key

FLG_ DUSTCLD	**Aerosol Dust Detection**	**u-byte, SF=1, 1 Byte**

Value	*Meaning*
255	Unavailable
$[0\ 254] \xrightarrow{SF=1} [0.0\ 25.4]$	Dust index value (scale factor = 1)

Table 33 : FLG_DUSTCLD Enumeration Key

Note: The field `FLG_DUSTCLD` contains a unitless indicator providing a pseudo-quantitative information of the dust load in the IASI pixels. The values typically range between 0 and 10, can reach higher values in exceptional dust outbreaks. The presence of dust is suspected when the index in greater than about 2. This parameter can take decimal values between 0 and 25.4 and is therefore defined as an unsigned byte with a scale factor equal to 1.

Bitfield: FLG_FGCHECK	**Validity check of the first guess**	**Bit string, length: 2 Bytes**

Bit number and Value	*Meaning*
0 (all Bits set to 0)	Retrieved values are within valid bounds
Bit 1 = 1	Temperature profile is out of valid bounds
Bit 2 = 1	Water-vapour profile is out of valid bounds
Bit 3 = 1	Ozone profile is out of valid bounds
Bit 4 = 1	Surface temperature is out of valid bounds
Bit 5 = 1	Surface emissivity is out of valid bounds
Bit 6 = 1	CO concentration is out of valid bounds
Bit 7 = 1	N_2O concentration is out of valid bounds
Bit 8 = 1	CH_4 concentration is out of valid bounds
Bit 9 = 1	CO_2 concentration is out of valid bounds
Bit 10 = 1	Spare
Bit 11 = 1	Spare
Bit 12 = 1	Spare
Bit 13 = 1	Spare
Bit 14 = 1	Spare
Bit 15 = 1	Spare
Bit 16 = 1	Spare

Table 34 : Bitfield Enumeration FLG_FGCHECK

FLG_IASIBAD	**Availability/Quality of IASI products**	**Enumerated, 1 Byte**

Value	*Meaning*
0	The IASI measurements and side information are available and of good quality for L2 processing
1	The IASI L1c products are of degraded quality according to IASI L1c flags, no L2 processing.
2	Quality control indicates that the IASI L1c data are of degraded quality (not indicated by the IASI L1c flags), no L2 processing.

Table 35 : FLG_IASIBAD Enumeration Key

Bitfield: FLG_INITIA	**Initialisation of the OEM and results**	**Bit string, length: 1 Bytes**

Bit number and Value	*Meaning*
0 (all Bits set to 0)	Default value, no OEM attempted
Bit 1 = 1	IASI included
Bit 2 = 1	AMSU included
Bit 3 = 1	MHS included
Bit 4-8	Spare

Table 36 : Bitfield Enumeration FLG_INITIA

FLG_ITCONV	OEM attempts, convergence and acceptance status	Enumerated, 1 Byte

Value	*Meaning*
0	OEM not attempted
1	OEM aborted because first guess residuals too high
2	The minimisation did not converge, sounding rejected
3	The minimisation did not converge, sounding accepted
4	The minimisation converged but sounding rejected
5	The minimisation converged, sounding accepted

Table 37 : FLG_ITCONV Enumeration Key

FLG_LANSEA	Surface type	Enumerated, 1 Byte

Value	*Meaning*
0	The IASI IFOV is completely covered by water
1	The IASI IFOV is completely covered by land, the variability of the surface topography is low
2	The IASI IFOV is completely covered by land, the variability of the surface topography is high
3	The IASI IFOV covers land and water, the variability of the surface topography is low
4	The IASI IFOV covers land and water, the variability of the surface topography is high
5	The IASI IFOV contains sea-ice

Table 38 : FLG_LANSEA Enumeration Key

FLG_MHSBAD	Availability of MHS products	Enumerated, 1 Byte

Value	*Meaning*
0	The expected MHS measurements are available, of good quality and collocated with IASI for processing.
1	MHS data are available but of degraded quality (according to MHS L1 flags or QC tests) and not used for processing.
2	No coincident (time and space) MHS measurements available for processing.

Table 39 : FLG_MHSBAD Enumeration Key

FLG_FLG_NUMIT	Number of iterations	Enumerated, 1 Byte

Value	*Meaning*
0	No iterations
N	Number of iterations

Table 40 : FLG_NUMIT Enumeration Key

FLG_NWPBAD	**Availability of MHS products**	**Enumerated, 1 Byte**

Value	*Meaning*
0	The expected NWP forecasts are available, of good quality and collocated with IASI for processing.
1	The expected NWP forecasts are available but of suspect quality, not used for processing.
2	No coincident NWP forecasts available for processing.

Table 41 : FLG_NWPBAD Enumeration Key

Bitfield: FLG_PHYSCHECK	**Check for physical supersaturation and superadiabiatic conditions**	**Bit string, length: 1 Bytes**

Bit number and Value	*Meaning*
0 (all Bits set to 0)	No superadiabatic or supersaturation found
Bit 1 = 1	Superadiabatic conditions in the first guess
Bit 2 = 1	Supersaturation conditions in the first guess
Bit 3 = 1	Superadiabatic conditions in the OEM retrieval
Bit 4 = 1	Supersaturation conditions in the OEM retrieval
Bit 5-8	Spare

Table 42 : Bitfield Enumeration FLG_PHYSCHECK

Bitfield: FLG_RETCHECK	**Validity check of the final geophysical retrieved parameters**	**Enumerated, 1 Byte**

Value	*Meaning*
0 (all Bits set to 0)	Retrieved values are within valid bounds
Bit 1 = 1	Temperature profile is out of valid bounds
Bit 2 = 1	Water-vapour profile is out of valid bounds
Bit 3 = 1	Ozone profile is out of valid bounds
Bit 4 = 1	Surface temperature is out of valid bounds
Bit 5 = 1	Surface emissivity is out of valid bounds
Bit 6 = 1	CO concentration is out of valid bounds
Bit 7 = 1	N2O concentration is out of valid bounds
Bit 8 = 1	CH4 concentration is out of valid bounds
Bit 9 = 1	CO2 concentration is out of valid bounds
Bit 10 = 1	Spare
Bit 11 = 1	Spare
Bit 12 = 1	Spare
Bit 13 = 1	Spare
Bit 14 = 1	Spare
Bit 15 = 1	Spare
Bit 16 = 1	Spare

Table 43 : FLG_RETCHECK Enumeration Key

FLG_ SATMAN **Indication of satellite manoeuvre** **Enumerated, 1 Byte**

Value	*Meaning*
0	The platform is not undergoing a manoeuvre
1	The platform is undergoing a manoeuvre, nominal processing
2	The platform is undergoing a manoeuvre, no processing

Table 44: FLG_SATMAN Enumeration Key

FLG_SUNGLNT **Identification of sun glint** **Enumerated, 1 Byte**

Value	*Meaning*
0	No sun glint
1	IASI observes sun glint

Table 45 : FLG_SUNGLNT Enumeration Key

FLG_THICIR **Thin cirrus cloud test** **Enumerated, 1 Byte**

Value	*Meaning*
0	No thin cirrus detected
1	Thin cirrus detected
2	Test failed or not executed

Table 46 : FLG_THICIR Enumeration Key

APPENDIX A: DOCUMENT CHANGE RECORD EXTENDED

Issue / Revision	Date	Section	Changed Pages / Paragraphs
v1	17/12/2004	Section 2 Section 3 Sections 4 and 8 Sections 6.2 – 6.6 Appendix B Appendix F General	Update to reflect start of Metop/IASI-L2: Additional references RD10, 25, 26, 74-79. Deleted reference RD59 which duplicates RD58. Configuration history added. Minor text additions and corrections. Additional dissemination details. Updates to sentences for Level 1c & Level 2. - GIADR table: Field sizes for PRESSURE_LEVELS_OZONE and SURFACE_EMISSIVITY_WAVELENGTHS corrected, affecting offsets and total record size. - MDR table: Updates to several values for scaling factor, dimensions, field size affecting ATMOSPHERIC_OZONE, INTEGRATED_OZONE, INEGRATED_N2O, INTEGRATED_CH4, SURFACE_EMISSIVITY, DATA_SIZES; also offsets and total record size corrected. Other general layout improvements and typo corrections.
V2A	12/11/2008	Section 4	New section 4.3.2 inserted “Vertical resolution of the temperature and humidity profiles”.
V2B	07/04/2009	Full document Section 3 Section 5.1 Section 6.5 Section 10 General	Document restructured – App. F & G renamed as Sec. 10 & 11, and common appendices removed to keep as separate document. Configuration history tables updated. EPSView description replaced by text on available generic tools. Table 6-7: Added lists of BUFR descriptor sequences. - Updates to Field Size and Offset values in GIADR & MDR to correspond to adopted default values of parameters NEW & NLO. Explanatory paragraph added near start of section. - Description of MDR.CLOUD_PHASE updated to include value 255. - Descriptions in NAVIGATION_STATUS bitfield updated to correspond with those in PFS. Various minor editorial updates, correction of typos and hyperlinks.

Issue / Revision	***Date***	***Section***	***Changed Pages / Paragraphs***
V2C	03/12/2010	Section 2 Section 3 Section 4 Section 8 Section 9.3 (now) General	Most of the updates relate to release of new PPF software version 5.1. Added references RD27 to RD31. Configuration History table updates including new PPF s/w versions. Sec. 4.2.2.2: Fewer cloud detection tests. Sec. 4.2.2.3: Simplified determination of cloud top height and fractional cloud cover. New section 4.2.3.5 "Temperature & water vapour profiles" – additional retrievals result in availability of temperature profiles for >50% of field of view where previously only 10-12%. Sec. 4.3.2: Clarification of cloudiness flags. Merged with Section 9 and introduced the four Product Validation Reports applicable to 'Day 2' operations. Added note on bit numbering convention used (different from IASI-L2 PGS). Updates to descriptions for FLG_IASICLR, FLG_CLDTST and FLG_IASICLD. Other minor textual and hyperlink updates.
V2D		Section 1 Section 2 Section 3 Section 4 Section 5 Section 6 Section 8	L2Pcore GHRSST updates: Added text. Added references RD32, 33, 42, 80-85. Configuration History – new PPF s/w version 5.1.1. New Sec. 4.2.4 & 4.4. New Sec. 5.3. New Sec. 6.2.3 & 6.6. Table 6-1 additions. New Sec. 8.2.
V2E	25/03/2011		New section. Not included in v2D).
V2F	20/10/2011		• Added table giving the IASI L2P Core SST Single Sensor Error Statistics updates. • New version of IASI L2 PPF- V5.2.1.
V2G	19/07/2012		Updates to Table 3-2 and Table 3-3
V3B	19/04/14	all	Update for version 6
V3D	12/06/17	Section 1 Section 2 Section 3 Section 5 Section 7 Section 8	Update for the version 6.3