

***Migration guide: Local EUMETSAT descriptors
to WMO descriptors for IASI Level 2 BUFR
products***

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Document Change Record

Version	Date of Version	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
v1	1 Aug 2018		Initial release of document.
v1A	21 Nov 2018		Sections 2, 2.2 (Table 6), 3.6 (including Table 14): Update migration schedule for incorrect global descriptor updated to reflect implementation changes.

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1 INTRODUCTION

1.1 Purpose

EUMETSAT has used local descriptors to encode IASI Level 2 products in BUFR for many years. This required users of these data to modify configuration items in order to process them. At the second meeting of the WMO Inter-Programme Expert Team on Codes Maintenance, new entries to WMO Manual on Codes [AD-1] were accepted which obviate the need for these local descriptors, and thus the need for non-standard configuration of BUFR decoding software.

This document describes the changes which were implemented and provides guidance for interpreting products which have been updated to use the new descriptors.

1.2 Scope

This document is intended for users of IASI Level 2 BUFR products, as well as software developers and maintainers who are responsible for ensuring that their systems can be used to interpret these products as they are migrated to use the new descriptors. It is of special interest to climate users, who want to ensure continuity of data series which encompass both the old and new ways of encoding these products.

1.3 Applicable Documents

Table 1: List of applicable documents

AD-1	Manual on Codes	WMO-No. 306
AD-2	Latest tables extracted from the Manual on Codes, Volume I.2	Link

1.4 Reference Documents

Table 2: List of reference documents

RD-1	Local BUFR Descriptors for IASI Level 2 Data	EUM/OPS/TEN/07/2410 v4B
RD-2	Product User Manual: Near real-time IASI CO	SAF/O3M/ULB/PUM/001 v1B
RD-3	Product User Manual: Near real-time IASI Brescia SO2	SAF/AC/ULB/PUM/002 v1
RD-4	BUFR descriptors for IASI Level 2 products	EUM/TSS/TEN/17/944272 v1B
RD-5	Validation report: BUFR descriptors for IASI Level 2 products	EUM/SEP/TEN/18/1002370 v1
RD-6	Second meeting of the Inter-Programme Expert Team on Codes Maintenance (IPET-CM-II): Summary	Link
RD-7	IASI Level 2: Product Guide	EUM/OPS-EPS/MAN/04/0033 v3E
RD-8	IASI Level 2: Product Format Specification	EPS.MIS.SPE.980760 v9B

1.5 Document Structure

Section 1 General information (this section)

Section 2 Overview of the motivation and effects of the migration to new descriptors

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Chapter 3 Specific migration guides from each local descriptor to a WMO descriptor

1.6 Acronyms

Table 3: List of acronyms

Acronym	Description
AMSU-A	Advanced Microwave Sounding Unit-A (a 15-channel radiometer for temperature soundings flown in polar orbit)
BUFR	Binary Universal Form for the Representation of meteorological data
EUMETSAT	European Organisation For the Exploitation of Meteorological Satellites
FORLI	Fast Optimal Retrievals on Layers for IASI
IASI	Infrared Atmospheric Sounding Interferometer
IASI-NG	IASI – New Generation
IPET-CM	Inter-Programme Expert Team on Codes Maintenance (WMO team)
MHS	Microwave Humidity Sounder
NWP	Numerical Weather Prediction
PWLR	Piece-Wise Linear Regression-cube
SI	Système international (d'unités), International System of Units
WMO	World Meteorological Organization

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2 USE OF LOCAL DESCRIPTORS IN EUMETSAT BUFR DATA PRODUCTS

Since the beginning of dissemination of IASI Level 2 data, EUMETSAT has encoded certain variables in BUFR products using local descriptors. Tables capable of processing these descriptors therefore had to be owned and maintained by any users wishing to interpret these products. The absence of such locally maintained tables could cause software used to process IASI Level 2 products encoded in BUFR to fail. The local descriptors used in IASI Level 2 data are detailed in [RD-1], [RD-2], and [RD-3].

Since BUFR Master Table Version 31 [AD-2], descriptors corresponding to the EUMETSAT local descriptors are available in the WMO sections of the BUFR tables. EUMETSAT products using Master Table Version 31 and above no longer use local descriptors. Instead, WMO descriptors are used. This reduces the number of local changes to configuration items on users' systems required in order to be able to process these products. It also reduces potential confusion for new users of the products.

Additionally, users should note that EUMETSAT BUFR products using WMO Master Table Versions up to Version 21 used an incorrect version global descriptor. Since migrating to BUFR Master Table Version 21, this issue has been corrected.

2.1 Affected products

The products listed in Table 4 have used local descriptors in the past and are thus affected by the migration to WMO descriptors.

Table 4: Products affected by the migration. Product names are linked to their reference in the EUMETSAT Product Navigator.

Product name	Example filename
IASI Cloud Parameters	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_clp_l2.bin
IASI Carbon Monoxide Profiles FORLI-CO	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_cox_l2.bin
IASI Surface Emissivity	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_ems_l2.bin
IASI Atmospheric Temperature Water Vapour and Surface Skin Temperature Error Estimate	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_err_l2.bin
IASI Ozone	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_ozo_l2.bin
IASI Sulphur dioxide	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_so2_l2.bin
IASI Trace Gases	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_trg_l2.bin

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IASI Atmospheric Temperature Water Vapour and Surface Skin Temperature	W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+IASI_C_EUMP_20180528120256_29533_eps_o_twt_l2.bin
--	---

It is possible to recognise if products have been migrated or not by the Master Table Version indicated in the BUFR product's Identification Section (Section 1). Further guidance on locating metadata within products encoded in BUFR can be found in [AD-1].

2.2 Migrated descriptors

Local BUFR descriptors which were used by EUMETSAT are listed in Table 5. For some of these descriptors, a straightforward relationship between the newer WMO descriptors exists. For others, the migration is not simply a transition to a new descriptor number, but also to a new way of representing the data in question. A specific section has been devoted to each type of migration.

Table 5: Local BUFR Table B entries used in EUMETSAT BUFR products, local table version 1, and the section of this document which details their migration to WMO descriptors

Descriptor	Name	Described in
0-10-220	Pressure (high precision)	Section 3.5
0-12-222	Retrieval error for temperature	Section 3.4
0-13-222	Retrieval error for water vapour	Section 3.4
0-15-222	Retrieval error for ozone	Section 3.2
0-40-197	Satellite manoeuvre indicator	Section 3.1
0-40-199	Integrated N2O density	Section 3.5
0-40-200	Integrated CO density	Section 3.5
0-40-201	Integrated CH4 density	Section 3.5
0-40-202	Integrated CO2 density	Section 3.5
0-40-216	General retrieval quality flag for SO2	Section 3.3
0-40-217	Dust Index	Section 3.1
0-40-220	Quality indicator for atmospheric temperature	Section 3.1
0-40-221	Quality indicator for atmospheric water vapour	Section 3.1
0-40-222	Quality indicator for atmospheric ozone	Section 3.2
0-40-223	Quality indicator for surface temperature	Section 3.4
0-40-230	Cloud formation and height assignment	Section 3.1
0-40-231	Cloudiness summary	Section 3.3
0-40-232	Validation flag for IASI level 1 product	Section 3.2
0-40-233	Validation flag of AMSU-A level 1 data flow	Section 3.1
0-40-234	Cloud tests executed and results	Section 3.1
0-40-235	Retrieval initialisation	Section 3.1
0-40-236	Convergence of the iterative retrieval	Section 3.1
0-40-237	Validation flag of MHS level 1 data flow	Section 3.5
0-40-238	Validation flag of NWP forecast	Section 3.5
0-40-239	Indication of super-adiabatic and super-saturation in final retrieval	Section 3.1
0-40-240	Number of iterations used for retrieval	Section 3.1

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<i>Descriptor</i>	<i>Name</i>	<i>Described in</i>
0-40-242	General retrieval quality flag	Section 3.1
0-40-243	IASI CO retrieval flags	Section 3.3
0-40-244	Number of vectors describing the characterization matrices	Section 3.1
0-40-245	Number of layers actually retrieved	Section 3.1
0-40-246	Number of CO profiles retrieved in scanline	Section 3.1
0-40-247	Air partial columns on each retrieved layer	Section 3.4
0-40-248	A-priori partial columns for CO on each retrieved layer	Section 3.4
0-40-249	Scaling vector multiplying the a priori CO vector in order to define the retrieved CO vector	Section 3.1
0-40-250	Main eigenvalues of the sensitivity matrix	Section 3.1
0-40-251	Main eigenvectors of the sensitivity matrix	Section 3.1
0-40-252	Retrieval flags part 1 processing and inputs potential errors	Section 3.2
0-40-253	Retrieval flags part 2 diagnostics on the retrieval	Section 3.2

Incorrect global BUFR descriptors which were used by EUMETSAT are listed in Table 5. This issue affects all pertinent BUFR using the descriptor listed in Table 6 and encoded using Master Table Versions 0-20. BUFR products encoded using Master Table Version 21 and above match the definition in [AD-1].

Table 6: Global BUFR Table B entries used improperly in EUMETSAT BUFR products up to Master Table Version 21, and the section of this document which details their migration to the correct WMO descriptors

<i>Descriptor</i>	<i>Name</i>	<i>Described in</i>
0-15-045	Sulphur dioxide	Section 3.6

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3 MIGRATIONS TO NEW DESCRIPTORS

Local descriptors were converted into WMO descriptors via one of the following mechanisms, ordered by increasing level of impact:

1. **Identical new descriptors.** This is the most straightforward case; name, units, scale, reference, and width of the descriptor remain identical, but a new descriptor number is allocated in the WMO domain of BUFR Table B in [AD-1].
2. **Similar descriptors with new names.** In this case, units, scale, reference, and width of the descriptor remain identical, but the name has been changed in order to add clarity.
3. **Descriptors with different value numberings.** In this case, the numbering in a code or flag table associated with a descriptor has changed in order to conform to WMO conventions. A software change might be necessary for interpretation, depending on how it is implemented.
4. **Descriptors with unit changes.** In this case, at least the units of the new descriptor differ from those of the old descriptor, possibly requiring a change to software which interprets affected products.
5. **Descriptors with differing representation in WMO tables.** In this case, the local descriptors are expressed differently than in [AD-1]. This might mean that a single local descriptor is replaced by multiple WMO descriptors to achieve the same semantic effect using a more generic notation. It is likely that a software change is necessary in order to interpret the migrated product.

Additionally, as described in Section 2.2, a WMO descriptor was used whose definition at EUMETSAT deviated from that found in [AD-1]. This is a case of a **global descriptor with different attributes than in WMO tables**, and is described in a dedicated section below.

3.1 Identical new descriptors

The local descriptors described in Table 5 are identical to their counterpart WMO descriptors in all aspects except for the descriptor number which is allocated for them.

Table 7: Local BUFR Table B entries used in EUMETSAT BUFR products, local table version 1, and their identical counterpart WMO descriptors

<i>Local descriptor</i>	<i>WMO descriptor</i>	<i>Name</i>
0-40-197	0-40-043	Satellite manoeuvre indicator
0-40-217	0-40-044	Dust index
0-40-220	0-40-067	Quality indicator for atmospheric temperature
0-40-221	0-40-066	Quality indicator for atmospheric water vapour
0-40-230	0-40-045	Cloud formation and height assignment
0-40-233	0-40-048	Validation flag of AMSU-A level 1 data flow
0-40-234	0-40-049	Cloud tests executed and results
0-40-235	0-40-050	Retrieval initialisation
0-40-236	0-40-051	Convergence of the iterative retrieval
0-40-239	0-40-052	Indication of super-adiabatic and super-saturation in final retrieval
0-40-240	0-40-053	Number of iterations used for retrieval
0-40-242	0-40-056	General retrieval quality flag

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<i>Local descriptor</i>	<i>WMO descriptor</i>	<i>Name</i>
0-40-244	0-40-058	Number of vectors describing the characterization matrices
0-40-245	0-40-059	Number of layers actually retrieved
0-40-246	0-40-060	Number of profiles retrieved in scanline
0-40-249	0-40-063	Scaling vector multiplying the a priori CO vector in order to define the retrieved CO vector
0-40-250	0-40-064	Main eigenvalues of the sensitivity matrix
0-40-251	0-40-065	Main eigenvectors of the sensitivity matrix

3.2 Similar descriptors with new names

Some of the entry names described in Table 8 have been updated to add clarity based on information which can be found in [RD-7], Section 3.2.2 and [RD-8], Section 3.5.4. Other names have been updated in order to make the descriptors more generic. This is intended to make it possible to reuse the same entries for IASI-NG products.

Table 8: Local BUFR Table B entries used in EUMETSAT BUFR products, local table version 1, and their renamed counterpart WMO descriptors

<i>Local descriptor</i>	<i>Local name</i>	<i>WMO descriptor</i>	<i>WMO name</i>
0-15-222	Retrieval error for ozone	0-40-071	Retrieval error covariance matrix for ozone in principal component domain
0-40-222	Quality indicator for atmospheric ozone	0-40-072	PWLR estimated retrieval quality indicator of atmospheric ozone
0-40-232	Validation flag for IASI Level 1 product	0-40-047	Validation flag for IASI or IASI-NG level 1 product
0-40-252	Retrieval flags part 1 processing and inputs potential errors	0-40-054	Potential processing and inputs errors
0-40-253	Retrieval flags part 2 diagnostics on the retrieval	0-40-055	Diagnostics on the retrieval

3.3 Descriptors with different value numberings

The EUMETSAT local descriptor 0-40-243 (Retrieval flags) has been replaced by WMO descriptor 0-40-057 (IASI Level 2 retrieval flags). Although all entries from the original table are preserved, the bits have been reassigned, as shown in Table 9. For further information on this descriptor, see [RD-2], Table 3.

Table 9: Local BUFR Table B flag table entries used in EUMETSAT BUFR products, local table version 1, descriptor 0-40-243 (Retrieval flags), and their counterpart WMO entries in 0-40-057 (IASI level 2 retrieval flags)

<i>Local bit no.</i>	<i>WMO bit no.</i>	<i>Description</i>
0	1	An error has been detected
1	2	Message from L1
2	3	Message from L2
3	4	Message from ancillary data
4	5	Message from fitting procedure

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<i>Local bit no.</i>	<i>WMO bit no.</i>	<i>Description</i>
	6	Reserved
8	7	Bad L1 or L2 flag raised
9	8	Level 2 not fully trusted
10	9	Missing temperature or humidity levels in the vertical profile
11	10	Missing surface pressure value
12	11	Radiance filtering
13	12	Polar regions
14	13	Location in the night
15	14	Negative altitude
16	15	Cloud covered scene
17	16	Scene above the sea
18	17	Scene above desert
19	18	Missing skin temperature
20	19	Retrieved skin temperature too different from model
21	20	Spectral line contrast too weak
22	21	Maximum number of iterations exceeds
23	22	Negative partial columns
24	23	Matrix ill conditioned
25	24	Fit diverged
26	25	Error in GSL usage
27	26	Residuals biased
28	27	Residuals sloped
29	28	Residuals RMS large
30	29	Weird averaging kernels
31	30	Ice presence detected
	All 31	Missing

The EUMETSAT local descriptor 0-40-216 (General retrieval quality flag for SO₂) has been replaced by WMO descriptor 0-40-068 (General retrieval quality flag for SO₂). Although all entries from the original table are preserved, the code figures have been reassigned, as shown in Table 10. For further information on this descriptor, see [RD-3], Table 2.

Table 10: Local BUFR Table B code table entries used in EUMETSAT BUFR products, local table version 1, descriptor 0-40-216 (General retrieval quality flag for SO₂), and their counterpart WMO entries in 0-40-068 (General retrieval quality flag for SO₂)

<i>Local bit no.</i>	<i>bit</i>	<i>WMO bit no.</i>	<i>Description</i>
9		0	Values calculated with IASI L2
11		1	Pressure and temperature profiles missing in IASI L2 data; model / forecast data used instead
		2	Best quality
		3-14	Reserved
0		15	Missing value

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The EUMETSAT local descriptor 0-40-231 (Cloudiness summary) has been replaced by WMO descriptor 0-40-046 (Cloudiness summary): Although all entries from the original table are preserved, the code figures have been reassigned, as shown in Table 11.

Table 11: Local BUFR Table B code table entries used in EUMETSAT BUFR products, local table version 1, descriptor 0-40-231 (Cloudiness summary), and their counterpart WMO entries in 0-40-046 (Cloudiness summary)

Local bit no.	WMO bit no.	Description
1	0	The IASI IFOV is clear
2	1	Small cloud contamination possible
3	2	The IASI IFOV is partially covered by clouds
4	3	High or full cloud coverage
5-6	4-6	Reserved
7	7	Missing value

3.4 Descriptors with unit changes

The local descriptors listed in Table 12 use different units than their counterpart WMO descriptors in order to more precisely describe the quantity in question, or in order to use SI units. Note that in some cases the scale factors have changed as well; this is noted where relevant.

Table 12: Local BUFR Table B entries used in EUMETSAT BUFR products, local table version 1, and their counterpart WMO descriptors which use different units

Local descriptor	Local name	Local units	Local scale	WMO descriptor	WMO name	WMO units	WMO scale
0-12-222	Retrieval error for temperature	Numeric		0-40-069	PWLR estimated retrieval error for surface air temperature	K	
0-13-222	Retrieval error for water vapour	Numeric		0-40-070	PWLR estimated retrieval error of surface dew point	K	
0-40-223	Quality indicator for surface temperature	Numeric		0-40-073	PWLR estimated retrieval error of surface skin temperature	K	
0-40-247	Air partial columns on each retrieved layer	molecules / cm ²	-20	0-40-061	Air partial columns on each retrieved layer	moles / cm ²	3
0-40-248	A-priori partial columns for CO on each retrieved layer	molecules / cm ²	-13	0-40-062	A-priori partial columns for CO on each retrieved layer	moles / cm ²	10

3.5 Descriptors with differing representation in WMO tables

Some EUMETSAT local descriptors have been replaced by using formulations which do not require the use of local descriptors. These are described in Table 13.

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Table 13: Representation of values formerly described using EUMETSAT local descriptors which have been replaced by using multiple WMO descriptors

<i>Local representation</i>	<i>Representation using WMO descriptors</i>
0-10-220 (Pressure (high precision))	2-01-134 (Add 6 bits to width of following descriptors) 0-10-004 (Pressure) 2-01-000 (Cancel increase in bit width)
0-40-199 (Integrated N2O density)	0-07-002 (Height or altitude), set to minimum possible value 0-07-002 (Height or altitude), set to maximum possible value 0-08-043 (Atmospheric chemical or physical constituent type), set to 6 (N2O) 0-15-021 (Integrated mass density)
0-40-200 (Integrated CO density)	0-07-002 (Height or altitude), set to minimum possible value 0-07-002 (Height or altitude), set to maximum possible value 0-08-043 (Atmospheric chemical or physical constituent type), set to 4 (CO) 0-15-021 (Integrated mass density)
0-40-201 (Integrated CH4 density)	0-07-002 (Height or altitude), set to minimum possible value 0-07-002 (Height or altitude), set to maximum possible value 0-08-043 (Atmospheric chemical or physical constituent type), set to 2 (CH4) 0-15-021 (Integrated mass density)
0-40-202 (Integrated CO2 density)	0-07-002 (Height or altitude), set to minimum possible value 0-07-002 (Height or altitude), set to maximum possible value 0-08-043 (Atmospheric chemical or physical constituent type), set to 3 (CO2) 0-15-021 (Integrated mass density)
0-40-237 (Validation flag of MHS level 1 data flow)	2-04-004 (add associated field with 4 bits) 0-31-021 (Associated field significance), set to 9 (Status of ancillary data) 0-02-019 (Satellite instruments), set to 203 (MHS). <i>Note: The encoding software precedes this value with the appropriate quality information.</i> 2-04-000 (cancel associated field)
0-40-238 (Validation flag of NWP forecast)	2-04-004 (add associated field with 4 bits) 0-31-021 (Associated field significance), set to 9 (Status of ancillary data) 0-01-030 (Numerical model identifier), set to "NWP forecast". <i>Note: The encoding software precedes this value with the appropriate quality information.</i> 2-04-000 (cancel associated field)

3.6 Global descriptor with different attributes than in WMO tables

Until migration to WMO Master Table Version 21, an incorrect version of a WMO descriptor was used, as described in Table 14. BUFR products encoded using Master Table Version 21 and above match the definition in [AD-1].

Migration guide: Local EUMETSAT descriptors to WMO descriptors for IASI Level 2 BUFR products***This Document is Public******Table 14: Incorrect descriptor 0-15-045 used in EUMETSAT BUFR products encoded with Master Table Versions 0-20, next to the correct values provided by WMO.***

<i>Descriptor</i>	<i>Name</i>	<i>Units</i>	<i>Local scale</i>	<i>WMO scale</i>	<i>Local reference</i>	<i>WMO reference</i>	<i>Local width</i>	<i>WMO width</i>
0-15-045	Sulphur dioxide	DU	0	2	0	-2000	10	15