TN7.3

ADM-Aeolus Level-2B BUFR description

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CHANGE LOG

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1 Introduction

This document defines the WMO approved BUFR (Binary Universal Form for the Representation of meteorological data) format of ADM-Aeolus L2B wind product. It is part of a CCN5 workpackage 2380 (L2B EE to BUFR converter) from ESA Contract No: 4200018555/04/NL/MM Development and Production of Aeolus Wind Data Products (see [AD1]). This WP was to provide data handling software to link the output of the L2B processing, provided in Earth Explorer (EE) format, to an operational NWP system as required for data assimilation of (H)LOS winds. The BUFR template part of the document was used as the basis of a submission for a WMO (World Meteorological Organization) approval of the BUFR representation of the L2B product. The L2B BUFR template has since been approved by WMO. This BUFR template differs from that suggested for the L2B format many years ago in [RD1] which is now considered obsolete (that document also considered the L1B BUFR representation, which is not considered in this document).

1.1 Documents

1.1.1 Applicable documents

	Title	Ref	Ver.	Date
[AD1]	Change Request No: 5, Aeolus Level 2B/C Enhancements and Launch Extension of ESA Contract No: 4200018555/04/NL/MM Development and Production of Aeolus Wind Data Products		1.1	24/01/2014

1.1.2 Reference documents

	Title	Ref	Ver.	Date
[RD1]	WMO FM94 (BUFR) description ADM-Aeolus L1B/L2B products	AE-TN-ECMWFL2BP-0072-TEMPLATE	1.31	12/04/2011
[RD2]	L2B/L2C Processor Input/Output Data Definition	AE-IF-ECMWF-L2BP-001	2.20	Mar 2015

1.2 Acronyms

ADM	Atmospheric Dynamics Mission
ALADIN	Atmospheric Laser Doppler Instrument
BRC	Basic Repeat Cycle
BUFR	Binary Universal Form for the Representation of meteorological data
CCN	Contract Change Note
CGMS	Coordination Group for Meteorological Satellites
CM	Continuous mode
CREX	Character form for the Representation and EXchange of data
DWL	Doppler Wind Lidar
ECMWF	European Centre for Medium-Range Weather Forecasts
EE	Earth Explorer
ESTEC	European Space Research and Technology Centre (part of ESA)
HLOS	Horizontal Line Of Sight
IODD	Processor Input/Output Data Definitions Interface Control Document
KNMI	Royal Netherlands Meteorological Institute
LOS	Line of sight
L1B	Level-1B
L2B	Level-2B
L2Bp	L2B processor
N/A	Not applicable
NWP	Numerical weather prediction
TBD	To be determined
TN	Technical note
WMO	World Meteorological Organization
WP	Work package

2 The new L2B BUFR template and its approval by WMO

ECMWF is responsible for the operational implementation of the L2 meteorological processing facility (L2/Met PF) for the Atmospheric Dynamics Mission Aeolus (ADM-Aeolus). This is the first space mission to acquire profiles of wind on a global scale with the Atmospheric Laser Doppler Instrument (ALADIN); a type of Doppler wind lidar (DWL). In the context of this activity ECMWF has developed, in collaboration with KNMI, a new BUFR sequence for level 2B data which are of interest for the data assimilation in NWP models.

Following interactions and many iterations between Jos de Kloe (KNMI, who created the drafts of the CM L2B BUFR template and L2B EE-to-BUFR converter tool), Enrico Fucile (ECMWF forecast department observations team leader), Michael Rennie (ECMWF, research department) and Dave Offiler (Met Office, Satellite Applications), a proposed template for assessment by WMO was produced.

In the L2B BUFR sequence the use of a new significance qualifier for the coordinates was proposed to avoid the introduction of new specific location elements in the BUFR table B and to allow more flexibility and reusability of the new proposed elements. The proposed "coordinates significance" element (0-08-091) is used also in the proposed sequence for GMI data (The Global Precipitation Measurement (GPM) satellite). Our aim was to describe the geometry in a generic way that can be used in other LIDAR instruments and other satellite platforms.

The observation geolocation geometry for the Aeolus L2B HLOS winds is quite complex and in the figure below (Figure 1) a schematic representation is shown with the aim to clarify the proposed entries in the "coordinates significance" table. One single observation in the L2B data set is characterised in the horizontal by the start, end and horizontal centre of gravity, in the vertical by the top, bottom and vertical centre of gravity. Those six points in space are enough to fully describe the observation volume. The observation depth is around 10 m, so effectively Aeolus winds are a 2 dimensional observation.

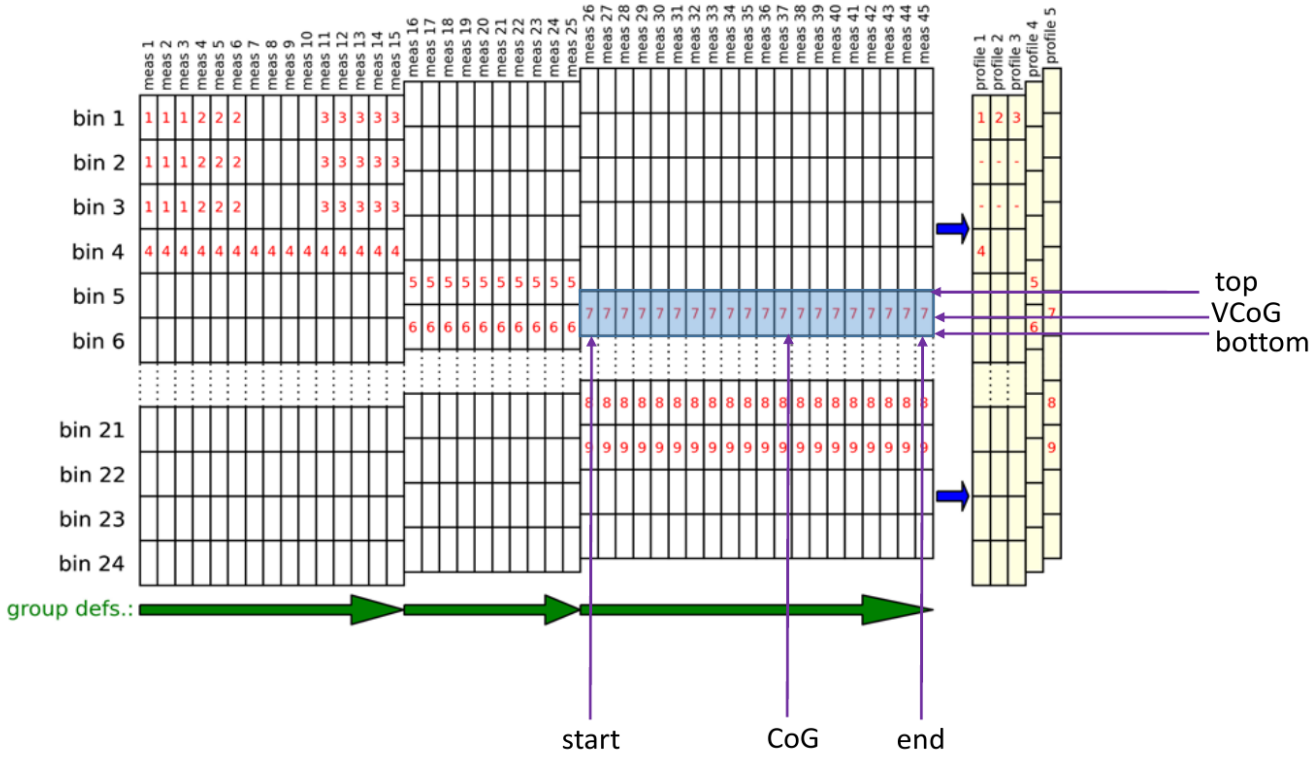

Figure 1. Guide to the Aeolus L2B BUFR observation geometry (observation represented by the blue rectangle). The vertical axis is the LOS direction (typically 35 degrees off-nadir), the horizontal axis corresponds to the along-track direction. The small boxes correspond to vertical range-bins of individual measurements. An observation is a wind retrieval derived using a selection of such measurement-bins (the smallest granularity of data in the L1B products). The observation geometry is described by geolocations for the horizontal and vertical extent that the observation samples. The horizontal geolocations are given by the start, end and centre of gravity (CoG) of the observation and the vertical geolcoations by top, bottom and vertical centre of gravity (VCoG).

The proposed template was submitted to (via a Word document) and discussed at the "Third Meeting of Inter-Programme Expert Team on Data Representation Maintenance and Monitoring" (IPET-DRMM), held in Beijing China on 20-24 July 2015; which was attended by Enrico Fucile. Enrico presented the proposal on a set of BUFR/CREX Table B and BUFR Table D descriptors and associated Code tables for ALADIN L2B wind data. The team at the meeting were requested to review the proposal and accept the new sequence and elements for validation. There was a request from the members to change the element "coordinate significance" in terms of width and a reordering of the entries; this was the only change requested. Dr Simon Elliott (EUMETSAT) in his capacity as the chair of CGMS Task Force on Satellite Data and Codes (TF-SDC) expressed this proposal should be sent to the Task Force for their inputs before decision by IPET-DRMM.

The CGMS did not raise any problems with the proposed template and hence Enrico reported on 5th October 2015 that the template was approved by the WMO and will be operational with FT2016-1 on May 2016 (should be accessible via this website in May 2016: http://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/LatestVERSION/LatestVERSION.html).

The following section (i.e. 3) is a copy of the WMO approved Aeolus L2B BUFR template. L2B BUFR files will be decodable by a released version of BUFRDC and ecCodes (both ECWMF BUFR

decoding software libraries) only after publication of WMO table version 26 with WMO codes (sequence=340013). Until that time the tables delivered with the L2BP software may be used to decode the L2B BUFR product.

3 New BUFR sequence for Atmospheric Laser Doppler Instrument (*approved by WMO*)

3.1 Responsible Organization

ECMWF

3.2 Requirements and Purposes

ECMWF is responsible for the operational implementation of the L2 meteorological processing facility (L2/Met PF) for the Atmospheric Dynamics Mission Aeolus (ADM-Aeolus). This is the first space mission to acquire profiles of wind on a global scale with the Atmospheric Laser Doppler Instrument (ALADIN). In the context of this activity ECMWF has developed in collaboration with KNMI a new BUFR sequence for level 2B data which are of interest for the assimilation in NWP models.

3.3 Description of Proposal

New BUFR sequence and elements are proposed to encode Atmospheric Laser Doppler Instrument (ALADIN) data from Atmospheric Dynamic Mission AEOLUS (ADM-AEOLUS).

3.4 Declaration of validation complete

Validated by ECMWF (Enrico Fucile), UK Met Office (David Offiler, Richard Weedon)

3.5 Result of Discussions

Uncontroversial.

3.6 Proposed Implementation Date and Procedure for Formality

Fast-track 2016-1

3.7 Summary of Discussions

BUFR sequence was proposed at the IPET-DRMM III meeting in Beijing. During the discussion it has been requested to be submitted to CGMS Task Force on Satellite Data and Codes.
The sequence has been approved without changes by CGMS and validation completed.

3.8 Appendix

The following new BUFR table B entries and corresponding code tables are proposed:

Class 08 – BUFR/CREX Significance qualifiers

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 08 091	Coordinates significance	Code table	0	0	8	Code table	0	3

Code table 0 08 091 – Coordinates significance

Code figure	
0	Satellite coordinates
1	Observations coordinates
2	Start of observation
3	End of observation
4	Horizontal centre of gravity of the observation
5	Vertical centre of gravity of the observation
6	Top of the observation
7	Bottom of the observation
8-254	Reserved
255	Missing value

Class 05 - BUFR/CREX Location (horizontal)

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 05 068	Profile number	**Numeric**	**0**	**0**	**16**	**Numeric**	**0**	**5**
0 05 069	Receiver channel	**Code table**	**0**	**0**	**2**	**Code table**	**0**	**1**
0 05 070	Observation identifier	**Numeric**	**0**	**0**	**30**	**Numeric**	**0**	**10**

Code table 0 05 069 – Receiver channel

Code figure	
0	Mie
1	Rayleigh
2	Reserved
3	Missing

Class 07 - BUFR/CREX Location (vertical)

TABLE	ELEMENT	BUFR	CREX

REFERENCE F X Y	NAME							
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 07 071	Height (high resolution)	m	3	-10000000	26	m	3	8

Class 25 - BUFR/CREX Processing information

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 25 187	Confidence flag	Code table	0	0	4	Code table	0	2

Code table 0 25 187 – Confidence flag

Code figure	
0	Valid
1	Invalid
2-14	Reserved
15	Missing

Class 40 – BUFR/CREX Satellite data

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 40 029	Horizontal observation integration length	m	0	0	26	m	0	8
0 40 030	Horizontal line of sight wind	$m\ s^{-1}$	2	-32767	16	$m\ s^{-1}$	2	5
0 40 031	Error estimate of horizontal line of sight wind	$m\ s^{-1}$	2	0	15	$m\ s^{-1}$	2	5
0 40 032	Derivative wind to pressure	$m\ s^{-1}\ Pa^{-1}$	3	-100000	18	$m\ s^{-1}\ Pa^{-1}$	3	6
0 40 033	Derivative wind to temperature	$m\ s^{-1}\ K^{-1}$	3	-100000	18	$m\ s^{-1}\ K^{-1}$	3	6
0 40 034	Derivative wind to backscatter ratio	$m\ s^{-1}$	3	-200000	19	$m\ s^{-1}$	3	6
0 40 035	Satellite range	m	0	380000	18	m	0	6
0 40 036	Lidar l2b classification type	Code table	0	0	4	Code table	0	1
0 40 037	Backscatter ratio	Numeric	3	500	20	Numeric	3	7

Code table 0 40 036 – Lidar l2b classification type

Code figure	
0	Clear
1	Cloud
2-14	Reserved
15	Missing

The following new entries are proposed in BUFR table D

TABLE REFERENCE	TABLE REFERE	Element name	

	NCES		
3 40 013	**Atmospheric Laser Doppler Instrument (ALADIN) L2B Data**		
	0 01 007	Satellite identifier	
	0 02 019	Satellite instruments	
	0 01 033	Identification of originating/generating centre	
	0 01 034	Identification of originating/generating sub-centre	
	0 04 001	Year	
	0 04 002	Month	
	0 04 003	Day	
	0 04 004	Hour	
	0 04 005	Minute	
	0 04 007	Seconds within a minute (microsecond accuracy)	
	0 05 068	Profile number	
	0 05 070	Observation identifier	
	0 05 069	Receiver channel	
	0 40 036	Lidar l2b classification type	
	0 08 091	Coordinates significance	2 -> Start of observation
	0 05 001	Latitude (high accuracy)	
	0 06 001	Longitude (high accuracy)	
	0 04 016	Time increment	
	0 08 091	Coordinates significance	3 -> End of observation
	0 05 001	Latitude (high accuracy)	
	0 06 001	Longitude (high accuracy)	
	0 04 016	Time increment	
	0 08 091	Coordinates significance	4 -> Horizontal Centre of gravity of observation
	0 05 001	Latitude (high accuracy)	
	0 06 001	Longitude (high accuracy)	
	0 04 016	Time increment	
	0 08 091	Coordinates significance	6 -> Top of observation
	0 07 071	Height (high resolution)	
	0 05 021	Bearing or azimuth	
	0 07 021	Elevation	
	0 40 035	Satellite range	
	0 08 091	Coordinates significance	7 -> Bottom of observation
	0 07 071	Height (high resolution)	
	0 05 021	Bearing or azimuth	
	0 07 021	Elevation	
	0 40 035	Satellite range	
	0 08 091	Coordinates significance	5 -> Vertical centre of Gravity of the observation
	0 07 071	Height (high resolution)	
	0 05 021	Bearing or azimuth	
	0 07 021	Elevation	
	0 40 035	Satellite range	
	0 40 029	Horizontal observation integration length	
	0 40 030	Horizontal line of sight wind	
	0 40 031	Error estimate of horizontal line of sight wind	
	0 25 187	Confidence flag	
	0 10 004	Pressure	
	0 12 001	Temperature/air temperature	
	0 40 037	Backscatter ratio	
	0 40 032	Derivative wind to pressure	
	0 40 033	Derivative wind to temperature	
	0 40 034	Derivative wind to backscatter ratio	