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COMMISSION FOR BASIC SYSTEMS
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**EXPERT TEAM ON REQUIREMENTS AND
IMPLEMENTATION AWS PLATFORMS (ET-AWS)**
Sixth Session

ITEM: 10

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BUFR descriptors related to AWS

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Summary and Purpose of Document

The document contains a set of new BUFR/CREX descriptors recommended by IPET-DRC for validation and a revised version of the Annex to Recommendation 6.1/2 (CBS-XIV).

ACTION PROPOSED

The meeting is invited to discuss the content of this document and the suggested recommendations.

References:

- [1] Manual on Codes, WMO-No. 306, Volume I.2.
- [2] Draft Recommendation 6.1/2 (CBS-XIV), Commission for Basic Systems, Fourteenth Session, Dubrovnik, Croatia, 2009.
- [3] Joint Meeting of the CT on Migration to Table Driven Code Forms and of the ET on Data Representation and Codes. Final Report. Geneva, 1 - 5 September 2008.
- [4] First meeting of the Inter-Programme Expert Team on Data Representation and Codes. Final Report. Geneva, 15 - 18 September 2009
- [5] Červená, E.: BUFR descriptors required by Recommendation 6.1/2 (CBS-XIV). First Meeting of the IPET-DRC. Doc. 3.3(3). Geneva, 15 - 18 September 2009.

1. Background

14th Session of the Commission for Basic Systems (Dubrovnik, Croatia, 25 March to 2 April 2009) reviewed the Functional Specifications for Automatic Weather Stations and adopted draft Recommendation 6.1/2 (CBS-XIV). The Commission requested the OPAG-ISS to develop BUFR descriptors for all the variables listed in the “Functional Specifications for Automatic Weather Stations” as included in the Annex to Recommendation 6.1/2.

Analysis of the Annex to Recommendation 6.1/2 indicated that some of the listed variables might be represented by already existing BUFR descriptors. On the other hand, there were several variables with the assigned BUFR descriptors not capable to meet the requested “Maximum Effective Range” or “Minimum Reported Resolution”. Document IPET-DRC/Doc 3.3(3) submitted to the IPET-DRC meeting (Geneva, 15 – 18 September 2009), contained detailed analysis of the requirements for representation of the listed variables and a proposal for several new BUFR/CREX descriptors. The IPET-DRC meeting invited the ET-AWS to perform validation of the new descriptors and to examine carefully all suggestions and proposals that were included in a concise form in the “Revised Annex to Recommendation 6.1/2 (CBS-XIV) of September 2009” in [4] and in more detail in document IPET-DRC/Doc 3.3(3) [5].

2. Descriptors proposed for validation

2.1 A descriptor proposed for validation in 2008 [3]

For UV-B radiation

In 2008, a proposal for representation of UV-B radiation was developed in cooperation of Météo-France and Czech Hydrometeorological Institute. The proposed descriptor 0 14 072 was recommended for validation in September 2008 [3] with a note as included below.

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 14 072	Global UV irradiation	J m ⁻²	-3	-8192	14	J m ⁻²	-3	4

Note:

- (2) Global UV irradiation (0 14 072) is UV energy integrated over period specified for spectral band specified. 0 14 072 shall be preceded by a time period descriptor and by 0 02 071 (Spectrographic wavelength) and 0 02 072 (Spectrographic width). E.g. If 0 14 072 is used for Global UV-B irradiation, 0 02 071 and 0 02 072 shall specify spectral band 280 to 315 nm.

2.2 Descriptors proposed for validation in 2009 [4]

For Temperature

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 12 120	Ground temperature	K	2	0	16	°C	2	4
0 12 131	Snow temperature	K	2	0	16	°C	2	4

For Humidity

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 13 110	Mass mixing ratio	%	0	0	7	%	0	3
0 13 111	Soil moisture, volumetric or water potential	g kg ⁻¹	0	0	10	g kg ⁻¹	0	4
0 13 112	Object wetness duration	s	0	0	17	s	0	5

For Radiation

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 14 056	Background luminance	Cd m ⁻²	0	0	18	Cd m ⁻²	0	6
0 14 052	Global upward solar radiation, integrated over period specified	J m ⁻²	-2	- 1048574	20	J m ⁻²	-2	7
0 14 053	Net radiation (high accuracy), integrated over period specified	J m ⁻²	-2	- 1048574	21	J m ⁻²	-2	7
0 14 054	Photosynthetically active radiation, integrated over period specified	J m ⁻²	-3	0	16	J m ⁻²	-3	5

It is suggested to use the term "irradiation" instead of "radiation integrated over period specified" in the names of 0 14 052, 0 14 053 and 0 14 054 in compliance with the terminology used for Global UV irradiation (0 14 072).

For Clouds

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 20 130	Cloud hydrometeor concentration	Numeric	0	0	10	Numeric	0	3
0 20 131	Effective radius of cloud hydrometeors	m	5	0	6	m	5	2
0 20 132	Cloud liquid water content	kg m ⁻³	5	0	11	kg m ⁻³	5	4
0 20 093	Height of inversion	m	-1	0	8	m	-1	3

And a Note under Class 20:

Cloud hydrometeor concentration 0 20 130 represents the number of hydrometeors in 1 dm³.

For Precipitation

Table reference		BUFR				CREX		
F X Y	Element name	Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 13 114	Rate of ice accretion	kg m ⁻² h ⁻¹	1	0	11	kg m ⁻² h ⁻¹	1	4

Moreover, the name of 0 20 032 is proposed to be changed from the current "Rate of ice accretion" to "Rate of ice accretion (estimated)".

For Obscuration

It is proposed to introduce two new descriptors (0 20 133 and 0 15 051) and to modify the already existing descriptor 0 15 029 (Extinction coefficient, m⁻¹, 0, 0, 10), currently under validation:

Table reference		BUFR				CREX		
F X Y	Element name	Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 20 133	Hydrometeor radius	m	5	0	6	m	5	2
0 15 051	Meteorological Optical Range	m	0	0	18	m	0	6
0 15 029	Extinction coefficient	m ⁻¹	9	0	30	m ⁻¹	9	10

For Lightning

Table reference		BUFR				CREX		
F X Y	Element name	Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 20 126	Lightning rates of discharge	Number h ⁻¹	0	0	23	Number h ⁻¹	0	7
0 20 127	Lightning - distance from station	m	-3	0	6	m	-3	2
0 20 128	Lightning - direction from station	Degree true	0	0	9	Degree true	0	3
0 20 119	Lightning discharge polarity	Code table	0	0	2	Code table	0	1

0 20 119 - Lightning discharge polarity:

Code figure

- 0 Not defined
- 1 Positive
- 2 Negative
- 3 Missing value

For Hydrologic and marine data

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 23 040	Flow discharge – river	m ³ s ⁻¹	1	0	22	m ³ s ⁻¹	1	7
0 23 041	Flow discharge – well	m ³ s ⁻¹	3	0	16	m ³ s ⁻¹	3	5
0 13 074	Ground water level	m	2	0	18	m	2	6
0 12 132	Ice surface temperature	K	2	0	16	°C	2	4
0 13 115	Ice thickness	m	2	0	19	m	2	6
0 20 135	Ice mass (on a rod)	kg m ⁻¹	1	0	10	kg m ⁻¹	1	3
0 13 117	Snow density (liquid water content)	kg m ⁻³	0	0	10	kg m ⁻³	0	3

And a Note under Class 13:

Ice thickness 0 13 115 shall be preceded by 0 08 029 (Surface type) set to 11, 12, 13 or 14 to specify river, lake, sea or glacier, respectively.

Moreover, the name of 0 08 029 is proposed to be changed from the current “Remotely sensed surface type” to “Surface type” and the following code figures introduced:

0 08 029 - Surface type:

Code figure

- 11 river
- 12 lake
- 13 sea
- 14 glacier

For Other

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 24 014	Gamma radiation dose rate	nSv h ⁻¹	1	0	14	nSv h ⁻¹	1	4

And a Note under Class 24:

Gamma radiation dose rate 0 24 014 is intended to be used for reporting of this element under normal conditions, nuclear accidents excluded.

2.3 An additional new descriptor proposed for validation in 2010**For Depth of fresh snow**

The existing BUFR/CREX descriptor 0 13 012 Depth of fresh snow (m, 2, -2, 12) is not capable to meet the requested demand for high precision (in 0.001 m). To avoid the necessity to apply all three operators 201Y, 202Y and 203Y, a new descriptor 0 13 118 is proposed for validation. This proposal has been discussed with IPET-DRC members, but it has not yet been submitted to an IPET-DRC meeting.

Table reference		BUFR				CREX		
F X Y	Element name	Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 13 118	Depth of fresh snow (high accuracy)	m	3	0	14	m	3	5

2.4. Usage of operators with descriptors for hydrologic and marine data

Several problems were detected in the requirements for representation of hydrologic and marine data in the Annex to Recommendation 6.1/2, i.e. majority of the selected descriptors did not have sufficient scale and/or reference value and/or data width to meet the requirements (highlighted in the table below).

Oceanographic experts were contacted in July 2009 to provide their comments on this part of Annex to Recommendation 6.1/2. Mr. Robert Keeley expressed his opinion that the ranges of existing BUFR descriptors would be mostly sufficient, apart from the extreme conditions in some cases.

Several new descriptors have been proposed for representation of hydrologic and marine data (see part 2.2 of this document). If the requirements for the remaining variables are confirmed, the IPET DRC suggested usage of the selected descriptors suitable for the normal operating conditions combined with appropriate operator descriptors to allow representation of the extreme values or the required high precision.

VARIABLE	Required Maximum Effective Range	Required Minimum Resolution	Range provided by existing BUFR descriptors	Precision provided by existing BUFR descriptors	BUFR / CREX
HYDROLOGIC AND MARINE OBSERVATIONS					
Wave period	0 – 100 s	1 s	0 – 62 s	1 s	2 01 129 0 22 011 2 01 000
1D spectral wave energy density	0 – 5x10 ⁵ m ² Hz ⁻¹	10 ⁻³ m ² Hz ⁻¹	0 - 4194.302 m ² Hz ⁻¹	0.001 m ² Hz ⁻¹	2 01 135 0 22 069 2 01 000
2D spectral wave energy density	0 – 5x10 ⁵ m ² Hz ⁻¹	10 ⁻³ m ² Hz ⁻¹	0 - 4194.302 m ² Hz ⁻¹	0.001 m ² Hz ⁻¹	2 01 135 0 22 069 2 01 000
Water salinity	0 – 40 % [0 – 400 psu]	10 ⁻⁴ % [10 ⁻³ psu]	0.000– 131.070 psu	0.001 psu	2 01 130 0 22 064 2 01 000
Water conductivity	0 – 600 S m ⁻¹	10 ⁻⁶ S m ⁻¹	0 – 67.108862 S m ⁻¹	0.000001 S m ⁻¹	2 01 132 0 22 066 2 01 000
Water pressure	0 – 11x10 ⁷ Pa	100 Pa	0 – 131 070 000 Pa	1000 Pa	2 07 001 0 22 065 2 07 000 see Note a)
Ice thickness	0 – 3 m	0.015 m	0 – 1.26 m	0.01 m	2 01 133 2 02 129 0 20 031 2 02 000 2 01 000
Tidal elevation with respect to local chart datum	-10 – +30 m	0.001 m	-10.000 – 22.766 m	0.001 m	2 01 129 0 22 038 2 01 000
Tidal elevation with respect to national land datum	-10 – +30 m	0.001 m	-10.000 – 22.766 m	0.001 m	2 01 129 0 22 037 2 01 000
Meteorological residual tidal elevation (surge or offset)	-10 – +16m	0.001 m	-5.000 – 11.382 m	0.001 m	0 22 040 see Note b)

Notes:

- a) In case of Water pressure 0 22 065 (Pa, -3, 0, 17), usage of operator 2 07 Y is suggested in the table above (if the data are produced in BUFR, Edition 4). The same result, i.e. change to (Pa, -2, 0, 21) would be obtained by the combined use of the less sophisticated operators 201Y and 202Y:

2 01 132
 2 02 129
0 22 065 Reported value of "Water pressure"
 2 02 000
 2 01 000

- b) In case of 0 22 040 (m, 3, -5000, 14), reference value and data width is not sufficient. The following sequence is to be used to change the data width and the reference value to become (m, 3, -10000, 15):

2 01 129
 2 03 015
 0 22 040 New reference value = -10000
 2 03 255
0 22 040 Reported value of "Meteorological residual tidal elevation"
 2 01 000
 2 03 000

3. Revised Annex to draft Recommendation 6.1/2 (CBS-XIV) – March 2010

Functional Specifications for Automatic Weather Stations

VARIABLE ¹⁾	Maximum Effective Range ²⁾	Minimum Reported Resolution ³⁾	Mode of Observation ⁴⁾	BUFR / CREX ⁵⁾	Status ⁵⁾
ATMOSPHERIC PRESSURE					
Atmospheric Pressure	500 – 1080 hPa	10 Pa	I, V	0 10 004	OP
TEMPERATURE ⁹⁾					
Ambient air temperature (over specified surface) ¹⁴⁾	-80 °C – +60 °C	0.1 K	I, V	0 12 101	OP
Dew-point temperature ¹⁴⁾	-80 °C – +60 °C	0.1 K	I, V	0 12 103	OP
Ground (surface) temperature (over specified surface) ¹⁴⁾	-80 °C – +80 °C	0.1 K	I, V	0 12 120	VAL
Soil temperature ¹⁴⁾	-50 °C – +50 °C	0.1 K	I, V	0 12 130	OP
Snow temperature ¹⁴⁾	-80 °C – 0 °C	0.1 K	I, V	0 12 131	VAL
Water temperature - river, lake, sea, well	-2 °C – +100 °C	0.1 K	I, V	0 13 082 or 0 22 043	OP OP
HUMIDITY ⁹⁾					
Relative humidity	0 – 100%	1%	I, V	0 13 003	OP
Mass mixing ratio	0 – 100%	1%	I, V	0 13 110	VAL
Soil moisture, volumetric or water potential	0 – 10 ³ g kg ⁻¹	1 g kg ⁻¹	I, V	0 13 111	VAL
Water vapour pressure	0 – 100 hPa	10 Pa	I, V	0 13 004	OP
Evaporation/evapotranspiration	0 – 0.2 m	0.1 kg m ⁻² , 0.000 m	T	0 13 033	OP
Object wetness duration	0 – 86 400 s	1 s	T	0 13 112	VAL
WIND					
Direction	0 ^{11,13)} , 1° – 360°	1°	I, V	0 11 001	OP
Speed	0 – 75 m s ⁻¹	0.1 m s ⁻¹	I, V	0 11 002	OP
Gust Speed	0 – 150 m s ⁻¹	0.1 m s ⁻¹	I, V	0 11 041	OP
X,Y component of wind vector	0 – 150 m s ⁻¹	0.1 m s ⁻¹	I, V	0 11 003	OP
Z component of wind vector	0 – 40 m s⁻¹	0.1 m s ⁻¹	I, V	0 11 004	OP

(horizontal and vertical profile)				0 11 006	OP
Turbulence type (Low levels and wake vortex) ¹⁶⁾	up to 15 types	BUFR Table Not specified yet	I, V	-	N
Turbulence intensity ¹⁶⁾	up to 15 types	BUFR Table Not specified yet	I, V	-	N
RADIATION ⁶⁾					
Sunshine duration	0 – 86 400 s	60 s	T	0 14 031	OP
Background luminance	0 – 1·10 ⁵ Cd m ⁻²	1 Cd m ⁻²	I, V	0 14 056	VAL
Global downward solar radiation	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 028	OP
Global upward solar radiation	-1·10 ⁷ – 0 J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 052	VAL
Diffuse solar radiation	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 029	OP
Direct solar radiation	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 030	OP
Downward long-wave radiation	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 002	OP
Upward long-wave radiation	-1·10 ⁷ – 0 J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 002	OP
Net radiation	-1·10 ⁷ – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 053	VAL
UV-B radiation ⁸⁾	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 072	VAL
Photosynthetically active radiation ²²⁾	0 – 1·10 ⁷ J m ⁻²	1·10 ³ J m ⁻²	I, T, V	0 14 054	VAL
Surface albedo	0 – 100%	1%	I, V	0 14 019	OP

VARIABLE ¹⁾	Maximum Effective Range ²⁾	Minimum Reported Resolution ³⁾	Mode of Observation ⁴⁾	BUFR / CREX ⁵⁾	Status ⁵⁾
CLOUDS					
Cloud base height	0 – 30 km	10 m	I, V	0 20 013	OP
Cloud top height	0 – 30 km	10 m	I, V	0 20 014	OP
Cloud type, convective vs. other types	up to 30 classes	BUFR Table	I	0 20 012	OP
Cloud hydrometeor concentration	1 – 700 hydrometeors dm ⁻³	1 hydrometeor dm ⁻³	I, V	0 20 130	VAL
Effective radius of cloud hydrometeors	2·10 ⁻⁵ – 32·10 ⁻⁵ m	2·10 ⁻⁵ m	I, V	0 20 131	VAL
Cloud liquid water content	1·10 ⁻⁵ –1.4·10 ⁻² kg m ⁻³	1·10 ⁻⁵ kg m ⁻³	I, V	0 20 132	VAL
Optical depth within each layer	Not specified yet	Not specified yet	I, V	-	N
Optical depth of fog	Not specified yet	Not specified yet	I, V	-	N
Height of inversion	0 – 1 000 m	10 m	I, V	0 20 093	VAL
Cloud cover	0 – 100%	1%	I, V	0 20 010	OP
Cloud amount	0 – 8/8	1/8	I, V	0 20 011	OP
PRECIPITATION					
Accumulation ⁷⁾	0 – 1000 mm	0.1 kg m ⁻² , 0.0001 m	T	0 13 011	OP
Depth of fresh snowfall	0 –1000 cm	0.001 m	T	0 13 118	VAL
Duration	up to 86 400 s	60 s	T	0 26 020	OP
Size of precipitating element ¹⁷⁾	1·10 ⁻³ – 0.25 m	1·10 ⁻³ m	I, V	0 13 058 0 20 066	OP OP
Intensity - quantitative	0 – 2000 mm h ⁻¹	0.1 kg m ⁻² s ⁻¹ , 0.1 mm h ⁻¹	I, V	0 13 155	OP
Type	up to 30 types	BUFR Table	I, V	0 20 021	OP
Rate of ice accretion	0 – 1 kg dm ⁻² h ⁻¹	1·10 ⁻³ kg dm ⁻² h ⁻¹	I, V	0 13 114	VAL
OBSCURATIONS					
Obscuration type	up to 30 types	BUFR Table	I, V	0 20 025	OP
Hydrometeor type	up to 30 types	BUFR Table	I, V	0 20 025	OP
Lithometeor type	up to 30 types	BUFR Table	I, V	0 20 025	OP

Hydrometeor radius	$2 \cdot 10^{-5} - 32 \cdot 10^{-5} \text{ m}$	$2 \cdot 10^{-5} \text{ m}$	I, V	0 20 133	VAL
Extinction coefficient	$0 - 1 \text{ m}^{-1}$	0.001 m^{-1}	I, V	0 15 029	VAL
Meteorological Optical Range ¹⁰⁾	1 – 100 000 m	1 m	I, V	0 15 051	VAL
Runway visual range	1 – 4 000 m	1 m	I, V	0 20 061	OP
Other weather type	up to 18 types	BUFR Table	I, V	0 20 023	OP
LIGHTNING					
Lightning rates of discharge	0 – 4 500 000	Number h ⁻¹	I, V	0 20 126	VAL
Lightning discharge type (cloud to cloud, cloud to surface)	3 types	BUFR Code Table	I, V	0 20 023	OP
Lightning discharge polarity	2 types	BUFR Code Table	I, V	0 20 119	VAL
Lightning discharge energy	Not specified yet	Not specified yet	I, V	-	N
Lightning - distance from station	0 – $3 \cdot 10^4 \text{ m}$	10^3 m	I, V	0 20 127	VAL
Lightning - direction from station	1° – 360°	1 degree	I, V	0 20 128	VAL

VARIABLE ¹⁾	Maximum Effective Range ²⁾	Minimum Reported Resolution ³⁾	Mode of Observation ⁴⁾	BUFR / CREX ⁵⁾	Status ⁵⁾
HYDROLOGIC AND MARINE OBSERVATIONS					
Flow discharge – river	$0 - 2.5 \cdot 10^5 \text{ m}^3 \text{ s}^{-1}$	$0.1 \text{ m}^3 \text{ s}^{-1}$	I, V	0 23 040	VAL
Flow discharge – well	$0 - 50 \text{ m}^3 \text{ s}^{-1}$	$0.001 \text{ m}^3 \text{ s}^{-1}$	I, V	0 23 041	VAL
Ground water level	0 – 1 800 m	0.01 m	I, V	0 13 074	VAL
Ice surface temperature ¹⁴⁾	-80 °C – +0 °C	0.5 K	I, V	0 12 132	VAL
Ice thickness - river, lake ¹⁵⁾	0 – 50 m	0.01 m	I, V	0 08 029 0 13 115	VAL
Ice thickness - glacier, sea ¹⁵⁾	0 – 4 270 m	1 m	I, V	0 08 029 0 13 115	VAL
Water level	0 – 100 m	0.01 m	I, V	0 13 071 0 13 072	OP OP
Wave height	0 – 50 m	0.1 m	V	0 22 021	OP
Wave period ¹⁸⁾	0 – 100 s ??	1 s	V	2 01 129 0 22 011 2 01 000	OP
Wave direction	0 ¹³⁾ ; 1 – 360 degrees	1 degrees	V	0 22 001	OP
1D spectral wave energy density ¹⁸⁾	0 – $5 \times 10^5 \text{ m}^2 \text{ Hz}^{-1}$??	$10^{-3} \text{ m}^2 \text{ Hz}^{-1}$	V, T	2 01 135 0 22 069 2 01 000	OP
2D spectral wave energy density ¹⁸⁾	0 – $5 \times 10^5 \text{ m}^2 \text{ Hz}^{-1}$??	$10^{-3} \text{ m}^2 \text{ Hz}^{-1}$	V, T	2 01 135 0 22 069 2 01 000	OP
Water salinity ¹⁸⁾	0 – 40 ‰ ¹²⁾ [0 – 400 psu] ??	$10^{-4} \%$ [10^{-3} psu]	I, V	2 01 130 0 22 064 2 01 000	OP
Water conductivity ¹⁸⁾	0 – 600 S m ⁻¹ ??	10^{-6} S m^{-1}	I, V	2 01 132 0 22 066 2 01 000	OP
Water pressure ^{18) 19)}	0 – $11 \times 10^7 \text{ Pa}$	100 Pa ??	I, V	2 07 001 0 22 065 2 07 000	OP
Ice thickness ¹⁸⁾	0 – 3 m ??	0.015 m ??	T	2 01 133 2 02 129 0 20 031 2 02 000 2 01 000	OP
Ice mass	0 – 50 kg m ⁻¹	0.5 kg m^{-1} (on 32 mm rod)	T	0 20 135	VAL
Snow density (liquid water content)	100 – 700 kg m ⁻³	1 kg m^{-3}	T	0 13 117	VAL
Tidal elevation with respect to	-10 – +30 m ??	0.001 m	I, V	2 01 129	OP

local chart datum ¹⁸⁾				0 22 038 2 01 000	
Tidal elevation with respect to national land datum ¹⁸⁾	-10 – +30 m ??	0.001 m	I, V	2 01 129 0 22 037 2 01 000	OP
Meteorological residual tidal elevation (surge or offset) ^{18) 20)}	-10 – +16m ??	0.001 m	I, V	0 22 040 Note 20)	OP
Ocean Current - Direction	0 ¹³⁾ ; 1° – 360°	1°	I, V	0 22 004 or 0 22 005	OP OP
Ocean Current - Speed	0 – 10 m s ⁻¹	0.01 m s ⁻¹	I, V	0 22 031 or 0 22 032	OP OP
OTHER SURFACE VARIABLES					
Runway conditions	up to 10 types	BUFR Table	I, V	0 20 085	OP
Braking action/friction coefficient	up to 7 types	BUFR Table	I, V	0 20 089	OP
State of ground	up to 30 types	BUFR Table	I, V	0 20 062	OP
Type of surface specified	up to 15 types	BUFR Table	I, V	0 08 010	OP
Snow depth	0 – 25 m	0.01 m	T	0 13 013	OP
OTHER					
Gamma radiation dose rate ²¹⁾	1 – 10 ³ nSv h ⁻¹	0.1 nSv h ⁻¹	I, T	0 24 014	VAL
Categories of stability	9 types	BUFR Table	I, V	0 13 041	OP

Notes:

- Name of variable, in line with WMO vocabulary and Technical Regulations.
- Maximum Effective Range - Maximum range of measuring capability; units traceable to SI.
- Minimum Reported Resolution – Lower resolution of reporting is not permitted.
- Mode of Observation – Type of data being reported:
I: Instantaneous – 1-minute value (instantaneous as defined in WMO-No. 8, Part II, paragraph 1.3.2.4);
V: Variability – Average (mean), Standard Deviation, Maximum, Minimum, Range, Median, etc. of samples – those reported depend upon meteorological variable;
T: Total – Integrated value over defined period; maximum 24 hours for all parameters except radiation which requires a maximum of one hour (exception, see note 6), and precipitation accumulation (6 hours maximum). The relevant element descriptor shall be preceded by a time period descriptor 0 04 024 (in hours) or 0 04 025 (in minutes).
A: Average (mean) value.
- BUFR/CREX descriptors for representation of the listed variables;
OP: Operational descriptors of BUFR/CREX Table B, Version Number 14.
VAL: Descriptors to be validated.
N: Not yet specified requirements.
- Radiation energy amounts are given over a 24-hour period.
- Maximum interval: 6 hours.
- Definition of UV-B according to WMO-No. 8 (Vol. 1, Chapter on Radiation). Descriptor 0 14 072 (Global UV irradiation) was recommended for validation in September 2008.
- Humidity related variables (*i.e.* dew point) expressed as temperature are collected under temperature.
- MOR uniquely related to "extinction coefficient", σ , by $MOR = -\ln(5\%)/\sigma$.
- Direction to indicate 0 (zero) if speed = 0.
- Salinity of 1‰ (1 g of salt per 100 g of water), or 10 ‰ converts to 10.000 ppm (parts per million), which equals 10 psu (practical salinity units). Ocean water is about 3.5‰ salt, *i.e.* 35.000 ppm or 35 psu. Lake Asal (Ethiopia) is the most saline body of water on earth with 34.8‰ [348 psu] salt concentration.

13. Calm.
14. Temperature data represented by 0 12 101, 0 12 103, 0 12 113, 0 12 120, 0 12 130, 0 12 131 and 0 12 132 shall be reported with precision in hundredths of a degree even if they are measured with the accuracy in tenths of a degree. This requirement is based on the fact that conversion from the Kelvin to the Celsius scale has often resulted into distortion of the data values. Temperature t (in degrees Celsius) shall be converted into temperature T (in degrees Kelvin) using equation: $T = t + 273.15$.
15. Ice thickness 0 13 115 shall be preceded by 0 08 029 (Surface type) set to 11, 12, 13 or 14 to specify river, lake, sea or glacier, respectively.
16. If the UNIT is specified as "BUFR Table", the BUFR descriptor cannot be proposed without the content of the table being available.
17. 0 13 058 (Size of precipitation element) is capable to express size of any precipitation element, apart from hailstones. Size of hailstones shall be represented by 0 20 066.
18. If these requirements are confirmed, it has to be noted that the selected descriptors are suitable for the normal operating conditions and shall be combined with appropriate operator descriptors to allow representation of the extreme values or the requested high precision.
19. Operator 2 07 Y is recommended to be used with Water pressure **0 22 065** (Pa, -3, 0, 17), if the data are produced in BUFR, Edition 4. The same result, i.e. change to (Pa, -2, 0, 21) would be obtained by the combined use of the less sophisticated operators 201Y and 202Y:
 2 01 132
 2 02 129
0 22 065 Reported value of "Water pressure"
 2 02 000
 2 01 000
20. The following sequence is to be used to change data width and reference value of **0 22 040** (m, 3, -5000, 14) to become (m, 3, -10000, 15):
 2 01 129
 2 03 015
 0 22 040 New reference value = -10000
 2 03 255
0 22 040 Reported value of "Meteorological residual tidal elevation"
 2 01 000
 2 03 000
21. Gamma radiation dose rate 0 24 014 is intended to be used for reporting of this element under normal conditions, nuclear accidents excluded.
22. Photosynthetically active radiation (PAR). The electromagnetic energy in the 400 – 700 nm wavelength range. Measured as the photosynthetic photon flux (PPF) in quanta per second per square meter, or mole of quanta per second per square meter or microeinsteins per second per square meter. Approximate conversion is $1 \text{ J m}^{-2} \text{ s}^{-1}$ equivalent to $5 \mu\text{E m}^{-2} \text{ s}^{-1}$ (suggested by Chairman of ET AWS).

The introduced changes are written in blue or marked by side bars.