

### **BUFR templates for AWS data**

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### **Summary and Purpose of Document**

This document contains information on the development and validation of BUFR templates for AWS data.

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### **ACTION PROPOSED**

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

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#### **References:**

- [1] Manual on Codes, WMO-No. 306, Volume 1.2.
- [2] Meeting of Expert Team on Data Representation and Codes. Darmstadt, 23 to 27 April 2007.
- [3] Meeting of Expert Team on Requirements for Data from Automatic Weather Stations. Geneva, 5 to 9 May 2008.
- [4] Joint Meeting of the CT on Migration to Table Driven Code Forms and of the ET on Data Representation and Codes. Geneva, 1 to 5 September 2008.
- [5] Recommendation 6.2/2 (CBS-XIV), Commission for Basic Systems, Fourteenth Session. Dubrovnik, Croatia, 25 March to 2 April 2009.

#### **Annex:**

- [1] BUFR template for surface observations from n-minute period with national and WMO station identification

## 1. BUFR templates for representation of AWS data (3 07 091, 3 07 092 and 3 07 093)

The proposal of sequence 3 07 091 (*BUFR template for surface observations from one-hour period with national and WMO station identification*) was submitted to the Meeting of Expert Team on Data Representation and Codes (Darmstadt, 23 to 27 April 2007). The Meeting requested also development of sequence 3 07 092 (*BUFR template for surface observations from n-minute period with national and WMO station identification*) and recommended the sequences 3 07 091, 3 07 092 and 3 07 093 for validation [2].

The complete proposal (descriptors 0 01 101, 0 01 102 and 3 01 089 for National station identification and the templates 3 07 091, 3 07 092 and 3 07 093) was submitted to the Meeting of Expert Team on Requirements for Data from Automatic Weather Stations (ET- AWS) held in Geneva from 5 to 9 May 2008. No objections to the proposed templates and descriptors were expressed by the meeting [3].

In 2008, IBL Software Engineering in cooperation with ET-DR&C performed validation of the template for surface observations from one-hour period (3 07 091), including the system of national station identification. Consequently, 3 07 091 and the descriptors 0 01 101, 0 01 102 and 3 01 089 for National station identification were pronounced pre-operational by the Joint Meeting of the CT-MTDCF and ET-DR&C (Geneva, 1 to 5 September 2008) [4] and recommended for operational implementation as from 4 November 2009 by the CBS-XIV [5].

The sequences 3 07 092 and 3 07 093 (see Annex to this document) were recommended to be left in the stage of validation in September 2008 [4]. They are still waiting for validation now.

Table reference	Element name	Status
3 07 092	<i>BUFR template for surface observations from n-minute period with national and WMO station identification</i>	<i>To be validated</i>
3 07 093	<i>Nominal values</i>	<i>To be validated</i>

## 2. BUFR template for representation of SYNOP data with supplementary information on one-hour observations (3 07 096)

In 2006, Mr. Michel Leroy, the representative of EUMETNET, developed a proposal for a BUFR template, blending the current AWS and SYNOP BUFR templates. A revised version of this template was submitted to the Meeting of ET DR&C (Darmstadt, 23 to 27 April 2007) that discussed the usage of this combined template and its consequences and recommended the template for further validation [2].

The Meeting of ET-AWS (Geneva, 5 to 9 May 2008) noted that the requirements for the “merged” BUFR template for surface observations from one-hour period and for reporting SYNOP data in BUFR was addressed by ET-DR&C, but it still requires validation. The meeting recommended that the validation of the template including proposed national station identification should be done as a matter of urgency. It accepted with pleasure an offer by M. Leroy, Météo-France, to take lead in this validation. The ET- AWS emphasized the need for the adoption of the relevant amendments to the Manual on Codes (WMO-No. 306) by CBS-XIV so that this “merged” template could be used instead of the TM 307080 - BUFR template for reporting SYNOP data in BUFR during and after the transition phase for the migration from traditional alphanumeric codes (TAC) to Table Driven Codes Forms (TDCF) [3].

A new version of the BUFR AWS-SYNOP template was submitted to the Joint Meeting of CT-MTDCF and ET-DR&C (Geneva, 1 - 5 September 2008) as “TM 307096 - BUFR template for representation of SYNOP data with supplementary information on one-hour observations”. It included national station identification and the extensive usage of delayed replications in compliance with the template TM 307091 for surface observations from one-hour period. Moreover, Météo-France agreed with modifications that had been suggested in June 2006. The

problem of specification of data subcategories was also discussed and the addition of three subcategories for surface data in Common Table C-13 was suggested. The Meeting recommended this template to be validated as soon as possible for approval of pre-operational status before CBS XIV [4].

Template TM 307096 was validated by Météo-France and the Czech Hydrometeorological Institute in the winter 2008/2009, including the newly requested descriptor 0 13 155 for "Intensity of precipitation (high accuracy)", and consequently recommended for operational implementation as from 4 November 2009 by the CBS-XIV [5].

### 3. Relevant BUFR descriptors recommended for operational use by the CBS-XIV [5]

BUFR descriptors recommended for operational implementation as from 4 November 2009 (BUFR Table B, Version Number 14), available in the Manual on Codes, WMO-No. 306, Volume I.2 [1] at <http://www.wmo.int/pages/prog/www/WMOCodes.html>

Table reference	Element name	BUFR				CREX		
		Unit	Scale	Reference value	Data width	Unit	Scale	Data width
0 01 101	State identifier	Code table	0	0	10	Code table	0	3
0 01 102	National station number	Numeric	0	0	30	Numeric	0	9
0 13 155	Intensity of precipitation (high accuracy)	kg m <sup>-2</sup> s <sup>-1</sup>	5	-1	16	mm h <sup>-1</sup>	1	5

And a note under Class 13 referring to 0 13 155:

An intensity of precipitation value of -0.00001 kg m<sup>-2</sup> s<sup>-1</sup> before scaling (-1 after scaling) and of -0.1 mm h<sup>-1</sup> before scaling (-1 after scaling) shall indicate a "trace" in BUFR and in CREX, respectively.

BUFR descriptors recommended for operational implementation as from 4 November 2009 (BUFR Table D, Version Number 14), available in the Manual on Codes, WMO-No. 306, Volume I.2 [1] at <http://www.wmo.int/pages/prog/www/WMOCodes.html>

Table reference	Element name
3 07 091	<i>BUFR template for surface observations from one-hour period with national and WMO station identification</i>
3 07 096	<i>BUFR template for representation of SYNOP data with supplementary one-hour observations</i>
3 01 089	<i>National station identification</i>
3 02 084	<i>"Instantaneous" data of sequence 307096</i>
3 02 085	<i>"Period" data of sequence 307096</i>
3 02 175	Intensity of precipitation (high accuracy), size of precipitation element

Data sub-categories were added in Common Code Table C-13 [1] to be used for data represented by template TM 307096:

Data categories		International data sub-categories (BUFR Ed. 4, CREX Ed.2)	
Code figure	Name	Code figure	Name
000	Surface data — land	50	Hourly synoptic observations with supplementary one-hour data
		51	Intermediate synoptic observations with supplementary one-hour data
		52	Main synoptic observations with supplementary one-hour data

## Annex 1

**BUFR template for surface observations from n-minute period  
TM 307092**

			Unit, scale
3 01 089		National station identification	
	0 01 101	State identifier <sup>(1)</sup>	Code table, 0
	0 01 102	National station number <sup>(1)</sup>	Numeric, 0
<b>3 01 090</b>		<b>Fixed surface station identification; time, horizontal and vertical co-ordinates</b>	
	3 01 004	Surface station identification	
		WMO block number	Numeric, 0
		WMO station number	Numeric, 0
		Station or site name	CCITT IA5, 0
		Type of station	Code table, 0
	3 01 011	Year <sup>(2)</sup>	Year, 0
		Month <sup>(2)</sup>	Month, 0
		Day <sup>(2)</sup>	Day, 0
	3 01 012	Hour <sup>(2)</sup>	Hour, 0
		Minute <sup>(2)</sup>	Minute, 0
	3 01 021	Latitude (high accuracy)	Degree, 5
		Longitude (high accuracy)	Degree, 5
	0 07 030	Height of station ground above mean sea level	m, 1
	0 07 031	Height of barometer above mean sea level	m, 1
0 08 010		Surface qualifier (for temperature data)	Code table, 0
<b>3 01 091</b>		<b>Surface station instrumentation</b>	
	0 02 180	Main present weather detecting system	Code table, 0
	0 02 181	Supplementary present weather sensor	Flag table, 0
	0 02 182	Visibility measurement system	Code table, 0
	0 02 183	Cloud detection system	Code table, 0
	0 02 184	Type of lightning detection sensor	Code table, 0
	0 02 179	Type of sky condition algorithm	Code table, 0
	0 02 186	Capability to detect precipitation phenomena	Flag table, 0
	0 02 187	Capability to detect other weather phenomena	Flag table, 0
	0 02 188	Capability to detect obscuration	Flag table, 0
	0 02 189	Capability to discriminate lightning strikes	Flag table, 0
0 04 015		Time increment (= - n minutes)	Minute, 0
0 04 065		Short time increment (= 1 minute)	Minute, 0
<b>1 25 000</b>		<b>Delayed replication of 25 descriptors</b>	
<b>0 31 001</b>		<b>Delayed descriptor replication factor (= n)</b>	Numeric, 0
0 10 004		Pressure	Pa, -1
<b>3 02 070</b>		<b>Wind data</b>	
	0 07 032	Height of sensor above local ground	m, 2
	0 07 033	Height of sensor above water surface	m, 1
	0 11 001	Wind direction	Degree true, 0
	0 11 002	Wind speed	m s <sup>-1</sup> , 1
	0 11 043	Maximum wind gust direction	Degree true, 0
	0 11 041	Maximum wind gust speed	m s <sup>-1</sup> , 1
	0 11 016	Extreme counterclockwise wind direction of a variable wind	Degree true, 0
	0 11 017	Extreme clockwise wind direction of a variable wind	Degree true, 0
<b>3 02 072</b>		<b>Temperature and humidity data</b>	
	0 07 032	Height of sensor above local ground	m, 2

	0 07 033	Height of sensor above water surface	m, 1
	0 12 101	Temperature/dry-bulb temperature (scale 2)	K, 2
	0 12 103	Dew-point temperature (scale 2)	K, 2
	0 13 003	Relative humidity	%, 0
0 07 032		Height of sensor above local ground (for ground temperature)	m, 2
0 12 101		Temperature/dry-bulb temperature (scale 2) (for ground temperature)	K, 2
<b>1 03 000</b>		<b>Delayed replication of 3 descriptors</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
1 01 005		Replicate 1 descriptor five times	
3 07 063	0 07 061	Depth below land surface	m, 2
	0 12 130	Soil temperature (scale 2)	K, 2
0 07 061		Depth below land surface (set to missing to cancel the previous value)	m, 2
<b>1 01 000</b>		<b>Delayed replication of 1 descriptor</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
<b>3 02 069</b>		<b>Visibility data</b>	
	0 07 032	Height of sensor above local ground	m, 2
	0 07 033	Height of sensor above water surface	m, 1
	0 33 041	Attribute of following value	Code table, 0
	0 20 001	Horizontal visibility	m, -1
0 07 032		Height of sensor above local ground (set to missing to cancel the previous value)	m, 2
0 07 033		Height of sensor above water surface (set to missing to cancel the previous value)	m, 1
<b>1 01 000</b>		<b>Delayed replication of 1 descriptor</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
<b>3 02 073</b>		<b>Cloud data</b>	
	0 20 010	Cloud cover (total)	%, 0
	1 05 004	Replicate 5 descriptors four times	
	0 08 002	Vertical significance	Code table, 0
	0 20 011	Cloud amount	Code table, 0
	0 20 012	Cloud type	Code table, 0
	0 33 041	Attribute of following value	Code table, 0
	0 20 013	Height of base of cloud	m, -1
<b>1 01 000</b>		<b>Delayed replication of 1 descriptor</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
<b>3 02 076</b>		<b>Precipitation, obscuration and other phenomena</b>	
	0 20 021	Type of precipitation	Flag table, 0
	0 20 022	Character of precipitation	Code table, 0
	0 26 020	Duration of precipitation <sup>(3)</sup>	Minute, 0
	0 20 023	Other weather phenomena	Flag table, 0
	0 20 024	Intensity of phenomena	Code table, 0
	0 20 025	Obscuration	Flag table, 0
	0 20 026	Character of obscuration	Code table, 0
<b>1 02 000</b>		<b>Delayed replication of 2 descriptors</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
0 13 155		Intensity of precipitation (high accuracy)	kg m <sup>-2</sup> s <sup>-1</sup> , 5
0 13 058		Size of precipitation element	m, 4
		<b>(end of the replicated sequence)</b>	
<b>1 02 000</b>		<b>Delayed replication of 2 descriptors</b>	
<b>0 31 000</b>		<b>Short delayed descriptor replication factor</b>	<b>Numeric, 0</b>
0 20 031		Ice deposit (thickness)	m, 2

0 20 032		Rate of ice accretion	Code table, 0
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 078</b>		<b>State of ground and snow depth measurement</b>	
	0 02 176	Method of state of ground measurement	Code table, 0
	0 20 062	State of ground (with or without snow)	Code table, 0
	0 02 177	Method of snow depth measurement	Code table, 0
	0 13 013	Total snow depth	m, 2
1 02 000		Delayed replication of 2 descriptors	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 079</b>		<b>Precipitation measurement</b>	
	0 07 032	Height of sensor above local ground	m, 2
	0 02 175	Method of precipitation measurement	Code table, 0
	0 02 178	Method of liquid water content measurement of precipitation	Code table, 0
	0 04 025	Time period (= - n minutes)	Minute, 0
	0 13 011	Total precipitation / total water equivalent of snow	kg m <sup>-2</sup> , 1
0 07 032		Height of sensor above local ground (set to missing to cancel the previous value)	m, 2
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 080</b>		<b>Evaporation measurement</b>	
	0 02 185	Method of evaporation measurement	Code table, 0
	0 04 025	Time period or displacement (= - n minutes)	Minute, 0
	0 13 033	Evaporation /evapotranspiration	kg m <sup>-2</sup> , 1
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 081</b>		<b>Total sunshine data</b>	
	0 04 025	Time period (= - n minutes)	Minute, 0
	0 14 031	Total sunshine	Minute, 0
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 082</b>		<b>Radiation data</b>	
	0 04 025	Time period (= - n minutes)	Minute, 0
	0 14 002	Long-wave radiation, integrated over period specified	J m <sup>-2</sup> , -3
	0 14 004	Short-wave radiation, integrated over period specified	J m <sup>-2</sup> , -3
	0 14 016	Net radiation, integrated over period specified	J m <sup>-2</sup> , -4
	0 14 028	Global solar radiation (high accuracy), integrated over period specified	J m <sup>-2</sup> , -2
	0 14 029	Diffuse solar radiation (high accuracy), integrated over period specified	J m <sup>-2</sup> , -2
	0 14 030	Direct solar radiation (high accuracy), integrated over period specified	J m <sup>-2</sup> , -2
1 02 000		Delayed replication of 2 descriptors	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
	0 04 025	Time period (= - n minutes)	Minute
	0 13 059	Number of flashes	Numeric
1 01 000		Delayed replication of 1 descriptor	
0 31 000		Short delayed descriptor replication factor	Numeric, 0
<b>3 02 083</b>		<b>First order statistics of P, W, T, U data</b>	
	0 04 025	Time period (= - n minutes)	Minute, 0
	0 08 023	First order statistics (= 9; best estimate of standard deviation) <sup>(4)</sup>	Code table, 0
	0 10 004	Pressure	Pa, -1
	0 11 001	Wind direction	Degree true, 0

	0 11 002	Wind speed	m s <sup>-1</sup> , 1
	0 12 101	Temperature/dry-bulb temperature (scale 2)	K, 2
	0 13 003	Relative humidity	%, 0
	0 08 023	First order statistics (= missing value)	Code table, 0
0 33 005		Quality information (AWS data)	Flag table, 0
0 33 006		Internal measurement status information (AWS)	Code table, 0

**Notes:**

- 1) 0 01 101 (WMO Member State identifier) and 0 01 102 (National AWS number) shall be used to identify a station within the national numbering system that is completely independent of the WMO international numbering system. The WMO international identification 0 01 001 (WMO block number) and 0 01 002 (WMO station number) shall be reported if available for the particular station.
- 2) The time identification refers to the end of the n-minute period.
- 3) Duration of precipitation (in minutes) represents number of minutes in which any precipitation was registered.
- 4) Best estimate of standard deviation is counted out of a set of samples (signal measurements) recorded within the period specified; it should be reported as a missing value, if the measurements of the relevant element are not available from a part of the period specified by 0 04 025.
- 5) If reporting nominal values is required, the template shall be supplemented with 3 07 093.

**3 07 093 - Representation of nominal values**

3 07 093		<b>Nominal values</b>	
	2 23 000	Substituted values operator	
	2 36 000	Backward reference bit map	
	1 01 000	Delayed replication of 1 descriptor	
	0 31 001	Delayed descriptor replication factor = number of element descriptors	Numeric, 0
	0 31 031	Data present indicator	Numeric, 0
	0 01 033	Indication of originating/generating center	Code table, 0
	0 01 032	Generating application	Code table, 0
	0 08 083	Nominal value indicator	Flag table, 0
	1 01 000	Delayed replication of 1 descriptor	
	0 31 001	Delayed descriptor replication factor	Numeric, 0
	2 23 255	Substituted values	
	1 08 000	Delayed replication of 1 descriptor	
	0 31 001	Delayed descriptor replication factor	Numeric, 0
	2 23 000	Substituted values operator	
	2 37 000	Use previously defined bit map	
	0 01 033	Indication of originating/generating center	Code table, 0
	0 01 032	Generating application	Code table, 0
	0 08 083	Nominal value indicator	Flag table, 0
	1 01 000	Delayed replication of 1 descriptor	
	0 31 001	Delayed descriptor replication factor	Numeric, 0
	2 23 255	Substituted values	