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DISCUSSION ON RADIOSONDE/SOUNDING SYSTEM USED IN WMO MESSAGES

(*Submitted by Secretariat)*

Summary and purpose of document

This document provides information on current and future possibilities to report on used radiosonde/sounding system.

Action proposed

The meeting is invited to take into account information presented in this document when discussing issues related to reporting of information on used radiosonde/sounding system.

Discussion on Radiosonde/Sounding system used in WMO Messages

1. Recently, there have been number of significant changes in radiosonde and ground systems designs. The user community requires that different sondes (designs) could be identified through the WMO Messages, such as TEMP and BUFR.

2. The last version of Common Table C-2 for radiosondes entries, included in a TEMP Message, is listed in ANNEX 1. One can see that this table is near saturation. On the contrary, with BUFR we would have up to 254 entries. And if that is not sufficient a new descriptor could be defined.

3. More Metadata would need to be transmitted with the radiosonde observations. See in ANNEX 2 the list of new tables used in BUF/CREX by USA for this information. Additions of metadata is easy in BUFR.

4. There is also a strong coming requirement for the transmission of all the sonde positions at every measurement points (Time and Latitude, Longitude Coordinates). The sonde flight is then seen as an aircraft flight. This is required by the very high resolution (non-hydrostatic) modellers who cannot accept inaccurate positioning of the sonde especially in the first 5000 meters. BUFR will also allow compression to transmit this high density information. You can see in ANNEX 3 the suggested templates proposed for that for upper-air observations reports.

5. The only way to satisfy all these requirements in the future is to go BUFR (or CREX if binary transmission is not possible- interim solution). The CBS and XIVth Congress have endorsed the migration to Table Driven Code Forms and NMHSs as well as manufacturers have to work for it (see recommended schedule in ANNEX 4). Experimental exchange in BUFR of radiosonding data can start now. The operational exchange of Radiosonding data should start in 2005 and the migration should be completed by 2010. Manufacturers should have the transmission in BUFR/CREX in their development shops and soon in their implementation shops.

6. The CBS Expert Team on Data Representation and Codes cannot accept to modify the FM 35 TEMP and FM 36 TEMP SHIP code forms, which would imply changes in all data processing systems, and perhaps, only before another one again later, etc.. On the contrary, the BUFR/CREX solution is once for all, and then you just modified the centralised code tables, for any subsequent changes.

7. For all these reasons, BUFR/CREX formats are the only solution in proper reporting on the radiosonde/sounding system used in WMO Messages.

ANNEX 1: COMMON CODE TABLE C-2: RADIOSONDE/ SOUNDING SYSTEM USED

Common Code Table: (Code table 3685 -r_ar_a (Radiosonde/sounding system used) – for alphanumeric codes
(Code table 0 02 011 (Radiosonde type) in BUFR

Code figure for r_ar_a (Code table 3685)	**Code figure for BUFR (Code table 0 02 011)**	
00–01	0–1	Reserved
02	2	No radiosonde – passive target (e.g. reflector)
03	3	No radiosonde – active target (e.g. transponder)
04	4	No radiosonde – passive temperature-humidity profiler
05	5	No radiosonde – active temperature-humidity profiler
06	6	No radiosonde – radio-acoustic sounder
07–08	7–8	No radiosonde – . . . (reserved)
09	9	No radiosonde – system unknown or not specified
10	10	VIZ type A pressure-commutated (USA)
11	11	VIZ type B time-commutated (USA)
12	12	RS SDC (Space Data Corporation – USA)
13	13	Astor (no longer made — Australia)
14	14	VIZ Mark I MICROSONDE (USA)
15	15	EEC Company type 23 (USA)
16	16	Elin (Austria)
17	17	Graw G. (Germany)
18	18	Reserved for allocation of radiosonde
19	19	Graw M60 (Germany)
20	20	Indian Meteorological Service MK3 (India)
21	21	VIZ/Jin Yang Mark I MICROSONDE (South Korea)
22	22	Meisei RS2-80 (Japan)
23	23	Mesural FMO 1950A (France)
24	24	Mesural FMO 1945A (France)
25	25	Mesural MH73A (France)
26	26	Meteolabor Basora (Switzerland)
27	27	AVK-MRZ (Russian Federation)
28	28	Meteorit Marz2-1 (Russian Federation)
29	29	Meteorit Marz2-2 (Russian Federation)
30	30	Oki RS2-80 (Japan)
31	31	VIZ/Valcom type A pressure-commutated (Canada)
32	32	Shanghai Radio (China)
33	33	UK Met Office MK3 (UK)
34	34	Vinohrady (Czechoslovakia)
35	35	Vaisala RS18 (Finland)
36	36	Vaisala RS21 (Finland)
37	37	Vaisala RS80 (Finland)
38	38	VIZ LOCATE Loran-C (USA)
39	39	Sprenger E076 (Germany)
40	40	Sprenger E084 (Germany)
41	41	Sprenger E085 (Germany)
42	42	Sprenger E086 (Germany)
43	43	AIR IS - 4A - 1680 (USA)
44	44	AIR IS - 4A - 1680 X (USA)
45	45	RS MSS (USA)
46	46	Air IS - 4A - 403 (USA)
47	47	Meisei RS2-91 (Japan)
48	48	VALCOM (Canada)
49	49	VIZ MARK II (USA)
50	50	GRAW DFM-90 (Germany)
51	51	VIZ-B2 (USA)
52	52	Vaisala RS80-57H
53	53	AVK-RF95 (Russian Federation)
54	54	GRAW DFM-97 (Germany)
55	55	Meisei RS-016 (Japan)
56	56	M2K2 (France)
57	57	M2K2-P (France)
58–59	58–59	Reserved for allocation of radiosondes
60	60	Vaisala RS80/MicroCora (Finland)

Code figure for $r_a r_a$ (Code table 3685)	Code figure for BUFR (Code table 0 02 011)	
61	61	Vaisala RS80/Loran/Digicora I,II or Marwin (Finland)
62	62	Vaisala RS80/PCCora (Finland)
63	63	Vaisala RS80/Star (Finland)
64	64	Orbital Sciences Corporation, Space Data Division, transponder radiosonde, type 909-11-XX, where XX correspond to the model of the instrument (USA)
65	65	VIZ transponder radiosonde, model number 1499–520 (USA)
66	66	Vaisala RS80 /Autosonde (Finland)
67	67	Vaisala RS80/Digicora III (Finland)
68–70	68–70	Reserved for additional automated sounding systems
71	71	Vaisala RS90/Digicora I,II or Marwin (Finland)
72	72	Vaisala RS90/PC-Cora (Finland)
73	73	Vaisala RS90/Autosonde (Finland)
74	74	Vaisala RS90/Star (Finland)
75	75	AVK-MRZ-ARMA (Russian Federation)
76	76	AVK-RF95-ARMA (Russian Federation)
77	77	GEOLINK GPSonde GL98 (France)
78	78	Vaisala RS90/Digicora III (Finland)
79	79	Vaisala RS92/Digicora I,II or Marwin (Finland)
80	80	Vaisala RS92/Digicora III (Finland)
81	81	Vaisala RS92/Autosonde (Finland)
82	82	Sippican MK2 GPS/STAR (USA) with rod thermistor, carbon element, and derived pressure
83	83	Sippican MK2 GPS/W9000 (USA) with rod thermistor, carbon element, and derived pressure
84	84	Sippican MARK II with chip thermistor, carbon element, and derived pressure from GPS height
85	85	Sippican MARK IIA with chip thermistor, carbon element, and derived pressure from GPS height
86	86	Sippican MARK II with chip thermistor, pressure, and carbon element
87	87	Sippican MARK IIA with chip thermistor, pressure, and carbon element
88-89	88-89	Reserved for additional automated sounding systems
90	90	Radiosonde not specified or unknown
91	91	Pressure-only radiosonde
92	92	Pressure-only radiosonde plus transponder
93	93	Pressure-only radiosonde plus radar-reflector
94	94	No-pressure radiosonde plus transponder
95	95	No-pressure radiosonde plus radar-reflector
96	96	Descending radiosonde
97–99	97–99	Reserved for allocation of sounding systems with incomplete sondes
	100–254 Reserved	
	255 Missing value	

NOTES:

(1) References to countries in brackets indicate the manufacturing location rather than the country using the instrument.

(2) Some of the radiosondes listed are no longer in use but are retained for archiving purposes.

ANNEX 2: NEW BUFR/CREX DESCRIPTORS FOR NEW RAWINSONDE DATA:

Radiosonde serial number	0-01-081	CCITT IA5	0	0	160
	B-01-081	Character	0		20
Radiosonde ascension number	0-01-082	Numeric	0	0	14
	B-01-082	Numeric	0		4
Radiosonde release number	0-01-083	Numeric	0	0	3
	B-01-083	Numeric	0		1
Balloon lot number	0-01-093	CCITT IA5	0	0	96
	B-01-093	Character	0		12
WBAN Number	0-01-094	Numeric	0	0	17
	B-01-094	Numeric	0		5
Observer identification	0-01-095	CCITT IA5	0	0	32
	B-01-095	Character	0		4
Radiosonde configuration	0-02-016	Flag table	0	0	5
	B-02-016	Flag table	0		2
Radiosonde ground receiving system	0-02-066	Code table	0	0	6
	B-02-066	Code table	0		2
Radiosonde operating frequency	0-02-067	Hz	-5	0	15
	B-02-067	Hz	-5		5
Balloon manufacturer	0-02-080	Code table	0	0	6
	B-02-080	Code table	0		2
Type of balloon	0-02-081	Code table	0	0	5
	B-02-081	Code table	0		2
Weight of balloon	0-02-082	Kg	3	0	12
	B-02-082	Kg	3		4
Type of balloon shelter	0-02-083	Code table	0	0	4
	B-02-083	Code table	0		2
Type of gas used in balloon	0-02-084	Code table	0	0	4
	B-02-084	Code table	0		2
Amount of gas used in balloon	0-02-085	Kg	3	0	13
	B-02-085	Kg	3		4
Balloon flight train length	0-02-086	m	1	0	10
	B-02-086	m	1		4
Type of pressure sensor	0-02-095	Code table	0	0	5
	B-02-095	Code table	0		2
Type of temperature sensor	0-02-096	Code table	0	0	5
	B-02-096	Code table	0		2
Type of humidity sensor	0-02-097	Code table	0	0	5
	B-02-097	Code table	0		2
Type of surface observing equipment	0-02-115	Code table	0	0	5
	B-02-115	Code table	0		2
Flight level significance	0-08-040	Code table	0	0	6
	B-08-040	Code table	0		2
Data significance	0-08-041	Code table	0	0	5
	B-08-041	Code table	0		2
Relative humidity	0-13-009	%	1	-1000	12
	B-13-009	%	1		4
Software identification	0-25-061	CCITT IA5	0	0	96
	B-25-061	Character	0		12
Orientation correction (azimuth)	0-25-065	Degree	2	-1000	11
	B-25-065	Degree	2		4
Orientation correction (elevation)	0-25-066	Degree	2	-1000	11
	B-25-066	Degree	2		4
Radiosonde release point pressure correction	0-25-067	Pa	0	-8000	14
	B-25-067	Pa	0		4

Number of archive recomputes	0-25-068	Numeric	0	0	7
	B-25-068	Numeric	0		3
Flight level pressure corrections	0-25-069	Flag table	0	0	8
	B-25-069	Flag table	0		3
Data quality check indicator	0-33-015	Code table	0	0	6
	B-33-015	Code table	0		2
Reason for termination	0-35-035	Code table	0	0	5
	B-35-035	Code table	0		2

Additional note under BUFR/CREX Class 1:

(12) Descriptor 0-01-082 is to be used for reporting the sequential number of the current radiosonde reporting period (e.g. synoptic cycle) within a given year or other similar locally-defined length of time. Descriptor 0-01-083 is to be used in the case of multiple sequential radiosonde releases during a single reporting period (e.g. synoptic cycle), in order to indicate which particular release generated the corresponding data values.

New code and flag tables:

Radiosonde configuration (0-02-016)

Bit	Meaning
1	Train regulator
2	Light unit
3	Parachute
4	Rooftop release
All 5	Missing value

Radiosonde ground receiving system (0-02-066)

Code	Meaning
0	TRS 2000
1	IMS 1500C
2-61	Reserved
62	Other
63	Missing value

Balloon manufacturer (0-02-080)

Code	Meaning
0	Kaysam
1	Totex
2	KKS
3-61	Reserved
62	Other
63	Missing value

Type of balloon (0-02-081)

Code	Meaning
0	GP26
1	GP28
2	GP30

Code	Meaning
3	HM26
4	HM28
5	HM30
6	SV16
7-29	Reserved
30	Other
31	Missing value

Type of balloon shelter (0-02-083)

Code	Meaning
0	High bay
1	Low bay
2	Balloon Inflation Launch System (BILS)
3	Roof-top BILS
4-13	Reserved
14	Other
15	Missing value

Type of gas used in balloon (0-02-084)

Code	Meaning
0	Hydrogen
1	Helium
2	Natural Gas
3-13	Reserved
14	Other
15	Missing value

Type of pressure sensor (0-02-095)

Code	Meaning
0	Capacitance aneroid
1	Derived from GPS
2	Resistive strain gauge
3-29	Reserved
30	Other
31	Missing value

Type of temperature sensor (0-02-096)

Code	Meaning
0	Rod thermistor
1	Bead thermistor
2	Capacitance bead
3-29	Reserved
30	Other
31	Missing value

Type of humidity sensor (0-02-097)

Code	Meaning
0	VIZ Mark II Carbon Hygristor
1	VIZ B2 Hygristor
2	Vaisala A-Humicap
3	Vaisala H-Humicap
4	Capacitance sensor
5	Vaisala RS90
6	Sippican Mark IIA Carbon Hygristor
7-29	Reserved
30	Other
31	Missing value

Type of surface observing equipment (0-02-115)

Code	Meaning
0	PDB
1	RSOIS
2	ASOS
3	Psychrometer
4	F420
5-29	Reserved
30	Other
31	Missing value

Flight level significance (0-08-040)

Code	Meaning
0	High resolution data sample
1	Within 20 hPa of surface
2	Pressure less than 10 hPa (i.e., 9, 8, 7, etc.) when no other reason applies
3	Base pressure level for stability index
4	Begin doubtful temperature, height data
5	Begin missing data (all elements)
6	Begin missing RH data
7	Begin missing temperature data
8	Highest level reached before balloon descent because of icing or turbulence
9	End doubtful temperature, height data
10	End missing data (all elements)
11	End missing RH data
12	End missing temperature data
13	Zero degrees C crossing(s) for RADAT
14	Standard pressure level
15	Operator added level
16	Operator deleted level
17	Balloon re-ascended beyond previous highest ascent level
18	Significant RH level
19	RH level selection terminated
20	Surface level
21	Significant temperature level
22	Mandatory temperature level
23	Flight termination level
24	Tropopause(s)
25	Aircraft report
26	Interpolated (generated) level
27	Mandatory wind level
28	Significant wind level
29	Maximum wind level
30	Incremental wind level (fixed regional)
31	Incremental height level (generated)
32	Wind termination level
33	Pressure 100 to 110 hPa, when no other reason applies
34-39	Reserved
40	Significant thermodynamic level (inversion)
41	Significant RH level (per NCDC criteria)
42	Significant temperature level (per NCDC)
43-61	Reserved
62	Other
63	Missing value

Data significance (0-08-041)

Code	Meaning
0	Parent site
1	Observation site
2	Balloon manufacture date
3	Balloon launch point
4	Surface observation
5	Surface observation displacement from launch point
6	Flight level observation
7	Flight level termination point
8-30	Reserved
31	Missing value

Flight Level Pressure Corrections (0-25-069)

Bit	Meaning
1	Smoothed
2	Baseline adjusted
3	Normalized time interval
4	Outlier checked
5	Plausibility checked
6	Consistency checked
7	Interpolated
All 8	Missing value

Data Quality Check Indicator (0-33-015)

Code	Meaning
0	Passed all checks
1	Missing-data check
2	Descending/reascending balloon check
3	Data plausibility check (above limits)
4	Data plausibility check (below limits)
5	Superadiabatic lapse rate check
6	Limiting angles check
7	Ascension rate check
8	Excessive change from previous flight
9	Balloon overhead check
10	Wind speed check
11	Wind direction check
12	Dependency check
13	Data valid but modified
14	Data outlier check
15-62	Reserved
63	Missing value

Reason for termination (0-35-035))

Code	Meaning

Code	Meaning
0	Reserved
1	Balloon burst
2	Balloon forced down by icing
3	Leaking or floating balloon
4	Weak or fading signal
5	Battery failure
6	Ground equipment failure
7	Signal interference
8	Radiosonde failure
9	Excessive missing data frames
10	Reserved
11	Excessive missing temperature
12	Excessive missing pressure
13	User terminated
14-29	Reserved
30	Other
31	Missing value

Add the following new entries to existing descriptor 0-33-035 (Manual/automatic quality control):

Code	Meaning
6	Automatic quality control flagged data as questionable and not manually checked
7	Automatic quality control flagged data as questionable and manually checked and failed
8	Manually checked and failed
9-14	Reserved

ANNEX 3: SUGGESTED BUFR TEMPLATES FOR TEMP, TEMP DROP, TEMP SHIP, TEMP MOBIL

		Identification and instrumentation	
3 01 001	0 01 001	WMO block number	Numeric
	0 01 002	WMO station number	Numeric
0 01 011		Ship or mobile land station identifier	CCITT IA5
0 01 006		Aircraft identifier (for dropsondes)	CCITT IA5
0 02 011		Radiosonde type	Code table
0 02 013		Solar and infrared radiation correction	Code table
0 02 014		Tracking technique/status of system used	Code table
0 02 003		Type of measuring equipment used	Code table
		Nominal date/time, horizontal and vertical coordinates of launch site	
3 01 011	0 04 001	Year	Year
	0 04 002	Month	Month
	0 04 003	Day	Day
3 01 012	0 04 004	Hour	Hour
	0 04 005	Minute	Minute
3 01 021	0 05 001	Latitude (high accuracy)	Degree, scale 5
	0 06 001	Longitude (high accuracy)	Degree, scale 5
0 07 030		Height of station ground above mean sea level	m, scale 1
0 07 031		Height of barometer above mean sea level	m, scale 1
0 07 007		Height of release of sonde above mean sea level	m
0 33 024		Station elevation quality mark (for mobile stations)	Code table
		Sea water temperature	
0 22 043		Sea/water temperature (for ship stations)	K, scale 2
		Cloud data	
0 08 002		Vertical significance	Code table
0 20 011		Cloud amount (of low or middle clouds N_h)	Code table
0 20 013		Height of base of cloud (h)	m, scale –1
0 20 012		Cloud type (low clouds C_L)	Code table
0 20 012		Cloud type (middle clouds C_M)	Code table
0 20 012		Cloud type (high clouds C_H)	Code table
		Date/time of the launch	
0 08 021		Time significance (value = 18 (radiosonde launch time))	Code table
3 01 011	0 04 001	Year	Year
	0 04 002	Month	Month
	0 04 003	Day	Day
3 01 012	0 04 004	Hour	Hour
	0 04 005	Minute	Minute
	0 04 006	Second	
		Level data	
1 10 000		Delayed replication of 10 descriptors	
0 31 002		Extended delayed descriptor replication factor	Numeric
		Data from a single level	
0 04 018		Time increment (since the launch time)	Second
0 08 001		Vertical sounding significance	Flag table
0 07 004		Pressure	Pa, scale –1
0 10 009		Geopotential height	gpm
0 05 011		Latitude increment since launch site (high accuracy)	Degree, scale 5
0 06 011		Longitude increment since launch site (high accuracy)	Degree, scale 5

0 12 101		Temperature/dry-bulb temperature (scale 2)	K, scale 2
0 12 103		Dew-point temperature (scale 2)	K, scale 2
0 11 001		Wind direction	Degree true
0 11 002		Wind speed	m s^{-1}, scale 1
		Wind shear data	
0 08 001		Vertical sounding significance	Flag table
0 07 004		Pressure	Pa, scale –1
3 01 023	0 05 002	Latitude (coarse accuracy)	Degree, scale 2
	0 06 002	Longitude (coarse accuracy)	Degree, scale 2
0 11 061		Absolute wind shear in 1 km layer below	m s^{-1}, scale 1
0 11 062		Absolute wind shear in 1 km layer above	m s^{-1}, scale 1

Notes: (1) If horizontal coordinates of the sonde are not available, latitude and longitude (high accuracy) of the location of launch shall be reported for 3 01 023.

ANNEX 4: Code migration schedule

	Category					
	Cat.1: common	**Cat.2: satellite observations**	**Cat.3: aviation [(1)]**	**Cat. 4: maritime**	**Cat. 5[(2)]: miscellaneous**	**Cat. 6[(2)]: almost obsolete**
Lists of Traditional code forms	SYNOP SYNOP MOBIL PILOT PILOT MOBIL TEMP TEMP MOBIL TEMP DROP CLIMAT CLIMAT TEMP	SAREP SATEM SARAD SATOB	METAR SPECI TAF CODAR AMDAR WINTEM ARFOR ROFOR	BUOY TRACKOB BATHY TESAC WAVEOB SHIP CLIMAT SHIP PILOT SHIP TEMP SHIP CLIMAT TEMP SHIP	RADOB RADREP IAC IAC FLEET GRID *(to GRIB)* MAFOR HYDRA HYFOR RADOF	ICEAN GRAF NACLI etc. SFAZI SFLOC SFAZU ROCOB ROCOB SHIP
	Schedule					
Start experimental exchange [(3)]	**Nov. 2002** for some data (AWS SYNOP, TEMP USA)	Current at some Centres	**2006** **2002** at some Centres for AMDAR	**2005** **2003** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2004**	Not applicable
Start operational exchange [(3)]	**Nov. 2005**	Current at some Centres	**2008** **2003** for AMDAR	**2007** **2003** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2006**	Not applicable
Migration complete	**Nov. 2010**	**Nov. 2006**	**2015** **2005** for AMDAR	**2012** **2008** for Argos data (BUOY, sub-surface floats, XBT/XCTD)	**2008**	Not applicable

Notes:

(1) Aviation codes require ICAO coordination and approval.

(2) Category 5 codes will need to be reviewed to determine if there is a final requirement to be migrated to BUFR/CREX. If not, they will be moved to category 6. Codes in category 6 are not to be migrated.

(3) All dates above are meant as "not later than". However, Members and organizations are encouraged to start experimental exchange, and, if all relevant conditions (see below) are satisfied, to start operational exchange as soon as possible.

(a) **Start of experimental exchange:** data will be made available in BUFR (CREX if needed) but not operationally, i.e. in addition to the current alphanumeric codes, which are still operational;

(b) **Start of operational exchange:** data will be made available in BUFR (CREX if needed) whereby some (but not all) Members rely on them operationally. Some distribution of the current alphanumeric codes will still be done;

(c) **Migration complete:** at this date the BUFR (CREX if needed) exchange becomes the standard WMO practice. Distribution of the current alphanumeric codes is terminated. For archiving purposes and where BUFR or CREX exchange still causes problems, the alphanumeric codes may be used on a local or national.

Relevant conditions to be satisfied before experimental exchange may start:

(a) Corresponding BUFR/CREX-tables and templates are available;
(b) Training of exchanging parties has been completed;
(c) Required software of exchanging parties (encoding, decoding, viewing) is implemented.

Relevant conditions to be satisfied before operational exchange may start:

(a) Corresponding BUFR/CREX-tables and templates are fully validated;
(b) Training of all concerned parties has been completed;
(c) ll required software (encoding, decoding, viewing) is operational.