



WMO

# World Meteorological Organization

*Working together in weather, climate and water*

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global ocean observations using ship logistics  
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## WMO operational Codes

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# Operational codes for the distribution of time critical data through the Global Telecommunication System (GTS)

- Traditional Alphanumeric Codes (TAC) - examples
  - **FM 13–XIV SHIP - Report of surface observation from a sea station**
  - FM 18–XII BUOY - Report of a buoy observation
  - FM 36–XI Ext. TEMP SHIP - Upper-level pressure, temperature, humidity and wind report from a sea station
  - FM 62–VIII Ext. TRACKOB - Report of marine surface observation along a ship's track
  - FM 63–XI Ext. BATHY - Report of bathythermal observation
  - FM 64–XI Ext. TESAC - Temperature, salinity and current report from a sea station
  - FM 65–XI Ext. WAVEOB - Report of spectral wave information from a sea station or from a remote platform (aircraft or satellite)
- Table driven Codes (TDC)
  - FM 94–XIV BUFR - Binary universal form for the representation of meteorological data
  - FM 95–XIV CREX - Character form for the representation and exchange of data



# FM 13–XIV SHIP

(report of surface observation from a sea station)

- Allow for the reporting of data from VOS, rigs and platforms, sea stations, moorings
- Often referred as “BBXX”
- Identification
  - D...D Ship's call sign (7-digit max, “SHIP” can be coded if no call sign is available)
  - A<sub>1</sub>b<sub>w</sub>n<sub>b</sub>n<sub>b</sub>n<sub>b</sub> Identifier for buoy, rig, sea platform
- Position in 1/10 of degree (LaLaLa QcLoLoLoLo)
- Metadata coding limited

FM 12–XIV SYNOP

Report of surface observation from a fixed land station

FM 13–XIV SHIP

Report of surface observation from a sea station

FM 14–XIV SYNOP MOBIL

Report of surface observation from a mobile land station

CODE FORM :

SECTION 0     $M_i M_j M_k M_l$      $\left\{ \begin{array}{l} D \dots D^{****} \\ \text{or} \\ A_1 b_w n_b n_b n_b^{**} \end{array} \right\}$      $Y Y G G i_w$      $\left\{ \begin{array}{l} \text{iiiii}^* \\ \text{or} \\ 99 L_a L_a L_a \quad Q_c L_o L_o L_o L_o^{****} \end{array} \right\}$      $MMM U_{L_a} U_{L_o}^{***}$      $h_0 h_0 h_0 h_0 i_m^{***}$

SECTION 1     $i_{R_x} h V V$      $N d d f f$      $(00 f f f)$      $1 s_n T T T$      $\left\{ \begin{array}{l} 2 s_n T_d T_d T_d \\ \text{or} \\ 29 U U U \end{array} \right\}$      $3 P_0 P_0 P_0 P_0$

$\left\{ \begin{array}{l} 4 P P P P \\ \text{or} \\ 4 a_3 h h h \end{array} \right\}$      $5 a p p p$      $6 R R R t_R$      $\left\{ \begin{array}{l} 7 w w W_1 W_2 \\ \text{or} \\ 7 w_a w_a W_{a1} W_{a2} \end{array} \right\}$      $8 N_h C_L C_M C_H$      $9 G G g g$

SECTION 2     $222 D_s V_s$      $(0 s_s T_w T_w T_w)$      $(1 P_{w_a} P_{w_a} H_{w_a} H_{w_a})$      $(2 P_w P_w H_w H_w)$      $((3 d_{w1} d_{w1} d_{w2} d_{w2}))$

$(4 P_{w1} P_{w1} H_{w1} H_{w1})$      $(5 P_{w2} P_{w2} H_{w2} H_{w2})$      $\left( \left\{ \begin{array}{l} 6 I_s E_s E_s R_s \\ \text{or ICING +} \\ \text{plain language} \end{array} \right\} \right)$

$(70 H_{w_a} H_{w_a} H_{w_a})$      $(8 s_w T_b T_b T_b)$      $(ICE + \left\{ \begin{array}{l} c_i S_i b_i D_i Z_i \\ \text{or} \\ \text{plain language} \end{array} \right\})$

SECTION 3     $333$      $(0 \dots)$      $(1 s_n T_x T_x T_x)$      $(2 s_n T_n T_n T_n)$      $(3 E j j j)$      $(4 E' s s s)$      $(5 j_1 j_2 j_3 j_4 \quad (j_5 j_6 j_7 j_8 j_9))$

$(6 R R R t_R)$      $(7 R_{24} R_{24} R_{24} R_{24})$      $(8 N_s C_h s_h s)$      $(9 S_p S_p S_p S_p)$

$(80000 \quad (0 \dots))$      $(1 \dots) \dots$

SECTION 4    444    N'C'H'H'C<sub>t</sub>

SECTION 5    555    Groups to be developed nationally



# Table Driven Codes

- Concerned codes
  - FM 94-XIV BUFR : Binary code (recommended for VOS data)
  - FM 95-XIV CREX : Character code
- More flexible
- Efficient in terms of volumes
  - Encoding according to required resolution
  - Compression for BUFR
- More data & metadata can be included
- Will permit the masking of ship's call sign using encryption
- Some preservability issues



# Migration to Table Driven Codes

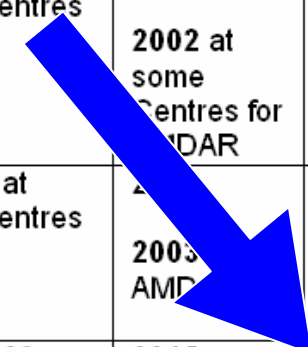
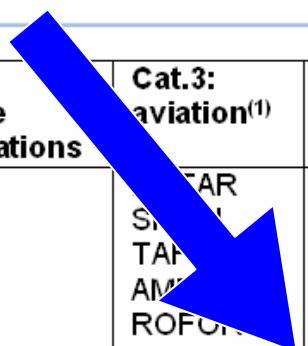
- Traditional Character Codes frozen by CBS
- All reports from sea stations shall be made in BUFR (or CREX) no later than 2012
- A transition period is recommended with distribution in both FM 13 SHIP and FM 94 BUFR formats
- BUFR encoding should be automated through the use of e-logbooks (no human encoding required)
- Encoders/decoders available from WMO

[http://www.wmo.int/pages/prog/www/WMOCodes/Software\\_encoder\\_decoder\\_20101005.doc](http://www.wmo.int/pages/prog/www/WMOCodes/Software_encoder_decoder_20101005.doc)



# Code migration schedule

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





# BUFR basics (1/7)

- Data are encoded in binary
  - Not for direct human encoding & decoding
  - Software needed to encode & decode
  - Minimum number of bits required to encode data
  - Compression is possible (e.g. time series)
- Table driven code
  - The format itself is quite stable
  - Tables are flexible and can be “easily” updated
    - » Changes submitted through the CBS Inter Programme Expert Team on Data Representation and Codes (IPET-DRC)



# BUFR Basics (2/7)

- Structure of BUFR report
  - Section 0 : "BUFR"
  - Section 1 : Identification
  - Section 2 : Optional section (local use)
  - Section 3 : Description of data
    - » Describes data to be coded (i.e. the list of descriptors used in Section 4)
  - Section 4 : Observational data
    - » Observed data values coded according to the ordering in section 3, and coding requirements for each descriptor
  - Section 5 : "7777"



# BUFR Basics (3/7)

- 4 Types of descriptors
  - Element descriptors (Table B)
    - » Elements to be encoded (e.g. identification, year, month, day, lat, long, P, T, present weather ...)
    - » Table indicates for each descriptor the coding requirements (units, nb bits, offset, scale)
  - Replication descriptors (e.g. repeat D/T/S data points for an ocean T profile)
  - Operator descriptors (e.g. re-scaling) (Table C)
  - Sequence descriptors: defines a sequence of descriptors (e.g. Date = Year + Month + Day) (Table D) – permits to standardize coding practices, and shorten Section 3



# BUFR Basics (4/7)

- BUFR Tables -  
<http://www.wmo.int/pages/prog/www/WMOCodes/TDCFtables.html#TDCFtables>
  - Table A – Categories of data
  - **Table B – Classification/Definition of elements**
  - Table C – Definition of operation descriptors
  - **Table D - Definition of BUFR sequences**
  - Code/Flag tables
    - » **Code Tables: List of possible values for an element descriptor (e.g. present weather)**
    - » Flag tables: Interpretation of each of the N-bits of an element descriptor
  - **Common features to binary and alphanumeric codes**
    - » Some Code/Flag tables common to TACs and TDCs



# BUFR Basic (5/7)

Example of element descriptors (Table B)

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR			
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)
0 02 038	Method of water temperature and/or salinity measurement	Code table	0	0	4
0 07 063	Depth below sea/water surface (cm)	m	2	0	20
0 22 001	Direction of waves	Degree true	0	0	9
0 22 011	Period of waves	s	0	0	6
0 22 021	Height of waves	m	1	0	10
0 22 043	Sea/water temperature	K	2	0	15



# BUFR Basics (6/7)

## Example of Flag Table

**0 02 038**

### **Method of water temperature and/or salinity measurement**

#### **Code figure**

0	Ship intake
1	Bucket
2	Hull contact sensor
3	Reversing thermometer
4	STD/CTD sensor
5	Mechanical BT
6	Expendable BT
7	Digital BT
8	Thermistor chain
9	Infrared scanner
10	Microwave scanner
11	Infrared radiometer
12	In-line thermosalinograph
13	Towed body
14	Other
15	Missing value



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# BUFR Basics (7/7)

## Example of BUFR sequence (Table D)

3 02 057		<b>Ship marine data</b>		
	3 02 056	Sea surface temperature, method of measurement, and depth below sea surface		
	0 02 038	Method of sea/water temperature measurement	Code table, 0	
	0 07 063	Depth below sea/water surface (for sea surface temperature measurement)	m, 2	
	0 22 043	Sea/water temperature $s_s T_w T_w T_w$	K, 2	
	0 07 063	Depth below sea/water surface (set to missing to cancel the previous value)	m, 2	
	3 02 021	Waves		
	0 22 001	Direction of waves	Degree true	
	0 22 011	Period of waves $P_{wa} P_{wa}$	s, 0	
	0 22 021	Height of waves $H_{wa} H_{wa}$	m, 1	
...	...	...	...	



# JCOMM DMPA Task Team on Table Driven Codes

- Chaired by Bill Burnett (US NDBC)
- Liaise with users of TDCs and consider their requirements
- Consider metadata requirements for TDCs (e.g. Pub47, ODAS, META-T)
- Review & evolve existing templates or new forms
- Maintain & evolve Master Table 10 (oceanographic data)
- Addresses climate requirements for preservability
- Coordinates implementation with CBS IPET-DRC
- Report progress to JCOMM



# BUFR Templates

- Series of BUFR descriptors for encoding specific types of platform data
- Correspond to specific coding practices
- May eventually correspond to a BUFR sequence





# BUFR Templates

- B/C10 - Regulations for reporting SHIP data in TDCF
- BUFR Template for synoptic reports from sea stations suitable for ship observation data from VOS stations (in validation)
- JCOMM rationalization of BUFR sequences
  - Standard sequences by variable throughout the different platform types
    - » e.g. same sequence for data + metadata for SST observations from VOS, moorings, drifters, tide gauges ...



# B/C10 - Regulations for reporting SHIP data in TDCF

[http://www.wmo.int/pages/prog/www/WMOCodes/BC\\_Regulations/BC10-SHIP.pdf](http://www.wmo.int/pages/prog/www/WMOCodes/BC_Regulations/BC10-SHIP.pdf)

Amendment: 15 Sep. 2010

TM 308009 - BUFR template for synoptic reports from sea stations suitable for SHIP data

(Translation of FM 13 SHIP in BUFR)

3 08 009		Sequence for representation of synoptic reports from a sea station suitable for SHIP data
	3 01 093	Ship identification, movement, date/time, horizontal and vertical coordinates
	3 02 001	Pressure data
	3 02 054	SHIP "instantaneous" data
	0 08 002	Vertical significance
	3 02 055	Icing and ice
	3 02 057	SHIP marine data
	3 02 060	SHIP "period" data

This BUFR template for synoptic reports from sea stations further expands as follows:

3 01 093			Ship identification, movement, date/time, horizontal and vertical coordinates	Unit, scale
	3 01 036	0 01 011	Ship or mobile land station identifier D...D	CCITT IA5, 0
		0 01 012	Direction of motion of moving observing platform <sup>(3)</sup> D <sub>s</sub>	Degree true, 0
		0 01 013	Speed of motion of moving observing platform <sup>(4)</sup> v <sub>s</sub>	m s <sup>-1</sup> , 0
		0 02 001	Type of station (i <sub>x</sub> )	Code table, 0
		0 04 001	Year	Year, 0
		0 04 002	Month	Month, 0
		0 04 003	Day YY	Day, 0
		0 04 004	Hour GG	Hour, 0
		0 04 005	Minute gg	Minute, 0
		0 05 002	Latitude (coarse accuracy) L <sub>a</sub> L <sub>a</sub> L <sub>a</sub>	Degree, 2
		0 06 002	Longitude (coarse accuracy) L <sub>o</sub> L <sub>o</sub> L <sub>o</sub>	Degree, 2
	0 07 030		Height of station platform above mean sea level	m, 1
	0 07 031		Height of barometer above mean sea level	m, 1



# BUFR Template for synoptic reports from sea stations suitable for ship observation data from VOS stations (in validation)

<b>3 08 014</b>		<b>Sequence for representation of synoptic reports from a sea station suitable for SHIP data from VOS stations</b>
	<b>3 01 093</b>	Ship identification, movement, type, date/time, horizontal and vertical coordinates
	<b>3 02 062</b>	SHIP "instantaneous" data from VOS
	<b>3 02 063</b>	SHIP "period" data from VOS

*In blue: not included in Manual on Codes yet*



# JCOMM rationalization of marine data BUFR sequences

e.g. 3-01-200: Ship information

F	X	Y	Name
0	01	079	Unique identifier for this message
0	01	078	IMO ship identifier
3	01	003	Ship's call sign plus motion 0-01-011 identifier 0-01-012 direction 0-01-013 speed
0	01	044	Ship's ground course: the direction the vessel actually moves over the fixed earth and referenced to true north.
0	07	071	Maximum height of deck cargo above summer maximum load line
0	07	072	Departure of summer maximum load line from actual sea level



# JCOMM rationalization of marine data BUFR sequences

e.g. 3-06-200: Surface water temperature data (high precision)

F	X	Y	Name
0	02	038	Method of water temperature and/or salinity measurement
0	07	063	Depth below sea water surface
0	04	080	Averaging period for following value
0	22	045	Sea/water temperature
0	08	080	Qualifier for quality class
0	33	050	GTSP quality class



# Conclusion and recommendations

- Workplan
  - 2010/2011: Validation of BUFR template for VOS data
  - 2011: Adaptation of e-logbooks
  - 2011/2012: Transition period
  - End 2012: Migration to BUFR completed
- Recommendations/Impact for PMOs
  - Understand basics of BUFR and requirements for the reporting of new variables
  - Implement new e-logbooks
  - Feedback requirements to TT-TDC