Dive into the BUFR

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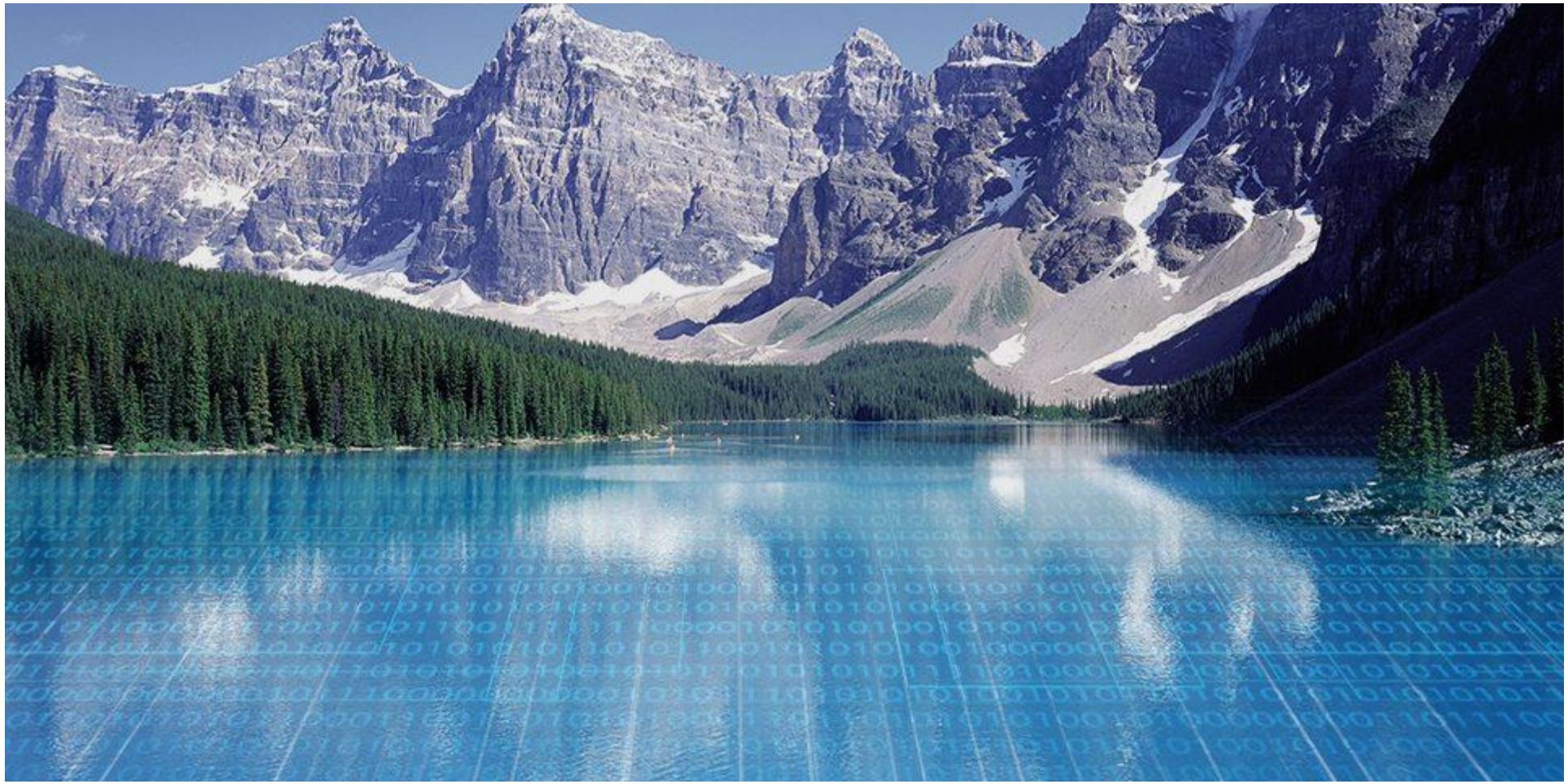
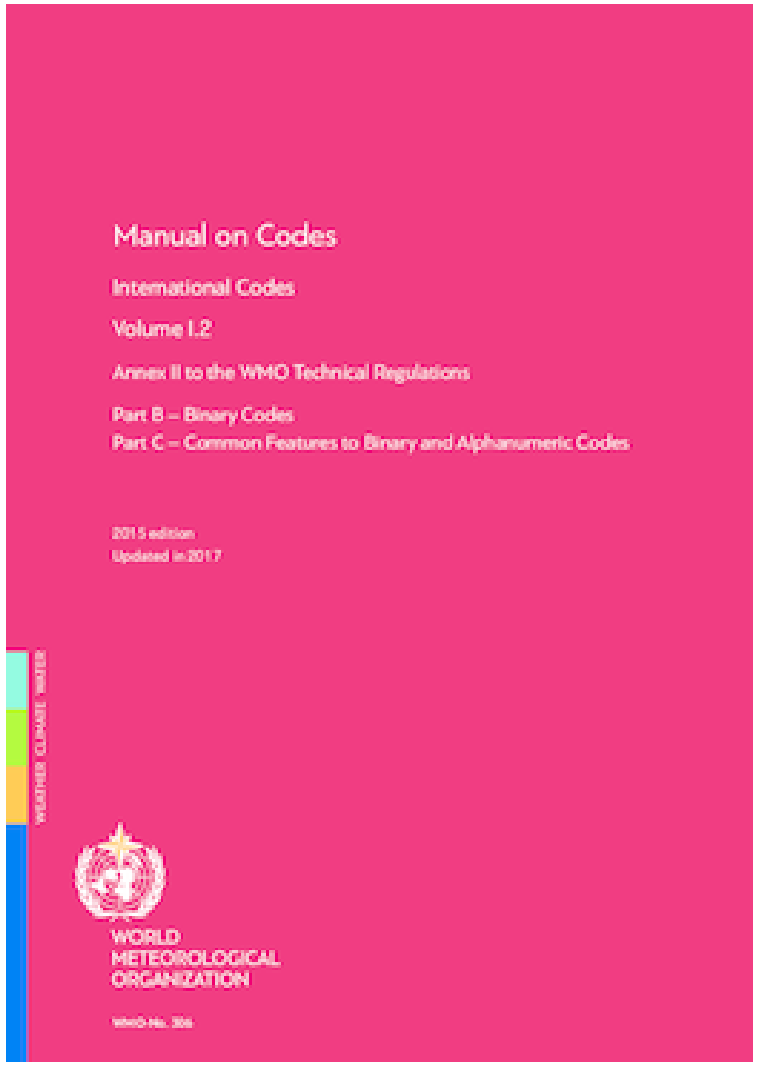
ECMWF

A ‘bit’ of hesitation…

Promising astonishing journey!

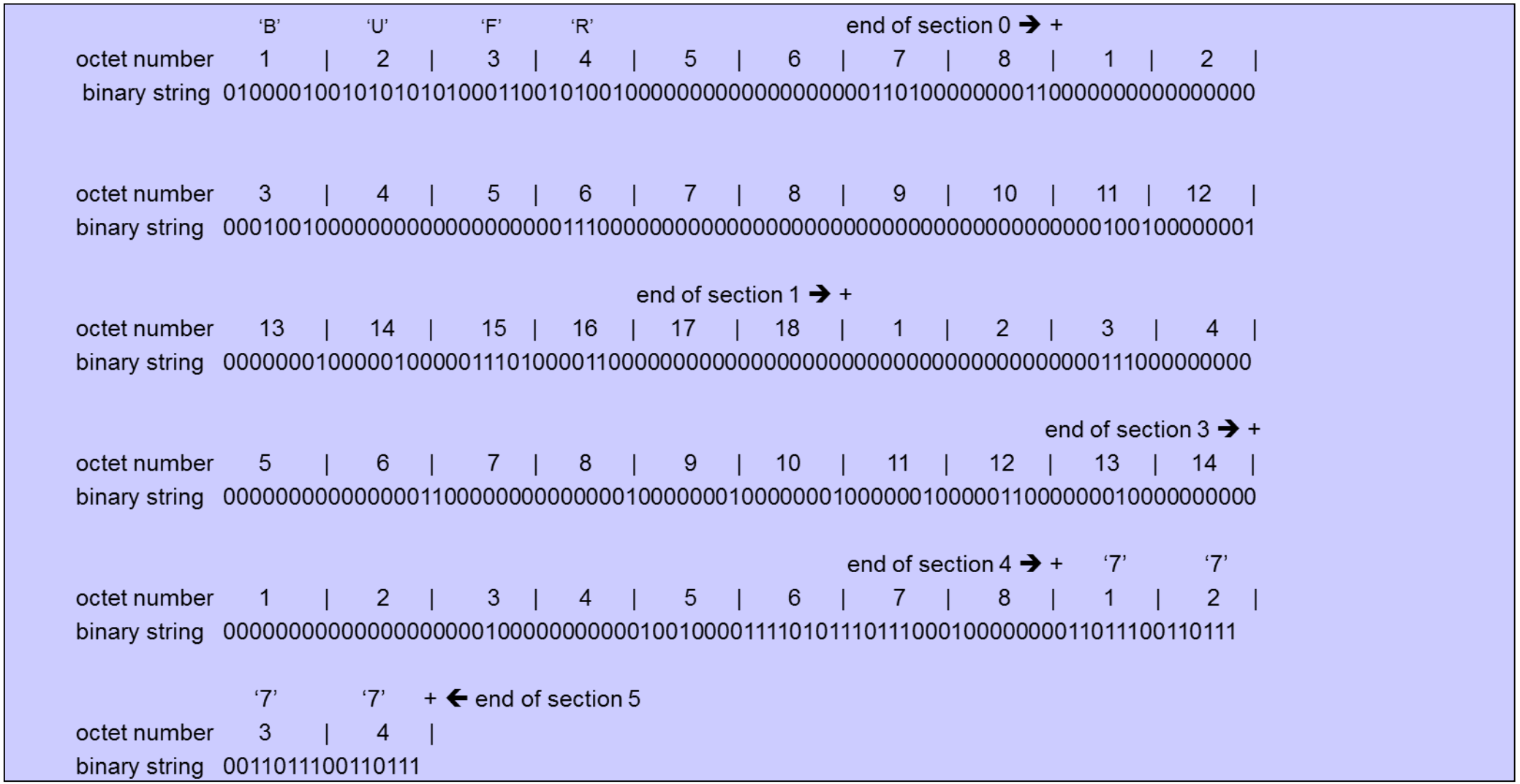


BUFR - WMO binary code



- **B**inary **U**niversal **F**orm for **R**epresentation of meteorological data govern by WMO.
- Continuous bit stream made of sequence of octets.
- Used to encode in situ and satellite observations.
- Self descriptive code and machine independent.
- Compression available for improved transmission speed.
- Table driven data format.
- A new version of the tables which are part of the manual is released externally twice a year.

BUFR message looks like this



SECTION 1 – Identification

Length of section

BUFR master table

Version number of master tables

Identification of originating/generating centre

Version number of local tables

Identification of originating/generating sub-centre

Data category

International data sub-category

Local data sub-category

Year

Month

Day

Hour

Minute

Second

What info is important to have before decoding BUFR message and how we can find it?

WMO tables are updated every six months and the latest tables can be found here

Data description and data section

SECTION 3
a list of six digit descriptors in the form
F-X-Y → 0-04-006

```
307080, 005001, 006001, 007001
222000, 101049, 31031, 001031,
001032, 101049, 033007
```

Descriptors starting with
- **F=0** are elements listed in **Table B**
- **F=1** denote replication of descriptors
- **F=2** are operators acting on descriptors **Table C**
- **F=3** are sequences of descriptors listed in **Table D**

SECTION 4
Contains the encoded values as a
bit stream to be decoded.

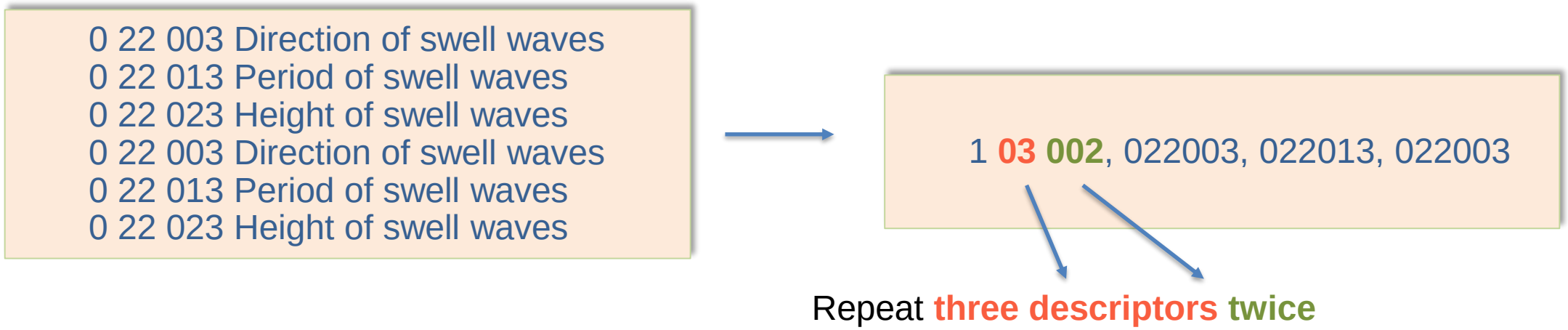
```
01001010111010100101010101010
10100010001010101010001010100
10100101010010010100101001010
10101010101111000010101001001
```

How?
- Implementing the decoding regulations and notes
- Using the Tables

@ Enrico Fucile

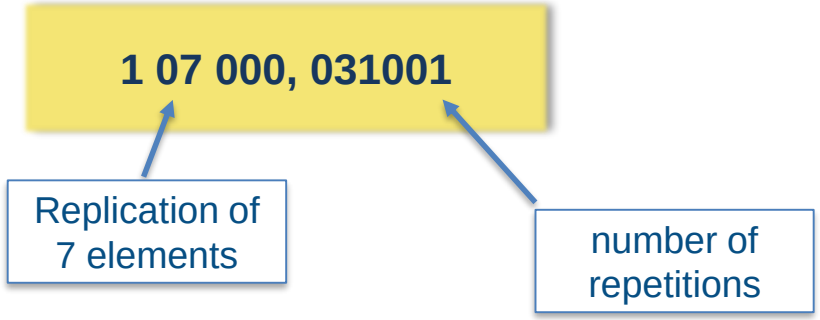
BUFR replication – descriptors starting with 1

We use replication for repetition of the BUFR descriptors or/and BUFR sequences



BUFR delayed replication - descriptors starting with 1

- Followed by operator 031000, 031001 or 031002
- The number of replication is encoded in the data section.



- Depending of replication value you can set:

Class 31 – BUFR Data description operator qualifiers

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 31 000	Short delayed descriptor replication factor	Numeric	0	0	1			
0 31 001	Delayed descriptor replication factor	Numeric	0	0	8			
0 31 002	Extended delayed descriptor replication factor	Numeric	0	0	16			

BUFR sequence for TEMP with Delayed replication

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME	ELEMENT DESCRIPTION
3 09 052		(Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data)	
	3 01 111	Identification of launch site and instrumentation for P, T, U and wind measurements	
	3 01 113	Date/time of launch	
	3 01 114	Horizontal and vertical coordinates of launch site	
	3 02 049	Cloud information reported with vertical soundings	
	0 22 043	Sea/water temperature	
	1 01 000	Delayed replication of 1 descriptor	
	0 31 002	Extended delayed descriptor replication factor	
	3 03 054	Temperature, dewpoint and wind data at a pressure level with radiosonde position	
	1 01 000	Delayed replication of 1 descriptor	
	0 31 001	Delayed descriptor replication factor	
	3 03 051	Wind shear data at a pressure level with radiosonde position	

Unexpanded descriptors & BUFR replication

Write expansion of the sequence below

```
107002  011001 011002 104003 005002 006002 010002 012001
```

- Use understanding of BUFR replication and delayed replication!

Unexpanded descriptors - solution

```
107002  011001 011002 104003 005002 006002 010002 012001
```

```
011001 011002 104003 005002 006002 010002 012001
011001 011002 104003 005002 006002 010002 012001
```

```
011001 011002 005002 006002 010002 012001 005002 006002 010002 012001 005002 006002 010002 012001
011001 011002 005002 006002 010002 012001 005002 006002 010002 012001 005002 006002 010002 012001
```

BUFR data descriptors operators

- Defined in Table C
- Descriptors starting with 2

TABLE REFERENCE F X Y	ELEMENT NAME	BUFR				CREX		
		UNIT	SCALE	REFERENCE VALUE	DATA WIDTH (Bits)	UNIT	SCALE	DATA WIDTH (Characters)
0 22 012	Period of wind waves	s	0	0	6	s	0	2
0 22 013	Period of swell waves	s	0	0	6	s	0	2
0 22 021	Height of waves	m	1	0	10	m	1	4
0 22 022	Height of wind waves	m	1	0	10	m	1	4

Work out scale and data width for the Height of wind waves (0 22 022)

```
2 01 130, 2 02 129 ,0 22 022, 2 02 000, 2 01 000
```

BUFR Table D (descriptors starting with 3)

Sequence description

Sequence descriptor

TABLE REFERENCE F X Y	TABLE REFERENCES	ELEMENT NAME
3 09 052		(Sequence for representation of TEMP, TEMP SHIP and TEMP MOBIL observation type data)
	3 01 111	Identification of launch site and instrumentation for P, T, U and wind measurements
	3 01 113	Date/time of launch
	3 01 114	Horizontal and vertical coordinates of launch site
	3 02 049	Cloud information reported with vertical soundings
	0 22 043	Sea/water temperature
	1 01 000	Delayed replication of 1 descriptor
	0 31 002	Extended delayed descriptor replication factor
	3 03 054	Temperature, dewpoint and wind data at a pressure level with radiosonde position
	1 01 000	Delayed replication of 1 descriptor
	0 31 001	Delayed descriptor replication factor
	3 03 051	Wind shear data at a pressure level with radiosonde position

In section 3 is equivalent to the list of descriptors

List of descriptors. It can contain sequence descriptors

Names of the descriptors in the sequence

@ Enrico Fucile

Explore BUFR sequences

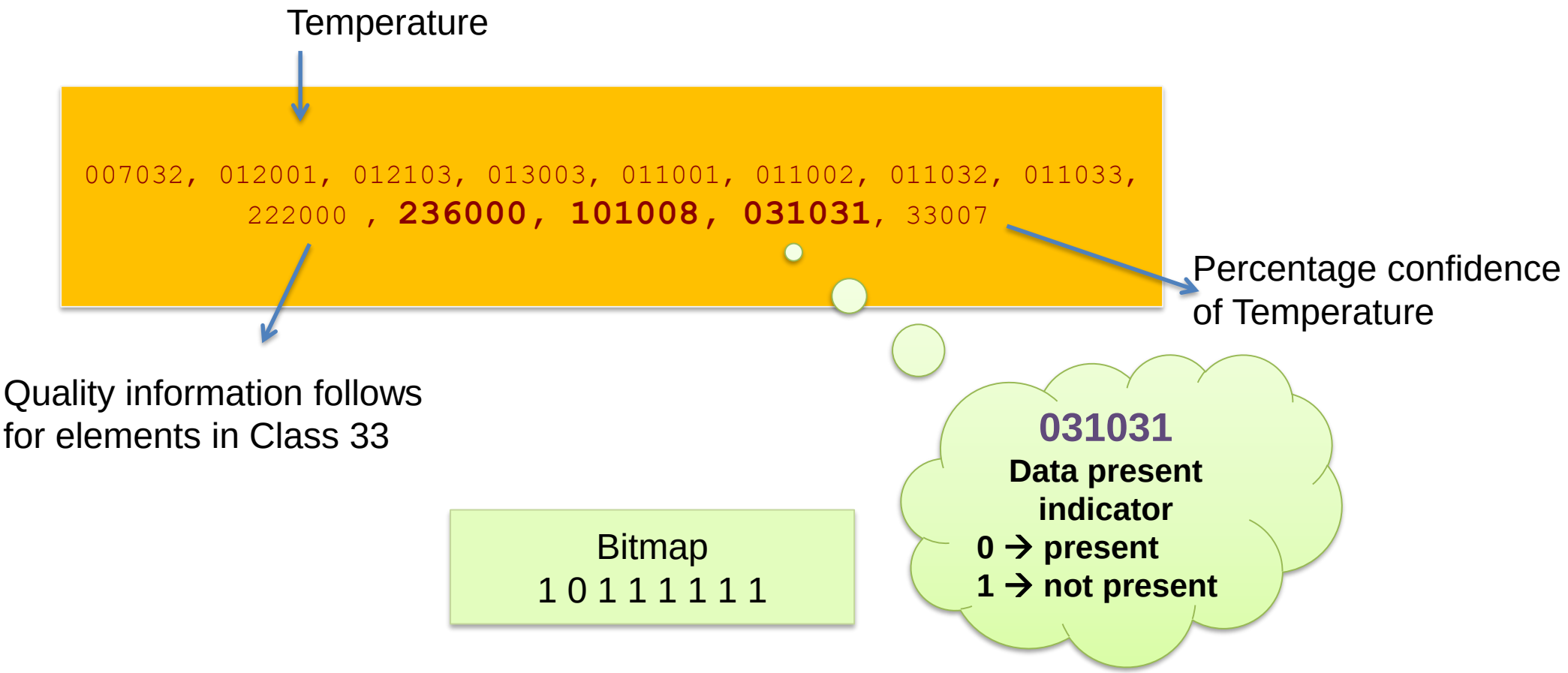
3 01 011

3 01 013

Have a look at the BUFR table D.

3 01 031

BUFR bitmap and quality info




thank you
gracias
merci
danke
謝謝
obrigado
dziękuję
bedankt
teşekkür ederim
go raibh maith agat
sukriya
kop khun krap
terima kasih
ngiyabonga
mochchakkeram
dank je
arigatô
dakujem
takk
grazie
taiku
tapadh leat
спасибо
рахмат
Баярлалаа
faafetai lava
mersi
kia ora
barka
welalin
tack
spas
misaotra
matondo
paldies
grazzi
mahalo
vinaka
спасибі
blagodaram
kiitos
dankie
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nandri
hvala
maururu
köszönöm
gràcie
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enkosi
akun
dankon
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sulpáy
sobodi
děkuji
mèsi
sagolun
didi madloba
najis tuke
kam sah hamnida
rahmat
ありがとう
tanemirt
rahmet
trugarez
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তোমাকে ধন্যবাদ