

SUGGESTED ENHANCEMENTS TO THE ARGO BUFR FORMAT FOR BIO-GEOCHEMICAL DATA

Present status

At this time the Argo BUFR (Binary Universal Form for the Representation of data) format used to exchange data on the WMO (World Meteorological Organization) GTS is able to handle:

- (i) core Argo CTD profiles (template 3-15-003)
- (ii) secondary temperature and/or temperature and salinity profiles (additional sequences 3-06-017 and 3-06-018 respectively) which map to the Argo netCDF reference table 16
- (iii) dissolved oxygen profiles (additional sequence 3-06-037).

The additional sequences (when used) should be specified in section 3 of the BUFR message after the core template descriptor. If more than one additional sequences are used their order is not critical. The additional data then follows that of the core CTD profile in section 4 in a continuous bit stream – however the order of the additional data must be in the same order as the additional sequences in section 3.

However, floats equipped with bio-geochemical sensors can also measure a range of additional variables. This note proposes some new BUFR sequences to allow for the representation of profile data for chlorophyll-A, nitrates, CDOM and pH. The approach taken is similar for each and follows that already approved for dissolved oxygen. The sequence for dissolved oxygen and the proposed new sequences for chlorophyll-A, nitrates, CDOM and pH are shown on the following pages, where entries in **red** will need to be defined and approved.

With the agreement of AST and ADMT these sequences can be proposed to the WMO IPET-DRMM meeting (30 May to 3 June 2016) at which it is anticipated they will be approved for validation, which can then be carried out during summer/autumn, so the additional sequences could be approved for operational use by the end of 2016.

Sequence 3-06-037 for dissolved oxygen profile data (approved)

Table Reference			Table References			Element Name	
F	X	Y					
3	06	037				Dissolved oxygen profile data	
			1	09	000	Delayed replication of 9 descriptors	
			0	31	002	Extended delayed descriptor replication factor	Gives number of depths
			0	07	062	Depth below sea / water surface	Code as missing
			0	08	080	Qualifier for quality class	Code as missing
			0	33	050	GTSP quality class	Code as missing
			0	07	065	Water pressure	
			0	08	080	Qualifier for quality class (set to 10, indicates pressure at a level)	
			0	33	050	GTSP quality class	
			0	22	188	Dissolved oxygen	in $\mu\text{mol kg}^{-1}$
			0	08	080	Qualifier for quality class (set to 16, dissolved oxygen at a level)	
			0	33	050	GTSP quality class	

Code depth related descriptors as missing as water pressure is used as the vertical axis.
Dissolved oxygen specified in range 0 to 524.287 $\mu\text{mol kg}^{-1}$ with a resolution of 0.001 $\mu\text{mol kg}^{-1}$.

Sequence 3-xx-xxx for chlorophyll-A profile data

Table Reference			Table References			Element Name	
F	X	Y					
3	xx	xxx				Chlorophyll-A (fluorescence) profile data	
			1	09	000	Delayed replication of 9 descriptors	
			0	31	002	Extended delayed descriptor replication factor	Gives number of depths
			0	07	062	Depth below sea / water surface	Code as missing
			0	08	080	Qualifier for quality class	Code as missing
			0	33	050	GTSP quality class	Code as missing
			0	07	065	Water pressure	
			0	08	080	Qualifier for quality class (set to 10, indicates pressure at a level)	
			0	33	050	GTSP quality class	
			0	41	002	Chlorophyll-A (fluorescence)	In kg l^{-1} ($= 10^9 \text{ mg m}^{-3}$)
			0	08	080	Qualifier for quality class (set to 16, chlorophyll-A at a level)	
			0	33	050	GTSP quality class	

Code depth related descriptors as missing as water pressure is used as the vertical axis.
Chlorophyll-A specified in range 0 to 65.535 mg m^{-3} with a resolution of 0.001 mg m^{-3} .

Sequence 3-xx-xxx for dissolved nitrates profile data

Table Reference			Table References			Element Name	
F	X	Y					
x	xx	xxx				Dissolved nitrates profile data	
			1	09	000	Delayed replication of 9 descriptors	
			0	31	002	Extended delayed descriptor replication factor	Gives number of depths
			0	07	062	Depth below sea / water surface	Code as missing
			0	08	080	Qualifier for quality class	Code as missing
			0	33	050	GTSP quality class	Code as missing
			0	07	065	Water pressure	
			0	08	080	Qualifier for quality class (set to 10, indicates pressure at a level)	
			0	33	050	GTSP quality class	
			0	41	003	Dissolved nitrates	In $\mu\text{mol kg}^{-1}$
			0	08	080	Qualifier for quality class (set to 16, nitrates at a level)	
			0	33	050	GTSP quality class	

Code depth related descriptors as missing as water pressure is used as the vertical axis.
Dissolved nitrates specified in range 0 to 131.07 $\mu\text{mol kg}^{-1}$ with a resolution of 0.001 $\mu\text{mol kg}^{-1}$.

Sequence 3-xx-xxx for CDOM profile data

Table Reference			Table References			Element Name	
F	X	Y					
3	xx	xxx				CDOM profile data	
			1	09	000	Delayed replication of 9 descriptors	
			0	31	002	Extended delayed descriptor replication factor	Gives number of depths
			0	07	062	Depth below sea / water surface	Code as missing
			0	08	080	Qualifier for quality class	Code as missing
			0	33	050	GTSP quality class	Code as missing
			0	07	065	Water pressure	
			0	08	080	Qualifier for quality class (set to 10, indicates pressure at a level)	
			0	33	050	GTSP quality class	
			0	41	xxx	CDOM	In parts per billion
			0	08	080	Qualifier for quality class (set to 16, CDOM at a level)	
			0	33	050	GTSP quality class	

Code depth related descriptors as missing as water pressure is used as the vertical axis.
CDOM specified in range 0 to x 1023 ppb with a resolution of 1 ppb.

New descriptor to be defined

0-41-xxx for CDOM concentration (parts per billion)

Scale 0, reference value 0, data width 10 (giving a range 0 to 1023 ppb)

Q. if we go to 1023 ppb is this enough so the sequence could be used in other non-Argo (e.g. estuarine) applications or should we add another bit?

Sequence 3-xx-xxx for pH profile data

Table Reference			Table References			Element Name	
F	X	Y					
3	xx	xxx				pH profile data	
			1	09	000	Delayed replication of 9 descriptors	
			0	31	002	Extended delayed descriptor replication factor	Gives number of depths
			0	07	062	Depth below sea / water surface	Code as missing
			0	08	080	Qualifier for quality class	Code as missing
			0	33	050	GTSP quality class	Code as missing
			0	07	065	Water pressure	
			0	08	080	Qualifier for quality class (set to 10, indicates pressure at a level)	
			0	33	050	GTSP quality class	
			0	13	xxx	pH scale	
			0	13	080	pH	dimensionless
			0	08	080	Qualifier for quality class (set to 16, pH at a level)	
			0	33	050	GTSP quality class	

Code depth related descriptors as missing as water pressure is used as the vertical axis.
 pH specified in range 0 to 102.3 with a resolution of 0.1 (Not sure why it goes so high?).

New descriptor to be defined

0-13-xxx code table for pH scale (3 bits)

0 - seawater scale

1 – freescale

2 - total scale

3 to 6 – not used

7 - missing