HMAS Cook XBT Documentation

Overview

This data submission of XBT data from HMAS Cook spans from 1985-1989, and includes 1803 profiles across 18 individual 'cruises' (see section "Cruise list" for cruise identifiers). The data was captured using a Sippican MK9 recorder, and XBT probes used included Sippican T-4, T-5 and T-7's. After digitisation the data was viewed and quality controlled with an in-house software application named MarineQC (see http://www.metoc.gov.au/documents/marineqc.pdf).

Data is submitted in 'marineXML' format with quality control (QC) flags. Metadata about the data can be found at: http://www.metoc.gov.au/geonetwork/ and enter the search string: "RAN XBT HMAS Cook".

It is to be noted that all data profiles contain an unflagged thermal start up transient for the first 5 depths (see later section titled 'Thermal transient in the first few metres of digitally recorded XBT profiles')

Cruise list

This list contains the unique cruise identifiers for the HMAS Cook data.

85001.CK
85002.CK
85003.CK
85004.CK
86001.CK
86002.CK
86003.CK
86004.CK
86005.CK
87001.CK
87002.CK
87003.CK
87004.CK
87005.CK
MSD189X_1
MSD189X_2
MSD1589_1
MSD1589_2

Fall rate coefficients

The below table identifies the fall rate coefficients that were used at the time of recording for the specified probe types:

Table 1 - Fall rate coefficients (*a*, *b*) used for Sippican T-4, T-7 and T-5 XBT probes.

Probe type	*a* coefficient	*b* coefficient
T-4	6.472	0.00216
T-7	6.472	0.00216
T-5	6.828	0.00182

Thermistor reading to temperature conversion

The MK9 XBT data was provided as thermistor readings in the data files, and therefore formulae provided by Sippican were used to convert the thermistor reading into depth and temperature values. Within the file, the variables of scale, offset, and fall rate coefficients were included in the header that was used in the formulae.

Temperature Formula:

```
temp = (r - o) * s
temperature (°C) = -2.22 + (1.145102e-2 + (-1.0144e-6 +
1.791067e-10 * temp) * temp) * temp
```

where r = thermistor reading, o = offset value, s = scale value.

Depth Formula:

```
Depth (m) = a * T - b * T^2
```

where a = fall rate coefficient *a*, b = fall rate coefficient *b*, and T = time in seconds

Quality Control with MarineQC

The marineXML files were finally loaded into the in-house software application MarineQC for viewing, checking and application of quality control flags (see http://www.metoc.gov.au/documents/marineqc.pdf).

Temperatures are flagged with a set of 17 'DODC' quality control flags which are stored with data. At a higher level there are also a simple fail/pass (true|false) flag for the time and/or position data for the profile and a pass/fail flag for the whole temperature profile. Table 1 gives the meaning of each DODC flag in the column labelled 'DODC'. The equivalent IODE-GTSPP flag (0-9 system) is given in the column IODE-GTSPP. In simple terms temperature data flagged as IODE-GTSPP flag 1 or 2 may be classed as "good" and '3' or '4' as "bad". The below list gives the meaning the of IODE-GTSPP flags (taken from http://www.nodc.noaa.gov/GTSPP/document/qcmans/MG22rev1.pdf)

0 = No quality control has been assigned to this element
1 = The element appears to be correct
2 = The element appears to be probably good
3 = The element appears doubtful
4 = The element appears erroneous
5 = The element has been changed
6 to 8 = Reserved for future use
9 = The element is missing.

The quality control flags in the MarineXML file occur at 3 level hierarchy below:

1) ***Spatial and Temporal Level - MarineDataRecord@reject flag***

At the Spatial and Temporal level with the flag MarineDataRecord@reject e.g.

<MarineDataRecord ID="43" reject="true" details="Bad date and/or position"> OR

<MarineDataRecord ID="36" reject="true" details="Failed SpeedCheck1.0 - Cannot be changed with confidence">

If this flag is set to “true” then the position and/or time of the observation is faulty and whole observation fails. The reason for the failure is usually given in the “details” attribute.

2) Whole profile Temperature Profile Level - DataObject@reject flag

At the whole profile level (DataObject element) for temperature the attribute DataObject@reject e.g.:

<DataObject index="0" name="XBT" type="Primary" numberOfParameterSets="1" reject="true">.

If this flag is set to “true” then whole temperature profile is flagged as failed usually due to fault with the XBT probe from near the surface such as a wire break or insulation damage. Also one of the DODC failure type flags (i.e. IODE-GTSPP class 3 or 4) will be attached to the first depth/temperature element for example:

<XbtValue index="0">-33.54,0.6,2</XbtValue>
<XbtValue index="1">-33.56,1.3,0</XbtValue>
……
……
Notice in the above at the first depth a qc flag of ‘2’ is set meaning a wire break from the surface and whole profile has failed (IODE-GTSPP class=4)

3) Within the Temperature Profile Level – DODC QC flags (see Table 1)

At the temperature profile level (XbtValue elements), QC flags apply to a sub-section of the depth/temperature profile and are attached to individual <XbtValue> elements. The flag is set at the first depth where the fault occurs and for depths greater than this the flag continues to apply.

Note that if any of the ‘fail’ type flags , equivalent to IODE-GTSPP class 3 or 4, are applied on **any** of the **first 5 depths** then the ‘Whole profile fail flag’ DataObject@reject mentioned above will be set to “true”.

For example in the below the XBT probe has hit the bottom at 609.0m and so a ‘1’ DODC (HBR, equivalent to IODE-GTSPP class 3) flag has been set and all data from 609.0m and below is rejected as IODE-GTSPP class 3. Therefore for this profile it is IODE-GTSPP class 1 from the surface to 608.4m and IODE-GTSPP class 3 from 609.0m to the final deepest depth.

<XbtValue index="0">23.0,1.1,0</XbtValue>
<XbtValue index="1">23.9,1.7,0</XbtValue>
…..
…..
…..
<XbtValue index="985">7.3,607.8,0</XbtValue>
<XbtValue index="986">7.3,608.4,0</XbtValue>
<XbtValue index="987">7.3,609.0,1</XbtValue>
<XbtValue index="988">7.3,609.6,0</XbtValue>
<XbtValue index="989">7.4,610.2,0</XbtValue>
….

….
As another example the below is a ‘Wire Stretch Accept’ (WSA-DODC flag=3, IODE-GTSPP flag=2) followed deeper down at 523.4m by a ‘Wire Break Reject’ (WBR-DODC Flag=2, IODE-GTSPP Flag=4. Therefore for this profile it is IODE-GTSPP class 1 from the surface to 231.0m, IODE-GTSPP class 2 from 231.6m to 522.8m and finally IODE-GTSPP class 4 from 523.4m to the deepest depth at 759.3m

….
….
<XbtValue index="362">17.7,231.0,0</XbtValue>
<XbtValue index="363">17.7,231.6,3</XbtValue>
<XbtValue index="364">17.7,232.3,0</XbtValue>
…..
…..
<XbtValue index="842">9.4,522.8,0</XbtValue>
<XbtValue index="843">9.4,523.4,2</XbtValue>
<XbtValue index="844">28.9,524.0,0</XbtValue>
<XbtValue index="845">35.6,524.6,0</XbtValue>
<XbtValue index="846">35.6,525.2,0</XbtValue>
…..
…..
<XbtValue index="1249">35.6,759.3,0</XbtValue> (last depth)

Table 1 – DODC Quality control flags applied to the XBT data in MarineXML file

DODC	CSIRO CookBook	IODE-GTSPP	Abbrev	Description	Flag conversion Rule DODC->IODE-GTSPP
0		1		No Flag	set point class 1
1	3	3	HBR	Hit Bottom	all rest of profile 3
2	4	4	WBR	Wire Break	all rest of profile 4
3	2	2	WSA	Wire Stretch	rest as class 2 unless another flag found deeper
4	3	3	WSR	Wire Stretch	all rest of profile 3
5	2	2	LEA	Leakage	class 2 from surface to this point and subsequent points class 2 unless another flag found deeper
6	3	3	LER	Leakage	all rest of profile 3
7		3		False Launcher Breech Contact	set whole profile to 3
8		3		False Launch Triggering	set whole profile to 3
9	4	4	SPR	Spikes	all rest of profile 4
10	3	3	CTR	Constant Temperature Profile	set whole profile to 3
11	3	3	IPR	Insulation Penetration	all rest of profile 3
12	3	3	TOR	Temperature Offset	set whole profile to 3
13	4	4	TPR	Test Probe	set whole profile to 4

14	4	4	NTR	No Trace	set whole profile to 4
15	4	4	NGR	No Good Profile	set whole profile to 4
16		3	DPR	Data Point Rejection (NOT being used in MQC3.0	all rest of profile 3

Thermal transient in the first few metres of digitally recorded XBT profiles

Due to the finite response time of the XBT probe thermistor (Sipplican Inc. quotes 0.63s) the first 5 or 6 depths (about 0.6m to 4.0m range) of many digitally recorded XBT profiles will contain a temperature transient as the XBT probe settles its temperature to the surrounding seawater. If a transient is present the true sea temperature is not recorded until about 4m depth. The transient is more marked if there is a large temperature difference between the air and sea temperatures and smaller if the air-sea temperature difference is small. For example below is a listing of temperatures showing a large transient (air cooler than sea):

<XbtValue index="0">22.5,0.8,0</XbtValue>
<XbtValue index="1">27.1,1.5,0</XbtValue>
<XbtValue index="2">30.8,2.2,0</XbtValue>
<XbtValue index="3">30.8,2.8,0</XbtValue>
<XbtValue index="4">30.8,3.5,0</XbtValue>
<XbtValue index="5">30.7,4.2,0</XbtValue>
<XbtValue index="6">30.7,5.0,0</XbtValue>

And another profile where the transient was small (0.8ºC 1.2m -> 1.8m)

<XbtValue index="0">23.8,1.2,0</XbtValue>
<XbtValue index="1">24.6,1.8,0</XbtValue>
<XbtValue index="2">24.6,2.5,0</XbtValue>
<XbtValue index="3">24.6,3.1,0</XbtValue>
<XbtValue index="4">24.6,3.8,0</XbtValue>
<XbtValue index="5">24.6,4.4,0</XbtValue>

Note in the first example above how the temperature starts at 22.5ºC at 0.8m and settles to 30.7ºC which is the actual near surface sea temperature. Therefore the temperature in the first few metres may not represent the true sea temperature. **Also take note** that although the transient is present and may be giving false temperatures **no particular temperature QC flag has been applied**

Quality control notes

Overall, the quality of the data was good, but there were persistent issues seen throughout all the cruises, particularly XBT wire stretches and breakages.