

## For Using Data

Data Policy	JAMSTEC
Principal Investigator	Data Management Office
Use Constraints	See Terms and Conditions about constrain of use.
Data Citation	See Terms and Conditions about data citation.

## Quality level

Processed (DMO)-QCed

## Instrument

Expendable bathythermograph (XBT)



## Overview

Using XBT (eXpendable Bathy Thermograph) system, the vertical distribution of water temperature is observed during free fall of its probe part in the seawater.

On board, the analogue signal is converted to the temperature by data processor and the data is stored in PC. Depth data is calculated from the elapsed time.

## Measurement System

## 1) Launcher

Manufacturer :	Tsurumi Seiki Co., LTD.
Type :	Hand launcher
Operation area :	Rear 2 Deck

## 2) Converter

Manufacturer :	Tsurumi Seiki Co., LTD.
Type :	See 'Use probes'
Sampling rate :	50 msec
Location :	No.3 Laboratory

## 3) XBT probe specifications

Probe Type	TSK T-5	TSK T-6	TSK T-7	TSK T-10
Range	-2 to 35 [deg-C]			
Accuracy	+/- 0.2 [deg-C]			
Resolution	0.01 [deg-C]			
Mesurement depth	1830 [m]	460 [m]	760 [m]	300 [m]
Depth accuracy	5 or +/- 2% of depth; whichever is larger [m]			
Maximum elapsed time	291 [sec]	73 [sec]	123 [sec]	48 [sec]
Rated ship speed	6 [knot]	15 [knot]	15 [knot]	10 [knot]

Since XBT carries no pressure sensor, we need to estimate depth from the elapsed time. The fall-rate equation is as follows.

$$Z = at + 10E^{-3} * bt^2$$

Where Z(m) is the depth and t(sec) is the elapsed time.

In addition, coefficients of the fall-rate equation are different by probe types.

Probe Type	TSK T-5	TSK T-6	TSK T-7	TSK T-10
Coefficient-a	6.828	6.691	6.691	6.301
Coefficient-b	-1.82	-2.25	-2.25	-2.16

## Use probes

The list of a XBT type used in each cast is as follows.

Cast name	Probe Serial No.	Probe Type	Launcher	Converter
XB000_20200617	-	T-5	Hand	MK-130
XB001_20200618	-	T-5	Hand	MK-130
XB002_20200619	-	T-5	Hand	MK-130

## Data processing

- 1) For sensor's stability, values of less than 1 m for temperature are replaced by missing values, respectively, based on manufacturer's recommendation.
- 2) Quality control
  - QCed data were added flag according to the NODC (National Oceanographic Data Center) quality control procedure.
    - i. The gradient check of adjacent depth data
    - ii. The broad range check set up at given ocean space and depth
  - Quality control and processing of historical oceanographic temperature, salinity, and oxygen data.
  - P. Boyer and Levitus, 1994. NOAA technical report NESDIS ; 81
  - \* <https://repository.library.noaa.gov/view/noaa/13443>
  - In addition, an abnormal value is identified by a visual check, and the flagged data is released.

**Note**

- 1) It is reported that T-5 probes produced by Tsurumi Seiki Co. Ltd. (TSK T-5 probes) have a fall-rate bias. Please see the following about publication policy of XBT fall-rate bias correction data.
- 2) If you would like the raw data set, please contact DMO at "dmo@jamstec.go.jp".

## Publication policy of XBT fall-rate bias correction data

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Analyses of concurrent XBT, CTD and Argo float observations indicate that there is a systematic difference in temperature profiles. Gouretski and Koltermann (2007) shows statistics from Expendable Bathythermograph (XBT) vs. Conductivity-Temperature-Depth (CTD)/reversing thermometer instrument comparisons which reveal a warm bias in XBT temperatures. The bias may be due to errors in the calculation of depth or in measurement of the temperature. A NOAA sponsored XBT Fall Rate Workshop was held to discuss this problem. Estimates of corrections recently published or submitted to scientific journals are provided here.

[Reference]

<https://www.ncei.noaa.gov/products/xbt-corrections>

Those XBT data with observed level data for World Ocean Database do not have any adjustments, This may be due to the recommendation of UNESCO(1994) that XBT data for archive and exchange should use non adjustment data to avoid confusing. However, data for T-5s have either no adjustment (Sippican) or a small adjustment (for TSK models) (Kizu et al., 2005). Information on the decision made on depth adjustment is included for each XBT data.

[Reference]

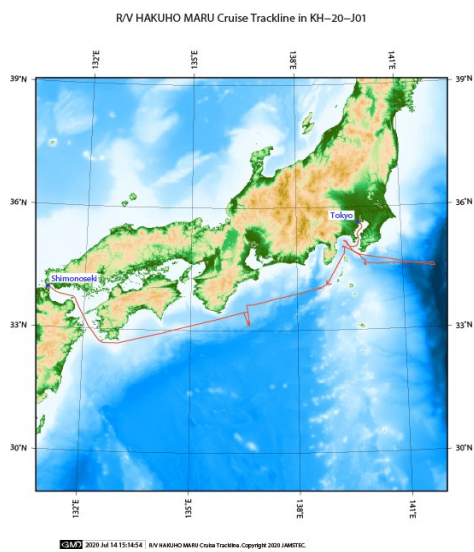
UNESCO (1994), Calculation of New Depth Equations for Expendable Bathythermographs Using a Temperature-Error-Free Methods (Application to Sippican/TSK T-7, T-6 and T-4 XBTs), IOC Technical Series No. 42, 46 pp. (by Hanawa, K., P. Rual, R. Bailey, A. Sy, and M. Szabados)

[https://www.ncei.noaa.gov/access/world-ocean-database-select/bt\\_bias\\_notes.html](https://www.ncei.noaa.gov/access/world-ocean-database-select/bt_bias_notes.html)

So, non adjustment XBT data are normally published from the "JAMSTEC Data Site for Research Cruises", but JAMSTEC also provide web page to publish fall-rate bias correction data for TSK T-5 XBTs. It should be noted that the fall-rate equation coefficients used here are not offered by manufacturer. Therefore, these data may be replaced if new fall-rate equation coefficients for TSK T-5 XBT are offered by manufacturer or any other more suitable fall-rate equation or coefficients is published.

## Related Information

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### KH-20-J01

Ship Name:

HAKUHO MARU

Period:

2020/06/17 - 2020/06/22

Chief Scientist:

Takatoshi Yamamura (JAMSTEC)

Proposal:

R/V Hakuho-maru Engineering cruise

## Format Description for XBT DMO

Each data file contains one line header (meta data) followed by data lines for each cast.

The number of data lines are recorded in the header.

### Header part

No.	Column	Content	Format	Remarks
1	1	Header ID	a1	fixed as '#'
2	3 - 6	Data ID	a4	XBT
3	8 - 22	Cruise ID	a15	
4	33 - 40	Date	i8	YYYYMMDD (UTC)
5	42 - 45	Time	i4	hhmm (UTC)
6	47 - 55	Latitude	i2,a1,f5.2,a1	dd-mm.mmN(S)
7	57 - 66	Longitude	i3,a1,f5.2,a1	ddd-mm.mmE(W)
8	68 - 71	Number of data lines	i4	
9	72 - 73	Terminator	a2	[CR][LF]

### Data part

No.	Column	Content	Format	Unit	Remarks
1	1 - 11	Depth	f11.1	m	
2	12 - 22	Temperature	f11.2	deg-C	ITS-90
3	45 - 55	Quality control flag	i11		45 - 51 : space 52 : flag of depth 53 : flag of temperature 54 - 55 : space
4	56 - 57	Terminator	a2		[CR][LF]

Each contents of the data part is stored in 11 bytes.

Missing value is presented by '-5', and error value is presented by '-9'.

### Definition of Quality Control Flags

#### 1) Depth Flags

- 0 - accepted value
- 1 - error in recorded depth ( same or less than previous depth )
- 2 - density inversion

#### 2) Observed Level Flags

- N - missing value
- 0 - accepted value
- 1 - range outlier ( outside of broad range check )
- 2 - failed inversion check
- 3 - failed gradient check
- 4 - zero anomaly
- 5 - failed combined gradient and inversion checks
- 6 - failed range and inversion checks
- 7 - failed range and gradient checks
- 8 - failed range and zero anomaly checks
- 9 - failed range and combined gradient and inversion checks
- A - failed visual check

\* Range and gradient check is performed to XBT data.