

XBT Data Processing – STARLITE 2007 MACII

XBT data were collected with Sippican MK21 software on the NOAA Ship McArthur II, Aug 26 through Nov 24, 2007. Typically, XBT drops were conducted every three hours during daylight operations. Typically, XBT drops were conducted every three hours during daylight operations at 0900, 1200, and 1500 (local ship time). Some XBT drops were performed in lieu of CTD casts at 0400 or 2000 (local ship time). Sippican Deep Blue Expendable Bathythermograph (XBT) probes were used to measure the temperature of the water column to 760 m.

Raw data files were checked for date/time and position and then edited to remove erroneous temperature data. All valid and edited profiles were then combined into final files. The XBTCorrect file has depth and temperature corrections according to Cheng et al. (2016, Bull. American Meteorological Soc., June 2016, 923-933). The XBTArchive file has depths calculated with the fall rate equation of Hanawa et al. (1995, Deep-Sea Research I 42:1423-1451) and excludes incomplete profiles that do not extend through the thermocline. This file is for archiving and allows for optional correction of depth and temperature by users.

All data and programs are stored in sub-folders of P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\ . The raw data files are in the sub-folder Raw. The programs used to process the data are stored in the sub-folder Current_Version\Programs. These programs read year-specific information from *.ini files, which are stored in the same folder as the programs. The intermediate files created during the processing steps are stored in the sub-folder Current_Version\Intermediate. The final processed data and documentation are stored in the sub-folder Current_Version\Final.

Raw Data Files

Sippican raw (*.RDF) and export (*.EDF) data files are in P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Raw\MACII.

Raw File Summaries

The data collected on each survey were backed up on several DVD's. The DVDs were frequently created at the end of each leg. Sometimes data from each leg were backed up separately, while at other times the backups included all data collected (e.g., data collected on legs 1-3 were backed up at the end of leg 3) . Consequently, there can be a great deal of overlap among the DVDs.

For the data collected on the MACII during STARLITE 2007, the DVD labeled "Legs1-4" was the most complete. These files were copied to P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Raw\MACII\ . Note that some files were edited at sea, and the DVD's contained both the original and edited versions. The original was copied to the Raw folder, the edited were move to Archived_Raw\From_DVDs.

Information about XBT drops, such as time, date, latitude, longitude, and comments about the profile by the at-sea oceanographer, was recorded at sea in a log book, an Excel spreadsheet, and an "ELog" database called Oceo2006_DSJ. (The name is inaccurate, it was carried over from the 2006 cruise.)

Raw File Checks

Perl program XBTRawFileInfo was used to check the raw files. No "Drop Times" were entered in the ini file, because drops did not happen at specific times for this cruise. The program reported that Latitude or Longitude was blank or had a value of 0 for 14 EDF files. It did not report any RDF files without an EDF file, or vice versa.

Some of the drops that were missing Latitude and Longitude in the EDF files actually had Latitude and Longitude in the RDF files. For those files, the Sippican program WinMk21 was used to export the RDF files to create new EDF. Those were drops 61, 62, 63, 64, 65, and 224. For the ones where the Latitude and Longitude were missing from both files, the Latitude and Longitude were read from the ODL or XBT log, then Sippican program WinMk21 was used to enter that info into the RDF file, then the RDF file was exported to create the EDF file. Those were drops 51, 58, 66, 99, 100, 127, and 163. Drop 67 did have coordinates in the RDF file, but they were incorrect. (They were the coordinates for drop 66.) Those coordinates were corrected in the RDF file using Sippican program WinMk21, then exported to create a new EDF file.

After these corrections were made, Perl program XBTRawFileInfo was run again. It still reported three distances greater than 1 nautical mile, but they were accepted.

Data Checks

Position Check

Perl program XBTPositionCheck compares the positions and times of the XBT drops to positions and times in the final TSG "Track Check" file. The program reads the following information from its .ini file: the location of the EDF files, the location of the final TSG Track Check file, and the number of seconds to search the TSG file for a record that matches each XBT file's time. Positions for stations without corresponding TSG data are checked against the XBT Log and ODL.

For 2007 STARLITE, nine XBT drops were greater than 1 nautical mile from TSG positions matched by time. For one of those, the time in the XBT files was incorrect. For five of them, the coordinates were incorrect. For one, the coordinates were correct in the RDF file, but incorrect in the EDF file. These times and positions were corrected.

For the remaining two, the positions were over the 1 nautical mile threshold, but were accepted. After making the corrections, program XBTPositionCheck was run again. It now reported three positions greater than one nautical mile, which were accepted.

Station and Drop Lists

Perl program XBTStationAndDrops creates the Station and Drops files. From its ini file, it reads the location of the EDF files, and the location of the time offsets file. The Drop file is simply a list of the EDF Files. The Station file lists additional information for each drop: time and location, number of data points, probe type, start and end depths, and drop rate coefficients in the EDF file.

For 2007 STARLITE, there were 277 drops, all using Deep Blue probes.

Profile Review and Edit

At the lab, profiles were examined by Paul Fiedler using the Visual Basic program ProfileViewer, which is located in

P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\ProfileViewer. The reviewer decided what edits need to be made, and recorded that information in file XBTDrops_2009_DELPHINUS_MACII PF.txt. Each XBT drop has a line in that file, with the EDF file name. If the profile requires any editing, the reviewer added codes to each line to tell what edits need to be made. Codes are based on Bailey et al. (Quality Control Cookbook for XBT Data, CSIRO Marine Laboratories Report 221, 1994). The Quality Control Cookbook can be found in P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\ . Codes are as follows, where ddd.d is the depth exactly as recorded in the .edf file:

- | | |
|-----------------|--|
| >FT ddd.d | False trigger, data recorded before the probe entered the water. Reject all data above ddd.d and change the depth at ddd.d to 0.7m, which is the starting depth for all drops (and then increment the depth estimates per Hanawa et al. 1995). |
| >ST ddd.d | Surface transient, identified by warming or cooling as the probe temperature equilibrates. Reject data before depth ddd.d.
If the profile also contains an FT error, ddd.d is an integer that indicates the number of records after the FT correction that should be rejected. |
| >XD ddd.d ddd.d | Bad data within the profile. Reject data from the first to the second depth. |
| >BD ddd | Bad data at the end of the profile (i.e., the drop was not as deep as the cast file makes it appear) due to wire break (indicated in the comments by wb), wire stretch (indicated in the comments by ws), the probe hitting the bottom (indicated in the comments by hb), or insulation penetration (indicated in the comments for this error or XD by ip). Reject data deeper than the specified depth. |
| >NN | The profile is too noisy for NODC, but suitable for deriving mixed layer depth and thermocline variables for protected species assessments. |
| >RJ | Reject profile. |

Apply Profile Edits

Perl program XBTEdit reads the editing codes entered by the reviewer, and creates edited output files. From its ini file, it reads: The location of the edit file (created in the previous step), the location of the time offsets file, the location of the raw XBT files, and the coefficients for the fall

rate equation. It creates output files with the editing codes applied. (e.g. Drops marked with RJ are excluded, depths marked with XD are removed, etc.)

The program reported the following:

```
277   lines read from input file
      P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTDrops_2007_STARLITE_MACII PF.txt
0     lines started with an apostrophe, so were ignored
5     lines had an RJ code, so were ignored

272   records written to
      P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTEdit_2007_STARLITE_MACII.txt

0     lines were not good enough for NODC, so their drop numbers were negated
272   records written to
      P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTNODC_2007_STARLITE_MACII_6.691_0.00225.txt

10.55 Average temperature of all 301371 output points whose drops met the Min
      To Avg depth
21.41 Average temperature of all 39685 output points <= 100 m whose drops met
      the Min To Avg depth
      Note that this is based on depths calculated using the Hanawa et al 1995
      formula
```

The average temperature values were used in the fall rate equations below.

Correct Depth and Temperature

Perl program XBTCorrect corrected XBT depths and temperatures using the Cheng et al method described in

P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\CH XBT fall-rate
method.pdf

Here is the output of XBTCorrect:

```
Reading XBTCorrect.ini...
Reading CH14 table 'P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\Fall
rate\CH14_table1.txt'...
Reading CH14 table 'P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\Fall
rate\CH14_table2.txt'...
Processing
      P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTEdit_2007_STARLITE_MACII.txt...
Deep Blue: Thermal Bias = 0.05557, A = 6.615, B = 0.00231, Offset = 1.888

273   lines read from
      'P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTEdit_2007_STARLITE_MACII.txt'
0     lines started with an apostrophe, so were ignored
272   records written to
      P:\Surveys\Data\ETP\2007_STARLITE\Oceanographic\XBT\Current_Version\Inter
      mediate\XBTCorrect_2007_STARLITE_MACII_Deep Blue.txt
```

0 had negative drop numbers, which means their data was not good enough for
NODC

Final data files

The NODC file created in the XBTEdit step was copied to \Final and was renamed as:
XBTArchive_2007_STARLITE_MACII_Deep Blue.txt

Each drop record in a XBTArchive file starts with fields under the following column headers:

UTC Date, UTC Time, Time Offset, Local Date, Local Time, Latitude, Longitude,
Drop #, Probe Type, # Points, H95 FRE Coefficients...

The column headers after that are depths (m), based on the Hanawa et al 1995 fall rate equation,
e.g:

..., 0.7, 1.3, 2.0, 2.7, 3.3, 4.0, 4.7, 5.4, 6.0, 6.7, 7.4, 8.0, 8.7,...

The drop records data in those columns are temperatures (°C) at those depths. Missing data (e.g.,
surface transients) are blank.

The file that had depth and temperature corrected based on Cheng et al was also copied to \Final.
This file is:

XBTCorrect_2007_STARLITE_MACII_Deep Blue.txt

Each drop record in a XBTCorrect file starts with fields under the following column headers:

UTC Date, UTC Time, Time Offset, Local Date, Local Time, Latitude, Longitude,
Drop #, Probe Type, CH14 Values, # Points...

The column headers after that are depths (m), based on the Cheng et al fall rate correction, e.g:

..., 0.1, 0.8, 1.4, 2.1, 2.7, 3.4, 4.1, 4.7, 5.4, 6.0, 6.7, 7.4, 8.0, 8.7,...

Paul Fiedler
Dan Prospero
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