XBT Data Processing – STAR 1998 ENDV

XBT data were collected with SEAS software (Shipboard Environmental data Acquisition System, NOAA/AOML) on the NOAA Ship Endeavor, July 30 through December 8, 1998. Typically, XBT drops were conducted every three hours during daylight operations. Sippican Deep Blue Expendable Bathythermograph (XBT) probes were used to measure the temperature of the water column to 760 m.

All data and programs are stored in sub-folders of P:\Surveys\Data\ETP\1998_STAR\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

SEAS raw data files were converted to *.edf files with Fortran program SEAS2EDF. No *.ini file is used by the SEAS2EDF program.

This program reported that three files' drop numbers didn't match the file name. These were files numbered 154, 194, and 197. In all three cases, the drop number was one higher than the file name (155, 195, and 198). The drop numbers were manually corrected in the EDF files.

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 ENDV during STAR 1998, the CD labeled "Univ_of_RI_RVEndeavor_SPAM98"was the most complete. These files were copied to P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Raw\ENDV\.

No XBT spreadsheets or Elog databases were created during the cruise.

Perl program XBTRawFileInfo was used to get a summary of the raw files. The program reported that there were many drop numbers that had two sets of files. This was because the drop number had been reset to 1 on 10/20. The files after 10/20'were manually edited to make their drop numbers continue the series of the previous drops. Once this was corrected, the program was run again to confirm that all SEAS raw files had matching EDF Files, and vice versa.

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 1998 STAR ENDV, 74 XBT drops were greater than 1 nautical mile of TSG positions matched by time. Several of these were because the date in the EDF was incorrect. In all cases, the time and position were corrected based on the ODL, if it gave a smaller distance from TSG. After correcting these, the program reported the following:

```
      319    EDF files read
        0    were missing date, time, latitude, or longitude
        0    were not in a valid format
        3    did not have a TSG record within 120 seconds in
  P:\Surveys\Data\ETP\1998_STAR\Oceanographic\TSG\Current_Version\Intermediate\TS
  GTrackCheck_1998_STAR_ENDV_Final.dat

      316    lines were compared to TSG

  0.34772    Root-mean-square-error of distances
       21    Distances >= 1 nautical mile
  2.08754    Max distance
```

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 1998 STAR ENDV, there were 319 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 decides what edits need to be made, and records that information in file XBTDrops_1998_STAR_ENDV 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 for the edits to be applied. 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:

>RJ   Reject profile.

>NN   The profile is not suitable for submission to the NCEI World Ocean Database, but is good enough for deriving surface temperature and mixed layer depth, and perhaps thermocline variables, for MMTD purposes.

>XD ddd.d ddd.d   Exclude data within the profile. Reject data between the first and second specified depths.

>BD ddd.d   Exclude data at the bottom end of the profile. Reject data deeper than ddd.d.

>FT ddd.d   False trigger, data recorded before the probe entered the water. This error is rare. 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. All temperatures at depths ≤ 4.0 m are rejected to routinely dismiss surface transients, so this flag is only effective if a depth >4.0 m is indicated. 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.

Profile rejections and data exclusions are usually explained in a comment following an apostrophe ('): wb = wire break, ws = wire stretch, hb = the probe hit the bottom, ip = insulation penetration.

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.)

Here is the output from XBTEdit:
```
    319     lines read from input file
            P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Current_Version\Intermed
            iate\XBTDrops_1998_STAR_ENDV PF.txt
    0       lines started with an apostrophe, so were ignored
    20      lines had an RJ code, so were ignored
```

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```
299     records written to
        P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Current_Version\Intermed
        iate\XBTEdit_1998_STAR_ENDV.dat

19      lines were not good enough for NODC, so their drop numbers were negated
280     records written to
        P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Current_Version\Intermed
        iate\XBTNODC_1998_STAR_ENDV_6.691_0.00225.dat

10.90   Average temperature of all 156877 output points whose drops met the Min
        To Avg depth
21.60   Average temperature of all 41035 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
```

Depth and Temperature Corrections

Perl program XBTCorrect was used to correct depths and temperatures, using the method described in P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\CH XBT fall-rate method.pdf. Here is the output from 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\1998_STAR\Oceanographic\XBT\Current_Version\Intermedi
        ate\XBTEdit_1998_STAR_ENDV.dat...
Deep Blue: Thermal Bias = 0.02346, A = 6.635, B = 0.00245, Offset = 2.015

300     lines read from
        'P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Current_Version\Intermed
        iate\XBTEdit_1998_STAR_ENDV.dat'
0       lines started with an apostrophe, so were ignored
299     records written to
        P:\Surveys\Data\ETP\1998_STAR\Oceanographic\XBT\Current_Version\Intermedi
        ate\XBTCorrect_1998_STAR_ENDV_Deep Blue.dat

19      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_1998_STAR_ENDV_Deep Blue.dat

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 (ºC) 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_1998_STAR_ENDV_Deep Blue.dat

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:

```
..., 0.0, 0.6, 1.3, 2.0, 2.6, 3.3, 4.0, 4.6, 5.3, 5.9, 6.6, 7.3, 7.9, 8.6,...
```

Paul Fiedler
Dan Prosperi
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