XBT Data Processing – CSCAPE 2005 MACII

XBT data were collected with SEAS software (Shipboard Environmental data Acquisition System, NOAA/AOML) on the NOAA Ship McArthur II Jun 5 through Jul 22, 2005. 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\WestCoast\2005_CSCAPE\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. There were two files that had a drop number of 41. The second one was temporarily changed to 99 (because the SEAS2EDF program requires drop numbers to be numeric). After conversion, the files for this drop were renamed to 41A.

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 CSCAPE 2005, the CD labeled "Leg1b McArthurII" was the most complete. These files were copied to P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Raw\MACII\.

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

Perl program XBTRawFileInfo was used to get a summary of the raw files. It showed that all SEAS files had matching EDF Files, and vice versa. However, there were two files whose names contained 41 (.041 and .041x), and internally they both said they were drop 41. In addition, the files named 42 and 43 had a drop number one lower internally. That is, file 42 had drop number 41 internally, and file 43 had drop number 42 internally. So the internal drop number 41 existed in three files (files .041, .041x, and .042). Looking at the contents of the files, the file named .041x was identical to file .042, so file .041x was excluded from further processing. In addition. files .042 and .043 were edited so their internal drop number matched the file name. This also matched what was in the ODL.

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 2005 CSCAPE, twelve XBT drops were originally greater than 1 nautical mile of TSG positions matched by time. The time and positions in the EDF files were corrected based on the ODL. However, this still left five positions greater than 1 nautical mile from TSG.

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 2005 CSCAPE, there were 74 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 needed to be made, and recorded that information in file XBTedit2005Cm_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.)
The edited data were written to file XBTEdit_2005_CSCAPE_MACII.dat. The program reported
the following:

```
74     lines read from input file
       P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\I
       ntermediate\MACII\XBTedit2005Cm_PF.txt
0      lines started with an apostrophe, so were ignored
3      lines had an RJ code, so were ignored
```

```
71      records written to
        P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\I
        ntermediate\MACII\XBTEdit_2005_CSCAPE_MACII.dat

4       lines were not good enough for NODC, so their drop numbers were negated
67      records written to
        P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\I
        ntermediate\MACII\XBTNODC_2005_CSCAPE_MACII_6.691_0.00225.dat

7.02    Average temperature of all 30601 output points whose drops met the Min To
        Avg depth
10.85   Average temperature of all 7974 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
```

Correct Depth and Temperature

Perl program XBTCorrect adjusted the XBT depths and temperatures based on the method described in P:\Surveys\Data_Processing_Resources\Oceanographic\XBT\CH XBT fall-rate method.pdf. The adjusted data were written to XBTCorrect_2005_CSCAPE_MACII.dat. The program reported the following:

```
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\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\I
        ntermediate\MACII\XBTEdit_2005_CSCAPE_MACII.dat...
Deep Blue: Thermal Bias = 0.05033, A = 6.588, B = 0.00212, Offset = 1.715

72      lines read from
        'P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\
        Intermediate\MACII\XBTEdit_2005_CSCAPE_MACII.dat'
0       lines started with an apostrophe, so were ignored
71      records written to
        P:\Surveys\Data\WestCoast\2005_CSCAPE\Oceanographic\XBT\Current_Version\I
        ntermediate\MACII\XBTCorrect_2005_CSCAPE_MACII_Deep Blue.dat

4       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_2005_CSCAPE_MACII_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_2005_CSCAPE_MACII_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:

```
..., 0.3, 0.9, 1.6, 2.2, 2.9, 3.6, 4.2, 4.9, 5.5, 6.2, 6.8, 7.5, 8.2, 8.8,...
```

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