National Reference Station Bio-Geochemical Sampling

ANMN Standardised Profiling CTD Data Processing Procedures

v. 2.0 - 25 March 2014

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A series of modifications to the CTD Standardised Profiling CTD Data Processing Procedures were decided in February 2013 and consisted of the following changes in the various sub-program menus:

1. Data conversion: scans to skip > set to 300 (allows dissolved oxygen and salinity sensors adequate time to stabilise).

2. Low Pass Filter dropdown: filter A time constant: set to a value of 1 (for a 4hz CTD).

3. Align parameters: advance values: set oxygen SBE43 to 2 seconds (required for slower SBE43 response time).

4. Loop Edit: a) surface soak depth > set to 1.0m, b) minimum soak depth > set to 0.5m, and c) maximum soak depth > set to 2.0m.

5. Bin average: Un-tick the box "exclude scans marked bad".

Operators of IMOS Profiling CTDs should ensure that the CTD time clock is set to UTC time at the start of each run/cast to bring date/time stamping of the data in-line with all other IMOS data instruments.

1. Software

1.1 SBE19+ SEACAT Profiler CTD

There are three main Windows-based programs used with the SEACAT SBE19+ Profiler

1. **SeaTermV2**: a terminal emulation (communications) program used to change settings, enter offsets, download data and check the SEACAT status.
2. **SBEDataProcessing-Win32**: the post-processing program for handling the raw data once it has been uploaded from the SEACAT.
3. **SeaSave-Win32**: a program that can be used to view data in real-time such as when performing pre-run checks and calibrations.

For profiling CTD data processing it is the **SBEDataProcessing-Win32** software and its subprogram modules that are to be used. Within the sub-programs a range of user-defined options can be setup and then applied to the raw data. Although recommendations on how best to treat the raw data in this processing phase are provided within the manual, a consistent data processing approach is required across the ANMN to standardise the final data output as the Quality Assured/Quality Controlled (QAQC-ed) data product for upload to the IMOS website as FV01.

Updates of the software can be obtained from the SeaBird website at **www**.seabird.com by choosing "Software" and then navigating to the FTP download site. There are a number of issues, however, that arise when trying to process raw data files that have been downloaded with one version of SeaTerm (v.**1.00d** circa 2008) but attempt to process the data with a later version of SBEDataProcessing (eg. 7.21f is a recent 2011 release). The version of SBEDataProcessing installed on the IMOS ANMN Laptops when SBE19+ SeaCat CTDs were deployed in 2008 was **SBE Data Processing v. 7.18c.** Issues arise with differences in the header formats used in the different versions. Although, there are ways to work around this, for ease of processing for the ANMN profiling CTD data it was decided that:

> **ALL OPTIONS DESCRIBED WITHIN THIS VERSION OF THE ANMN SeaCat CTD PROCESSING MANUAL UTILISE SeaTermV2 1.00c and SBEDataProcessing 7.18c or versions distributed in late 2008.**

Using a batch-processing function will also be discussed here. In batch processing the user can choose to process multiple files from one or many days at a single time. There are advantages and disadvantages to the batch processing function. The initial setup is somewhat laborious, but once in place makes processing a "one-click" task. Those files to be batch processed, however, must all be files for which the same CTD CONFIGURATION (CON extension files) is to be applied. This and other issues associated with batch processing are detailed further below (Section 4).

DATA HANDLERS BEWARE:
The SBEDataProcessing steps detailed below do not constitute a QAQC check on the data that has been collected with the profiling CTD. The processing procedure and application of the various modules provides a means to adjust and/or correct the data for field associated and/or instrument induced anomalies in the raw data. Thus, at the end of the process the data files will still be considered FV00 (Raw Data – see IMOS naming convention protocols) even though in reality they are not the original raw scans from the SeaCat.

1.2 NetCDF conversion for IMOS portal upload

The Matlab TOOLBOX is the second piece of software that will be used in this post-processing procedure. The Toolbox is a module of Matlab that may be used to QAQC the data files. The toolbox function is to read in the processed SEABIRD data file and then run a series of data continuity tests according to the procedure described at https://code.google.com/p/imos-toolbox/wiki/QCProcedures#Profiles. Data is then considered to be of FV01 standard. Currently, none of the Pre-Run Profiling CTD Check data (see **Pre-Run Check and Field Sampling CTD Procedural Guide v. 1.1, 9 November 2011**) are applied, however, it is envisaged that this QAQC information may be able to be incorporated and applied in future Toolbox versions.

Matlab Toolbox is also used to rename (see IMOS naming convention protocols) and convert the "regional climate" filtered QAQC FV01 files to netCDF format for upload to the IMOS portal.

The final step in the process requires data handlers to gain access to the relevant staging point on the AODN FTP upload site. This involves establishing a username and password on a third party data sharing service provided by the University of Melbourne for AODN. Most of the ANMN institutions are already subscribers to it. To gain access go to:

http://emii1.its.utas.edu.au/FTPUploadersRegistration/register.php

and register. Once connected to this FTP, CTD profiling and fieldsheet data can be uploaded to the staging point. You must then notify the portal adminstrators at EMii that data has been posted. Checks on the files will then be performed before EMii upload them to the public portal. Contacts at EMII – Marty Hidas marty.hidas@utas.edu.au.

2. Data Processing

2.1 Windows Explorer Folder Structure

If you are processing a small number of files then you may be content with simply stepping through each of the 6 individual steps in the data processing procedure detailed below. In this case you may choose to ignore the batch processing option.

However, if you will be block processing many files at a time, some economy can be achieved by first setting up your file and folder structure to accommodate batch processing. The batch processing function can then be utilised indefinitely with some minor adjustments to the CONFIG files used in 2 of the modules (DATCNV, DERIVE).

In order for batch processing to function correctly and accommodate the way SBEDataProcessing manages files in auto-mode, an appropriate FOLDER structure should be established within Windows Explorer. For the purposes of demonstrating processing utilising the batch function, an example folder structure is provided below. The folder structure detailed will be used throughout this procedural manual.

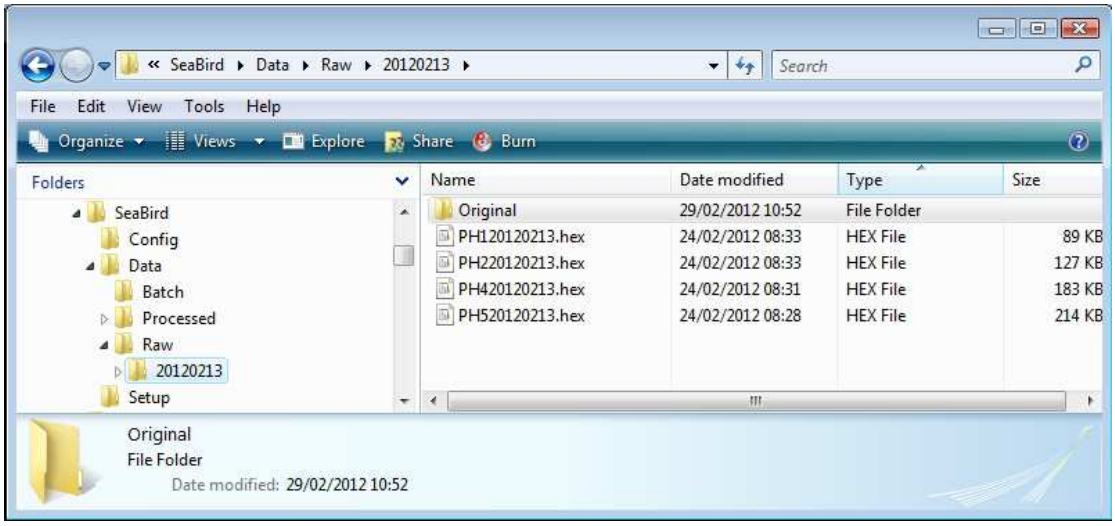


Figure 1.2 Example of folder setup to be used to facilitate batch processing in Windows Explorer with HEX files downloaded from the SeaCat 19+.

NOTE: A simplified file name that differs to the IMOS filename convention is used here for processing purposes only.

Once you have created the folder structure:

COPY place a copy of a sample raw data file (HEX extension files) in the batch processing folder.
(eg. Files copied from **C:\SEABIRD\DATA\RAW** to the **C:\SEABIRD\DATA\BATCH** sub directory).

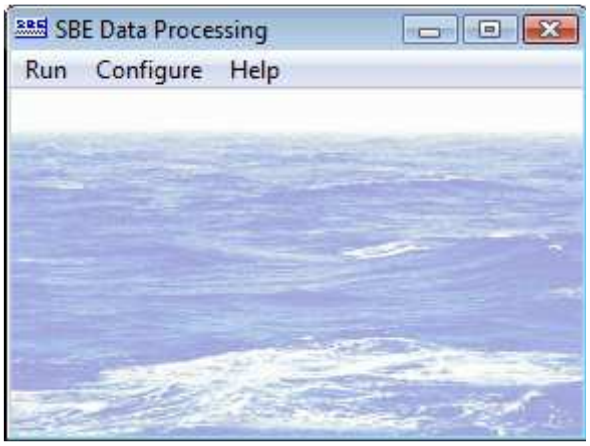
If you do not wish to use batch processing then you can set up each of the modules to find the files in whichever folder you have placed your HEX files ready for processing. Locate that folder in each of the appropriate STEPS in section 2.2 below.

CHECK Ensure that the CTD configuration file you need to apply is setup correctly and placed in the **CONFIG** sub-directory. (eg. Configuration file is called **6178B_2011_08.con** and denotes SeaCat Serial Number 6178 and date of last factory calibration August 2011).

2.2 SBE Data Processing – Win32

This first step in the data processing protocol requires you to set up the parameters within the SBEDataProcessing software. You will get the opportunity to save these setup files along the way and so, provided you do not overwrite them, you should not have to do this more than once.

OPEN Open up the procesing software program by choosing PROGRAMS> SEABIRD> SBEDataProcessing – WIN32. Examine the sub-program menu options under the drop down menu >RUN.



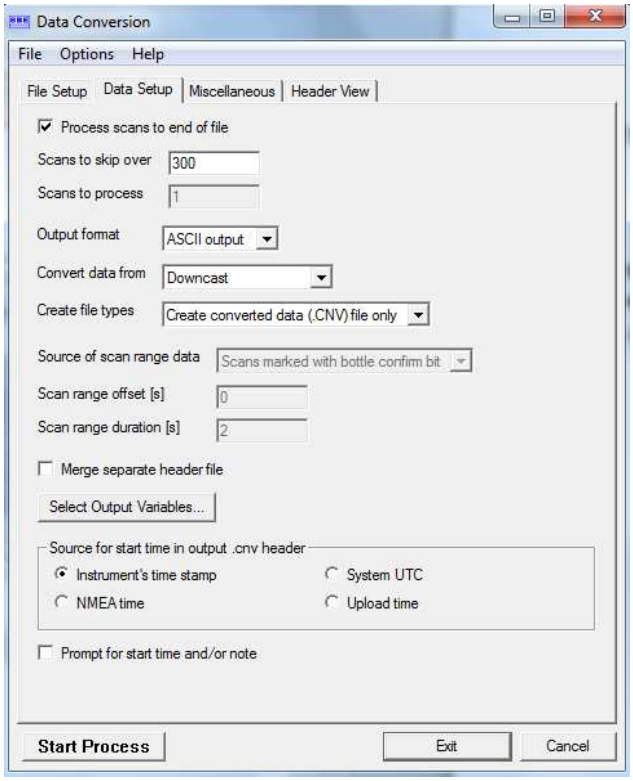
The data is to be processed in six (6) steps; convert to ASCII (DATCNV), low pass filter (FILTER), align parameters (ALIGN), loop edit (LOOPEDIT), derive values (DERIVE) and bin average (BINAVG). The data file(s) produced at each step is/are retained and the steps and settings are outlined below.

Note: for the examples presented in the figures below processing has been conducted with SBE Data Processing, Version 7.18c-d.

STEP 1: Data conversion to ASCII

From the dropdown menu select RUN> 1. DATA CONVERSION…

S1.1 This subprogram converts *filename*.hex to *filename*C.cnv using the subprogram **DatCnv. SELECT** the **DATA SETUP** tab and set up the sub-program window **Data Setup** with the following settings;



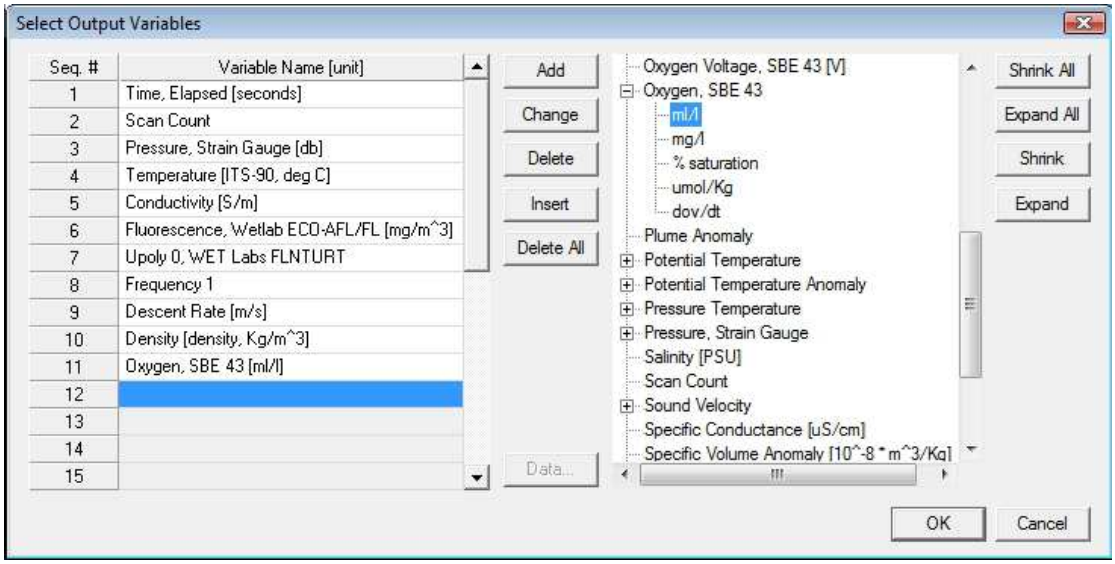
Note: The 300 scan skip (150 s @ 4Hz) allows the dissolved oxygen and salinity sensors to stabilise adequately during the recommended 3 min soak phase for IMOS Profiling CTD deployment.

S1.2 Choose the SELECT OUTPUT VARIABLES button in the DATA SETUP window. Set up the variables to be output from the conversion of raw voltages to SI unit variables using according to FIGURE 1.2. Search from the range of SeaBird output types from the right hand menus and ADD them individually to the left hand list of VARIABLES.

WARNING: for some sensors such as temperature, for example, there are multiple options to choose from depending on the sensor type. Select according to the Variable Names and Sensor types (i.e. Temperature is ITS-90, degrees Celsius) as detailed below.

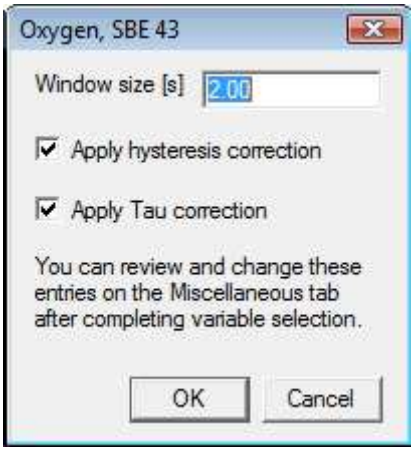
For DESCENT RATE you will be prompted to enter a value for the time window size the program is to use – retain the default of 2 seconds.

ENSURE that the variables to output are listed in the correct order detailed below. The order of the variables is significant for later conversion and uploading of files to the IMOS portal as netCDF.



NOTE: All nodes should have received and installed Dissolved Oxygen probes on their SeaCat CTDs in late 2011. Ensure that the output is in the correct units as ml/l – this will be converted to the standard units umol/l at a later stage.

When adding in the Dissolved Oxygen variable (ml/l) you will be prompted for the following. Select both corrections with a window of 2 seconds and choose OK.



In the SELECT OUTPUT VARIABLES window, revise your selection (11 variables selected – note salinity and depth will be derived in a later step), choose OK and return to the DATA SETUP tab window.

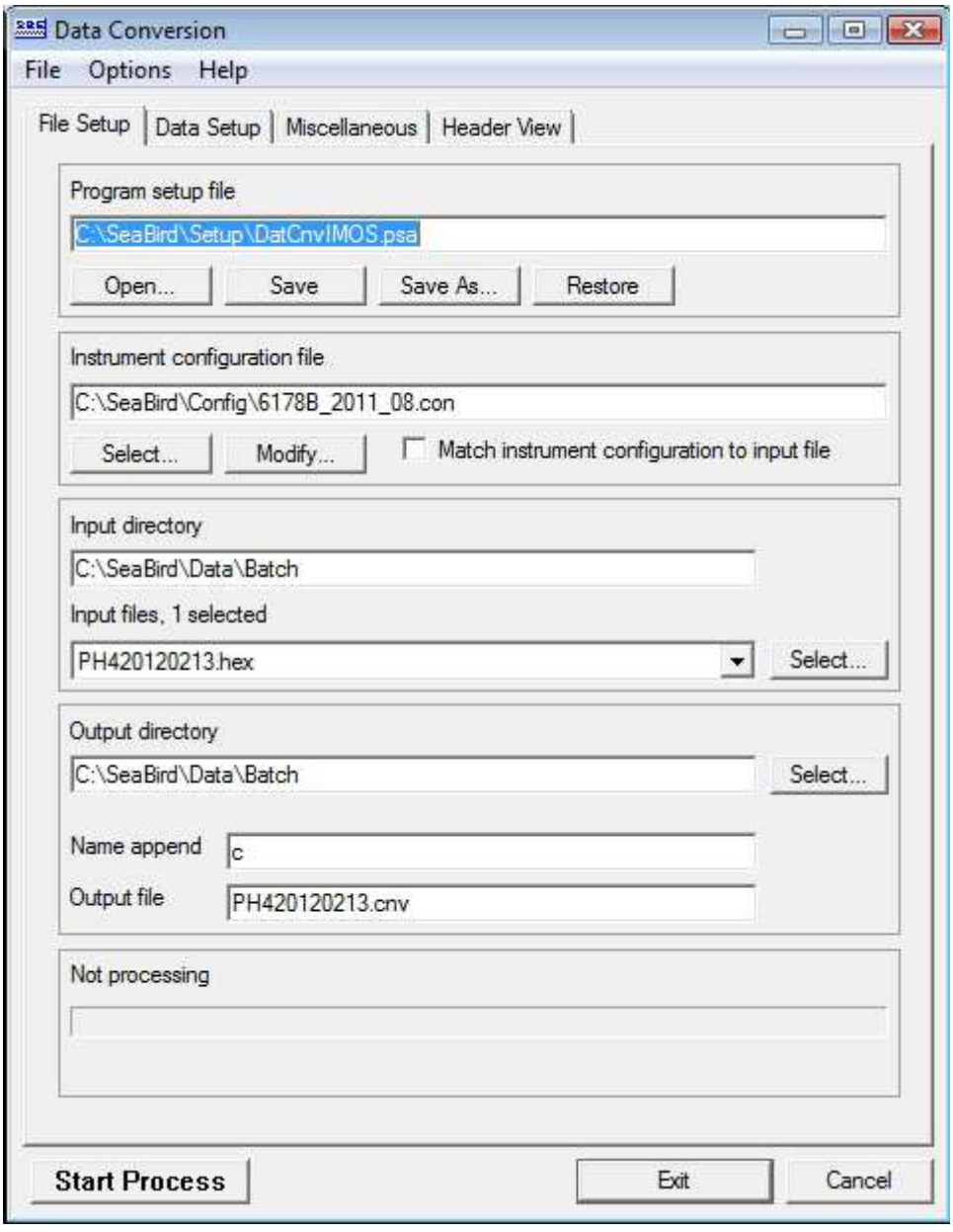
S1.3 Retain options for the other tabs i.e MISCELLANEOUS and HEADER, at their default settings.

In the FILE SETUP tab window, choose the most recent instrument configuration file relevant to the data files you wish to process from **CONFIG** sub-directory.

Also select the Raw Data File with the HEX extension from within the **C:\SEABIRD\DATA\BATCH** sub-directory. For the purpose of demonstration and setting up the BATCH processing options the file **PH420120213.hex** is to be used here.

Define the file Output Directory as **C:\SEABIRD\DATA\BATCH**. In the AMEND FILENAME field place the letter **"C"** to indicate that processed files will be converted files.

Choose the FILE SETUP tab and save the settings as a PROGRAM SETUP FILE by selecting SAVE AS. Save the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\DatcnvIMOS.psa**.



S1.4 There is generally no need to amend the Header View tab unless you wish to add information to the header file at this time. For example you may wish to add information about the data file lat long location, name of CTD operator and date of collection, name and date of person processing the data etc. This is optional as most information will be contained within the Data File Name according to the IMOS convention.

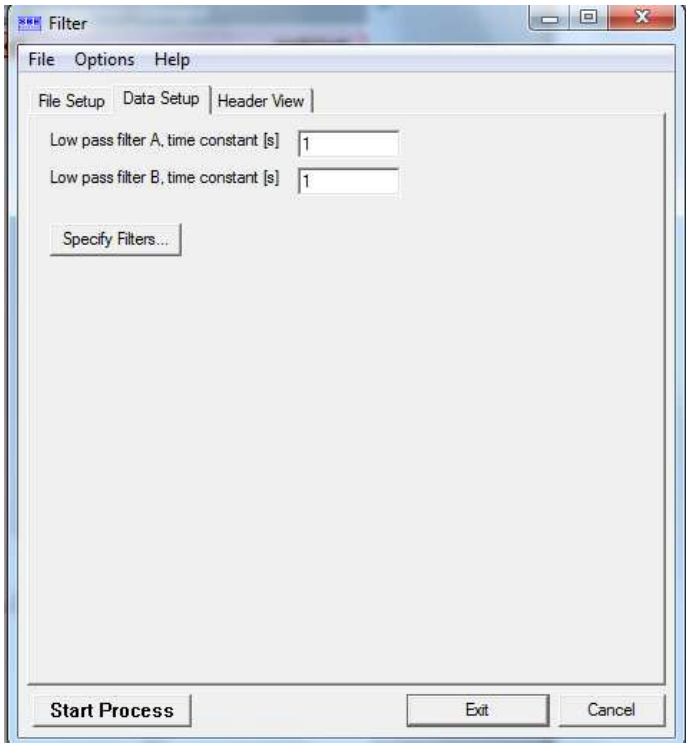
S1.5 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

STEP 2. Low Pass Filter

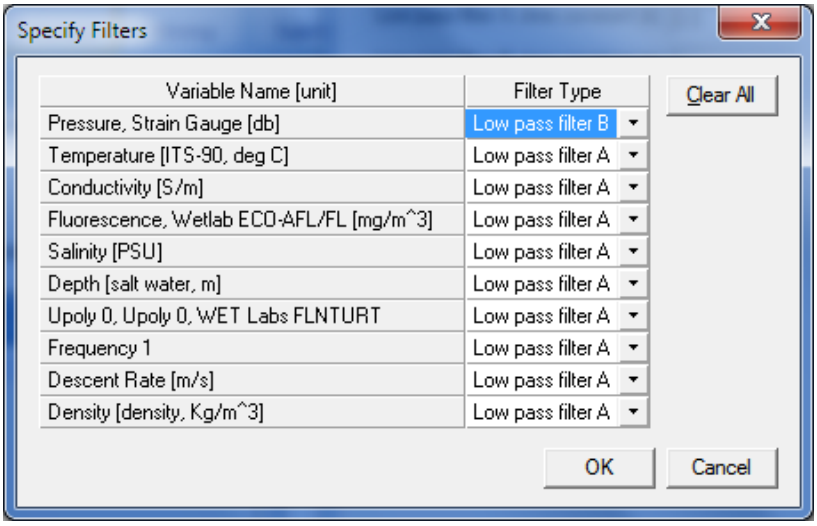
From the dropdown menu select RUN> 2. Filter …

This sub program converts *filename*CF.cnv to *filename*CF.cnv using the sub-program **Filter.**

S2.1 In the **Data Setup** dialog ensure that the following settings are applied with Low Pass Filter options A and B.



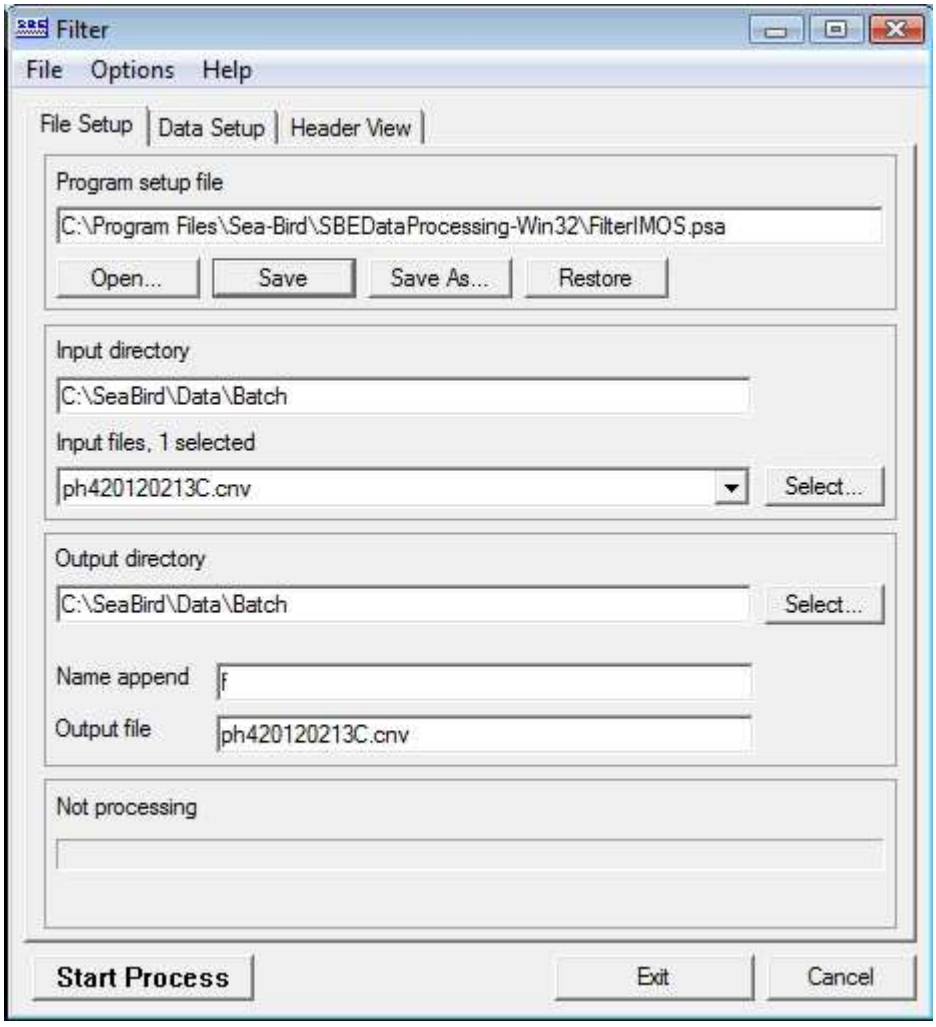
S2.2 Choose the **Specify Filters** radio button and ensure that the Low Pass Filter B is applied to the variable "Pressure, Strain Gauge (db), while Low Pass Filter A is applied to all other variables listed.



S2.3 In **File Setup** dialog ensure that the following settings are applied with the input and output directories identified and a letter **"f"** entered in the **Name Append** field.

Click on SELECT for the INPUT FILES and navigate to **C:/SEABIRD/DATA/BATCH**. Highlight the data files (with the extension CNV) amended with the letter **"c"** that were output from the previous module (DATCNV), i.e. **PH420120213c.cnv**, etc, and click OK.

In the FILE SETUP tab save the settings as a PROGRAM SETUP FILE by selecting SAVE AS and saving the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\FilterIMOS.psa**.



S2.4 There is no need to amend the Header View tab unless you wish to add information to the header file at this step.

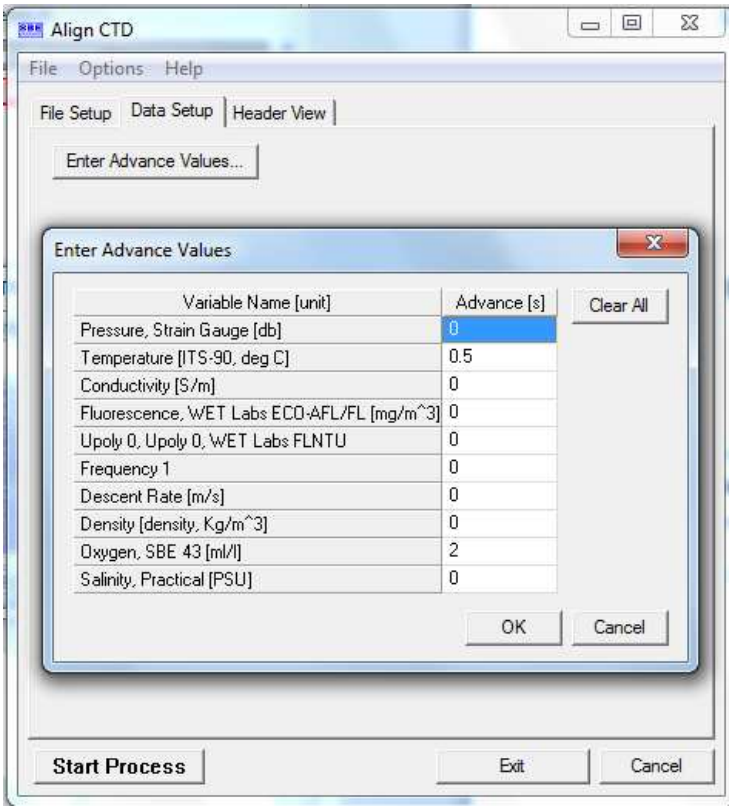
S2.5 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

STEP 3. Align Parameters

From the dropdown menu select RUN> 3. Align CTD…

This sub-program outputs *filename*CFA.cnv using the program module **AlignCTD.**

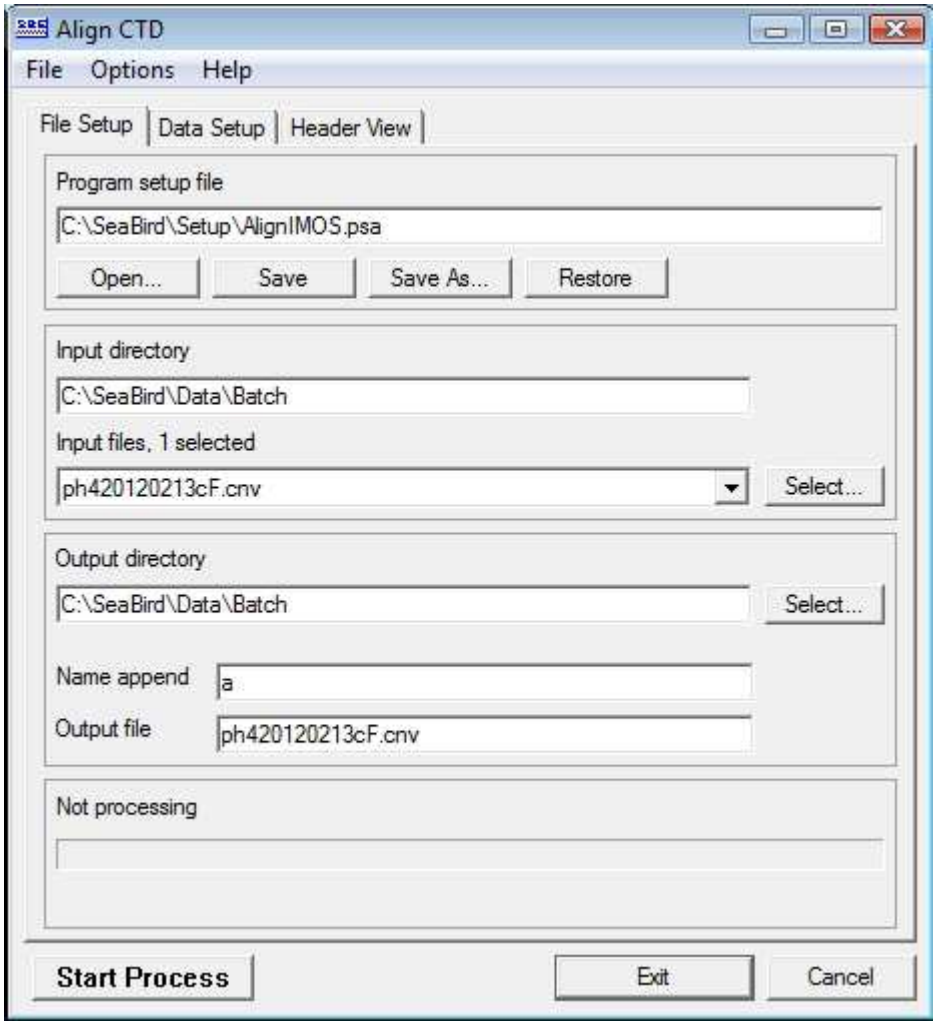
S3.1 Select the **Enter Advance Settings** in the **DATA SETUP** tab dialog and ensure that it has the following settings.



S3.2 In **File Setup** dialog ensure that the following settings are applied with the input and output directories identified and a letter **"a"** entered in the **Name Append** field.

Click on SELECT for the INPUT FILES and navigate to **C:\SEABIRD\DATA\BATCH**. Highlight the CNV extension files with data filenames amended with the letters **"cf"** converted in the previous FILTER module, i.e. **PH420120213cf.cnv**, etc.

In the FILE SETUP tab save the settings as a PROGRAM SETUP FILE by selecting SAVE AS and saving the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\AlignIMOS.psa**.



S3.3 There is no need to amend the Header View tab unless you wish to add information to the header file at this step.

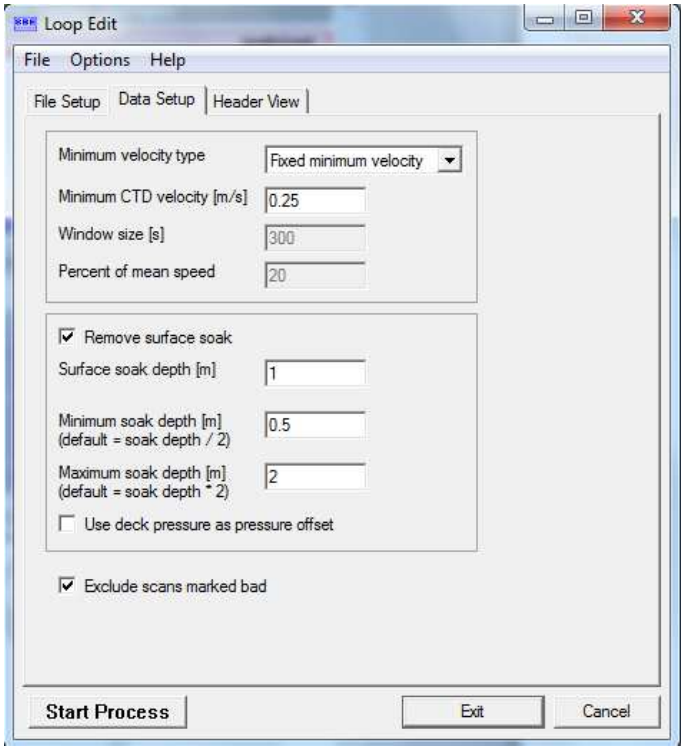
S3.4 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

STEP 4. Loop Edit

From the dropdown menu select RUN> 5. Loop Edit…

Outputs *filename*CFAL.cnv using the **Loop Edit** program module.

S4.1 Select the Data Setup tab and ensure that the following settings are selected.

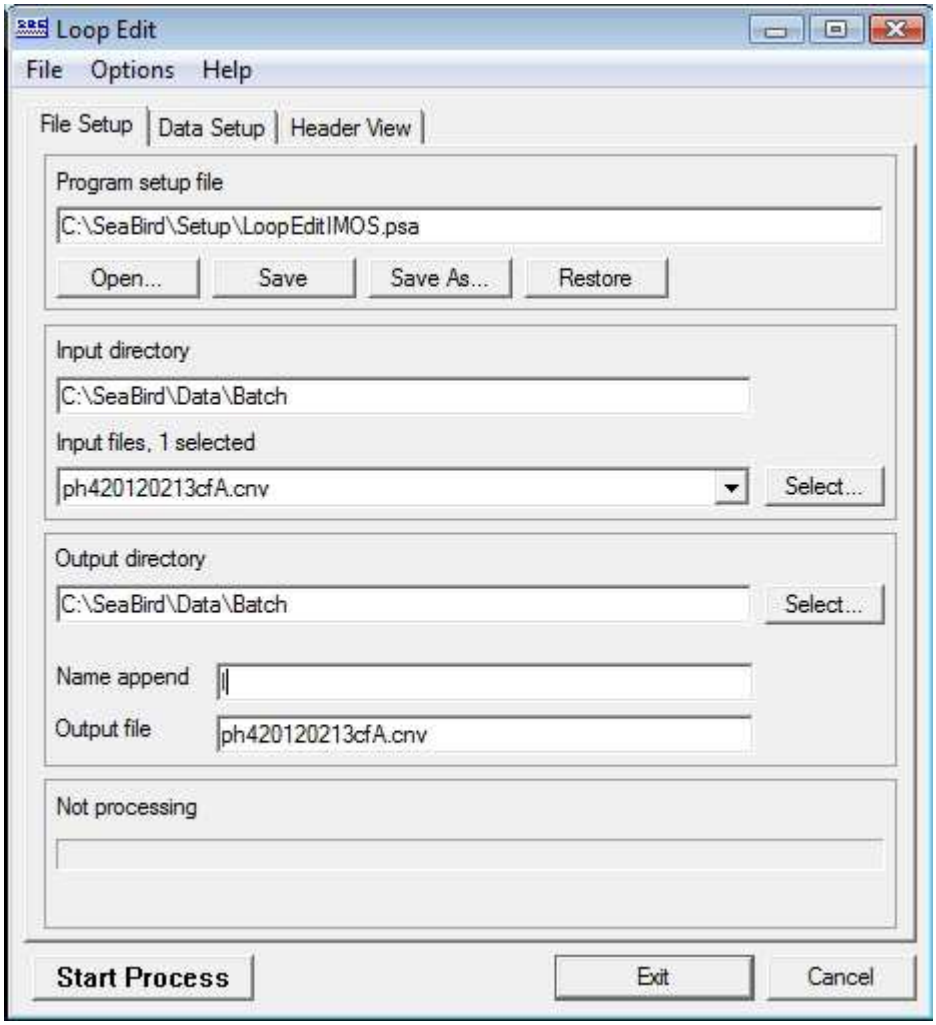


Note: Values for removing surface soak will need to be determined on a site by site basis and may also often vary between sampling runs.

S4.2 In **File Setup** dialog ensure that the following settings are applied with the input and output directories identified and a letter **"l"** entered in the **Name Append** field.

Click on SELECT for the INPUT FILES and navigate to C:\SEABIRD\DATA\BATCH. Highlight the CNV extension files with data filenames amended with the letters **"cfa"** converted in the previous ALIGN module, i.e. **PH420120213cfa.cnv**, etc

In the FILE SETUP tab save the settings as a PROGRAM SETUP FILE by selecting SAVE AS and saving the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\LoopEditIMOS.psa**.



S4.3 There is no need to amend the Header View tab unless you wish to add information to the header file at this step.

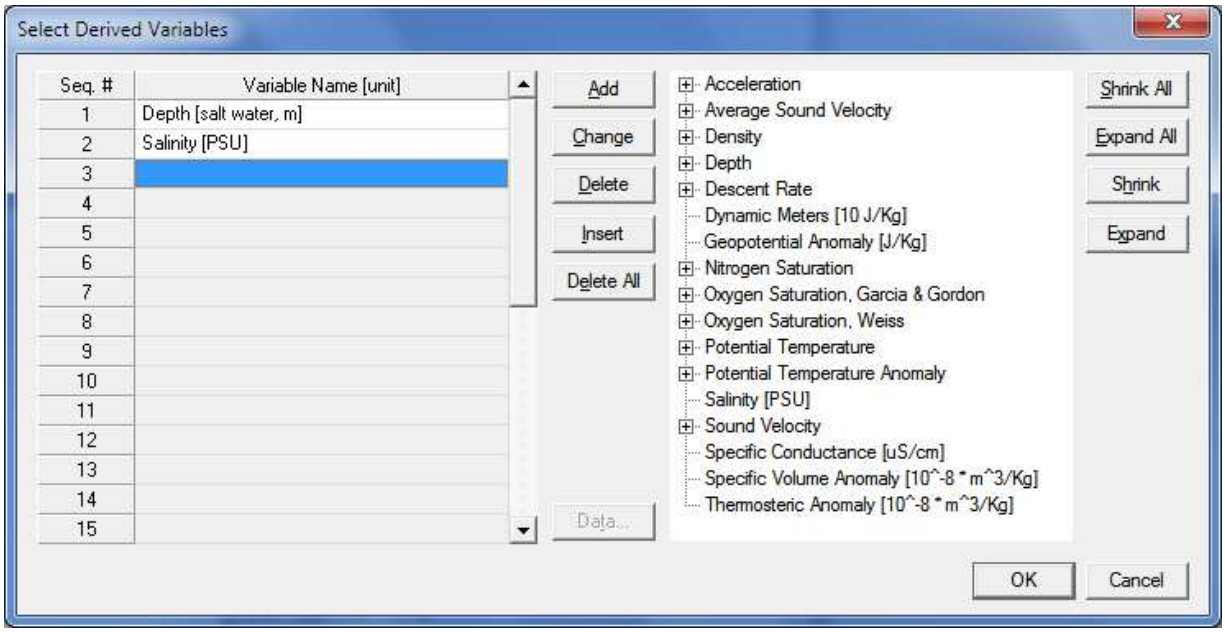
S4.4 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

STEP 5. Derive depth and salinity

From the dropdown menu select RUN> 6. Derive…

Outputs *filename*CFALD.cnv using **Derive** program module.

S5.1 In the Data Setup tab choose Select Derived Variables and ensure that the following variables are selected in the left hand list Variable Name as indicated below.

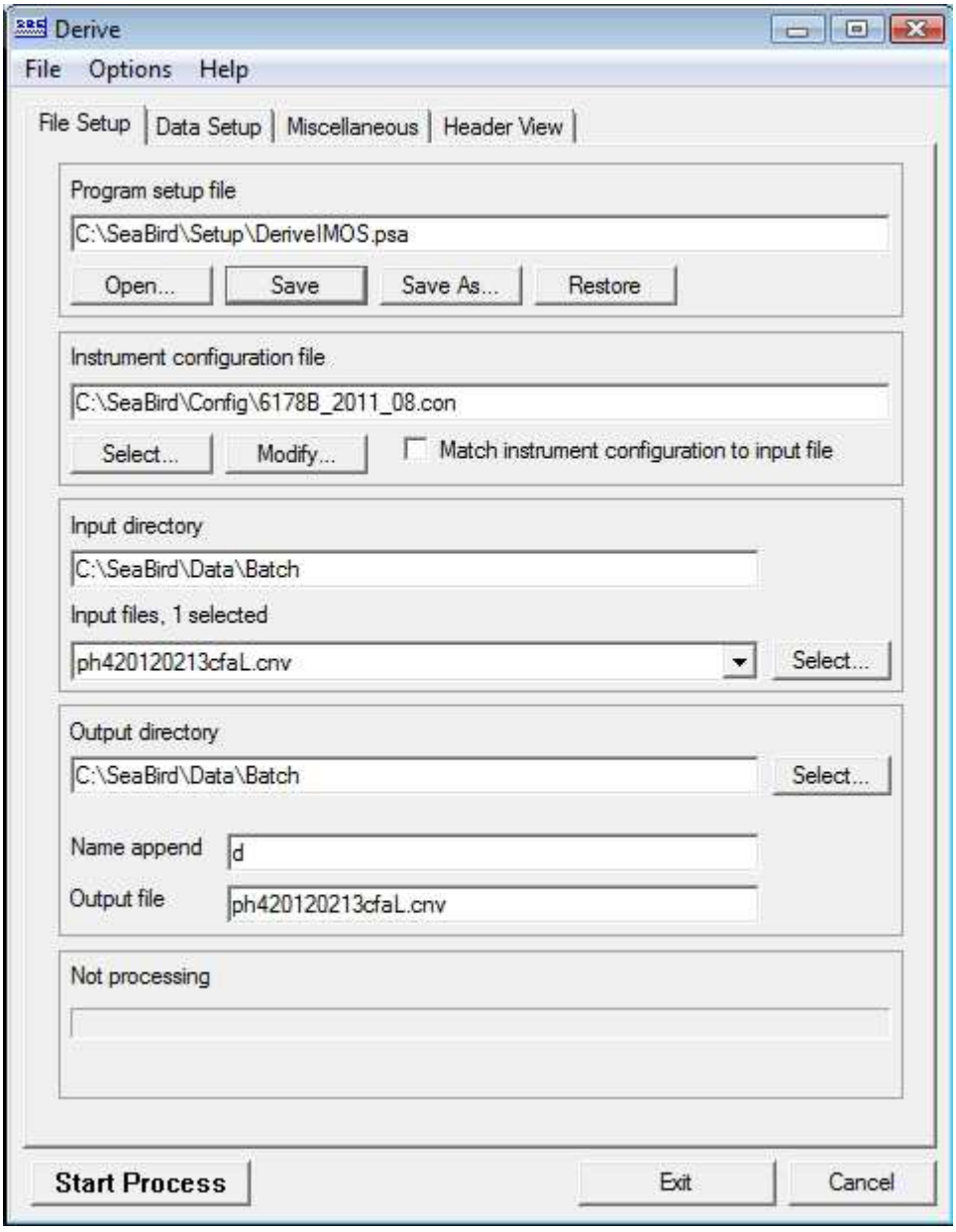


For the DEPTH variable you will be required to enter the LATITUDE you are working in; e.g. PORT HACKING is -34 (south).

S5.2 In **File Setup** dialog ensure that the following settings are applied with the input and output directories identified and a letter **"d"** entered in the **Name Append** field.

Click on SELECT for the INPUT FILES and navigate to **C:\SEABIRD\DATA\BATCH**. Highlight the CNV extension files with data filenames amended with the letters **"cfal"** converted in the previous LOOPEDIT module, i.e. **PH420120213cfal.cnv**, etc

In the FILE SETUP tab save the settings as a PROGRAM SETUP FILE by selecting SAVE AS and saving the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\DeriveIMOS.psa**.



S5.3 There is no need to amend the Header View tab unless you wish to add information to the header file at this step.

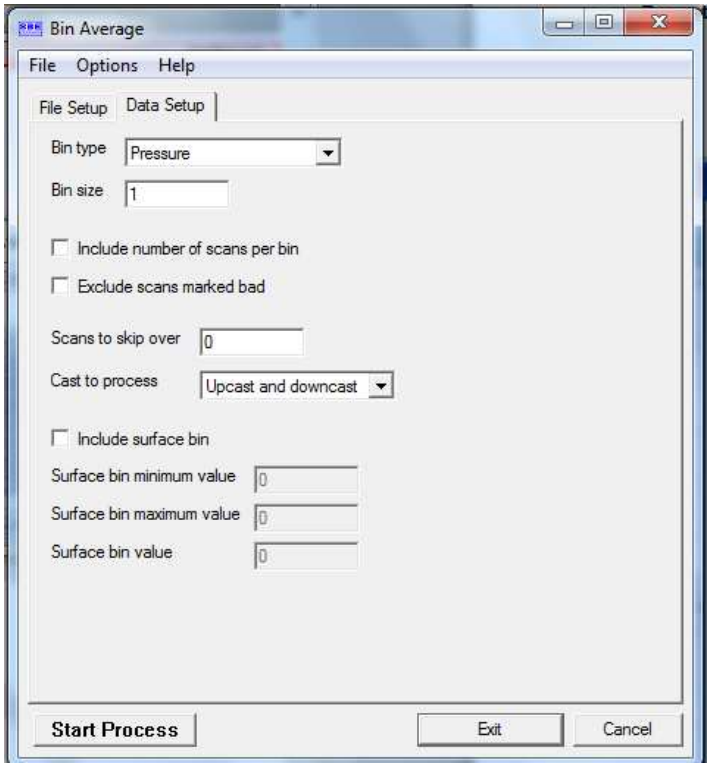
S5.4 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

STEP 6. Bin Average to 1m depth intervals

From the dropdown menu select RUN> 7. Bin Average…

Outputs *filename*CFALDB.cnv using **BinAvg** program module.

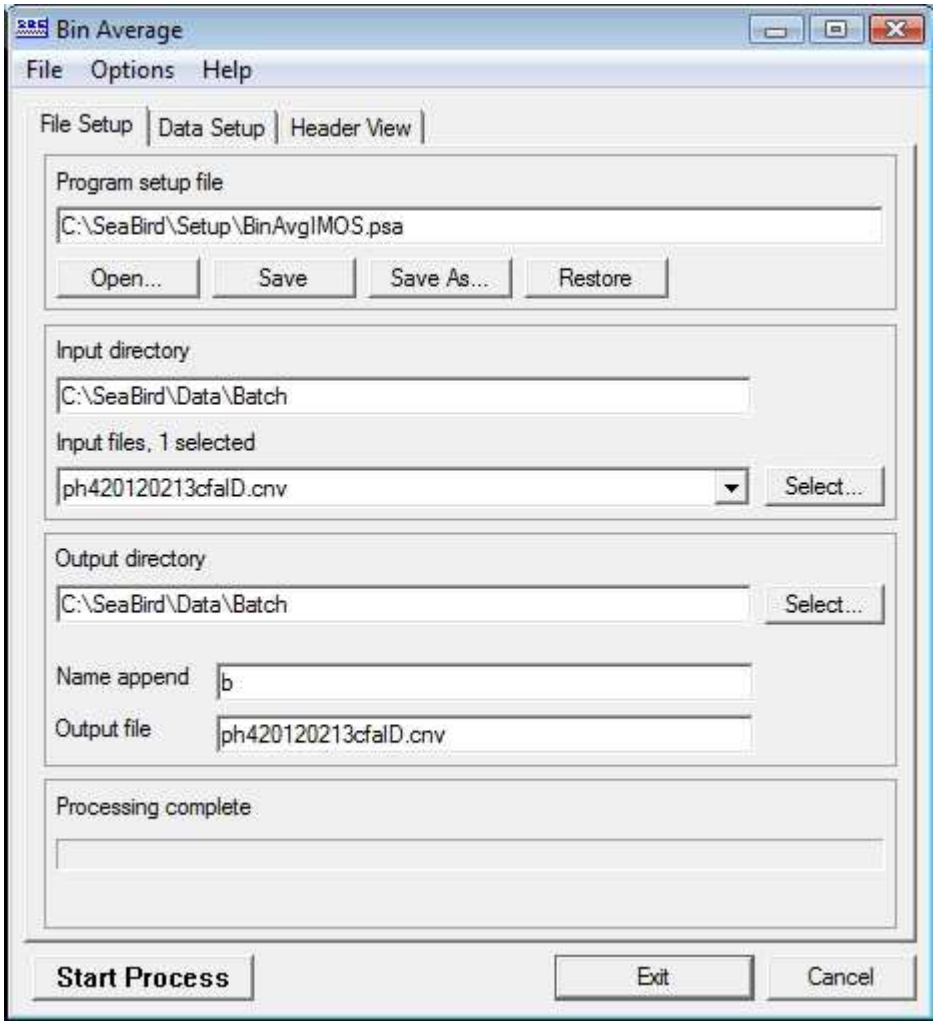
S6.1 Choose Data Setup tab and ensure that the following settings are selected.



S6.2 In **File Setup** dialog ensure that the following settings are applied with the input and output directories identified and a letter **"b"** entered in the **Name Append** field.

Click on SELECT for the INPUT FILES and navigate to **C:\SEABIRD\DATA\BATCH**. Highlight the CNV extension files with data filenames amended with the letters **"cfald"** converted in the previous DERIVE module, i.e. **PH420120213cfald.cnv**, etc

In the FILE SETUP tab save the settings as a PROGRAM SETUP FILE by selecting SAVE AS and saving the file to a folder on your c:\drive for example: **C:\SEABIRD\SETUP\BinAvgIMOS.psa**.



S6.3 There is no need to amend the Header View tab unless you wish to add information to the header file at this step.

S6.4 Hit **Start Process**, wait until the files have finished processing and then hit **Exit**.

2.3 Module Processing Outputs

The following set of figures are provided to demonstrate how the processing functions effect the final data output. NOTE: SBEDataProcessing is not considered a QAQC procedure within the Data Handling Protocols of IMOS and thus the data at the end of the process is still considered FV00 (raw).

The figures below display the salinity and/or temperature data versus depth output for a file after DATCNV (Figure 2.3.1) and salinity versus depth output (Figure 2.3.2) at each the end of the processing steps covered in Section 2.2. Note the spiky nature of the salinity data in the downcast (Figure 2.3.1) especially as the SeaCat profiled through the pycnocline. In comparison, the variability is absent from the thermocline according to the temperature profile. This is a function of the different response times for the conductivity and temperature sensors. SEABIRD advise that this is corrected for using the ALIGN function in SBEDataProcessing and it is recommended that Salinity not be output until after the ALIGN function has been completed.

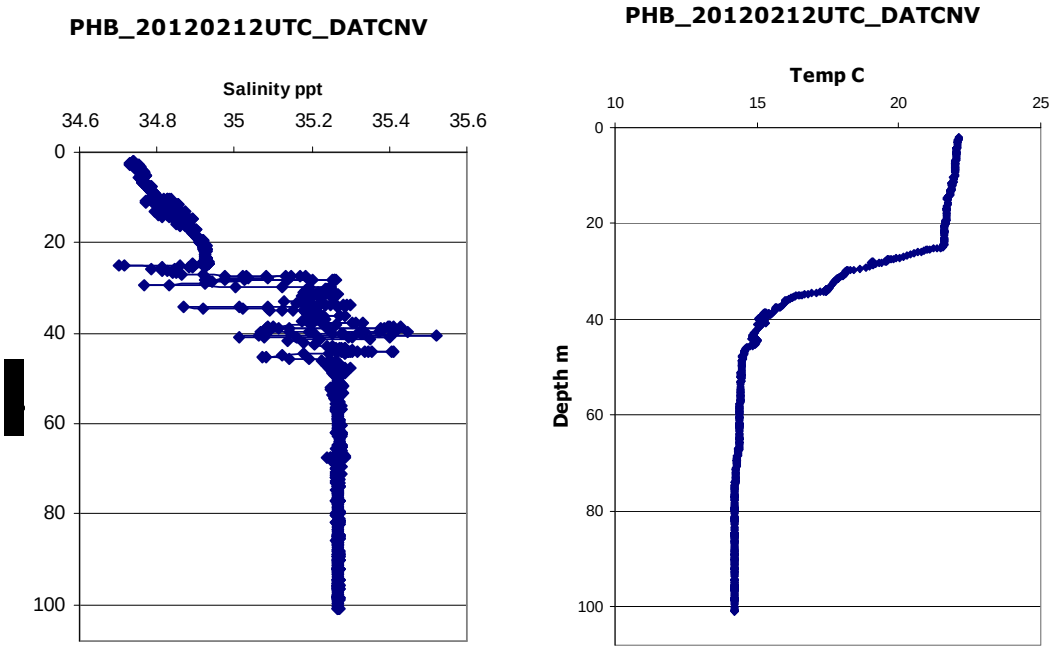
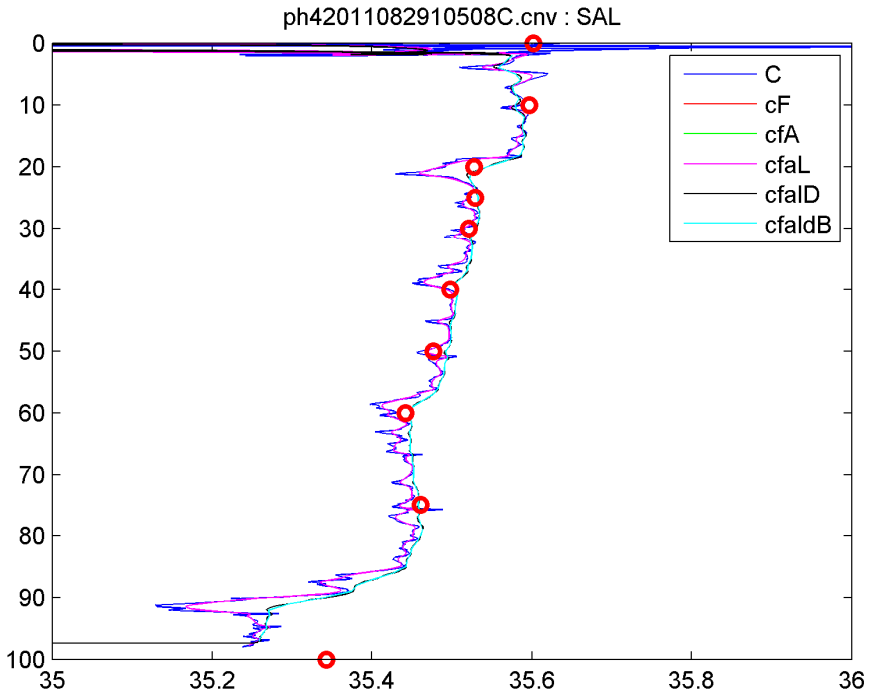
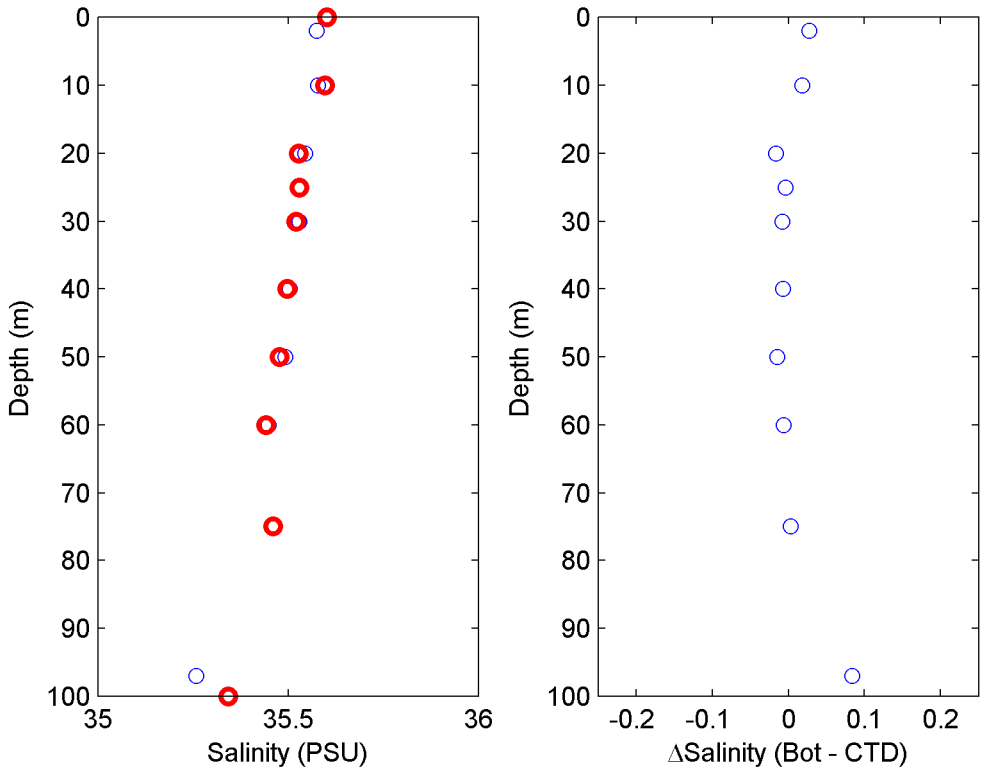


Figure 2.3.1 Plots of salinity and temperature for a summer 2012 file at Port Hacking after applying DATCNV only.



a)



b) c)

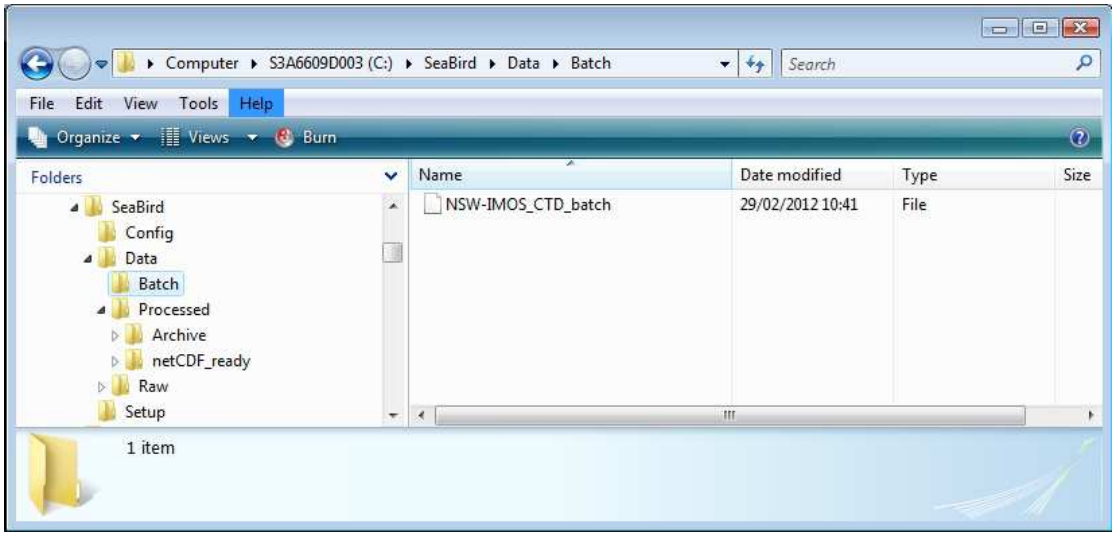
Figure 2.3.2 Plots of salinity for an autumn 2011 file at Port Hacking at; a) each stage of the data processing and compared to bottle data (red circles), b) final salinity (blue circles) and bottle data (red circles) at the sampled depths, and c) calculated differences between CTD and bottle salinity at the sampled depths.

3. Post-processing Files and conversion to netCDF

COPY Make a copy of the FINAL processed file(s), i.e. the file(s) with the xxxxxxx***CAFLDB.cnv*** suffix and place it/them into the **netCDF_ready** folder at:- C:\SEABIRD\DATA\PROCESSED\netCDF_ready.

Edit the file name of this FINAL file by removing the suffix CAFLDB.

MOVE Cut all the files sitting in the BATCH folder (i.e. 6 x CNV extension files C to CAFLDB and 1 x HEX extension original data file) and paste them into an **ARCHIVE** folder, i.e. the folder will now be empty of HEX and CNV files:- C:\SEABIRD\DATA\PROCESSED\ARCHIVE



4. To BATCH process or NOT?

As mentioned previously, if you are content stepping through each of the individual (6) processing steps above then you can choose to ignore the batch processing option. Following from the Steps 1-6 above, your final processed file ready for Matlab, as well as all of your step files are sitting within the BATCH folder. You can ignore the following instructions and move to **section 5**.

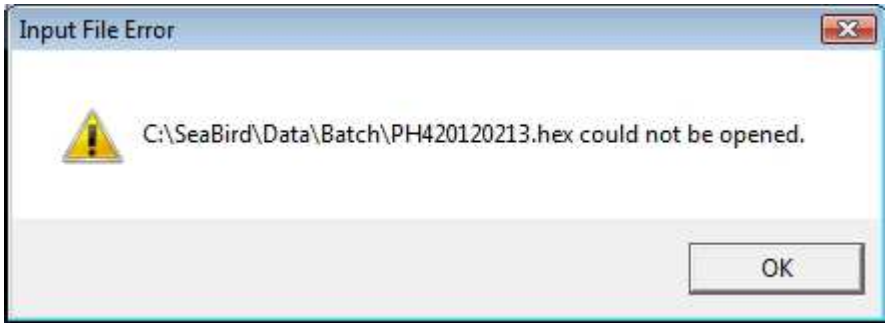
However, if you are multi-file processing and have set up your folder structure to accommodate the batch function, continue with the following.

ENSURE that the BATCH folder is empty of HEX and all CNV files and only contains the BATCH RUN FILE (eg. A sample batch file named **NSW-IMOS_CTD_batch** has been provided with this manual and should be renamed and edited accordingly). NOTE: The batch file does not have an extension but can be readily viewed in a text viewer window.

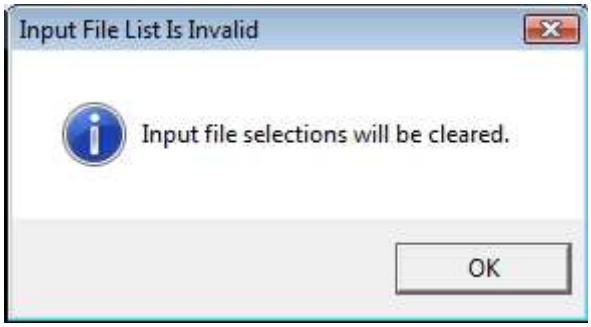
OPEN One by one, step back into each of the processing modules in SBEDataProcessing by selecting:

Run> 1. Data Conversion… etc.

At each STEP you will be prompted with an "INPUT FILE ERROR" window.



CLICK on OK and a message that the INPUT FILE LIST IS INVALID will appear. Select OK again and the DATA CONVERSION module window will open.

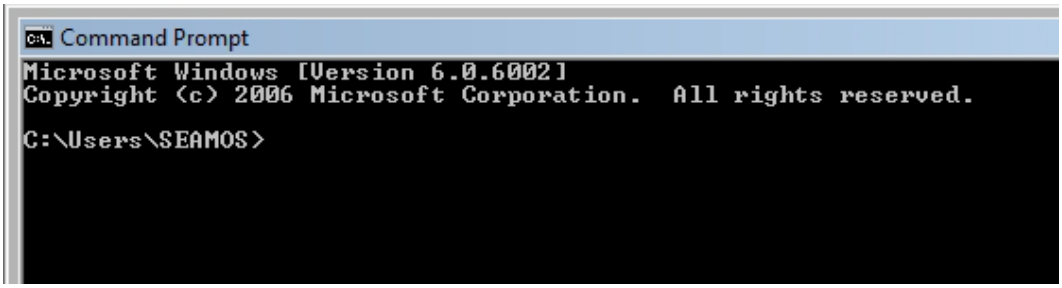


SAVE Once the module window has opened you should see that the Input Files filed should have no FILES identified and the text above the field will read "Input Files, 0 selected". SAVE the DATA CONVERSION setup file (extension .psa) again – it will simply overwrite the setup file in the C:\SEABIRD\SETUP folder.

REPEAT Step back into the FILTER, ALIGN, LOOPEDIT, DERIVE and BINAVG modules as well, check that no files are selected in the FILE INPUT field and resave the setup file.

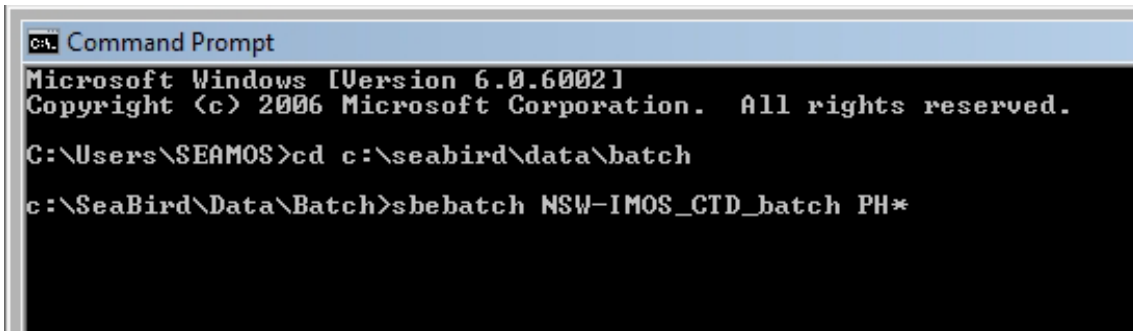
COPY Place a copy of the HEX files you wish to BATCH process into the BATCH folder.

RUN With a copy of the batch processing file (eg. **NSW-IMOS_CTD_batch)** in the Folder C:/SEABIRD/DATA/BATCH open a command window (DOS) dialog. You can access a DOS window in Microsoft Windows by going START>ACCESSORIES>COMMAND PROMPT. The command prompt window will open at some default point in the computers file structure.



To run the BATCH command, you need to navigate to the appropriate folder. After the ">" (eg. C:\Users\SEAMOS>) type in the text:
cd c:\seabird\data\batch
and hit RETURN.

To RUN the BATCH processing type the following command and batch filename at the prompt:-
c:\SeaBird\Data\Batch>**sbebatch NSW-IMOS_CTD_batch PH***
and hit enter.



Note: **sbebatch** tells the computer to run the SeaBird Batch script using the **NSW-IMOS_CTD_batch** file settings and the text **PH*** instructs the program to process all files that start with the prefix PH.

The batch function should be finished within a number of seconds and the processed files should all be sitting in the BATCH folder.

ERRORS? If you have experienced any errors return to each of the Modules and check that all the settings are correct. Also check that the name of the batch file and the commands have been typed exactly as they appear – if not then the batch function will not work.

MANAGE Move your processed files from the BATCH folder after processing is completed as per the instructions covered in Section 3.

5. MATLAB Toolbox

5.1 Applying Pre-Run CTD checks

Pre-Run CTD Checks conducted before each run are not currently corrected for in the data processing conducted for IMOS data. It is envisaged that QAQC of field data using the Pre-Run check data might be applied in future versions of the MATLAB toolbox – further discussions with the working group to be had on this issue.

5.2 Application of Automated Filters to CTD data

A working group should be defined to develop and test automated Filters for CTD profiled data, based on the Morello et al filters similar to that used currently for processing timeseries data from moored CTD instruments (see https://code.google.com/p/imos-toolbox/wiki/QCProcedures). When complete it is envisaged that these filters along with other QAQC will be implemented through the use of the Matlab imos-toolbox.

5.3. Converting to netCDF in the TOOLBOX

Work is also currently underway to verify and test the function of the Matlab IMOS-toolbox for use with profiling CTD data. At the time of issue of this Procedural Guide the task had not been designated. Once complete full instructions for use of the toolbox to undertake QAQC, incorporate metadata and convert to IMOS compliant netCDF files will be rolled out.