OMEL HyperPro Processing Instructions

Jasmine Nahorniak

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ProSoft Version 8.1.5

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Before we start, I'd just like to make it clear that this is *not difficult*. However, it does require attention to detail and an hour or two to process a cruise's worth of data. Yes, the instructions are long. This is to help you avoid the many, many pitfalls along the way. After the first time through, processing will be a breeze.

The important thing is that we want all OMEL HyperPro data to be processed in exactly the same way.

HyperPro photos and diagrams are from www.satlantic.com.

Bon voyage!

Contents

Step 0: Preparing for Processing

System Requirements

Operating System

Microsoft Windows 2000/2003/XP/Vista/7
(ProSoft does not run on Mac or Linux)

Software

You will need the following software installed on your PC:

- ProSoft 8.1.5_2
  - this version is not yet available from the Satlantic website – ask Jasmine for a copy
- Matlab (I use R2014b)
- Excel (for editing the processing log)

Files

You will need the following files on your PC:

- HyperPro calibration files
- HyperPro Matlab processing scripts

Directory Structure

You will need to create a folder on your PC to contain the necessary files for HyperPro processing. Let's call it "hyperpro". Create the following subfolders under your "hyperpro" folder:

cal	to contain the Hyperpro calibration and context files
matlab	to contain the Matlab processing scripts
logs	to contain the processing logs
data	to contain the Hyperpro data (raw and processed)

cal

Copy the HyperPro calibration files to the cal folder. You will need four folders and their contents: context_files, cal_files, Instruments, and Processing Parameters. These four folders should be placed inside your "cal" folder. These folders contain the calibration and context files for all OMEL Hyperpros (107, 120, 127). The cal_files folder contains the calibration files from Satlantic. The latter two folders (Instruments and Processing Parameters) are from ProSoft's hidden AppData files and provide an easy way to add someone else's existing context files to your system. See the Prosoft Setup section below for more details.

matlab

Place the HyperPro Matlab routines (from Jasmine) in the "matlab" folder.

logs

The log file is an excel spreadsheet. You should have one log per project (e.g. HOT, MILOCO, etc). If the data to be processed are a continuation of an existing data set (e.g. MILOCO, HOT, etc), use the existing log file for that project. It is important to keep a log to keep track of the processing settings you use so your results are reproducible.

data

Under the "data" folder, you will then need to create a new folder to contain the data for your cruise. This folder should have a name that describes the cruise such as "HOT-236". This folder will be referred to as the **cruise folder**. Place your raw data files in the cruise folder.

You should now have this directory structure on your PC:

- hyperpro
  - cal
    - context_files
      - 107
      - 120
      - 127
    - cal_files
      - 107
      - 120
      - 127
    - Instruments
    - Processing Parameters
  - matlab
  - logs
  - data
    - HOT-236

ProSoft Setup

New Calibration and Context Files

Always check for new calibration and context files as they will change after calibrations.

NOTE: If the HyperPro was just calibrated and there are new calibration files (in the cal_files folder) but no corresponding new context files (in the context_files folder), follow the “Creating Context Files” instructions in Appendix A.

Importing Context Files

We will set up ProSoft with “context files”. These files contain critical information such as which calibration files to use, instrument-specific characteristics like sensor-to-sensor distances, and processing options.

For consistency in processing at OSU, **always use the provided context files**. For more information, see Appendix A.

Several different context files may be available for the same sensor. It is important to use context files that match the collection date of your data. For example, if the data were collected in 2010, use the context files from 2010, not 2011. In addition, context files created under one version of ProSoft may not work under another version. For this reason, the ProSoft version is included in the context filename (8.1.1). If possible, use the context file that matches your ProSoft version (provided that the dates also match). If this is not possible, you may have to re-create the context files for your ProSoft version. See Appendix A.

There are two possible ways to add the context files to ProSoft. The first method is via the ProSoft interface, which can be laborious as it involves entering the filename to be saved each time. The second method involves adding files to a hidden folder. Both methods are described here.

Method 1: Importing the context files using the ProSoft interface

1. Launch ProSoft on your PC.
2. First, you will import all Instrument Context files for all sensors (107, 120, and 127).
    - Each sensor has two or more instrument context files. One is designed specifically for use with underway (on deck) HyperPro data only. This underway instrument context file has “UW” (for underway) in the filename. There may also be a file for HyperPro data collected in Buoy mode – this file will have “BUOY” in the filename. The other file is for use with profile, yo-yo, and dark data. See Table 2 below for example filenames.
    - In the “Current Instrument” section of the ProSoft window, click on the “Import” button.
    - Navigate to the “cal/context_files” subfolder of your hyperpro folder.
    - Continue to navigate down two more levels of subfolders.
    - Select the appropriate *.cfs file for import. Click on “Save”.

- Repeat the last 3 steps until all Instrument Context files have been loaded for all sensors.

3. Next, you will import all Parameter Context files for all sensors (107, 120, and 127).
   - In this case, there are at least three files per sensor. The "UNDERWAY" file is for underway (on deck) data. The "SURFACE" file is for use with yo-yo or cast data to derive surface parameters. The "PROFILE" file is needed for dark data, and to derive profile data from cast or yo-yo data. The "BUOY" file is for data collected in buoy mode.
   - In the "Current Parameters" section, click on the "Import" button.
   - Navigate to the "cal/context_files" subfolder of your hyperpro folder.
   - Navigate into one of the sensor subfolders.
   - Select the appropriate *.mat file for import and click on "Open".
   - Click on "Save As" – you will then need to enter the filename. Use the same filename that you just imported (it's displayed in the window title bar).
   - Repeat the last 3 steps until all Parameter Context files have been loaded for all sensors.
4. Exit ProSoft.

Method 2: Importing the context files by adding them to a hidden ProSoft folder

1. Navigate to the folder *above* the "AppData" or "Application Data" folder as listed in the table below (i.e. c:\Users*username*\ or c:\Documents and Settings*username*\\)
2. The "AppData" or "Application Data" subfolders are usually hidden. To see the hidden folder, select "Organize – Folder and search options – View – Show hidden files, folders, and drives". You will now be able to navigate to the "Processing Parameters" and "Instruments" folders as listed in the table below.
3. Copy the *.mat files from your hyperpro/cal/Processing Parameters folder to this hidden Processing Parameters folder.
4. Copy all of the subfolders in your hyperpro/cal/Instruments folder to this hidden Instruments folder.

ProSoft stores all imported/created context files on your PC in the locations below. Note that the "AppData" and "Application Data" folders may be hidden system folders.

Windows 7
c:\Users*username*\AppData\Roaming\ProSoft V.V.V\Processing Parameters
c:\Users*username*\AppData\Roaming\ProSoft V.V.V\Instruments
Windows XP
c:\Documents and Settings*username*\Application Data\ProSoft V.V.V\Processing Parameters
c:\Documents and Settings*username*\Application Data\ProSoft V.V.V\Instruments

Example Set of Context Filenames	
Instrument Context	
underway	HP120-2011-8.1.1-UW.cfs
buoy	HP120-2011-8.1.1-BY.cfs
surface	HP120-2011-8.1.1-PR.cfs
profile	
dark	
Parameter Context	
underway	UNDERWAY_8.1.1.mat
buoy	BUOY_8.1.1.mat
surface	SURFACE_8.1.1.mat
profile	PROFILE_8.1.1.mat
dark	

Table 2: An example set of context filenames for sensor 120. Each sensor has five or more context files; two or more instrument context files and three or more parameter context files. The filename segments include the sensor ID (120), the year of calibration (2011), the output data type (UW/UNDERWAY, BY/BUOY, PR/PROFILE, SURFACE), and the ProSoft version number (8.1.1).

Step 1: Raw Data Files

Place the raw data files in your cruise folder.

All raw filenames end in the extension "**.raw**". There are four different possible types of files: profile, yo-yo, dark, and underway (on deck). Some of the processing scripts expect filenames to be in a particular form. Please rename raw files as necessary to follow the conventions below. For example, an underway file named h236_uw1.raw should be renamed to h236_UW_01.raw. Otherwise the processing scripts will not recognize the file as an underway file.

Raw data type	Example Filename	Filename convention comments
SINGLE CAST	h236_aloha1.raw	Do not use "dark" or "_UW_" in the filename
YO-YO	h236_aloha_yoyo1.raw	Contains "yoyo" in the filename
DARK	h236_dark.raw	Contains "dark" in the filename
UNDERWAY	h236_UW_01.raw	Ends with "_UW_??.raw"
BUOY	H236_buoy.raw	Contains "buoy" in the filename

Step 2: Log File

The log makes it easy to keep track of what has been processed, information about the data, and any errors. The tables below list important things to keep track of and where to find them. Most of the needed metadata can be output for an entire cruise folder at once using the Matlab function **hyperpro_getmetadata.m.** To use this function, follow these steps:

1. Launch Matlab
2. Navigate to the Hyperpro matlab folder
3. Run "hyperpro_getmetadata".
4. Select the cruise folder of interest.
5. A CSV text file called "metadata.txt" will be output to the cruise folder.
6. Launch Excel.
7. Using File-Open, load the existing log file (or create a new one).
8. Select the cell where the new block of metadata should be inserted.
9. Under the "Data" tab in the "Get External Data" section, select "From Text". Select the metadata.txt file. Choose comma delimited. Set the format for all columns to "text" otherwise Excel accidentally changes some text (like cloud fractions) to dates when imported.

Raw Filename	hyperpro_getmetadata.m
Cruise ID	hyperpro_getmetadata.m
Operators	hyperpro_getmetadata.m
Latitude	hyperpro_getmetadata.m
Longitude	hyperpro_getmetadata.m
Cloud Percent	hyperpro_getmetadata.m
Wave Height	hyperpro_getmetadata.m
Wind Speed	hyperpro_getmetadata.m
Comment	hyperpro_getmetadata.m
Station ID	hyperpro_getmetadata.m
Timestamp	hyperpro_getmetadata.m
Pressure Tare	hyperpro_getmetadata.m
Sensor ID	hyperpro_getmetadata.m
Calibration File Date	enter manually
Calibration File Type	“stray light corrected” or “not stray light corrected”
Pressure Tare Type	hyperpro_checkpressuretare.m (run during processing below)
Prosoft Version	enter manually
Instrument Context	enter manually
Parameter Context	enter manually
Processed Successfully (yes or no)	ProSoft output window (look for “successfully completed”)
Errors	ProSoft output window

Step 3: ProSoft

Selecting Context Files

The context files used during processing should correspond to the correct (a) sensor ID, (b) date of collection, (c) input file type (underway, cast, yoyo, or dark), (d) output data type to generate (underway, surface, profile, or dark), (e) ProSoft version, and (f) calibration type (stray light or not). All of this information should already be available in the log file from the previous step.

The tables below contain example sets of context files for each output data type.

No Stray Light Correction			
Input File Type	**Output Data Type**	**Instrument Context**	**Parameter Context**
DARK	**DARK**	**HP120-2011-8.1.1-NSL-PR**	**PROFILE-8.1.1-NSL**
CAST or YOYO	**PROFILE**	**HP120-2011-8.1.1-NSL-PR**	**PROFILE-8.1.1-NSL**
CAST or YOYO	**SURFACE**	**HP120-2011-8.1.1-NSL-PR**	**SURFACE-8.1.1-NSL**
UNDERWAY	**UNDERWAY**	**HP120-2011-8.1.1-NSL-UW**	**UNDERWAY-8.1.1-NSL**
BUOY	**BUOY**	**HP120-2011-8.1.1-NSL-BY**	**BUOY-8.1.1-NSL**

Stray Light Correction			
Input File Type	**Output Data Type**	**Instrument Context**	**Parameter Context**
DARK	**DARK**	**HP120-2011-8.1.1-SLC-PR**	**PROFILE-8.1.1-SLC**
CAST or YOYO	**PROFILE**	**HP120-2011-8.1.1-SLC-PR**	**PROFILE-8.1.1-SLC**
CAST or YOYO	**SURFACE**	**HP120-2011-8.1.1-SLC-PR**	**SURFACE-8.1.1-SLC**
UNDERWAY	**UNDERWAY**	**HP120-2011-8.1.1-SLC-UW**	**UNDERWAY-8.1.1-SLC**
BUOY	**BUOY**	**HP120-2011-8.1.1-SLC-BY**	**BUOY-8.1.1-SLC**

Remember to always use the context files appropriate for the date of the raw data you are processing. If the data were collected in 2010, use the context files from 2010, not 2011. Otherwise the wrong calibration factors will be applied to the data.

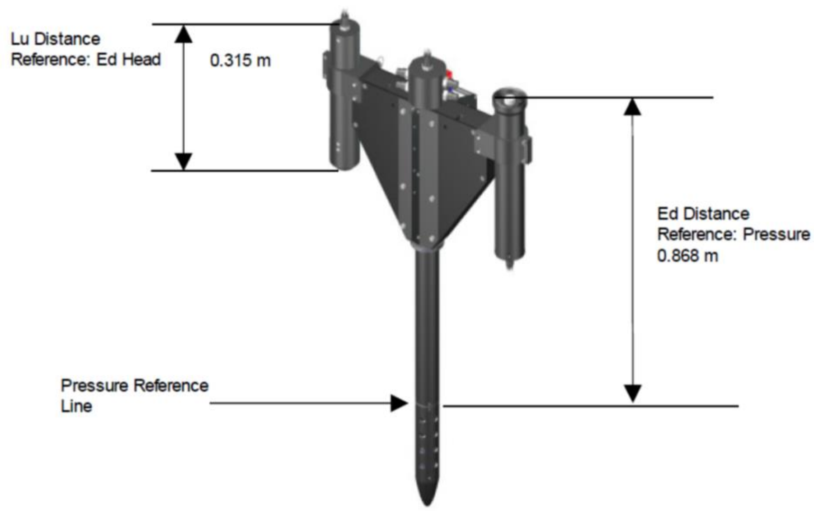
Loading the Context Files

1. Launch ProSoft
2. Decide which raw data file you would like to process. You will need to know the sensor ID, which output data type you desire (underway, profile, surface, or dark), and date of collection.
3. In the “Current Instrument” section, select the appropriate file from the drop-down list by clicking on the small down arrow. For more information see “Selecting Context Files” above.
4. In the “Current Parameters” section, select the appropriate file from the drop-down list by clicking on the small down arrow. For more information see “Selecting Context Files” above.

Profile Instrument Distances

Profiles (cast or yo-yo)

The offset of the Ed sensor head from various sensors on the profiler (Lu, pressure, and ECO PUC) is needed as input to the instrument context file for profiles. The diagram below was taken from the ProSoft User Manual and shows approximate offset distances. These distances may change over time; they should be measured at least once per cruise.



In newer HyperPro raw files (after September 2013), the measurements needed to derive the offset values can be found in the COMMENTS section of the metadata. For example:
“PRESS 0.726 m, ED 0.118 m, LU 0.145 m, PUC 0.152 m”.
See the HOT HyperPro Protocols document for more information. To calculate the offsets from these measurements, use the following equations:

sensors	equation
ED distance to pressure (m)	ED + PRESS – 0.062
LU distance to Ed head (m)	ED + LU
ECO PUC distance to Ed head (m)	ED + PUC

For reference, approximate values for the three OMEL sensors in profile mode are listed below. These values should be used if there is no offset information in the header (such as before September 2013).

sensor	107	120	127
ED distance to pressure (m)	0.776/0*	0.782/0*	0.781/0*
LU distance to Ed head (m)	0.320	0.318	0.315
ECO PUC distance to Ed head (m)	0.270	0.270	0.270

Before processing each raw file, the above values must be checked in the Instrument Context file for profiles. To edit the values, simply click on the "Edit" button. These values are found in 5 places in the context file (HPE, HPL, PED, PLD, SATBB2F).

*The "Distance to Pressure" values in the instrument context file for Ed (HPE and PED) must be appropriate for the pressure tare type.

a. **If the pressure tare type is "In Water", the "Distance to Pressure" should be set to 0.**
b. **If the pressure tare type is "On Deck", the "Distance to Pressure" should be the distance from the pressure line to the top of the Ed sensor.**

Underway

No distances are needed for the processing of our underway (on-deck) data. During underway measurements at HOT, the HyperPro is kept on the deck of the ship. The only sensor in use is Es.

Buoy

Buoy mode is when the HyperPro is deployed with a flotation collar, hence the HyperPro sits only at the surface and does not profile. This mode is not used at HOT. If this mode is used, the instrument distance that is needed is the **distance from the face of the Lu sensor to the surface of the water** (typically around 0.2 m). In buoy mode, the Lu sensor should be facing down, and the Ed sensor should be facing up. The data from the Ed sensor will not be used. Instead, the Es data measured on the boat is used for surface calculations.

Raw File Parsing

The following options should be verified before processing each data file. The options can be found in the ProSoft main menu under "File" - "Options".

Processing Mode		
SURFACE	**"Enable Raw File Parsing"**	**NOT checked**
PROFILE	**"Enable Raw File Parsing"**	**NOT checked**
DARK	**"Enable Raw File Parsing"**	**NOT checked**
UNDERWAY	**"Enable Raw File Parsing"** **"Raw File Parsing Size (Mb)"**	**checked** **20**
BUOY	**"Enable Raw File Parsing"** **"Raw File Parsing Size (Mb)"**	**checked** **20**

If “Enable Raw File Parsing” is checked, ProSoft will split any large (> 20 Mb) raw files into several smaller files (20 Mb max) before processing. Single cast, yo-yo, and dark files are small so this isn’t necessary in their case. However, often the underway files can be large (80 Mb or so), as can the buoy files (depending on the deployment length). If you try to process a file greater than 30 Mb in ProSoft without selecting “Enable Raw File Parsing” it will freak out.

Pressure Tare Type

An incorrect pressure tare type (“On Deck” or “In Water”) in the instrument context file will lead to incorrect depth values for the profile, and incorrect extrapolated nLws. This setting is important for single casts and yo-yo casts only (it is irrelevant for dark, underway, and buoy data).

The current protocol (as of September 2013) is to measure the pressure tare “On Deck”. In the past, the pressure tare was frequently (but not necessarily always) measured “In Water”. Unfortunately, there is no record of which method was used – this must be determined by looking at the depth values in a profile or yo-yo cast as explained in the “Checking the Pressure Tare Type” section below.

Modifying the Raw File

If it is absolutely necessary to modify the metadata in the raw file, DO NOT make the edits using Notepad or Word. Doing so will corrupt the file (which contains binary data) and give erroneous results (odd profiles). Instead, either make the edits using Notepad++ (on PC) or on linux/unix using vi. Always keep a copy of the original raw file.

The only example of a time when it was necessary to modify the metadata was when the pressure tare needed to be changed. Two examples when this occurred follow.

(1) Two pressure tares (on deck and in water) were taken before the profile. The in water pressure tar, since it was collected last, was the one written to the raw data file. To process the data with the on deck pressure tare, I had to modify the pressure tare value in the metadata of the raw file.

(2) Only in water pressure tares were measured, but they were highly variable. I replaced them with the mean on deck pressure tare (9.83), a value derived from HOT 210 – 269.

Processing the Data

Process only one file at a time. This makes it easier to read errors in the output window.

There are four different processing modes:

1. **DARK** returns the ECO PUC dark values
2. **SURFACE** calculates surface parameters such as nLw
3. **PROFILE** calculates data profiles such as Lu(z)
4. **UNDERWAY** calculates underway Es
5. **BUOY** calculate surface parameters such as nLw

YOYO CASTS can be processed using two different modes: **SURFACE** and **PROFILE**. Surface processing must be done first. *If SINGLE CAST data are available, there is no need to do PROFILE processing on YOYO data.*

SINGLE CASTS can be processed using two different modes: **SURFACE** and **PROFILE**. *If YOYO data are available, there is no need to do SURFACE processing on SINGLE CAST data.* ***Please note that surface values derived from single casts using SURFACE mode are MUCH LESS ACCURATE than those derived from yoyo casts.***

The table below lists which processing modes are appropriate for your situation.

For a given station, if you have …	Then perform the following processing …
SINGLE CASTS ONLY (*no yoyo files*)	**PROFILE** then **SURFACE** on the single casts
YOYO CASTS ONLY (*no single cast files*)	**SURFACE** then **PROFILE** on the yoyo casts
SINGLE CASTS and YOYO CASTS	**PROFILE** on the single casts **SURFACE** on the yoyo casts
UNDERWAY	**UNDERWAY**
DARK	**DARK**
BUOY	**BUOY**

DARK MODE (ECO PUC)

Calculates dark counts for the ECO PUC

Input data: **DARK**

1. Ensure that "Enable Raw File Parsing" is NOT checked (see above).
2. Check that the correct instrument context file has been selected ("PR").
3. Load the "PROFILE" version of the parameter context file.
4. In the "Single Level Processing" section, select "Level 1 → 1a"
5. Select the cruise folder containing the raw data.
6. Select the raw dark file to be processed.
7. Click on the "Add>>" button and then the "OK" button.
8. If successful, it should finish with "master_level1_level1a: Level 1a processing complete". If there are errors, see Appendix C (page 61).
9. Record any processing errors in the log.
10. The output will be a *.L1a.hdf file.
11. Launch Matlab and run:
    hyperpro_moveoutput(cruisefolder,'Darks')
    where *cruisefolder* is the path and filename of your cruise folder containing the raw data. This will move the *.L1a.hdf file into the "Darks" folder.

SURFACE MODE

Calculates surface data extrapolated from depth (nLw, etc.)
Input data: **YOYO** or **SINGLE CAST** *(results are less reliable)*
NOTE: If YOYO data are available, there is no need to use SURFACE mode on SINGLE CAST data.

These processing steps are run *twice* – once for the entire profile (the resulting data may be used to derive profile parameters using the profile mode below), and then again for just the surface (to derive accurate surface values).

General

1. Ensure that "Enable Raw File Parsing" is NOT checked (see above).
2. Check that the correct instrument context file has been selected ("PR").
3. Within the instrument context file, verify that the sensor distance offsets match those calculated from the metadata of the raw file (see "Inserting the sensor distance offsets" above). Also check that the correct pressure tare type is selected.

Run 1: Full profile (300 m)

1. If this is a reprocessing, don't forget to delete any output HDF files first. Otherwise the new data get appended to the earlier files. Ack!
2. Load the "SURFACEFULL" version of the parameter context file. This version has the "Maximum Depth" set to **300 m** (this number should be well over the actual profile depth).
3. In the "Multi-Level Processing" section, select "Level 1 → 4"
4. Select the cruise folder containing the raw data.
5. Select the file(s) to be processed. These can either be single casts or yo-yo casts. Better nLws will be derived from yo-yo casts if they are available.
6. Click on the "Add>>" button and then the "OK" button.
7. If the "Select Casts" box was checked in the "SURFACE" parameter file, a window will open with a list of the casts. Select the cast(s) for processing.
8. If successful, the processing should finish with "MasterLevel4: Level 4 processing complete". If there are errors, see Appendix C (page 61).
9. Save the figures by clicking the "Save All" button at the bottom of the ProSoft window. The PNG figures will be save in the "figures" folder.
10. Review the figures.
11. If one of the profiles in a yoyo set looks bad, it can be selected for removal. If the selection box for removing a cast isn't displayed during processing, edit the "SURFACE" parameter file … first select the "Select Casts" checkbox and then reprocess. Don't forget to delete the output files first (hdf and ascii). It is possible to guess which cast should be removed based on the Es time series and the output file sizes.

12. If this is the first or last file of the cruise to be processed, ensure that the correct pressure tare type was used by running hyperpro_checkpressuretare.m (see instructions below).
13. Record any processing errors in the log.
14. Repeat for all files for that cruise.
15. After running the full profile for each file in the cruise, launch Matlab and run the script:
    hyperpro_moveoutput(cruisefolder,'SurfaceFull')
    where *cruisefolder* is the path and filename to the cruise folder containing the raw data. This will move all of the output files into a folder called SurfaceFull. We have to keep the SurfaceFull and SurfaceUpper output separate, otherwise they overwrite each other.
16. For **YOYO** data, you may then process each full profile using the profile mode instructions below.

Run 2: Upper profile (5 m)

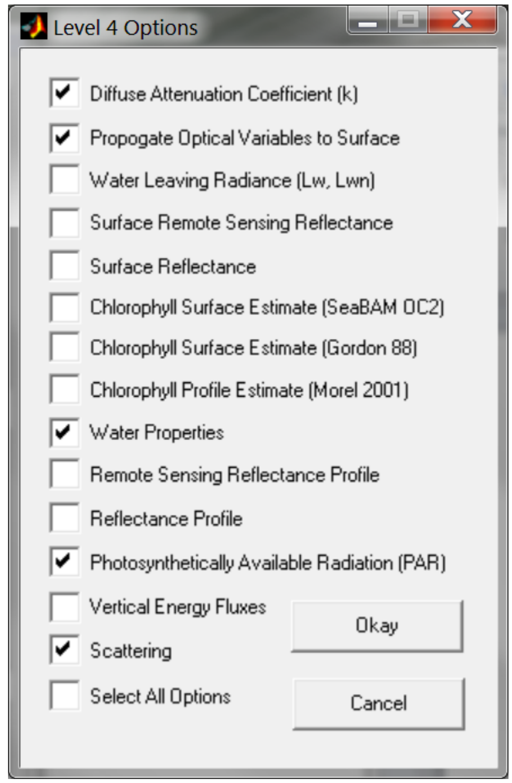
1. Load the "SURFACE" version of the parameter context file. This version has the "Maximum Depth" set to **5 m**.
2. Reprocess the data following steps 3 – 8 above.
3. If the resulting extrapolation is not representative of the profile (for example, if min values of 10^-7 are present), delete the output, adjust the Maximum Depth (e.g. from 5 to 3) and reprocess.
4. AVG_ES is calculated based on the "Normalization" setting in the "SURFACE" parameter file (CAST BEGIN/ MIDDLE/END). The green linear dots in the Es figure represent a linear trend for the Es data. The green dots at the beginning/middle/end will be used to calculate AVG_ES. If those green values aren't representative of the general Es values, choose another "Normalization" setting and reprocess.
5. Record any processing errors in the log.
6. Repeat for all files for that cruise.
7. After running the full profile for each file in the cruise, run the Matlab script:
   hyperpro_moveoutput(cruisefolder,'SurfaceUpper').
   where *cruisefolder* is the path and filename to the cruise folder containing the raw data. This will move all of the output files into a folder called SurfaceUpper. We have to keep the SurfaceFull and SurfaceUpper output separate, otherwise they overwrite each other.

PROFILE MODE

Calculates profiles (Ed(z), Lu(z), etc.)

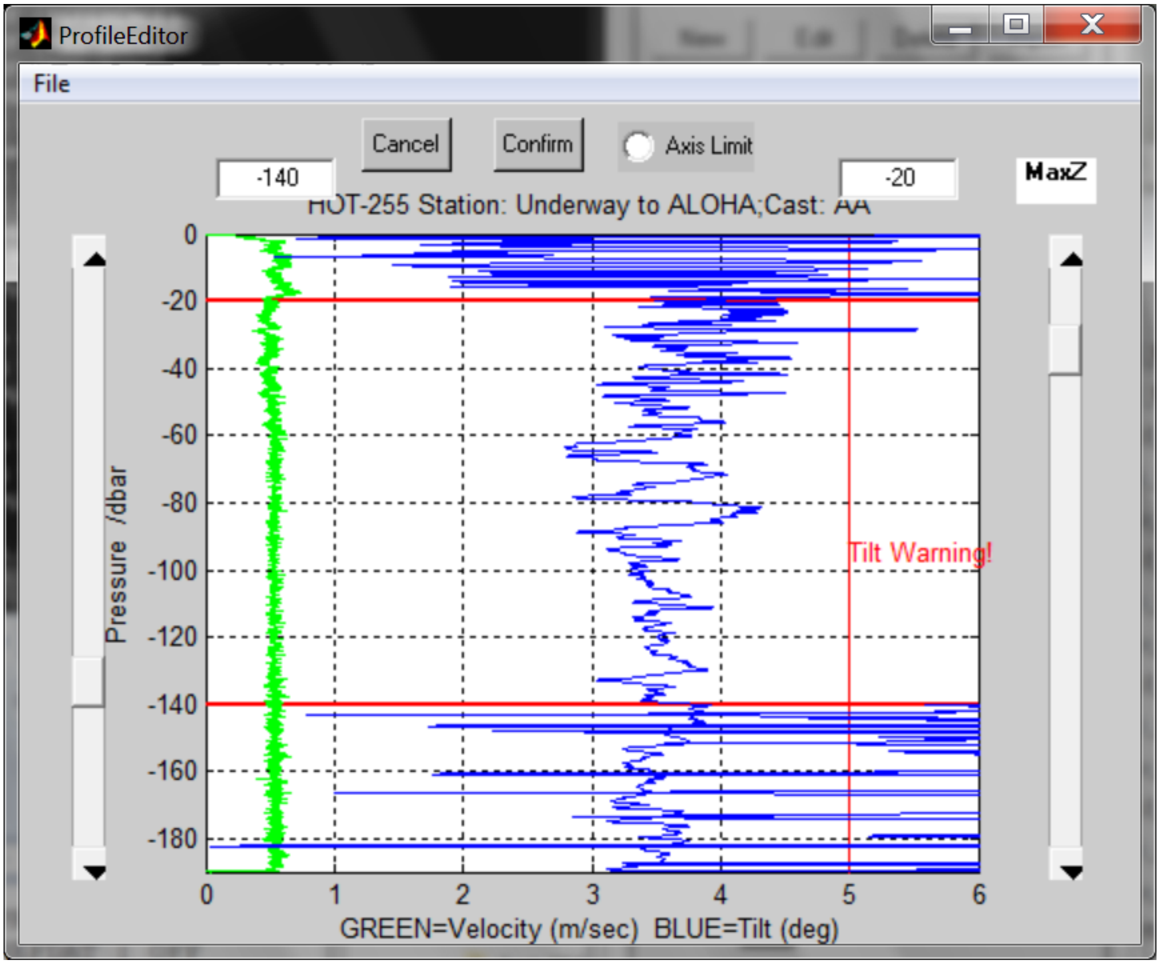
Input data: **SINGLE CAST** or **YOYO (after processing the full profiles in SURFACE MODE first to pull out the separate casts)**

*If **SINGLE CAST** data are available, there is no need to use **PROFILE** mode on **YOYO** data.*



1. Remove any existing output HDF files first. For **YOYO** processing, this means deleting any L3a.hdf and L4.hdf files from the SurfaceFull folder. For **SINGLE CAST** processing, this means remove all HDF output from any earlier runs.
2. Ensure that “Enable Raw File Parsing” is NOT checked (see above).
3. Only select “Use SLC Calibration Files” for files with an associated stray light calibration.
4. Check that the correct instrument context file has been selected (“PR”).
5. Within the instrument context file (HPE, HPL, PED, PLD, SATBB2F), verify that the sensor distance offsets match those calculated from the metadata of the raw file (see “Profile Instrument Distances” above). Also check that the correct pressure tare type is selected.
6. Load the “PROFILE” parameter context file.
7. In the “Multi-Level Processing” section:
   For **SINGLE CAST** data: “Level 1 → 4”
   For **YOYO** data: “Level 2s → 3a”.
8. Select the folder containing the input data.
   For **SINGLE CAST** data: this is the cruisefolder.
   For **YOYO** data: this is the SurfaceFull folder.
9. Select the single cast (*.raw) or yoyo cast (*P*_L2s.hdf) to be processed. All files can be processed at once.
10. Click on the “Add>>” button and then the “OK” button.
11. For **YOYO** data: repeat steps 7 – 10 for “Level 3a → 4”.
12. Select only the parameters shown in the screenshot above, then click “Okay”. Do not select any of the other surface parameters with this mode; they are inaccurate. We will calculate them with the SURFACE mode.
13. For **SINGLE CAST** data, a figure window will pop up (see below). Adjust the scrollbars or enter depth values to select the section of the profile to process (shown by the horizontal red lines). Note the

chosen depths in the log so the processing can be reproduced. Then click “Confirm”.



14. If successful, the processing should finish with “MasterLevel4: Level 4 processing complete”. If there are errors, see Appendix C (page 61).

15. Record any processing errors in the log.

16. If this is the first or last profile to be processed for the cruise, check the data to ensure that the correct pressure tare type was used (see instructions below).

17. Repeat for all profiles.

18. For **SINGLE CAST** processing, launch Matlab and run the Matlab script:

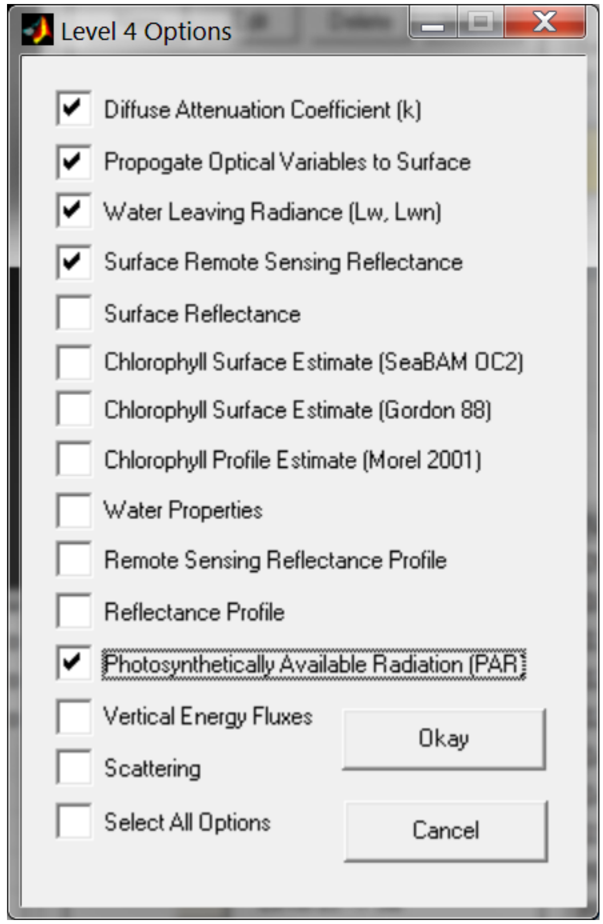
hyperpro_moveoutput(cruisefolder,’Profiles’)

where *cruisefolder* is the path and filename to the cruise folder containing the raw data. This will move all of the output Profiles data into a folder named Profiles.

For **YOYO** data, leave the output files where they are (in the SurfaceFull folder).

BUOY MODE

*For Buoy mode, you MUST use ProSoft version **8.1.5** (or later). Earlier versions did not handle the data correctly above 700 nm.*



Calculates above-water data (Lw, RSR, PAR, etc.)
Input data: **BUOY**

1. **Make sure you are using ProSoft 8.1.5 (or later).**
2. Ensure that "Enable Raw File Parsing" is checked and that the size is 20 Mb (see above).
3. Check that the correct instrument context file has been selected ("BY").
4. Load the "BUOY" version of the parameter context file.
5. In the "Multi-Level Processing" section, select "Level 1 → 4"
6. Select the cruise folder containing the raw data.
7. Select the raw buoy files for processing (*buoy*). All of the buoy files can be processed at once, if desired.
8. Click on the "Add>>" button and then the "OK" button.
9. Select only the parameters shown in the screenshot to the right, then click "Okay". Do not select any of the other parameters with this mode.
10. If the raw files are large, ProSoft will split them into several smaller files (20 Mb max) and process them separately one after the other. The split raw files will remain in the same folder as your original file. Their filenames will be the same as the original raw filename, but with an added "_1" or "_2" etc.
11. If successful, each split file processing should end with "MasterLevel4: Level 4 processing complete". If there are errors, see Appendix B: ProSoft (page 61).
12. *NOTE: The Buoy mode will NOT create L4 SeaBASS output files, only L3a. This is true even if all of the output parameters are selected. However, all L4 data are available in the ASCII files folder.*
13. Record any processing errors in the log.
14. Repeat for all buoy files.
15. Launch Matlab and run the Matlab script:

hyperpro_moveoutput(cruisefolder,'Buoy')

where *cruisefolder* is the path and filename to the cruise folder containing the raw data. This will move all of the buoy output files into the folder "Buoy".

UNDERWAY MODE

Calculates above-water data (PAR, etc.)
Input data: **UNDERWAY**

1. Ensure that "Enable Raw File Parsing" is checked and that the size is 20 Mb (see above).
2. Check that the correct instrument context file has been selected ("UW").
3. Load the "UNDERWAY" version of the parameter context file.
4. In the "Multi-Level Processing" section, select "Level 1 → 4"
5. Select the cruise folder containing the raw data.
6. Select the raw underway files for processing (_UW_). All of the underway files can be processed at once, if desired. It takes about an hour to process a 100 kB underway file.
7. Click on the "Add>>" button and then the "OK" button.
8. Select ONLY "Photosynthetically Available Radiation" (two others will automatically be checked – keep these too). Then click on "Okay".
9. ProSoft will split the original raw file into several smaller files (20 Mb max) and process them separately one after the other. The split raw files will remain in the same folder as your original file. Their filenames will be the same as the original raw filename, but with an added "_1" or "_2" etc.
10. If successful, each split file processing should end with "MasterLevel4: Level 4 processing complete". If there are errors, see Appendix B: ProSoft (page 61).
11. Record any processing errors in the log.
12. Repeat for all underway files.
13. Launch Matlab and run the Matlab script:

hyperpro_moveoutput(cruisefolder,'Underway')
where *cruisefolder* is the path and filename to the cruise folder containing the raw data. This will move all of the Underway output files into the folder "Underway".

Checking the Pressure Tare Type

Follow the instructions below to verify that the correct pressure tare type was used during the processing.

1) Launch Matlab
2) Run **hyperpro_checkpressuretare.** It will ask for the directory containing the L1B HDF files (this is the Profiles folder). It will iterate over all L1B files in the folder.
3) The code will output (a) the measured pressure tare value, (b) the measured profile pressure values at the start of the cast, (c) the probable pressure tare type that was used in the processing, and (d) the probable *actual* pressure tare type that should have been used.

Assuming that the profile was started right at the surface (not 5 m depth, for example):

a. If the profile pressure values and the measured pressure tare are similar, then the pressure tare type should be “In Water”.
b. If the profile pressure values are larger than the measured pressure tare, the pressure tare type should be “On Deck”.

Usually operators use the same pressure tare type throughout the cruise (but not always!).

Sometimes a cast is started some distance below the surface (e.g. 5 m), in which case the above assumptions don’t work. Study the pressure values at the top of each of the associated casts to help determine the pressure tare type (in case one of the casts was started deeper than usual).

Another method to determine the pressure tare type is by examining the pressure tare values themselves. **A typical in water pressure tare at Station ALOHA is approximately 10.7. A typical on deck pressure tare is 9.8. In both cases, the variability is +/- 0.1.**
The same pressure tare value is usually used for a set of multiple casts.

In addition, sometimes the pressure tare measurement is incorrectly made below (rather than at) the water surface. This results in inaccurate (and sometimes positive) depth values.

4) Make sure the “distance to surface” values in the instrument context file for Ed (HPE and PED) are appropriate for the pressure tare type.
   a. If the pressure tare type is “In Water”, the distance to surface should be set to 0.
   b. If the pressure tare type is “On Deck”, the distance to surface should be the actual distance from the pressure line to the top of the Ed sensor.
5) If the “probable actual pressure tare type” differs from the pressure tare type used to process the data, reprocess it with the correct pressure tare type and distance-to-surface settings.

Step 4: Matlab

Matlab Path Setup

All of the following steps should be performed from your PC. This step only needs to be performed once.

1. Launch matlab
2. Within matlab, cd to the hyperpro matlab folder (the folder that contains all of the hyperpro matlab processing routines).

3. In the Matlab menu bar, click the “Set Path” button in the “Environment” section of the “Home” tab. For earlier versions of Matlab that don’t have such a button, navigate to the hyperpro Matlab folder using the Matlab folder list window, then right-click on the folder and select “Add to Path. Select “Add with Subfolders”, and “Apply”. These folders will be added permanently to the Matlab path.

Matlab Processing Summary

This processing must occur *after* the ProSoft processing from the previous section. The matlab processing will accomplish the following tasks:

- calculate mean dark counts (to keep track of instrument performance)
- calculate KPAR
- concatenates ascii underway files
- pulls out a subset of desired data
- creates figures

Matlab Processing Steps

All of the following steps should be performed from your PC.

4. Launch matlab
5. Within matlab, cd to the hyperpro matlab folder (the folder that contains all of the hyperpro matlab processing routines).
6. At the matlab prompt, type:
   hyperpro_main
   and follow the instructions. Record the dark value mean and std in the log. You will be asked to select a set of files for the single cast (profile) plots. Select a set of 2 or 3 files based on the date (which also implies the same location) so that the replicate casts will be plotted on the same figure. You will be prompted to repeat this process as often as needed. When done, you will next be asked to select a set of files for the surface plots (from the yoyo casts). In this case, select all yoyo casts from the same location regardless of date. This will result in a plot from a single location (e.g. Station ALOHA) that displays the change in the Rrs spectrum from day to day. Again, you will be prompted to repeat this process for different locations as often as needed.
7. Exit matlab

The program hyperpro_main.m calls the functions listed in the table below.

hyperpro_dark (for dark data only) (*see Step 3 below*)	Calculates the mean dark values for the red, blue, and green channels
hyperpro_KPAR	Calculates KPAR and adds a KPAR column to the files in the “Ascii Files” folder
hyperpro_subset	Pulls out a small subset of the most popular parameters (output goes in the “subset” folder)

hyperpro_UW_cat (for underway data only)	Concatenates the split ascii underway files back together into a single file.
hyperpro_plot_profile_ascii (optional)	Plots the profile data (79 figures)
hyperpro_plot_surface_ascii (optional)	Plots the surface data
hyperpro_plot_underway_ascii (optional)	Plots the underway data
hyperpro_plot_subset (optional)	Plots the subset data as a quality check.
hyperpro_plot_profile_final	Plots the profiles
hyperpro_plot_surface_final	Plots the surface spectra

Matlab Output

The final output (to be sent to Lance, etc.) is located in the “subset” and “figures” folders.

Step 5: Dark Values

There are two types of dark values. The first type is the “calibration dark values”. These are the dark values for the various sensors (Lu, Ed, Es, etc.) measured at Satlantic during a calibration, and are hard-coded in the calibration files. They are the values used during ProSoft processing. The second type of dark values is the “measured dark values”. These are the ECO PUC dark values measured during a deployment and saved in a *dark*.raw file. These values are *not* used during processing. Rather, they are used to monitor the ECO PUC status over time. Dark values for the other sensors (Lu, Ed, and Es) are not measured.

The mean and standard deviations calculated from running the matlab routine “hyperpro_dark” should be recorded in the log and compared with earlier values. Any large deviations from the normal values may indicate an instrument problem. The mean and standard deviations are output in the Matlab command window, and are also listed in the title of each output figure.

If the measured dark values slowly drift over time, it may be necessary to replace the hard-coded calibration dark values with the new measured dark values. The file to edit is the **SATBB2F*.tdf** file in the cal/cal_files/* subfolder. If the dark values are changed, make a note of the old and new values in the log. Reprocessing of all raw data from that cruise is then necessary.

Note that the measured dark values are meaningless if the dark measurement was not performed correctly. The entire face of the ECO PUC sensor *must* be covered in black electrical tape. Do not simply cover the sensor with the sensor cap. The cap is reflective and does not exclude all light - it will yield inaccurate dark values.

Step 6: Finishing Up

Notify the OMEL data manager about the new hyperpro files. Then do the hula.

Appendix A: Creating Context Files

Details are important. It is very straightforward to create context files, but you must be very careful to do it correctly.

bad context file → bad data

Calibration Files

Because the HyperPro is made up of multiple sensors, there are multiple calibration files. The context files are a way to group all of the appropriate calibration files and other processing options together into a single package.

To create a context file for a sensor, you will need a copy of all relevant calibration files on your PC. Calibration files are stored on garcia in instruments/HyperPro/cal_files.

Keep the calibration files in a separate folder for each sensor. Otherwise the calibration files may overwrite each other (most of the calibration filenames are the same). If you're ever not sure which sensor a calibration file belongs to, simply open the calibration file with a text editor and search for "MPR". The sensor ID follows the letters "MPR" (e.g. MPR0120).

Example sets of calibration files are shown in the table below.

Without stray light correction	With stray light correction
HED329c.cal	HED329c.slc
HPE328c.cal	HPE328c.slc
HPE328c_Eu.cal *	HPE328c_Eu.slc
HPL278c.cal	HPL278c.slc
Hse329c.cal	Hse329c.slc
MPR120a.cal	MPR120a.cal
PED328c.cal	PED328c.slc
PED328c_Eu.cal *	PED328c_Eu.slc
PLD278a.cal	PLD278c.slc
SATBB2F0554.tdf	SATBB2F0554.tdf
HSE0329_13Aug15.sip	HSE0329_13Sep03_SLC.sip
MPR0120_13Jul31.sip	MPR0120_13Sep03_SLC.sip
MPR0120_13Jul31_Eu.sip *	MPR0120_13Sep03_SLC_EU.sip

* may not be present in older calibration file sets

If both calibration file types are available for the same date (i.e. with and without stray light), the stray light correction files should be used.

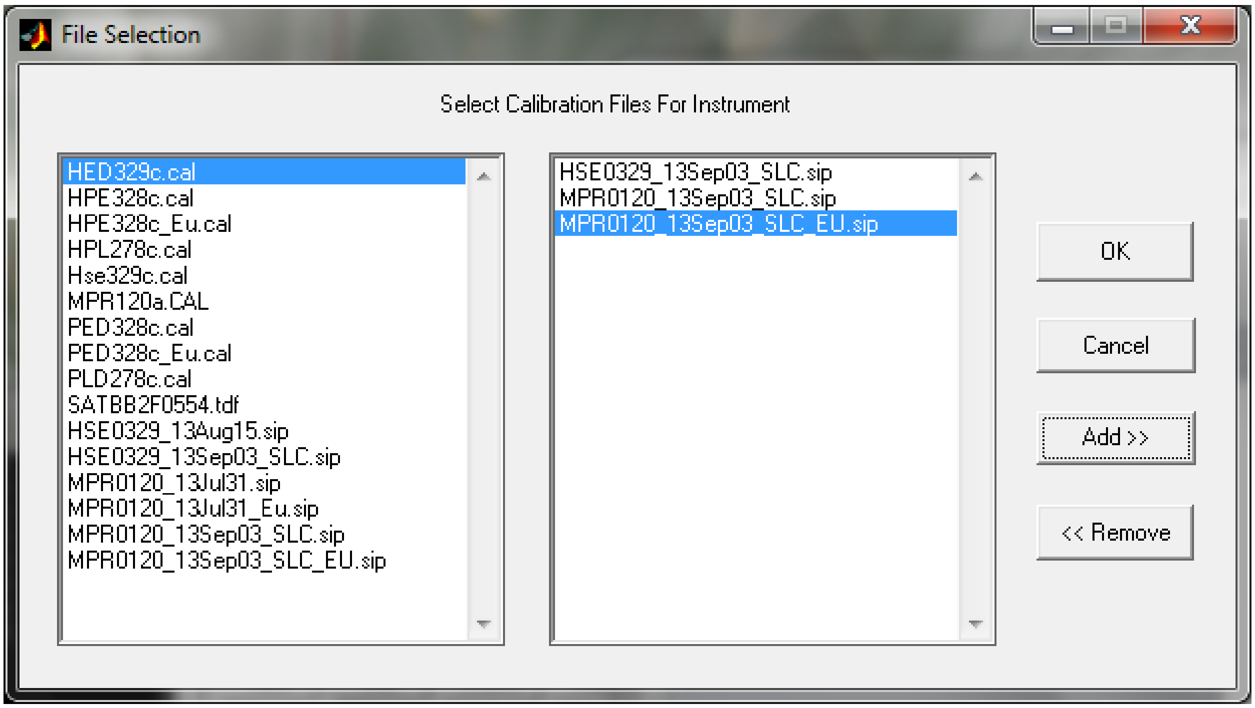
Instrument Context

Before beginning, navigate to:

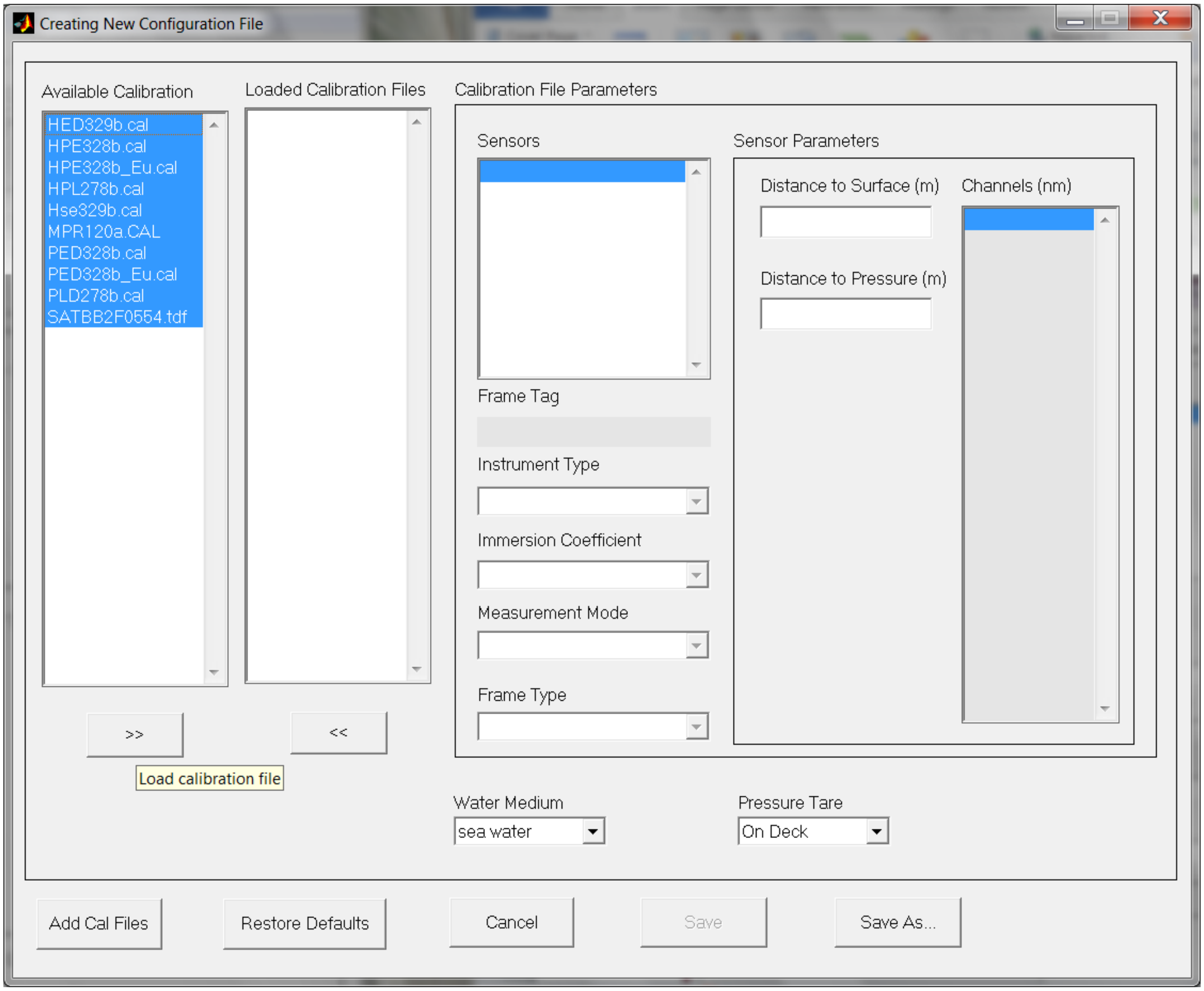
File – Options – "Use SLC Calibration Files"

If you have stray light correction calibration files (*.slc or *_SLC.sip) and wish to use them, check this box (otherwise they won't show up as options later).

To begin creating an instrument context file, launch ProSoft and select the "New" button from the Current Instrument section. Select the *.sip files for your sensor and click on the "Add >>" button; this will load all of the needed calibration files. If you have stray light correction (*_SLC.sip) files, use those instead of the non-SLC files. Click the "OK" button when done.



On the next window that opens, select all of the files listed in the "Available Calibration" list, then click on the ">>" (Load calibration file) button under the list. This will populate the "Loaded calibration files" list. See screenshot below.



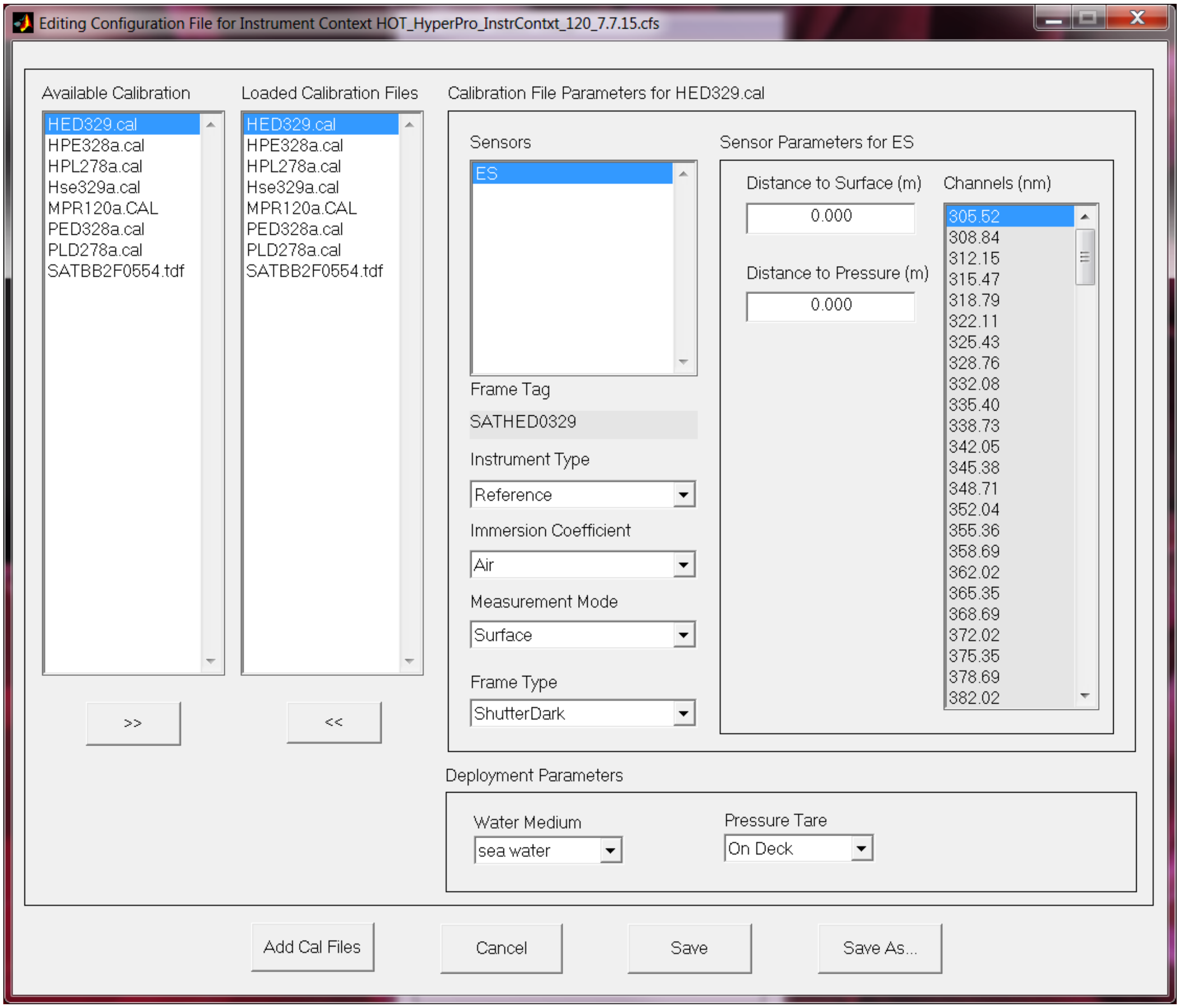
Next follow the screenshots shown on the pages below by clicking on the different loaded calibration files and modifying settings as needed. After import, ProSoft will store this new instrument context file and the associated calibration files on your PC in the following location:

Windows 7	c:\Users*username*\AppData\Roaming\ProSoft 8.1.1\Instruments
Windows XP	c:\Documents and Settings*username*\Application Data\ProSoft 8.1.1\Instruments

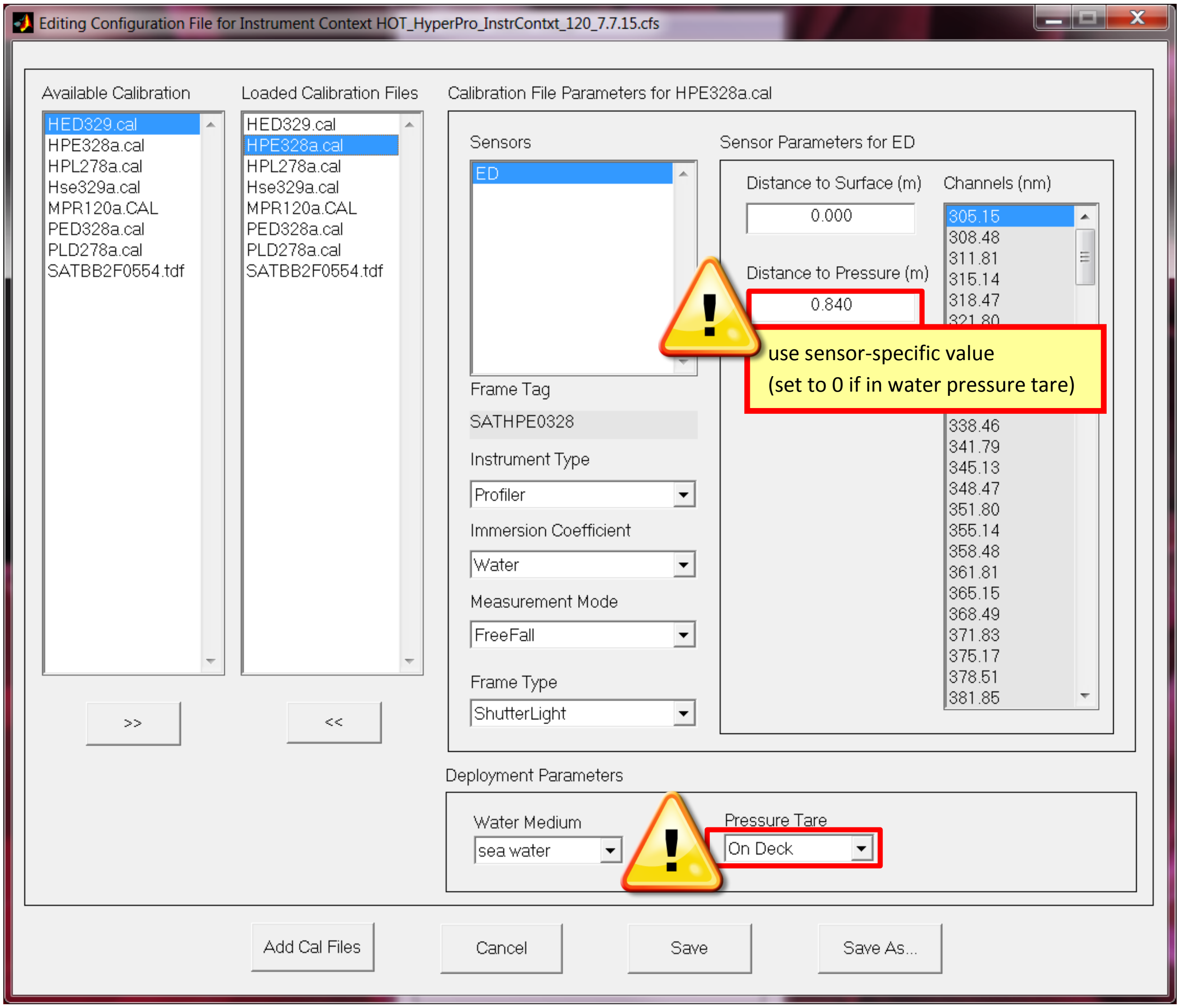
When finished, copy the contents of the above folder to garcia in instruments/HyperPro/context_files.

Instrument Context: PROFILE, SURFACE, and DARK CAST Part 1

Filename examples: (1) HP120-2011-8.1.1-NSL-PR, (2) HP120-2013-8.1.1-SLC-PR



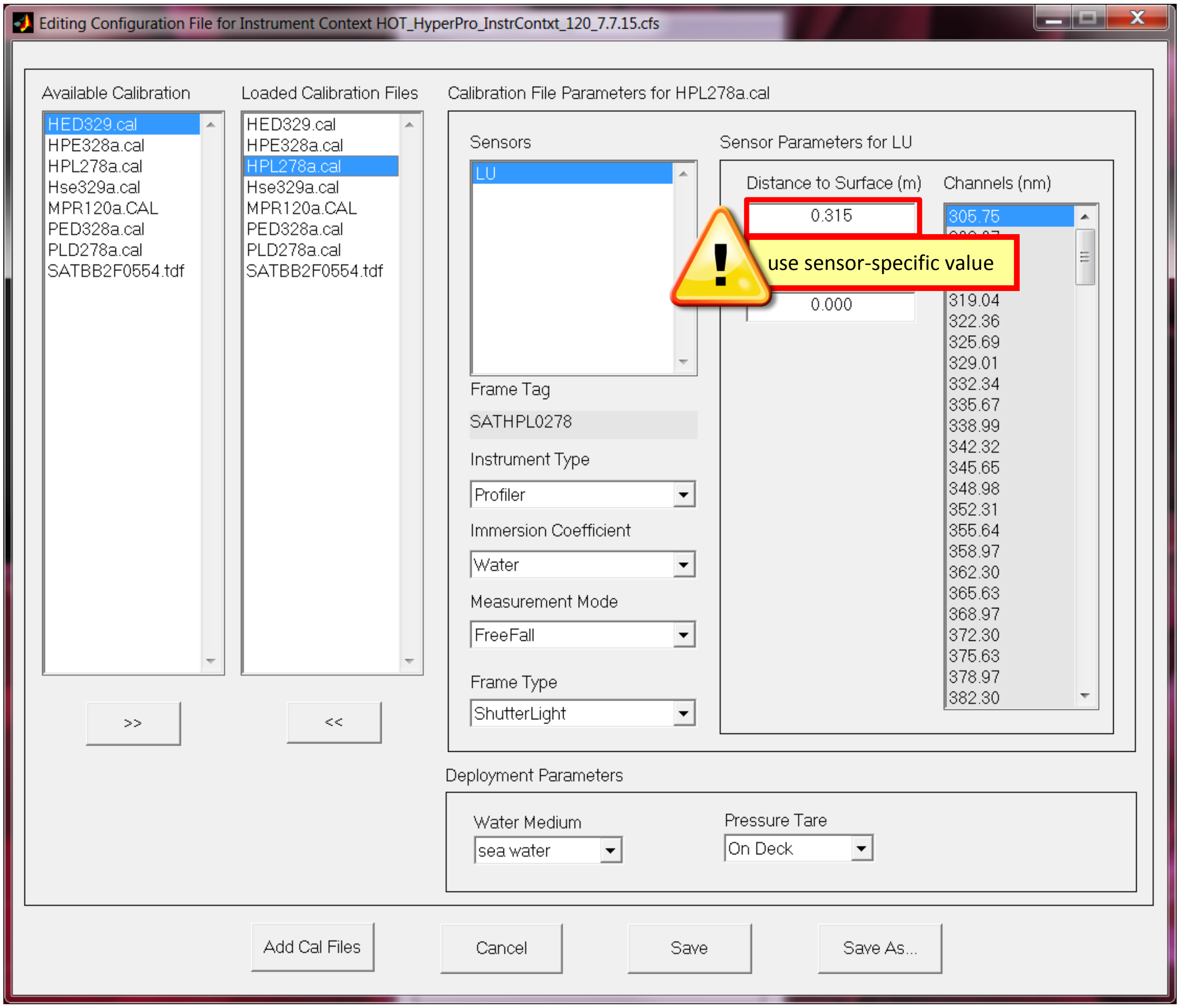
Instrument Context: PROFILE, SURFACE, and DARK CAST Part 2



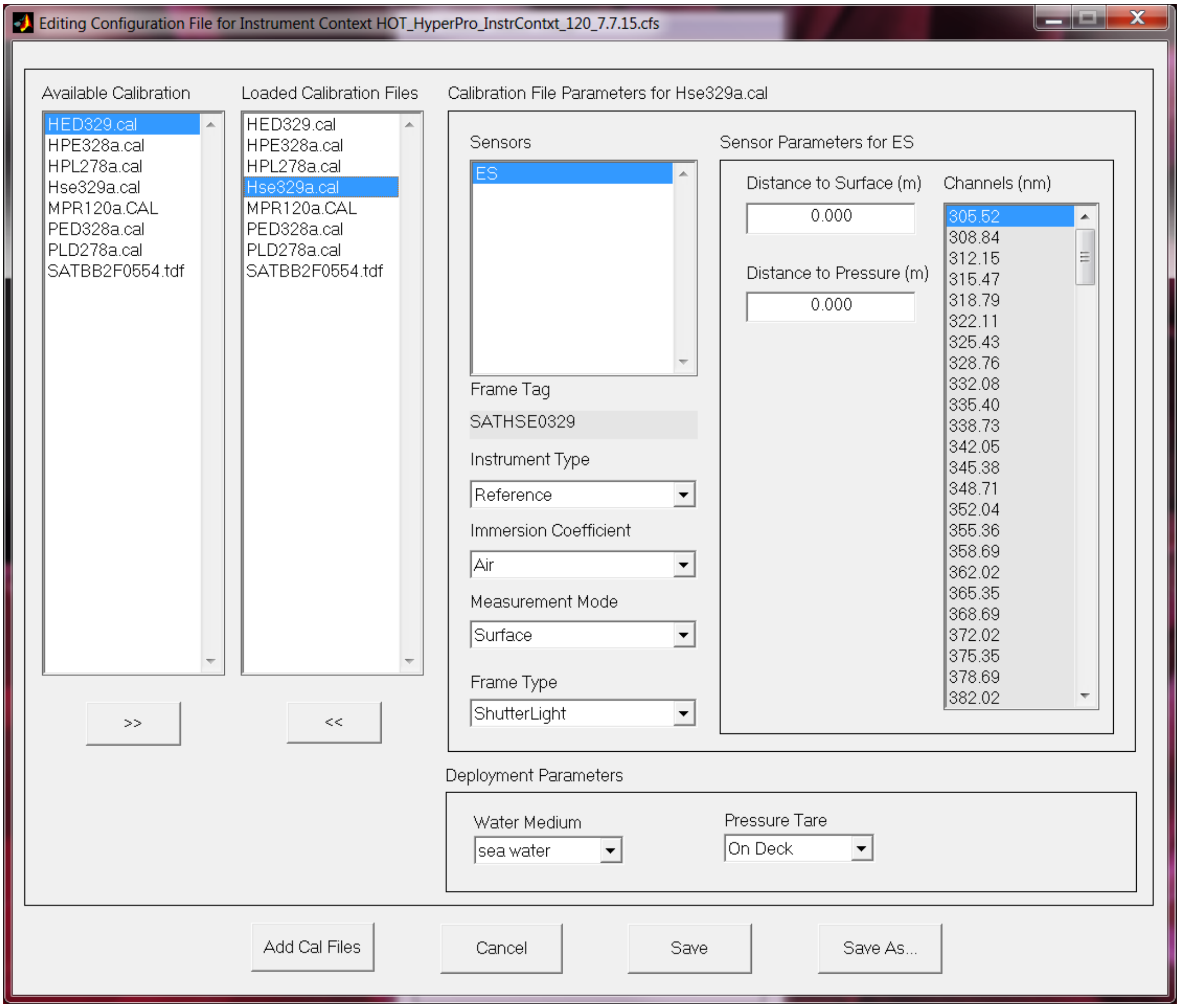
Default values to use if the actual measurements are unknown:

sensor	107	120	127
ED distance to pressure (m)	0.776/0*	0.782/0*	0.781/0*
LU distance to Ed head (m)	0.320	0.318	0.315
ECO PUC distance to Ed head (m)	0.270	0.270	0.270

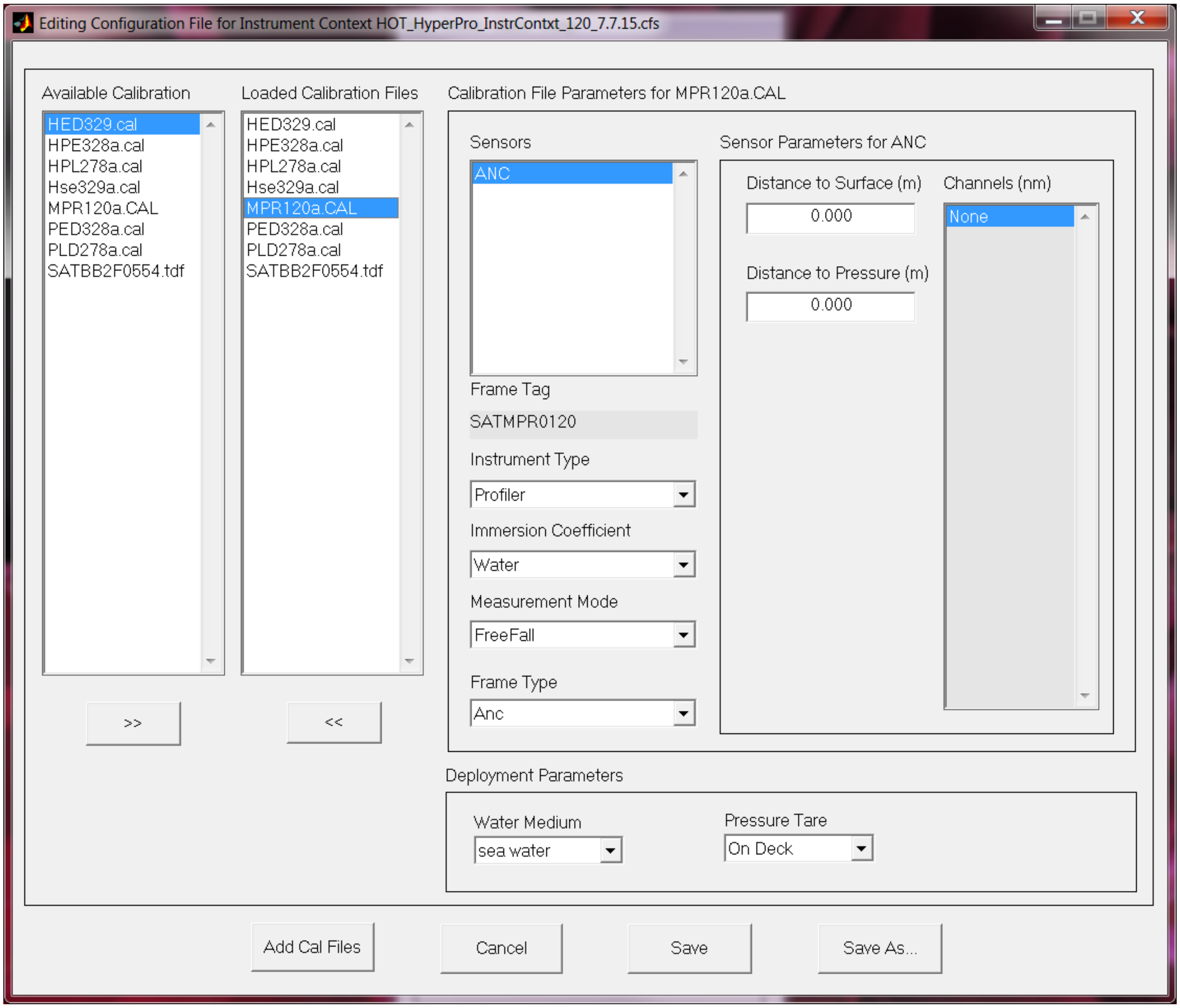
Instrument Context: PROFILE, SURFACE, and DARK CAST Part 3



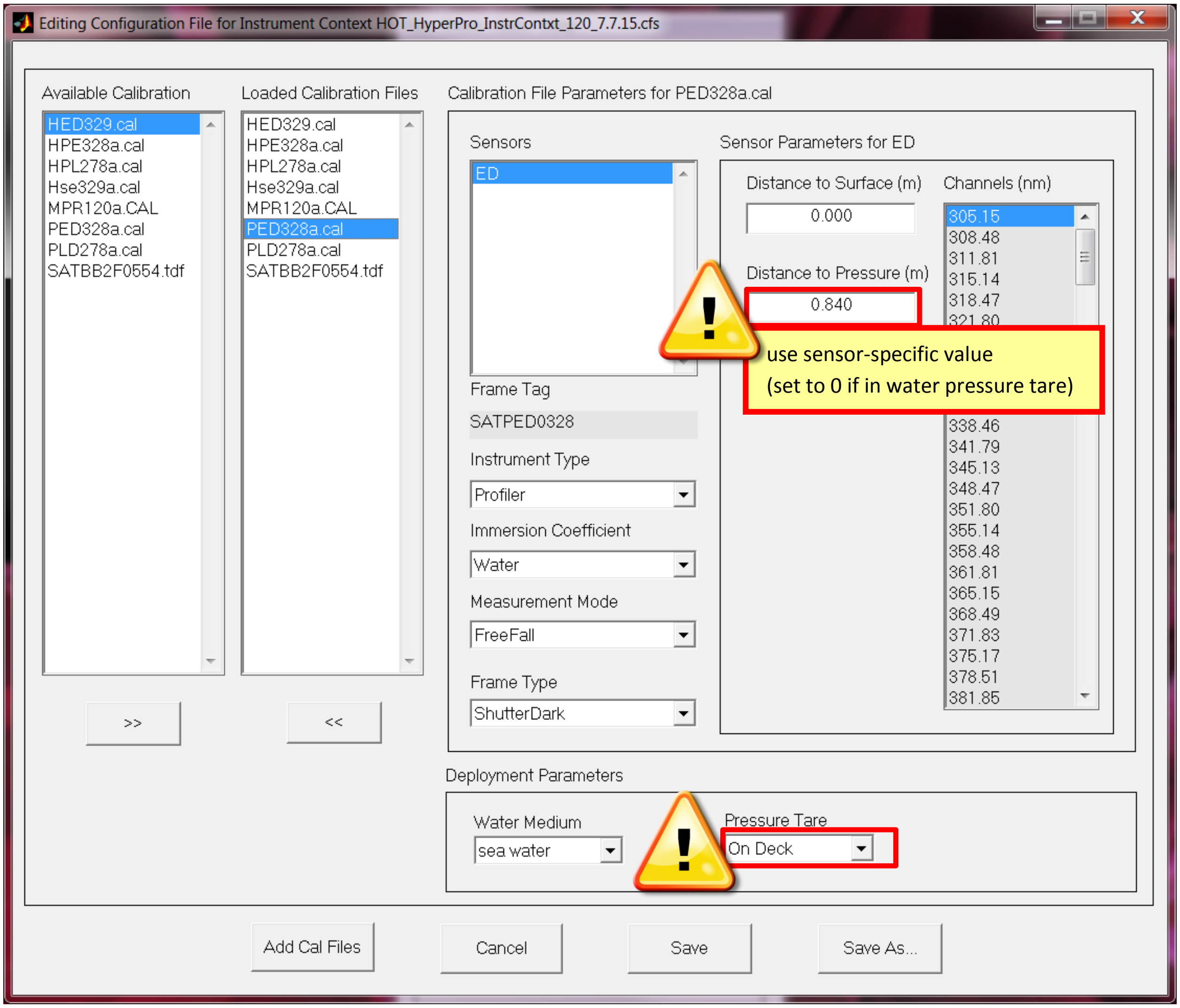
Instrument Context: PROFILE, SURFACE, and DARK CAST Part 4



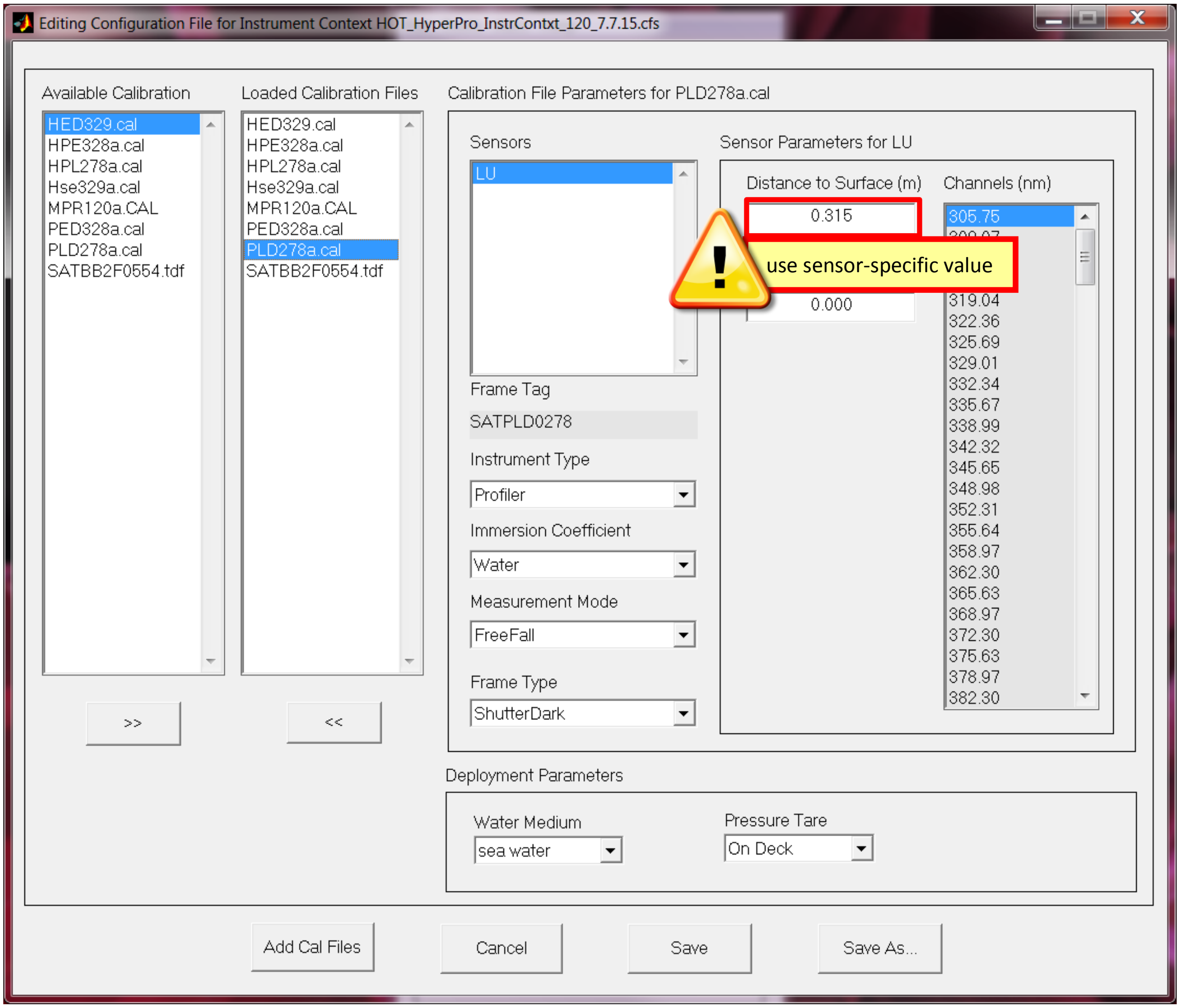
Instrument Context: PROFILE, SURFACE, and DARK CAST Part 5



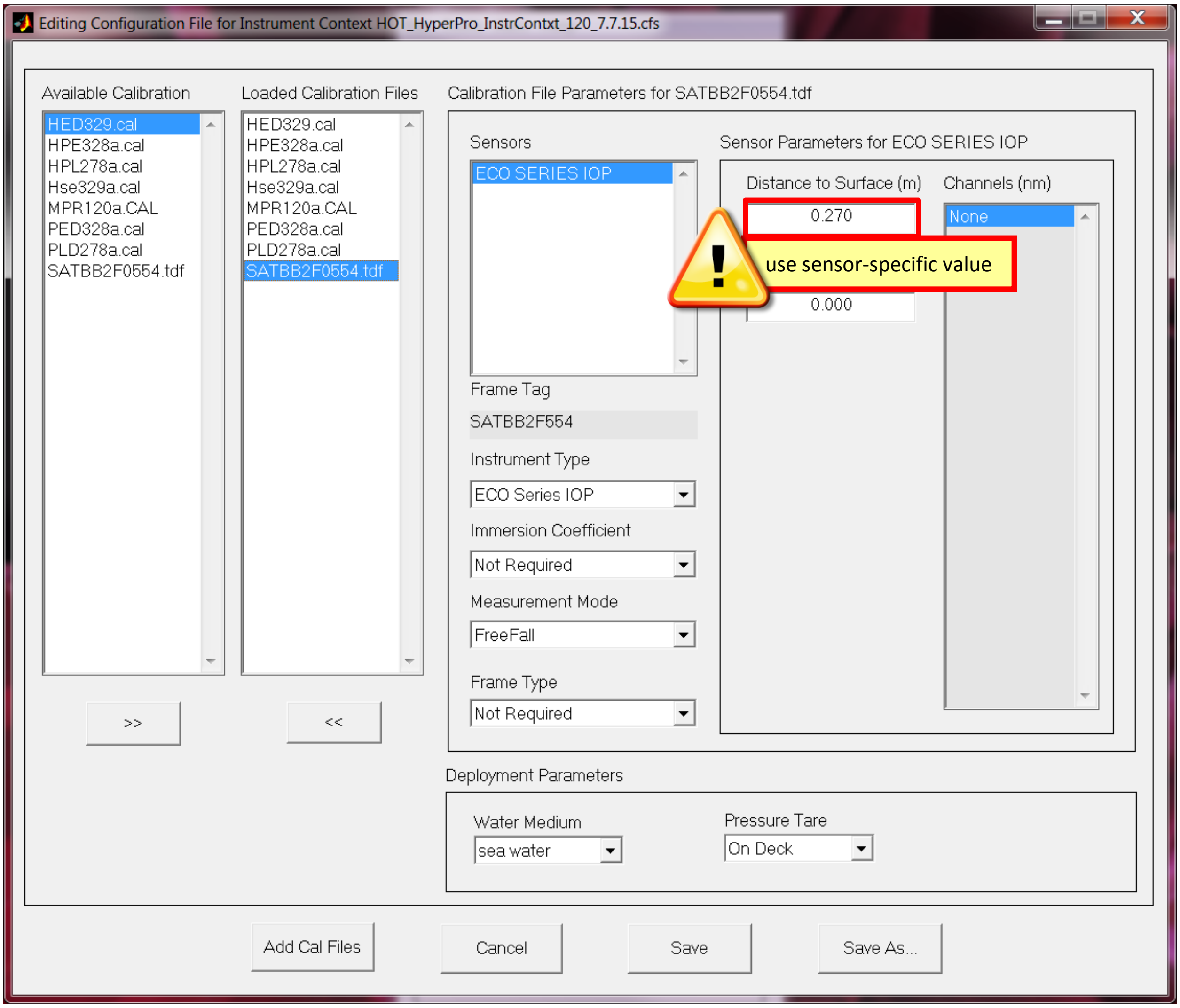
Instrument Context: PROFILE, SURFACE, and DARK CAST Part 6



Instrument Context: PROFILE, SURFACE, and DARK CAST   Part 7

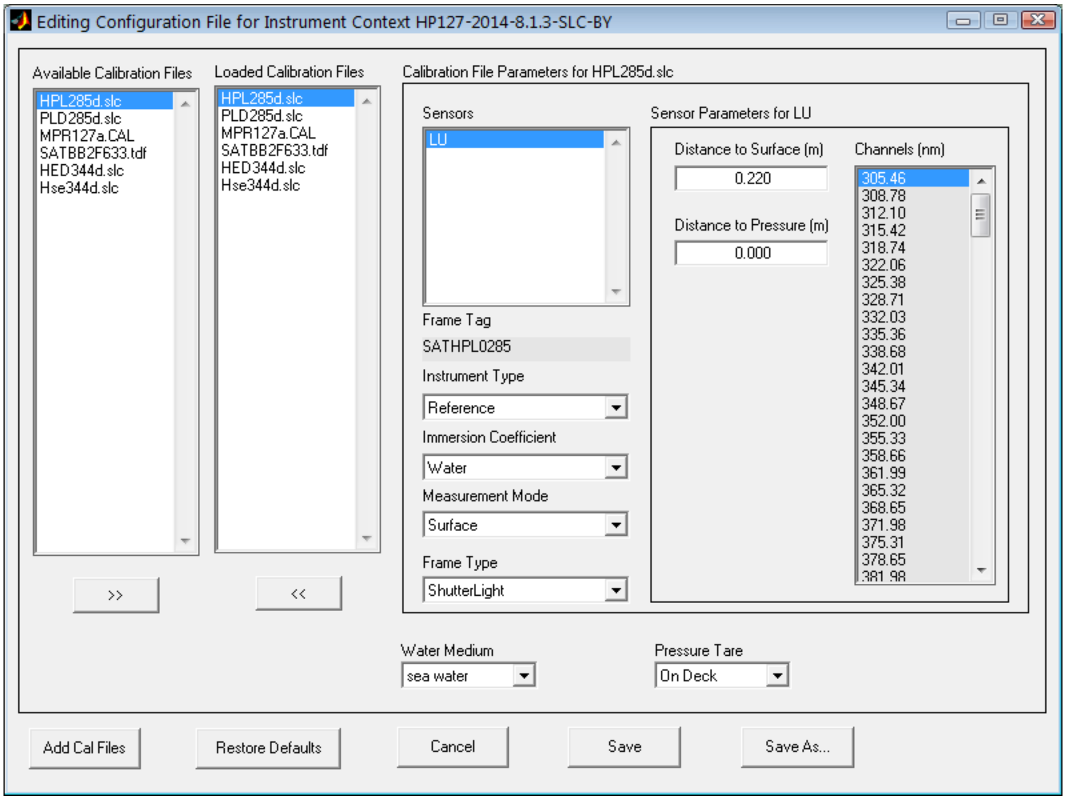


Instrument Context: PROFILE, SURFACE, and DARK CAST Part 8

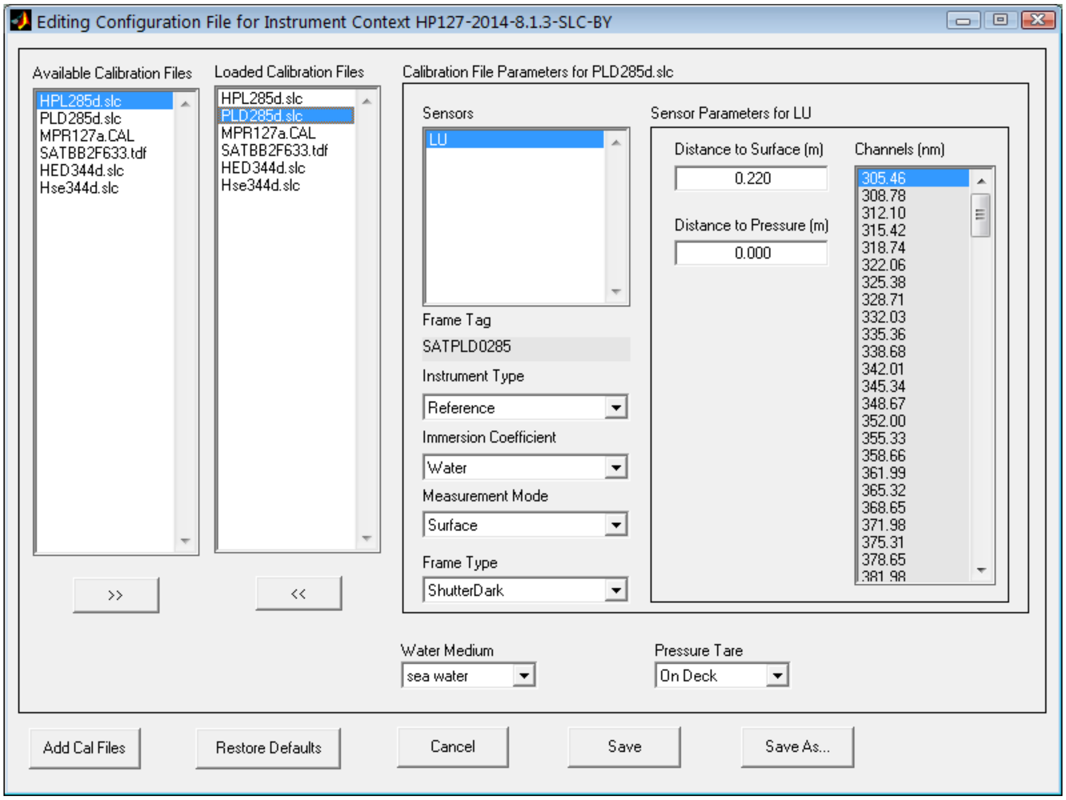


Instrument Context: BUOY Part 1

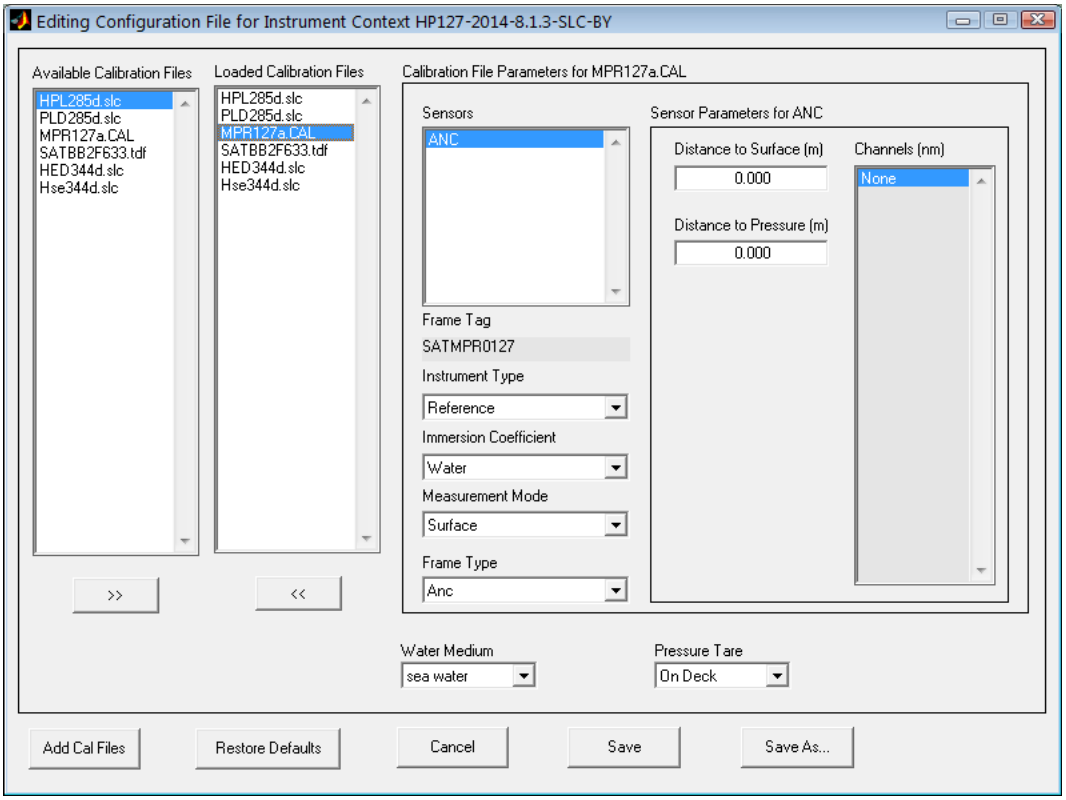
Filename examples: (1) HP120-2011-8.1.1-NSL-BY, (2) HP120-2013-8.1.1-SLC-BY



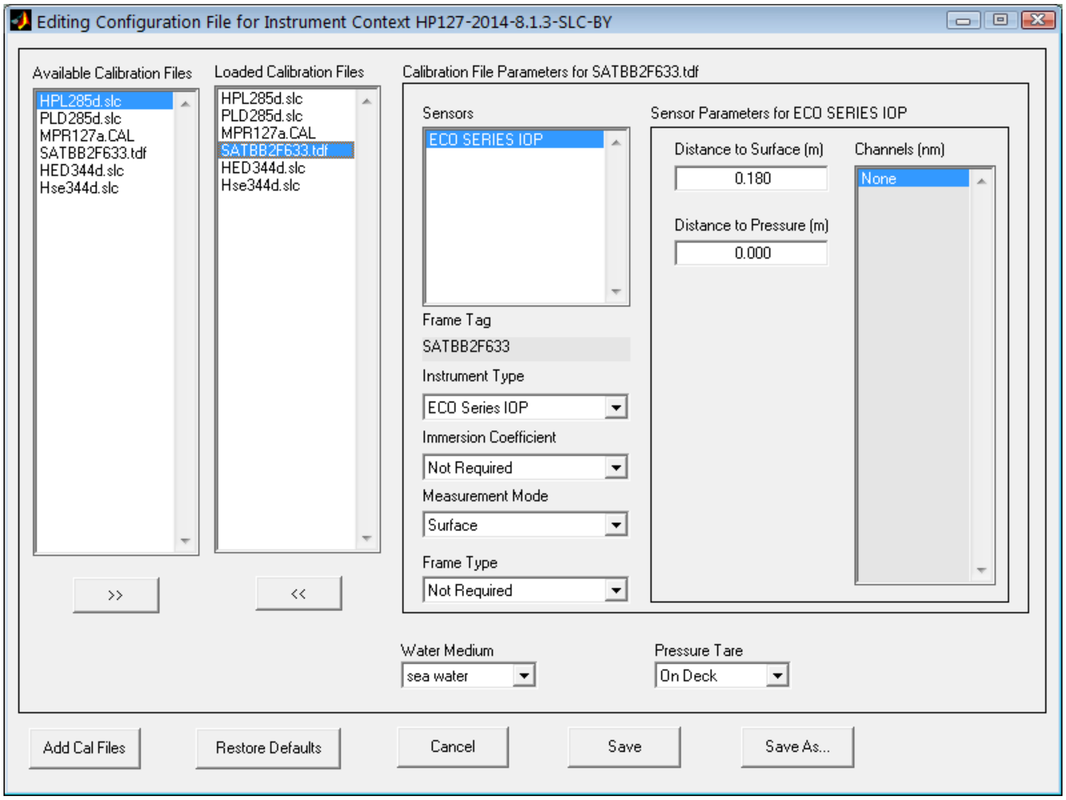
Instrument Context: BUOY Part 2



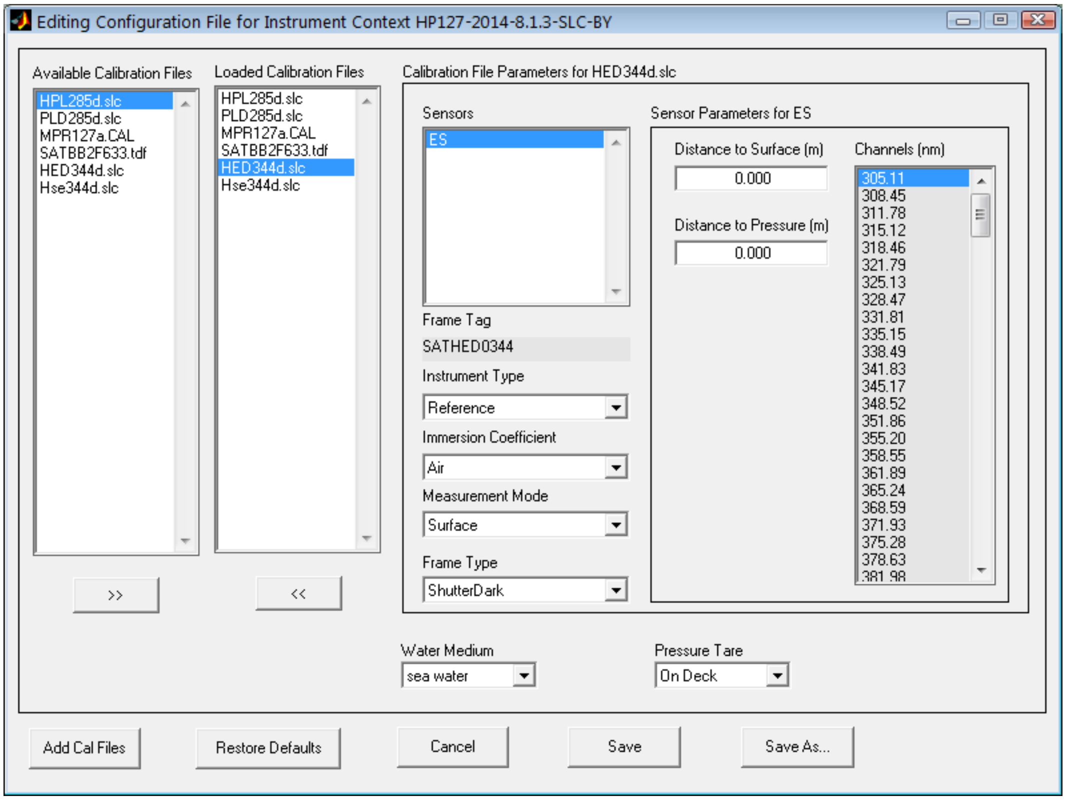
Instrument Context: BUOY Part 3



Instrument Context: BUOY Part 4

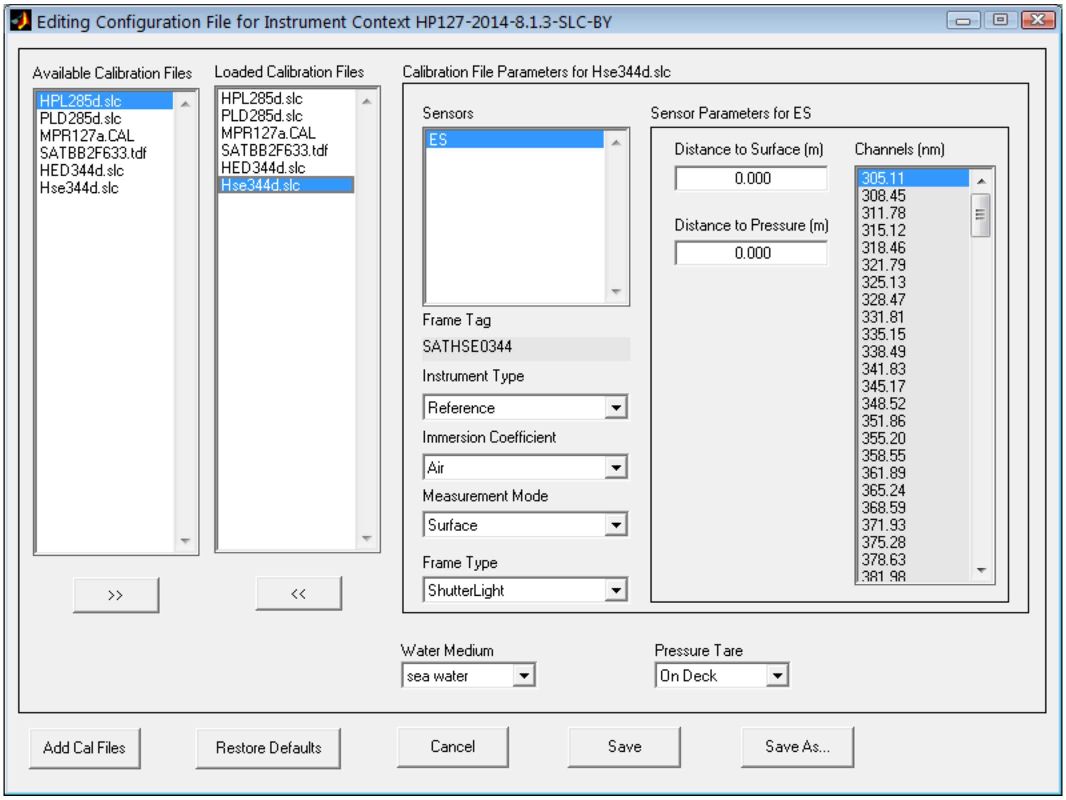


Instrument Context: BUOY Part 5



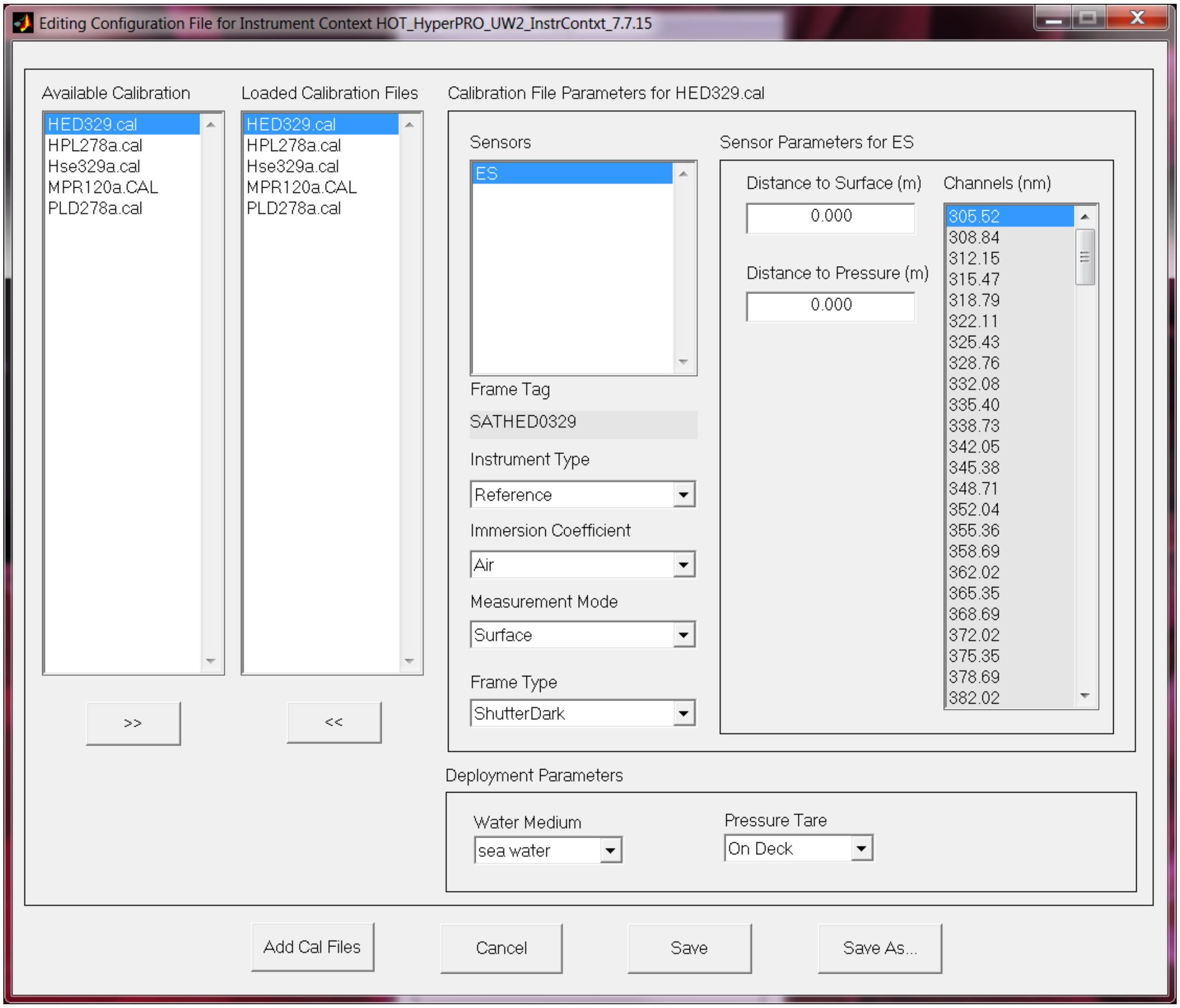
Instrument Context: BUOY

Part 6

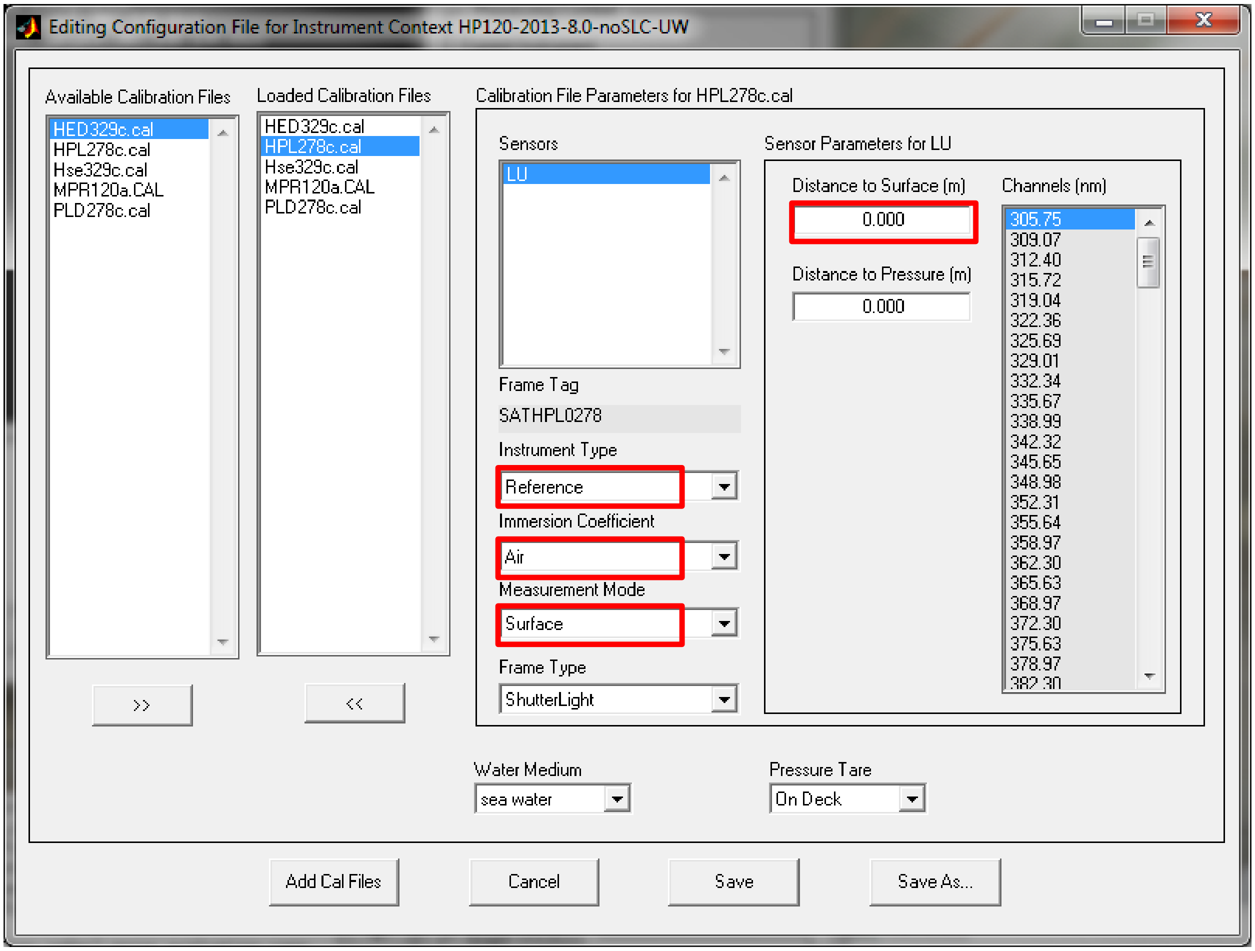


Instrument Context: UNDERWAY Part 1

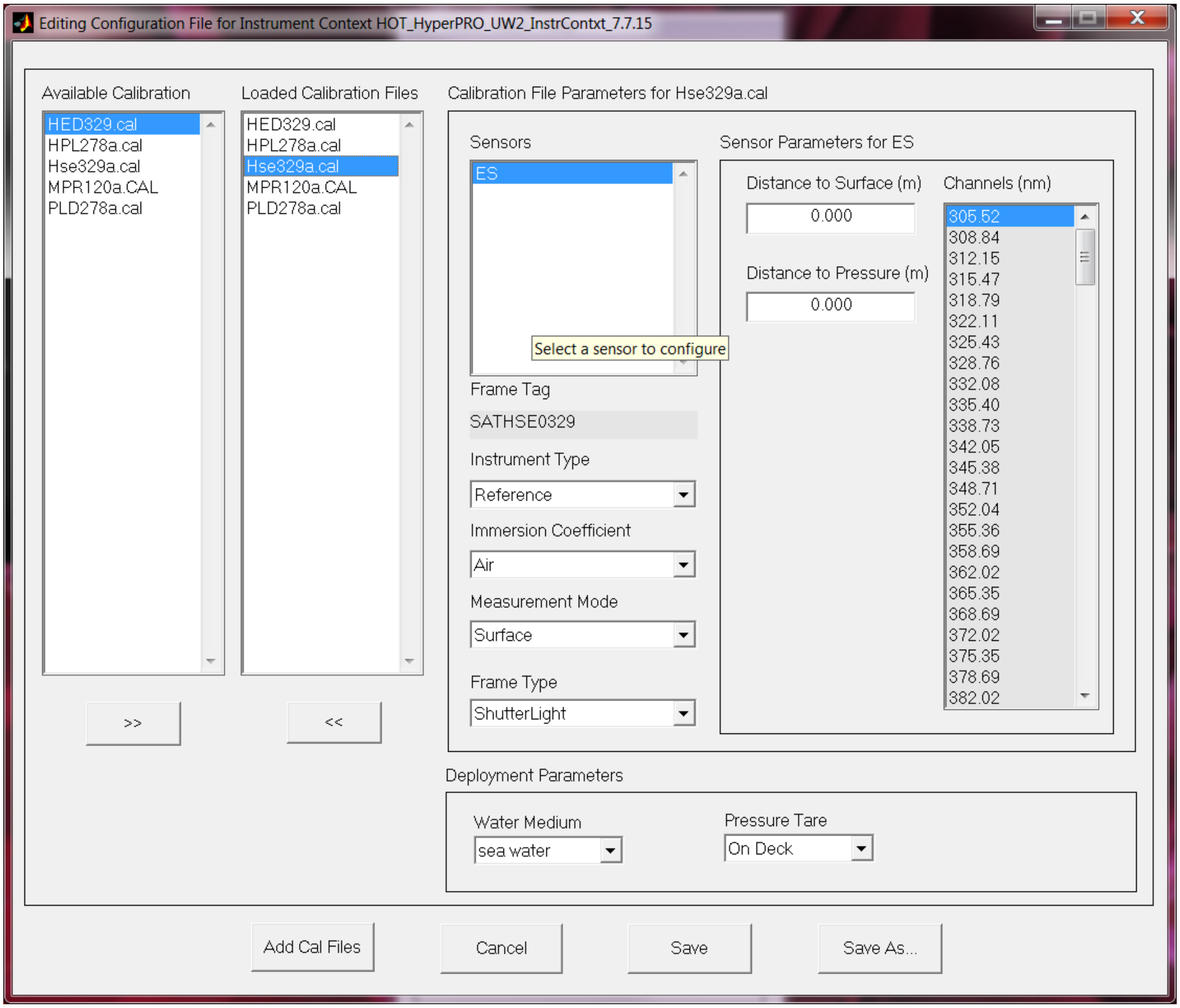
Filename examples: (1) HP120-2011-8.1.1-NSL-UW, (2) HP120-2013-8.1.1-SLC-UW



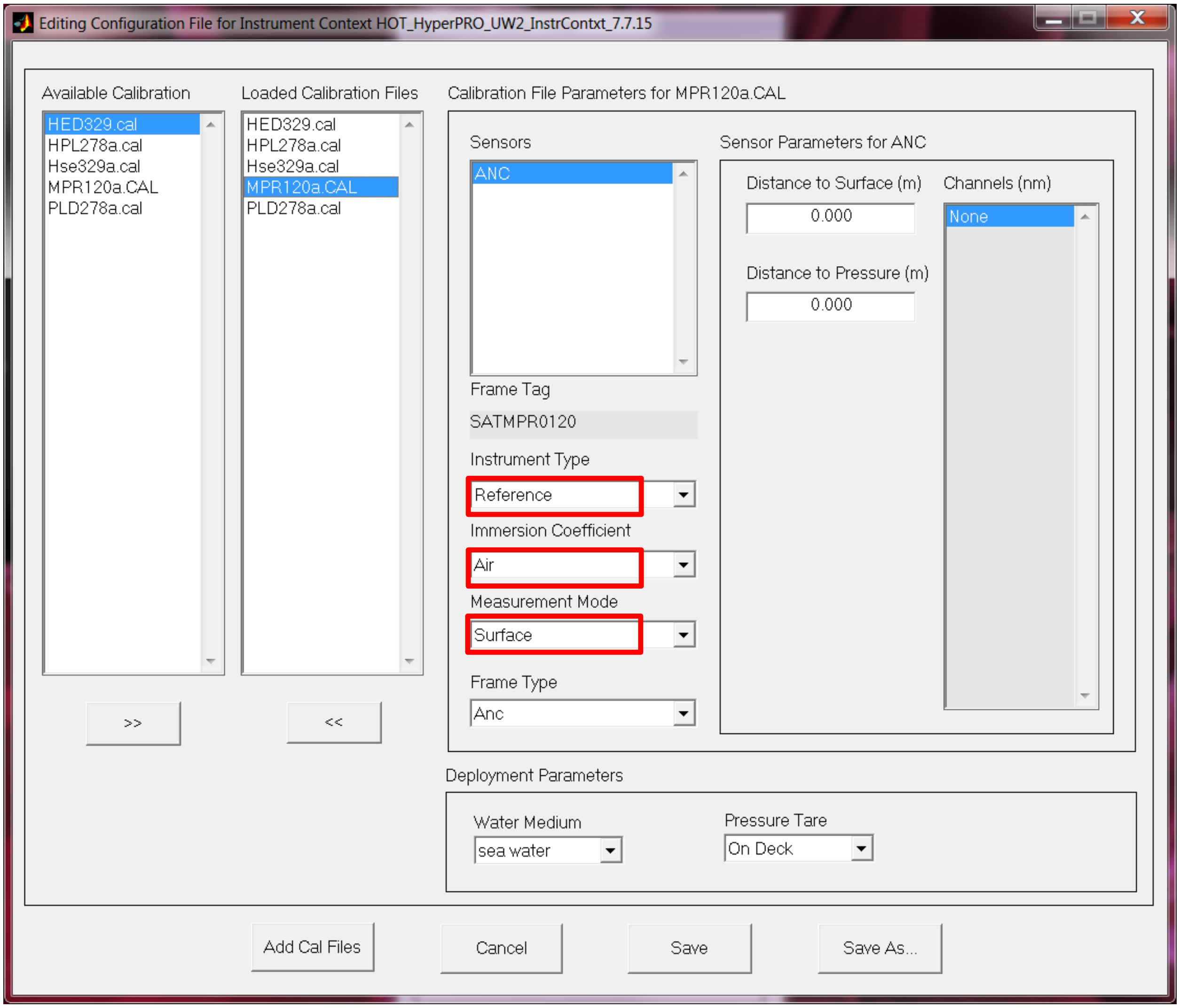
Instrument Context: UNDERWAY Part 2



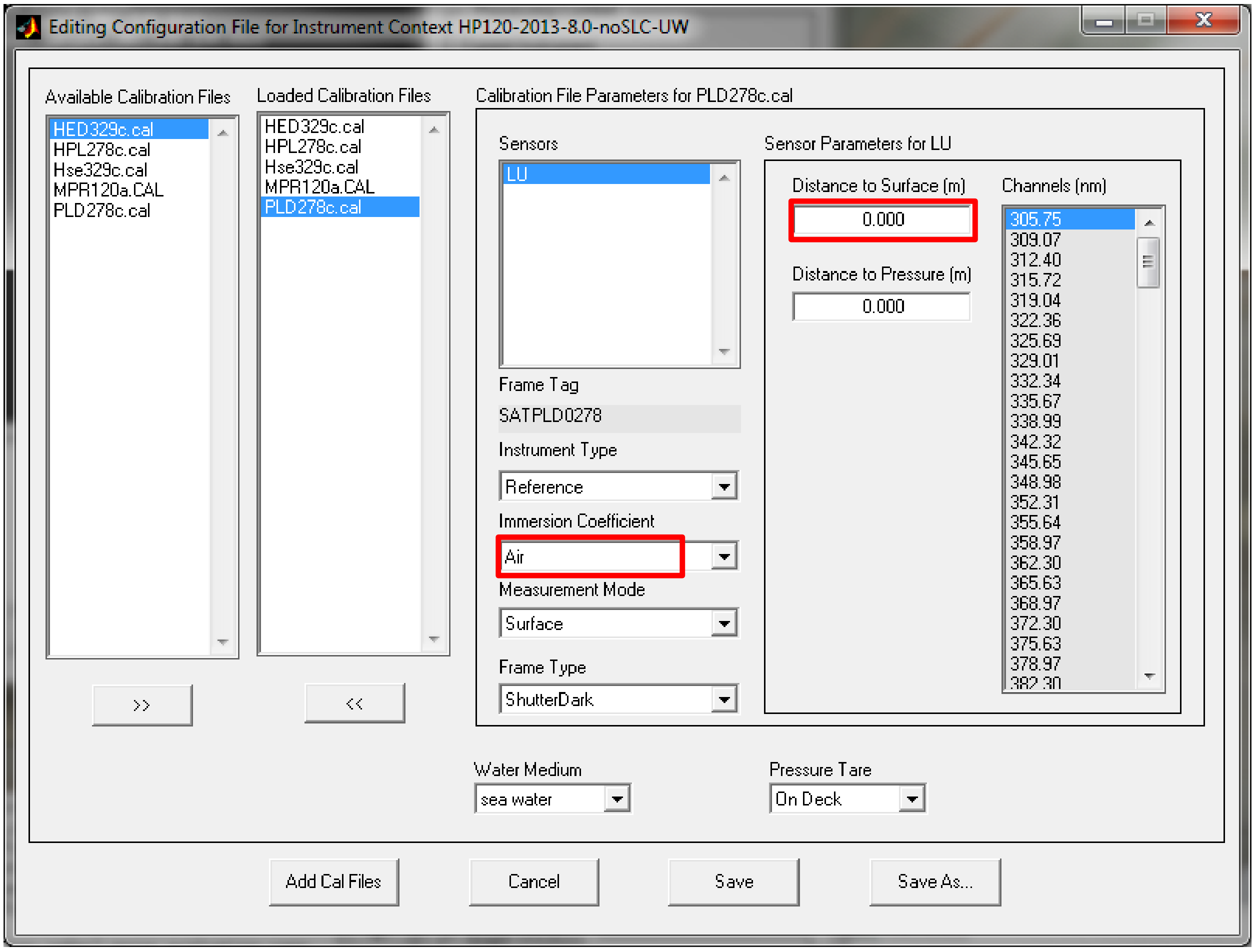
Instrument Context: UNDERWAY Part 3



Instrument Context: UNDERWAY Part 4



Instrument Context: UNDERWAY Part 5



Parameters Context

To begin creating a parameters context file, launch ProSoft and select the “New” button from the Current Parameters section.

Next copy the settings from the screenshots below.

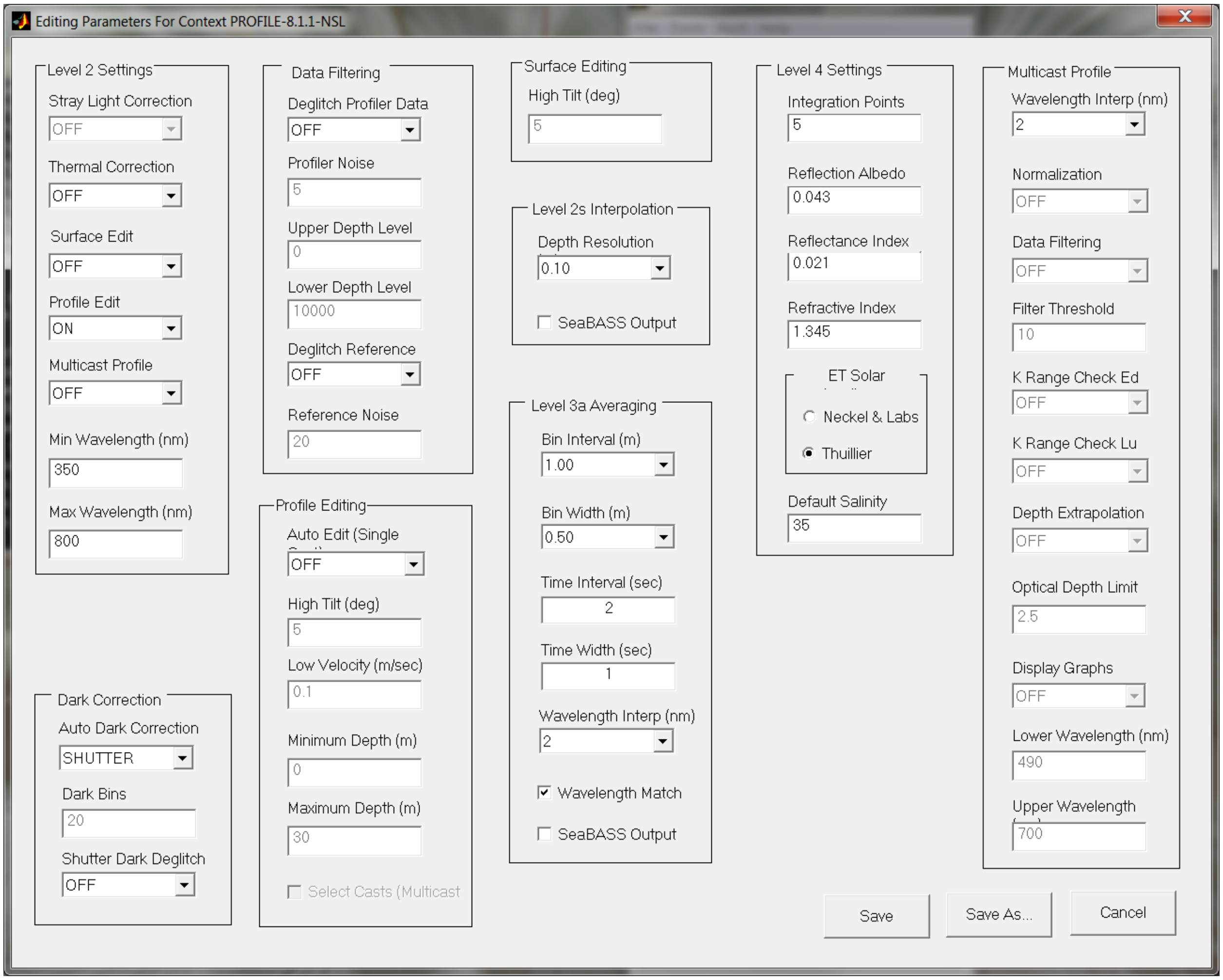
The setting “Profile Editing – Auto Edit” will set itself back to “ON” every time you open a parameters context file. (I think it’s a bug.) Make sure to set it back to “OFF” before you save the file!

ProSoft will store the new parameters context file on your PC in the following location:

Windows 7	c:\Users*username*\AppData\Roaming\ProSoft 8.1\Processing Parameters
Windows XP	c:\Documents and Settings*username*\Application Data\ProSoft 8.1.1\Processing Parameters

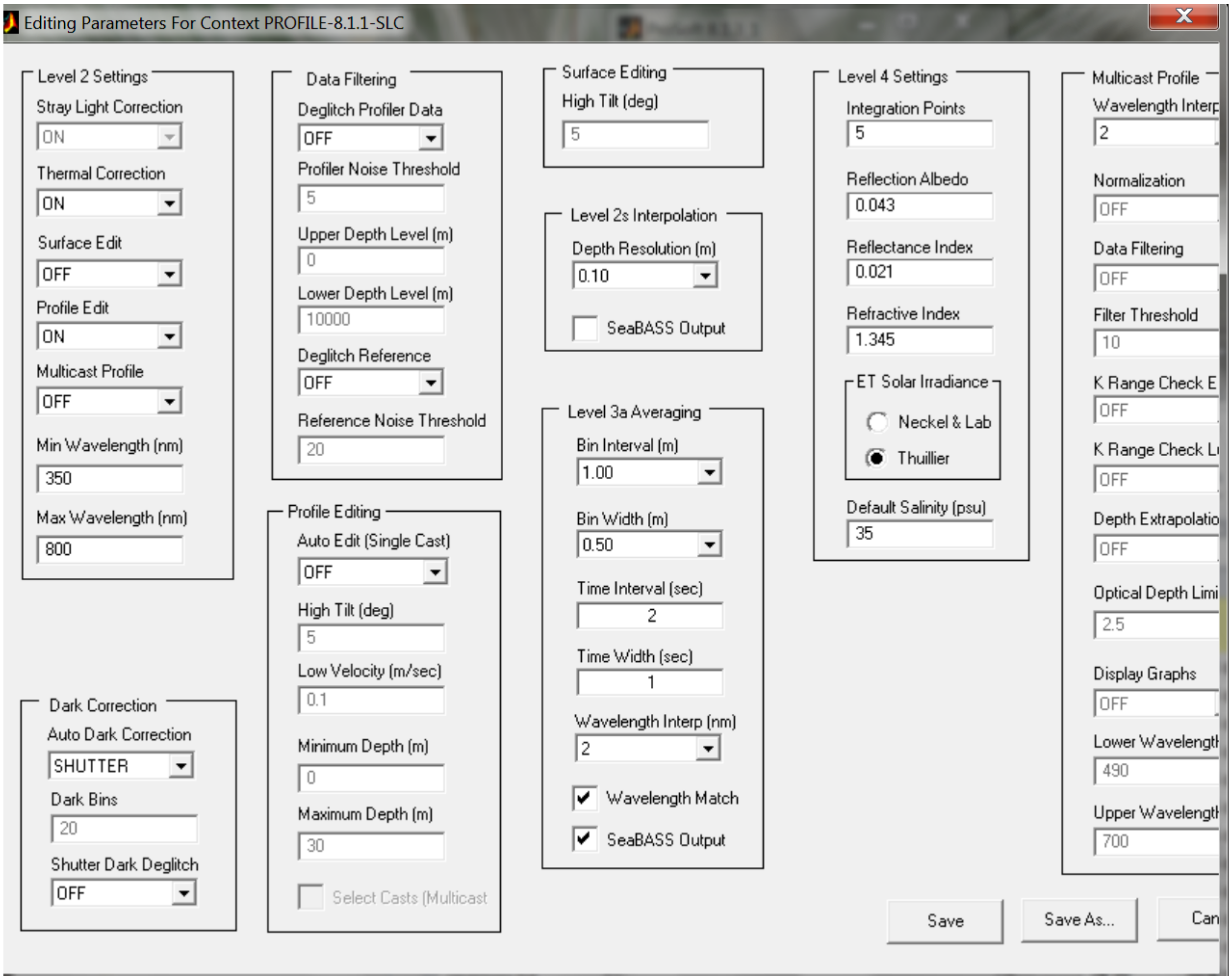
Parameters Context: PROFILE without stray light correction

Example filename: PROFILE_8.1.1_NSL



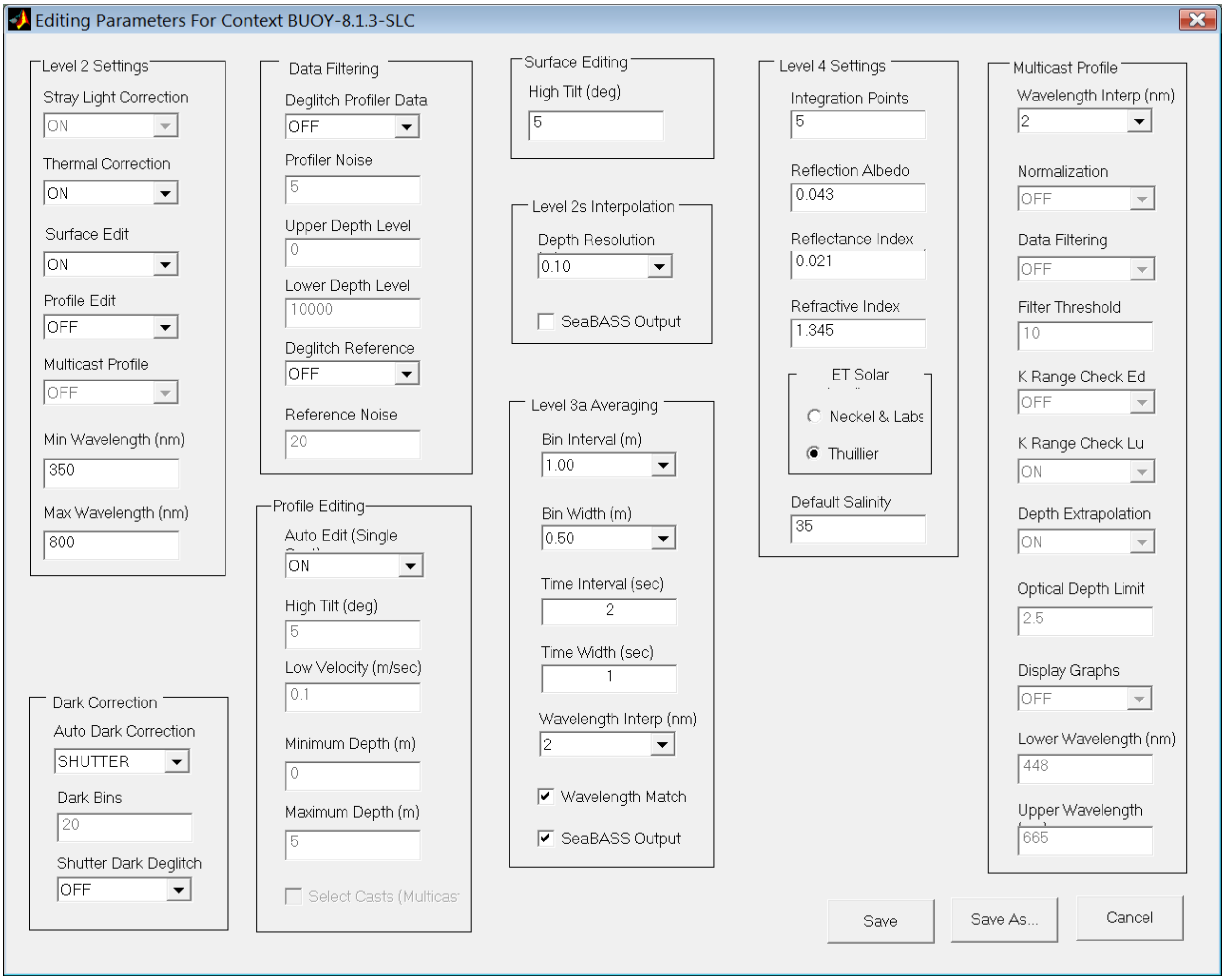
Parameters Context: PROFILE with stray light correction

Example filename: PROFILE_8.1.1_SLC



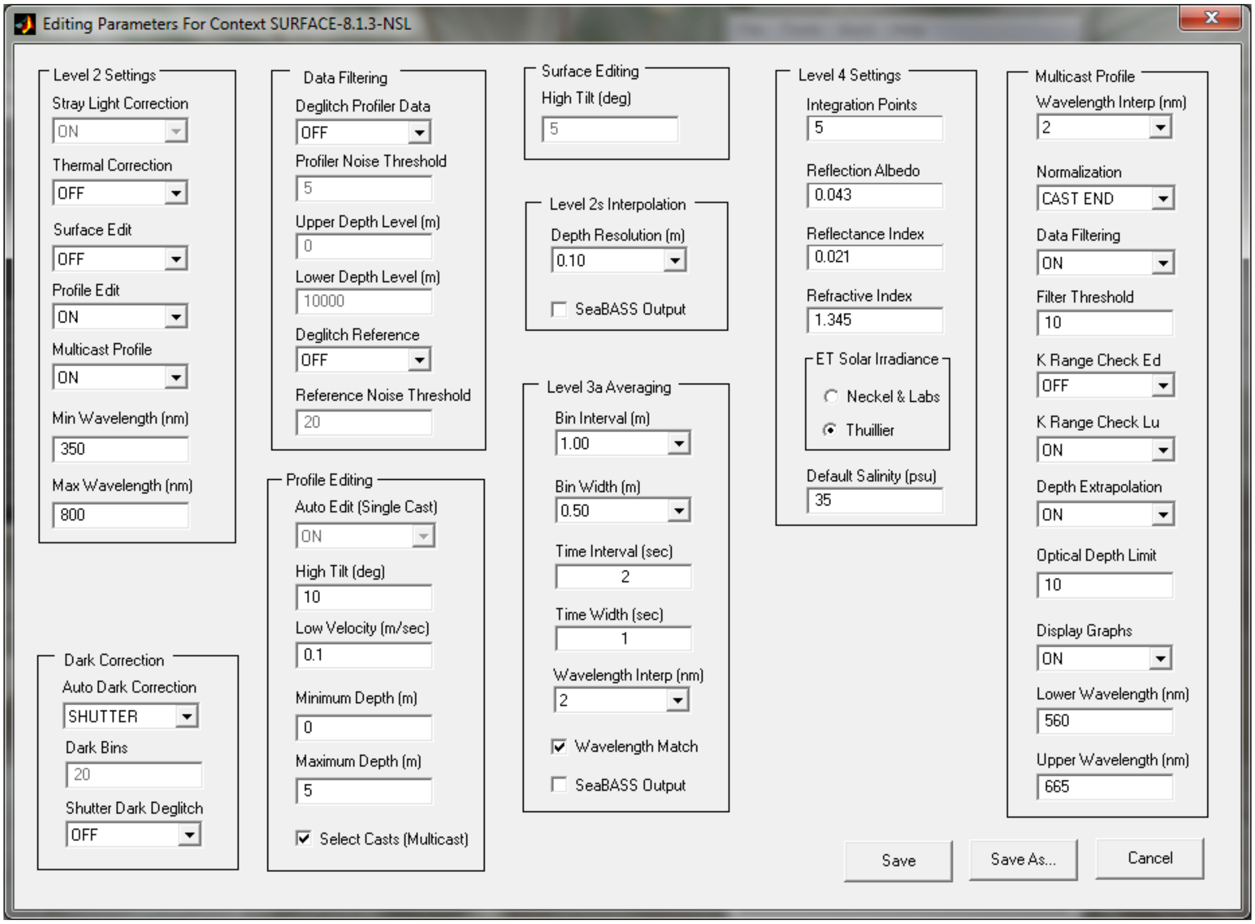
Parameters Context: BUOY *with* stray light correction

Example filename: BUOY_8.1.3_SLC



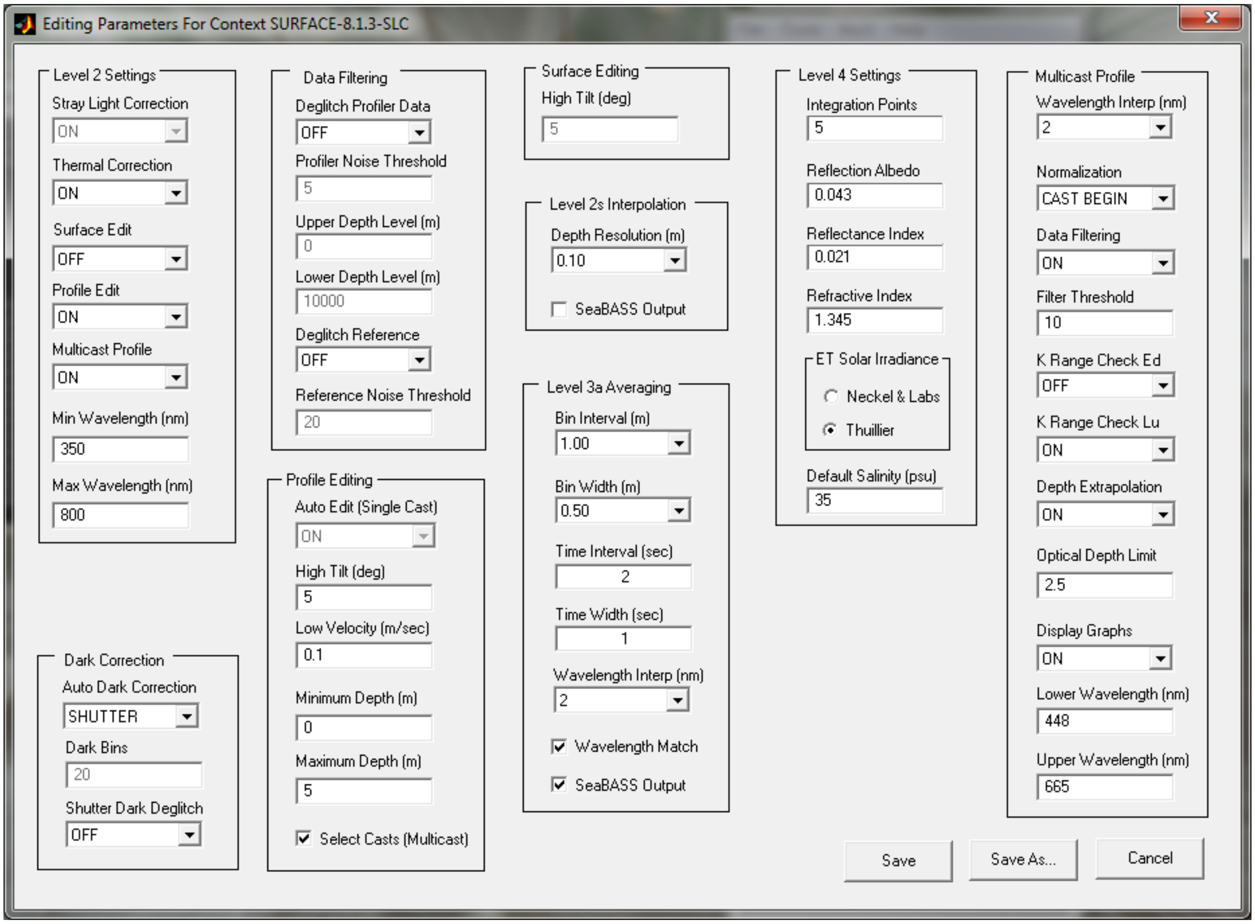
Parameters Context: SURFACE without stray light correction

Example filename: SURFACE_8.1.3_NSL



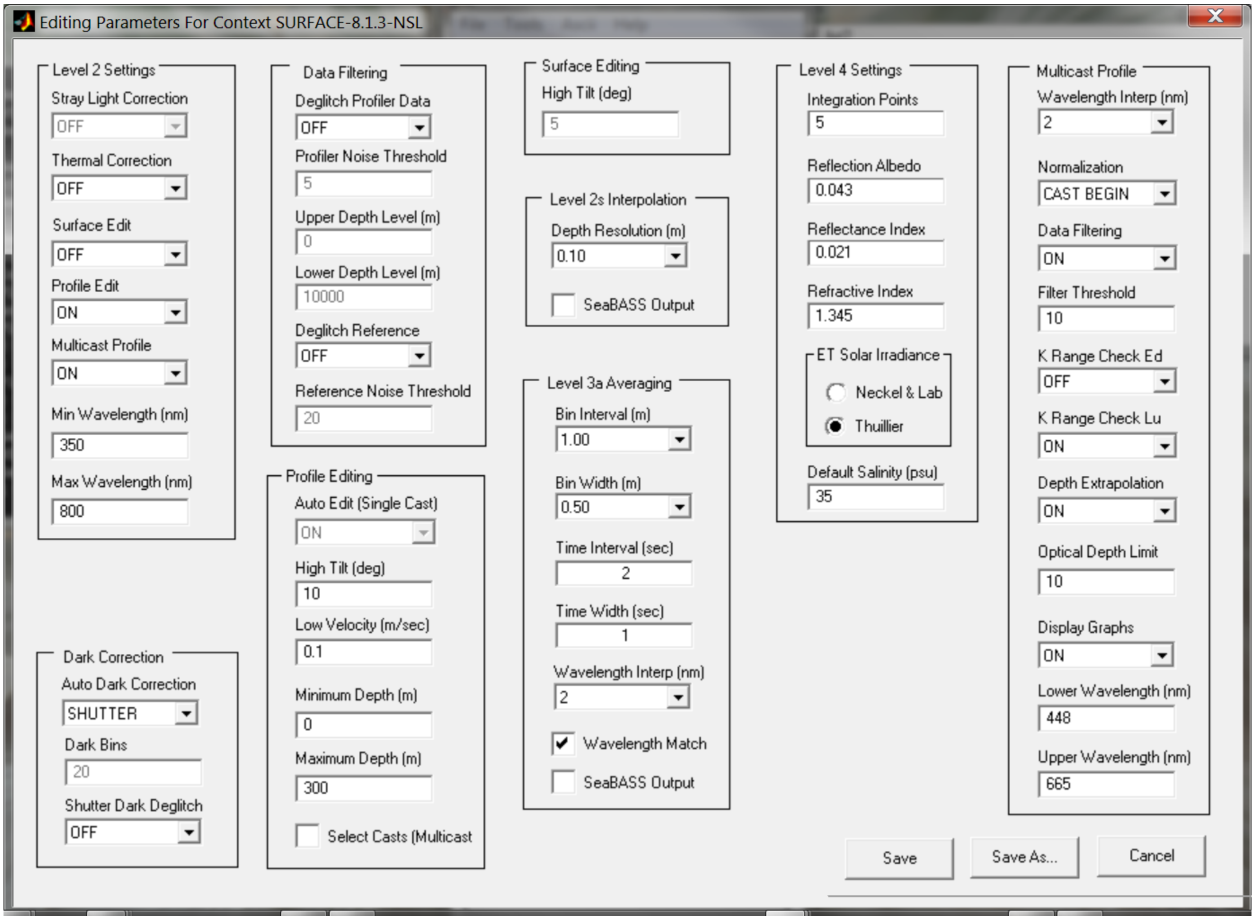
Parameters Context: SURFACE with stray light correction

Example filename: SURFACE_8.1.3_SLC



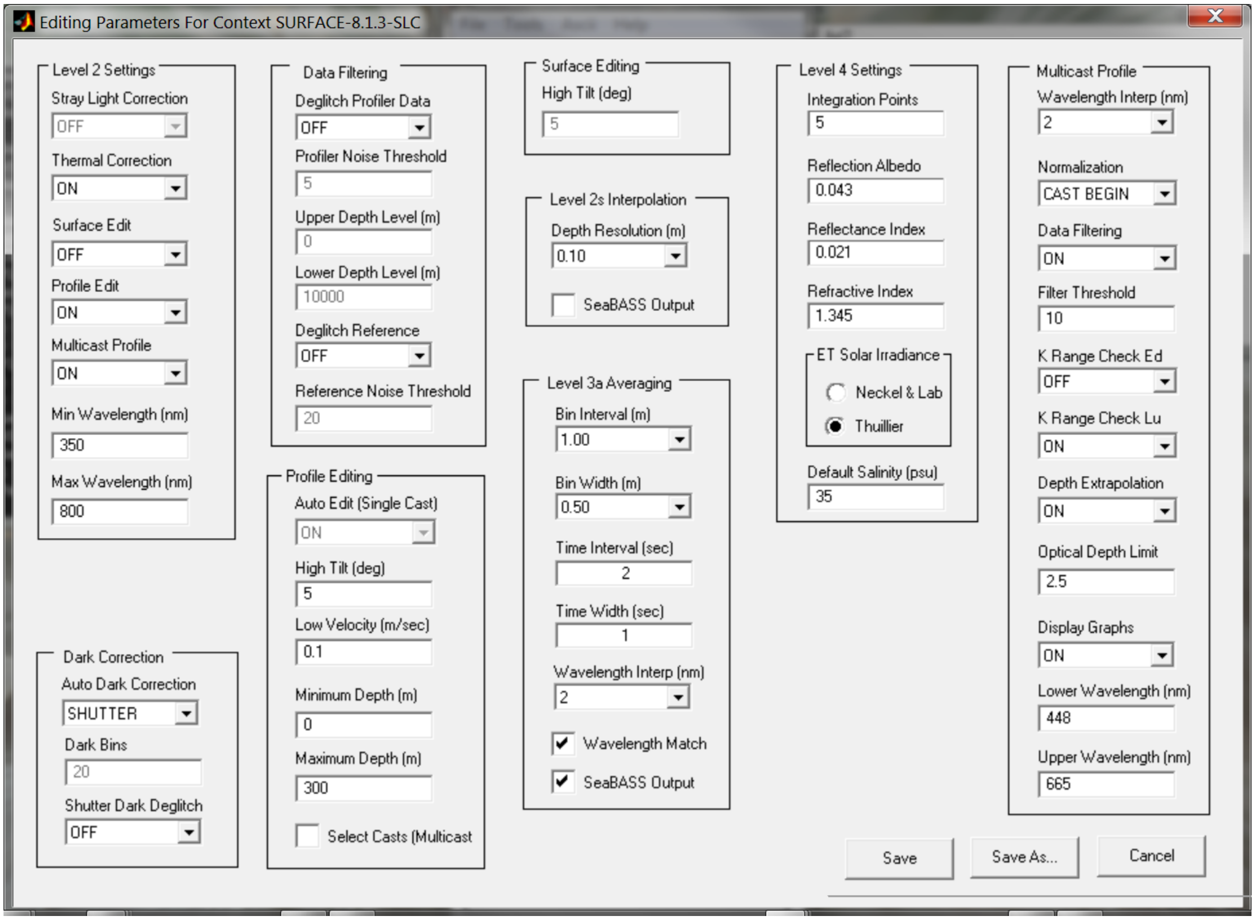
Parameters Context: SURFACEFULL without stray light correction

Example filename: SURFACEFULL_8.1.3_NSL



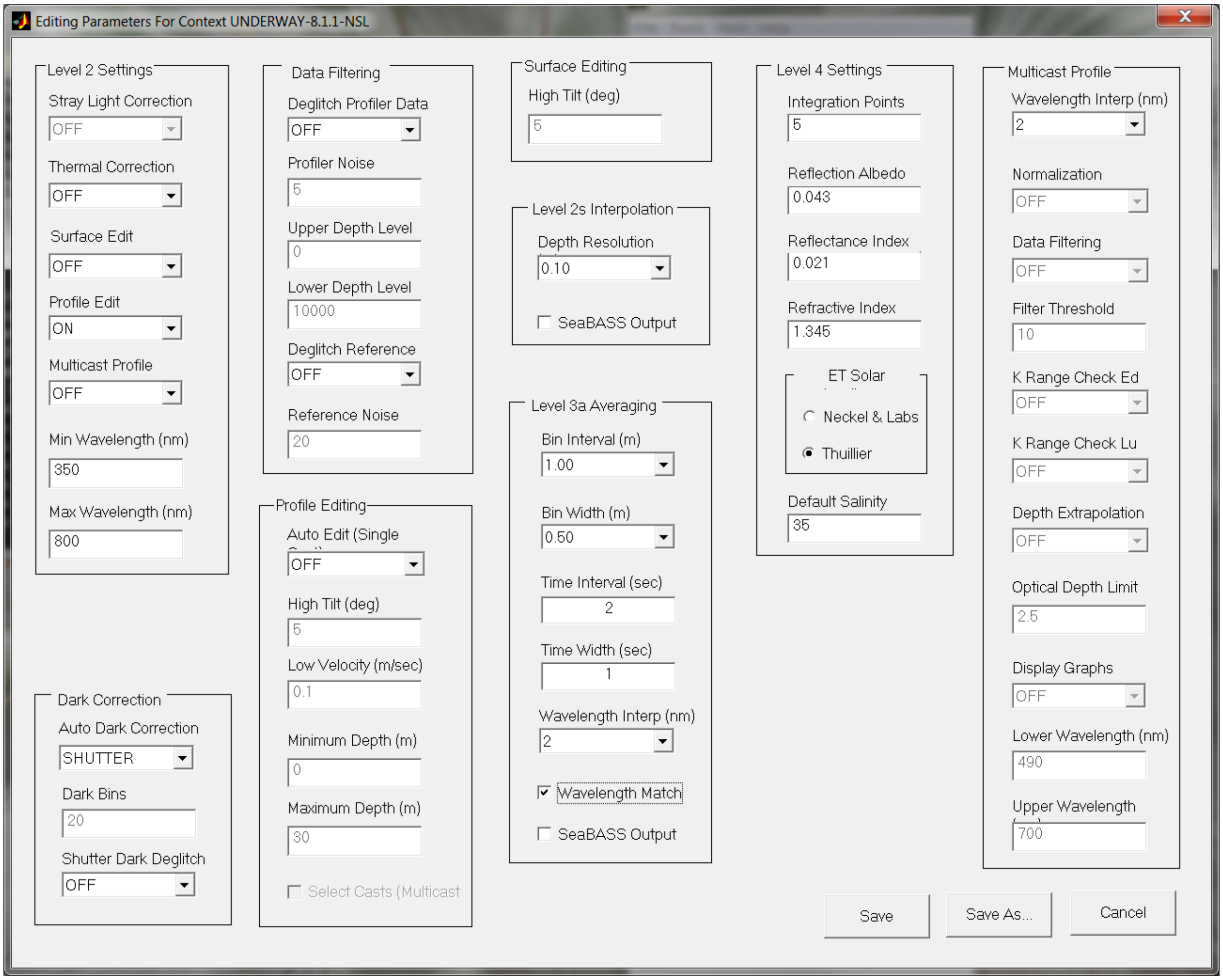
Parameters Context: SURFACEFULL with stray light correction

Example filename: SURFACEFULL_8.1.3_SLC



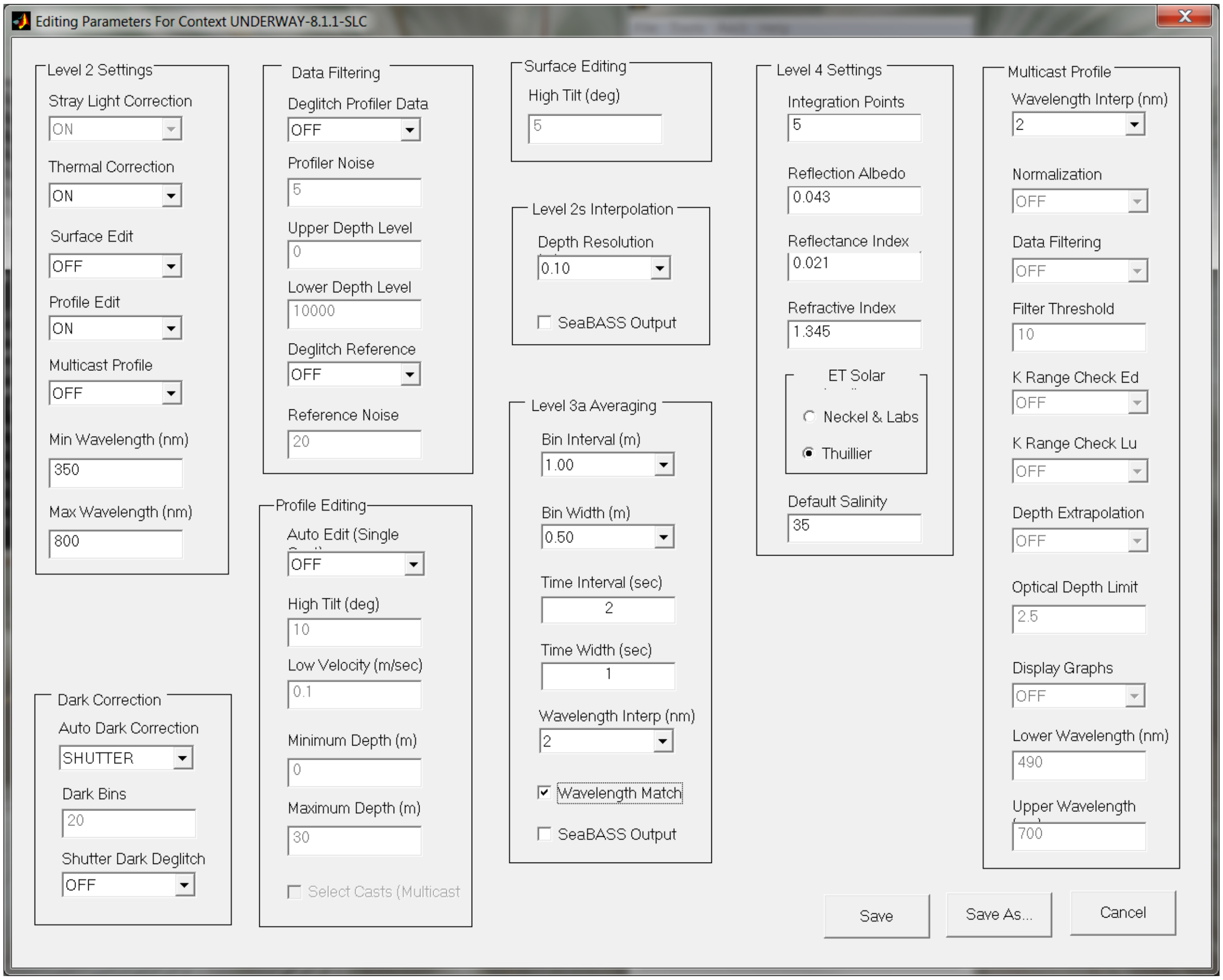
Parameters Context: UNDERWAY *without* stray light correction

Example filename: UNDERWAY_8.1.1_NSL



Parameters Context: UNDERWAY *with* stray light correction

Example filename: UNDERWAY_8.1.1_SLC



Appendix B: ProSoft Settings

Profile Editing

If Profile Editing "Auto Edit" is ON, the entire upper profile is removed down to the depth where tilt > 5 degrees (or some other specified angle), even if the tilt is good in the rest of the upper profile. This can lead to the removal of a significant portion (e.g. 10 meters) of the upper profile. This is an issue because Lw is calculated by extrapolating the measured Lu's from the top of the edited profile to the sea surface. Extrapolating over a large distance can result in significant differences between the measured Lu near the surface and the calculated Lw. **It is recommended that profile editing "auto edit" is always turned OFF.**

Appendix C: Troubleshooting

ProSoft

Occasionally during processing, a data file will stubbornly refuse to be processed. A list of errors that I have come across and their workarounds follows below.

A memory allocation request failed.

Cause: The file is too big (approx > 40 MB).

Solution: Select "File - Options - Enable Raw File Parsing". Set the parsing size to 20 Mb.

Undefined function or variable 'profiler_index'.

Cause: This error happens for underway (on deck) deployments because there is no profiler working.

Solution: Make sure to use an underway instrument context file and an underway parameter context file. Select only "photosynthetically available radiation" and the two default parameters that go with it (K and surface optical values) for processing.

No radiance sensors detected, no wavelength matchups

Cause: This error happens for underway (on deck) deployments because there is no profiler working.

Solution: This is normal and can be ignored. Processing will continue.

Invalid instrument for level 4 ...

Cause: This happens for some split files from underway (on deck) deployments.

Solution: Make sure that the option "Enable Raw File Parsing" under the File-Options menu is not checked, otherwise the split files may be split again, which causes this error.

Matrix dimensions must agree.

Cause: Not using the correct context file or selecting the wrong parameters to process for underway data.

Solution: Make sure to use an underway instrument context file and an underway parameter context file. Select only "photosynthetically available radiation" and the two defaults that go with it (K and surface optical values) for processing.

Index exceeds matrix dimensions.

Cause: Corrupt file.

Solution: If the file was transferred via ftp, re-download it. Make sure to download the file as binary instead of ascii.

Missing data at the start of the output files.

Cause: Deglitching turned on.

Solution: Turn off deglitching in the parameter context file.

There should be at least two data points.

Cause: Bad file????

Solution: Skip it. Find something better to do.

Invalid instrument for level 3a …

Cause: Bad file????

Solution: Skip it. Find something better to do.

No instruments specified in cal file were found.

Cause: Using wrong instrument cal file.

Solution: Check the hyperpro ID number in the header of one of the data files (e.g. MPR0120) and make sure it matches the context file you're using.

Invalid fid

Cause: Can happen when trying to create new instrument context files on an incompatible version of Windows. This issue has been encountered with Prosoft 8.0 on Windows 7.

Solution: Use a different computer (with a different version of Windows) to make the context files, then copy the context files to your PC.

FATAL ERROR, CHECK PRESSURE VALUES …. CONSTANT PRESSURE

Cause: The cast went too deep, saturating the pressure values causing repeated values. When processing in multicast mode, the maximum depth for the cast should be at about 180 m.

Solution: If it is necessary to use multicast mode, the raw file must be edited to remove the repeated (saturated) values. I do not currently have code to do this. Otherwise, process the file using single cast mode instead of multicast mode. Ensure that future casts are not sent deeper than 180 m.

cannot create file …. No SDS Global Attributes are found … No valid information about Instrument Type

Cause: A bad output file is in place and cannot be overwritten.

Solution: Delete the bad output files (L1a.hdf, L1b.hdf, etc), restart ProSoft, and reprocess.

Warning … interpolated wavelengths exceeded HDF4 maximum fields limit

Cause: The number of output wavelengths exceeds the maximum value of 256. For example, 350 – 900 nm at 2 nm resolution yields 275 wavelengths.

Solution: Set the range of wavelengths to 350 – 800 nm, and keep the interpolation at 2 nm resolution.

Exact stray light correction matrix for … not found – using generic SLC matrix.

This is normal. Only four Hyperpros in the world have been fully characterized for stray light (an expensive process). The remaining Hyperpros, like ours, use a generic stray light correction instead.

Profiles show sudden shifts in value, like as if the gain hasn't been applied

The file may be corrupt. Was the file manually edited? If so, make sure to make any edits using vi on unix/linux. Attempting to edit the file using Notepad on Windows will cause a corrupt file. The file may still process, but will create erroneous results.

Number of rows of data must match order of field.

Cause: Unknown.
Solution: Unknown.

Hardware (Sensor)

Es data are either missing or have noisy small values.

Cause: Es sensor may have been covered or not connected properly.
Hardware Solution: Check that the sensor face is uncovered, mounted in the correct location (out of shadow), and connected. If the issue persists, check the cable.
Software Workaround: Surface irradiance data are required to calculate surface values such as RSR. In the absence of Es data, RSR (and other surface properties) can be estimated using extrapolated Ed in place of Es. Note, however, that the results will not be as accurate. To accomplish this calculation, create a new instrument context file

Appendix D: Prosoft Version Differences

	stray light correction	yo-yo	nLw	Accurate buoy processing above 700 nm
7.7.16	no	no	yes (but not good)	no
8.0	no	yes	yes	no
8.1.1	yes	yes	yes	no
8.1.3	yes	yes	yes	no
8.1.5	yes	yes	yes	yes

Appendix E: Other Resources

Two key documents are available on garcia in: instruments/HyperPro/docs

HOTHyperProDeploymentProtocols.pdf	Operating instructions for HOT HyperPro deployments (OSU)
ProSoft User Manual SAT-DN-00228_Rev8_0B.pdf	ProSoft user manual (Satlantic)
Hyperpro_protocols_5_31_12.doc	HyperPro guide by Mike Ondrusek

Appendix F: Cheat Sheet

1. **Raw Data**
    a. Move Hyperpro data to appropriate folder structure

2. **Log File**
    a. Matlab: hyperpro_getmetadata
    b. Edit log sheet with the output from the above command

3. **Sensor offsets**
    a. Derive the sensor offsets (for data collected after Sep 2013)

sensors	equation	107	120	127
ED distance to pressure (m)	ED + PRESS – 0.062	0.776	0.782	0.773
LU distance to Ed head (m)	ED + LU	0.320	0.318	0.305
ECO PUC distance to Ed head (m)	ED + PUC	0.270	0.270	0.269

4. **ProSoft 8.1.5**
    a. Delete existing output hdf files
    b. Edit raw cast files to contain mean pressure tare (9.83) instead of in water tare if necessary (don't need to do this for dark, buoy, or underway data).
    c. Check SLC setting
    d. Check pressure tare setting
    e. Check Ed "Distance to Pressure" value (should be 0 if in water pressure tare)
    f. Use hyperpro_moveoutput between each step:
    e.g. hyperpro_moveoutput(cruisefolder,'Darks')

For a given station, if you have …	Then perform the following processing …
DARKS	**DARKS**
SINGLE CASTS ONLY (*no yoyo files*)	**SURFACE-UPPER** on the single casts **SINGLE PROFILES** on the single casts
YOYO CASTS ONLY (*no single cast files*)	**SURFACE-FULL** on the yoyo casts **SURFACE-UPPER** on the yoyo casts **YOYO PROFILES** on the SURFACE-FULL L2s data
SINGLE CASTS and YOYO CASTS	**SURFACE-UPPER** on the yoyo casts **SINGLE PROFILES** on the single casts
BUOY DEPLOYMENTS	**BUOY**
UNDERWAY DEPLOYMENTS	**UNDERWAY**

	DARKS	**SURFACE-FULL**	**SURFACE-UPPER**	**YOYO PROFILES**	**SINGLE PROFILES**	**BUOY**	**UNDERWAY**
Raw File Parsing	No	No	No	No	No	Yes	Yes
Inst Context	PR	PR	PR	PR	PR	BY	UW
Parameter Context	PROFILE	SURFACEFULL	SURFACE	PROFILE	PROFILE	BUOY	UNDERWAY
Maximum Depth		300	5				
Normalization		BEGIN	BEG/MID/END			BEG/MID/END	
Starting Folder	Raw	Raw	Raw	SurfaceFull	Raw	Raw	Raw
Files to Delete				L3a, L4			
Processing Steps	Level 1 -> 1a	Level 1 -> 4	Level 1 -> 4	Level 2s -> L3a Level 3a -> 4	Level 1 -> 4	Level 1 -> 4	Level 1 -> 4
Parameters				**Water Properties** **PAR** **Scattering**	**Water Properties** **PAR** **Scattering**	**Lw/Lwn** **Surface RSR** **PAR**	**PAR**
Output Folder	**Darks**	**SurfaceFull**	**SurfaceUpper**	***do not move***	**Profiles**	**Buoy**	**Underway**

5. **Matlab**
    a. hyperpro_checkpressuretare
    b. hyperpro_main

Appendix G: Important Dates

March 2009

- first HyperPro casts collected at HOT

September 2013

- first **stray light** correction calibration file for S/N 120
- began **yo-yo** deployments
- began recording **sensor offsets** in metadata “comments” section
- new protocol: **pressure tare on deck** (previously was usually, but not always, in water)

December 2014

- first stray light correction calibration file for S/N 127

June 2016

- received ProSoft 8.1.5 from Satlantic after pointing out bug – this version correctly calculates products from 700-800 nm - this affects buoy processing only

Appendix H: Output Data

PROFILE MODE			
File Type	**Parameters**	**Wavelengths**	**Depth Intervals**
ASCII FILES			
Ed_L2s.dat	Ed(z) (Wt, cond, tilt, pvel)	all	0.1 m
Lu_L2s.dat	Lu(z) (Wt, cond, tilt, pvel)	all	0.1 m
Es_L2s.dat	Es(t)	all	
Ed_L3a.dat	Ed(z) (Wt, cond, tilt, pvel)	2 nm intervals	1 m
Lu_L3a.dat	Lu(z) (Wt, cond, tilt, pvel)	2 nm intervals	1 m
Es_L3a.dat	Es(t)	2 nm intervals	
L4.dat	K_LU(z)	2 nm intervals	1 m
	K_Ed(z)	2 nm intervals	1 m
	Ed(0+)	2 nm intervals	
	Ed(0-)	2 nm intervals	
	Es(0-)	2 nm intervals	
	Es(0+)	2 nm intervals	
	Lu(0-)	2 nm intervals	
	Tw, Cond, Cond_Ratio, Salinity, Density, Sigma-T		1 m
	FLUOR(z) ()		1 m
	PAR(z), PAR(%)(z) (LightLevel)		1 m
	PAR(0+)(t)		
	B(470), Bw(470), Bp(470), bbp(470), bb(470)		1 m
	B(700), Bw(700), Bp(700), bbp(700), bb(700)		1 m
L4_KPAR.dat	KPAR(z)		1 m
SRF_L4.dat	AVG_ES (same as Es(0+))	2 nm intervals	
	K_LU (average)	2 nm intervals	
	K_SE_LU (average)	2 nm intervals	
	K_ED (average)	2 nm intervals	
	K_SE_ED (average)	2 nm intervals	
	LU(0-) (same as L4.dat)	2 nm intervals	
	ED(0-) (same as L4.dat)	2 nm intervals	
	ED(0+) (same as L4.dat)	2 nm intervals	
SUBSET FILES			
profile_subset.txt	Tw(z), Cond(z), Salinity(z), Density(z)		1 m
	FLUOR(z)		1 m
	PAR(z)		1 m
	PAR(0+)(t)		
	LightLevel(z)		1 m
	KPAR		1 m
	Ed(z)	subset	1 m
	Lu(z)	subset	1 m
	Es(t)	subset	
prosurf_subset.txt	Es(0+) (average)	subset	

BUOY MODE			
File Type	**Parameters**	**Wavelengths**	**Time Intervals**
ASCII FILES			
Ls_L2s.dat	Ls(0-) (Wt, cond, tilt, pvel)	all	2 s
Es_L2s.dat	Es(t)	all	2 s
Ls_L3a.dat	Ls(0-) (Wt, cond, tilt, pvel)	2 nm intervals	2 s
Es_L3a.dat	Es(t)	2 nm intervals	2 s
L4.dat	Es(0+)	2 nm intervals	
	K_LS	2 nm intervals	
	LS(0-)	2 nm intervals	
	ES(0-)	2 nm intervals	
	Lw	2 nm intervals	
	RSR	2 nm intervals	
	F0_ES	2 nm intervals	
	Lwn	2 nm intervals	
	PAR(0+,t)		2 s
SRF_L4.dat	AVG_ES (same as Es(0+) in L4.dat)	2 nm intervals	
	K_LS (same as L4.dat)	2 nm intervals	
	LS(0-) (same as L4.dat)	2 nm intervals	
	LW (same as L4.dat)	2 nm intervals	
	LWN (same as L4.dat)	2 nm intervals	
	F0	2 nm intervals	
SUBSET FILES			
surface_subset.txt	Es(0+)	subset	
	Lwn	subset	
	RSR	subset	
	PAR(0+,t)		2 s

SURFACE MODE			
File Type	**Parameters**	**Wavelengths**	**Depth Intervals**
ASCII FILES			
Ed_L2s.dat	Ed(z) (Wt, cond, tilt, pvel)	all	0.1 m
Lu_L2s.dat	Lu(z) (Wt, cond, tilt, pvel)	all	0.1 m
Es_L2s.dat	Es(t)	all	
MC_L4.dat	AVG_ES (i.e. Es(0+))	2 nm intervals	
	K_LU (average)	2 nm intervals	
	K_SE_LU (average)	2 nm intervals	
	K_ED (average)	2 nm intervals	
	K_SE_ED (average)	2 nm intervals	
	LU(0-)	2 nm intervals	
	ED(0-)	2 nm intervals	
	Lw	2 nm intervals	
	LwSE(+)	2 nm intervals	
	LwSE(-)	2 nm intervals	
	ED(0+)	2 nm intervals	
	F0	2 nm intervals	
	Lwn	2 nm intervals	
	FLUOR(z)		all
	BETA_BLUE(z)		all
	BETA_RED(z)		all
SUBSET FILES			
surface_subset.txt	AVG_ES (i.e. Es(0+))	subset	surface
	Lwn	subset	surface

UNDERWAY MODE			
File Type	**Parameters**	**Wavelengths**	**Time Intervals**
ASCII FILES			
Es_L2s.dat	Es(t)	all	2 s
Es_L3a.dat	Es(t)	2 nm intervals	2 s
L4.dat	Es(0-) average	2 nm intervals	average
	Es(0+) average	2 nm intervals	average
	PAR(0+)(t)	N/A	2 s
SUBSET FILES			
underway_subset.txt	PAR(0+)(t)	N/A	2 s

DARK MODE (ECO PUC)		
File Type	**Parameters**	**Time Intervals**
L1a.hdf	BETA_BLUE (dark counts)	2 s
	BETA_RED (dark counts)	2 s
	FLUOR (dark counts)	2 s

Appendix I: Parameters

Wt, Tw	water temperature	
cond	conductivity	
cond_ratio		
salinity	salinity	
density	density	
Sigma-T	Sigma-T	
tilt	degrees of profiler from vertical	
pvel	velocity	
Ed	downwelling irradiance (in water)	
Lu	upwelling radiance (in water)	
Es	reference sensor downwelling irradiance (above water)	
K_LU(z)	diffuse attenuation coefficient for Lu	derived from Lu
K_Ed(z)	diffuse attenuation coefficient for Ed	derived from Ed
Ed(0+)	Ed just above the surface	derived from Ed
Ed(0-)	Ed just below the surface	derived from Ed
Es(0-)	Es just below the surface (representative)	derived from Es
Es(0+)	Es just above the surface (representative)	derived from Es
Lu(0-)	Lu just below the surface	derived from Lu
Lw, Lu(0+)	Lu just above the surface	derived from Lu
Lwn	normalized water leaving radiance	derived from Lw and F0/Es
FLUOR	fluorescence at 695 nm	
BETA_BLUE	470 nm	
BETA_RED	700 nm	
PAR(z)	PAR	derived from Ed
PAR(%)(z), LightLevel	percentage of PAR relative to the surface	derived from Ed and PAR(0+)
PAR(0+)	PAR just above the surface	derived from Es
KPAR(z)	Instantaneous diffuse attenuation coefficient for PAR	derived from PAR(z) and PAR(0+)
B(λ)	total volume scattering	measured
Bw(λ)	water volume scattering	derived from salinity
Bp(λ)	particle volume scattering	derived from B and Bw
bbp(λ)	particle backscattering coefficient	derived from Bp
bb(λ)	total backscattering coefficient	derived from bbp