# ISUSCal

# The Satlantic ISUS Coefficient File Manager

# Users Guide

**Version 2.0**

# 1. Introduction

The Satlantic ISUS Coefficient File Manager (**ISUSCal**) is a software utility to be used in conjunction with Satlantic's ISUS Nitrate Sensor. ISUSCal allows the user to update the ISUS instrument coefficient file and thereby ensure up-to-date instrument calibration.

ISUS users should check instrument performance periodically and before critical deployments to ensure instrument accuracy is optimized. We recommend users measure the nitrate concentration in ultra-clean de-ionized water (DIW) to ensure the ISUS measures $0 \pm 2$ µM $NO_3^-$. It is very important to make sure there are no air bubbles on the probe lenses when measuring the DIW samples. The most common source of error when testing an ISUS instrument in bench top mode is the formation of bubbles on the probe tip. If the instrument does not read $0 \pm 2$ µM $NO_3^-$, we strongly recommend removing the sample, cleaning the tip and replacing the sample ensuring no bubbles cling to the lens surfaces. If the instrument still does not measure the expected value, some instrument drift may have occurred over time, and an update of the coefficient file may be required.

The ISUSCal program enables the user to create ISUS coefficient files in an easy and straightforward manner.

To create a coefficient file, two basic steps are required:

1. Collect reference spectra with SatView
2. Create updated coefficient file with ISUSCal

The created coefficient file can then be uploaded to the ISUS instrument flash memory or used for data post-processing. When a new coefficient file is created and uploaded, we recommend that users do a reality check with a water sample of known salinity and nitrate concentration. This water sample can be prepared in a laboratory or one could use *in situ* measurements. It is recommended to use a water sample with the highest expected nitrate concentration (e.g. for measurements in ocean one could use a sample with nitrate concentrations somewhat higher than 30 µM).

# 2. Software Installation

ISUSCal is available as a Microsoft Windows NT 4.0, Windows 2000 or Windows XP application and is supplied as a single self-extracting install program on CD-ROM or for download from Satlantic's website (www.Satlantic.com). Before installing the program, make sure no other version of ISUSCal is installed. Otherwise, first uninstall the previous version. To install ISUSCal from CD, insert CD into a CD drive and start the setup program. This can be done in Windows Explorer, or by selecting "**Run...**" in the "**Start**" menu and typing "**D:\ISUSCal_<version.number>_Installer.exe**". (The CD drive letter may be different from D.) Follow the instructions on the screen. To install ISUSCal from the self-extracting install program, download the file and open it in Windows Explorer or through the Start menu as described above.

The ISUSCal software is written in the MatLab programming language, and requires the MatLab Runtime Component (MRC) for execution. The MRC is provided on CD or is available for download from Satlantic's website.

# 3. Coefficient File Generation

## *3.1 Collecting Reference Spectra*

Ensure that the probe tip is clean and not damaged in any way. Use KIMWIPES and isopropyl alcohol to clean the probe tip. Place the ISUS instrument on a bench, start it (see ISUS manual for details) and let it warm-up for at least 30 minutes. The warm-up period is required to achieve relative stability of the ISUS internal temperature.

Using a clean cup (or vial or test-tube), submerse the probe tip in ultra-clean de-ionized water (DIW). Ensure that there are no bubbles on the probe lens. Using SatView, log the reference DIW spectra for about three minutes into a RAW file. Stop ISUS.

Note that during the whole warm-up period and subsequent DIW log, the ISUS will automatically log the data internally into one of the "Divexxx.dat" (xxx stands for a file number) files. If you are not able to use SatView, the respective Divexxx.dat file can be downloaded from the instrument and used as the reference file. Note that in both cases, ISUSCal will use the last 24 frames of the Reference file to calculate an average reference spectrum.

## *3.2 Generating Coefficient File*

Starting the ISUSCal program, for example via a double click on the ISUSCal shortcut, will open the graphical user interface (GUI) as shown in Figure 1. The user must fill the five input fields in order to generate a new coefficient file.

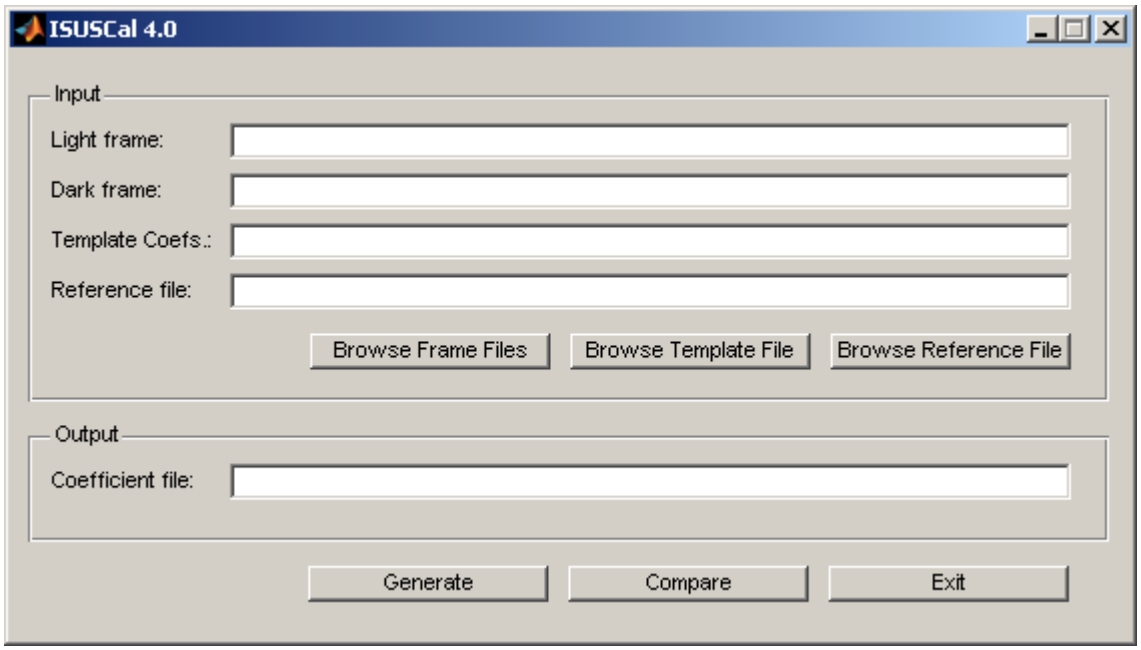


**Figure 1: ISUSCal GUI at startup.**

ISUS data are generated in telemetry frames. Their format is specified in telemetry frame description files matching the ISUS instrument. These files are provided on the CD that comes with the ISUS instrument. Depending on the ISUS frame mode, the default file names are `ISUSnnnnNLF.TDF` and `ISUSnnnnNDF.TDF` files (ASCII telemetry frames) or `ISUSnnnnNLB.CAL` and `ISUSnnnnNDB.CAL` files (BINARY telemetry frames). Here `nnnn`

is the serial number of the instrument, and the letter ‘N’ stands for Satlantic’s family of nitrate sensors. The letters ‘D’ and ‘L’ stand for ‘dark’ and ‘light’ frames, respectively. The file names can be browsed for using the “Browse Frame Files” button (highlight both files) or entered by hand in the text boxes.

Secondly, an existing coefficient file is needed. This file is present on the ISUS instrument, and can be downloaded from the instrument to the computer. (See the ISUS manual for details.) Depending on the ISUS instrument version, the file will be named `ISUSnnn$.CAL` (Version 1) or `ISUSnnn$.ECF` (Version 2). Again, `nnn` is the serial number of the instrument, and ‘ $‘ is a letter between A and Z. The letter indicated the version of the coefficient file, with A being the first version. If there is more than one coefficient file on the ISUS instrument, it will use the coefficient file with the highest version letter. Thus, for upload of the new coefficient file, a letter one above the currently highest on the instrument should be used.

When using the “*Browse*”-button to enter the template coefficient file, the ISUSCal software will generate a suggested output coefficient file name. The user is free to change this name.

Lastly, the file containing the reference spectra has to be given, either selected via the “*Browse Reference File*” button or by typing the name in the text box. The reference file is either a file collected using Satlantic’s SatView software, or a DIVE-file, that is recorded on the ISUS instrument. In any case, the ISUSCal software will average the last 24 spectra of the selected file.

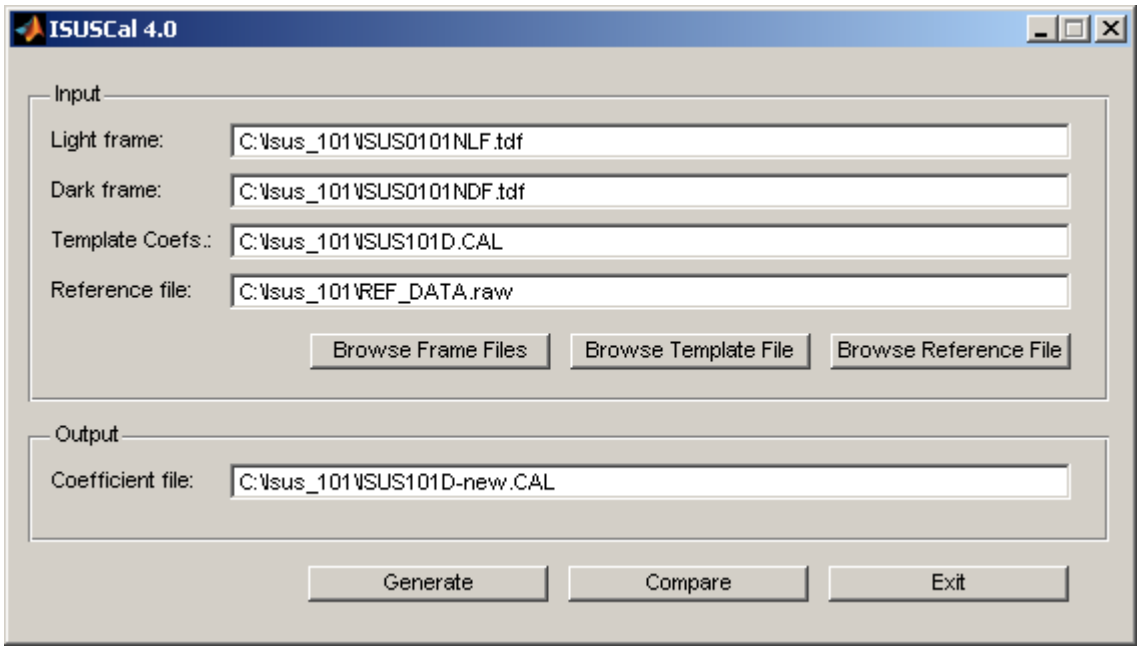


**Figure 2: ISUSCal GUI with example input and output file names.**

After specifying the input files, pressing the *“Generate”* button will create the new coefficient file.

The ISUSCal program provides a built-in tool to compare different coefficient files, which must reside in one folder. Browse that folder by pressing the *“Compare”* button, and highlight all coefficient files to be compared. ISUSCal will plot the reference spectra of all selected coefficient files.

# 4. Verification of Coefficient File

## *4.1 Checking Reference Spectrum Against a DIW Sample*

The procedure for verifying the new coefficient file essentially repeats the steps taken to acquire the reference spectrum.

Ensure that the probe tip is clean and not damaged in any way. Use KIMWIPES and isopropyl alcohol to clean a probe tip. Start the ISUS and let it warm-up about 20 minutes if it has not been warmed up already. Then submerse the probe tip in a sample of ultra-clean DIW and monitor the nitrate concentration values using either HyperTerminal or SatView.

If the nitrate values deviate from 0 µM by more than +/- 2 µM, collect a new reference spectra file as described in the section "Collect Reference Spectra". Then create a new coefficient file as described in the section "Generate Coefficient File". Upload the respective coefficient file onto an ISUS and repeat the current step.

## *4.2 Checking Accuracy Using a Seawater Sample of Known Concentrations*

The accuracy check requires a seawater solution with known nitrate and salinity values.

Again, it is important to have a clean and dry probe tip. After approximately twenty minutes of warm-up of the ISUS, submerse the probe tip into the prepared seawater standard.

Using HyperTerminal or SatView, monitor the nitrate concentration values. The ISUS nitrate concentrations should not deviate from the expected value by more than +/- 2 µM.

# A. Appendix: Coefficient File Format

An ISUS coefficient file is a comma separated ASCII data file with meta-data and data lines. Meta-data lines begin with the letter “H”, followed by a comma and then the meta-data. Data lines begin with the letter “E”, also followed by a comma and the data.

Depending on the ISUS version, there are two types of coefficient files. ISUS Version 1 coefficient files are named ‘ISUSnnn$.CAL’, ISUS Version 2 files are named ‘ISUSnnn$.ECF’.

## *A.1 File Version 1*

The version 1 coefficient files consist of a meta-data section followed by a data section. The meta-data section consists of a variable number of lines, the data section contains one line for each of the 256 channels of the ISUS spectrometer. Each data line contains 5 comma-separated columns. The columns are labeled in the meta-data line just before the data lines begin:

1. WaveLen Wavelength in nm
2. ESW Salinity extinction coefficient at this wavelength.
3. ENO3 Nitrate extinction coefficient at this wavelength.
4. E3 A third extinction coefficient at this wavelength.
   Depending on the origonal instrument calibration,
   the values in this column may be zero or not.
5. DIW An average reference spectrum of de-ionized water.
   The ISUSCal program updates this column.

```
H,22-Jan-2004,,,,
H,Satlantic Version 023 ISUS,,,,
H,Salinity psu from regression,,,,
H,Nitrate uM,from regression,,,
H,ResidualAbsorbanceBaseLine1,,,
H,Average Reference ,,,,
H,WaveLen,ESW,ENO3,BL1,DIW
```

| | | | | | |
|---|---|---|---|---|---|
| E, | 189.6954069, | 0.00000000, | 0.00000000, | 0.0000000, | 6301.33016365 |
| E, | 190.4873070, | 0.00163646, | 0.00074221, | 0.0000000, | 7141.69386103 |
| … | … | … | … | … | … |
| E, | 394.2479665, | 0.00000000, | 0.00000000, | 0.0000000, | 4202.08010918 |

## *A.2 File Version 2*

In the ISUS version 2, an extended coefficient file is used. This file version contains, in addition to the data in file version 1, also so-called inverted coefficients that are used for the instrument internal calculations. Rather than performing the inversion in the instrument, that time consuming calculation is done once, and then used.

The file format is like the format of a version 1 file, with a number of lines appended. First, a variable number of meta-data lines, describing the inverted data, are given. Then a number of data lines follow, beginning with the letter “E” followed by a comma, and then followed by six (instead of, as before, five) columns of data.