Sound Speed Manager

Release 2024.0.0

CCOM/JHC,UNH & CSDL,NOAA

Feb 10, 2024

CONTENTS

1 In Brief 1

2 User manual 5

3 Developer's guide 97

4 SSM-SIS app 101

5 License 105

6 Credits 111

CHAPTER

ONE

IN BRIEF

The Sound Speed package is part of the HydrOffice framework. HydrOffice is a research development environment for ocean mapping. It provides a collection of hydro-packages, each of them dealing with a specific issue of the field. The main goal is to speed up both algorithms testing and research-to-operation (R2O).

The Sound Speed package provides both a library and an application with functionalities to manage sound speed profiles, and to provide pre-processing ocean mapping tools to help bridge the gap between sound speed profiling instrumentation and multibeam echosounder acquisition systems.

It has been developing with the aim to merge together functionalities present in several applications that process sound speed profiles (SSP) for underwater acoustic systems:

- *Velocipy*, an application originally developed at the NOAA Coast Survey Development Laboratory (CSDL) as part of the Pydro environment.
- *SVP Editor*, an application originally developed at the Center for Coastal and Ocean Mapping (CCOM, UNH) for the MAC project (Multibeam Advisory Committee) under the NSF grant 1150574.
- *SSP Manager*, an application developed at the Center for Coastal and Ocean Mapping (CCOM, UNH) as part of the HydrOffice framework under NOAA grants NA10NOS4000073 and NA15NOS4000200.

In the integration of all these implementations to the current package several improvements have been introduced to enhance code maintainability (e.g., Python 3 support) and to store the collected data for further processing and analysis.

The current development of Sound Speed Manager is partially supported by:

- NOAA grant NA20NOS4000196, and
- NSF grant 1933720.

1.1 Operation modes

Currently, the hydro-package can operate in two mutually exclusive operation modes:

1. *Operator Mode*
2. *Synthetic Profile Server Mode*

The *Operator Mode* represents the primary mode, and it is used to convert data from different source formats, to graphically edit them, and to export/send the resulting profiles for use by underwater acoustic systems. Optional steps are the augmentation with measurements from a reference cast (to either improve salinity modeling or extrapolate the cast to the required depth), either manually specifiying a loaded profile as reference cast, or deriving the reference from oceanographic models (currently, WOA09, WOA13, WOA18 and RTOFS) as described in *Appendix A - Oceanographic Atlases*.

The *Synthetic Profile Server Mode* was developed to deliver WOA/RTOFS-derived synthetic SSPs to one or more network clients in a continuous manner, enabling opportunistic mapping while underway. Given the uncertainty of such an approach, this mode is expected to only be used in transit, capturing the current position and using it as input to lookup into the selected oceanographic model.

1.2 Currently implemented features

- Import of several commonly used sensor/file formats:
  - AML (.csv)
  - AOML AMVER-SEAS XBT (.txt)
  - CARIS (.svp)
  - Castaway (.csv)
  - Digibar Pro (.txt), and S (.csv)
  - ELAC Hydrostar (.sva)
  - Hypack (.vel)
  - Idronaut (.txt)
  - ISS Fugro (.svp, .v*, .d*)
  - Kongsberg Maritime (.asvp)
  - Rolls-Royce Moving Vessel Profiler (MVP) (.asvp, .calc, .m1, .s12)
  - Oceanscience Underway CTD (.asc)
  - SAIV (.txt)
  - Sea&Sun (.tob)
  - Seabird (.cnv)
  - Sippican XBT, XSV, and XCTD (.EDF)
  - Sonardyne (.pro)
  - Turo XBT (.nc)
  - University of New Brunswick (.unb)
  - Valeport Midas, MiniSVP, Monitor, RapidSVT, and SWiFT (.000, .txt, .vp2)

- Network reception of data from:
  - Kongsberg Maritime SIS4 and SIS5
  - Basic NMEA 0183 streams (only GGA and GLL)
  - Sippican systems
  - Moving Vessel Profiler (MVP) systems
- Data visualization and interactive graphical inspection (e.g., outlier removal, point additions) of sound speed, temperature and salinity profiles
- Use of the World Ocean Atlas of 2009/2013/2018 (WOA09/13/18) and Real-Time Ocean Forecast System (RTOFS) for tasks such as:
  - Salinity augmentation for Sippican XBT probes
  - Temperature/salinity augmentation for Sippican XSV probes and SVP sensors
  - Vertical extrapolation of measured profiles
  - Creation of synthetic sound speed profiles from the model of choice
- Augmentation of sound speed profile surface layer with measured surface sound speed (from Kongsberg SIS or manually)
- Designation of a reference profile, for example from a deep CTD, for use in tasks such as:
  - Salinity augmentation for Sippican XBT probes
  - Temperature/salinity augmentation for Sippican XSV probes and SVP sensors
  - Vertical extrapolation of measured profiles
- Export of several file formats:
  - Caris (.svp) (V2, multiple casts supported)
  - Comma separated values (.csv)
  - ELAC Hydrostar (.sva)
  - Hypack (.vel)
  - iXBlue (.txt)
  - Kongsberg Maritime (.asvp, .ssp and .abs)
  - NCEI (.nc)
  - QPS (.bsvp)
  - Sonardyne (.pro)
  - University of New Brunswick (.unb)
- Network transmission of processed casts to data acquisition systems (see *Appendix B - Connection Settings*):
  - Kongsberg Maritime SIS4 and SIS5
  - QPS QINSy
  - Reson PDS2000
  - Hypack
- Persistent storage of collected SSP data in a SQLite database
- Survey data monitoring (see *Survey Data Monitor*)

1.3 Compared Functionalities

Functionality	Sound Speed Manager	Velocipy	SSP Manager
Input of Kongsberg format	**x**	**x**	
Input of OceanScience format	**x**	**x**	
Input of Seacat serial data	**x**	**x**	
Output of NCEI format	**^**	**x**	
Output of QPS format	**x**	**x**	
Support of WOA13 atlas	**x**	**x**	
Data filtering/smoothing	**x**	**x**	
DQA analysis	**x**	**x**	
Calculation of profile statistics	**x**	**x**	
Input of Digibar Pro format	**x**	**x**	**x**
Input of Idronaut format	**x**		**x**
Input of Fugro ISS format	**^**		**x**
Input of SAIV format	**x**		**x**
Input of Turo format	**x**		**x**
Input of Valeport format	**^**		**-**
Output of Elac format	**x**	**x**	**x**
Output of iXBlue format	**x**		**x**
Output of Sonardyne format	**x**		**x**
Output of UNB format	**x**		**x**
Retrieval of current SIS profile	**x**		**x**
Retrieval/View/Use of SIS data	**^**		**x**
SIS data view	**x**		**x**
Portable profiles database (SQLite)	**x**		**x**
Export to geospatial formats	**^**		**x**
Multiple setups	**x**		**x**
HTML/PDF manuals	**x**		**x**
Public stand-alone installer	**x**		**x**
Synthetic Profile Server mode	**x**		**x**
Output of Kongsberg format	**^**	**x**	**x**
Input of AML format	**x**		
Input of AOML format	**x**		
Input of Caris format	**x**		
Input of ELAC format	**x**		
Input of Hypack format	**x**		
Input of Sonardyne format	**x**		
Automated processing steps	**x**		
Data management for multiple projects	**x**		
Surface sound speed monitoring	**x**		
Cast timing based on past data	**x**		

Symbols: **x** = *New functionality*; **-** = *Basic functionality*; **^** = *Improved functionality*

CHAPTER

TWO

USER MANUAL

2.1 Installation

2.1.1 Installation using the Pydro distribution

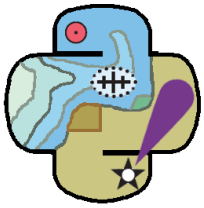

Fig. 2.1: The Pydro logo.

If you are on Windows, you can easily install Sound Speed Manager as part of the NOAA Office of Coast Survey Pydro distribution.

Pydro is a suite of software tools used to support hydrography. It is (almost exclusively) built from open source components as well as public domain custom developed software. Pydro is maintained by Hydrographic Systems and Technology Branch (HSTB) to support NOAA operations (aiding Office of Coast Survey fleet) and is made available for public use.

You can download the latest Pydro installer from here.

2.1.2 Installation as stand-alone Python package

If you decide to install the package in a Python environment, the dependencies are:

- basemap
- gdal
- gsw *(version == 3.0.6)*
- matplotlib
- pillow
- netCDF4
- numpy
- scipy
- pyproj

- pyserial
- PySide2 *(only for the application)*

If you want to install the last stable version (from PyPI):

- *pip install hyo2.soundspeed*

Or, if you prefer the bleeding edge code:

- *pip install https://github.com/hydroffice/hyo2_soundspeed/archive/master.zip*

2.1.3 Supplemental Data Space Requirements

Approximately 500 MB of additional disk space is required for the WOA09 db set optionally required (but warmly suggested) by this hydro-package. If not available, the package will attempt to download it.

Among other improvements, the WOA13 and WOA18 dbs provide a much better spatial resolution, but this comes with a much larger data size (~18 GB).

Alternatively, it is also possible to adopt a manual installation procedure:

- Manually download the zip files from https://www.hydroffice.org/soundspeed/.
- Unpack the atlas data sets at any path that SSM can have access to.
- Modify the configuration file to point to the correct root path (see *Possible Configurations*).

By default, SSM looks for databases at:

- "C:/Documents and Settings/**<username>**/Application Data/HydrOffice/Sound Speed/atlases/**[woa09|woa13|woa18]**" (Windows XP), or
- "C:/Users/**<username>**/AppData/Local/HydrOffice/Sound Speed/atlases/**[woa09|woa13|woa18]**" (newer Windows OS)

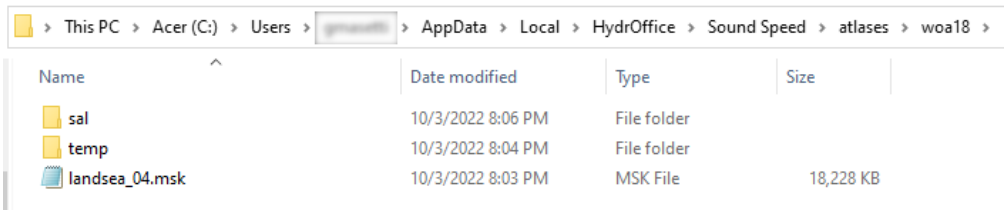

Fig. 2.2: The default location and internal structure of the WOA18 folder on recent Windows OS.

For the manual installation, when the atlas is composed of multiple zip files (e.g., WOA18), the file content needs to be unzipped under the same folder (e.g., Fig. 2.61).

Note: If a previous version of the application was installed, *Sound Speed Manager* will try to localize past installations of WOA databases (WOA09, WOA13 and WOA18).

2.2 Setup

2.2.1 Possible Configurations

Given its specific aim, *Sound Speed Manager* is usually installed to run in one of two configurations:

On the machine used for sound speed profile acquisition

This represents a quite common choice since many of the operations accomplished in the software are typically done immediately after acquisition of a cast.

If the machine is on the same network as the multibeam acquisition workstation, the processed profile can be directly delivered via network.

When this is not possible, the package can export the processed data to files that can then be manually uploaded to the multibeam workstation.

On the multibeam acquisition workstation

This configuration is particularly useful when it is anticipated that the software will run in *Server Mode*. In fact, it is important that multibeam watch standers are able to monitor the server, and to disable it in the event that a measured profile is to be uploaded.

2.2.2 Upgrading

It is possible to copy configuration settings from a previous installation. When a new installation is performed, the user is prompted (see Fig. 2.3) to select existing configuration settings (if any).

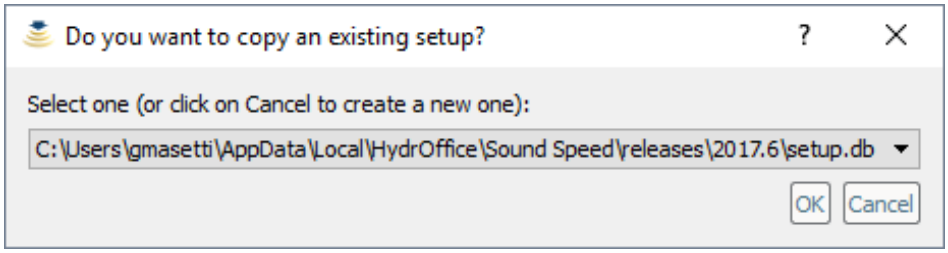

Fig. 2.3: Select the desired setup and click on the *OK* button to copy an existing setup.

2.2.3 Application Settings

In the *Sound Speed* release data folder, you can find a configuration file: `setup.db`.

This SQLite database file has to be modified to reflect the chosen software deployment and environment-specific configuration settings (e.g., the SIS IP address and ports).

Use the *Setup* tab to view the available configuration options in the database. If you want to modify them, click on the 'Lock/Unlock' button (Fig. 2.4).

Warning: If you want to use the RTOFS data, Internet (and the port 9090) must be accessible from the machine in use.

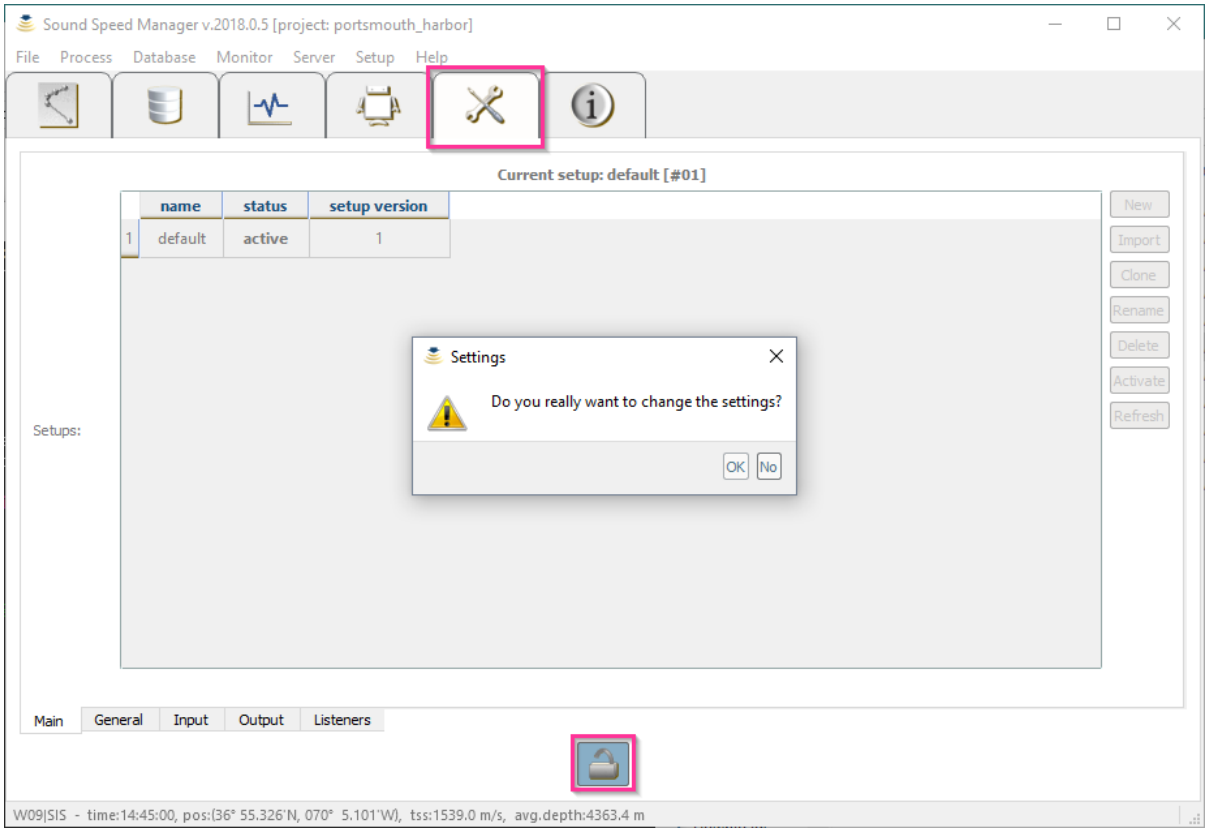

Fig. 2.4: When unlocking, you will be asked to confirm that you want to modify the setup.

NOAA Tools Flag

For NOAA field, it is recommended to turn on the *NOAA tools* flag in the *General Settings* tab.

Currently, the *NOAA Tools* flag is mainly used for NCEI format output. When NOAA tools flag is on:

- In the *Setup* tab, the default institution is not editable.
- In the *Metadata* dialog, the vessel name is not editable
- During NCEI files exporting, the NOAA-specific project naming format is enforced.

Note: This flag is *True* by default when the setup is created withing Pydro.

2.2.4 Sound Speed Manager - SIS v4 interaction

As with any communication between any software, whether it is on the same computer or between different computers on a network, some setup is required. For SIS and Sound Speed Manager, all communication is done across User Datagram Protocol (UDP). UDP on the same windows-based computer requires port numbers; UDP across a network requires both IP addresses on the network and port numbers from each computer. *The easiest way to find this information for a given computer is by typing "ipconfig" into a windows command prompt, and note the IPv4 Address.*

In order for Sound Speed Manager to automatically interact with *Kongsberg SIS*, some initial configuration are required on the *SIS* side to make it to broadcast a specific subset of datagrams that can then be interpreted by the *SSP* hydro-package (identification codes in parentheses):

- **Position** ('P', 80, 0x50): for retrieving current date and position
- **Sound Speed Profile** ('U', 85, 0x55): checking whether a SSP transmission was successful
- **XYZ88** ('X', 88, 0x58): to retrieve:
  - The surface sound speed (used in beam forming and steering) and the transducer draft (both used when augmenting SSPs with the measured surface sound speed value).
  - The depth (to estimate the approximate water depth). This is used in the sound speed, temperature and salinity plots to help the user appreciate the minimal depth to which the profiles should be extended.

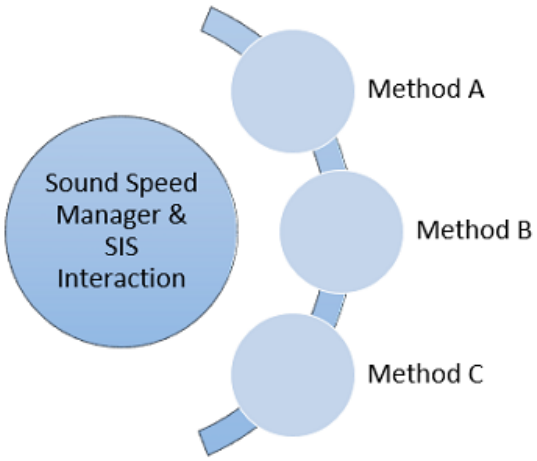

Fig. 2.5: *Kongsberg SIS v4* can be configured to broadcast datagrams in three different ways as discussed in Methods A, B, and C.

Method A: Sound Speed Manager and SIS v4 Installed on the same Computer

This method is usually used for the case where *Sound Speed Manager* and *SIS* are installed on the same machine. However, this method may not be suitable if this mechanism is already in used by another program. In such a case, the *DataDistrib.exe* program explored in *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager* should be attempted.

The configuration for this method is actually quite simple:

- Open *SIS*, do not "Ping"
- Under the *Installation Parameters* Tearoff, in *PU Communication Setup, Output Setup*
  - Choose *User Defined* from the *UDP Host Port* dropdown menu
  - Note the Port Address (the Display Port Address is used during the Sound Speed Manager Setup)
  - Select the following datagrams: Depth, Position, and Sound Speed Profile
  - Click the *OK* button on the top left of the *Installation Parameter* Tearoff and close the window
- Access the *Installation Parameters* dialog (see Fig. 2.6) from the *View* menu by choosing *Tear off* and then *Installation Parameters*

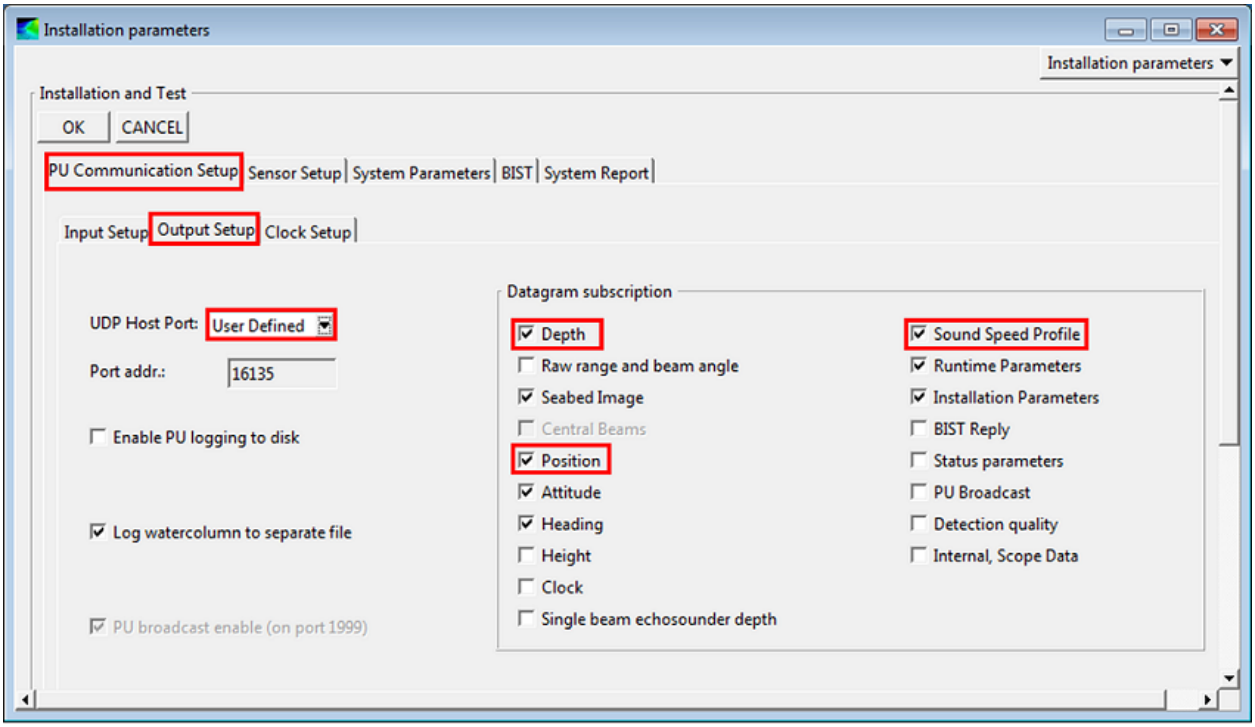

Fig. 2.6: *SIS Installation parameters* dialog, with key settings in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

- On the main SIS screen, start *Pinging*
- Open Sound Speed Manager, and open the *Setup Tab*, and unlock settings editing
  - Under *Output*, you can leave the client list set to default, or create a new client with IP = 127.0.0.1, port = 4001, and protocol = SIS (see Fig. 2.7). These settings will tell Sound Speed Manager that SIS is on the same computer, and to send the CTD cast data to port 4001 (KM default).

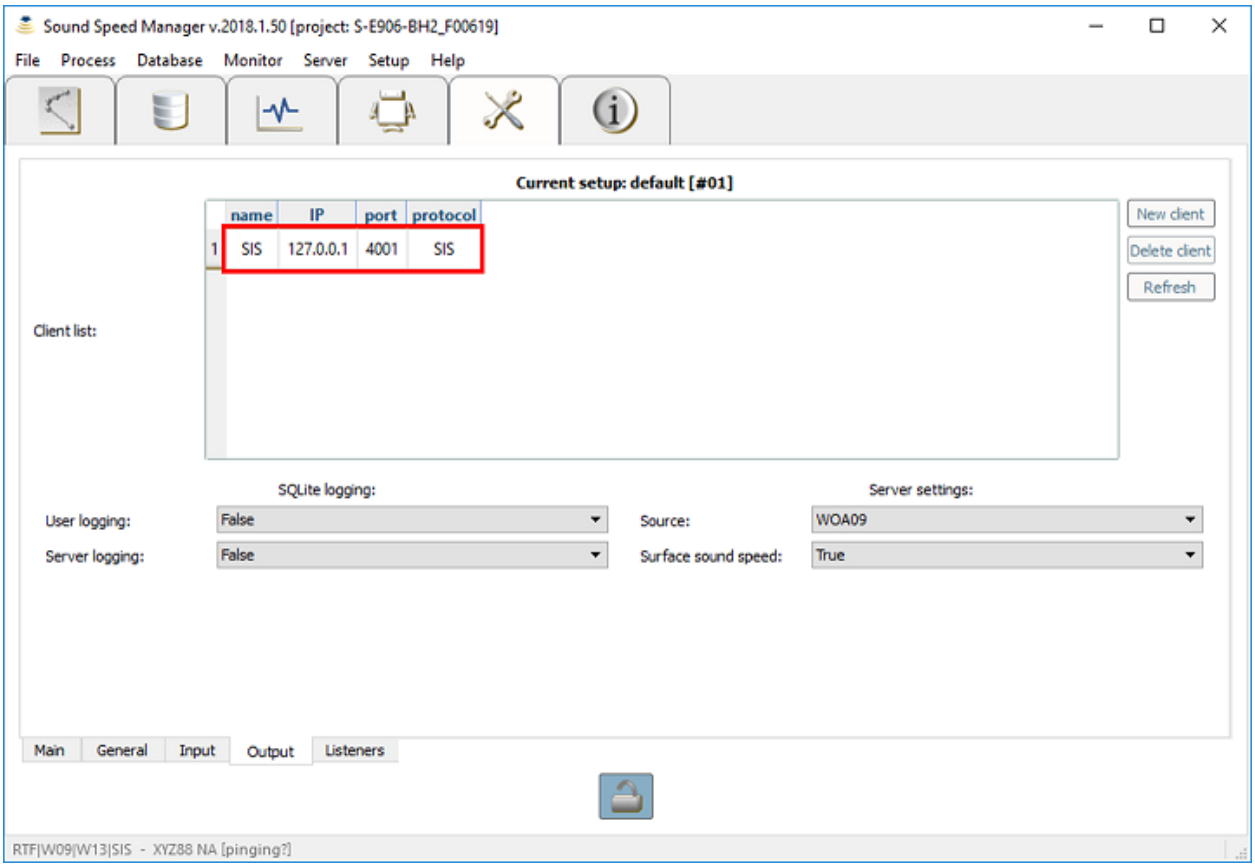

Fig. 2.7: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

- Under *Listeners*, in the *Listen port*, enter the Port Address noted from the *User Defined UDP Host Port* in SIS. This will allow SIS to send a received CTD cast message to Sound Speed Manager, and well as real time data including time, position, surface sound speed, and average depth (see Fig. 2.8).

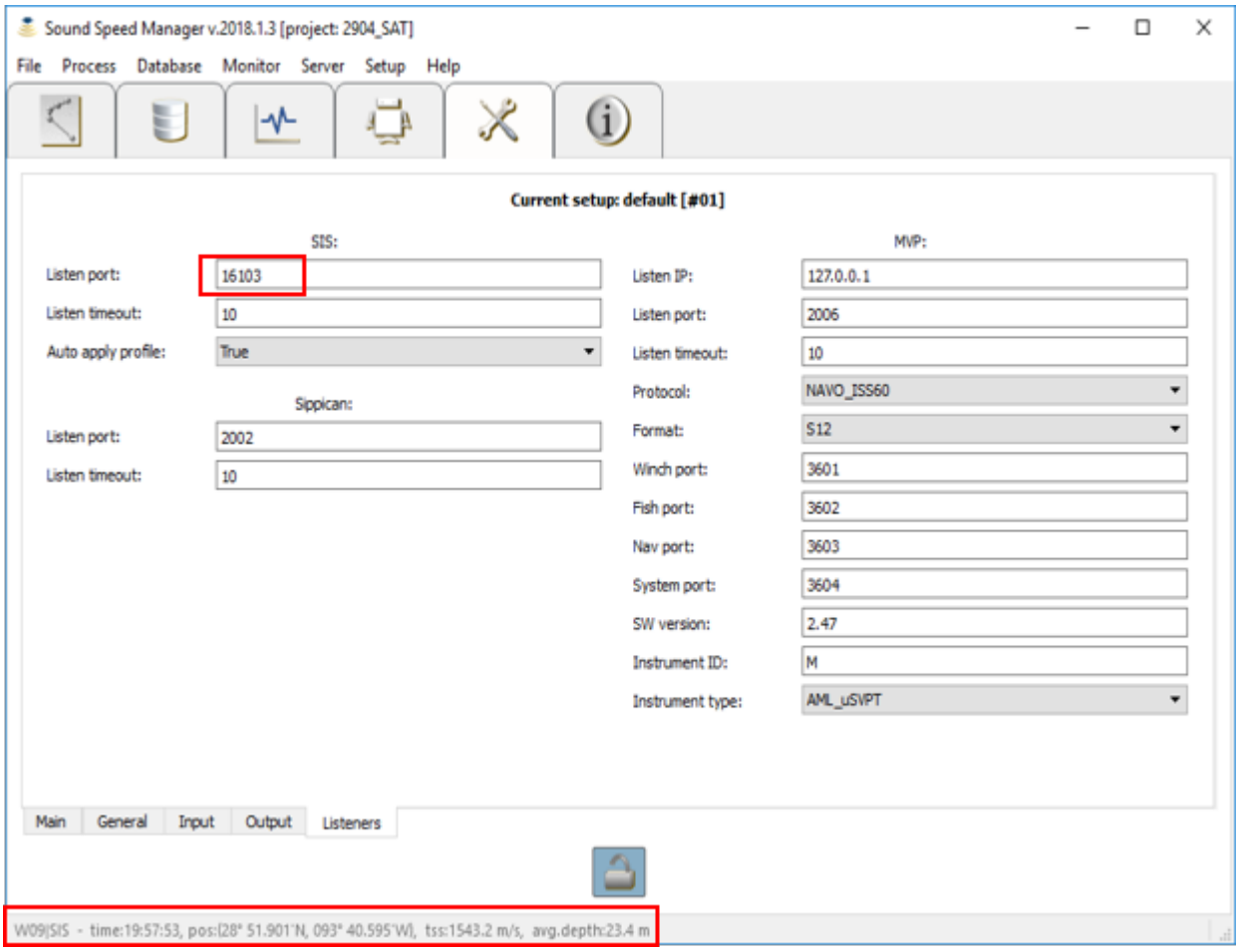

Fig. 2.8: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming SIS data highlighted in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

Note: The surface sound speed and depth will only update if the echosounder is pinging (since the surface sound speed information can only be extracted when *Sound Speed Manager* receives the depth datagram).

You will now be able to send a sound speed profile from Sound Speed Manager to SIS and receive a receipt message (see Fig. 2.9), and see the SIS-received information displayed in the status bar.

Note: The value of the *User Defined UDP* port in *SIS* cannot be modified.

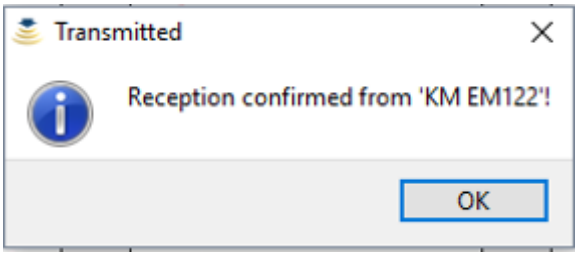

Fig. 2.9: *Sound Speed Manager SIS Receipt* dialog.

Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network

This method is more general, and it can be used for data transmission to other computers on the network (by specifying IP address and port, as well as transmission rate).

- In *SIS*, from the *Tools* menu, choose *Custom...* and then *Datagram Distribution* (see Fig. 2.10).
- Choose the datagram from the drop down menu, starting with *Position (P)*.
- Type in the IP address (e.g. 192.168.0.100) of the remote machine where Sound Speed Manager is installed, immediately followed by a colon (:), then the port number (e.g. 16103) that the data should be delivered to on the remote machine: e.g., Entire address: `192.168.0.100:16103`.
- Click the *Subscribe* button.
- Repeat Steps 2-4 for the *SVP (U)* and the *XYZ88 (X)* datagrams.
- With Sound Speed Manager open, go to the *Setup Tab*, and unlock setting editing (see Fig. 2.11).
  - In *Output*, create a new Client. Enter the SIS computer IP Address, use default port "4001", and protocol "SIS". Sound Speed Manager will send your cast from the acquisition computer, to this SIS connection.

Note: Local test should be removed from the Client list if you add an additional Client. Otherwise, this will cause a failed receipt message.

- Under Listeners, in the Listen port, enter the Port Address noted from Request datagrams from EM and the Enter the Listen port number (e.g. 16103). This is where Sound Speed Manager will be receiving messages from (see Fig. 2.12).

Note: The surface sound speed and depth will only update if the echosounder is pinging (since the surface sound speed information can only be extracted when *Sound Speed Manager* receives the depth datagram).

You will now be able to send a sound speed profile from Sound Speed Manager to SIS and receive a receipt message (see Fig. 2.13), and see the SIS-received information displayed in the status bar.

Note: *SIS* needs to be restarted for the changes to take effect. Furthermore, since the software does not seem to validate user inputs, mistakes made cannot be easily discovered and undone (unsubscribe).

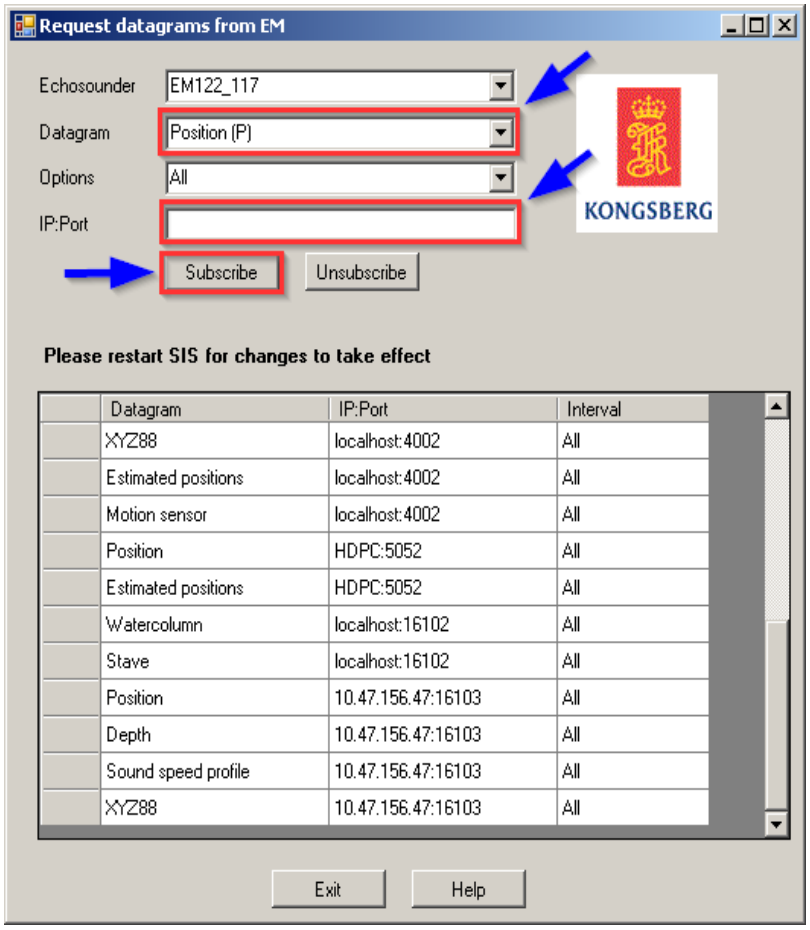

Fig. 2.10: *Request Datagrams from EM* dialog, with key settings in red for *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*.

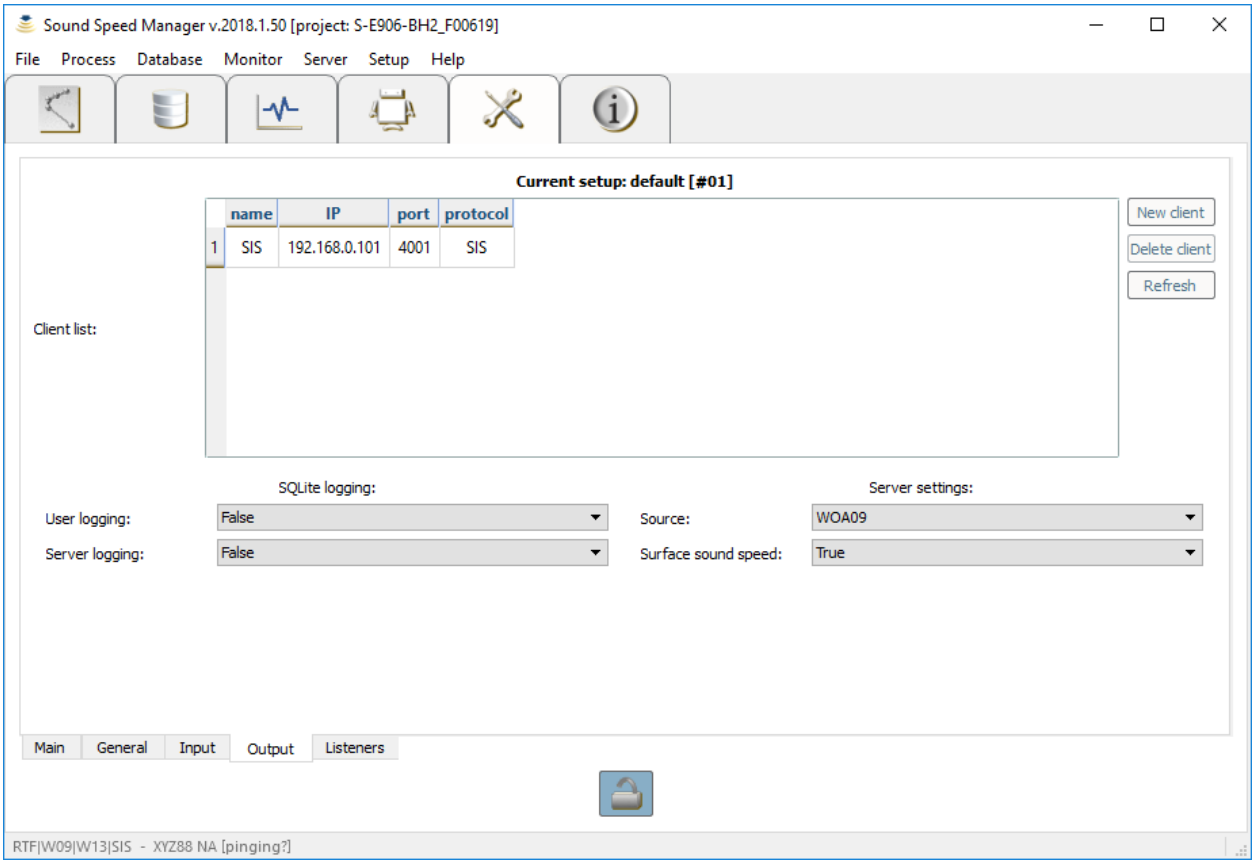

Fig. 2.11: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*.

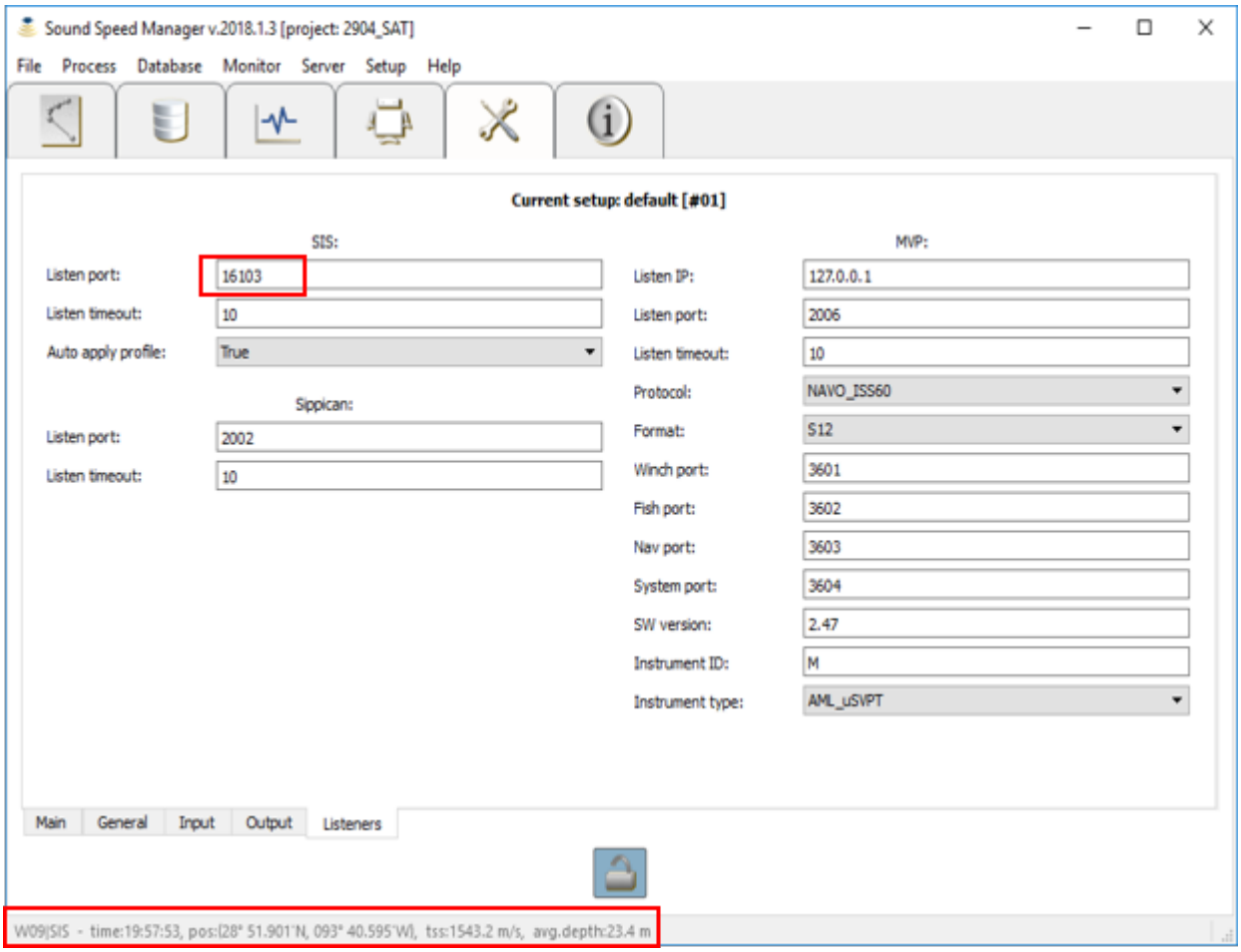

Fig. 2.12: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming SIS data highlighted in red for *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*.

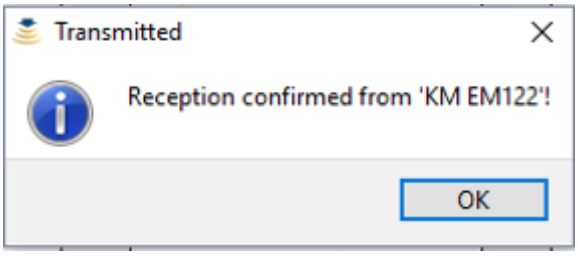

Fig. 2.13: *Sound Speed Manager SIS Receipt* dialog.

Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager

This method is required when multiple software packages need to receive data from SIS v4, and it represents an extension of the previous two methods. **Methods A and B are not required in addition to Method C.** SIS v4 uses a standalone program, named *DataDistrib.exe*, bundled with SIS and usually installed in "C:/Program Files/Kongsberg Maritime/SIS/bin" (together with a configuration file "DataDistrib.ini" with all the subscriptions).

It is suggested to add the *DataDistrib.exe* to the *Startup* menu of the computer, in Windows OS (so that it is automatically started). However, common backsides of this method is that the executable can be accidentally closed (stopping the data distribution to this package), or it can accidentally runs twice corrupting the configuration file (to prevent this, it could be made "read only").

Because *Sound Speed Manager*, *SIS*, and *Data Distribution - MDM 400* are on different computers within a network, we have to know the IP Addresses of each computer. The easiest way to find this information for a given computer is by typing "ipconfig" into a windows command prompt, and note the IPv4 Address. With this information, we can tell Sound Speed Manager where to send our sound speed profile.

The setup of this method is summarized as follows:

- In Sound Speed Manager, Setup, Output, unlock settings editing, and add a new Client.
  - Give the Client a name, enter the SIS computer IP Address, use default port "4001", and protocol "SIS". Sound Speed Manager will send your cast from the acquisition computer, to this SIS connection (see Fig. 2.14). Note: Local test should be removed from the Client list if you add an additional Client. This will caused a failed receipt message.

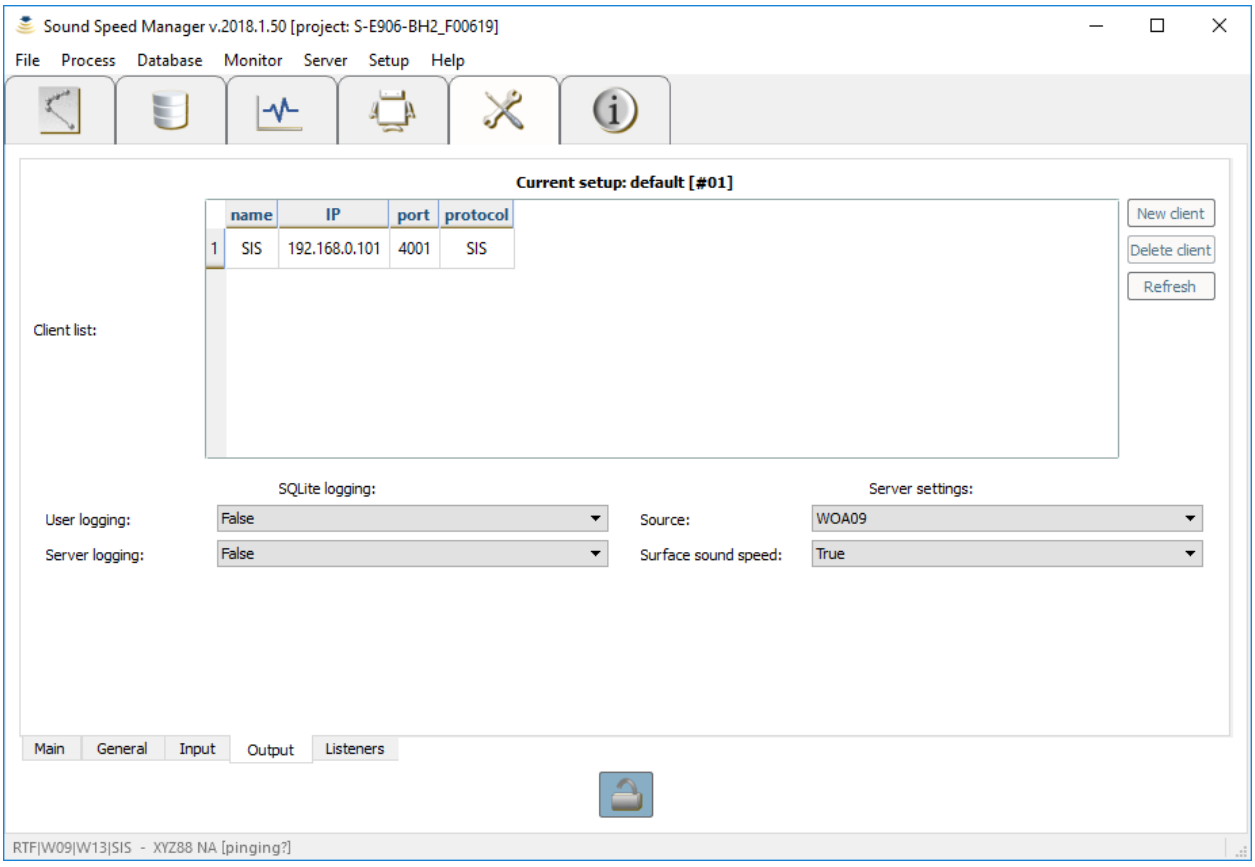

Fig. 2.14: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

- In *SIS*, *Installation parameters*, *PU Communication Setup*, *Output Setup*, *UDP Host Port* drop down, select *User Defined* (note this Port address).
  - This address is used in *Data Distribution - MDM 400* as the source port (where the data is coming from) (see Fig. 2.15).

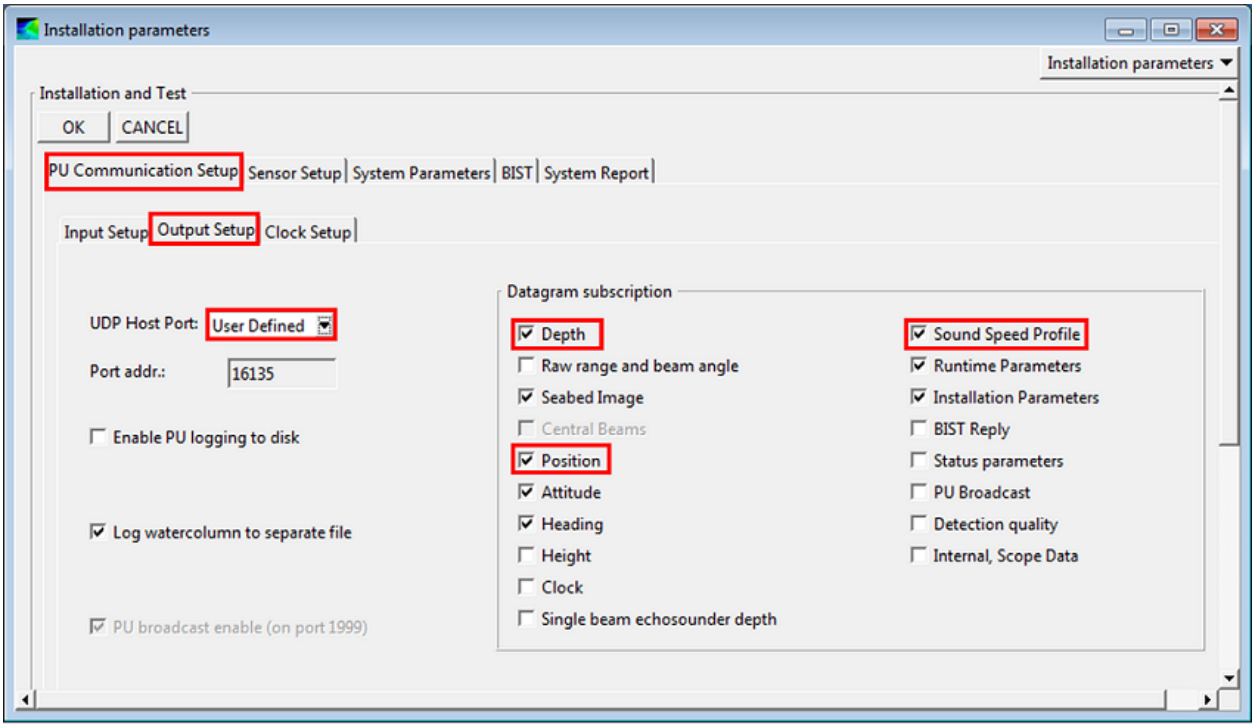

Fig. 2.15: *SIS Installation Parameters* dialog, with key settings in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

- In *Data Distribution - MDM 400*, messages will be sent from your "User Defined" UDP Host Port (noted in previous step) to any number of *Destination Ports* of your choosing.
  - First, the enter the "User Defined" UDP Host Port (from the previous step) in the "Source Port" column. The information for the "Destination: Port" column includes: the IP Address for the computer where Sound Speed Manager in located, followed by a ":" and the port number, which can be any port not already in use (e.g. 192.168.0.100: 16103). Note this port number; it will be used in the Sound Speed Manager setup.
- In Sound Speed Manager, Setup, Listeners, unlock settings editing.
  - Enter the Listen port number (the Destination Port number from Data Distribution - MDM 400). This is where Sound Speed Manager will be receiving messages from.

For an example using Method C, see Fig. 2.18 for a complete diagram. Here the "User Defined" Port Address "16103" found in SIS's Installation Parameters, is enter in the "Source Port" column in Data Distribution - MDM 400. The IP Address of the computer with Sound Speed Manager is entered in Data Distribution - MDM 400's "Destination: Port" column, followed by an open port number, here "16103". This same port number is entered into Sound Speed Manager's Listeners tab, in the "Listen port:" dialog.

You will now be able to send a sound speed profile from Sound Speed Manager to SIS and receive a receipt message (see Fig. 2.19), and see the SIS-received information displayed in the status bar.

Note: In case of troubles in configuring the interaction between SSM and SIS, use *SSM-SIS app*.

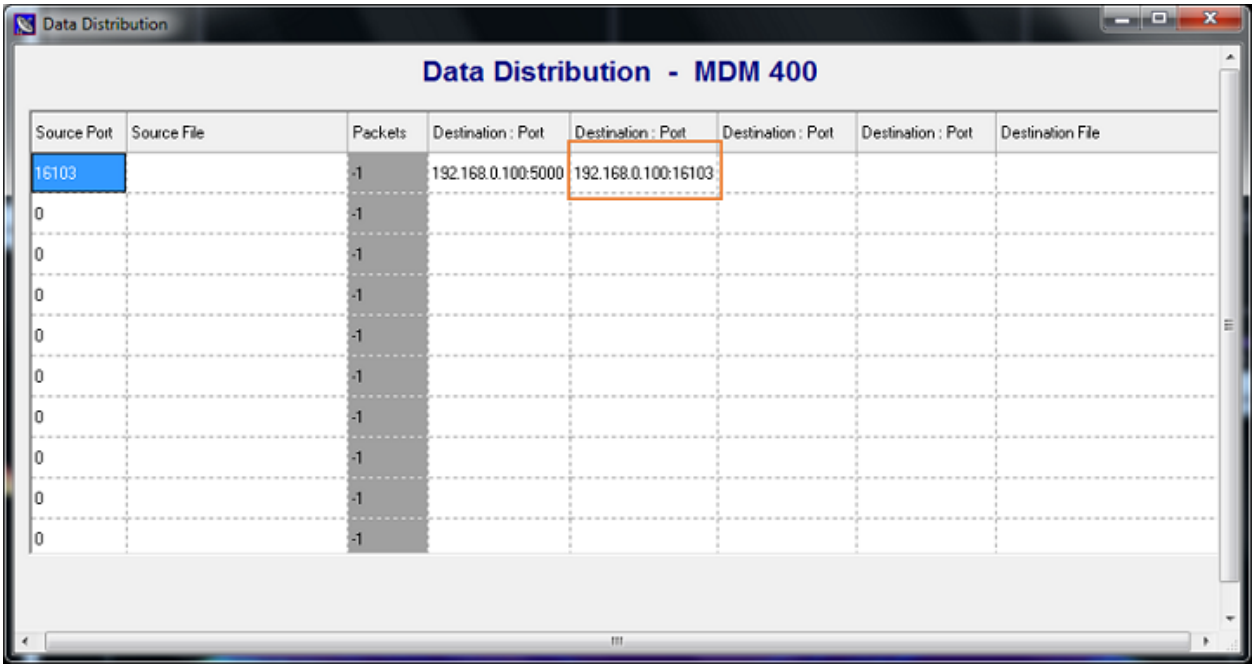

Fig. 2.16: *Data Distribution - MDM 400* dialog, with key settings in orange for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

2.2.5 Sound Speed Manager - SIS v5 interaction

SIS v5 is currently supported through the Data Distribution application (usually installed with SIS v5).

This method covers both cases:

- Sound Speed Manager and SIS v5 installed on the same machine.
- Sound Speed Manager and SIS v5 installed on the different machines.

SIS v5 settings

Verify Data Distribution settings in SIS v5:

- Open *SIS*.
- Under *Tools* in *Parameter Setup/Logging*, locate the *Disable DDIST if 1* entry (see Fig. 2.20).
- If the value of *'Disable DDIST if 1'* is 1, change the value to 0 and restart SIS.

Under the SIS v5 installation folder, locate and execute 'DataDist.exe'. Once started, you need the following settings (see Fig. 2.21):

- Select the Echo Sounder.
- Add a datagram distribution.
- Write (and remember!) the IP address and the port where you want to send the datagrams: e.g., '127.0.0.1:16103'.
- Select the following datagram types: MRZ, SPO and SVP.
- Save the configuration.

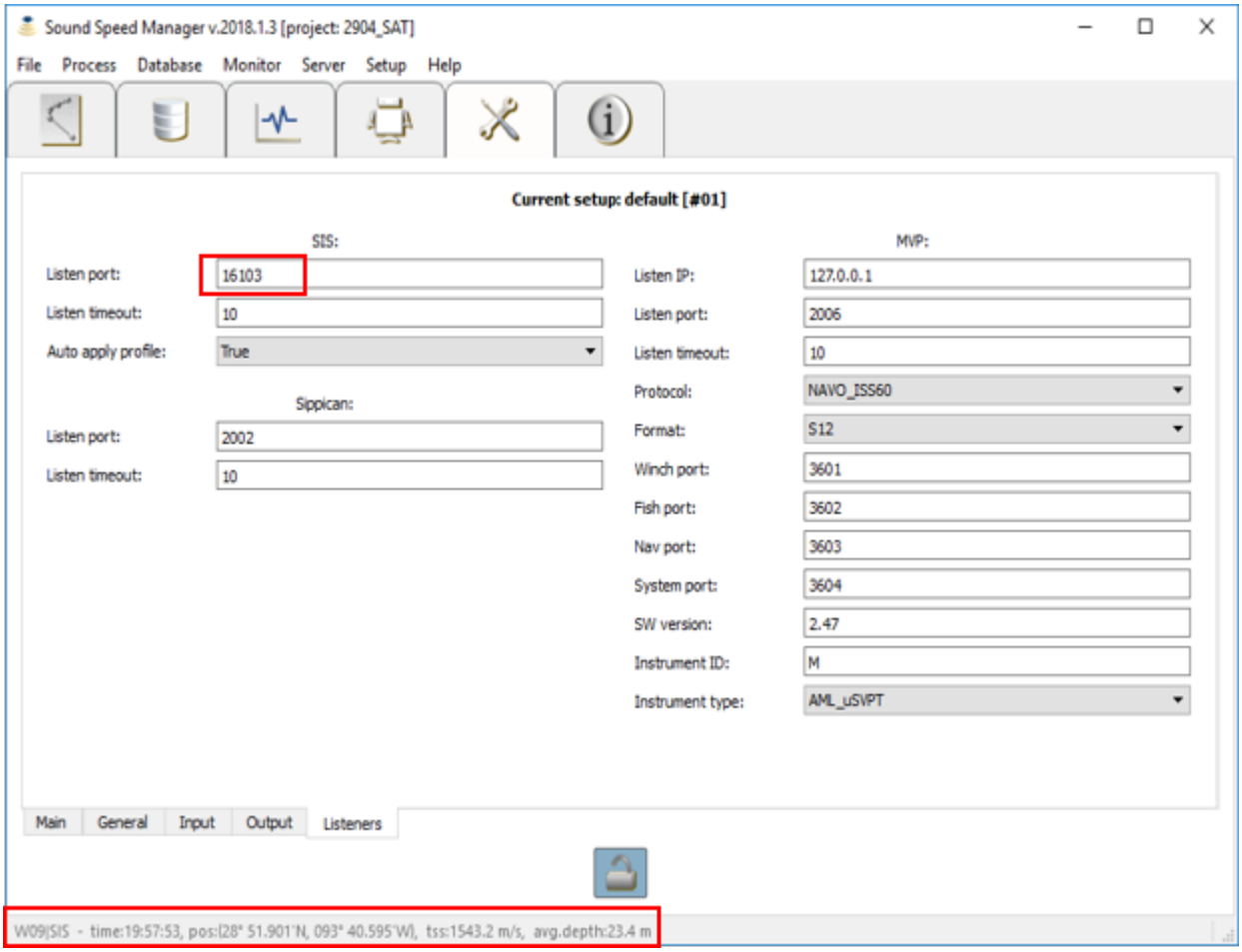

Fig. 2.17: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming SIS data highlighted in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

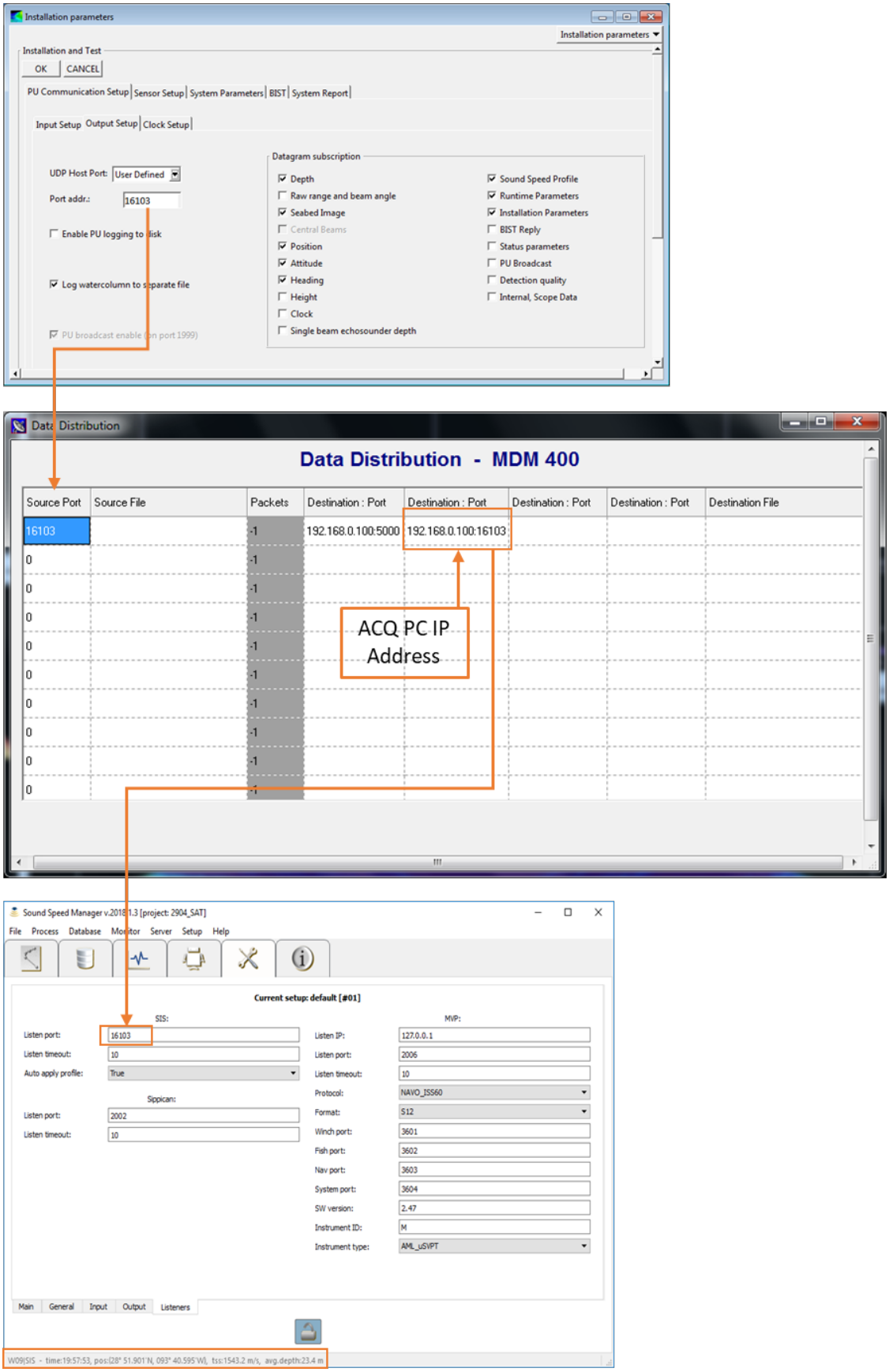

Fig. 2.18: *Complete Method C Diagram*, with key information and connections highlighted in orange for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

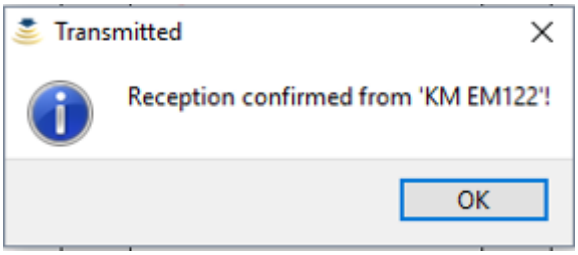

Fig. 2.19: *Sound Speed Manager SIS Receipt* dialog.

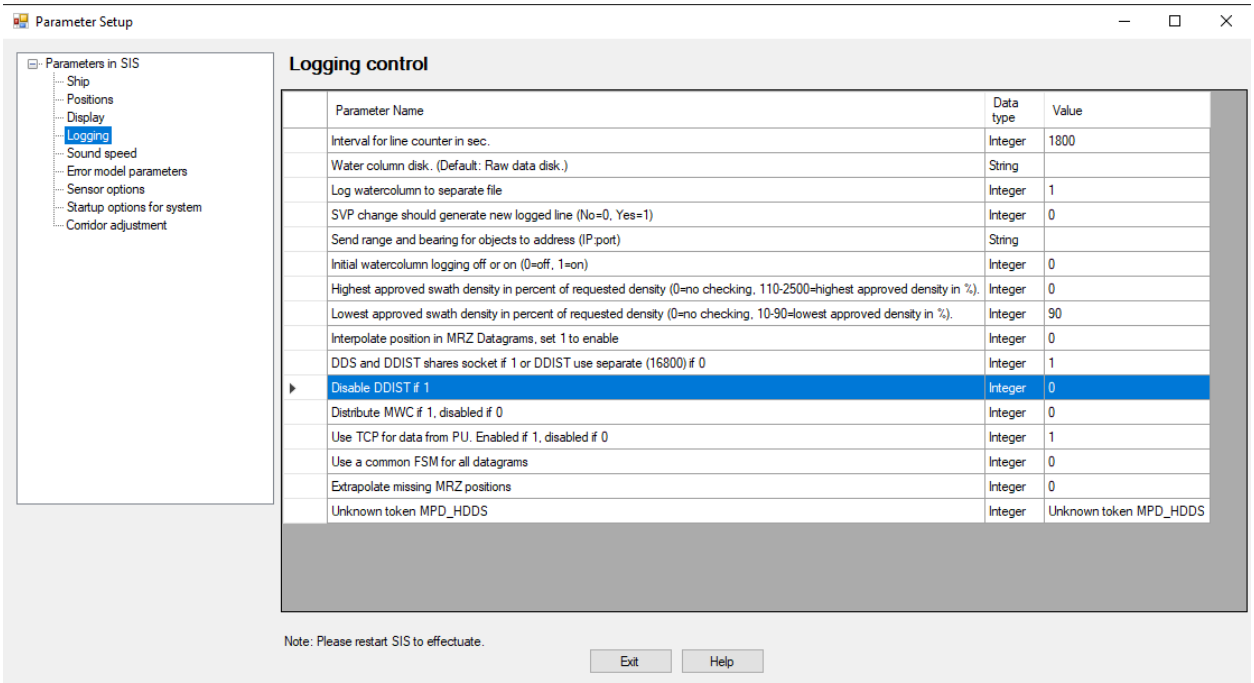

Fig. 2.20: The *'Disable DDIST if 1'* entry under *Tools* in *Parameter Setup/Logging*.

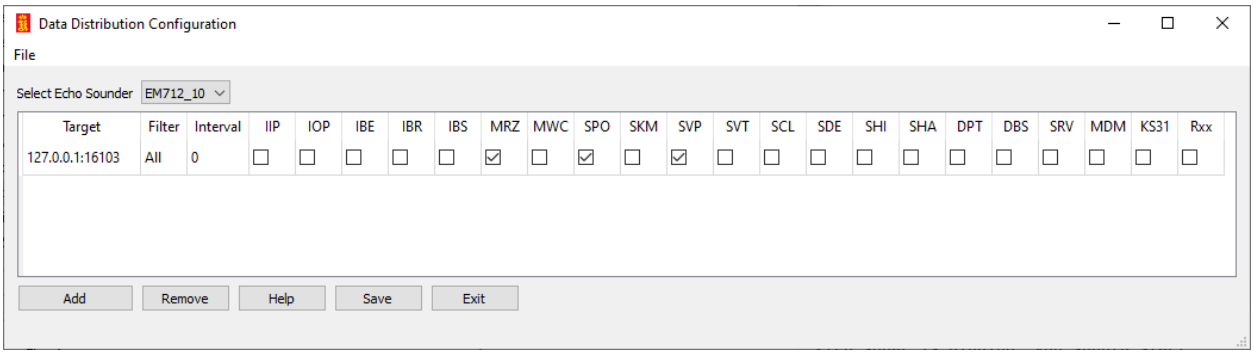

Fig. 2.21: *Data Distribution Configuration* application with required settings.

Warning: Data Distribution requires to have SIS v5 in execution. Setups with the K-Controller interacting with acquisition software different from SIS v5 are *currently* unsupported.

SSM settings

Open in editing mode the Sound Speed Manager's Setup Tab, then set the SIS listen port (that you have set in the Data Distribution Configuration) in the Listeners sub-tab (see Fig. 2.22).

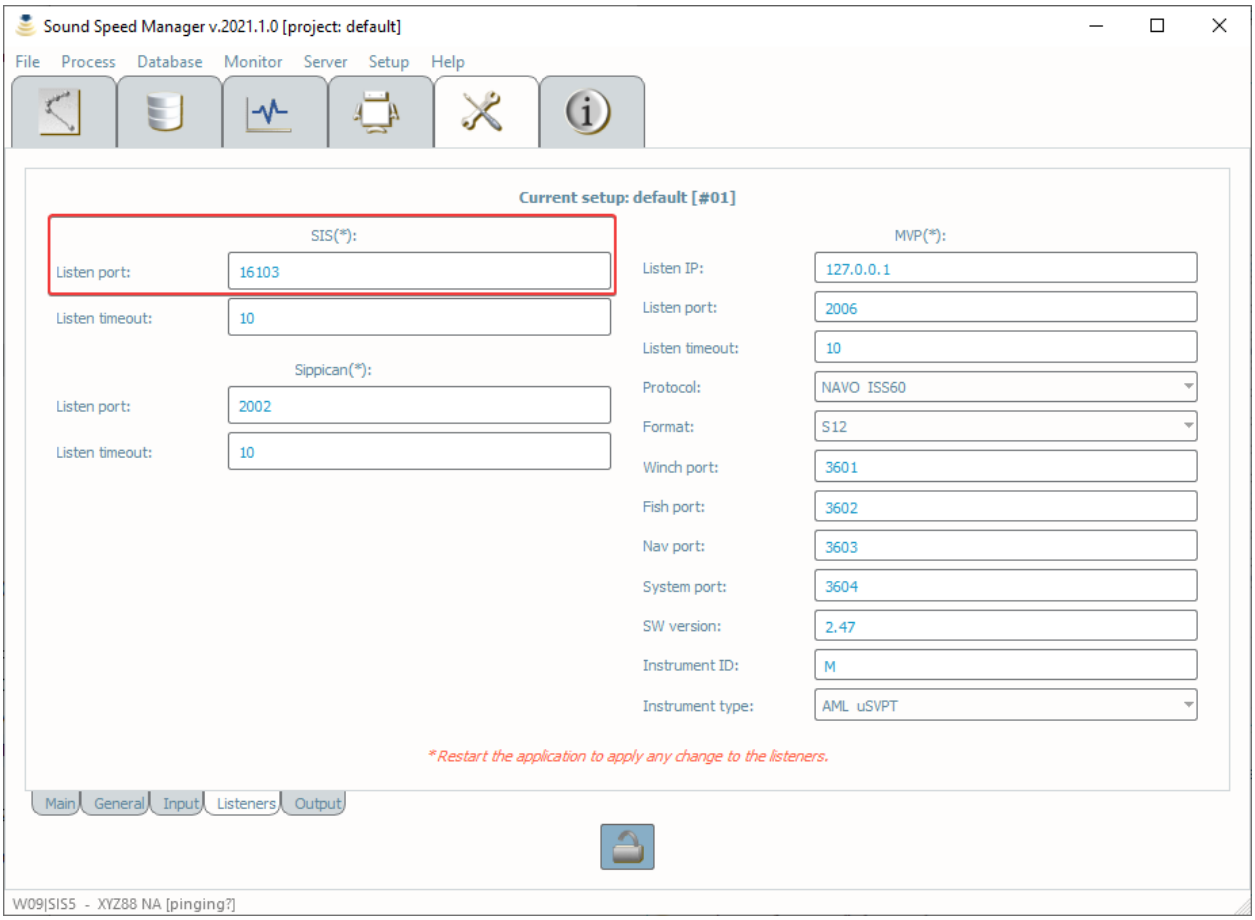

Fig. 2.22: *Listeners tab* in the Sound Speed Manager's Setup.

Then, switch to the Input sub-tab (see Fig. 2.23) and select the True value for the Listen SIS v5 field.

The previous steps are required to make Sound Speed Manager able to listen survey data from SIS v5 (through the Data Distribution application).

In order to be able to transmit to SIS v5, you need to add a client in the Output sub-tab (see Fig. 2.24) using the following settings:

- IP: 127.0.0.1 *(if SIS v5 is on the same machine, otherwise the network IP address of the other machine)*
- port: 14002 *(always!)*
- protocol: SIS *(always!)*

Now **restart** Sound Speed Manager. If a SIS-controlled sonar is pinging, you should start to see the parsed information in the status bar (see Fig. 2.23).

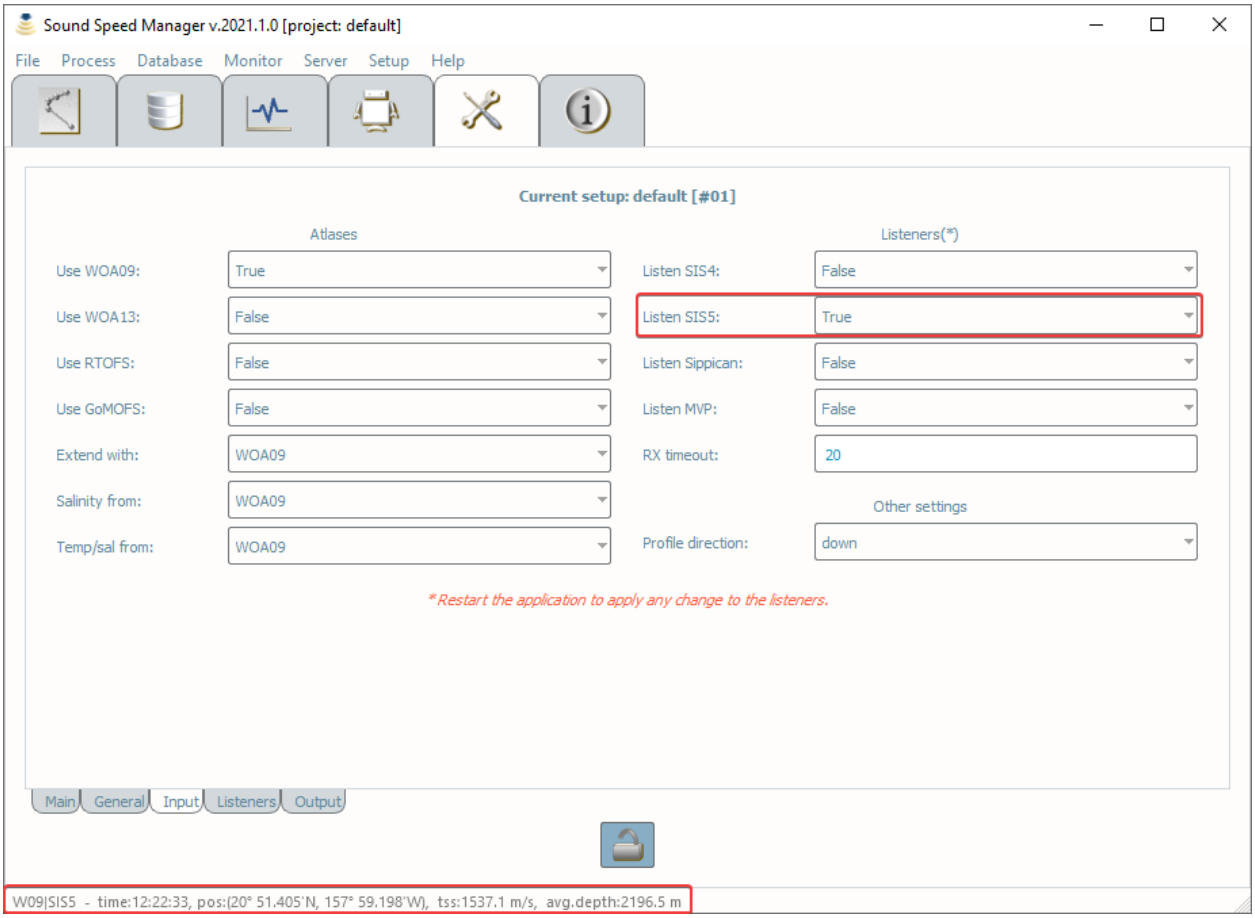

Fig. 2.23: *Input tab* in the Sound Speed Manager's Setup.

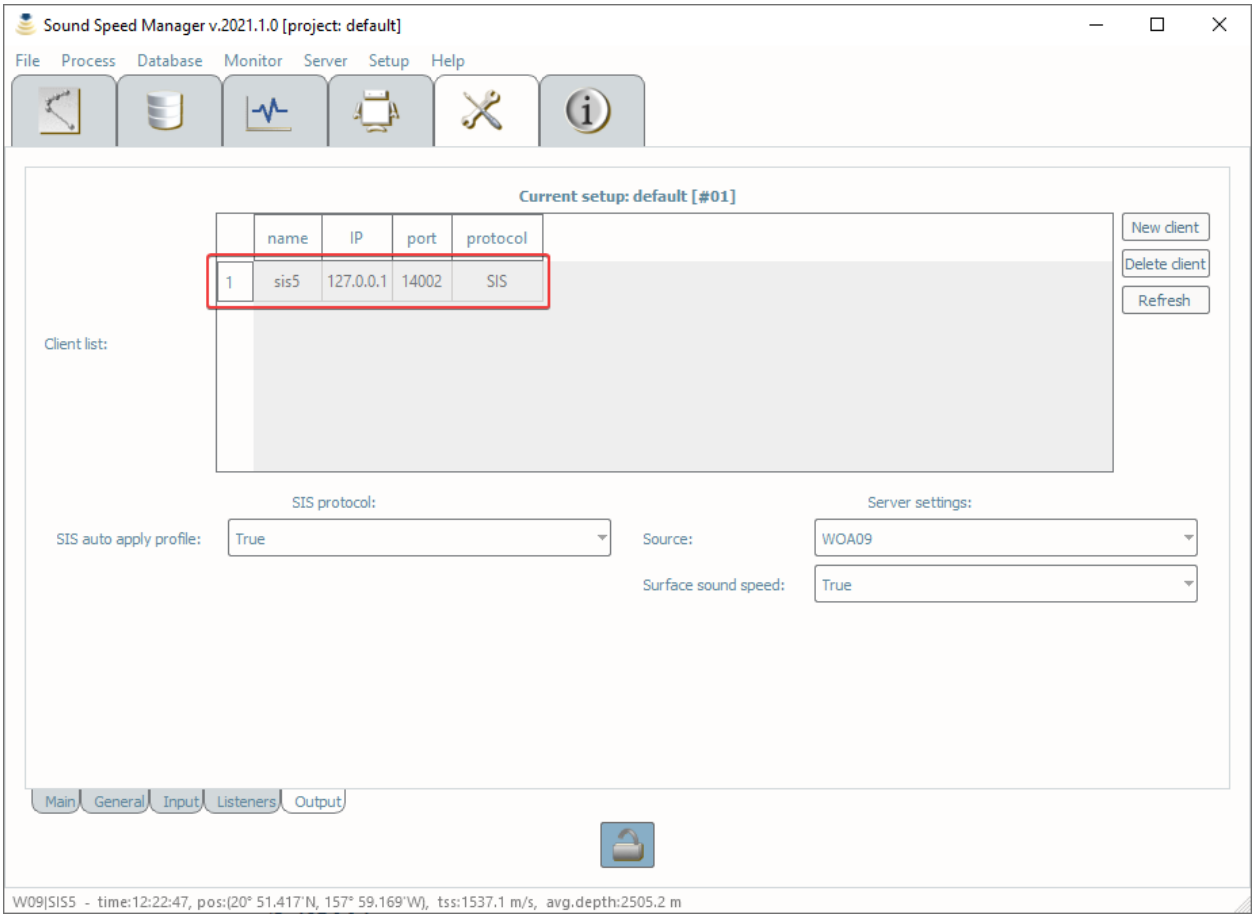

Fig. 2.24: *Output tab* in the Sound Speed Manager's Setup.

Note: In case of troubles in configuring the interaction between SSM and SIS, use *SSM-SIS app*.

2.2.6 Sound Speed Manager - NMEA 0183 interaction

A basic NMEA 0183 listener is available to capture the current location via a UDP broadcast of NMEA 0183 $–GGA or $–GLL sentences. This feature can be used to associate the current position for sound speed profiles that do not store location information.

Open the *Setup Tab* and set the NMEA 0183 port in the *Listeners* sub-tab (see Fig. 2.25).

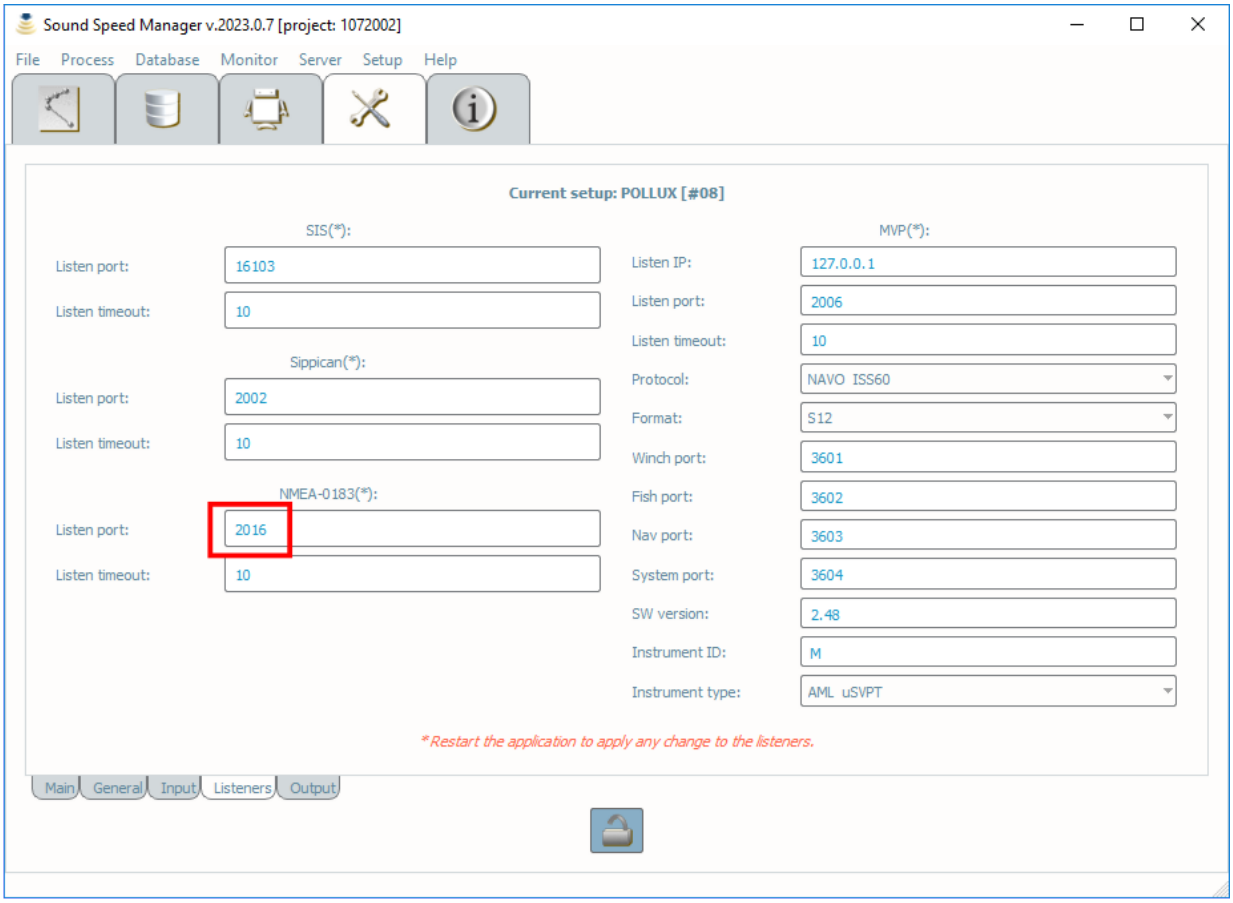

Fig. 2.25: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming NMEA 0183 data highlighted in red.

Then, switch to the *Input* sub-tab (see Fig. 2.26) and set *True* the *Listen NMEA 0183* field. After a **restart**, the current position should be displayed in the status bar.

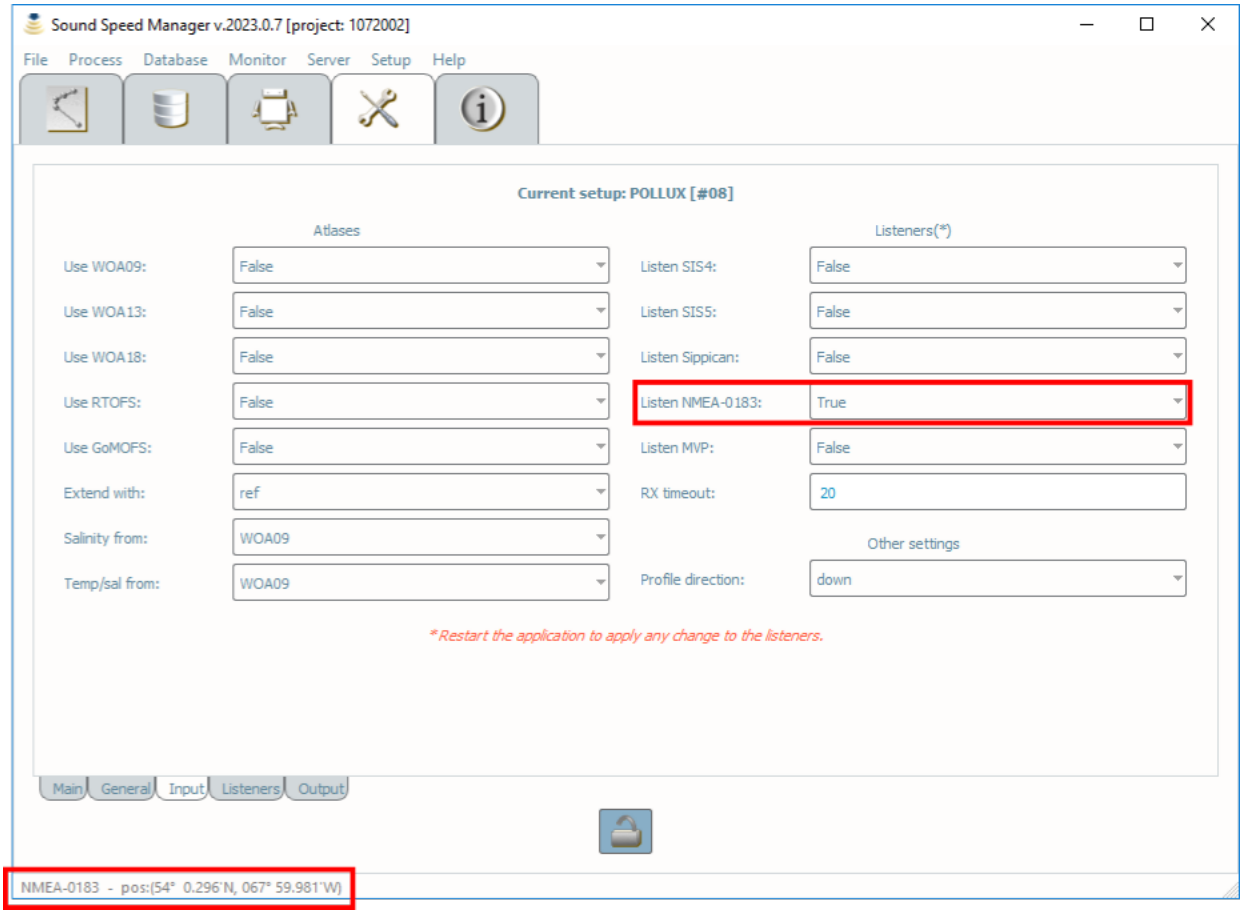

Fig. 2.26: *Input tab* in the Sound Speed Manager's *Setup Tab*.

2.3 Supported Formats

Format	Read	Write
AML (.calc)		X
AML (.csv, .aml)	X	
AOML (.txt)	X	
CARIS (.svp)	X	X
Castaway (.csv)	X	
CSIRO DTC (.json)	X	
CSV (.csv)		X
Digibar Pro (.txt)	X	
Digibar S (.csv)	X	
ELAC (.sva)	X	X
Hypack (.vel)	X	X
Idronaut (.txt)	X	
ISS (.v*, .d*, .svp)	X	
iXBlue (.txt)		X
Kongsberg asvp (.asvp)	X	X
Kongsberg absorption (.abs)		X
Kongsberg HiPAP (.usr)		X
Rolls-Royce MVP (.asvp, .calc, .s12)	X	
NCEI (.nc)[1]		X
QPS (.bsvp)[2]		X
OceanScience (.asc)	X	
RBR Ltd. (.txt)	X	
Sea&Sun (.tob)	X	
SAIV (.txt)	X	
Seabird (.cnv)	X	
Sippican (.edf)	X	
Sonardyne (.pro)	X	X
Turo (.nc)	X	
UNB (.unb)	X	X
Valeport Midas/Monitor SVP/SVX2 (.000)	X	
Valeport MiniSVP/MiniCTD (.txt)	X	
Valeport RapidSV/SVT (.txt)	X	
Valeport Monitor CTD, Midas SVP/SVX2 (.vpd)	X	
Valeport SWiFT SVP/CTD (.vp2)	X	

[1] For details on how to browse the content of a generated NCEI file, see *Appendix C - Exploring Profiles in NCEI format*.
[2] The QPS bsvp format is only supported by old versions of some QPS applications (e.g., FMGT and FMMW).

2.4 How to use

2.4.1 Operator Mode

Data Editor Tab

Data import

From the *Editor* tab, select *Import data* (Fig. 2.27) and choose the desired import file type (Fig. 2.28).

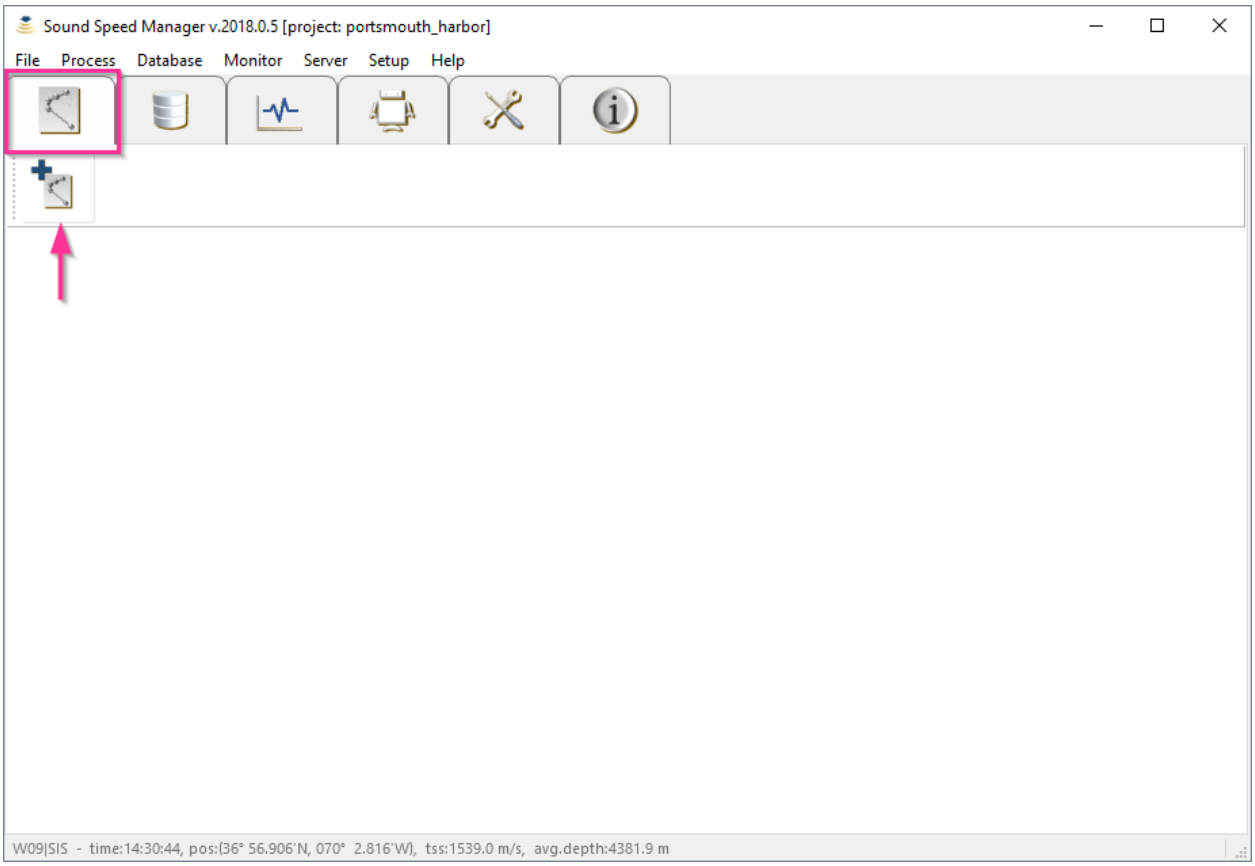

Fig. 2.27: Click on the *Import data* button in the *Editor* tab to start the import process.

This will launch a file selection dialog (Fig. 2.29) with the expected file extension set as a filter, e.g. `.edf` for *Sippican* files.

Note: A number of sample data files can be downloaded from the data folder in the project repository.

After the selection of the desired file, the window shows panels with the sound speed, temperature and salinity profiles drawn in solid blue (left to right, respectively, in Fig. 2.30).

During the import stage, the geographic position and date in the input file are used to query WOA or RTOFS atlases (if available) to obtain mean sound speed, temperature and salinity profiles (to provide a context during data editing), which are drawn in dashed colours. Thus, it is important that the cast positional metadata are correct for this lookup operation.

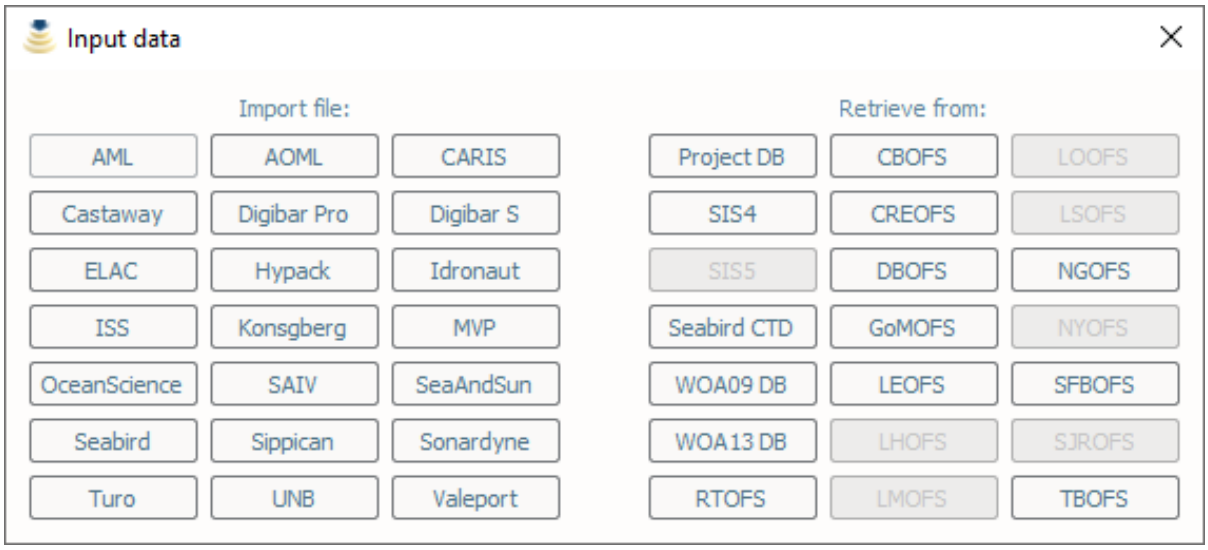

Fig. 2.28: Click on the desired import file type.

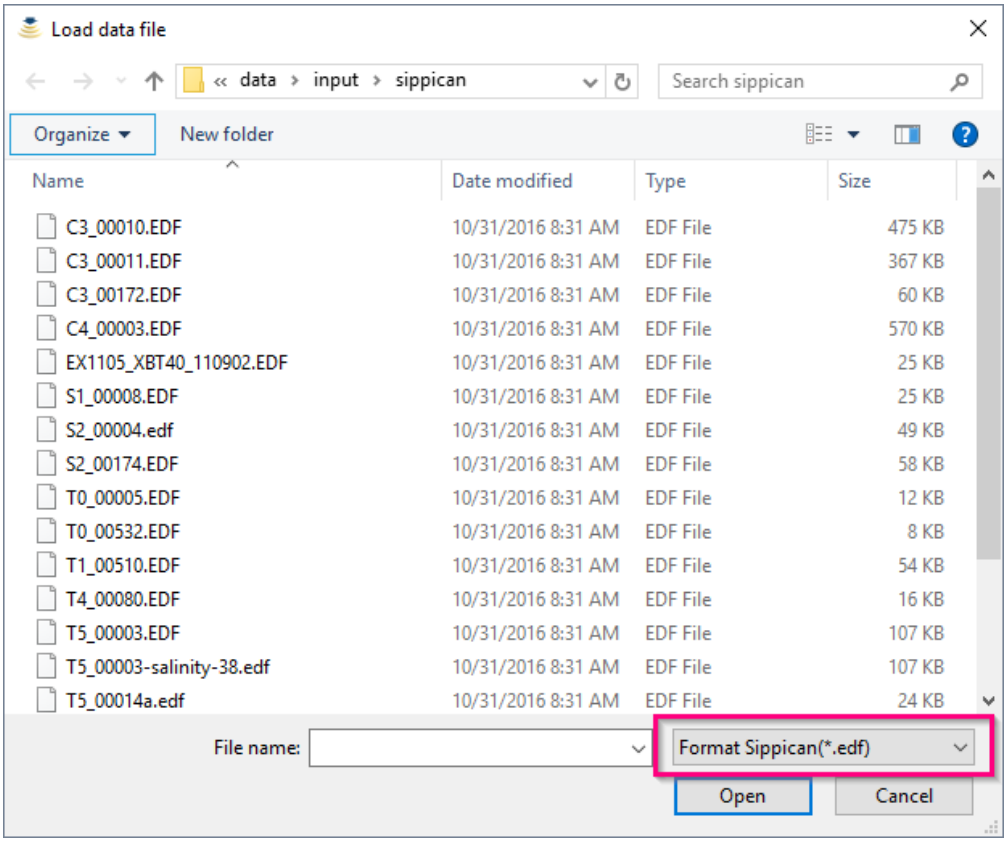

Fig. 2.29: Browse to the desired data file.

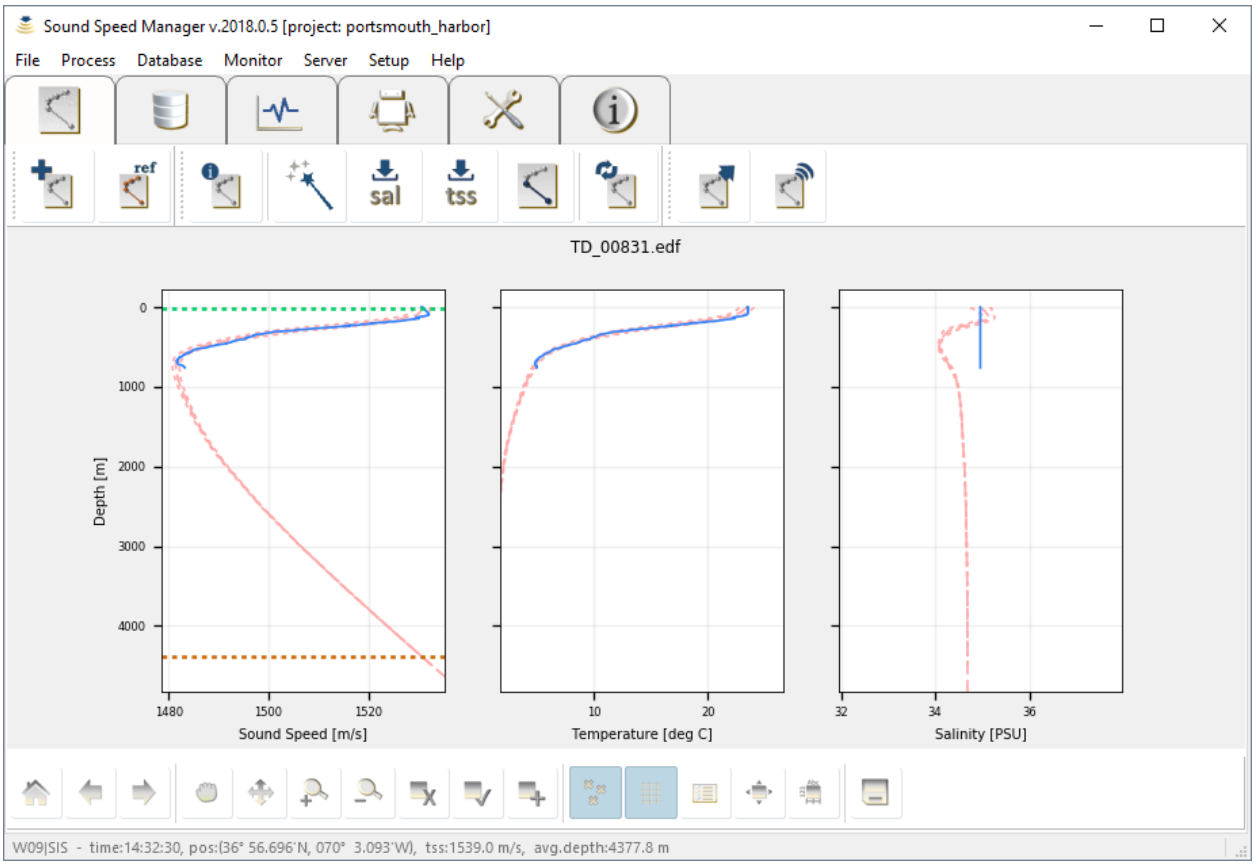

Fig. 2.30: *Sound Speed Manager* showing the three main plots: sound speed, temperature, and salinity.

Furthermore, the position is also required by some formats to compute the pressure to depth conversion (since this has a latitudinal dependence). Since some file formats do not support recording of geographic position (e.g., *Valeport* `.000`) the user must enter these manually during import (if the SIS position datagram is not available).

All the available processing steps can be accessed from the *Process* menu. A selection of these steps is present in the toolbar for ease their access in operation. This selection can be customized through the *Button Visibility* dialog (Fig. 2.31) accessible using *Process/Change Buttons Visiblity*.

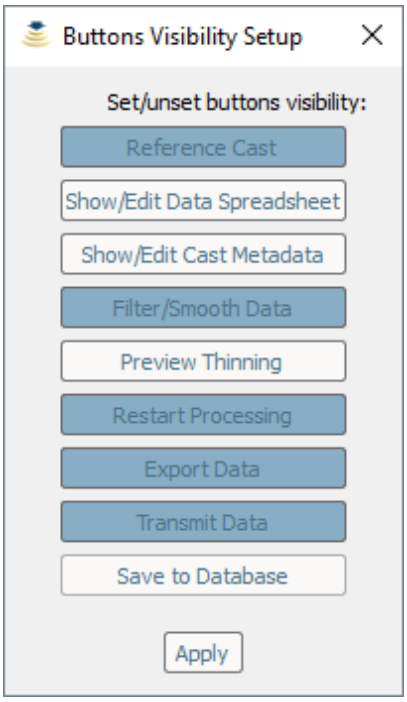

Fig. 2.31: The *Button Visibility* dialog.

Interactive data editing

The mouse interactive mode is set using the plotting toolbar at the bottom (Fig. 2.32) or by directly right-clicking on the plots once a cast is loaded. Currently available inspection modes are:

- *Reset view*: to visualize the full profile
- *Pan*: to move the area visualized in the plot
- *Scale*: to modify the horizontal and vertical scales of the plots
- *Zoom in*: to zoom in to a selected area
- *Zoom out*: to zoom out from a selected area
- *Flag*: mark spurious measurements for removal from any plot panel through a left-click drag motion over the bad data points. The flagged points will be drawn in red.
- *Unflag*: reclaiming previously flagged data, using the same left-click and drag motion as *Flag*.
- *Insert*: manually adding points to the profiles can be useful to create a more realistic cast extension. This is particularly useful when the measured temperature and/or salinity values deviate from WOA/RTOFS or the reference profile near the bottom of the profile.

Zooming back out to the full view is accomplished by choosing *Reset view* from the plotting toolbar (or by directly right-clicking on the plot and selecting *Reset view*). The *Hide flagged* option in the plotting toolbar will toggle the display of flagged points.

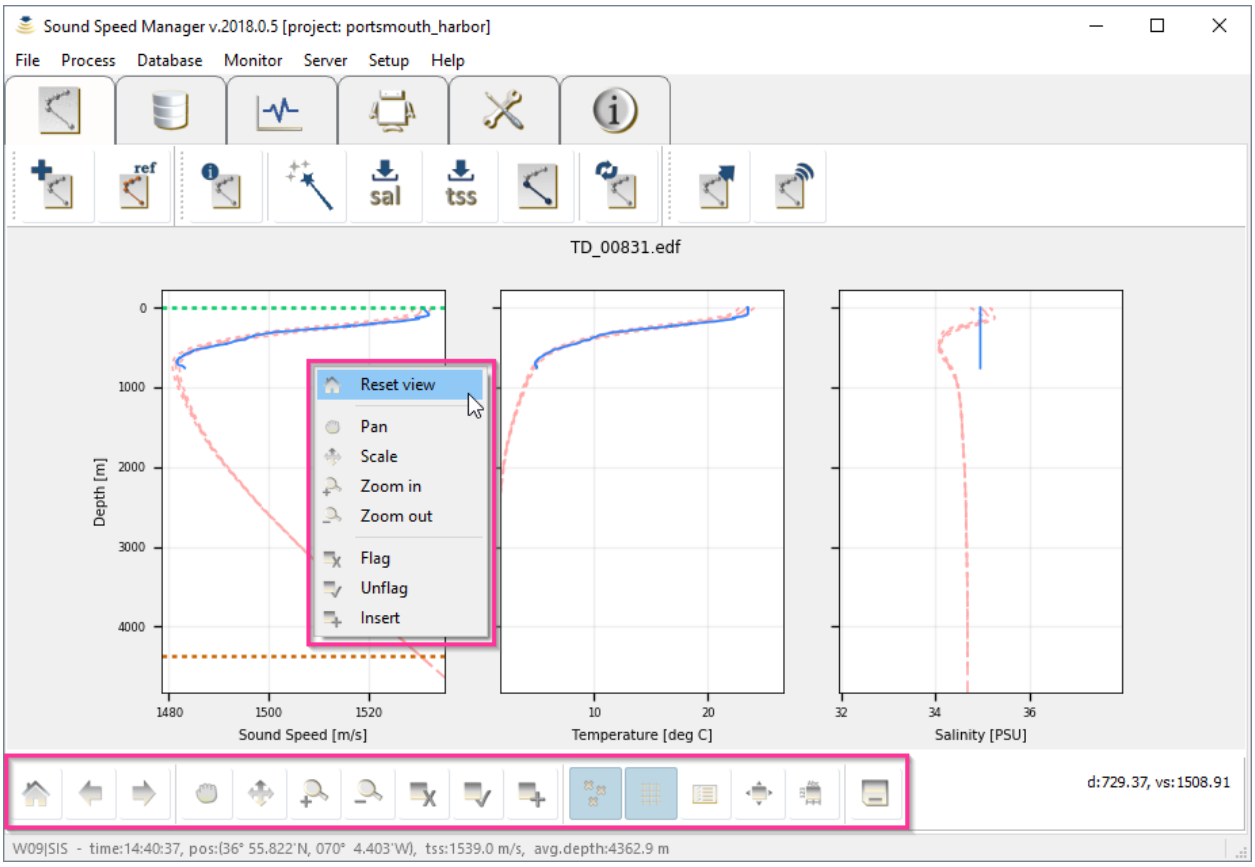

Fig. 2.32: Interactive data editing of a loaded profile.

Metadata editing

Several information related to the cast are collected during the import and the processing of a cast. Metadata can be viewed by clicking the *Metadata* button on the tool bar (Fig. 2.33).

Fig. 2.33: Button to access the *Metadata* widget.

It is also possible to manually edit several of the metadata entries (Fig. 2.34) and to force the visualization of the *Profile metadata* tool at the import time (Fig. 2.35).

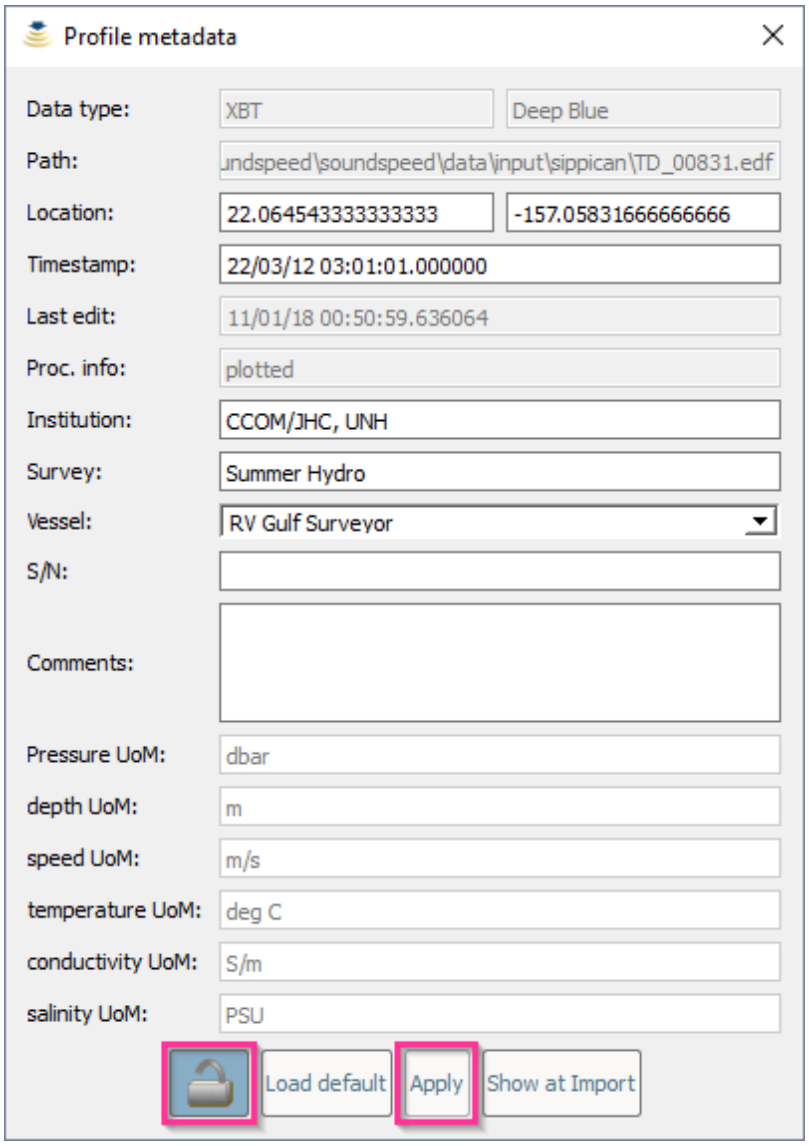

Fig. 2.34: The *Profile metadata* tool.

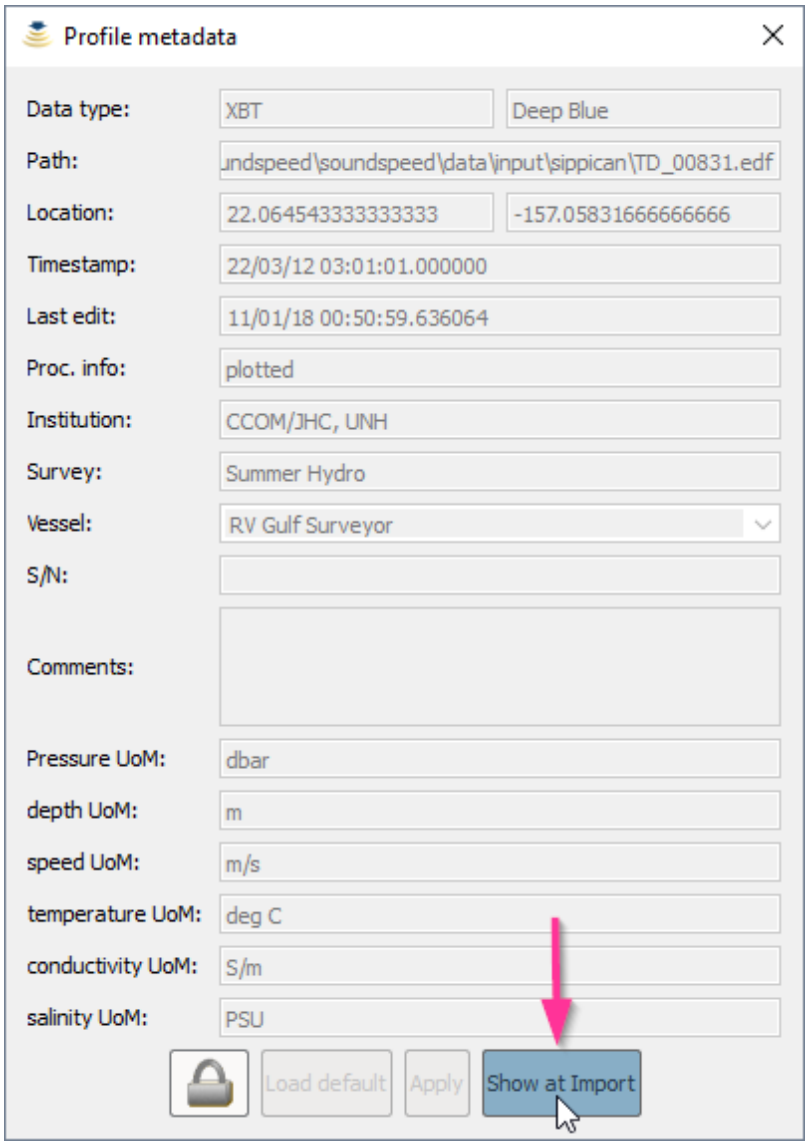

Fig. 2.35: When the "Show at Import" button is flagged like in the figure, the *Profile metadata* tool is automatically displayed when a new profile is imported.

Data filtering/smoothing

If required, the profile data can be automatically filtered and smoothed using the *Filter/Smooth Data* button (Fig. 2.36).

Fig. 2.36: The *Filter/Smooth Data* button in the *Editor* toolbar.

Data augmentation

Sound speed data can be augmented with WOA/RTOFS/reference salinity and/or temperature. If a reference cast has been set, then the reference cast will be used to augment salinity and/or temperature profiles instead of the WOA/RTOFS profiles.

Note: You can set the desired augmentation source (e.g., the user-defined reference cast) in the *Input* tab available in the *Application Settings*.

XBT probes

XBT probes measure the temperature of water as they drop to the seafloor. Since the speed of sound in water is strongly affected by water temperature, this measurement can be used to estimate the sound speed profile. Since salinity can also influence the speed of sound in water, the accuracy of the sound speed estimate can be improved through better approximation of the water's salinity. This approximation can be as simple as assuming that the salinity is constant over all depths or it could be as sophisticated as using an independent salinity depth profile from an alternate sensor such as a CTD or perhaps from an oceanographic model.

The package follows this second approach. The salinity profile is specified by selecting *Retrieve salinity* (Fig. 2.37) from the *Editor* toolbar (the option is only active when an XBT cast is loaded). With this command, the dashed WOA or RTOFS salinity profile is used to augment the XBT temperature measurement. Since the vertical resolution of the WOA/RTOFS grids is coarse compared to the typical sampling interval of the measured data, the salinity estimates are linearly interpolated to the depths associated with each of the temperature observations in the measured XBT profile.

The salinity plot (right-most of the three panels) will update with a salinity profile and the sound speed plot (left-most panel) is updated with sound speed (recalculated using the new salinity estimates). Sound speed values are calculated using the UNESCO equation (*Fofonoff and Millard, 1983*).

Fig. 2.37: The *Retrieve salinity* button in the *Editor* toolbar.

XSV probes

In the case of an XSV file, the user can decide to augment the measured sound speed with WOA/RTOFS temperature and salinity through the XSV load temperature/salinity option under the *Process* menu (Fig. 2.38). The option is only active when an XSV cast is loaded.

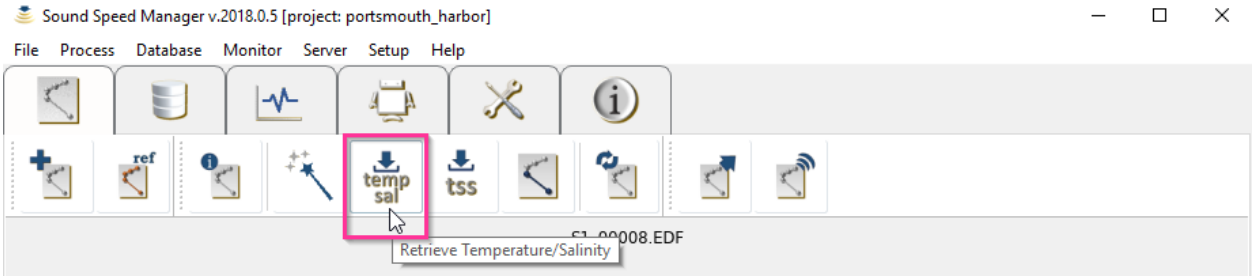

Fig. 2.38: The *Retrieve temperature/salinity* button in the *Editor* toolbar.

Note: In this mode, the sound speed is NOT recalculated, the temperature and salinity are meant merely for SIS to compute transmission loss corrections for improved backscatter normalization. Thus, the application disallows the *Retrieve salinity* button in the *Editor* toolbar for XSV profiles.

Manual user insertions

There are two methods to add points, after having selected the *Insert* mode in the right-click menu or in the plotting toolbar:

1. *Adding sound speed points in the sound speed plot.* This method adds points to the sound speed profile only and it holds the current temperature and salinity gradients constant (i.e., it makes no attempt to update the temperature/salinity profiles for the chosen sound speed). Thus, this method is well suited for output formats or transmission protocols in which the temperature/salinity values are not used.

2. *Adding salinity and temperature points.* This method adds salinity and temperature points in their respective plots and then calculates the resulting sound speed based on the temperature/salinity plots. A first click in the salinity plot sets both the point depth and salinity. A second click in the temperature plot sets the temperature for the point depth selected in the prior step. The package will automatically calculate the sound speed based off the temperature/salinity points previously selected. The click order can be reversed (i.e., a first click in temperature sets the depth and temperature).

Multipoint extensions are achieved through repeating the above sequence. If a deep extension that exceeds the view limits is required, use the pan utility to adjust the view limits.

Applying surface sound speed

If configured to receive data from SIS, the surface sound speed and transducer draft from the depth datagram broadcast can be used to create a surface layer of thickness equal to the transducer draft and of sound speed equal to the value used in beam forming (this is based on the assumption that the value comes from the surface sound speed probe). This operation can be achieved by selecting *Retrieve Surface Sound Speed* from the *Editor* toolbar (Fig. 2.39).

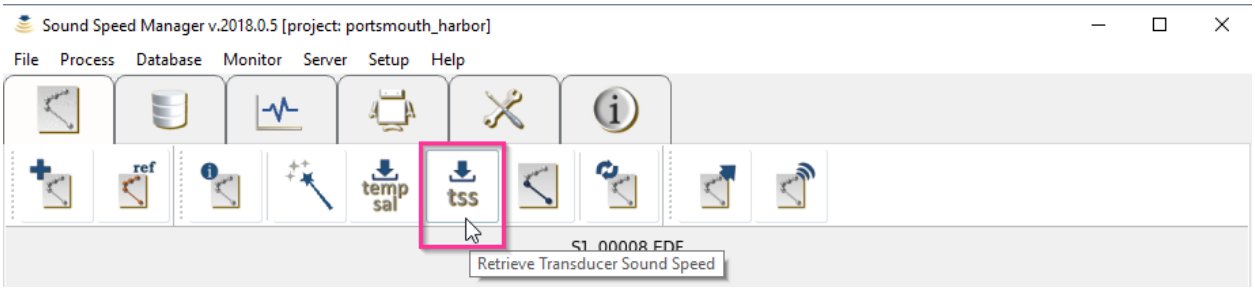

Fig. 2.39: The *Retrieve Surface Sound Speed* button in the *Editor* toolbar.

If neither the surface sound speed or transducer draft values are available from a SIS data broadcast, the software will prompt the user to input values for both.

The intent of this feature is to keep the sound speed profile and sound speed sensor values similar such that the numerical display monitors in SIS do not warn against sound speed discrepancies between the two measurements. It should be noted that this is done internally in SIS during their ray tracing operations, regardless of this external processing stage: "transducer depth sound speed is used as the initial entry in the sound speed profile used in the ray tracing calculations" (*Kongsberg, 2012*).

Using this package method, keeps the system from warning against discrepancies based on:

- The uncertainty in XBT temperature measurements ($\pm$ 0.1°C, roughly equivalent to $\pm$ 0.4 m/s)
- Inadequate choice of salinity in the Sippican acquisition system
- Deviations of true salinity from the mean surface salinity in the WOA/RTOFS.

Profile extension using WOA/RTOFS atlases or a reference cast

Profile extension can be applied by selecting *Extend profile* from the *Editor* toolbar (Fig. 2.40). This operation will extend the observed cast in depth as much as possible using the WOA/RTOFS profile. After that, the three plot panels will be updated. If necessary, users should edit any discontinuities between the cast in depth and the extension in the vicinity of the maximum observation depth.

The extension will only go as deep as 5,500 m as this is the deepest depth layer that the WOA/RTOFS atlases support (more details on such an operation are provided in *Appendix A - Oceanographic Atlases*).

However, when files are transmitted to *SIS* or exported in `.asvp` format, the software extends the profile to 12,000 m depth to meet *SIS* input criteria (thus, there is no need for the user do this manually). Similar to data augmentation for XBT probes and for XSV probes, when a reference cast is set, this will be used to extend the cast instead of WOA/RTOFS atlases data.

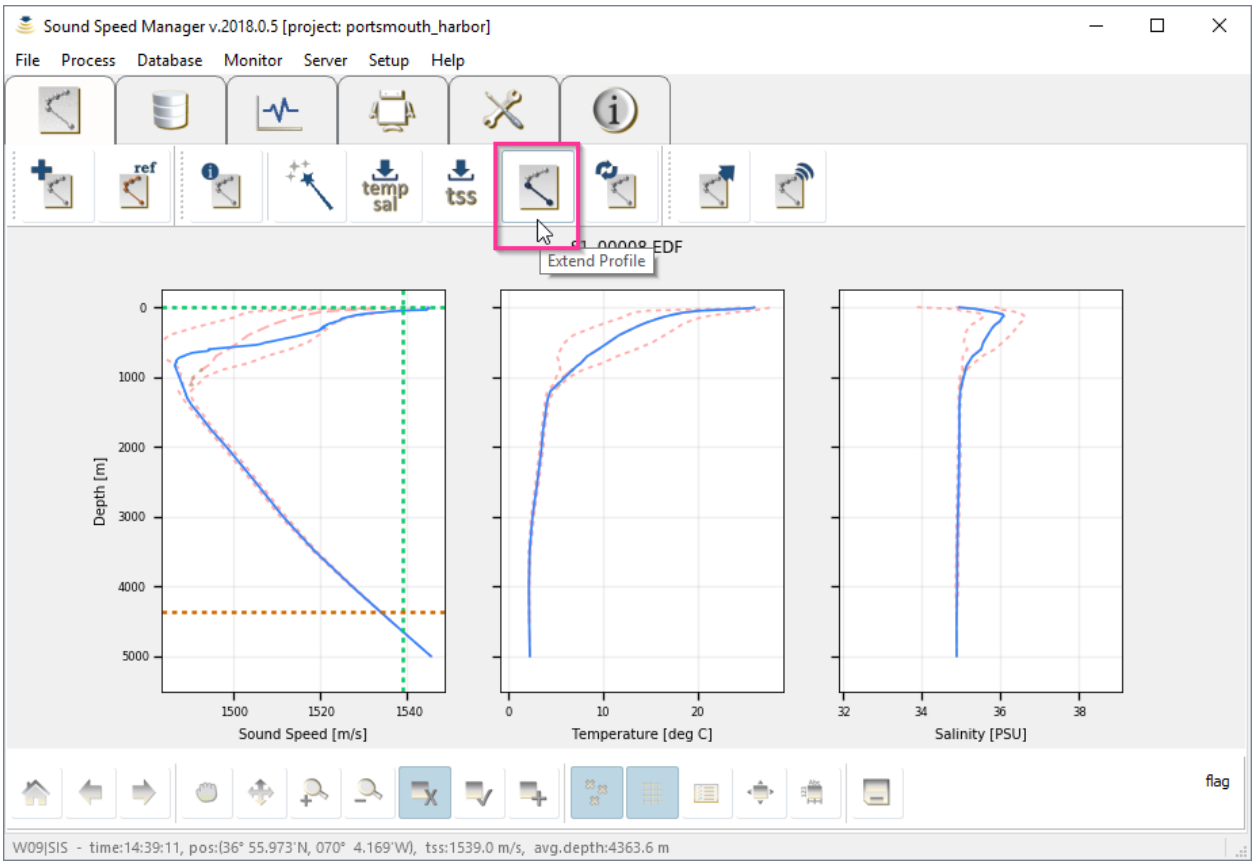

Fig. 2.40: The *Extend profile* button in the *Editor* toolbar.

Automated processing

To streamline the processing of new sound speed profiles, it is also possible to automate a number of steps in the workflow. The *Automated Processing Setup* dialog (Fig. 2.41) can be accessed under *Process/Automate Processing*.

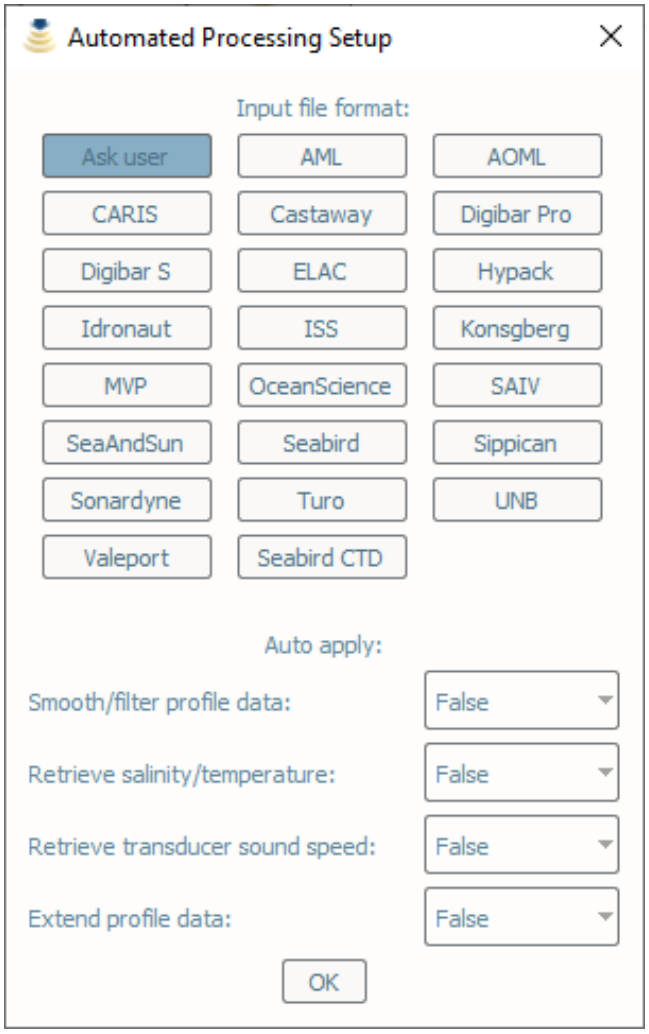

Fig. 2.41: The *Automated Processing Setup* dialog.

Output creation

The profile accepted by *SIS* has a limited number of samples, thus the collected profile often requires the application of a thinning algorithm when exporting in Kongsberg format. The thinning is obtained by iteratively running a custom version of the Douglas-Peucker algorithm.

In addition, a *Preview thinning* method is provided to inspect the result of such an algorithm before the actual transmission.

Data export

Any file that is loaded into the package can be exported by accessing the *Export data* from the *Editor* toolbar (Fig. 2.42).

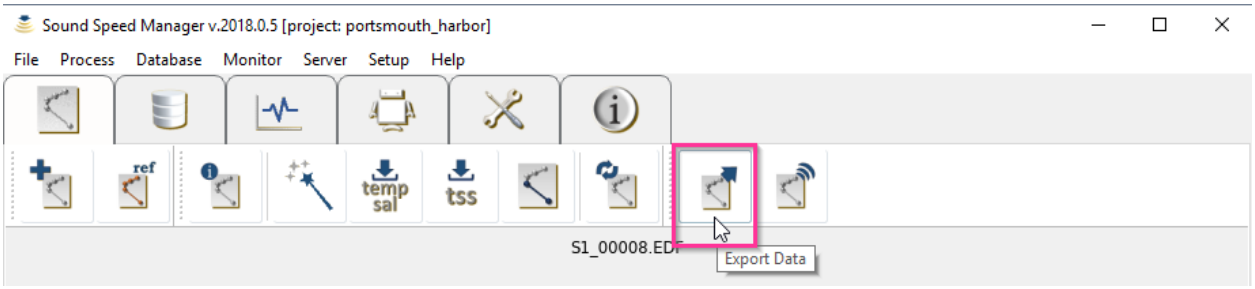

Fig. 2.42: The *Export data* button in the *Editor* toolbar.

Several formats are currently supported, so the user must select the format of interest and then choose *Export selected formats* to actually perform the export. To inspect the content of a profile exported in the NCEI format, see *Appendix C - Exploring Profiles in NCEI format*.

The export function will prompt the user for an output prefix prior to export.

Data transmission

Data transmission is triggered by selecting the *Transmit data* from the *Editor* toolbar (Fig. 2.43).

Fig. 2.43: The *Transmit data* button in the *Editor* toolbar.

The recipients of such a transmission are configured in the configuration file (see *Possible Configurations*).

Data storage

Each time that a profile is exported or transmitted, it is also automatically stored in the current active database.

It is also possible to force the storage of a profile using *Process/Save to Database*.

Database Tab

The package provides functionalities to permanently store, delete and retrieve the sound speed profiles. Any time that a profile is exported or transmitted, its data content is stored in the database. A profile can also be stored in the database by using *Save to database* in the *Editor* toolbar (Fig. 2.44).

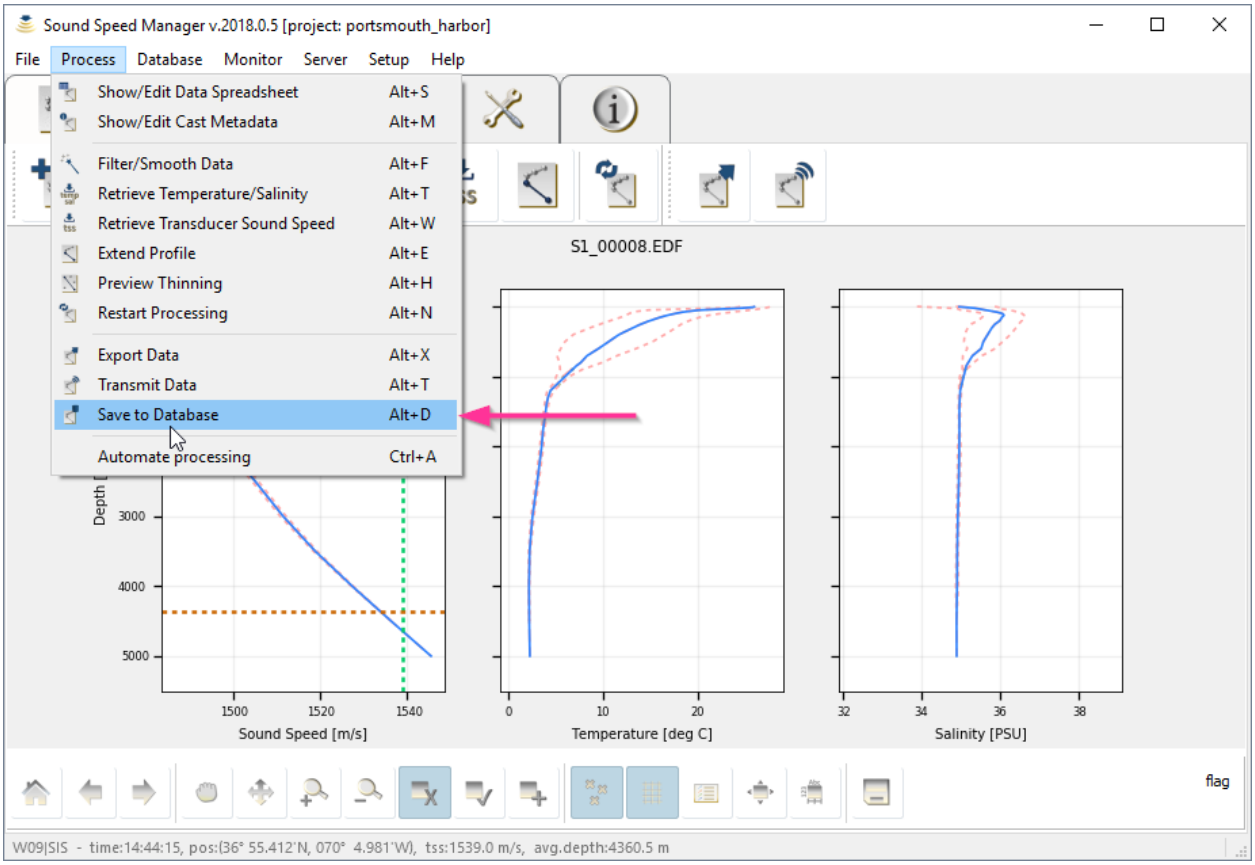

Fig. 2.44: The *Save to database* menu entry in the *Process* menu.

In particular, each profile contains three types of stored data:

1. The raw data (which makes it possible to redo the processing from scratch).
2. The processed samples (with flags to identify the different sources of data).
3. An optional SIS profile (that represents the result of the thinning process required by *Kongsberg SIS*).

Once stored in the database, the *Database* tab provides analysis functions and tools to manage the collected profiles (Fig. 2.45).

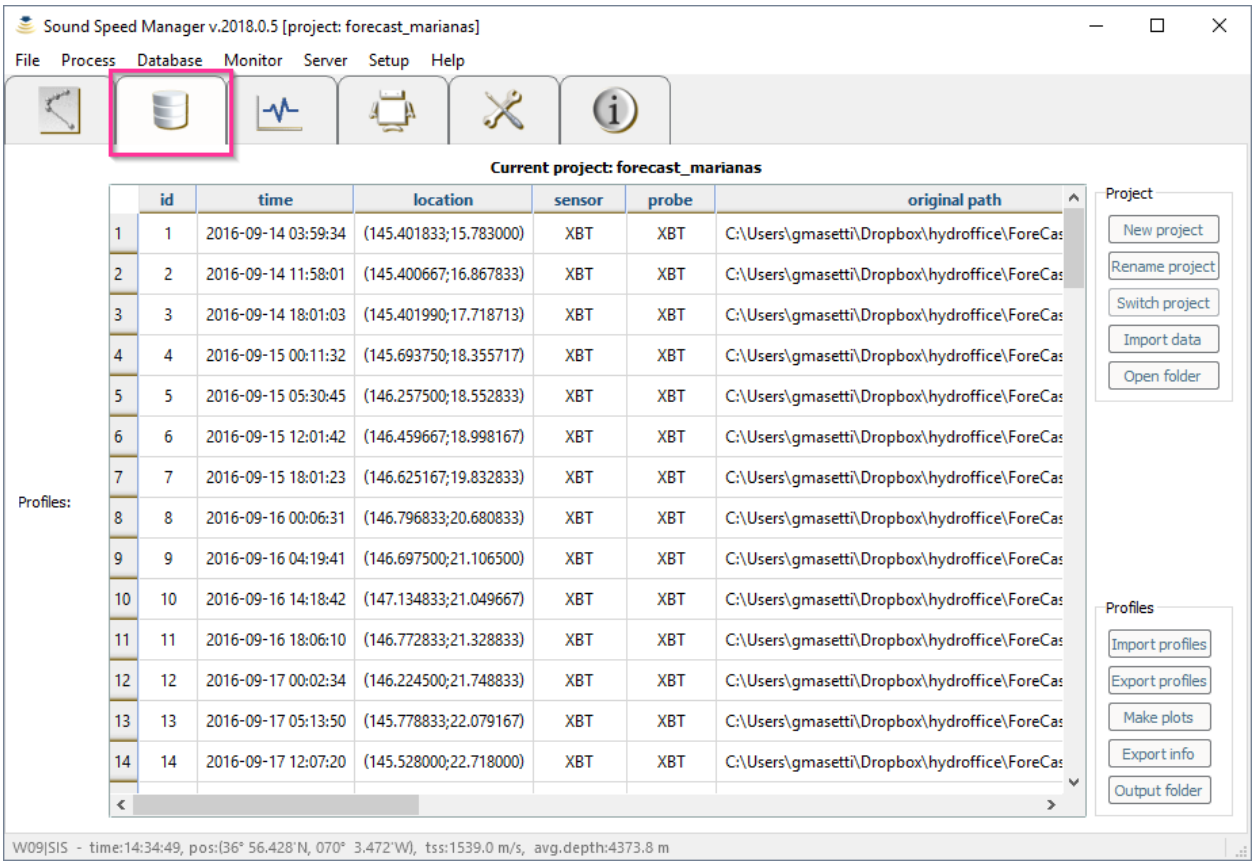

Fig. 2.45: The *Database* tab provides access to the collected profiles and related tools.

Context menu

The context menu provides access to different tools based on the number of selected profiles:

- Single-profile selection (Fig. 2.46).
- Pair-profile selection (Fig. 2.47).
- Multi-profile selection (Fig. 2.50).

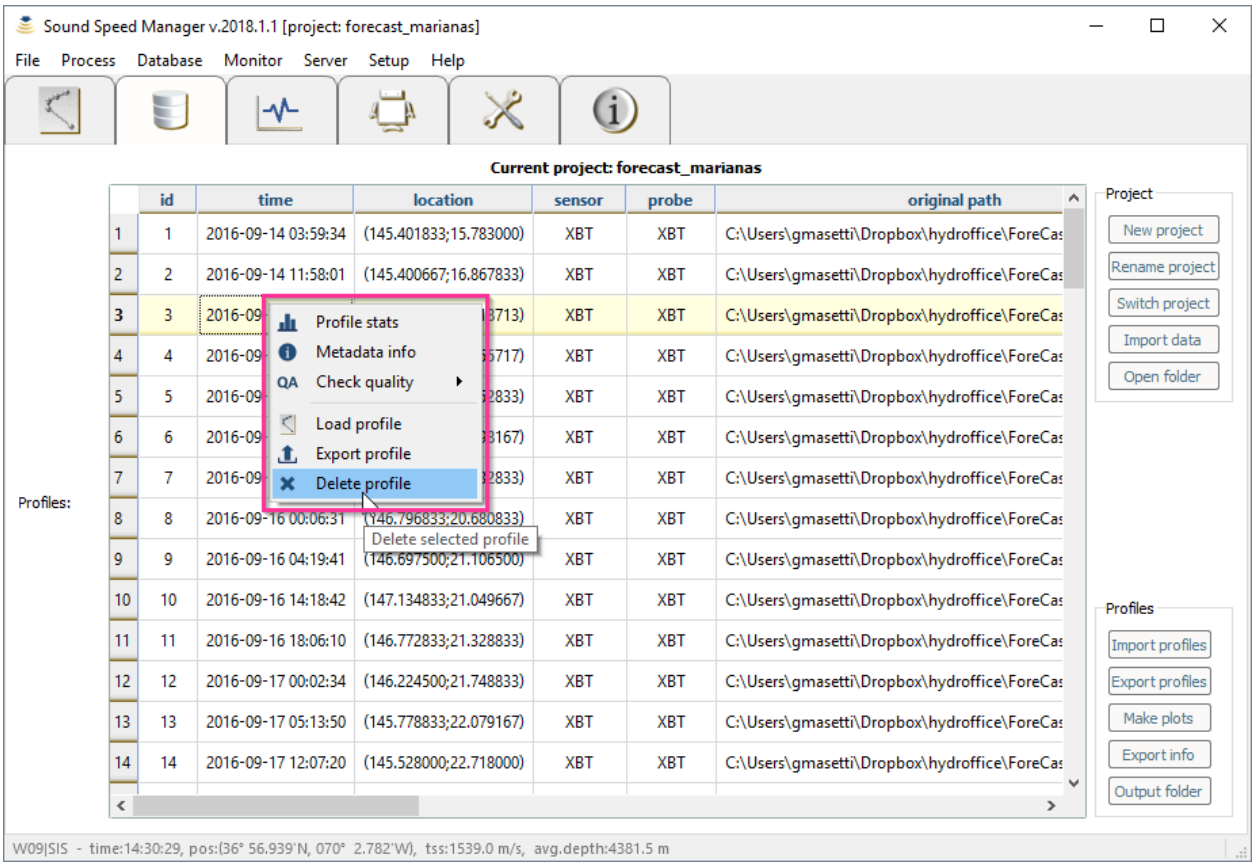

Fig. 2.46: The single-selection context menu provides functionalities specific to a single profile.

Project and Profiles groups

The *Project* group provides functionalaties to:

- Create a new project (*New project* button).
- Rename an existing project (*Rename project* button).
- Switch among existing projects (*Switch project* button).
- Import data from an existing database to the current project (*Import data* button).
- Open the folder that contains the project databases (*Open folder* button).

From the *Profiles* group, it is possible to import (*Import profiles* button) or export (*Export profiles* button) multiple profiles.

Using the *Make plots* and *Export info* buttons (Fig. 2.51), you may:

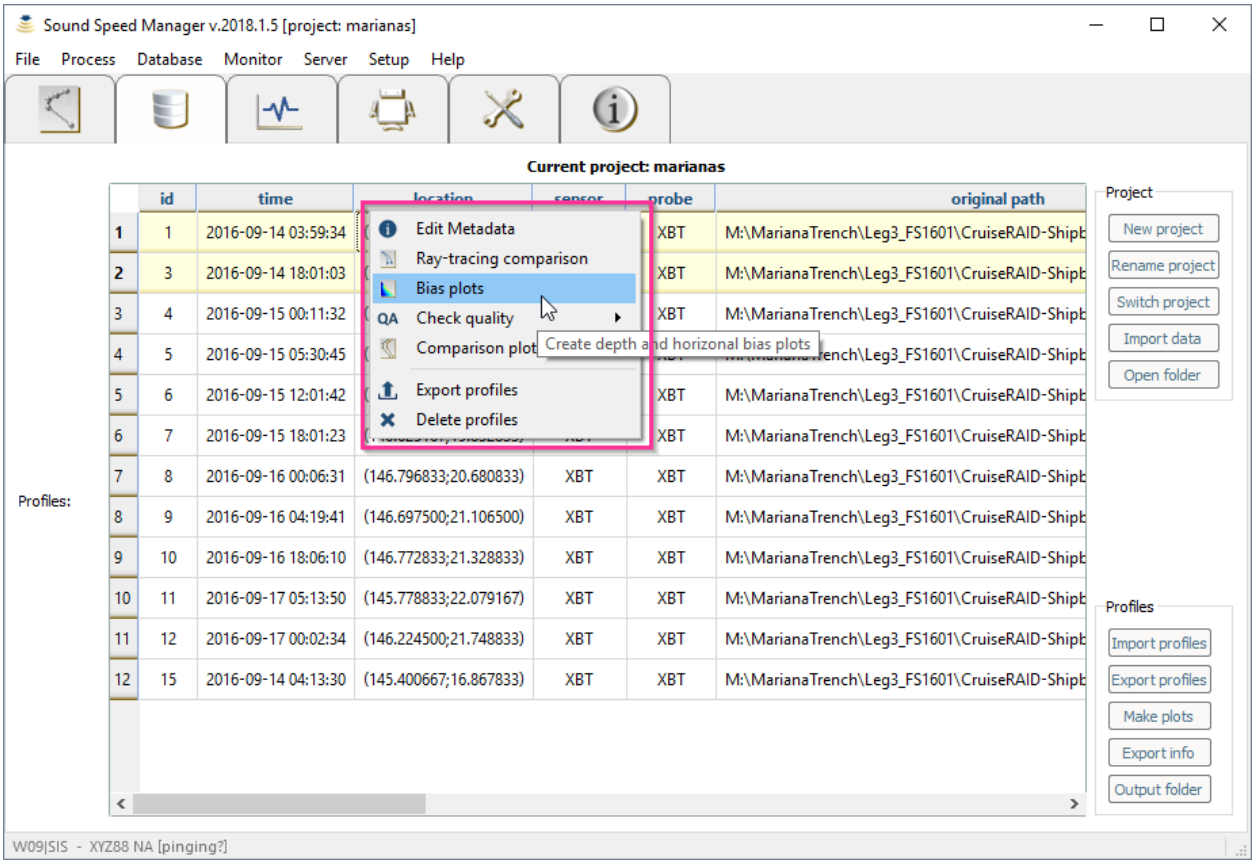

Fig. 2.47: The pair-selection context menu provides functionalities like ray-tracing comparison (Fig. 2.48) and bias plots (Fig. 2.49).

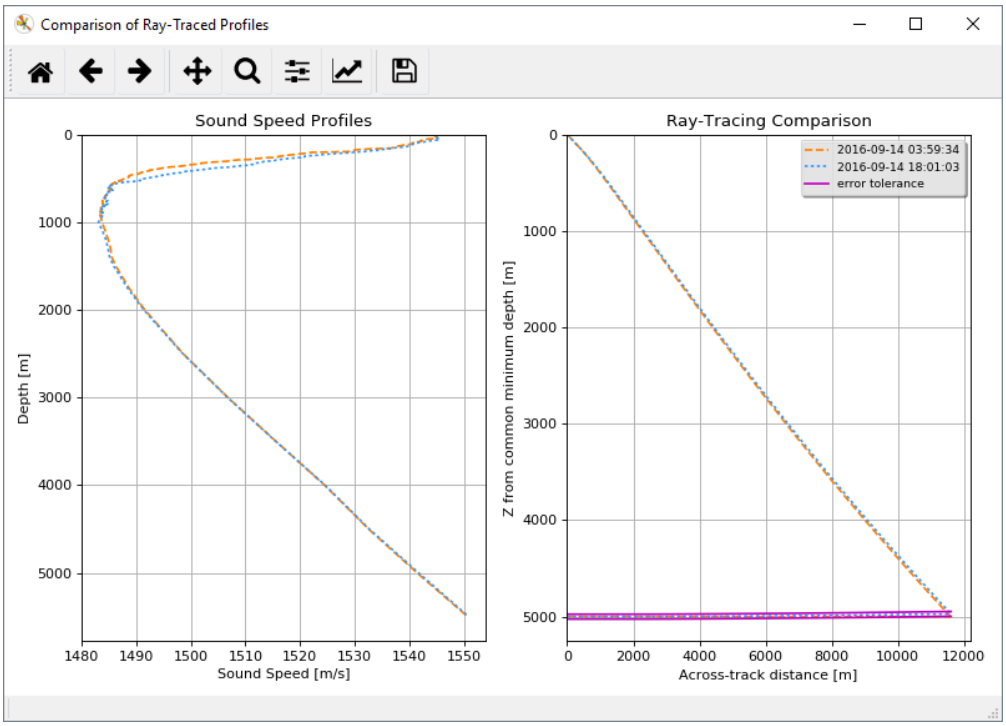

Fig. 2.48: The ray-tracing comparison between the pair of selected profiles.

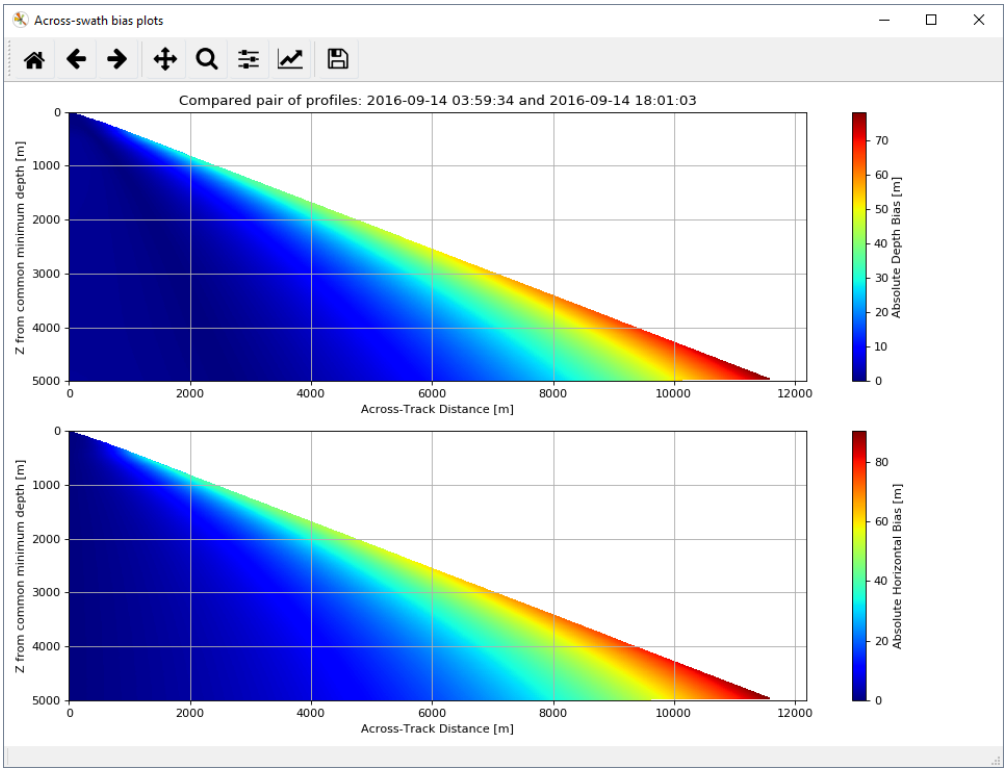

Fig. 2.49: The plots show the vertical and the horizontal bias using the pair of selected profiles.

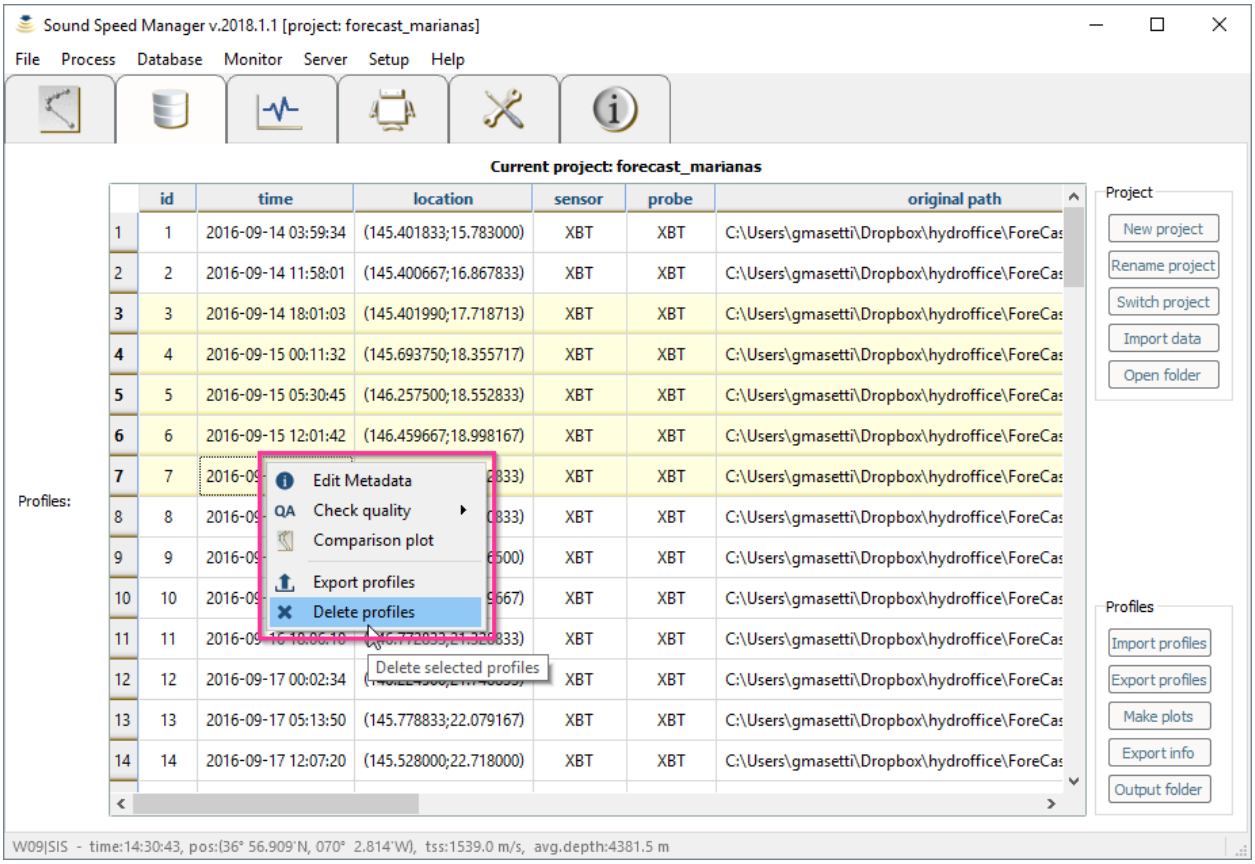

Fig. 2.50: The multi-selection context menu provides functionalities that apply to multiple profiles (e.g., editing common metadata fields for multiple profiles).

- Export the profile metadata in several geographic formats: csv, kml, shapefile (e.g., Fig. 2.52), and
- Create maps (Fig. 2.53) and plots (Fig. 2.54 and Fig. 2.55).

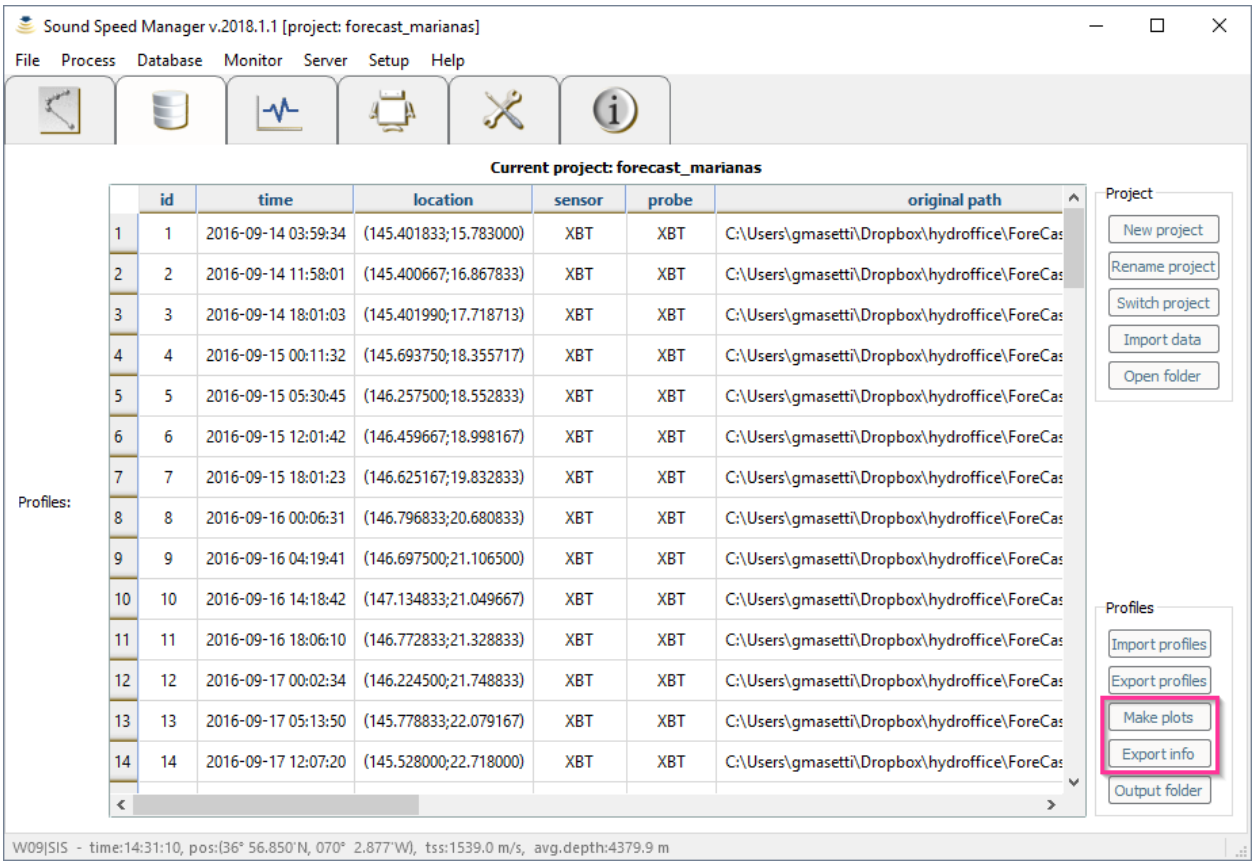

Fig. 2.51: The *Make plots* and *Export info* buttons in the *Profiles* group creates plots/maps and exports the metadata for all the profiles in the database.

Additional Functionalities

Retrieve Profiles from Various Sources

It is possible to retrieve a profile from a number of sources. This can be done by selecting one of the options listed under *Retrieve from* in the *Input data* dialog (Fig. 2.56). Database specific instructions for creating a profile are detailed in the sections below.

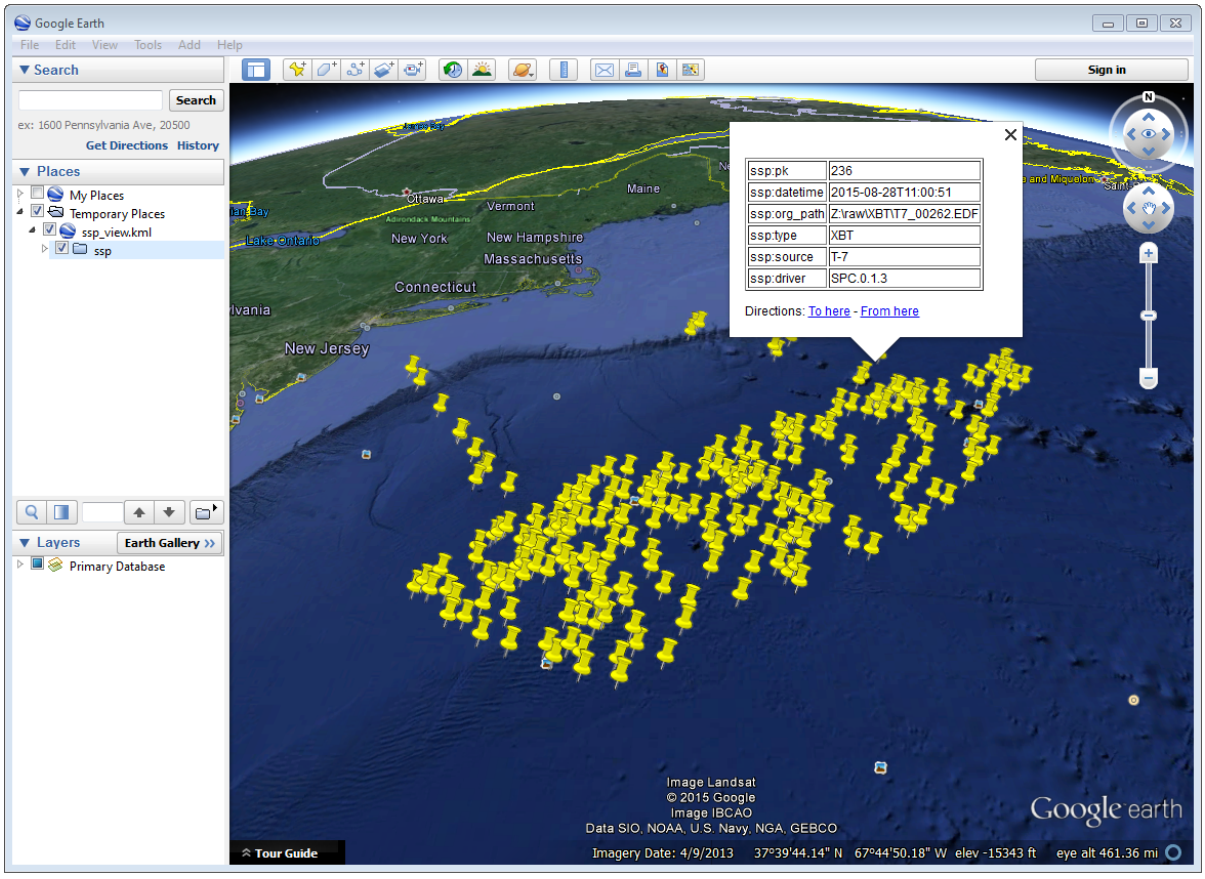

Fig. 2.52: Loading result of the exported metadata (kml format) in Google Earth.

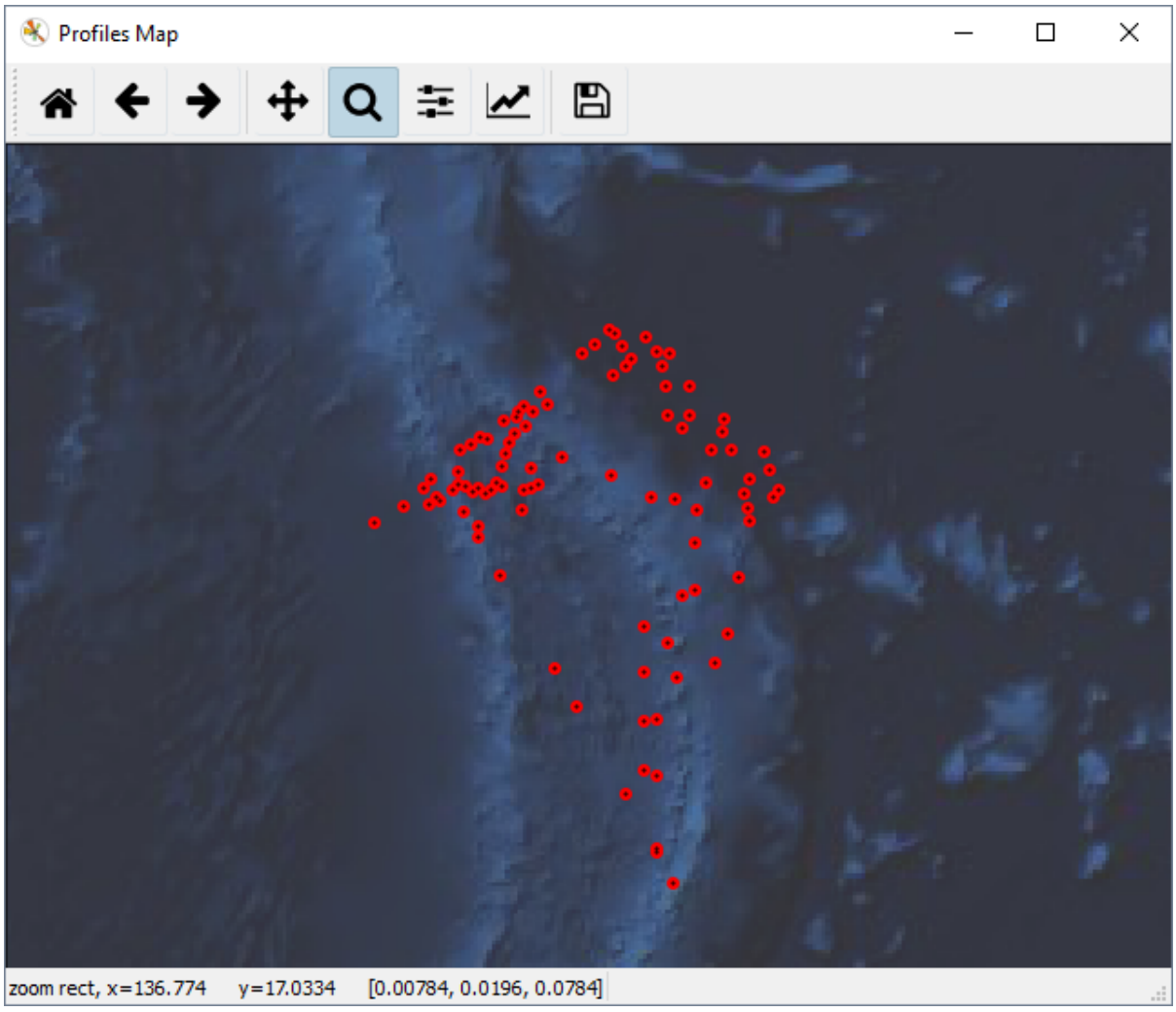

Fig. 2.53: Example of a map created from a stored SSP data set.

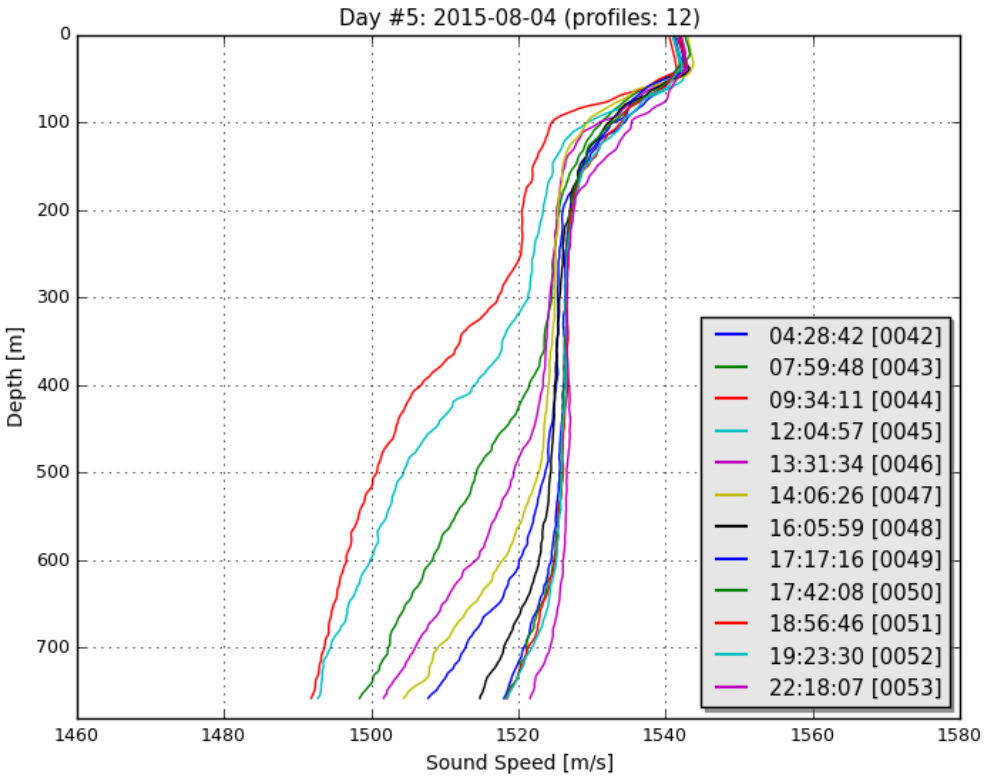

Fig. 2.54: Example of a daily plot that can be created from a stored SSP data set.

Project Database

The *Input data* dialog can be used to recall a profile from the project database. Clicking the *Project DB* button will open a dialog with a drop-down menu containing all the profiles in the current project database. After selecting a profile, it can be edited, and the resulting cast can be eventually sent as described in *Data transmission*.

Request profile from SIS4/SIS5

The *Input data* in the *Editor* toolbar can also be used to retrieve the cast currently being used by *SIS* and use it to create a new profile.

This is only possible if the package is receiving data transmissions from *SIS*. If it is not, the package will request a cast and will wait a few seconds until it times out on the request. During this wait period, the package will be unresponsive to further user interaction.

If a profile is received, it will be given the name `YYYYMMDD_HHMMSS_SIS` with the date/time in the filename based on the cast time recorded by *SIS*.

There are a number of shortcomings regarding the Kongsberg datagram format for sound speed profiles:

- It does not preserve the latitude/longitude of the observed cast. You will be prompted to enter the position of the cast when you request the cast from SIS. It is up to you to determine the position as accurately as you require it to be, perhaps by consulting CTD/XBT logs.
- The observation time associated with the cast is known to be incorrect in the *SIS* sound speed profile datagram format so it is not necessarily straightforward to use the observation time to look up the navigation.

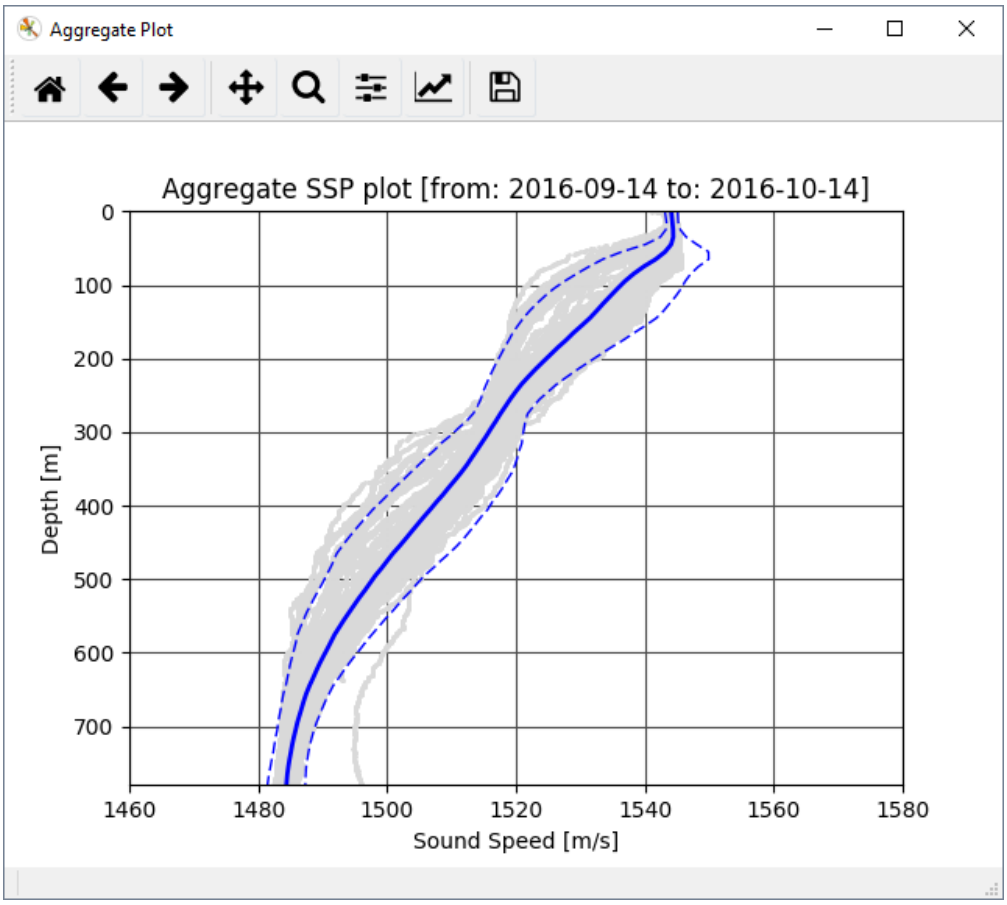

Fig. 2.55: Example of aggregate plot to study the sound speed variability during a selected time span.

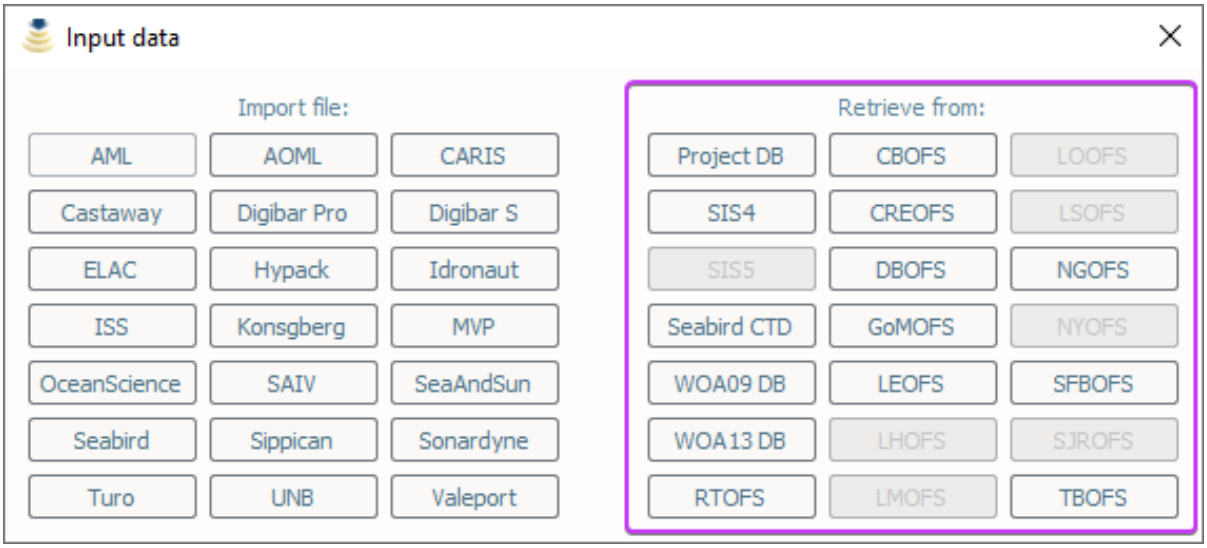

Fig. 2.56: The *Input data* button in the *Editor* toolbar.

- Temperature and salinity are not included in the datagram, even if they are provided to *SIS* when the associated cast was originally uploaded (they are preserved internally in SIS, however).

These shortcomings are overcome through the use of the "W" datagram in *SIS*, however, it is not currently possible to dynamically request this datagram from *SIS* (though it is possible to have *SIS* broadcast it as discussed in the section *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*).

Note: *SIS5* functionality is currently unavailable.

Seabird CTD

Clicking Seabird CTD in the *Retrieve from* section of the *Input data* dialog opens a dialog that allows for direct interaction with a SeaCAT instrument.

Oceanographic and Regional Atlases

It is possible to upload a single WOA, RTOFS, or any of the supported RegOFS models listed in *Appendix A - Oceanographic Atlases*. This can be done by selecting the button under *Request from* that matches the desired model service.

This will trigger a series of question dialogs about timestamp and position to apply a spatio-temporal search. The user can decide to use the SIS timestamp/position input (when available) or manually set these inputs. After, a surface sound speed can be applied, and finally the resulting cast can be sent as described in *Data transmission*.

The new cast will be given the filename YYYYMMDD_HHMMSS_MODEL where the date/time of the filename is based on the query time of the cast and MODEL corresponds to the model descriptor described in *Appendix A - Oceanographic Atlases*.

Using a reference cast

There are several scenarios where a CTD profile can be used as a reference cast by this package:

- To support XBT measurements by providing a salinity profile measurement in place of using an assumed constant salinity
- To augment SVP/XSV casts with temperature and salinity profiles to improve seafloor backscatter attenuation corrections
- Since CTD casts typically sample much deeper than most XBT probes, to provide an improved vertical extrapolation to the XBT cast.

To establish a reference cast, the desired cast is imported using the same mechanism described in *Data import*. After that the profile is verified, edited and perhaps extended further in depth using an oceanographic database, it is set as the reference profile by selecting "Reference cast" in the *Editor* toolbar (Fig. 2.57).

Once a profile is set as the reference cast, the reference profile is drawn in orange. This cast is retained in memory as the currently loaded cast to allow for additional operations, such as exporting or transmission to a sounder. The reference profile can be cleared from memory at any time via the *Clear reference cast* option under the *Reference cast* menu (Fig. 2.58). Further extensions and augmentations will then use WOA/RTOFS.

The reference cast can be reimported into memory by choosing *Reload reference cast as current profile* from the *Reference cast* menu. This will load a copy of the reference cast into memory for further manipulation. If desired, the edited version can then be set as the new reference cast and will replace the previous version. Prior to setting a cast as the reference cast, it is advisable to store it in database such that future sessions do not need to repeat any reference cast processing.

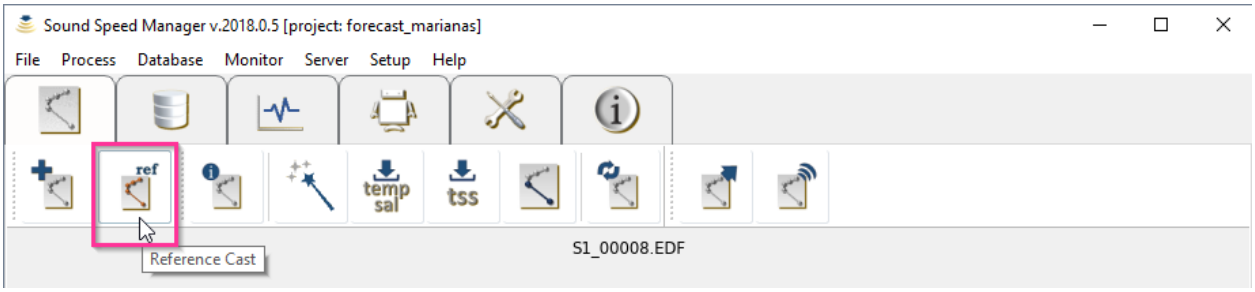

Fig. 2.57: The *Reference cast* button in the *Editor* toolbar.

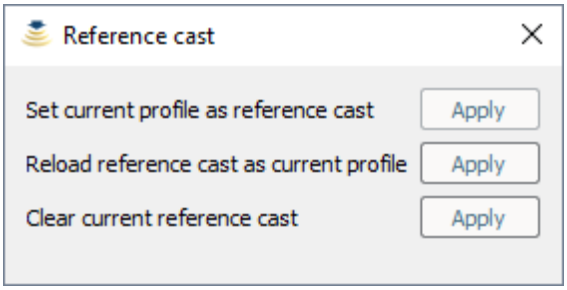

Fig. 2.58: The *Reference cast* tool.

Refraction monitor

Note: This plugin is currently disabled.

An experimental feature has been set up to allow the user to establish the impact of their currently loaded sound speed profile on the refraction correction by plotting swath data with the new sound speed profile applied prior to sending the profile to the multibeam echosounder.

This provides a preview of the effect of the new sound speed profile allowing appropriate action if the results are not as expected without introducing artifacts into the multibeam data stream.

Network data reception

The package is configurable to listen on specified ports for UDP input of sound speed cast data. Currently supported systems are *MVP* and *Sippican*. See *Appendix B - Connection Settings* for more on how to configure these systems. The port numbers associated with various data sources can be changed in the `setup.db` file using the *Setup* tab.

Upon reception of a network cast, the display panels will be colored red to indicate that operator intervention is required in order to further process the data and deliver it to the multibeam acquisition system. Once the cast has been processed and delivered, the statusbar color-coding will return to the normal background.

If the *Server mode* happened to have been running at the moment of reception, it will be stopped and the received cast will be displayed as described above.

2.4.2 Synthetic Profile Server Mode

The *Synthetic Profile Server mode* is meant for transits during which perhaps one XBT per day might be thrown. For much of the world oceans, using the WOA is a reasonable substitute for *in situ* measurements (*Beaudoin et al., 2011*).

Given that transit data are usually a lower priority, this mode supports continuous underway logging of multibeam data that are refraction corrected, using the mean temperature and salinity profiles provided by oceanographic models. This mode should not be used if SSPs are going to be collected on a regular basis.

Warning: The Server Mode is meant for use in transit, NOT for systematic seabed mapping.

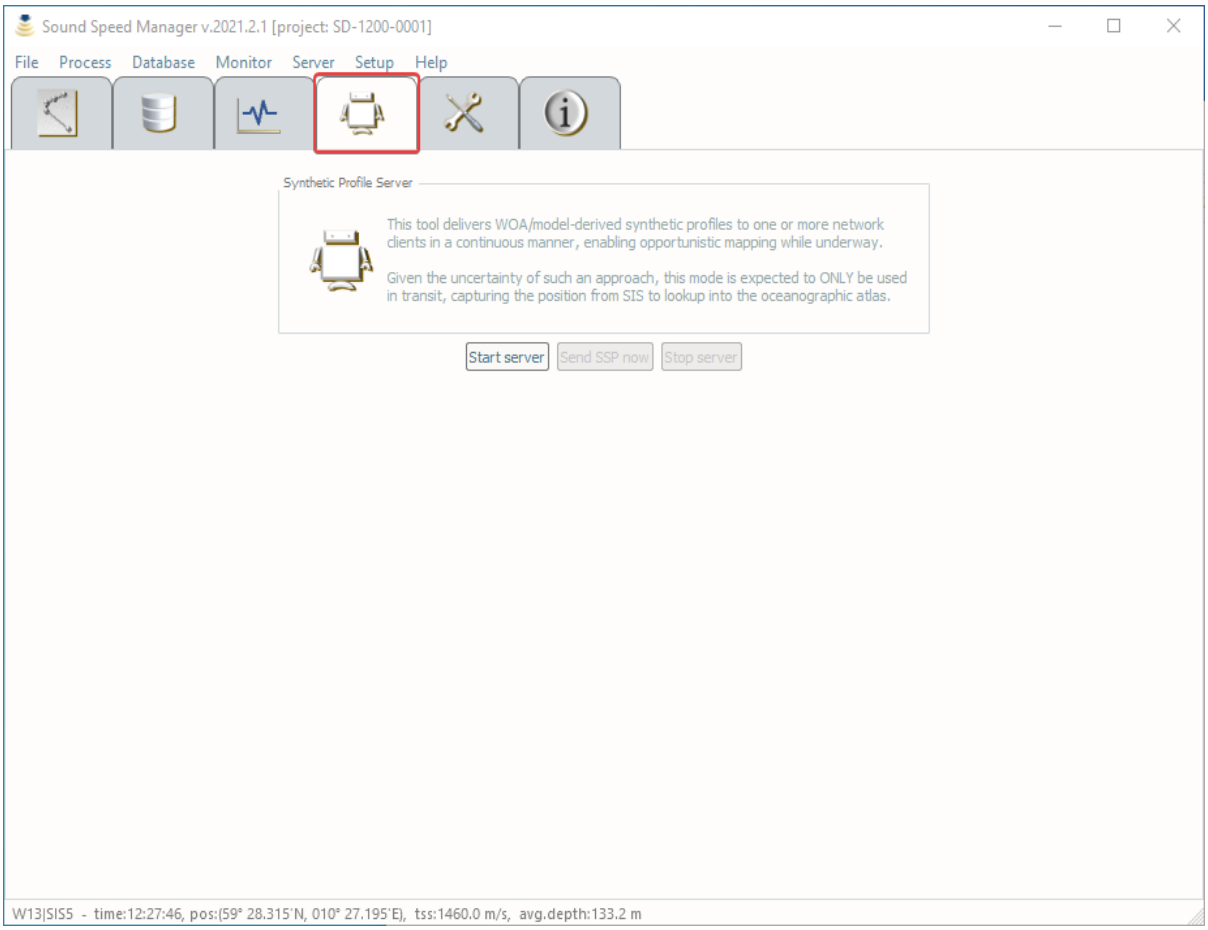

Fig. 2.59: The *Synthetic Profile Server* tab provides the controls to manage the *Server* mode.

Setup

To run the *Server Mode*, it is required to have properly set the two-way interaction with *SIS* (both receiving and transmitting specific datagrams). Based on the SIS version in use, follow the instructions in *Sound Speed Manager - SIS v4 interaction* or *Sound Speed Manager - SIS v5 interaction*.

Note: When the *SIS* interaction is properly set, the status bar updates with information like the position (*'pos:'*) and the transducer sound speed (*'tss:'*).

The *Setup* tab has the following *Server settings* options that specifically apply to the *Server Mode*:

- *Source*. It defines the source used to retrieve the synthetic profile.
- *Surface sound speed*. If true, the received transducer sound speed is used to enhance the transmitted synthetic profile.

When clicking on the "Start server" button and in case that unidirectional clients (e.g., QINSy) are present, the user is prompted to decide whether or not transmitting the profiles to them. Given that no acknowledgment is received, *SSM* cannot automatically verify the profile transmission.

Each time that the *Server Mode* is started, a few initialization checks are performed:

- The selected *Source* being currently in use.
- The reception of navigation and depth datagrams from SIS.
- Only for SIS clients, the interaction with them (by requesting the sound speed profile in use).

Note: *SIS* will accept and rebroadcast SVP datagrams even if it is not pinging. Thus, to make a client appearing "dead" to the server, you must shutdown *SIS*.

If any of these checks fails, an error message is displayed (Fig. 2.60).

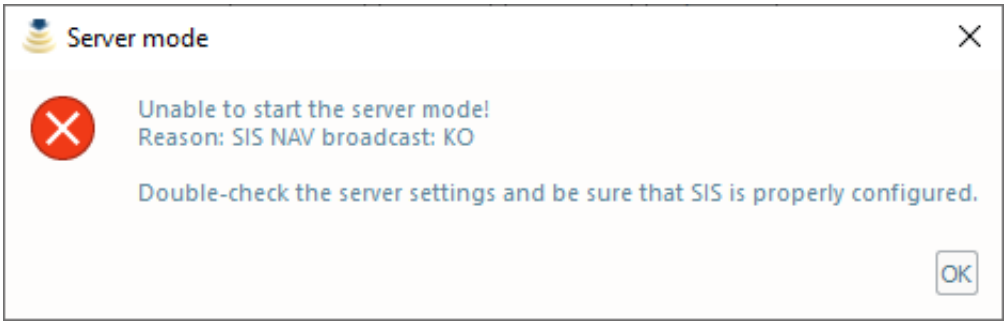

Fig. 2.60: An example of error message after the failure of one of the initialization checks for the *Server Mode*.

How to use

The *Server Mode* is activated by clicking on the "Start server" button (Fig. 2.59).

Note: When the *Server Mode* is active, all the other SSM functionalities becomes unavailable until it is stopped.

During the *Server Mode*:

- The last transmitted profile is displayed in the view panel.
- The status bar is colored in cyan.

While activated, the *Server Mode* evaluate the need for transmitting a new synthetic profile every 60 seconds.

The evaluation is done following these steps:

- The latest location (with associated timestamp) is retrieved from SIS. If a new navigation datagram is not available, the retrieval is attempted several times for a total time of 60 seconds. In case that such an amount of time is not sufficient, the *Server Mode* is automatically stopped.
- Based on the retrieved information and the selected source, the indices for retrieving the synthetic profile are calculated. If the location is out of the coverage for the selected source, the *Server Mode* is NOT stopped because the vessel may later enter the area covered by the selected source.
- If the 'Surface sound speed' option is active, an attempt to retrieve the surface sound speed from SIS is performed.
- The transmission of a new synthetic profile is decided in case of:
  - A variation of transducer sound speed greater than 1 m/s.
  - A change of source indices given by the vessel navigation.
  - The user have clicked the 'Send SSP now' button.
- To guard against accidentally overwriting a profile uploaded by the operator (or by another program) directly into SIS, the *Server Mode* compares the SSP currently on *SIS* against the latest two transmitted synthetic SSP. This **cannot** happen in case on unidirectional clients (e.g., QINSy).

Note: In case that the SIS and the transmitted profiles differ, the *Server Mode* automatically stops.

- If a new transmission is decided, the synthetic profile is generated.

In case of multiple clients, the *Server Mode* delivers the cast sequentially to all clients. Failure on transmission to one client will not interfere with other clients.

Once a SIS-based client is deemed "dead", i.e., no reception confirmation is received, no further attempts to send to the client are made. Thus, in case that a "dead" SIS-based client comes back to life, a *Server Mode* restart is required.

Note: If the *Server Mode* is unable to confirm clients, the *Server Mode* automatically stops.

The *Server Mode* can be manually stopped by clicking the *Stop server* button (Fig. 2.59). Closing SSM will also stop the server.

2.4.3 Survey Data Monitor

The *Survey Data Monitor* (Fig. 2.61) has two main functionalities:

- Monitoring the survey data being collected *(SIS required)*.
- Estimation of the time of the next cast (always available, but SIS information are used if present).

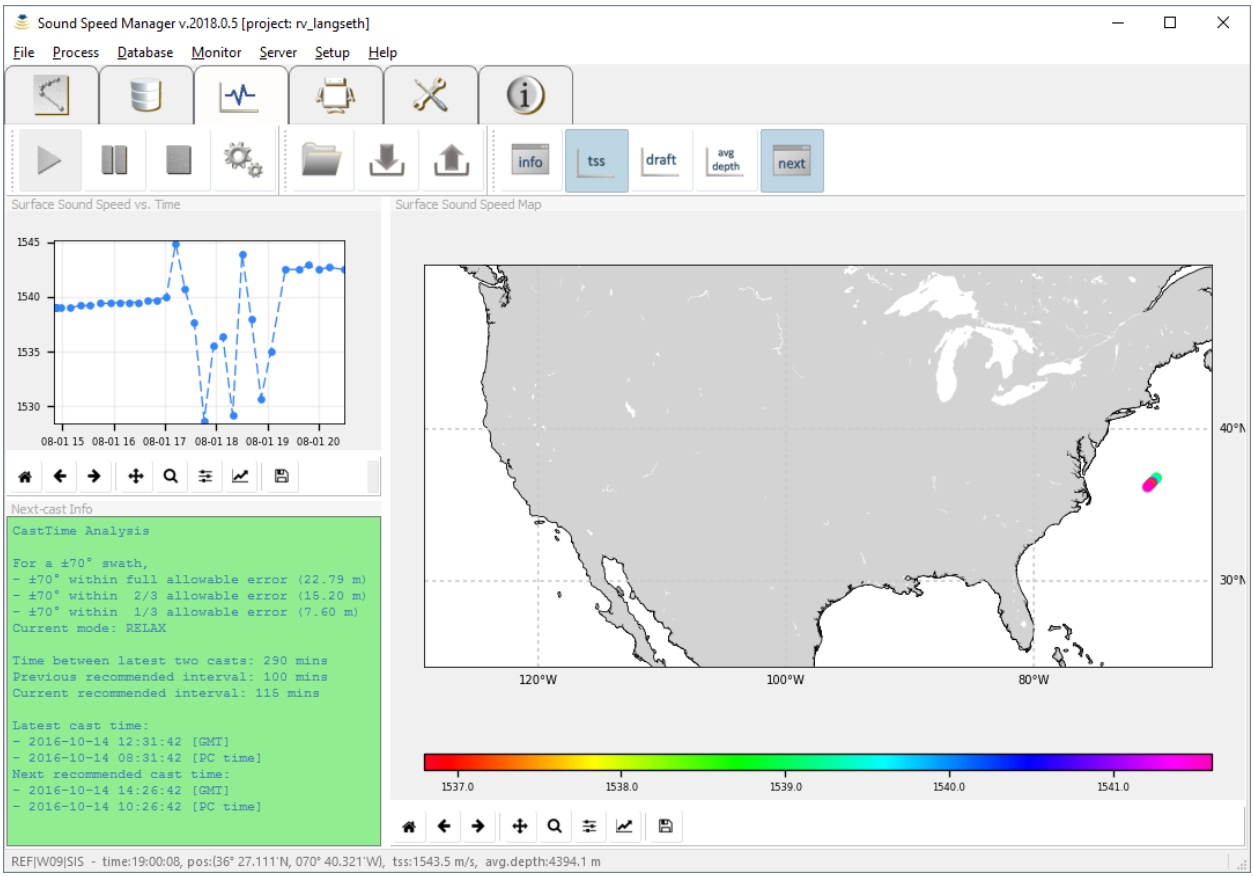

Fig. 2.61: Survey Data Monitor tab.

In Brief

The default configuration uses the *CastTime* algorithm to estimate the time suggested for the next cast. *CastTime* analysis is based on the two latest casts from the Sound Speed Manager database (see *Database Tab*).

The background color in the *Next-cast Info* viewer (Fig. 2.61) identifies three possible estimation states (calculated in function of the maximum allowable error):

- *Steady* state (blue): the casting interval is the same as in the previous estimation.
- *Relax* state (green): the previous casting interval was increased.
- *Panic* state (red): the previous casting interval was reduced.

Independently by the current estimation state, the *Next-cast Info* viewer starts to blink when the suggested next-cast time was reached, and there have not been newer casts stored in the database.

In the following sections, more details on how to use the *Survey Data Monitor* usage are provided.

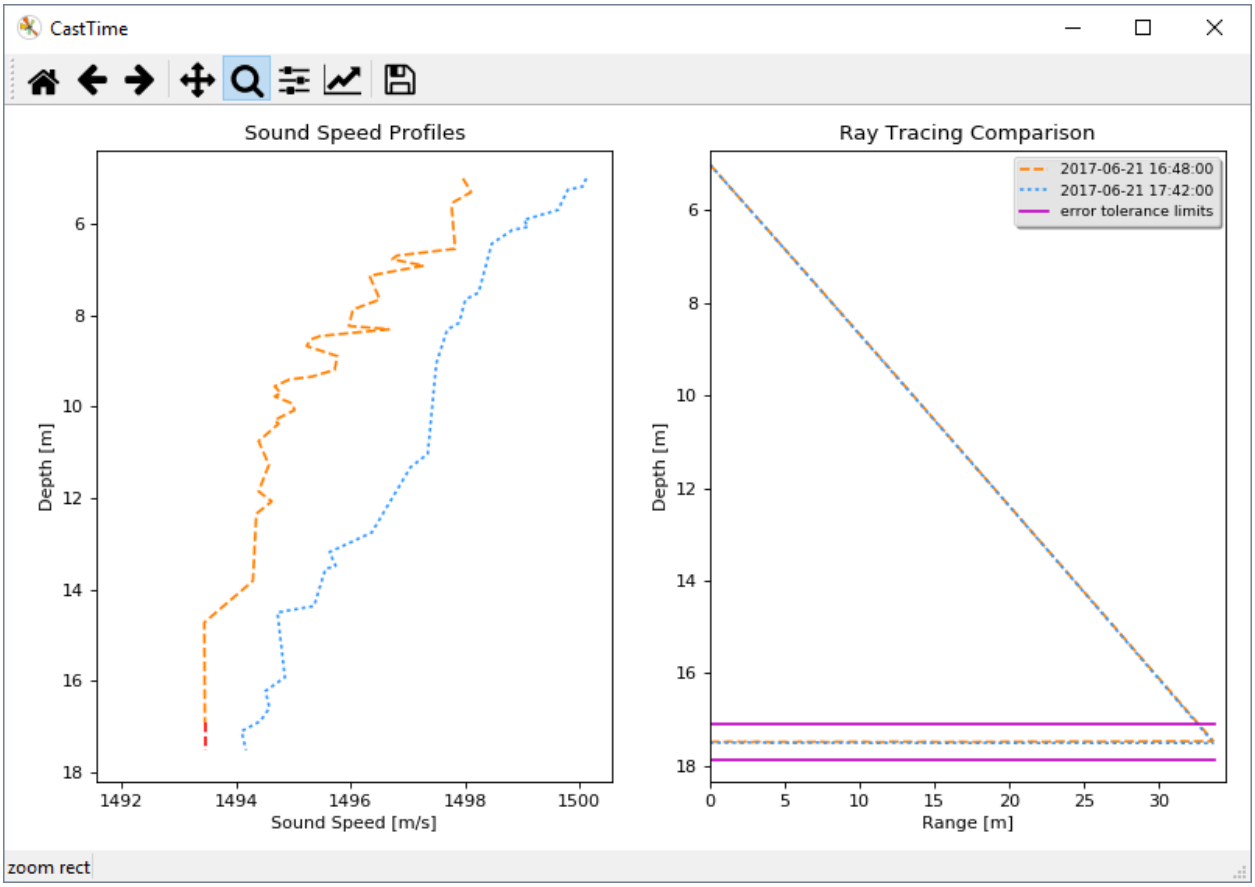

Fig. 2.62: Example of analysis plot to display the error tolerance limits (in magenta on the right pane) used by CastTime to estimate the next cast time.

Data Monitor toolbar

The *Data Monitor* toolbar (Fig. 2.63) is used to start, pause, or stop the collection and the analysis of the survey data.

When SIS interaction is active, additional data (i.e., dynamic transducer draft, sound speed at transducer, and average depth across the sonar swath) are collected.

The collected monitoring data are stored in a survey database (.mon).

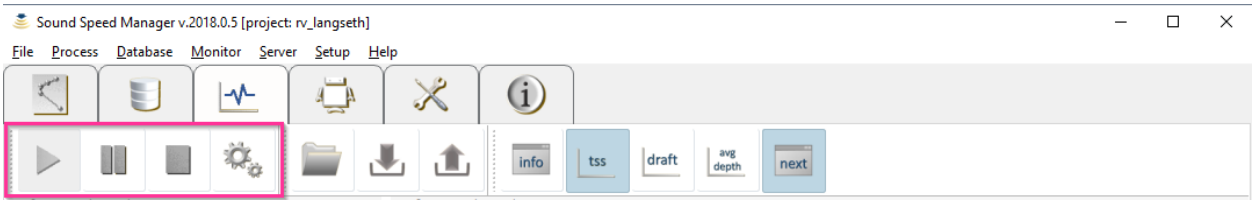

Fig. 2.63: In red, the *Data Monitor* toolbar controls to start, pause, or stop the data monitoring.

The *Options* button in the *Data Monitor* toolbar (Fig. 2.63) provides access to the setup, organized as follows:

- *General* tab (Fig. 2.64).
- *CastTime* tab (Fig. 2.65).
- *ForeCast* tab *(currently disabled)*.
- *Plots* tab (Fig. 2.66).

Note: A high number of samples selected in the *Plots* tab (Fig. 2.66) may reduce the reactivity of Sound Speed Manager.

Data Manager toolbar

The *Data Manager* toolbar (Fig. 2.67) provides functionalities to load previously collected data as well as to export such data in a few geospatial formats (Fig. 2.68).

It is also possible to import Kongsberg EM Series (.all) files.

When a GeoTiff output is selected, the surface sound speed values in the collected data points are rasterized in two kinds of files:

- Floating point GeoTiff, to be loaded in GIS applications (like QGis, Caris Hips&Sips, Esri ArcMap).
- Color-table Geotiff, supported by a large number of applications (e.g., Xylem HYPACK).

Data Views toolbar

The *Data Views* toolbar (Fig. 2.69) helps the user to customize the data visualization.

The *Survey Data Monitor* tool provides several plots and viewers that can be un-docked to ease their visualization while performing other tasks with Sound Speed Manager:

- *General Info* viewer.
- *Surface Sound Speed Map* plotter.
- *Surface Sound Speed vs. Time* plotter.

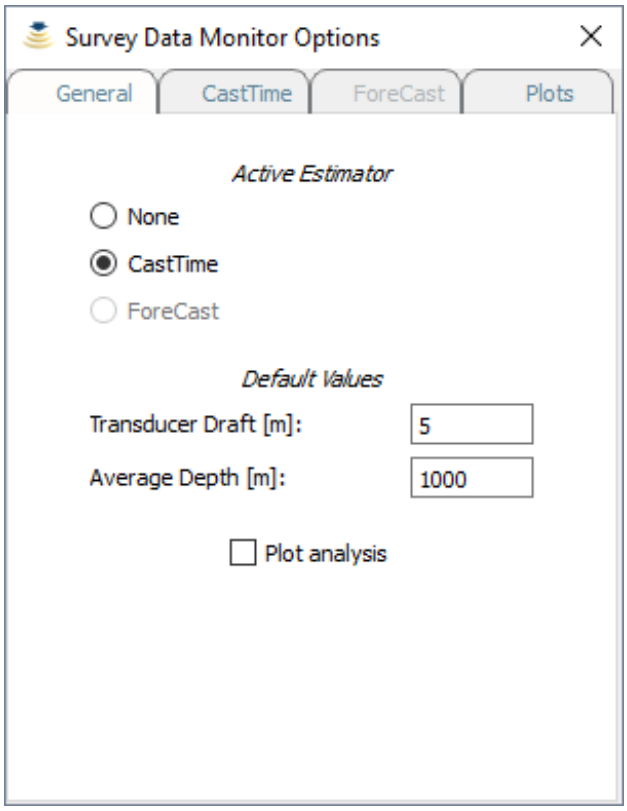

Fig. 2.64: In the *General* tab, you can select the estimator to be used *(ForeCast is currently disabled)*. You can also change the default values adopted by the estimator in case that SIS data are not available. When the *Plot analysis* flag is set, additional plots are visualized at the time of next-cast estimation.

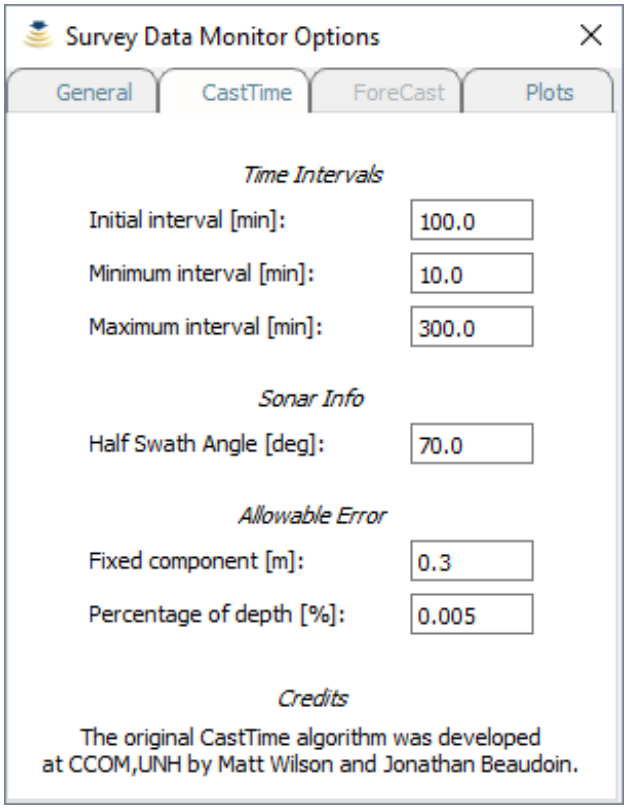

Fig. 2.65: This tab contains the *CastTime*-specific settings: the initial casting interval, the possible range of variability for the estimated casting interval, the angle at which to calculate the ray-tracing, and the factors used in the formula used to calculate the maximum allowable error.

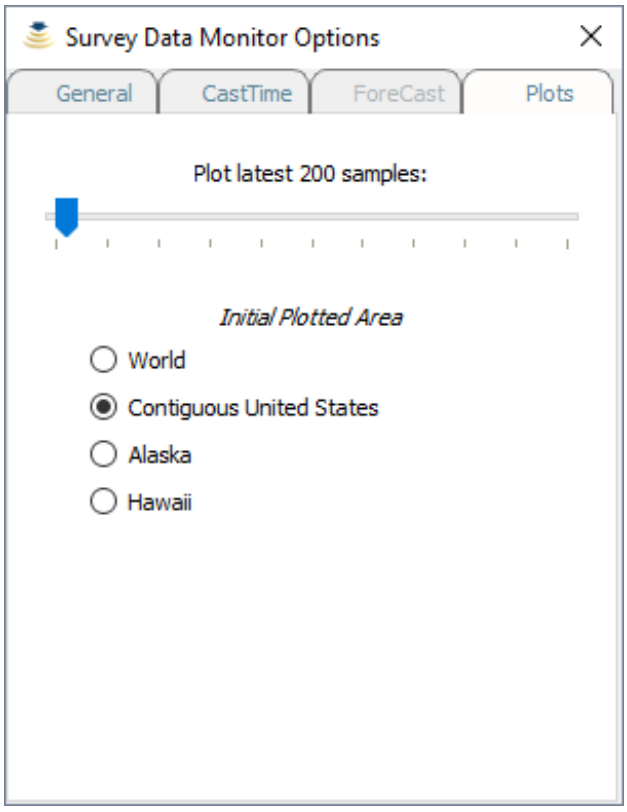

Fig. 2.66: This tab is used to change the number of samples displayed in the plotters. This value does not affect the storing in the survey database (.mon). It is also possible to select the initial plotted area (e.g., CONUS).

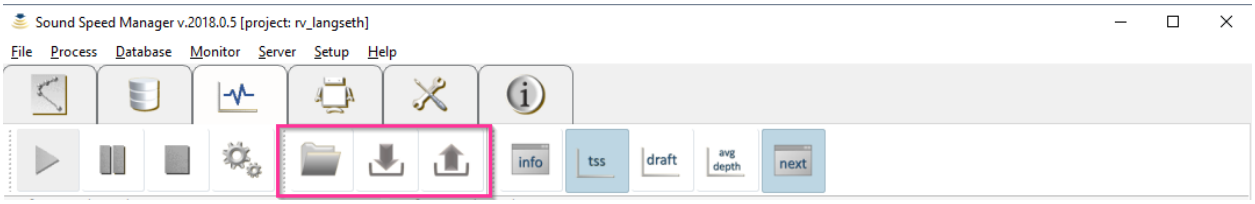

Fig. 2.67: In magenta, the *Data Manager* toolbar controls to open the output folder, to load data, and to export in various formats.

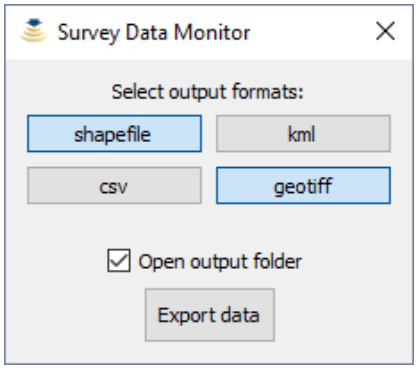

Fig. 2.68: The dialog shows the available export data formats.

- *Transducer Depth vs. Time* plotter.
- *Average Depth vs. Time* plotter.
- *Next-Cast Info* viewer.

Each plotter has a navigation toolbar that provides basic functionalities like panning and zooming.

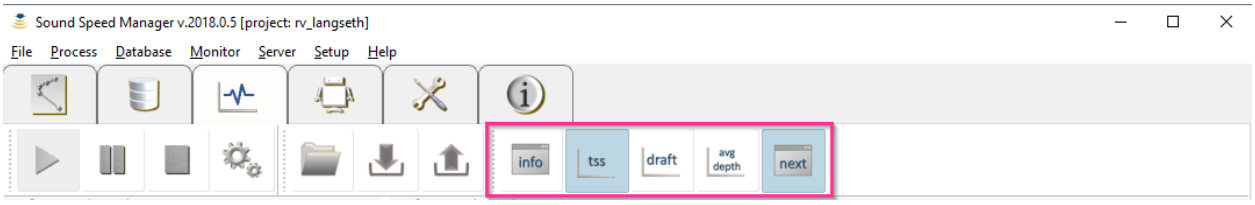

Fig. 2.69: In magenta, the *Data Views* toolbar controls to toggle the visualization of viewers and plotters.

The *Next-Cast Info* viewer (Fig. 2.70) displays textual information related to the latest analysis performed by the next-cast estimator (e.g., *CastTime*).

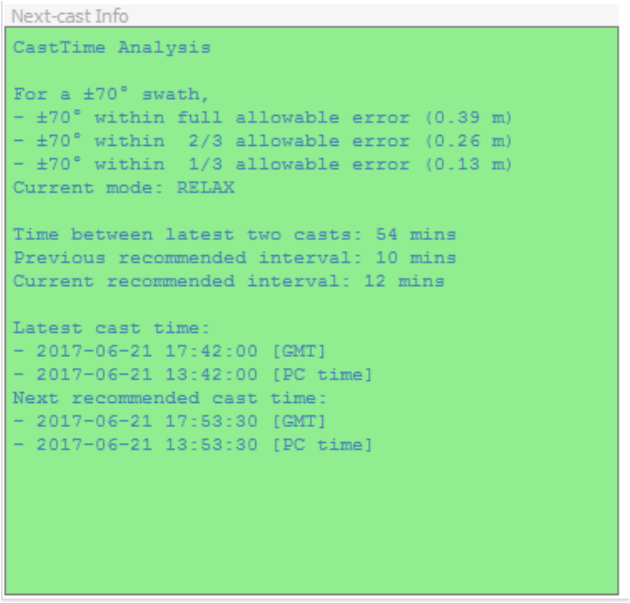

Fig. 2.70: The *Next-Cast Info* viewer provides information on the analysis performed by the *CastTime* algorithm.

2.4.4 List of references

- Masetti, G., Gallagher, B., Calder, B.R., Zhang, C., and Wilson, M.J., 2017, *Sound Speed Manager: An Open-Source Application to Manage Sound Speed Profiles*: International Hydrographic Review, v. 17, p. 31-40.
- Gallagher, B., Masetti, G., Zhang, C., Calder, B.R., and Wilson, M.J., *Sound Speed Manager: An Open-Source Initiative to Streamline the Hydrographic Data Acquisition Workflow*, in Proceedings US Hydro Conference 2017, March 20-23, Galveston, TX, USA.
- Beaudoin, J., Smyth, S., Furlong, A., Floc'h, H., and Lurton, X., *Streamlining Sound Speed Profile Pre-Processing: Case Studies and Field Trials*, in Proceedings US Hydro Conference 2011, April 25-29, Tampa, FL, USA.

- Fofonoff, N. P., and Millard, R. C., 1983, *Algorithms for computation of fundamental properties of seawater*: Rep. No. 44, Division of Marine Sciences, UNESCO, Place de Fontenoy, 75700, Paris, France.
- Taira, K., Yanagimoto, D., and Kitagawa, S., 2005, *Deep CTD Casts in the Challenger Deep, Mariana Trench*: Journal of Oceanography, v. 61, no. 3, p. 447-454.

Note: For some examples on how to use the library: https://github.com/hydroffice/hyo2_soundspeed/tree/master/examples

2.5 Appendix A - Oceanographic Atlases

2.5.1 World Ocean Atlas

The World Ocean Atlas is a 3-dimensional grid of mean temperature and salinity for the world's oceans that is based upon a large set of archived oceanographic measurements in the World Ocean Database.

More information about the World Ocean Atlas 2009 (WOA09) can be found online

The WOA09 netCDF temperature and salinity grids used by the package can be accessed from http://www.nodc.noaa.gov/OC5/WOA09/netcdf_data.html

The files required are:

- *temperature_annual_1deg.nc*
- *temperature_seasonal_1deg.nc*
- *temperature_monthly_1deg.nc*
- *salinity_annual_1deg.nc*
- *salinity_seasonal_1deg.nc*
- *salinity_monthly_1deg.nc*

Basin and land/sea masks can be downloaded from: http://www.nodc.noaa.gov/OC5/WOA09/masks09.html

2.5.2 Global Real-Time Ocean Forecast System

The Global Real-Time Ocean Forecast System (RTOFS Global) is a 1/12°, 3-D oceanographic forecast model. More information can be found online at: http://polar.ncep.noaa.gov/global/

Daily forecast/nowcast grids can be downloaded via the URL listed above, but the file sizes for the daily forecast are prohibitive for use at sea. Instead, the package relies on the OpenDAP portal to download only small segments of the nowcast grids for surrounding a specified query location. The downloaded subset is a 5x5 grid centered on the query location.

2.5.3 Regional Operational Forecast System

The NOAA Operational Forecast System (RegOFS) is a network of operational nowcast/forecast hydrodynamic models covering a number of coastal regions in the USA. Models are run 4 times a day and generate current and short-term (0 to 48 hour) forecast predictions of pertinent parameters such as water levels, currents, temperature, and salinity.

More information about RegOFS models can be found at: https://tidesandcurrents.noaa.gov/models.html

Daily forecast/nowcast grids can be downloaded via the URL: https://opendap.co-ops.nos.noaa.gov/thredds/catalog.html

Similar to the RTOFS Global atlas, the package relies on the OpenDAP portal to download only small segments of the nowcast grids surrounding a specified query location.

Currently the package supports a limited number of the RegOFS models. The full list of models with related support is provided in the table below.

Regional Operational Forecast System Model	Descriptor	Support
Chesapeake Bay	CBOFS	X
Deleware Bay	DBOFS	X
Gulf of Maine	GoMOFS	X
New York and New Jersey	NYOFS	
St. John's River	SJROFS	
Northern Gulf of Mexico	NGOFS	X
Tampa Bay	TBOFS	X
Lake Erie	LEOFS	X
Lake Huron	LHOFS	
Lake Michigan	LMOFS	
Lake Ontario	LOOFS	
Lake Superior	LSOFS	
Columbia River Estuary	CREOFS	X
Sanfrancisco Bay	SFBOFS	X

2.5.4 Synthetic cast values derived from atlases

The cast extrapolation algorithm vertically extends temperature and salinity profiles as deep as possible using the estimates immediately local to the area of the cast in either WOA or OFS.

WOA09-based profiles

The World Ocean Atlas 2009 (WOA09) extension algorithm uses a nearest neighbor lookup in each of the 33 depth levels in the grids within a 3x3 grid node search box centered on the cast's geographic position. This is roughly equivalent to a search radius of 1.5° or 90 nmi at the equator. Note that this grid node search box becomes rapidly narrower in the east-west direction with latitude. The nearest-neighbor geodetic distance is, however, correctly computed and the nearest neighbor will indeed be the geographically most proximal grid node; the only shortcoming is that the lookup will ignore potentially closer data in the east-west direction at high latitudes.

Future updates to the WOA09 extraction algorithms will remedy this shortcoming. The search radius is set this large to enable the extension to at least estimate deeper temperature and salinity values in the case where the true depth at the requested location is significantly larger than the coarse depth reported in the WOA09 grid for that location (the WOA09 grid depth will generally always be smaller than the true depth).

The search algorithm will not respect topographic boundaries and may extrapolate profiles using data from a neighboring oceanographic basin. Future versions of the algorithm will address this shortcoming as well, likely with the use of

the basin mask file provided with the WOA09 data set.

WOA13-based and WOA18-based profiles

WOA13 represents the ocean state variables of temperature and salinity with more detail and less uncertainty than WOA09 due to large increases in data holdings and better temporal and spatial coverage coupled with refined analysis and quality control techniques:

- Increased vertical resolution (3x in the upper ocean, 2x below 1500 m.)
- Increased spatial resolution (16x)
- Release of the decadal climatologies which were used to calculate the final 1955-2012 long-term climatological mean fields.

In the specific, the package uses the WOA13v2 release that was prepared to address both methodology concerns and, to a lesser extent, quality control concerns which have surfaced since the initial release of WOA13.

WOA18 was released September 30, 2018. It includes approximately 3 million new oceanographic casts added to the WOD, as well as renewed and updated quality control.

RTOFS-based profiles

The RTOFS extension algorithm differs in the size of the search area (5x5), roughly equivalent to a search radius of 0.2° or 12.5 nmi at the equator. All of the shortcomings of the WOA09 lookup described above also apply to the RTOFS lookup.

RegOFS-based profiles

The Regional Operational Forecast System Models follow an approach similar to the *RTOFS-based profiles*. However, the resulting search radius is function of the regular grid resolution at which each model output is published.

Profile Finalization

The final extrapolation to a depth of 12,000 m is done using the values measured by *(Taira et al., 2005)* in Challenger Deep. This could be improved by searching for the nearest neighbor grid node at the deepest level observed in the basin using the basin mask file.

2.6 Appendix B - Connection Settings

2.6.1 Settings for data reception

Moving Vessel Profiler

The MVP controller interface can be configured to transmit data via UDP using a variety of data format and transmission protocols (*Figure – MVP Controller configuration dialog. Boxes A through C are required for transmission of cast information. Box D can be configured to transmit sensor data.*).

The MVP computer IP address and the IP address of the machine running the *SSM* package can be configured in *Box A*. For newer versions of the MVP controller, it is recommended to choose the `NAVO_ISS60` transmission protocol as this will allow for large cast files to be transmitted in several packets without overflowing the UDP maximum packet size limitation (*Box B*). Older versions of the MVP controller software (up to version `2.35` to the best of our knowledge)

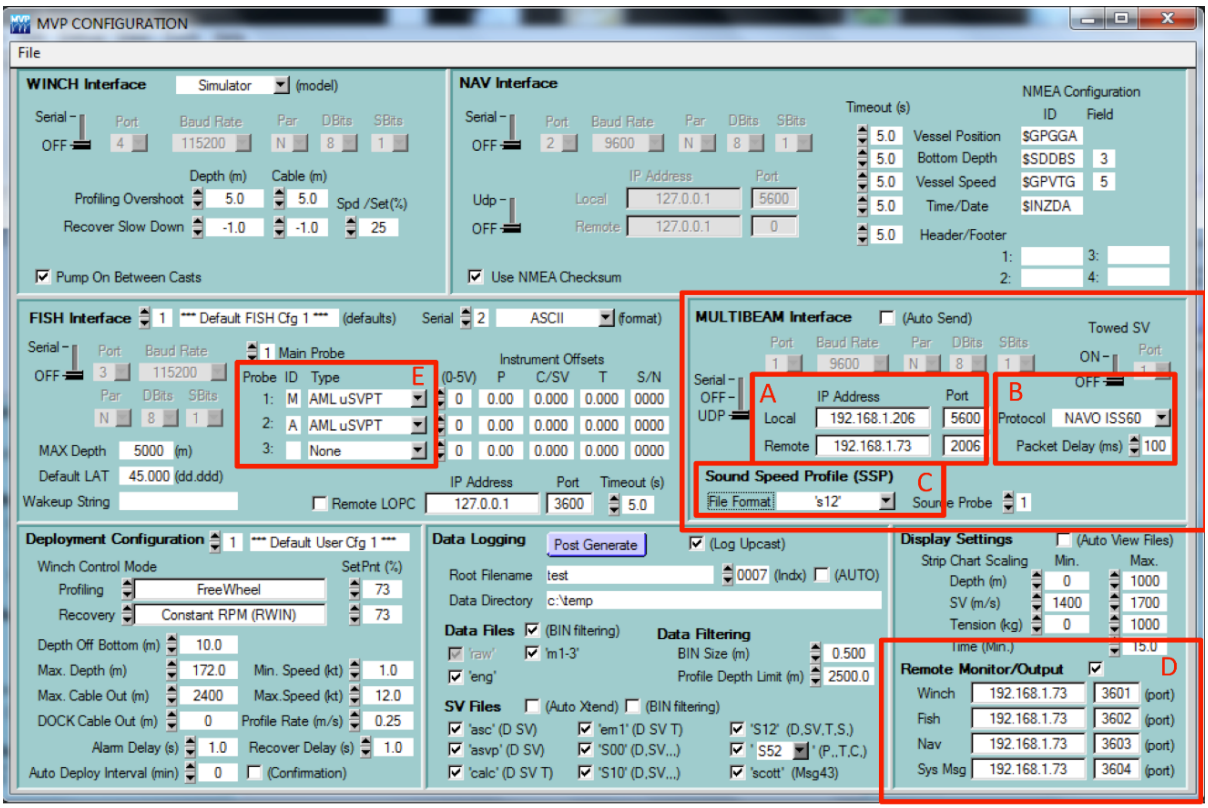

Fig. 2.71: Figure – MVP Controller configuration dialog. Boxes A through C are required for transmission of cast information. Box D can be configured to transmit sensor data.

do not support the NAVO_ISS60 protocol and the package must be configured to use the UNDEFINED protocol in the SSP package configuration file. The file format can be adjusted to accommodate a CTD with the S12 format or a sound speed sensor with the CALC or ASVP formats (Box C).

Note that the transmission protocol and file format must be configured in both the MVP controller interface and in the the *Setup* tab (in the *Input* tab, to activate the MVP listener and, in the *Listeners* sub-tab, for the communication settings).

Boxes D and E refer to raw instrument transmission settings that are configurable for future use. Since casts received from an MVP system do not have a filename embedded in the data stream, the *Sound Speed* package will name casts received using the following convention: YYYYMMDD_HHMMSS_MVP. The date/time stamp embedded in the filename will be the time of the cast.

Note: Once the MVP listener is activated, a "MVP" token will be visualized on the left side of the SSM's status bar.

Sippican

There does not currently exist any internal mechanism in the Sippican software to broadcast data via UDP, this capability has been included to accommodate vessels that use UDP network broadcasts to log data from various systems. The expected data format is the Sippican native .EDF file format.

Note that a single Sippican data file can sometimes exceed the maximum buffer size for UDP packet transmissions. If software is written to transmit Sippican data files via UDP, this limitation should be kept in mind. The *Sound Speed* package currently only accepts transfer of a single UDP packet thus transmission software may need to reduce the data by thinning the profile. Received profiles will use the filename embedded in the .EDF.

2.6.2 Settings for data transmission

The *Sound Speed* package can be configured to transmit data to a number of systems by selecting the *Transmit data* button in the *Editor* tab.

For installations with multiple clients, the *Sound Speed* package will deliver the cast sequentially to all clients. Failure on transmission to one client will not interfere with other clients. However, it will slow down the transmission sequence through all clients for any clients who are timing out on confirmation of reception as the *Sound Speed* package will wait up to the 'RX timeout' value defined in the setup (default: 20 seconds) for confirmation.

Note: Server mode will only *currently* work with the *SIS* transmission protocol.

Kongsberg SIS v4

SIS v4 does not require additional configuration to receive sound speed files since it always listens on port 4001 for input sound speed data.

The following indications are useful for monitoring reception of sound speed profiles:

- The SSP profile filename will be updated in the Runtime parameters menu in the form: YYYYMMDD_HHMMSS.asvp. The date and time fields are populated based on the time stamp in the profile that was received from the SSP package. In the case of measured casts, this is the time of acquisition, as found in the input file. In the case of synthetic WOA profiles, the date/time is based on the time of transmission of the cast (using the computer clock where the SSP package is installed).
- *SIS* creates several files in the last location from which it loaded a sound speed profile.

- The SVP display window, if being viewed in *SIS*, will update with the new cast.
- In the event that a cast is rejected, *SIS* will launch a warning dialog to indicate that the cast it received was rejected.

Although *SIS v4* will always allow incoming sound speed transmissions, it has several restrictions that must be observed in order for the data to be accepted (see *Kongsberg manual*). As this particular transmission protocol is used by other acquisition systems, it is worth describing in detail what the *Sound Speed* package does to the cast data to satisfy the input criteria for *SIS*.

The transmission procedure used by the SSP package will format the temperature and salinity profiles into the Kongsberg Maritime format. Since the WOA09/RTOFS grids only extend to a maximum depth of 5,500 m, the profile undergoes a final extrapolation to a depth of 12,000 m to satisfy *SIS v4* input criteria, this is done with temperature and salinity values measured in the Mariana Trench by *Taira et al. (2005)*.

Since *SIS v4* input profiles have a limit on the maximum allowable number of data points, the sound speed profile is thinned using a modified version of the Douglas-Peucker line reduction method as described by *Beaudoin et al. (2011)*. The algorithm begins with a small tolerance and increases it linearly until the number of points in the profile falls below the maximum allowed by *SIS*.

By default, the cast header is formatted to instruct *SIS v4* to accept the profile for immediate application without launching the *Kongsberg SVP Editor*. This behavior can be changed through the configuration file by setting *Auto apply profile* to *False* (in the *Setup* tab). In this case, *SIS v4* will accept the cast but will then launch its own editor interface and user interaction will be required on the *SIS v4* computer in order to have the cast applied to the multibeam system.

Once the cast has been prepared for transmission, it is sent to *SIS v4* via UDP transmission over the network. If *SIS v4* receives the profile and accepts it, it will rebroadcast the SVP datagram. The *Sound Speed* package waits for this rebroadcast to ensure reception of the cast. The profile that was re-broadcasted from SIS is compared against that which was sent. If they match, then the transmission is considered successful. If there is a discrepancy, or if no rebroadcast profile is received, the user is notified that reception could not be confirmed. The lower left status bar notifies the user of the various stages of this verification process.

In deep water, the rebroadcast event may take several seconds to occur and the software will wait up to a user-defined amount of time (e.g., 20 seconds) for reception of the re-broadcasted SVP. All other package functionalities are suspended during this wait period.

Hypack

The *Sound Speed* package can transmit data to *HYPACK* using *HYPACK*'s driver for Moving Vessel Profiler (MVP) systems (`MVP.dll` version 23.3.0.0 and above). The next figures provide a guidance on how to configure a *HYPACK* 2023 project to receive data from the *Sound Speed* package.

First, open an existing project or create a new project using the Project Manager or Project Wizard (see Fig. 2.72 and Fig. 2.73)

Once your project is selected, click the *Add device* button to add the MVP driver to the list of installed drivers.

Now, configure the network parameters accordingly. In this case, *HYPACK* and the *Sound Speed* package are running on the same computer.

Press the *Setup* button to configure the MVP driver accordingly. See Fig. 2.77 for a short description of the driver configuration features.

Press the *Test Device* button to test the MVP driver together with the *Sound Speed* Package.

Once you are satisfied that the connection between the *Sound Speed* package and *HYPACK* works, start *HYSWEEP Survey*. A new permanent window displaying the received casts should be visible (See Fig. 2.80). An update of the "SV From Profile" value in Fig. 2.79 is also an indicator that *HYSWEEP Survey* has received a new cast.

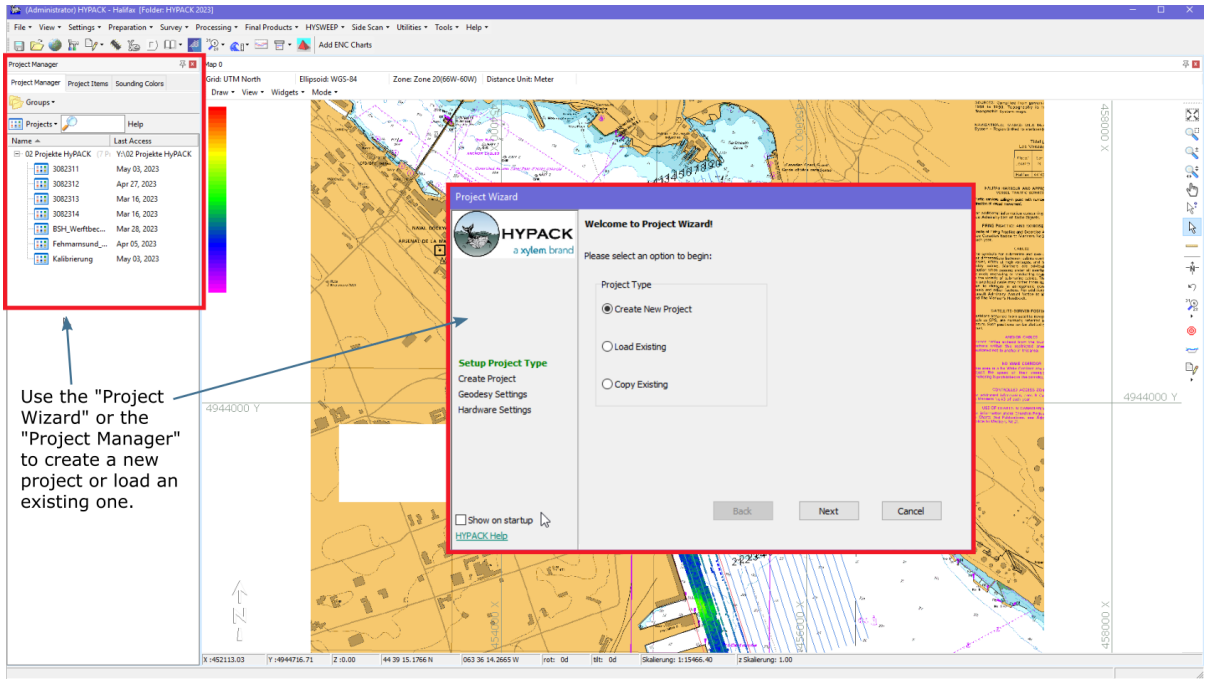

Fig. 2.72: The *HYPACK* Project Manager or the Project Wizard can be used to load or create a project.

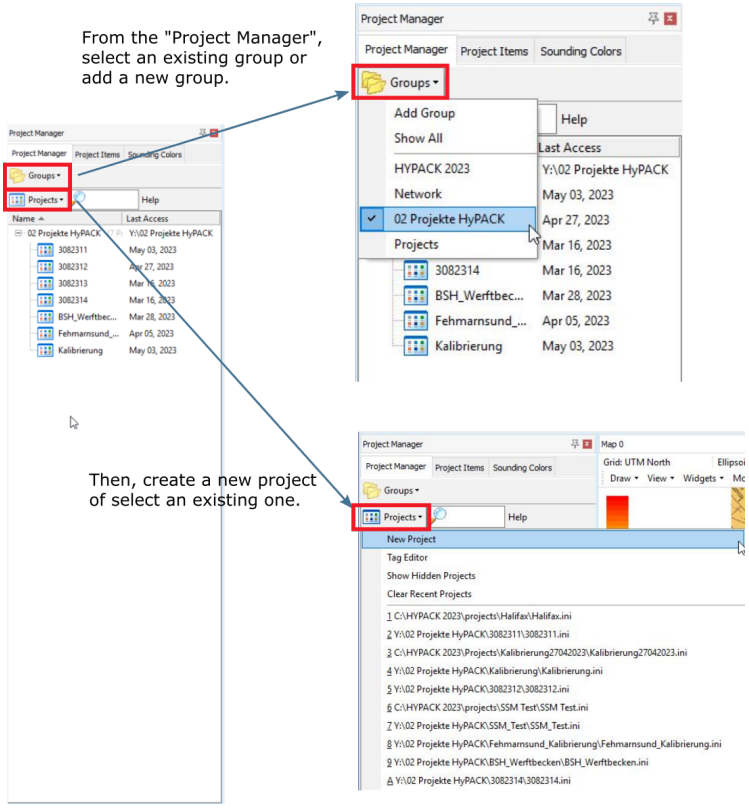

Fig. 2.73: Selecting or creating a *HYPACK* project from the Project Manager.

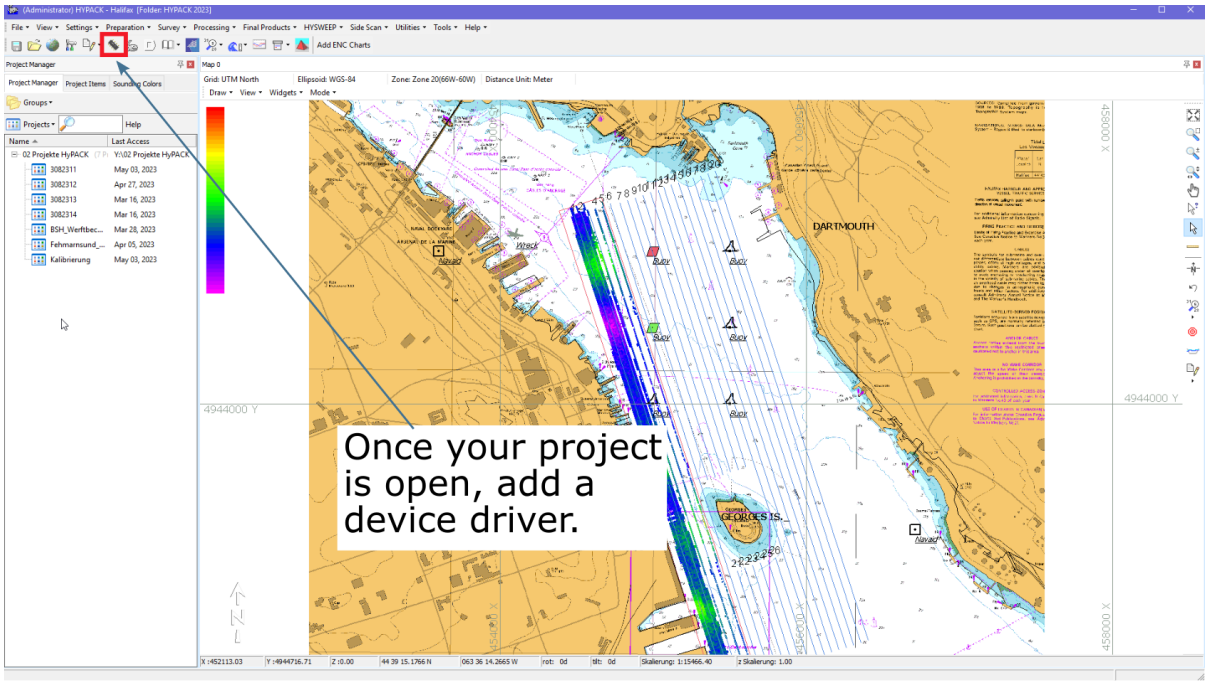

Fig. 2.74: Selecting the Add device button.

If the MVP driver has been configured as per Fig. 2.77, a new sound velocity file should be visible in *HYPACK* (See Fig. 2.81). A target should be also be visible in both HYPACK (See Fig. 2.81) and in the *HYSWEEP* Map display (See Fig. 2.82).

QINSy

QINSy accepts the same SVP transmission protocol as *SIS*, but a method to verify reception of the cast is not currently known thus the user should confirm reception in the acquisition system.

PDS2000

PDS2000 accepts the same SVP transmission protocol as SIS, but a method to verify reception of the cast is not currently known thus the user must confirm reception in the acquisition system.

2.7 Appendix C - Exploring Profiles in NCEI format

Among many other formats (see *Supported Formats*), Sound Speed Manager is able to export the loaded sound speed profiles in NCEI format.

The NCEI format requires to store the profile data and metadata in NetCDF format. As such, the content of this format can be explored using applications that are able to browse the content of NetCDF file such as HDF Compass and Panoply.

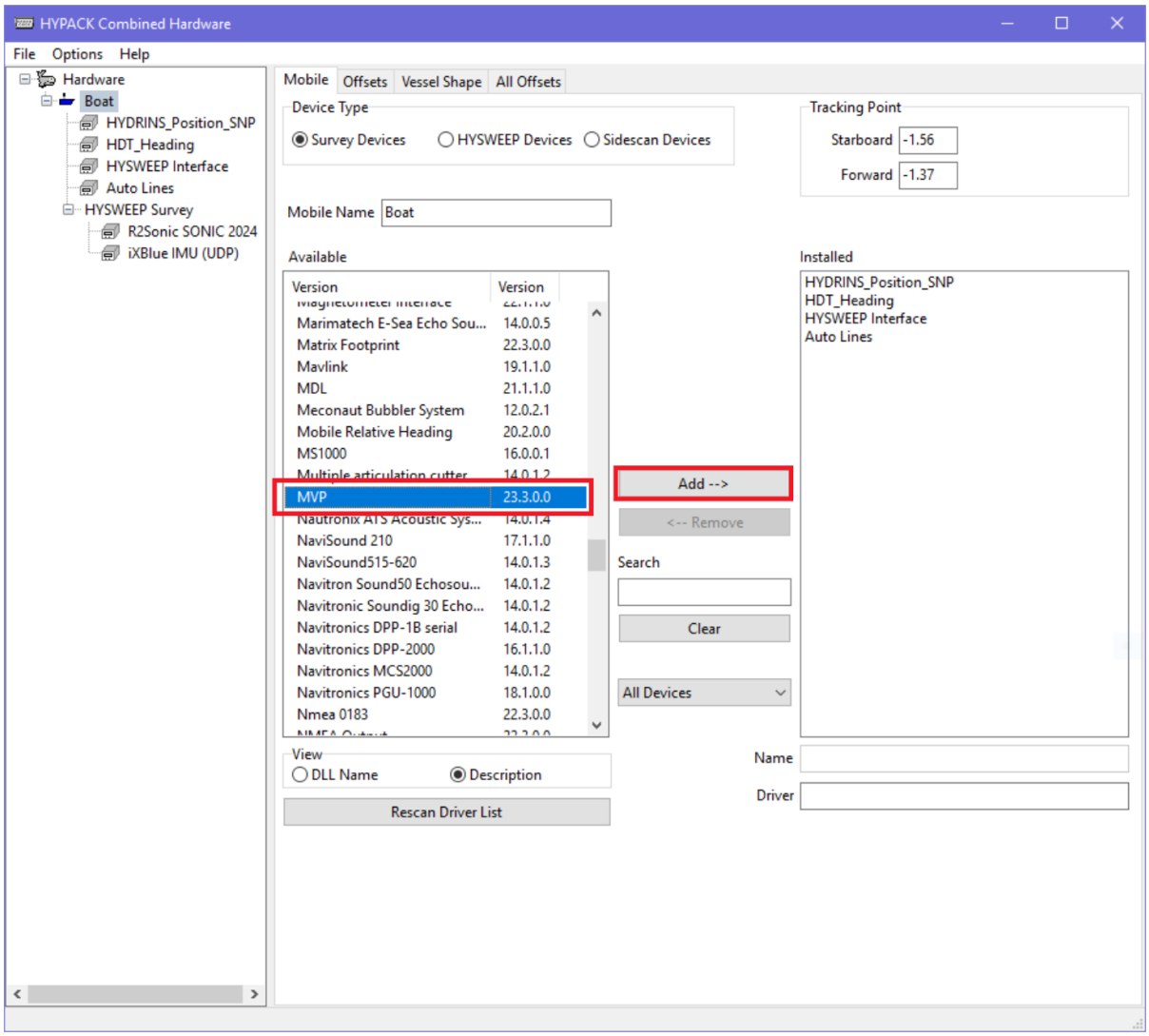

Fig. 2.75: Adding the MVP device driver.

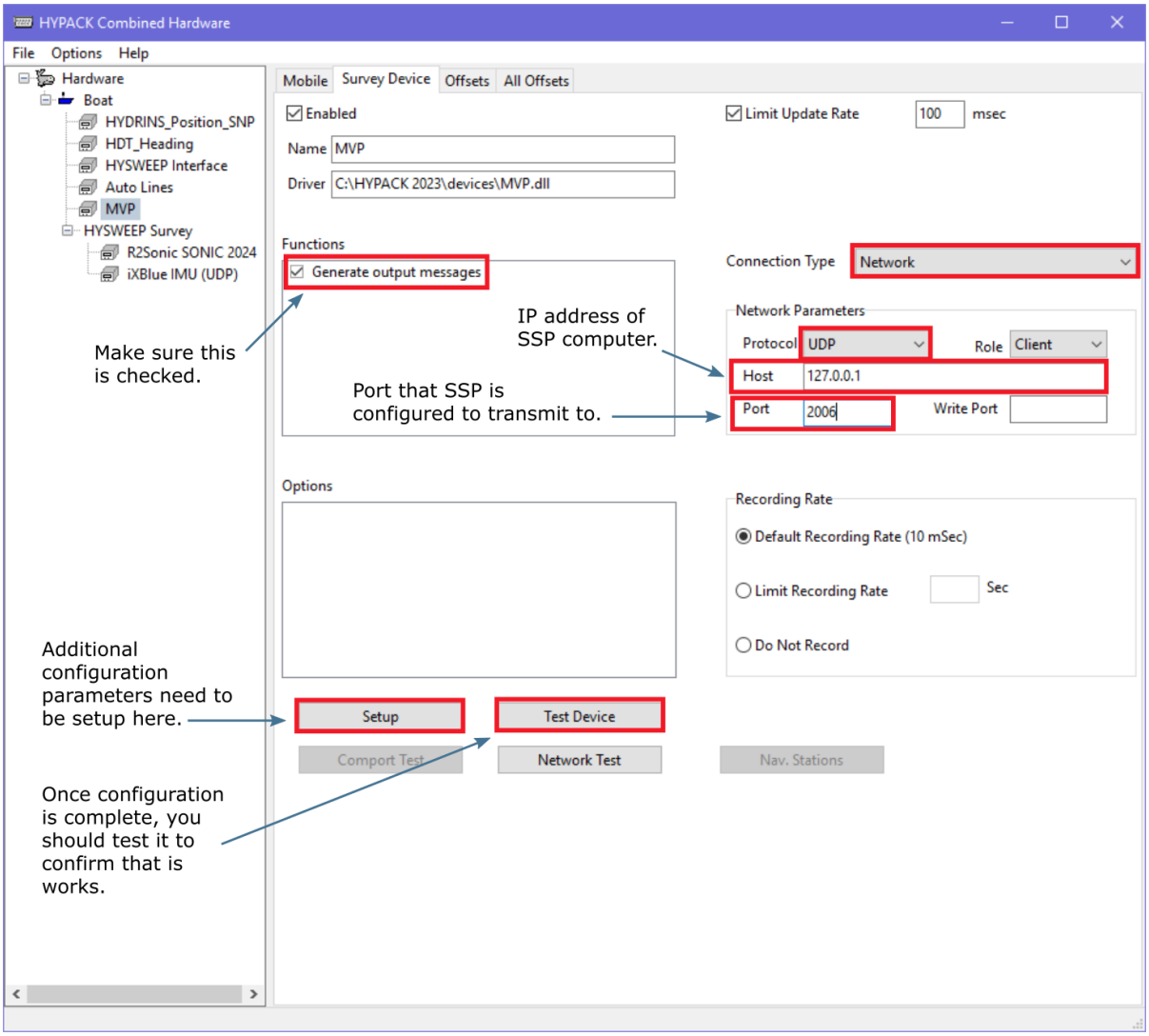

Fig. 2.76: Configuring the MVP driver. The network parameters of the driver are configured to use a UDP input protocol in a client role. The host IP address must match the address used by the computer running the *Sound Speed* package and the reception port must match the port configuration chosen in the package configuration file. The "Write Port" is left as zero.

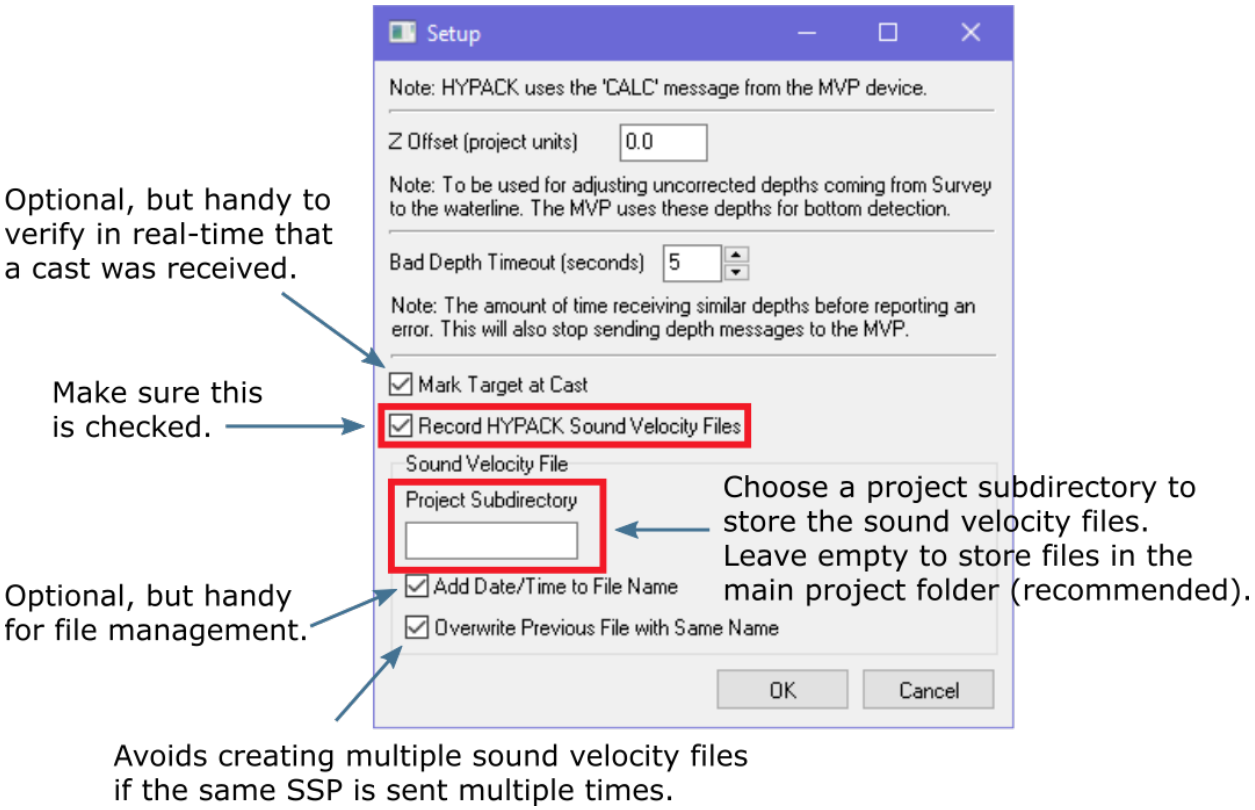

Fig. 2.77: Additional configuration of the MVP device driver.

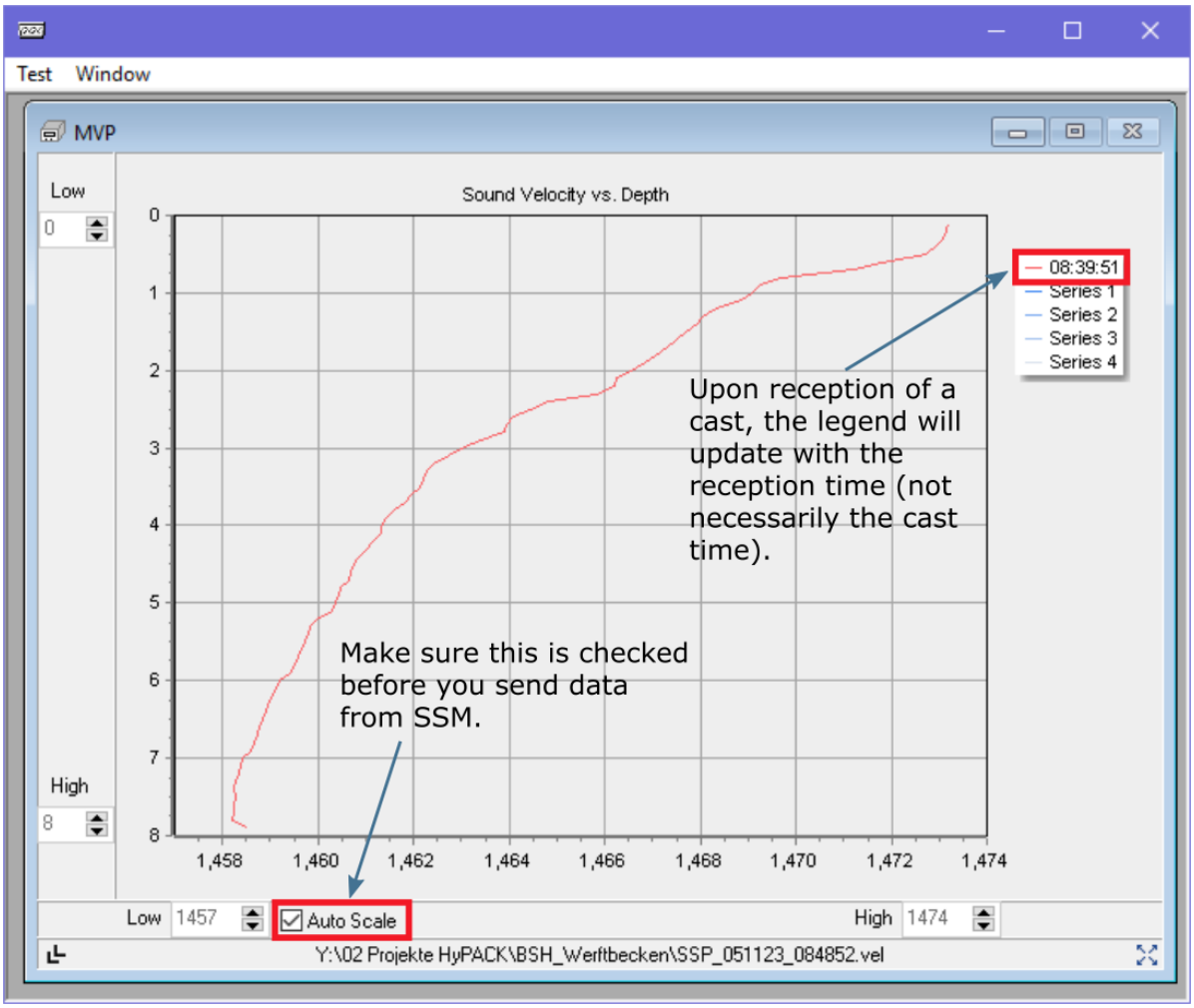

Fig. 2.78: Testing reception capabilities in *HYPACK*. After having loaded a sample cast into the *Sound Speed* package and sent it, the profile should be visualized in *HYPACK*.

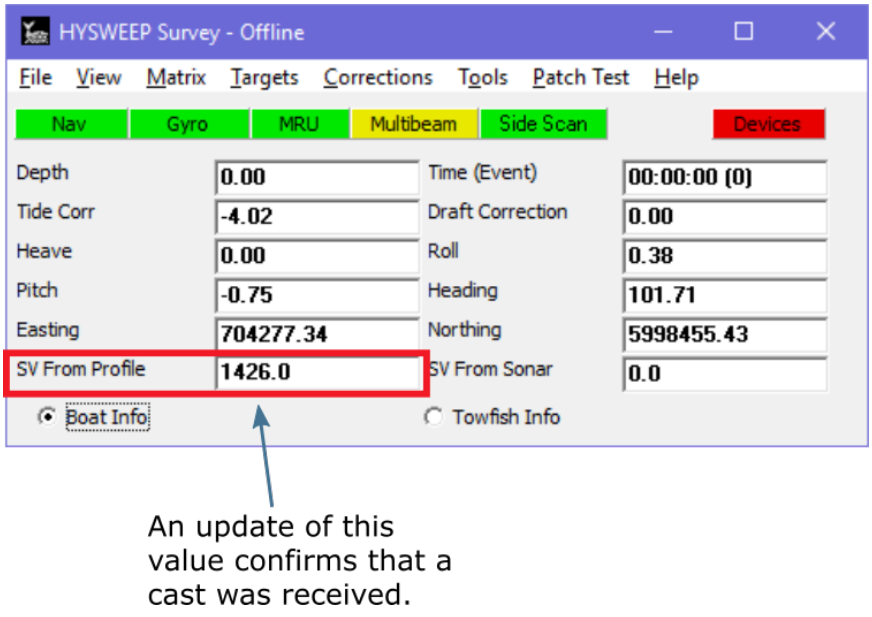

Fig. 2.79: In HYSWEEP Survey, an update of the "SV From Profile" field should occur after reception of a new cast.

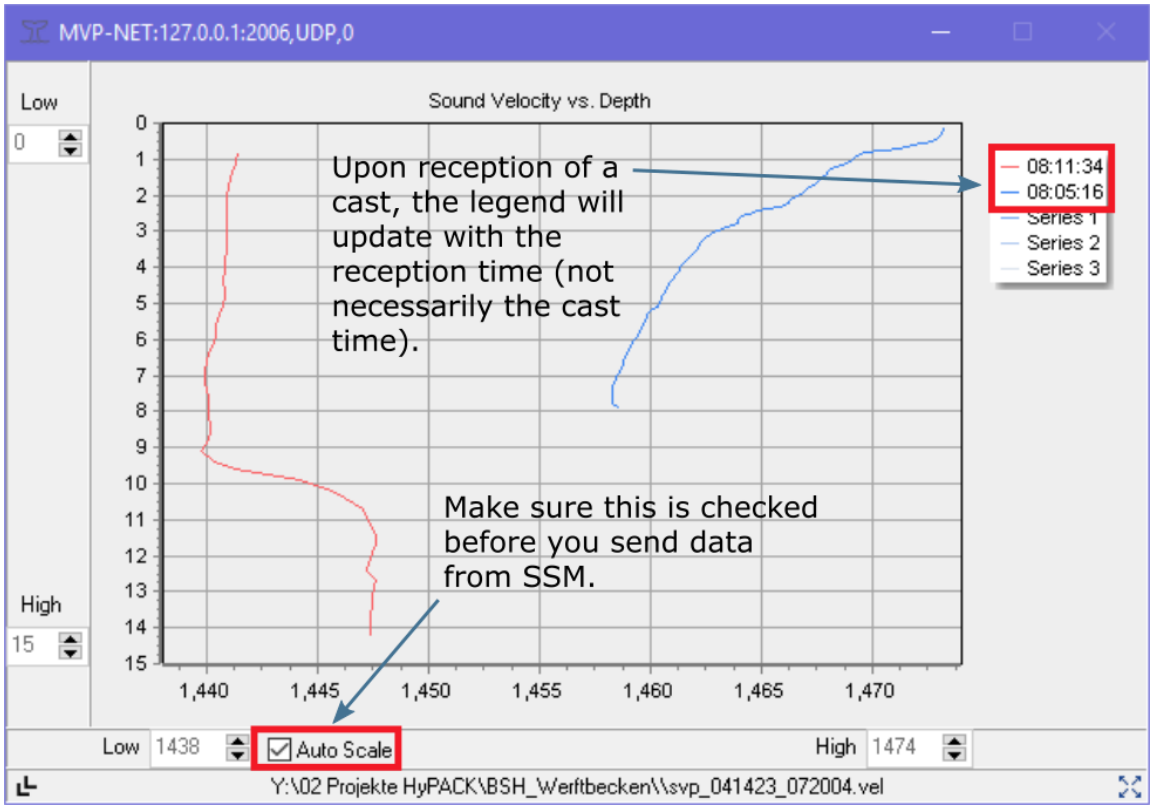

Fig. 2.80: In HYSWEEP, the MVP plot will display all received casts.

It may be necessary to use the "Rescan Folders" option to view the received

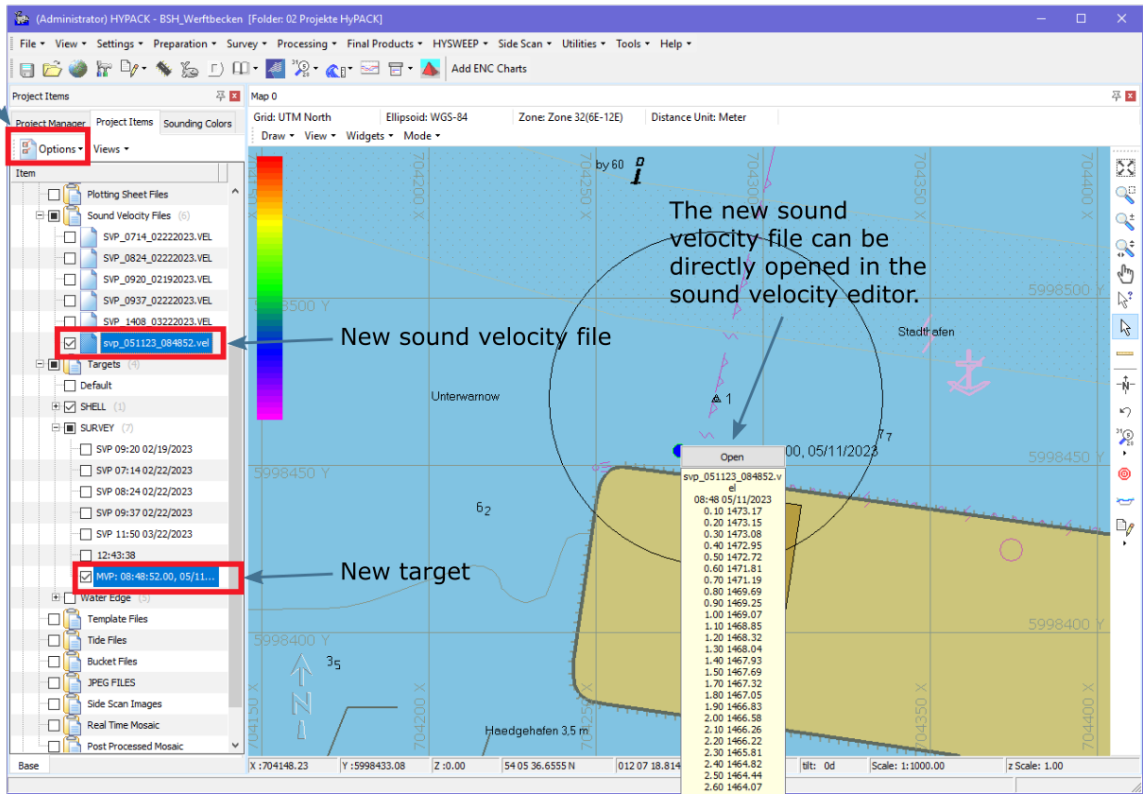

Fig. 2.81: In HYPACK, a new sound velocity file and a new target will appear if these options were selected in the MVP driver setup page.

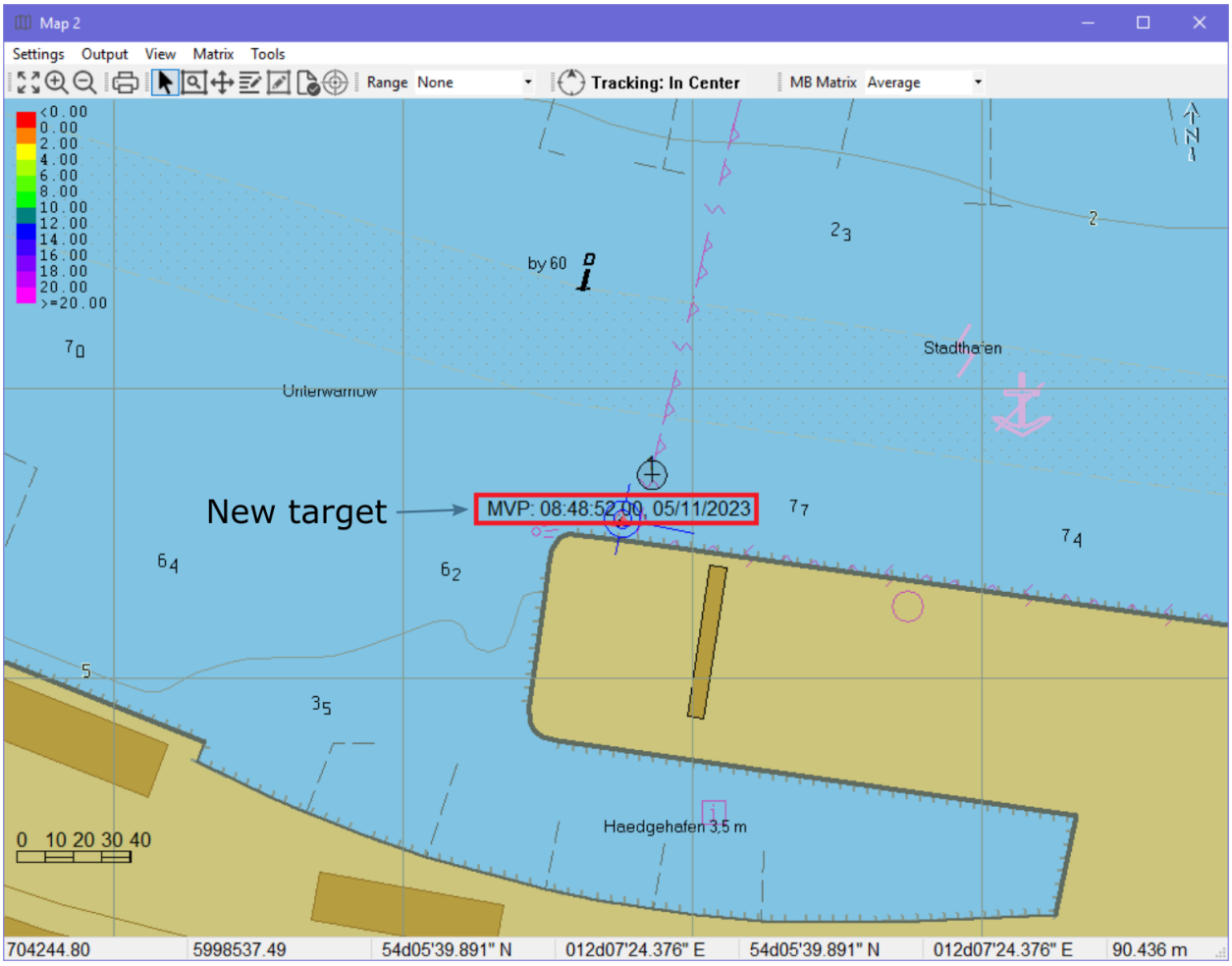

Fig. 2.82: In HYSWEEP, the new target corresponding to the received cast will be displayed in the Map view.

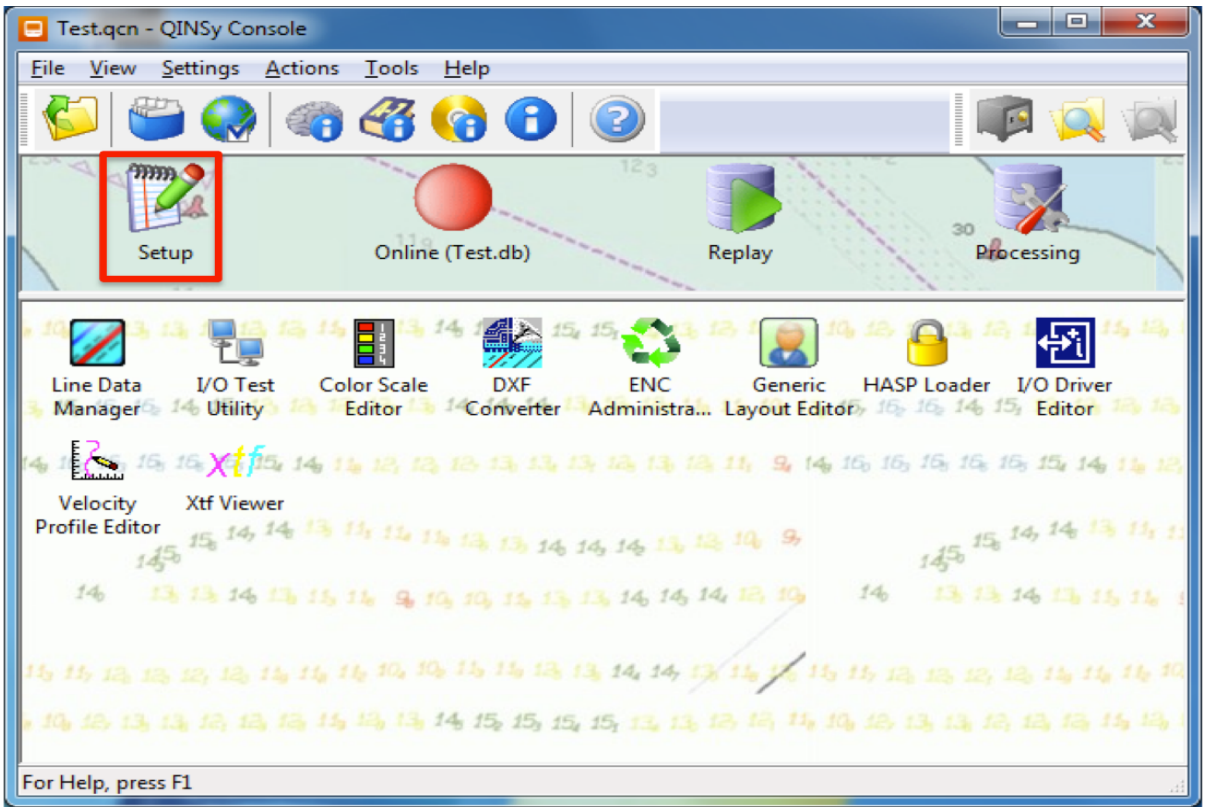

Fig. 2.83: Select *Setup* from the QINSy console after loading your project. Refer to QINSy documentation for information regarding setting up a project.

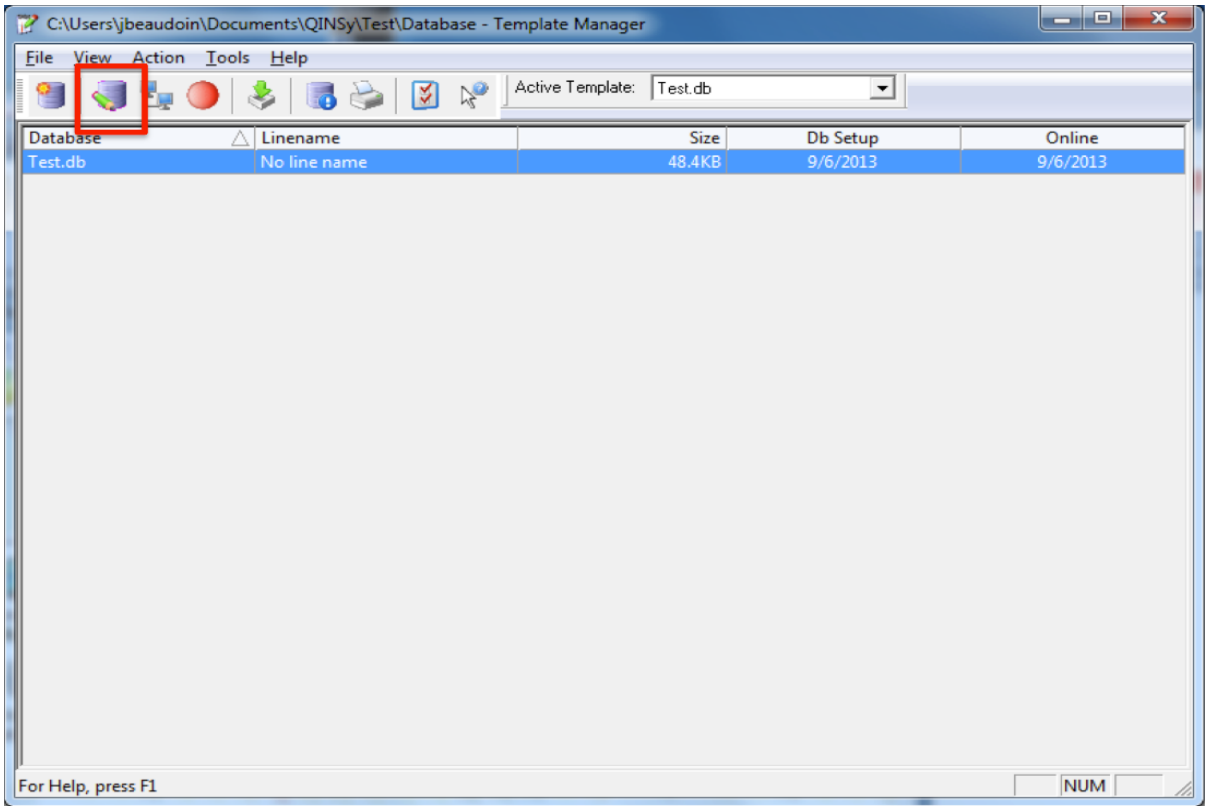

Fig. 2.84: Edit your project database

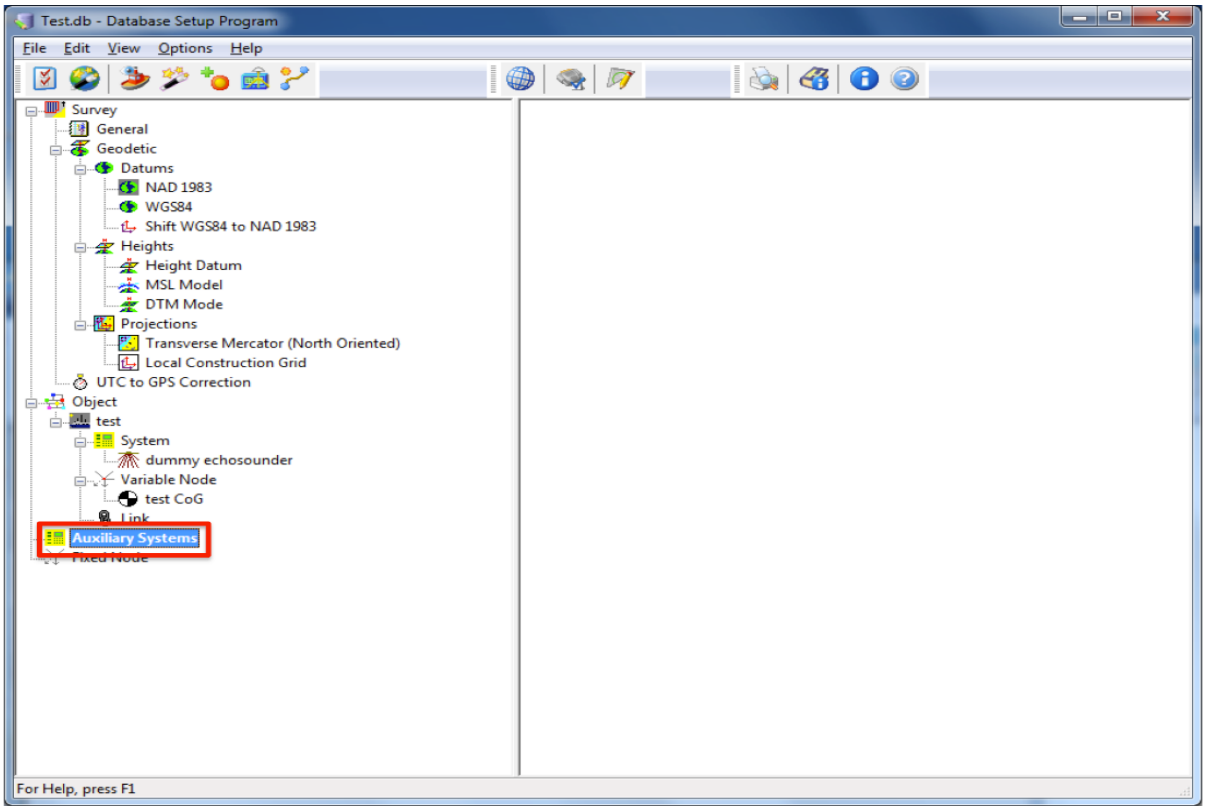

Fig. 2.85: Right click the *Auxiliary Systems* icon and select *New System*.

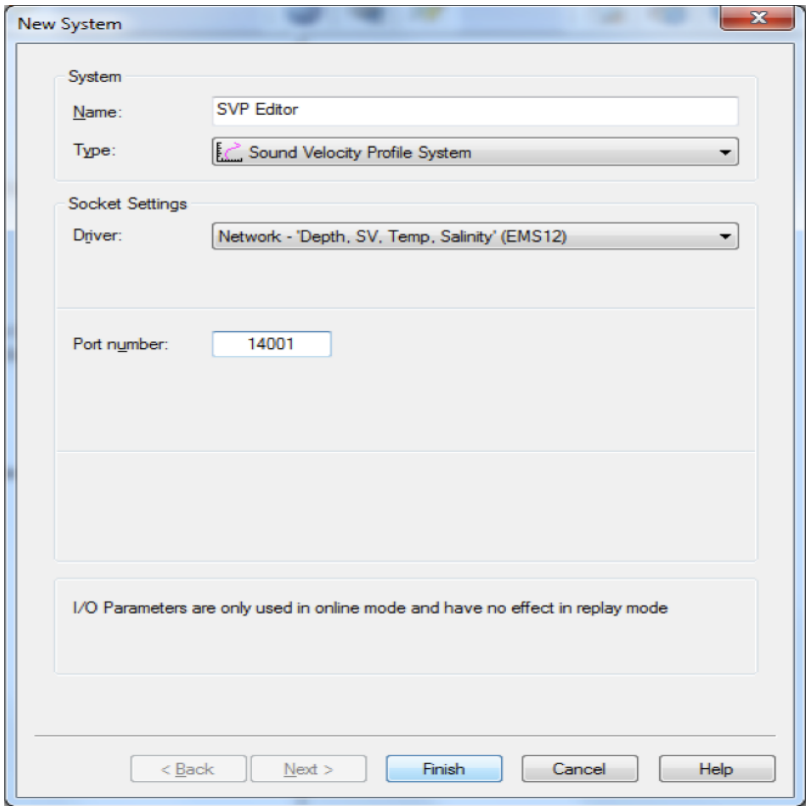

Fig. 2.86: Configure the new system as shown above. Choose the same port number that SSP package will be sending casts to (this is configured in the `__config__.db` file).

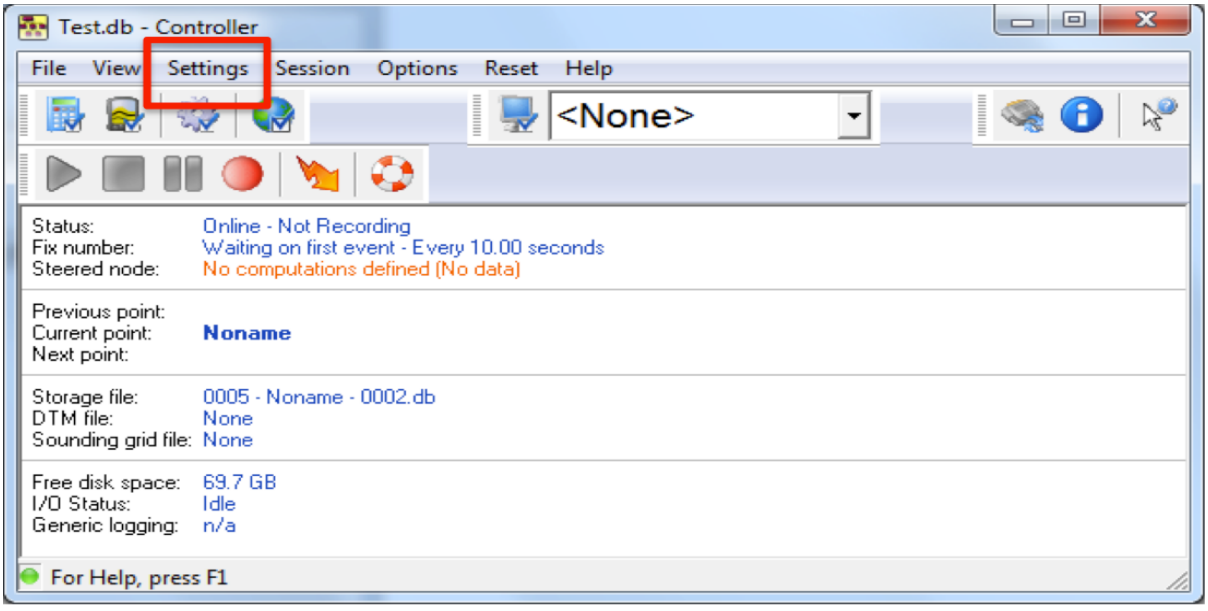

Fig. 2.87: Choose *Echosounder Settings* from the *Settings* menu. This will allow you to configure the behavior of QINSy when it receives new sound speed profiles from SSP package.

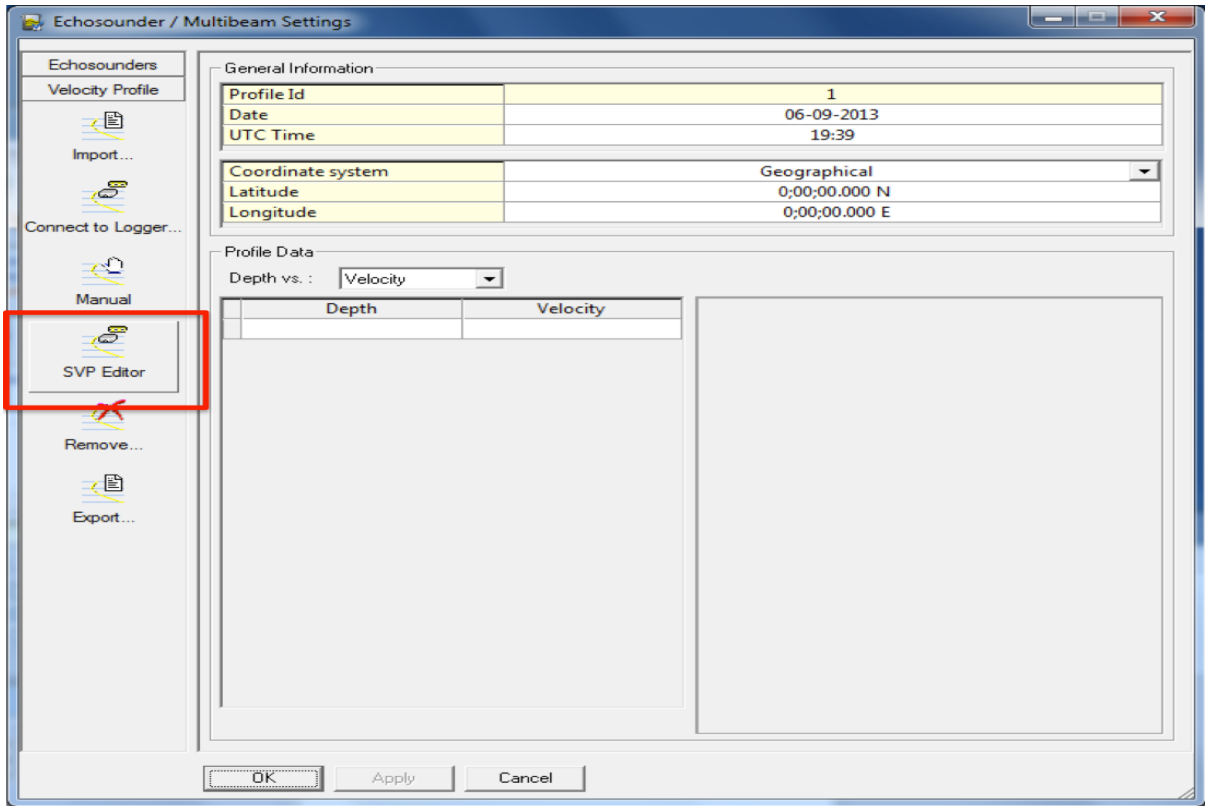

Fig. 2.88: Leftclick the icon for the *SVP Editor* device.

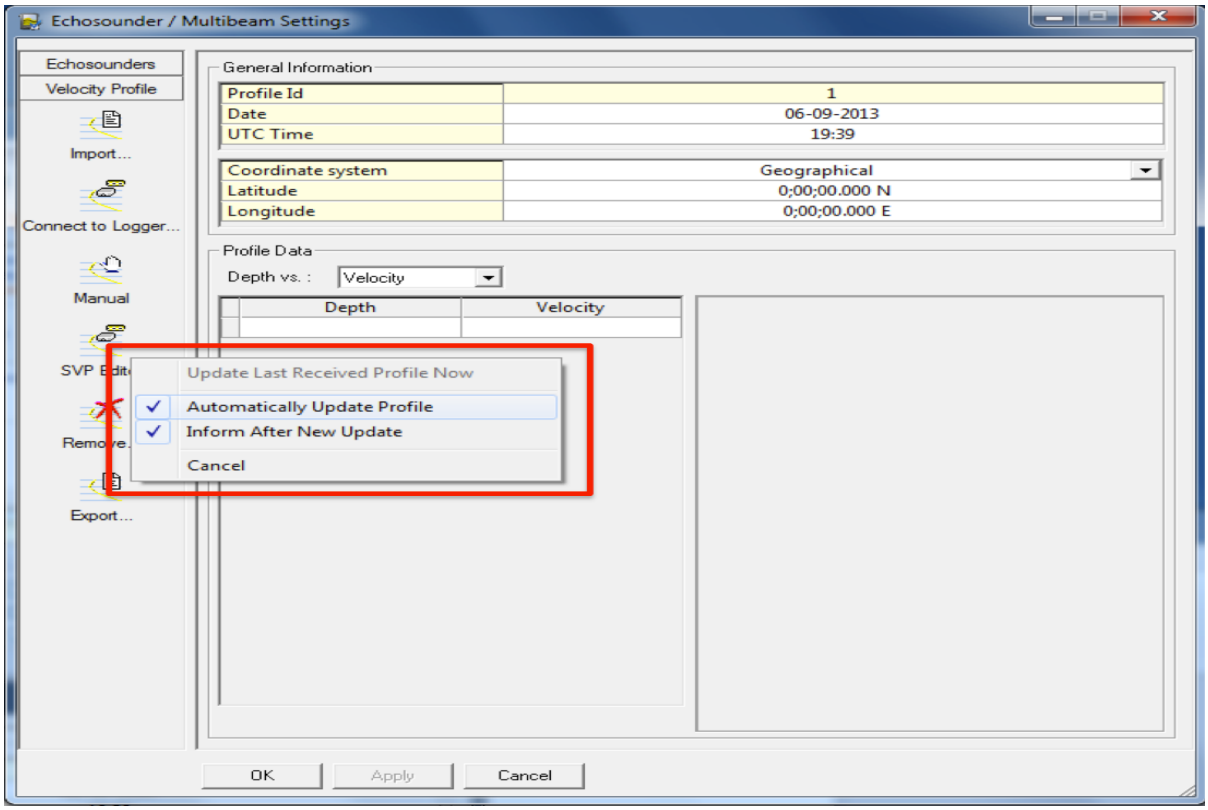

Fig. 2.89: Choose appropriate options to control QINSy's behavior when it receives casts from SSP package. If you plan to deliver casts using ef:*server_mode*, remember to set the "Automatically Update Profile" flag.

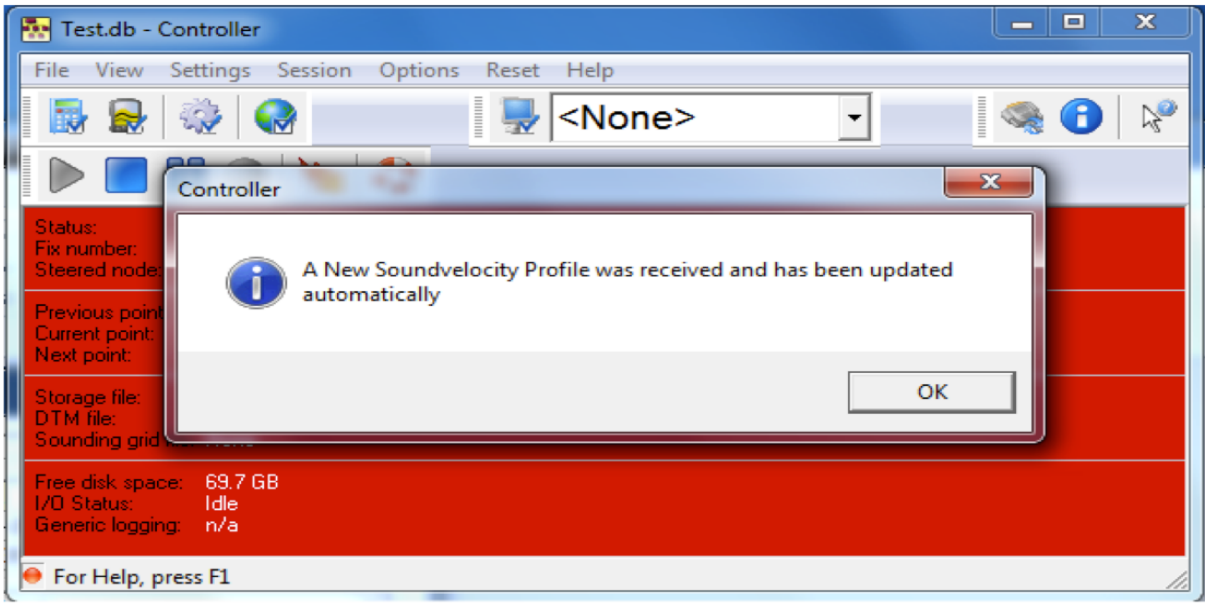

Fig. 2.90: With QINSy "online" and recording, send a test profile from SSP package. If you have chosen to be informed upon reception of a new cast, a message window will appear for acknowledgement.

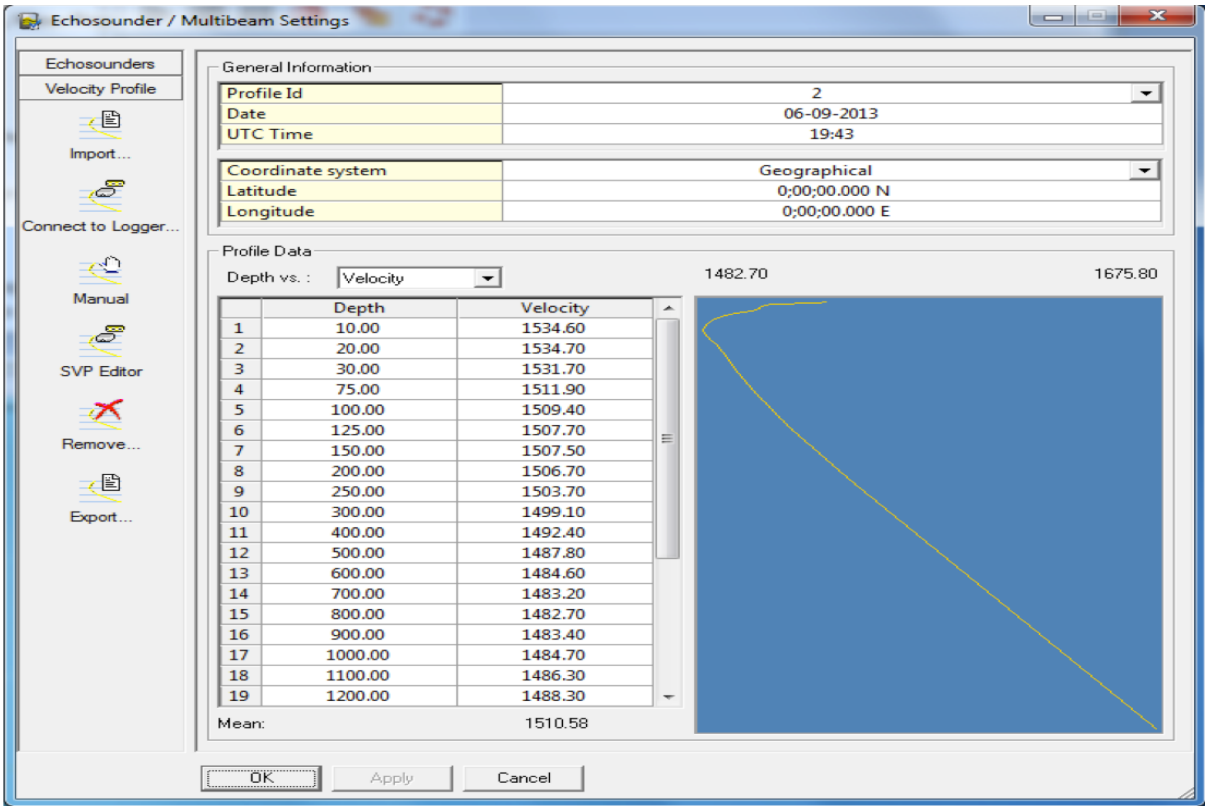

Fig. 2.91: By choosing *Echosounder Settings* from the *Settings* menu again, you can verify that the cast was received.

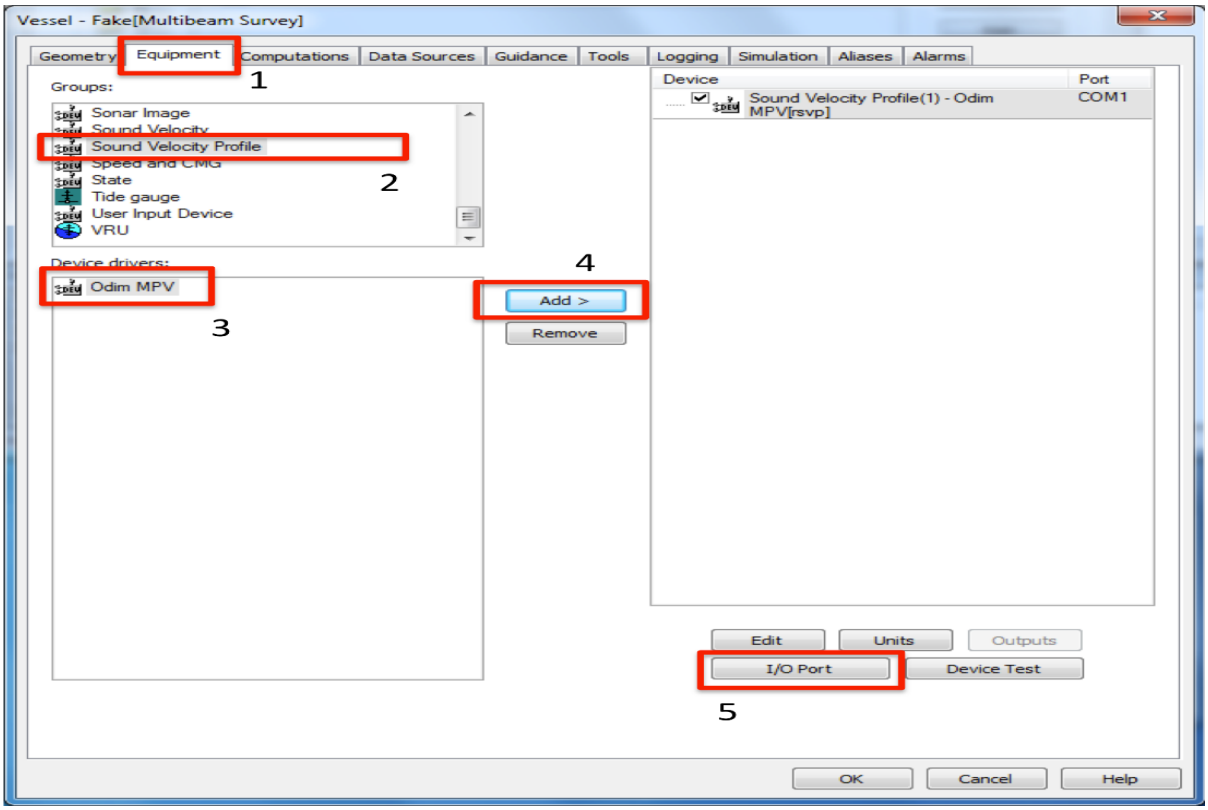

Fig. 2.92: Adding an MVP driver to PDS2000.

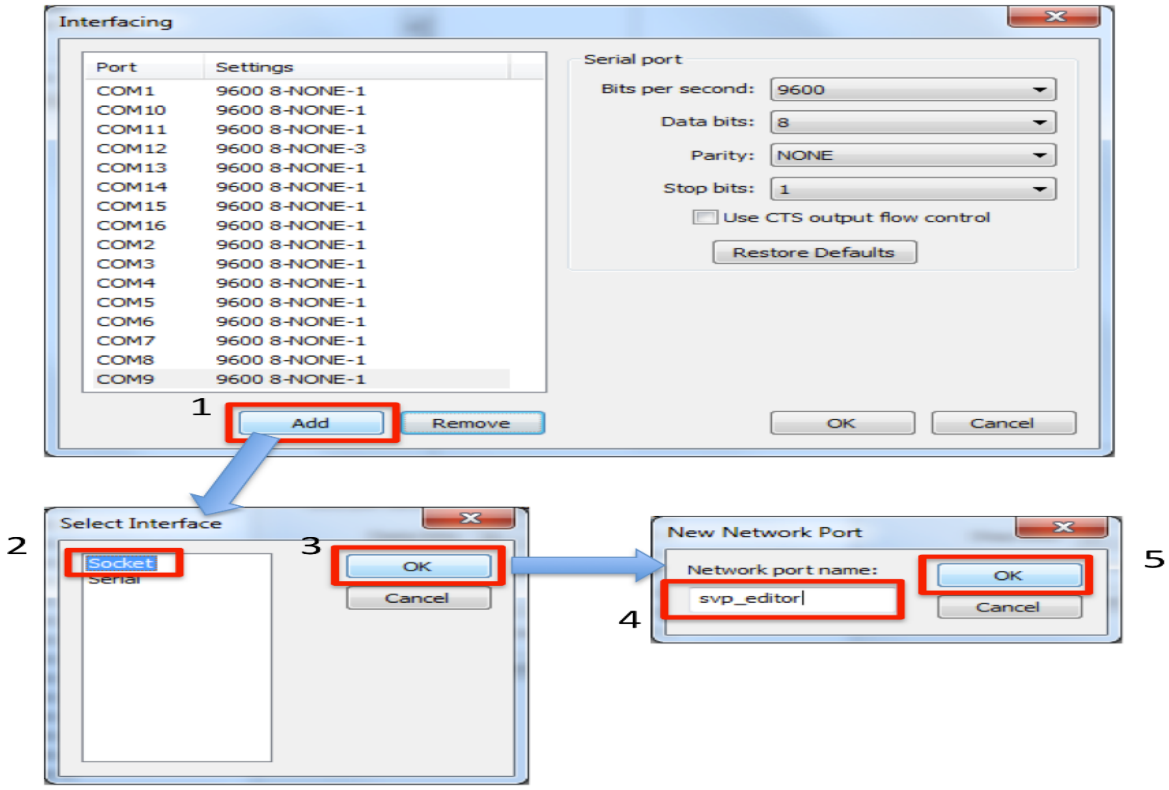

Fig. 2.93: Configuring the MVP driver for PDS2000.

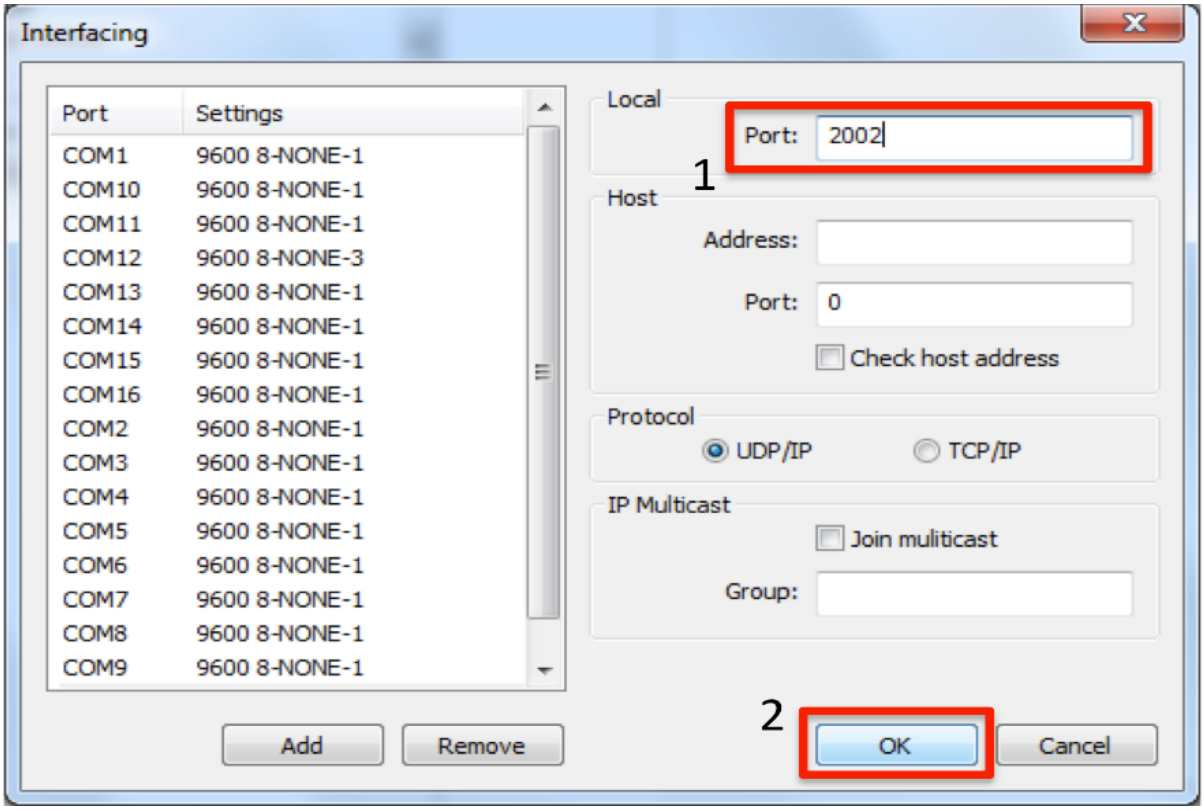

Fig. 2.94: Configuring an MVP driver for PDS2000. Be sure to scroll down in the list on the left side and choose the driver you added in the previous step before modifying the port number. The port number must match that which SSP package is sending data to (configured in the `__config__.db` file).

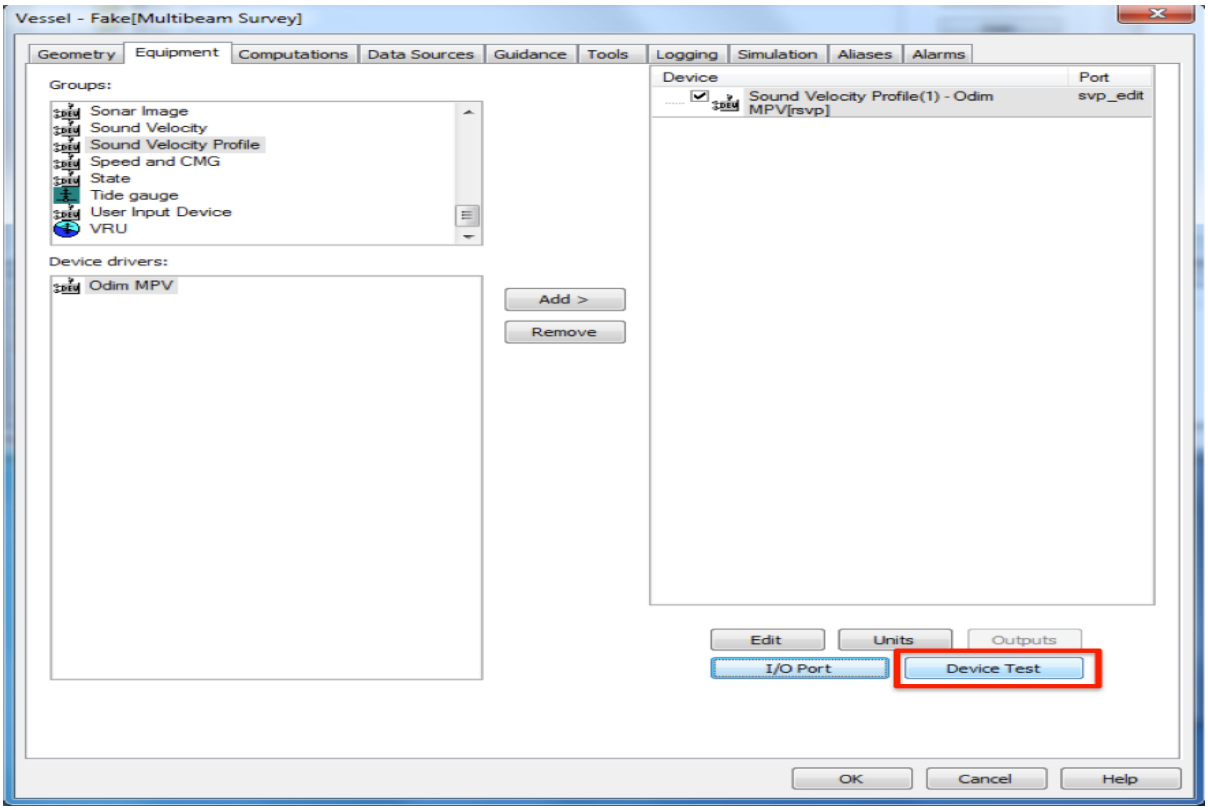

Fig. 2.95: After the driver is added, test the device to verify correct configuration of communication protocols.

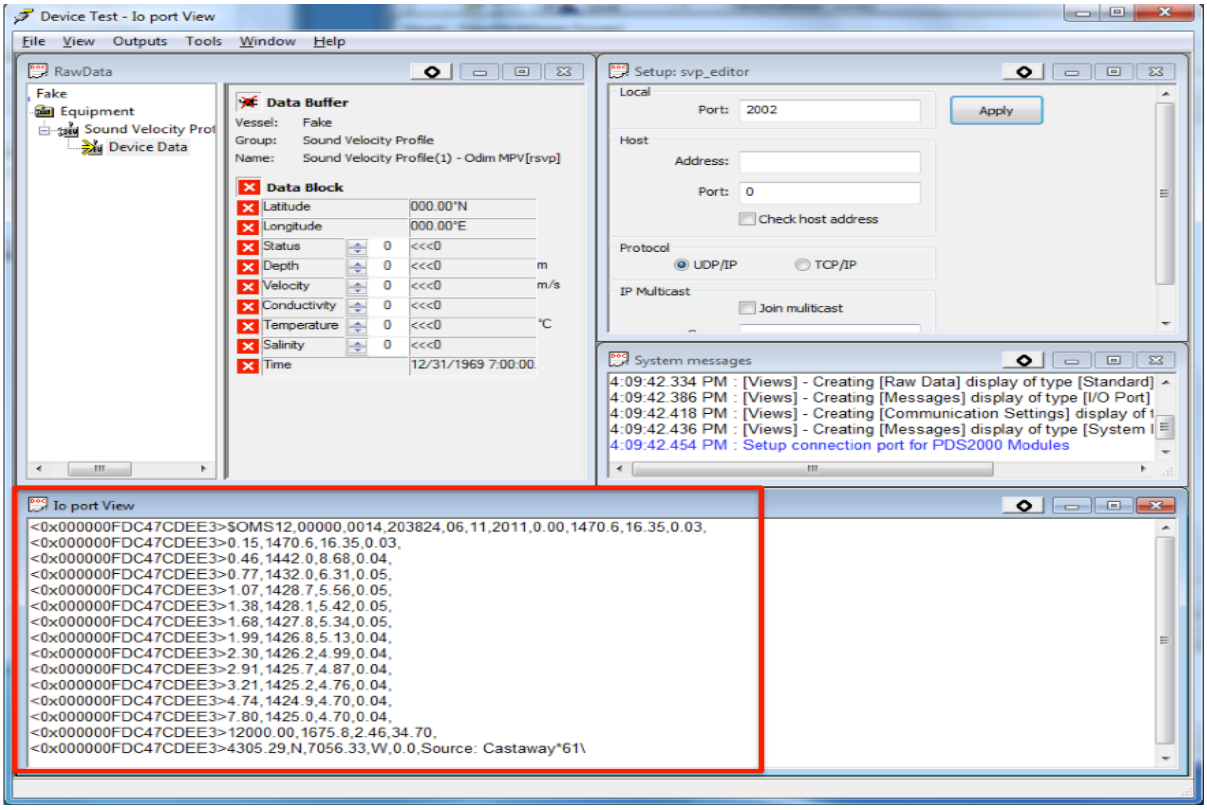

Fig. 2.96: With the device driver open, send a test cast from SSP package. The data should appear in the Io port View window. Be sure that the correct device driver is selected from the top left list window.

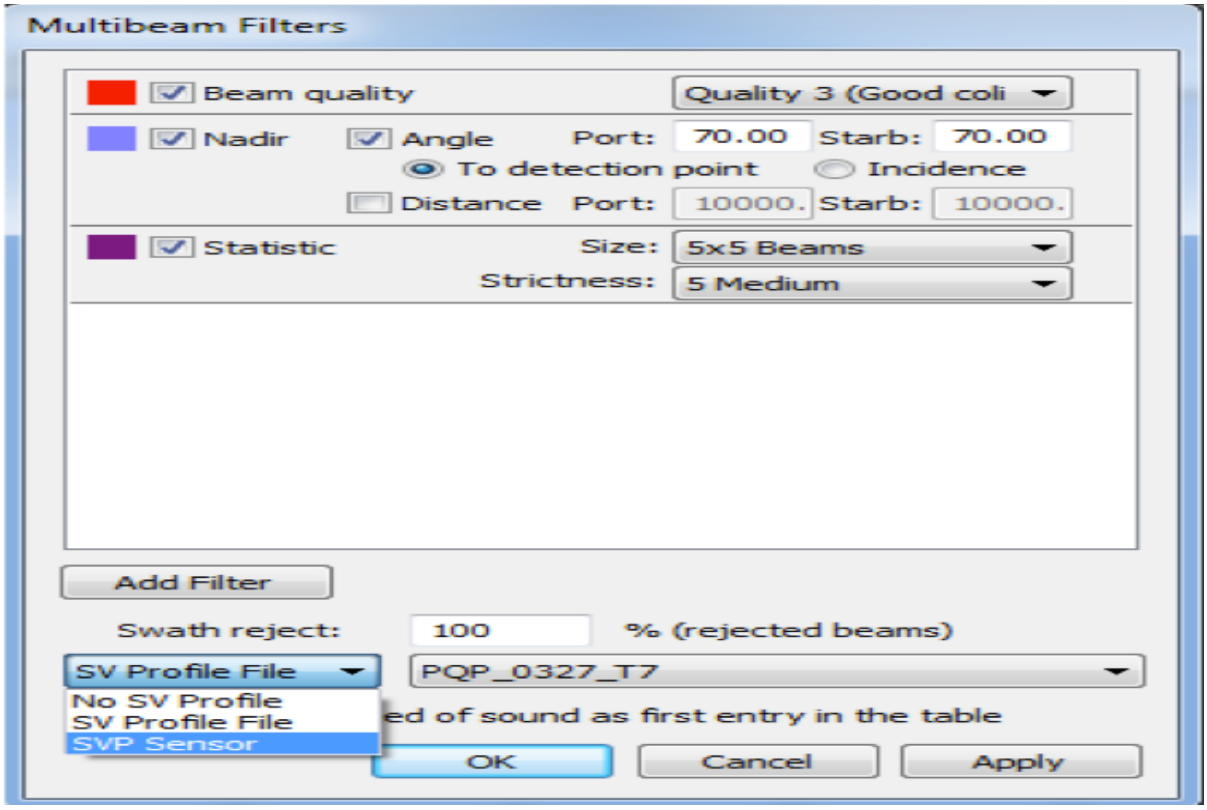

Fig. 2.97: While running PDS2000 in acquisition mode, right click in the multibeam raw profile display and choose "Multibeam filters". Choose "SVP Sensor" as the source of sound speed profiles to be used.

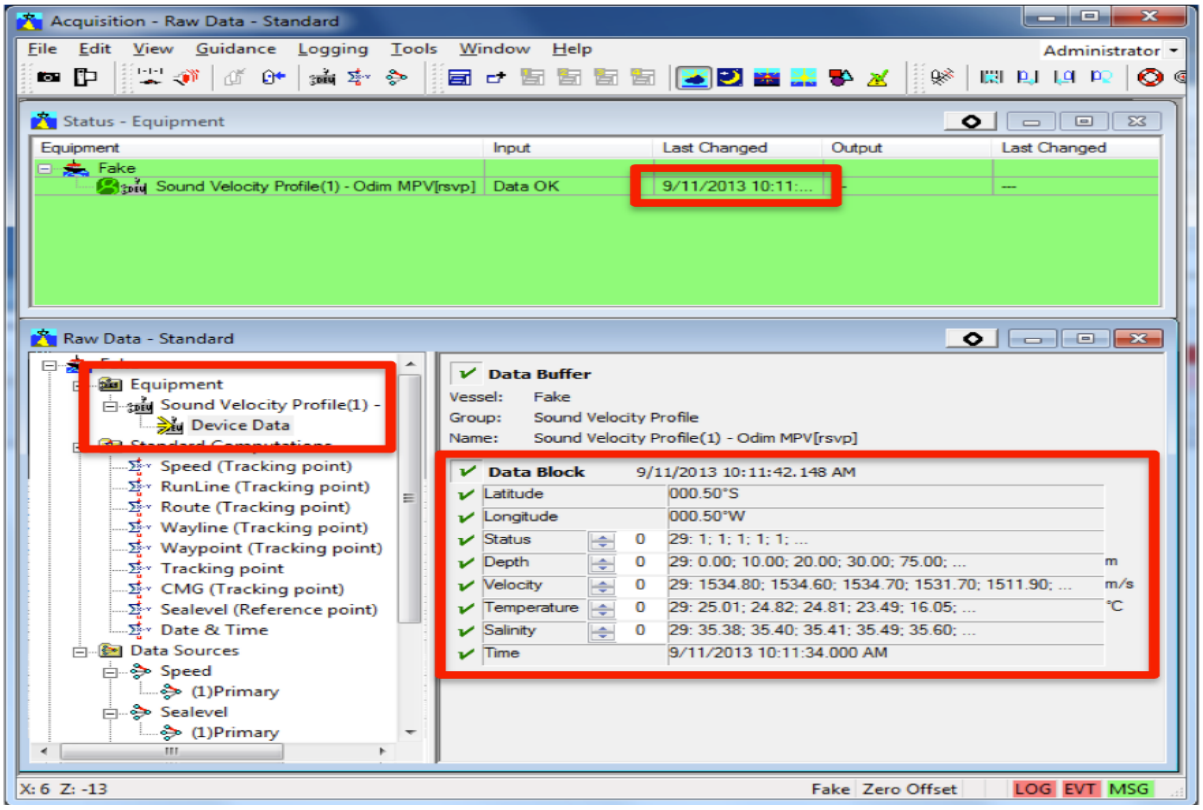

Fig. 2.98: While running PDS2000 in acquisition mode, you can verify reception in the Status displays and the "Raw Data" displays. Check the date, time, latitude, longitude against what you sent from SSP package.

2.7.1 About HDF Compass

HDF Compass enables you to view HDF5 datasets, attributes, and groups. Simple line, image, and contour plots are supported as well. HDF Compass does not provide any editing functionality.

If you are using Sound Speed Manager with the Pydro distribution (see *Installation using the Pydro distribution*), you can easily access HDF Compass from Pydro Explorer (Fig. 2.99).

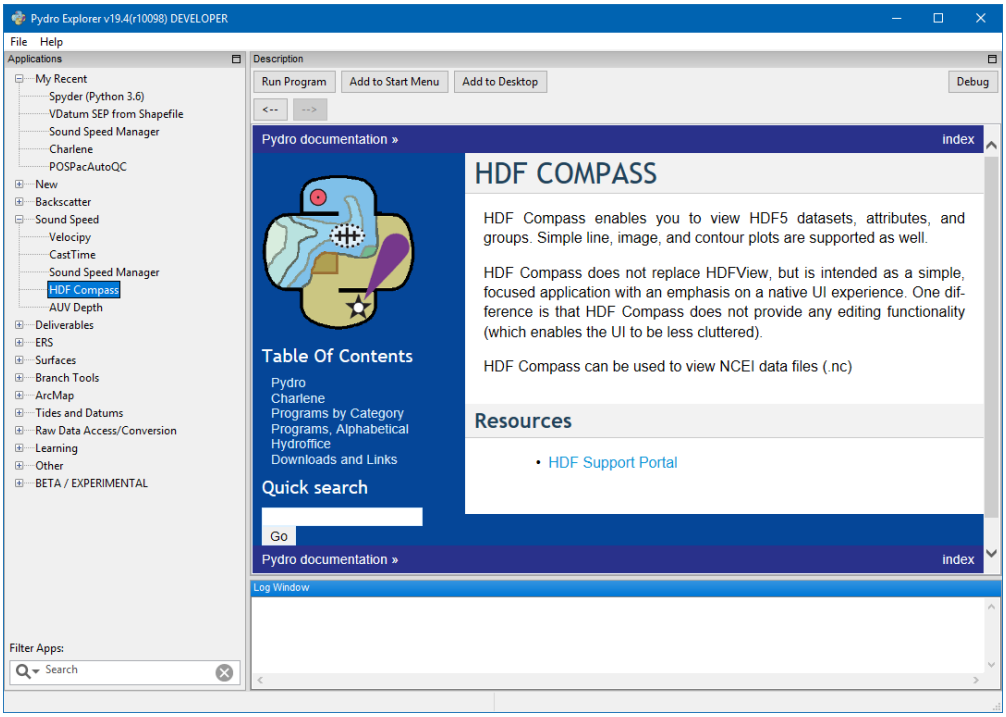

Fig. 2.99: Pydro Explorer Sound Speed Menu.

2.7.2 How to explore a NCEI (.nc) file with HDF Compass

After opening HDF Compass from Pydro Explorer, select *File* and *Open* (see Fig. 2.100).

Fig. 2.100: HDF Compass Interface.

The default file extension filter, *HDF5 File* contains the NCEI .nc file extension (see Fig. 2.101).

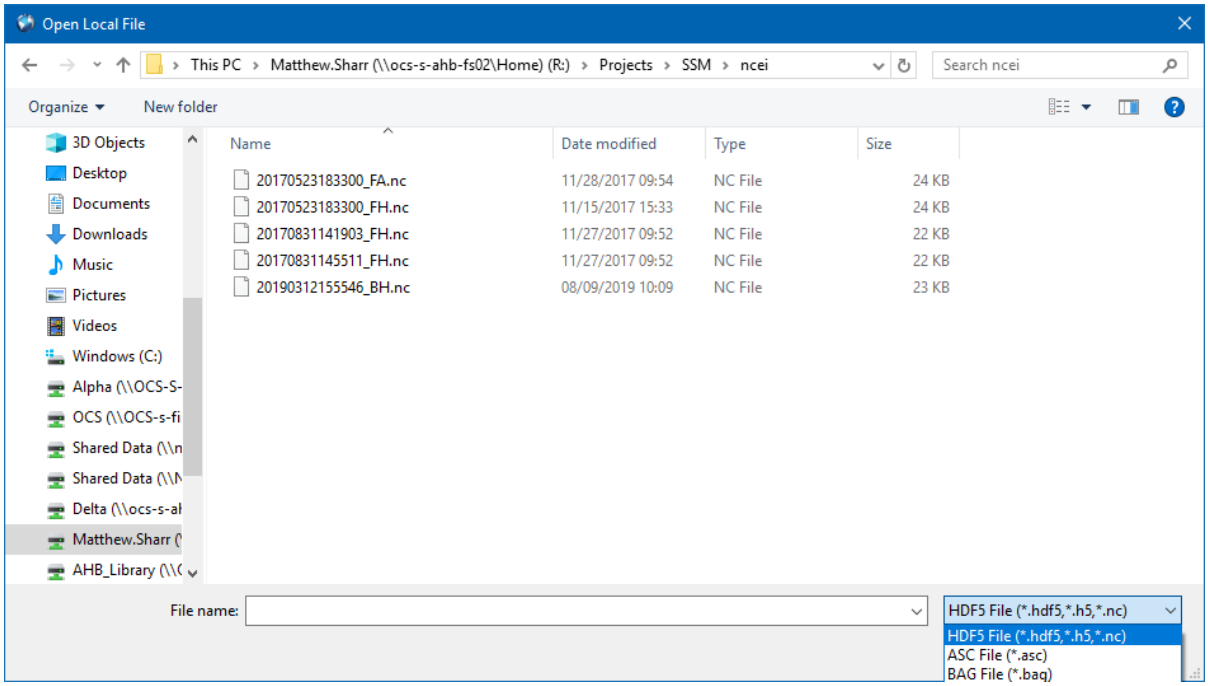

Fig. 2.101: HDF Compass Browse Dialog.

After opening the .nc file, HDF Compass allows the user to explore different data stored in the file. To view the file metadata, using the *Window* menu, reopen the file as HDF5 attributes (see Fig. 2.102).

Your .nc file attributes will open in a new window (see Fig. 2.103)

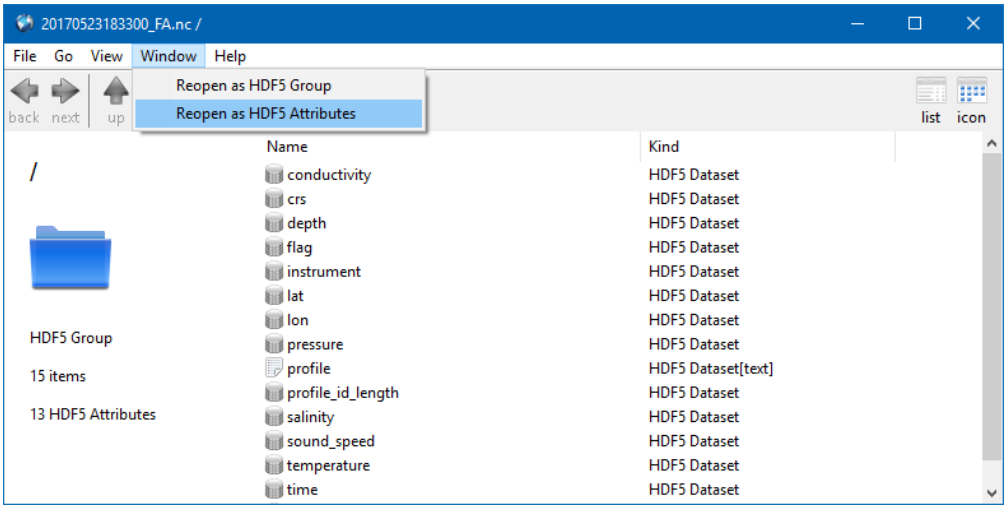

Fig. 2.102: HDF Compass HDF5 Window Menu.

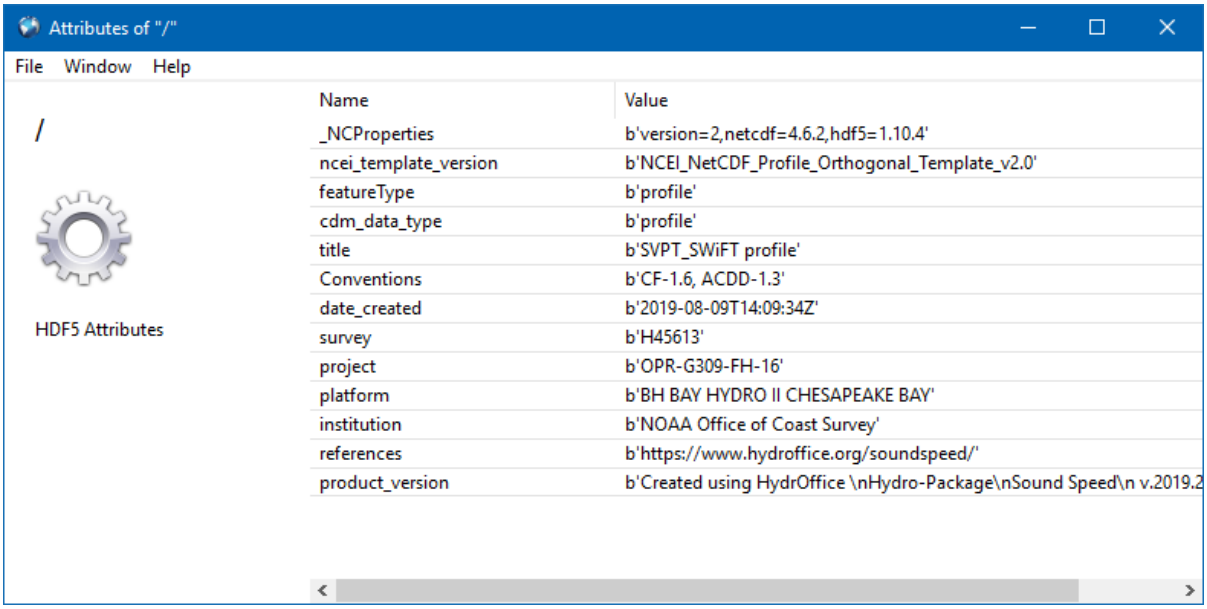

Fig. 2.103: HDF Compass .nc file Attributes.

CHAPTER

THREE

DEVELOPER'S GUIDE

3.1 How to contribute

Every open source project lives from the generous help by contributors that sacrifice their time and this is no different.

3.1.1 Public Repositories

The source code is available on both GitHub and BitBucket.

To propose changes to Sound Speed Manager, you can follow the common Fork & Pull Request workflow. If you are not familiar with such a workflow, a good starting point may be this short tutorial.

3.1.2 Coding Style

To make participation as pleasant as possible, this project adheres to the Code of Conduct by the Python Software Foundation.

Here are a few hints and rules to get you started:

- Add yourself to the AUTHORS.txt file in an alphabetical fashion. Every contribution is valuable and shall be credited.
- If your change is noteworthy, add an entry to the changelog.
- No contribution is too small; please submit as many fixes for typos and grammar bloopers as you can!
- Don't *ever* break backward compatibility.
- *Always* add tests and docs for your code. This is a hard rule; patches with missing tests or documentation won't be merged. If a feature is not tested or documented, it does not exist.
- Obey PEP 8 and PEP 257.
- Write good commit messages.
- Ideally, collapse your commits, i.e. make your pull requests just one commit.

Note: If you have something great but aren't sure whether it adheres – or even can adhere – to the rules above: **please submit a pull request anyway**! In the best case, we can mold it into something, in the worst case the pull request gets politely closed. There's absolutely nothing to fear.

Thank you for considering to contribute! If you have any question or concerns, feel free to reach out to us (see *Credits*).

3.2 How to build the documentation

3.2.1 Requirements

The documentation is built using `sphinx`, so you neeed to have it:

- `pip install sphinx sphinx-autobuild`

To build the pdf manual on Ubuntu:

- `sudo apt-get install texlive-full`

3.2.2 First-time creation of documentation template

Just once for each project, you can create the documentation template as follows:

- `mkdir docs`
- `cd docs`
- `sphinx-quickstart`

3.2.3 Generate the documentation

To create the html

- `make html`

3.3 How to distribute

3.3.1 Preliminary steps

- First of all, run the full test suite and check that there are no failures.
- Verify the release version in the following files:
  - setup.cfg
  - setup.py
  - docs/conf.py
  - hydroffice/soundspeed/__init__.py
  - hydroffice/soundspeedmanager/__init__.py
  - hydroffice/soundspeedsettings/__init__.py
- Push any 'release' changes to GitHub/BitBucket

3.3.2 Update docs

- Build the new docs as html (make html) and as pdf (make latexpdf)
- Update the web site with the new html and pdf docs (urls too)
- Update the embedded pdf docs

3.3.3 Freeze the app

- Update the pyinstaller files under 'freeze/'
- Freeze the application and test it on a 'clean' VM
- Upload the app on BitBucket
- Update the download link and the version on the SSM web page
- Update the latest file on the HydrOffice site

3.3.4 Final steps

- Push any 'release' changes to GitHub/BitBucket
- Create a 'tag' with the release
- Create a GitHub release
- Push the package on PyPI: 'python setup.py build bdist_wheel upload -r pypi'
- Start to work on the next release :)

3.4 How to freeze

- `pyinstaller --clean -y freeze\SoundSpeedManager.1file.spec`
- `pyinstaller --clean -y freeze\SoundSpeedManager.1folder.spec`

3.5 Todo List

3.5.1 Sound Speed

- Increase GSW use

3.5.2 Manager

- Plot x-y for additional fields
- Display a '-' close to tss, draft and bottom
- Rethink the Refraction Monitor

3.5.3 Atlases

- Add World Ocean Database 2013 (same data as WOA BUT preserved record of input data)
- Add World Ocean Atlas 2018
- Add HYCOM (near real time global prediction system)
- Add more NOAA OFS models

3.5.4 Research

- Planning tool: how many xbt?
- Real-time estimation of variability

CHAPTER

FOUR

SSM-SIS APP

The SSM-SIS app is a simple application used to check the settings/interaction between Sound Speed Manager and Kongsberg SIS (Fig. 4.1).

Warning: To avoid interference with Sound Speed Manager keep it closed while using SSM-SIS.

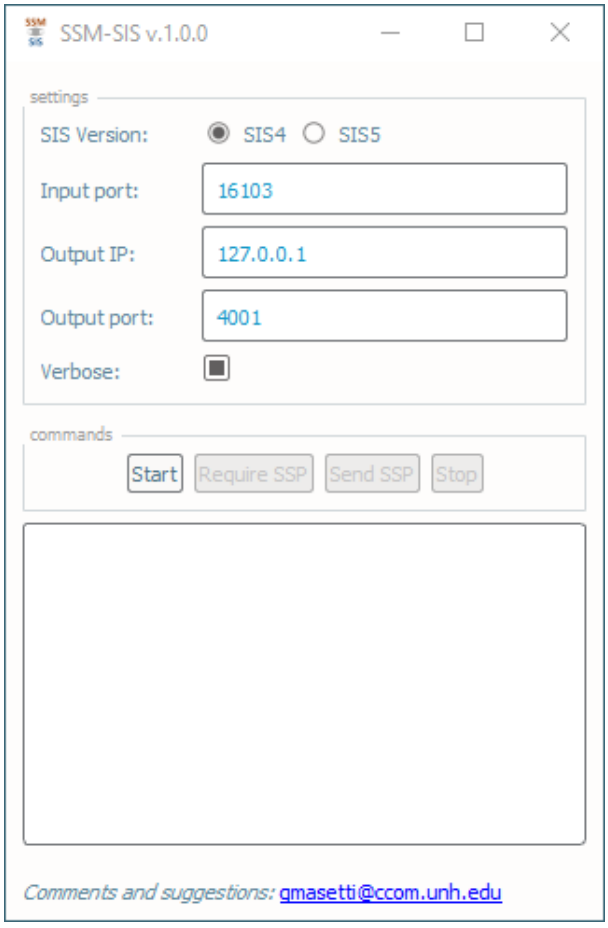

Fig. 4.1: The *SSM-SIS* app with the default parameters.

4.1 Settings

Note: For the settings required on the SIS side, see *SIS v5 settings*.

The *Settings* group box lists the app configuration settings:

- *SIS Version*: switching between SIS4 and SIS5 loads the default settings for each of the two options.
- *Input port*: the port used by SIS to broadcast the datagrams.
- *Output IP*: the IP address of the SIS machine.
- *Output port*: the port used by SIS to receive the sound speed profile. The default port should work.
- *Verbose*: this flag increases the number of debug messages printed in the windows shell by the SSM-SIS app.

4.2 Commands

The *Commands* group box lists the app commands:

- *Start*: to start the listening of SIS datagrams.
- *Require SSP*: to send a message to SIS that should trigger the reception of the sound speed profile currently in use by Kongsberg SIS.
- *Send SSP*: to send a fake sound speed profile to Kongsberg SIS. It should also trigger the reception of the same speed profile.
- *Stop*: to end the listening of SIS datagrams.

Warning: Do not use the *Send SSP* command during regular survey operations because it will trigger the transmission of a fake sound speed profile.

4.3 Output

The *Output* view provides updates on the received and transmitted datagrams (Fig. 4.2).

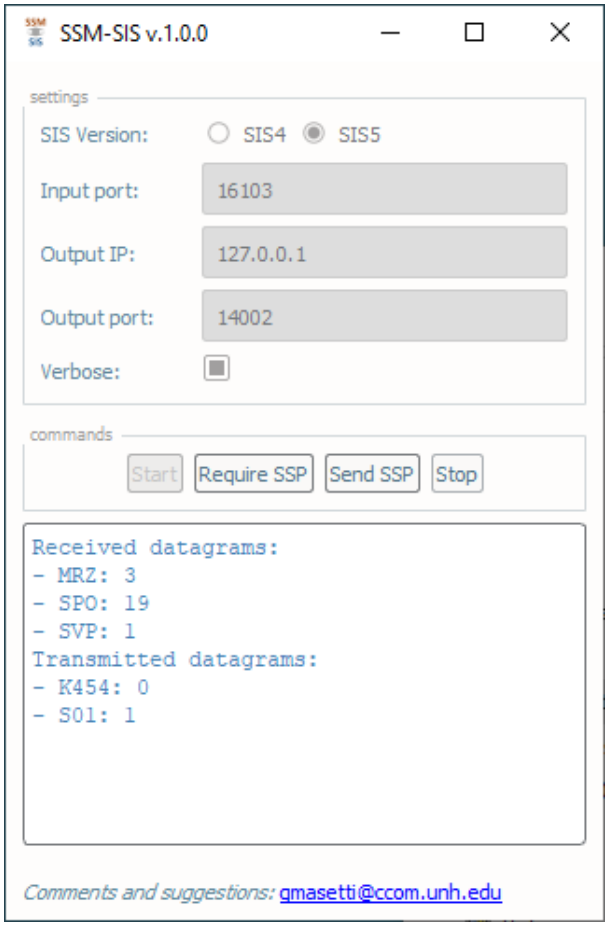

Fig. 4.2: The *SSM-SIS* app showing the results of the interaction with Kongsberg SIS5.

CHAPTER

FIVE

LICENSE

GNU LESSER GENERAL PUBLIC LICENSE

Version 2.1, February 1999

51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA

[This is the first released version of the Lesser GPL. It also counts as the successor of the GNU Library Public License, version 2, hence the version number 2.1.]

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public Licenses are intended to guarantee your freedom to share and change free software–to make sure the software is free for all its users.

This license, the Lesser General Public License, applies to some specially designated software packages–typically libraries–of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

When we speak of free software, we are referring to freedom of use, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish); that you receive source code or can get it if you want it; that you can change the software and use pieces of it in new free programs; and that you are informed that you can do these things.

To protect your rights, we need to make restrictions that forbid distributors to deny you these rights or to ask you to surrender these rights. These restrictions translate to certain responsibilities for you if you distribute copies of the library or if you modify it.

For example, if you distribute copies of the library, whether gratis or for a fee, you must give the recipients all the rights that we gave you. You must make sure that they, too, receive or can get the source code. If you link other code with the library, you must provide complete object files to the recipients, so that they can relink them with the library after making changes to the library and recompiling it. And you must show them these terms so they know their rights.

We protect your rights with a two-step method:

(1) we copyright the library, and

(2) we offer you this license, which gives you legal permission to copy, distribute and/or modify the library.

To protect each distributor, we want to make it very clear that there is no warranty for the free library. Also, if the library is modified by someone else and passed on, the recipients should know that what they have is not the original version, so that the original author's reputation will not be affected by problems that might be introduced by others.

Finally, software patents pose a constant threat to the existence of any free program. We wish to make sure that a company cannot effectively restrict the users of a free program by obtaining a restrictive license from a patent holder. Therefore, we insist that any patent license obtained for a version of the library must be consistent with the full freedom of use specified in this license.

Most GNU software, including some libraries, is covered by the ordinary GNU General Public License. This license, the GNU Lesser General Public License, applies to certain designated libraries, and is quite different from the ordinary General Public License. We use this license for certain libraries in order to permit linking those libraries into non-free programs.

When a program is linked with a library, whether statically or using a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the "Lesser" General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License Agreement applies to any software library or other program which contains a notice placed by the copyright holder or other authorized party saying it may be distributed under the terms of this Lesser General Public License (also called "this License"). Each licensee is addressed as "you".

A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

1. You may copy and distribute verbatim copies of the Library's complete source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and distribute a copy of this License along with the Library.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

> a) The modified work must itself be a software library.
>
> b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
>
> c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.
>
> d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.
>
> (For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may opt to apply the terms of the ordinary GNU General Public License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2, instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices.

Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

> a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)
>
> b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that
>
> > (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and
> >
> > (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.
>
> c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities. This must be distributed under the terms of the Sections above.

b) Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

8. You may not copy, modify, sublicense, link with, or distribute the Library except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense, link with, or distribute the Library is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

9. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Library or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Library (or any work based on the Library), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Library or works based on it.

10. Each time you redistribute the Library (or any work based on the Library), the recipient automatically receives a license from the original licensor to copy, distribute, link with or modify the Library subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties with this License.

11. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Library at all. For example, if a patent license would not permit royalty-free redistribution of the Library by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Library.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply, and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

12. If the distribution and/or use of the Library is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Library under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

13. The Free Software Foundation may publish revised and/or new versions of the Lesser General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Library specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Library does not specify a license version number, you may choose any version ever published by the Free Software Foundation.

14. If you wish to incorporate parts of the Library into other free programs whose distribution conditions are incompatible with these, write to the author to ask for permission. For software which is copyrighted by the Free Software Foundation, write to the Free Software Foundation; we sometimes make exceptions for this. Our decision will be guided by the two goals of preserving the free status of all derivatives of our free software and of promoting the sharing and reuse of software generally.

NO WARRANTY

15. BECAUSE THE LIBRARY IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE LIBRARY, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE LIBRARY "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE LIBRARY IS WITH YOU. SHOULD THE LIBRARY PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

16. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE LIBRARY AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE LIBRARY (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE LIBRARY TO OPERATE WITH ANY OTHER SOFTWARE), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

CHAPTER

SIX

CREDITS

Sound Speed library and manager are based on an ongoing joint development between the NOAA's Office of Coastal Survey and UNH's Center for Coastal and Ocean Mapping.

HydrOffice Sound Speed is developed and maintained by:

- Giuseppe Masetti
- Barry Gallagher
- Chen Zhang

Other contributors:

- Hugh Barker
- Jonathan Beaudoin
- Brian R. Calder
- Lindsay Gee
- Sam Greenaway
- Kevin Jerram
- Paul Johnson
- Damian Manda
- Jean-Guy Nistad
- Patrice Ponchant
- Glen Rice
- Jack Riley
- Matthew Sharr
- Michael Smith
- Matthew J. Wilson

Feel free to contact us for comments and suggestions.

For bugs and feature requests: soundspeed@hydroffice.org