



# **Sound Speed Manager**

***Release 2024.2.1***

**CCOM/JHC, UNH & CSDL, NOAA**

**Oct 20, 2024**



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## IN BRIEF



Sound Speed Manager (SSM) is a software application that provides the user with a streamlined workflow to perform accurate processing and management of sound speed profiles for underwater acoustic systems.

SSM has merged together functionalities present in several applications that process sound speed profiles (SSP):

- *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, 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, UNH](#) as part of the HydrOffice framework under NOAA grants NA10NOS4000073 and NA15NOS4000200.

SSM has been designed to ease integration into existing data acquisition workflows. The liberal open source license used by the project (specifically, GNU LGPL) provides for understanding of the chosen processing solutions through ready inspection of the source code, as well as the ability to adapt the application to specific organization needs.

This adaptation is eased by the modular design of the application, with the NOAA-specific functionalities organized so that they can be easily deactivated for non-NOAA users.

The main functionalities include:

- Wide support of commonly-used sound speed profile formats
- Compatibility with various data sources
- Integration with common data acquisition/integration applications (e.g., Kongsberg SIS)
- Profile enhancement based on real-time and climatologic models
- Database management of the collected data with built-in functionalities for analysis and visualization.

With a long-term support and development plan, Sound Speed Manager is a turnkey application ready to be used (and extended) by professionals and institutions in the hydrographic community.

The package is jointly developed by the [Center for Coastal and Ocean Mapping, UNH](#) and [NOAA Coast Survey Development Laboratory \(CSDL\)](#).

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 specifying 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		

continues on next page

Table 1.1 – continued from previous page

Functionality	Sound Speed Manager	Velocipy	SSP Manager
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Symbols: **x** = *New functionality*; **-** = *Basic functionality*; **^** = *Improved functionality*



## 2.1 Installation

### 2.1.1 Installation using the Pydro distribution

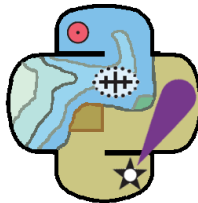


Fig. 2.1: The Pydro logo.

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`
- `PySide6` (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/hydrooffice/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.hydrooffice.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/atlas/[woa09|woa13|woa18]” (Windows XP), or
- “C:/Users/<username>/AppData/Local/HydrOffice/Sound Speed/atlas/[woa09|woa13|woa18]” (newer Windows OS)

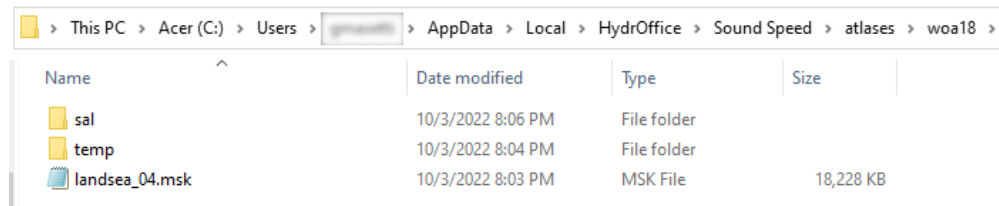


Fig. 2.2: The default location and internal structure of the WOA18 folder on recent Windows OS.

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. 2.62).

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**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).

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## 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).

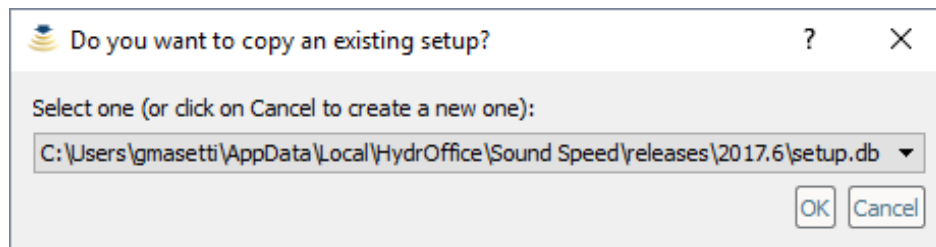


Fig. 2.3: Select the desired setup and click on the *OK* button to copy an existing setup.

### 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.

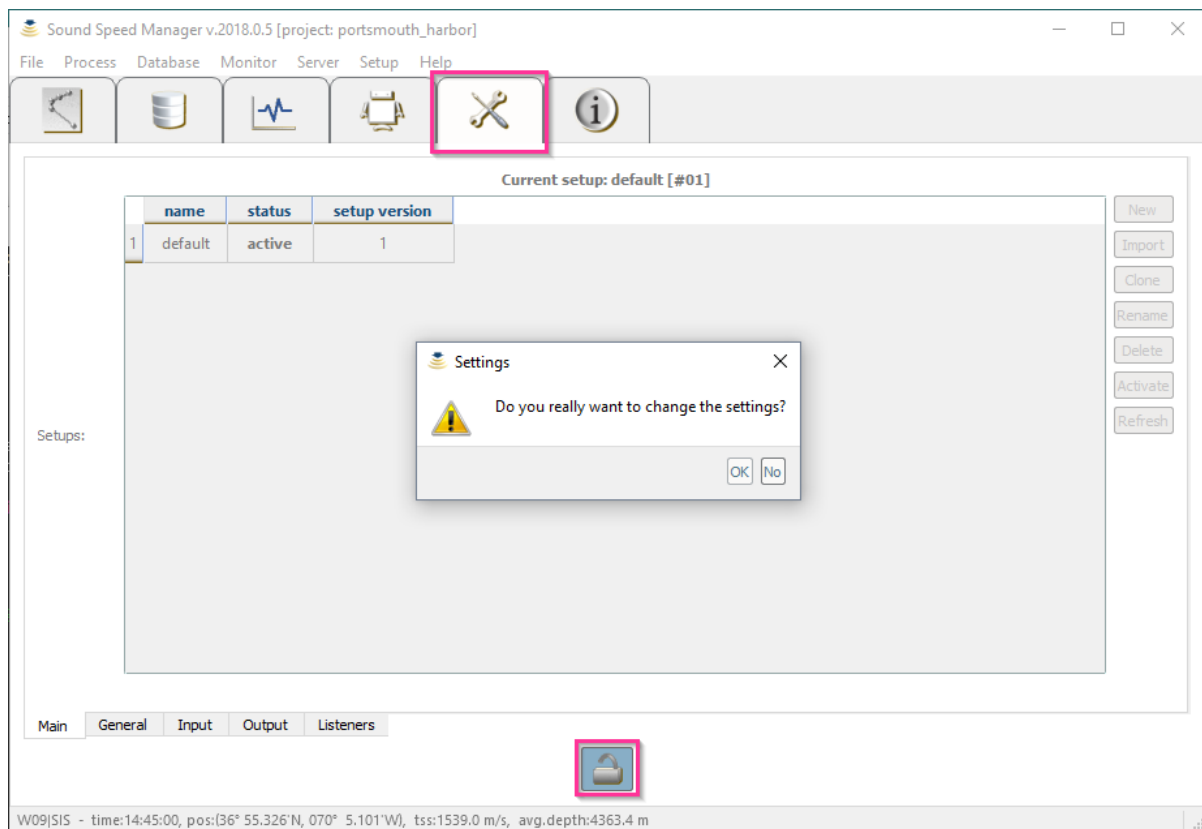


Fig. 2.4: When unlocking, you will be asked to confirm that you want to modify the setup.

## 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.

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

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## 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.

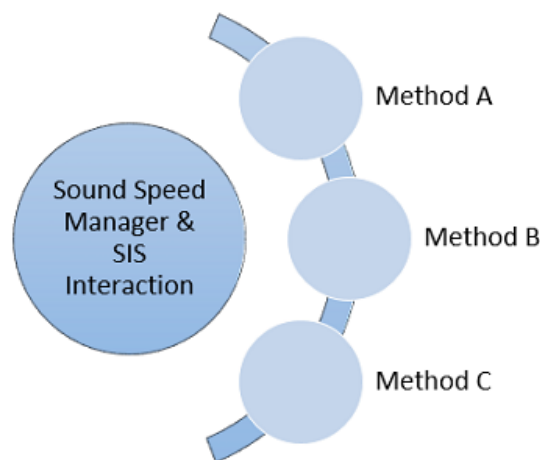


Fig. 2.5: *Kongsberg SIS v4* can be configured to broadcast datagrams in three different ways as discussed in Methods A, B, and C.

## 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 use 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*

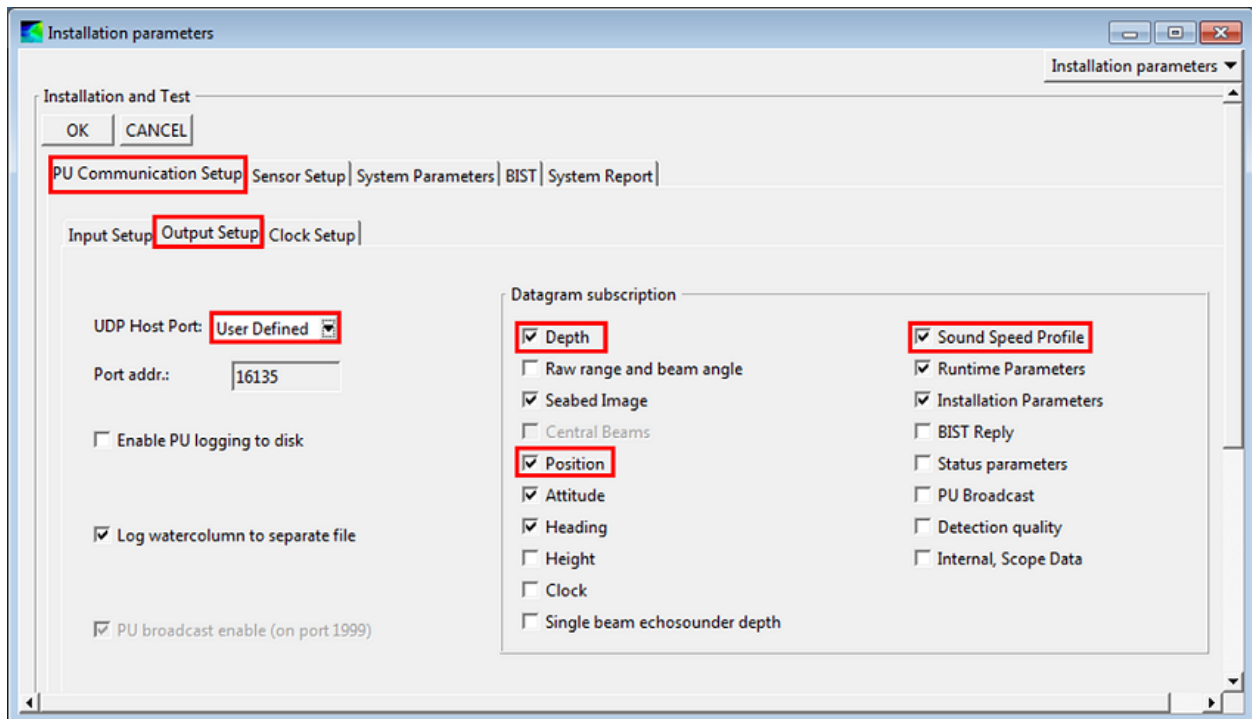


Fig. 2.6: *SIS* Installation parameters dialog, with key settings in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

- 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).

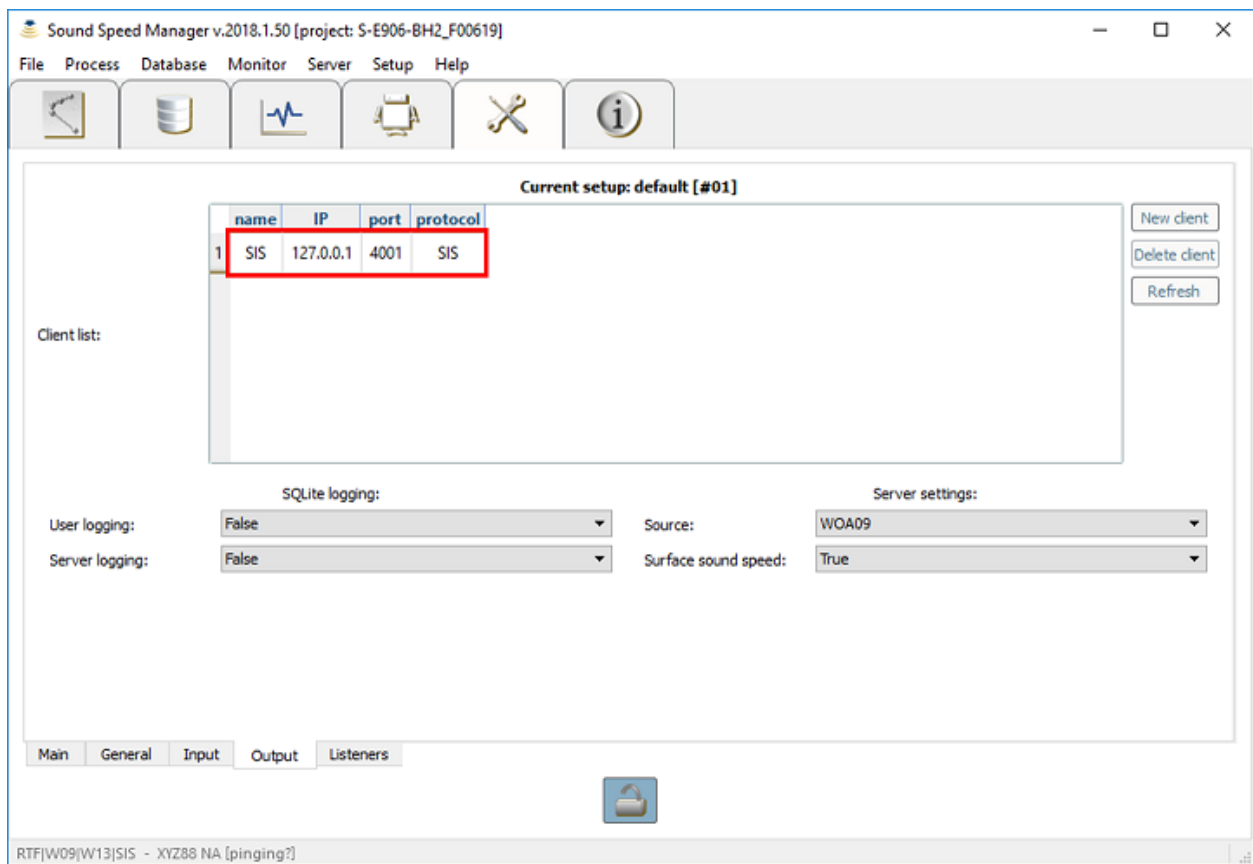


Fig. 2.7: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

- 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).

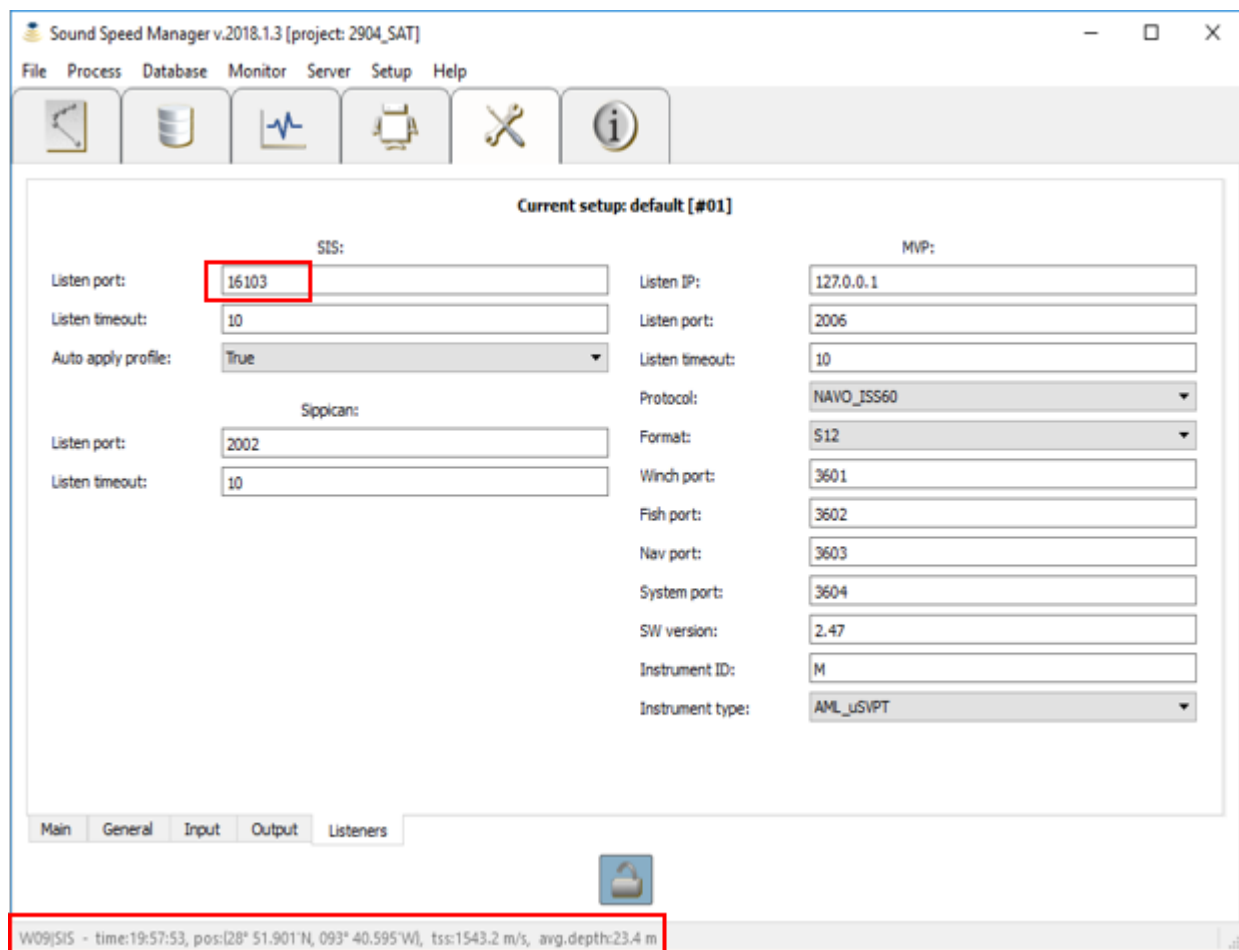


Fig. 2.8: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming SIS data highlighted in red for *Method A: Sound Speed Manager and SIS v4 Installed on the same Computer*.

**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.

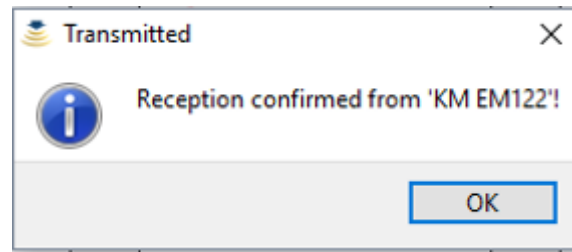


Fig. 2.9: Sound Speed Manager SIS Receipt dialog.

## 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.

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

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- 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).

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**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.

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**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).

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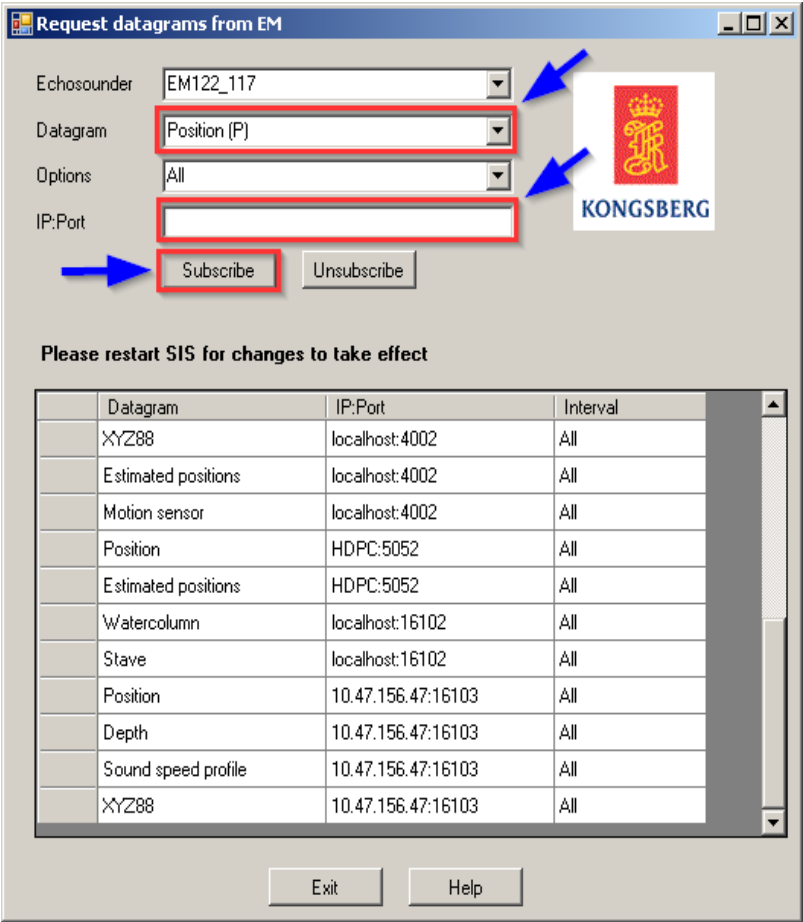


Fig. 2.10: *Request Datagrams from EM* dialog, with key settings in red for *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*.



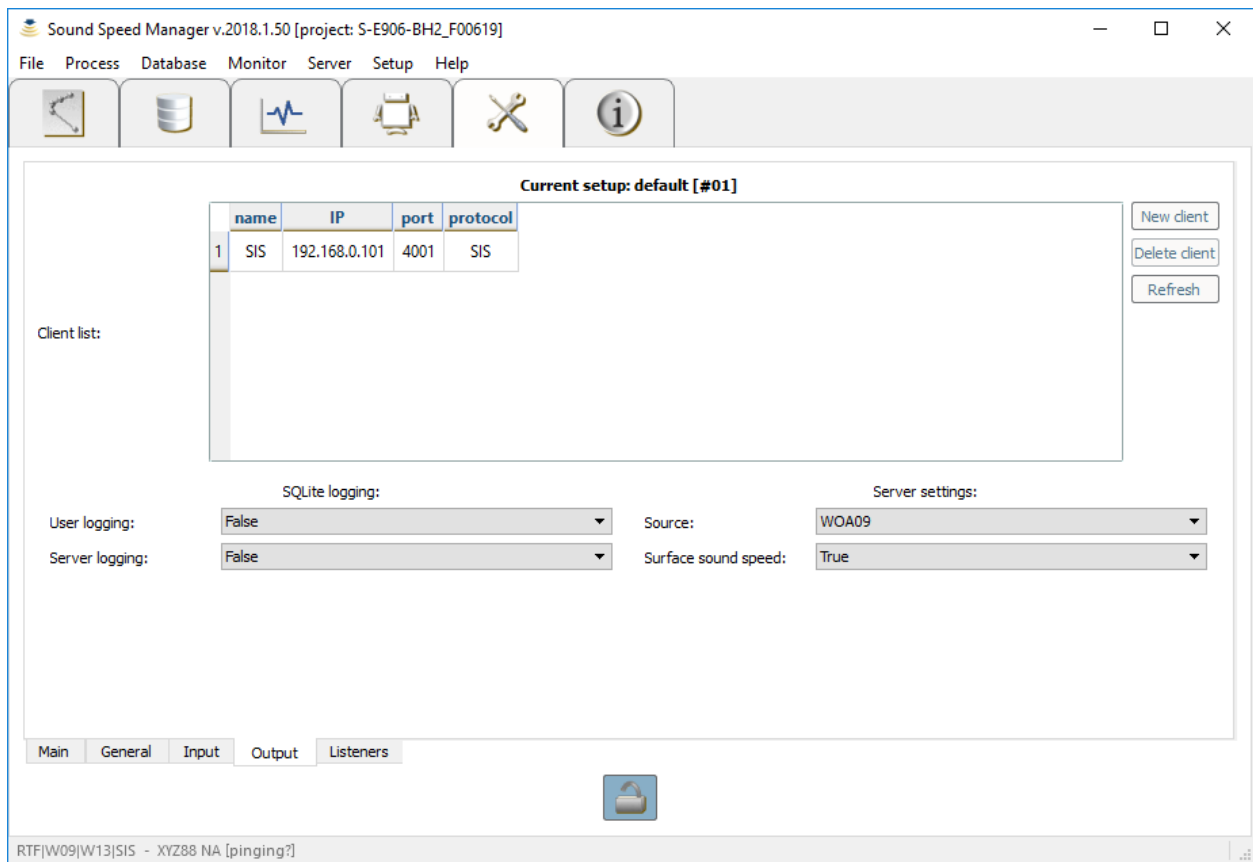


Fig. 2.11: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network*.

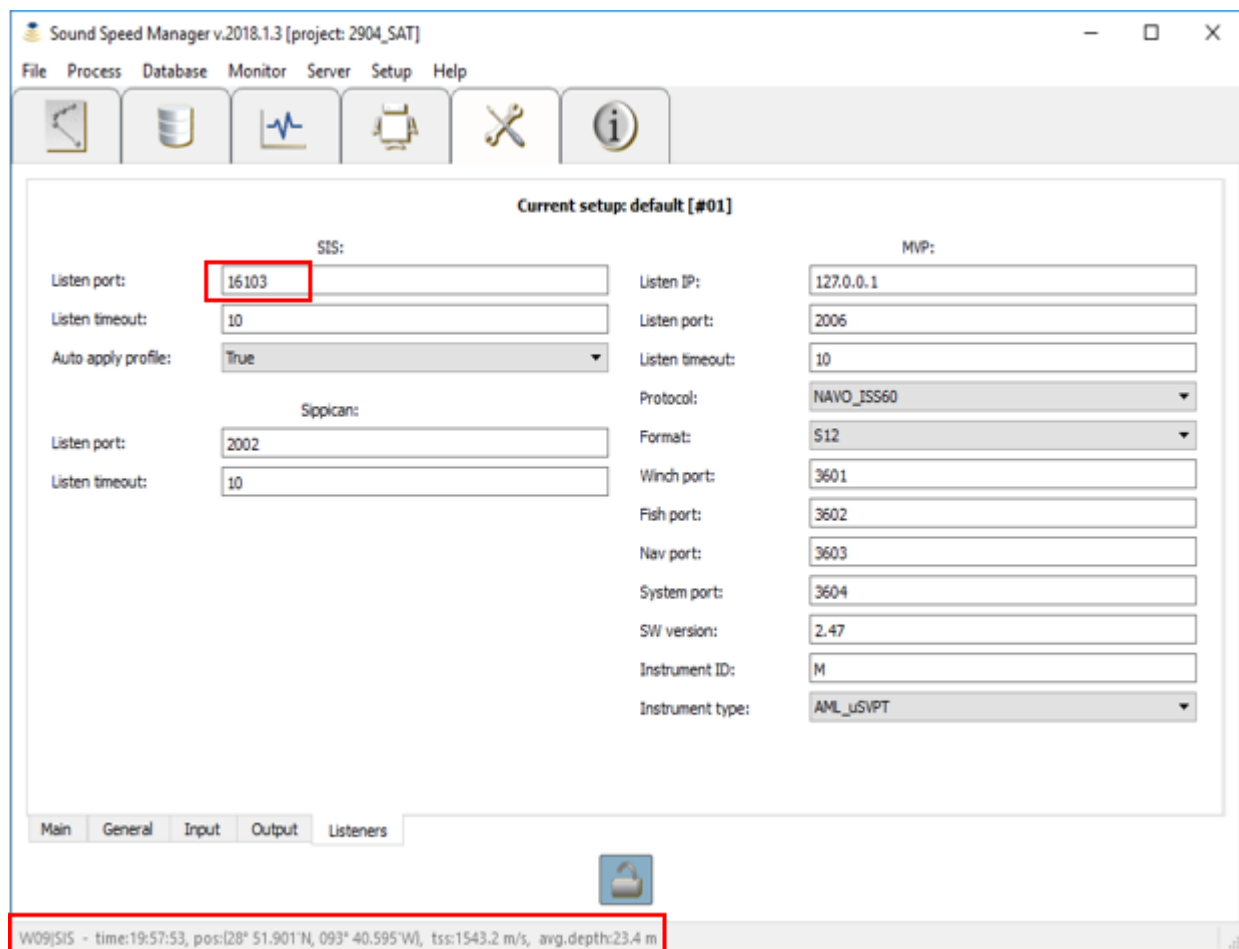


Fig. 2.12: Sound Speed Manager Setup Listeners dialog, with the Listen Port setting and incoming SIS data highlighted in red for Method B: Sound Speed Manager and SIS v4 Installed on Separate Computers within a Network.

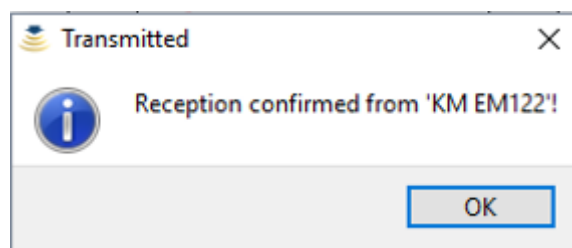


Fig. 2.13: Sound Speed Manager SIS Receipt dialog.

## 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 backside 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.

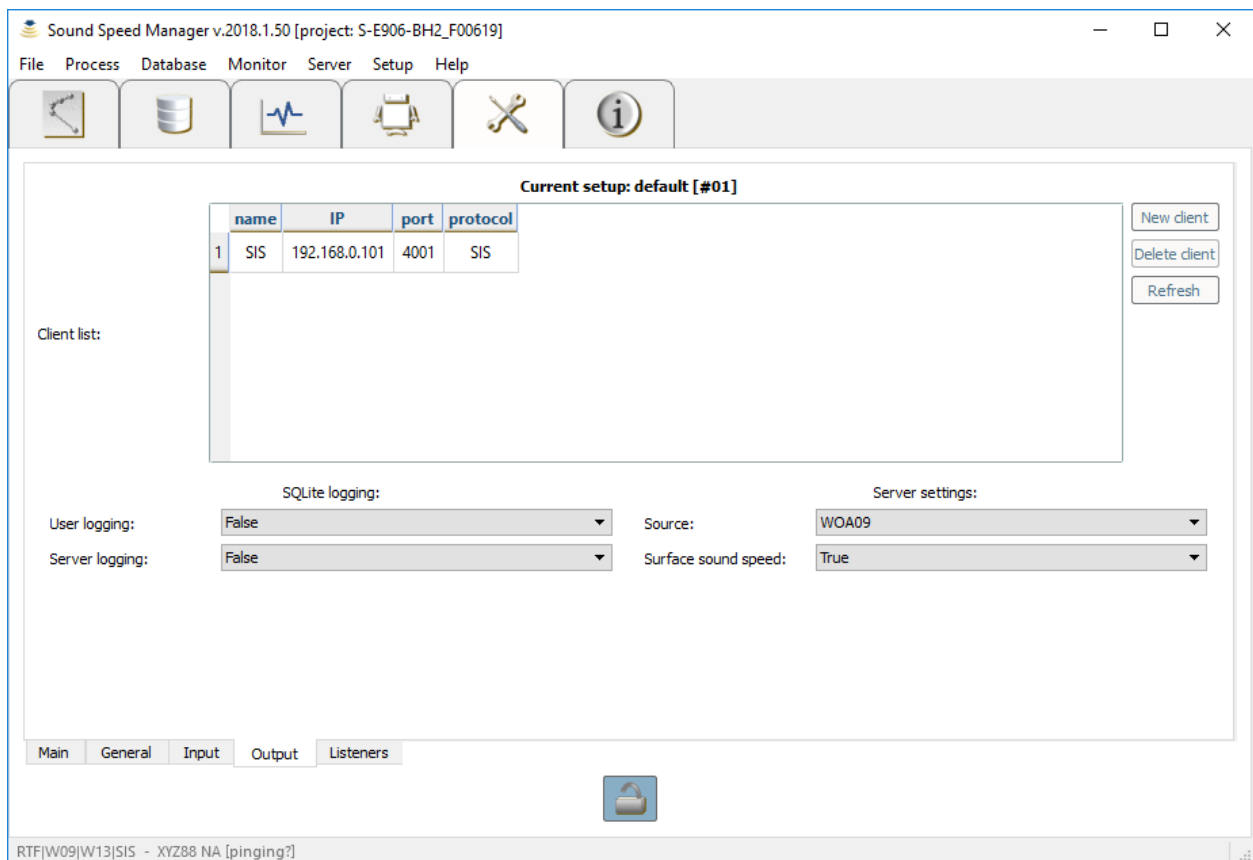


Fig. 2.14: *Sound Speed Manager Setup Output* dialog, with key settings in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

- 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).

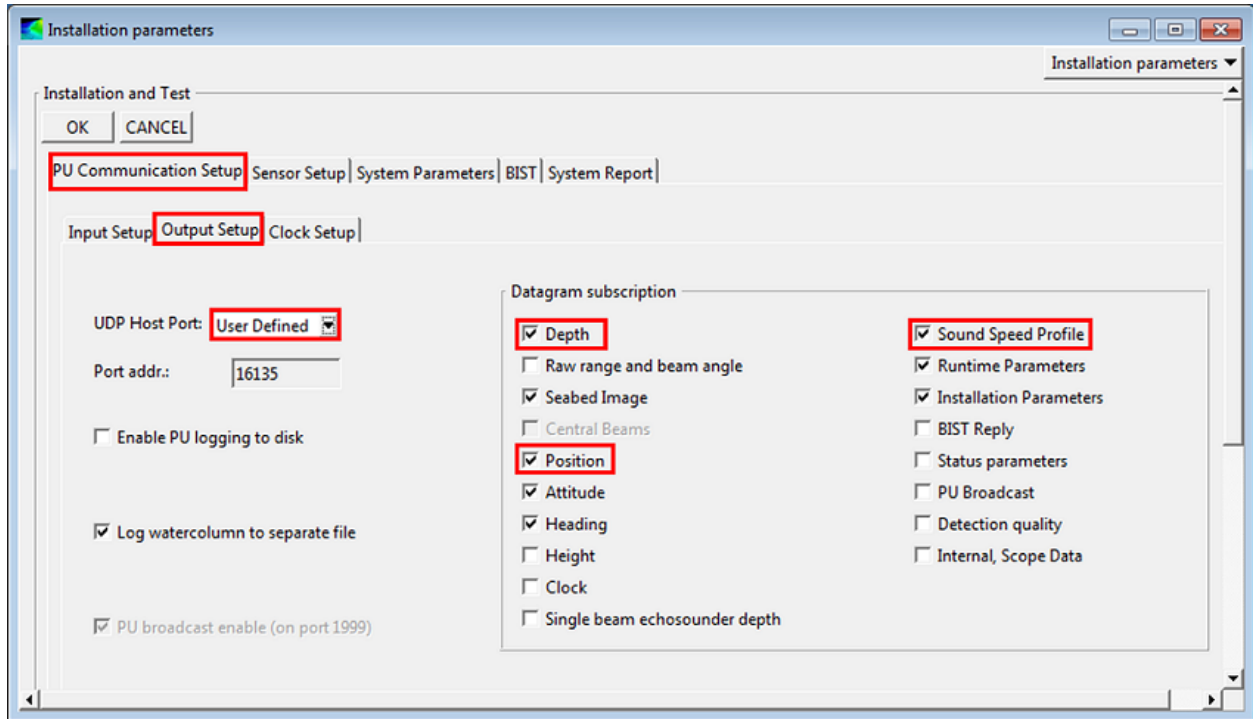


Fig. 2.15: *SIS Installation Parameters* dialog, with key settings in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

- 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 is 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.

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

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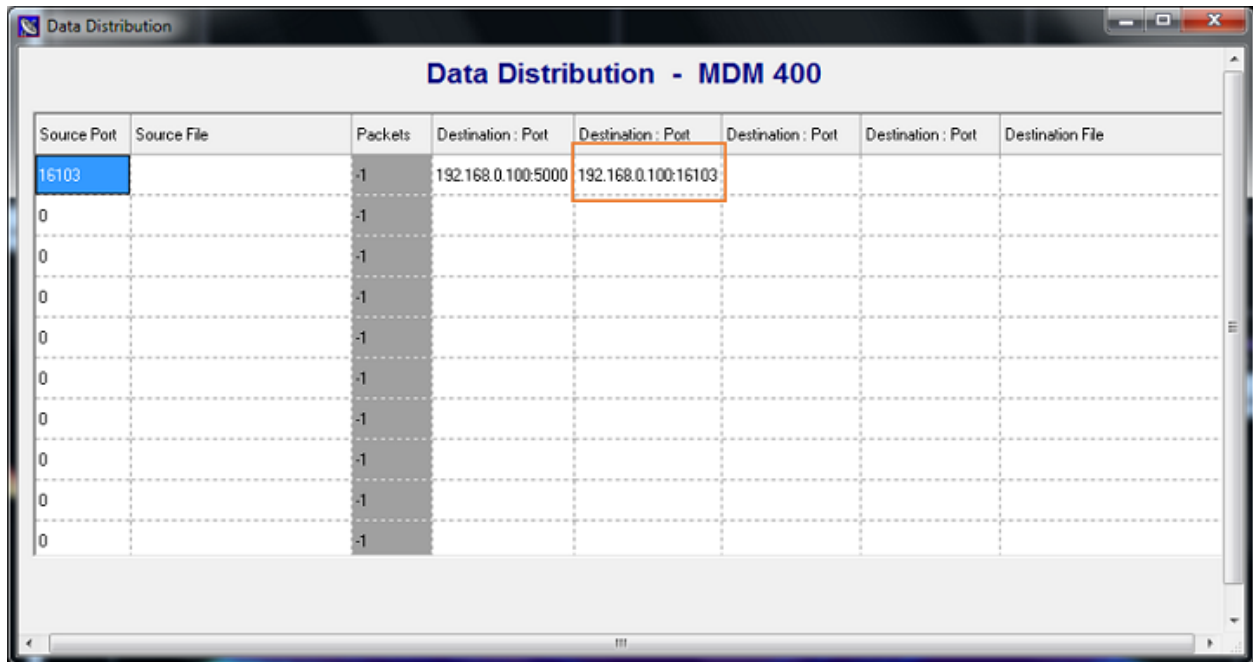


Fig. 2.16: *Data Distribution - MDM 400* dialog, with key settings in orange for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

## 2.2.5 Sound Speed Manager - SIS v5 interaction

SIS v5 is currently supported in two ways:

- Through the Data Distribution application (usually installed with SIS v5).
- Using the dedicated *Sound Speed Manager (SSM) IP and port* field (**only for SIS v5.14+**).

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 (through Data Distribution)

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.

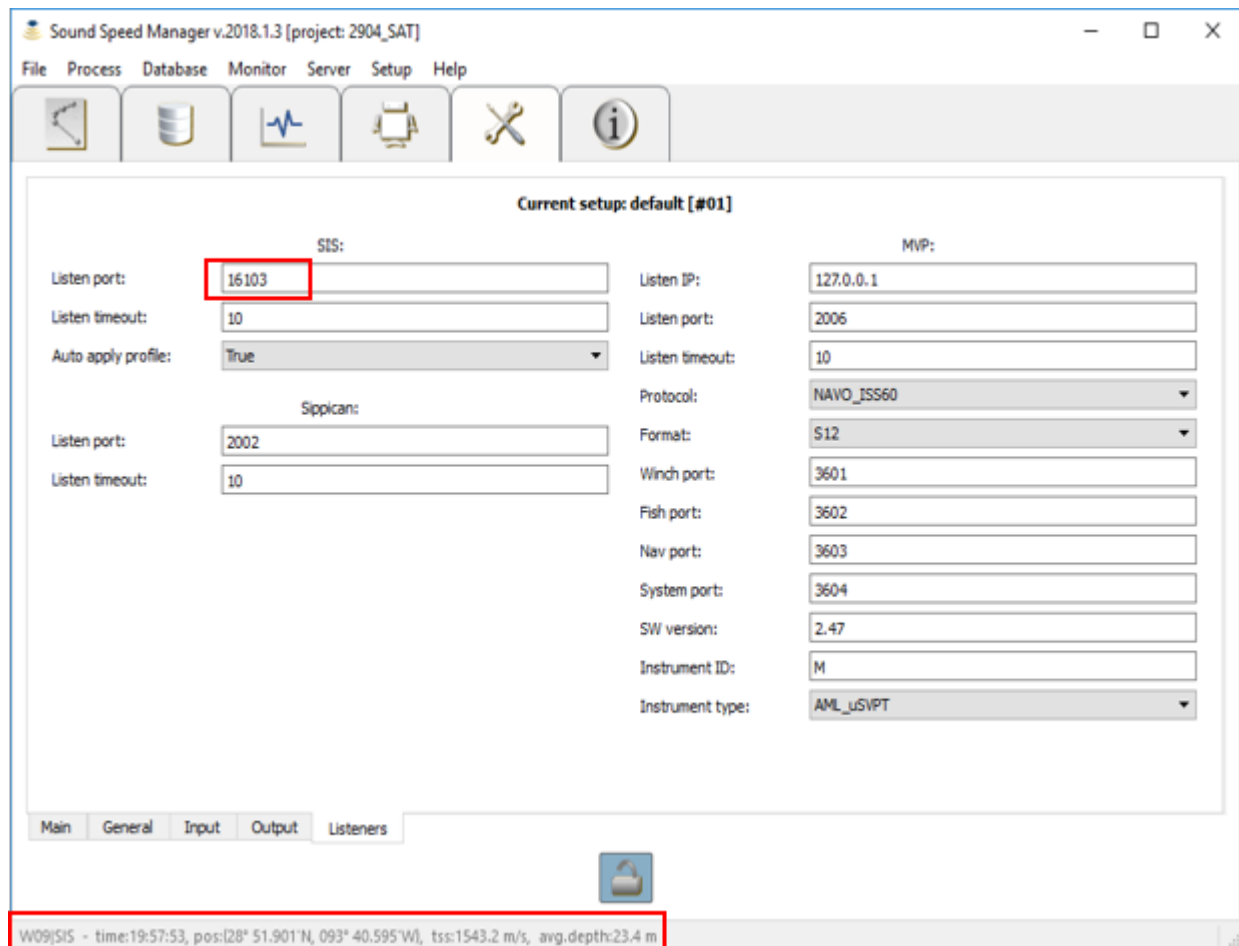


Fig. 2.17: Sound Speed Manager Setup Listeners dialog, with the Listen Port setting and incoming SIS data highlighted in red for *Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager*.

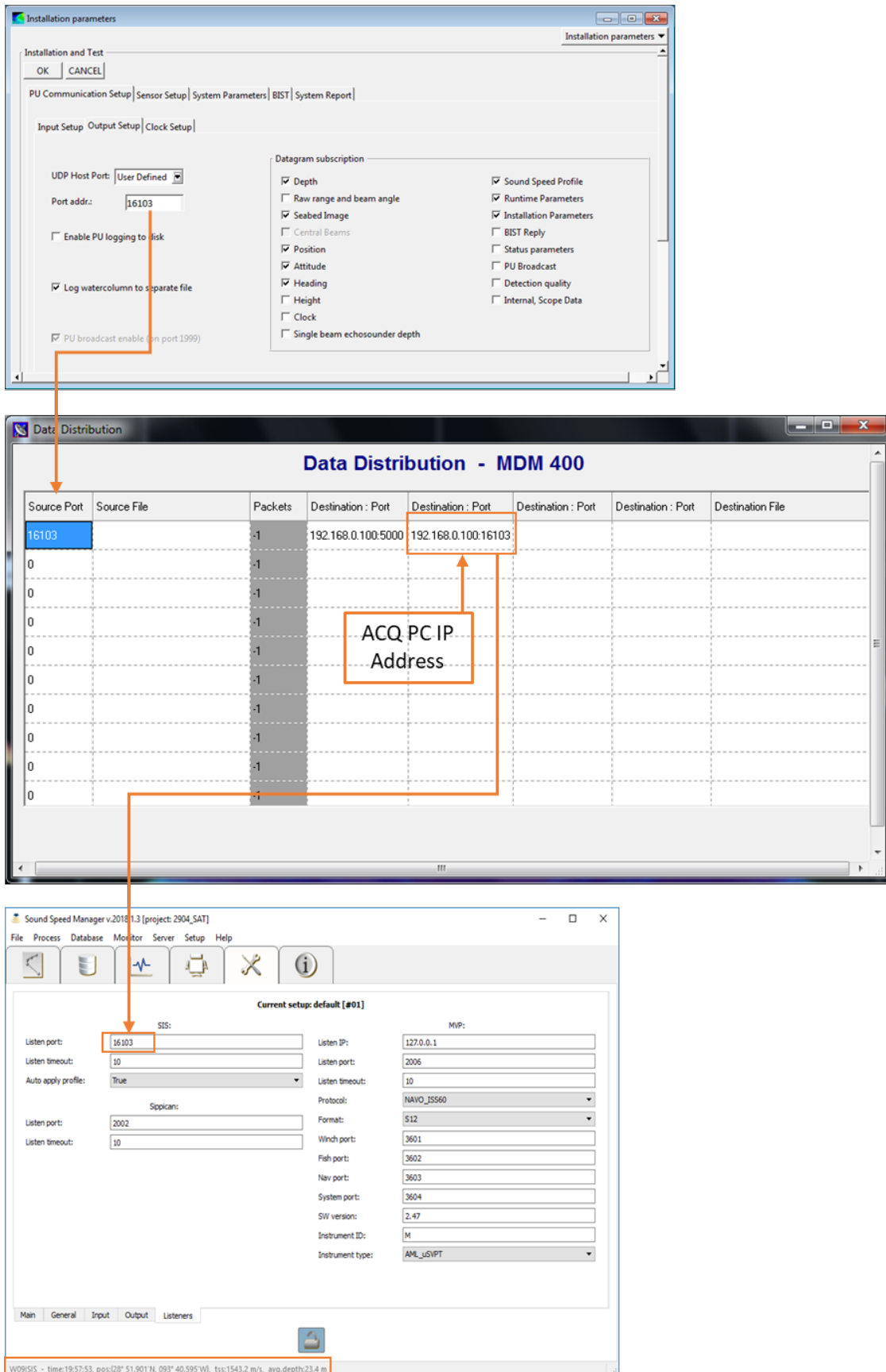


Fig. 2.18: Complete Method C Diagram, with key information and connections highlighted in orange for Method C: Managing Multiple Software Connections to SIS v4, Including Sound Speed Manager.

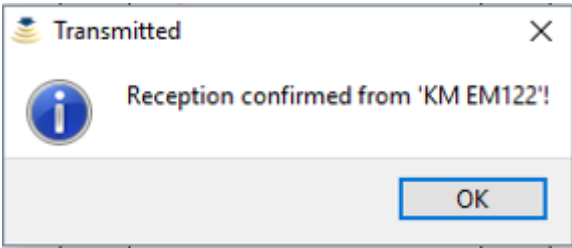


Fig. 2.19: Sound Speed Manager SIS Receipt dialog.

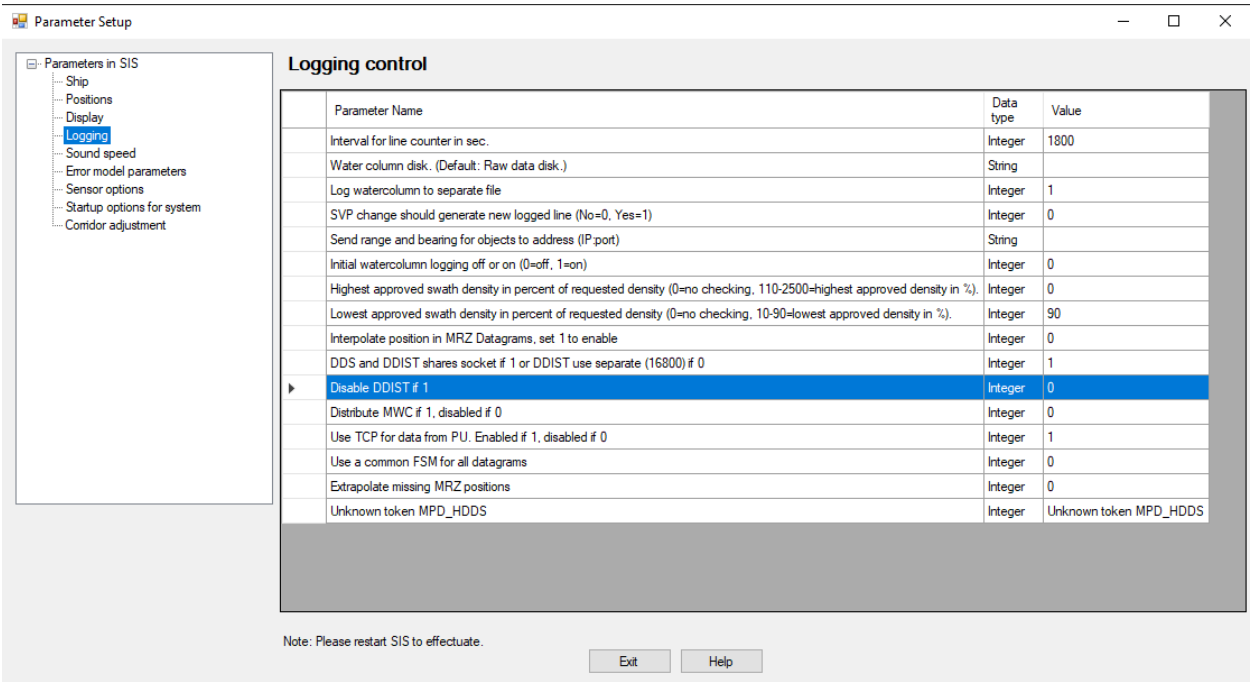


Fig. 2.20: The 'Disable DDIST if 1' entry under Tools in Parameter Setup/Logging.



- Save the configuration.

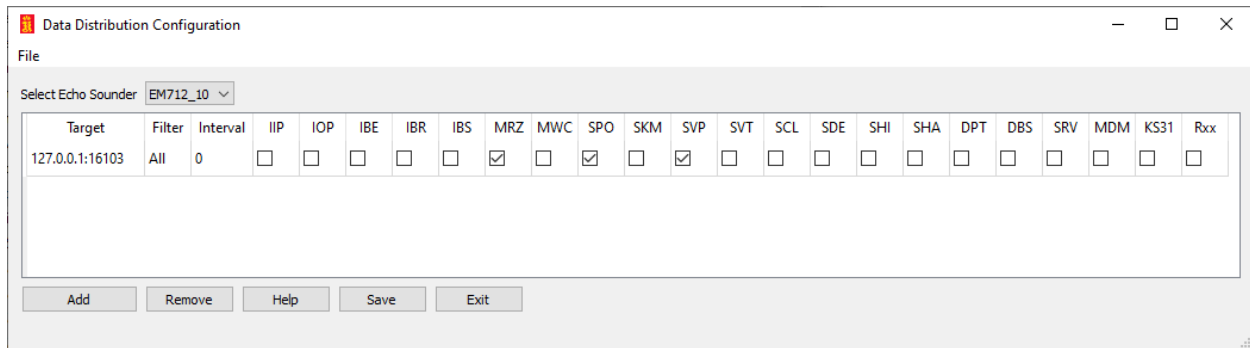


Fig. 2.21: *Data Distribution Configuration* application with required settings.

**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.

### SIS v5 settings (using *Sound Speed Manager (SSM) IP and port* field)

This solution is available only in SIS 5.14 (and higher):

- In the SIS *Tools* menu, open the *Parameter Setup*.
- Navigate to the *sound speed* menu.
- In the *Sound Speed Manager (SSM) IP and port* field (see Fig. 2.22), enter the IP address of the SSM workstation and the port number (e.g., 16103). If SIS and SSM are on the same computer, use: 127.0.0.1:16103
- Restart SIS.

### 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 or in the *Sound Speed Manager (SSM) IP and port* field) in the Listeners sub-tab (see Fig. 2.23).

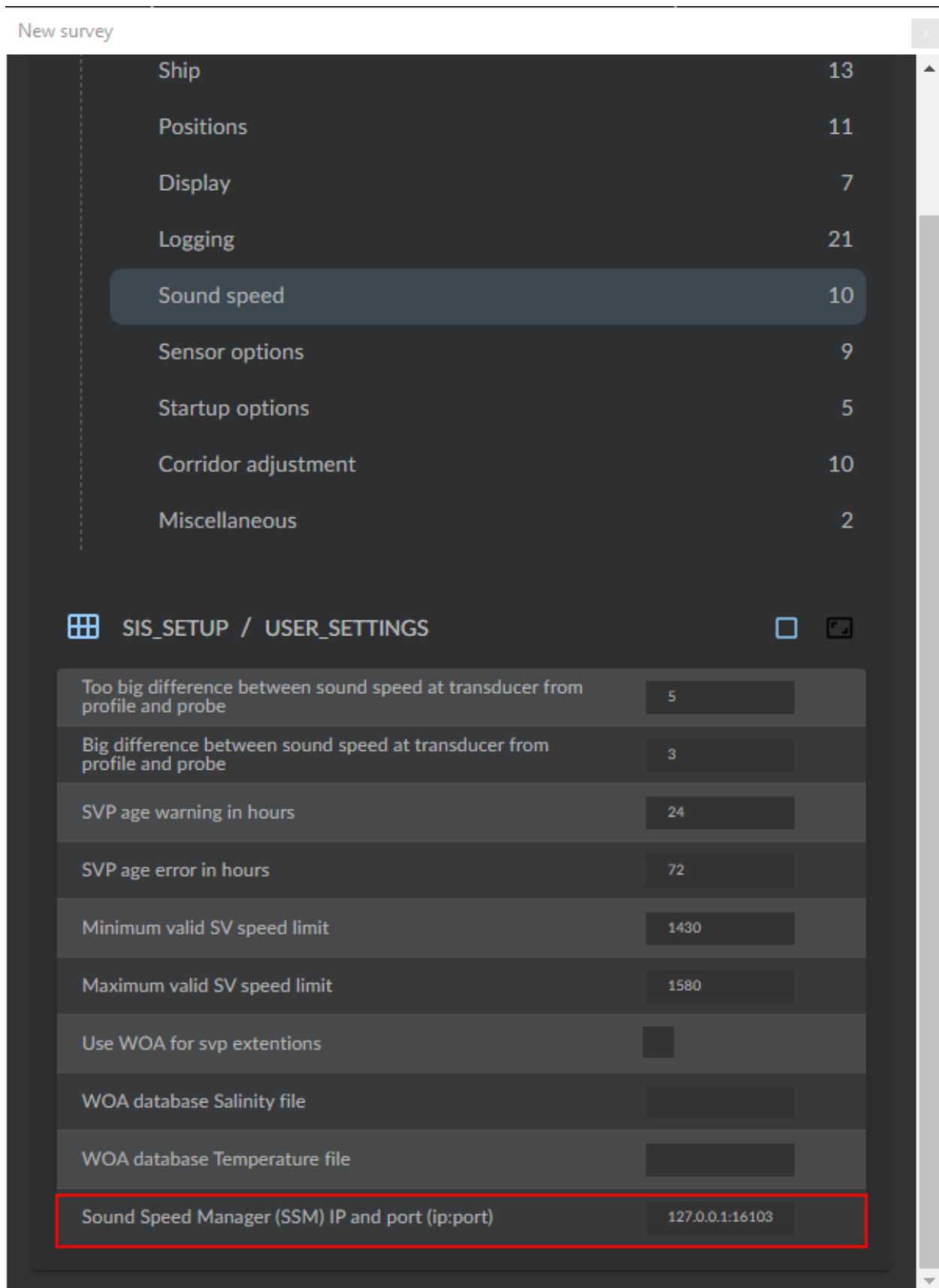
Then, switch to the Input sub-tab (see Fig. 2.24) and select the True value for the Listen SIS v5 field.

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. 2.25) 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. 2.24).



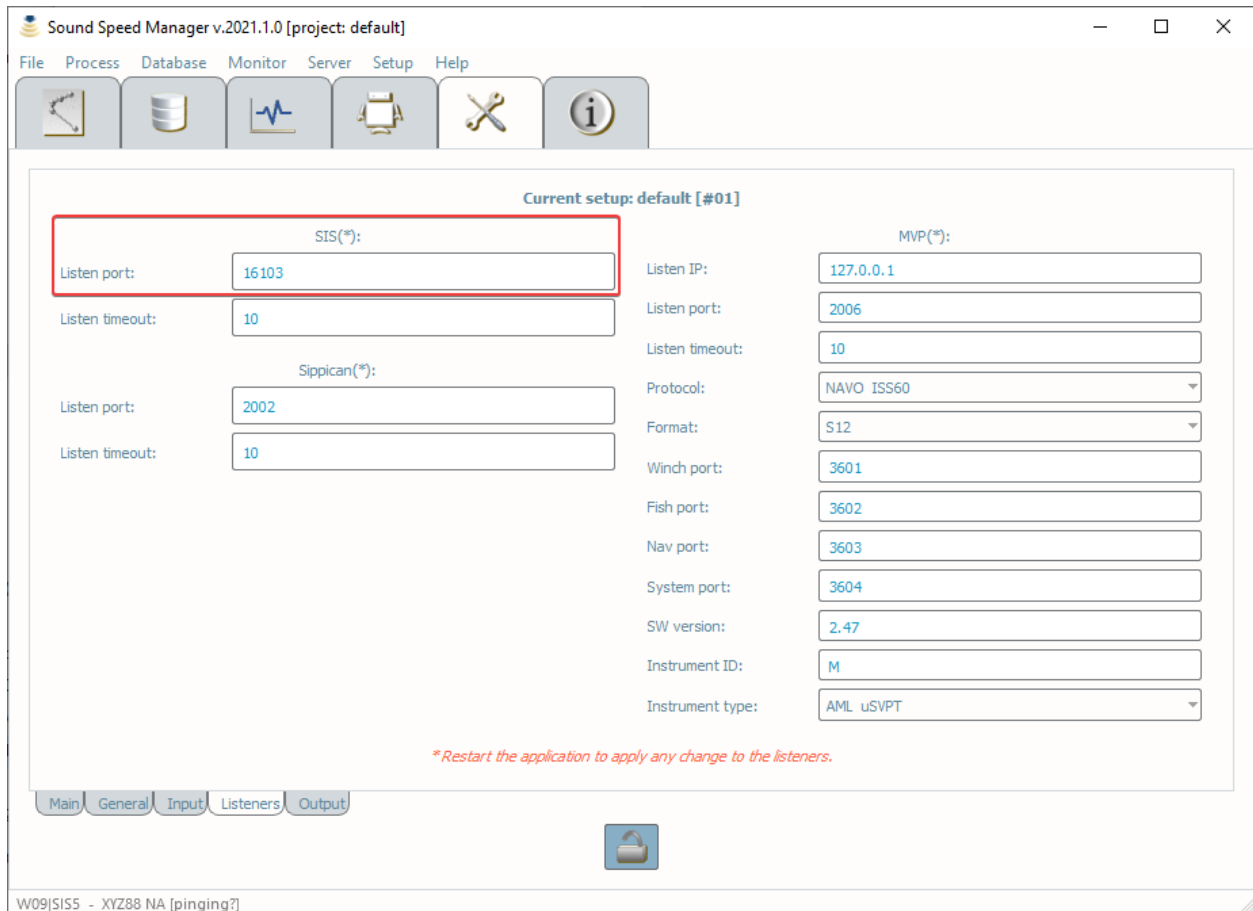


Fig. 2.23: Listeners tab in the Sound Speed Manager's Setup.

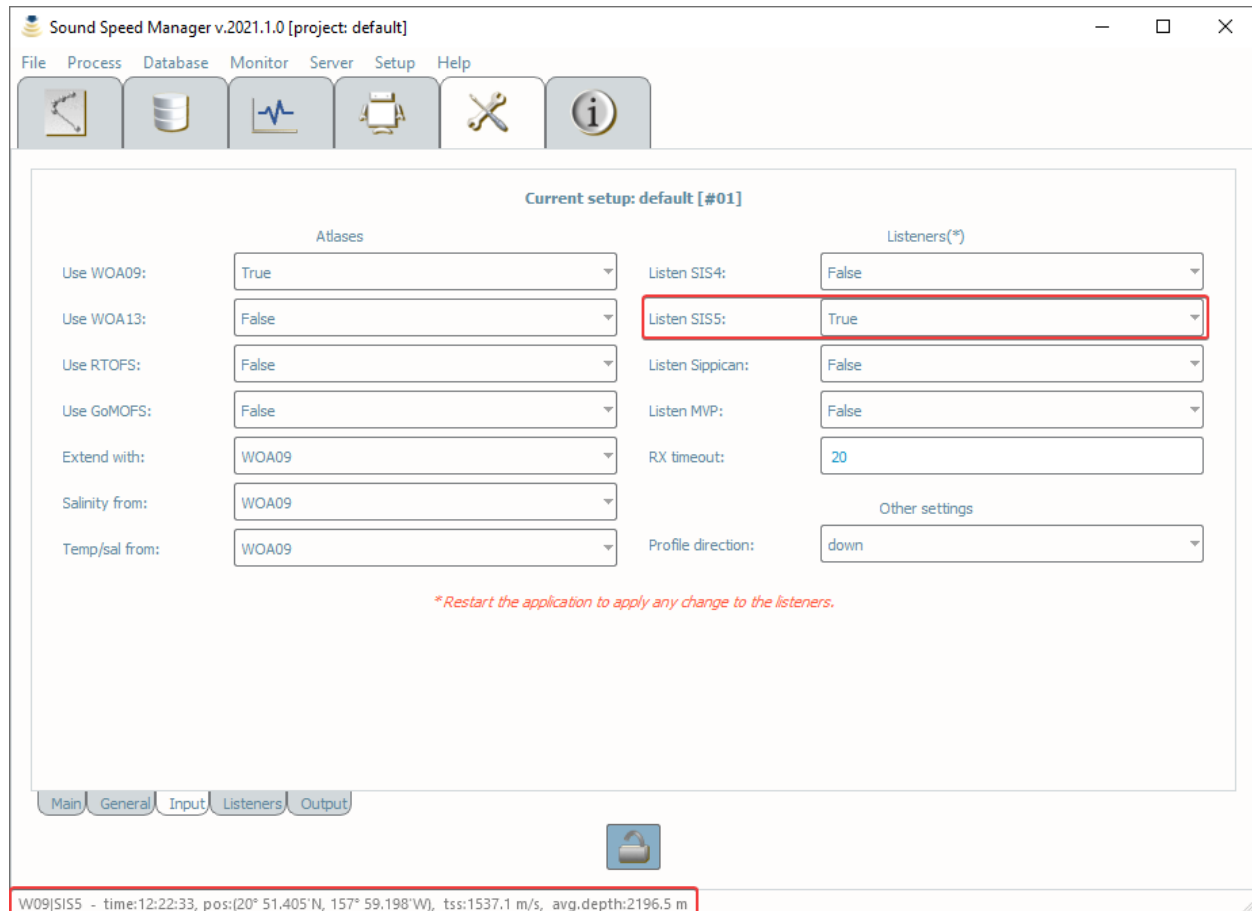


Fig. 2.24: *Input tab* in the Sound Speed Manager's Setup.

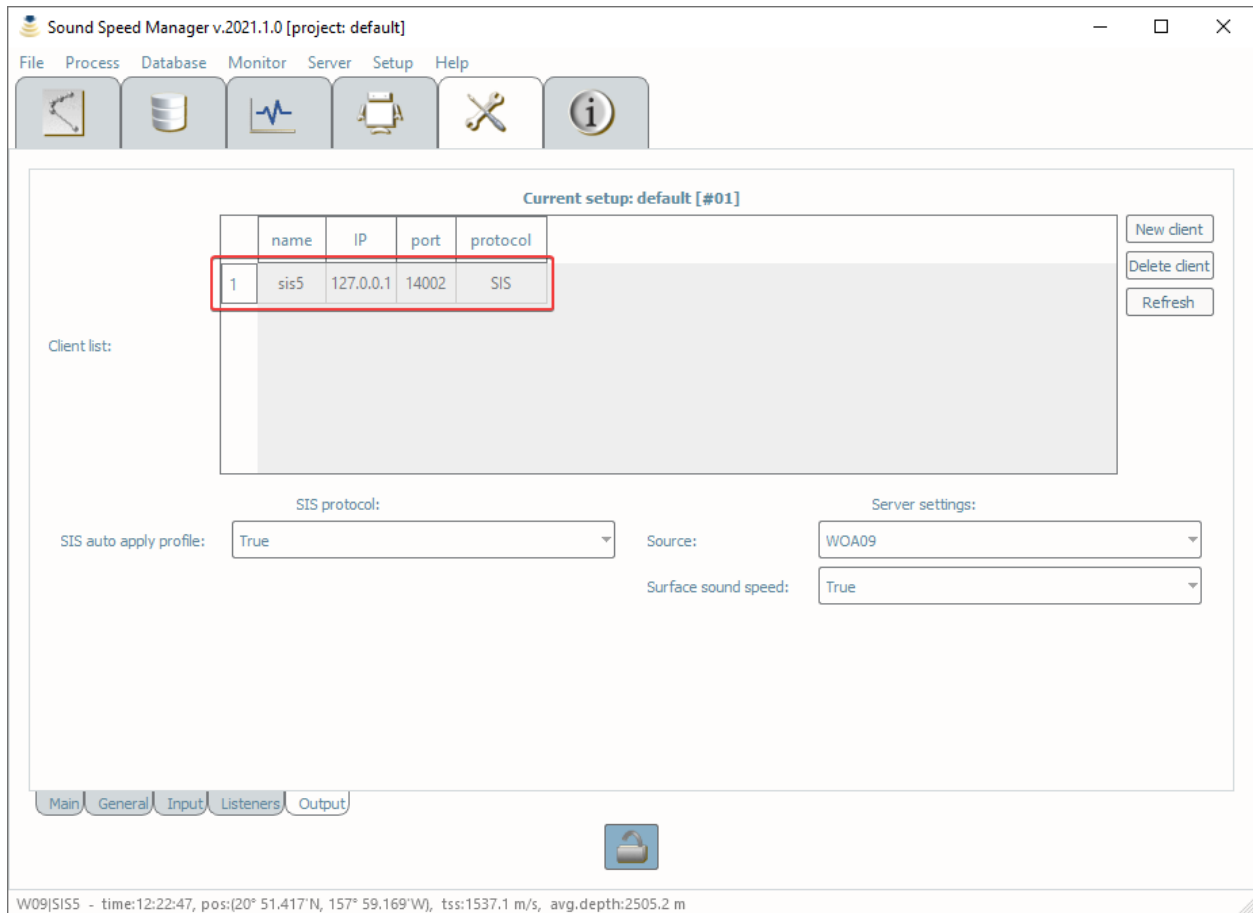


Fig. 2.25: *Output tab* in the Sound Speed Manager's Setup.

**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 \$-GDL 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. 2.26).

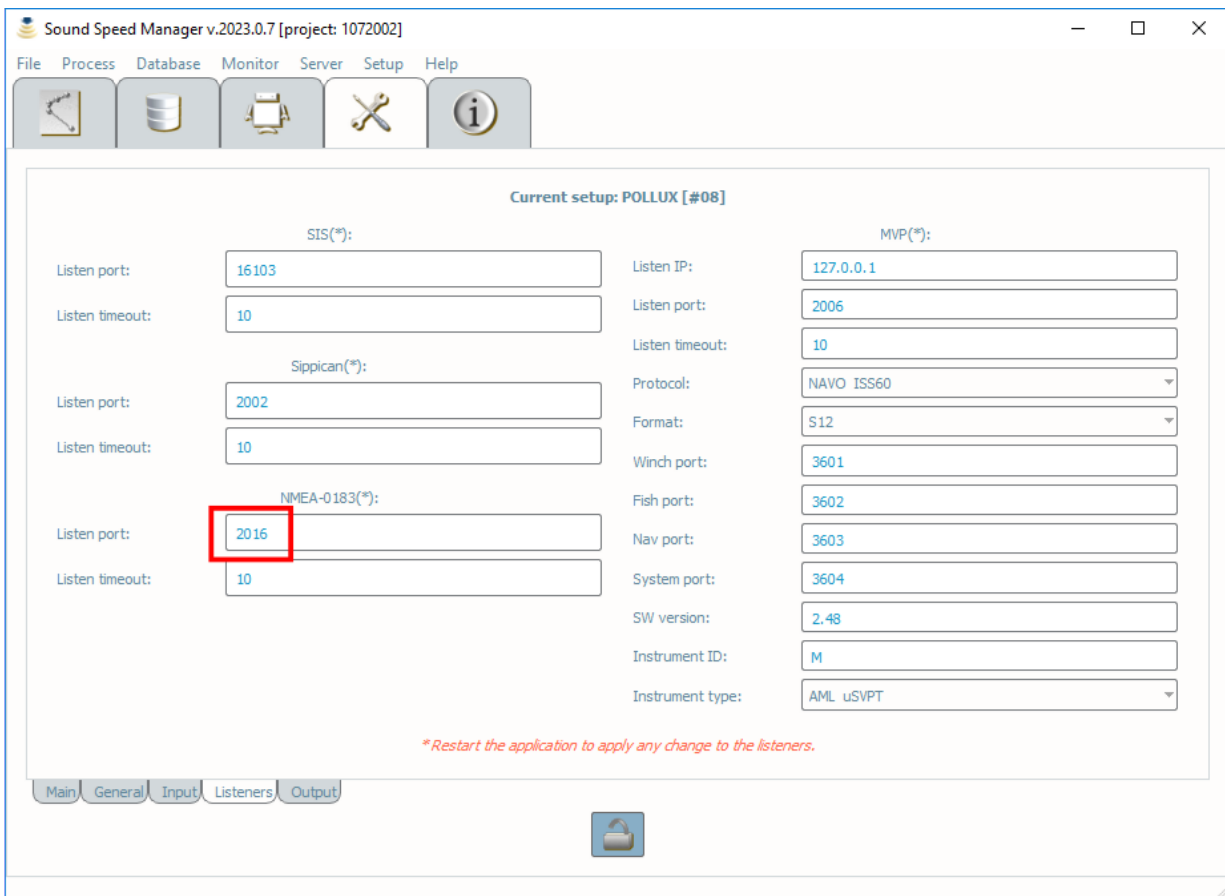


Fig. 2.26: *Sound Speed Manager Setup Listeners* dialog, with the *Listen Port* setting and incoming NMEA 0183 data highlighted in red.

Then, switch to the *Input* sub-tab (see Fig. 2.27) and set *True* the *Listen NMEA 0183* field. After a **restart**, the current position should be displayed in the status bar.

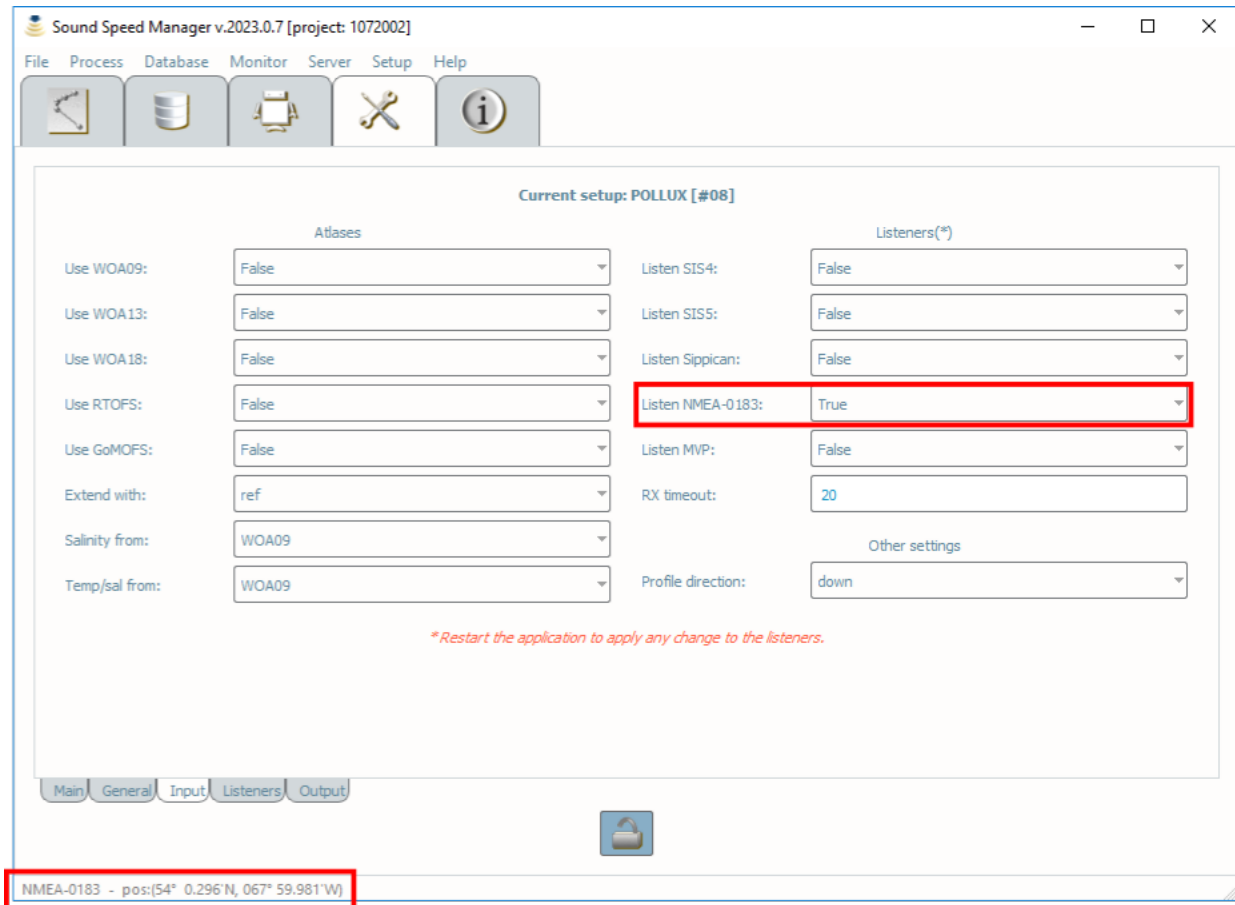


Fig. 2.27: Input tab in the Sound Speed Manager's Setup Tab.

## 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) <sup>1</sup>		X
QPS (.bsvp) <sup>2</sup>		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	

<sup>1</sup> For details on how to browse the content of a generated NCEI file, see [Appendix C - Exploring Profiles in NCEI format](#).

<sup>2</sup> 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. 2.28) and choose the desired import file type (Fig. 2.29).

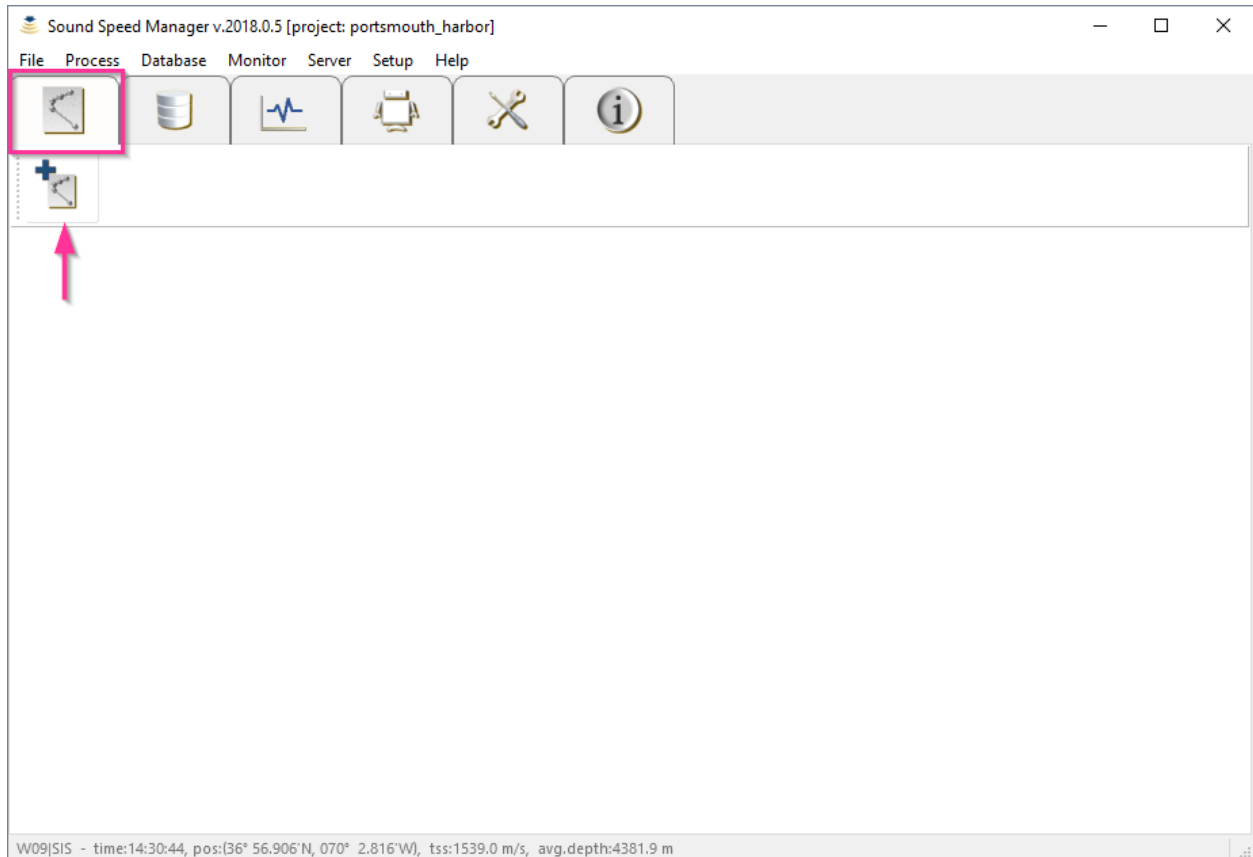


Fig. 2.28: Click on the *Import data* button in the *Editor* tab to start the import process.

This will launch a file selection dialog (Fig. 2.30) 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. 2.31).

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.

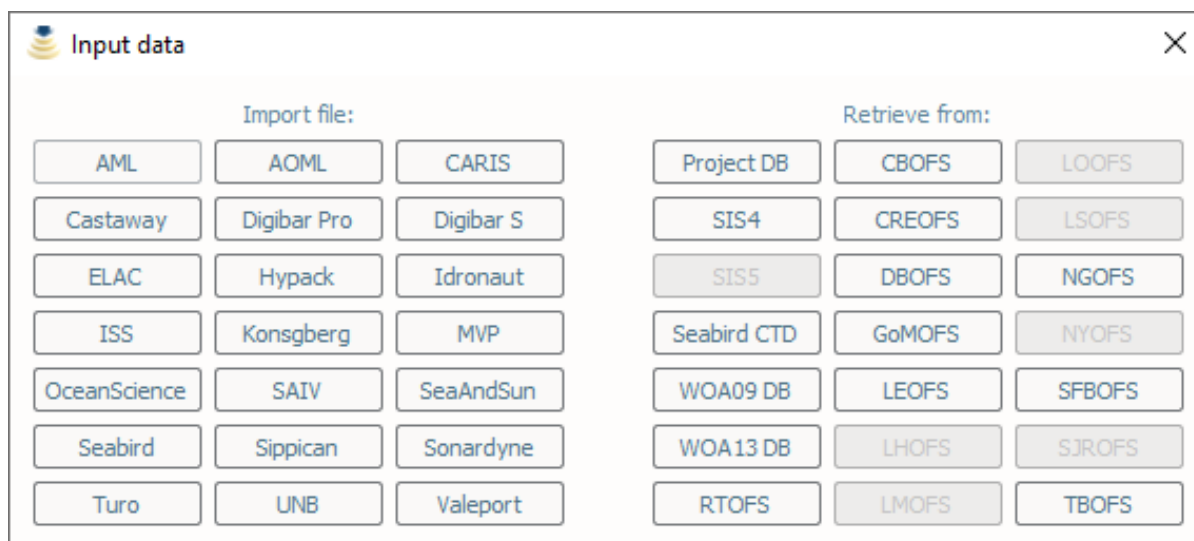


Fig. 2.29: Click on the desired import file type.

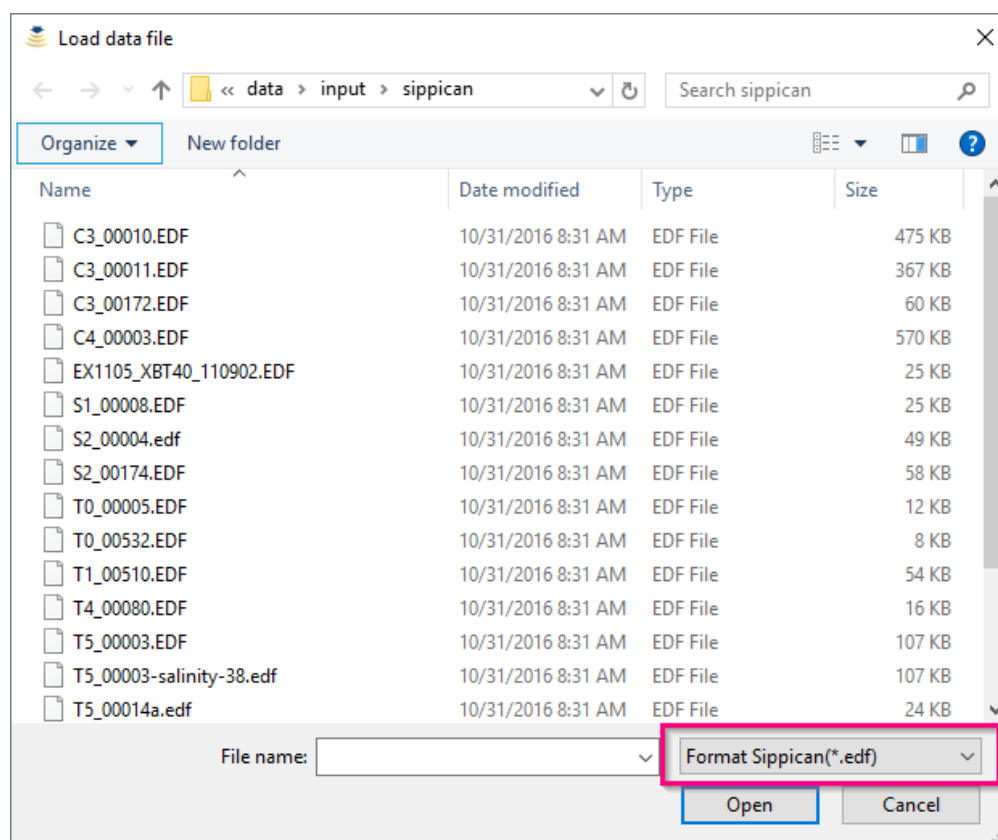


Fig. 2.30: Browse to the desired data file.

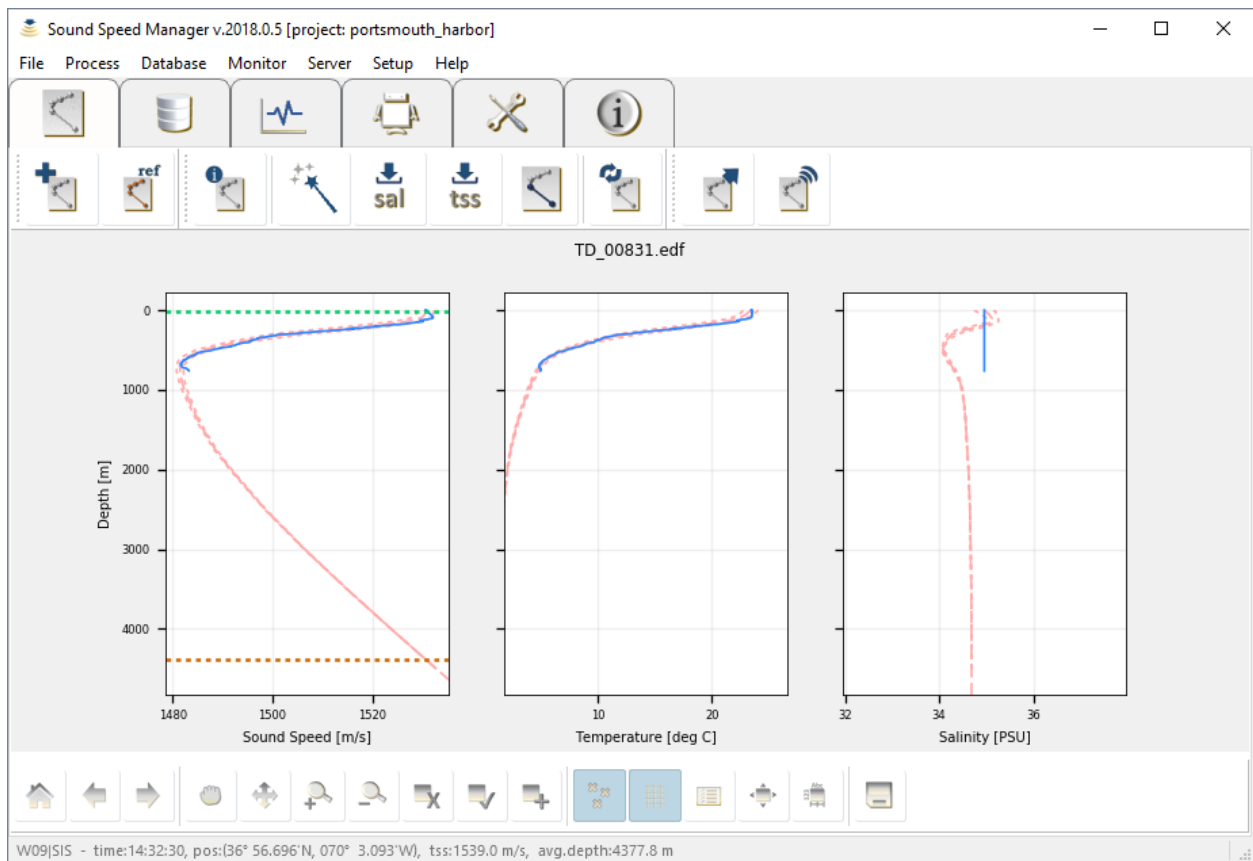


Fig. 2.31: *Sound Speed Manager* showing the three main plots: sound speed, temperature, and salinity.

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. 2.32) accessible using *Process/Change Buttons Visibility*.

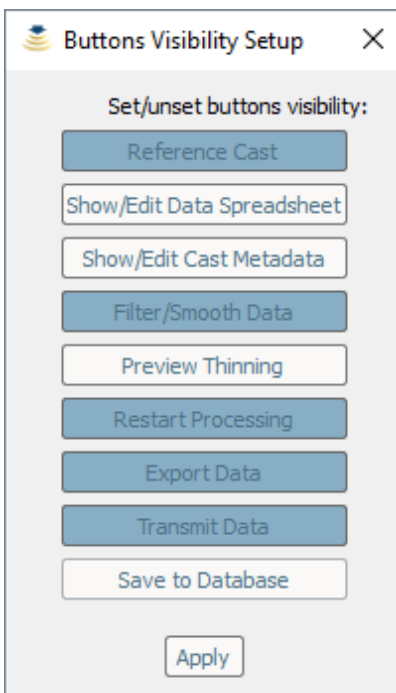


Fig. 2.32: The *Button Visibility* dialog.

### Interactive data editing

The mouse interactive mode is set using the plotting toolbar at the bottom (Fig. 2.33) 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.

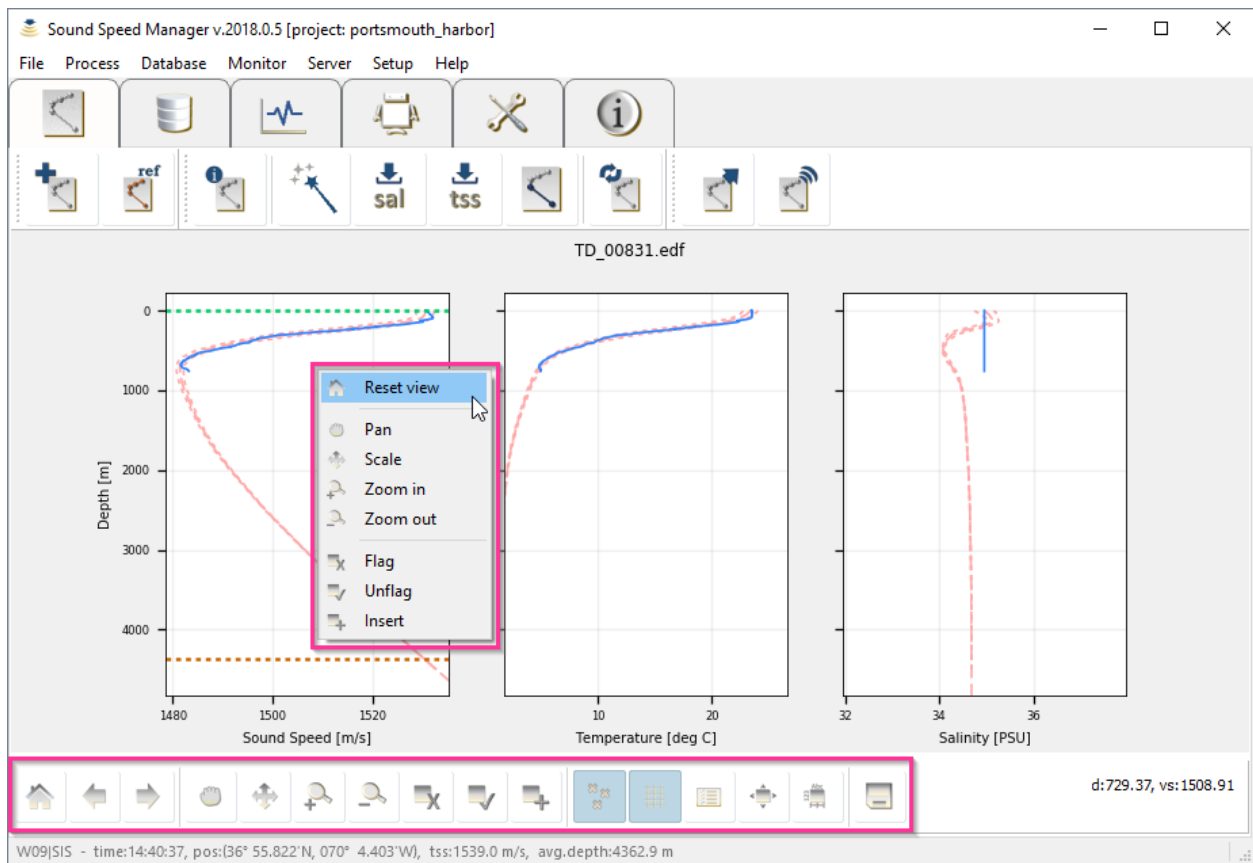


Fig. 2.33: Interactive data editing of a loaded profile.

## 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. 2.34).

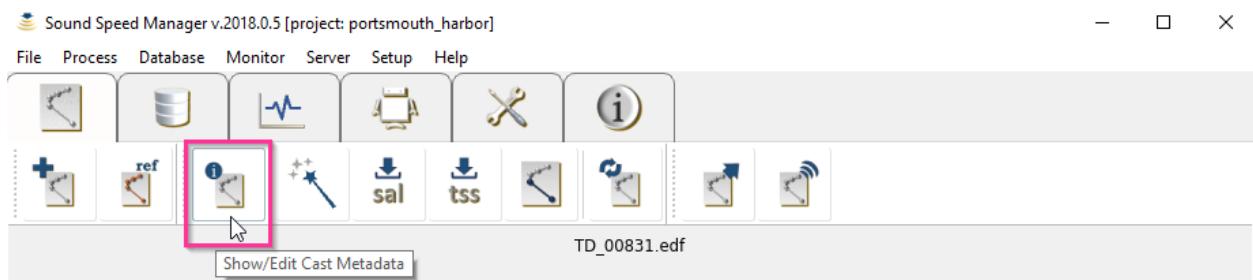
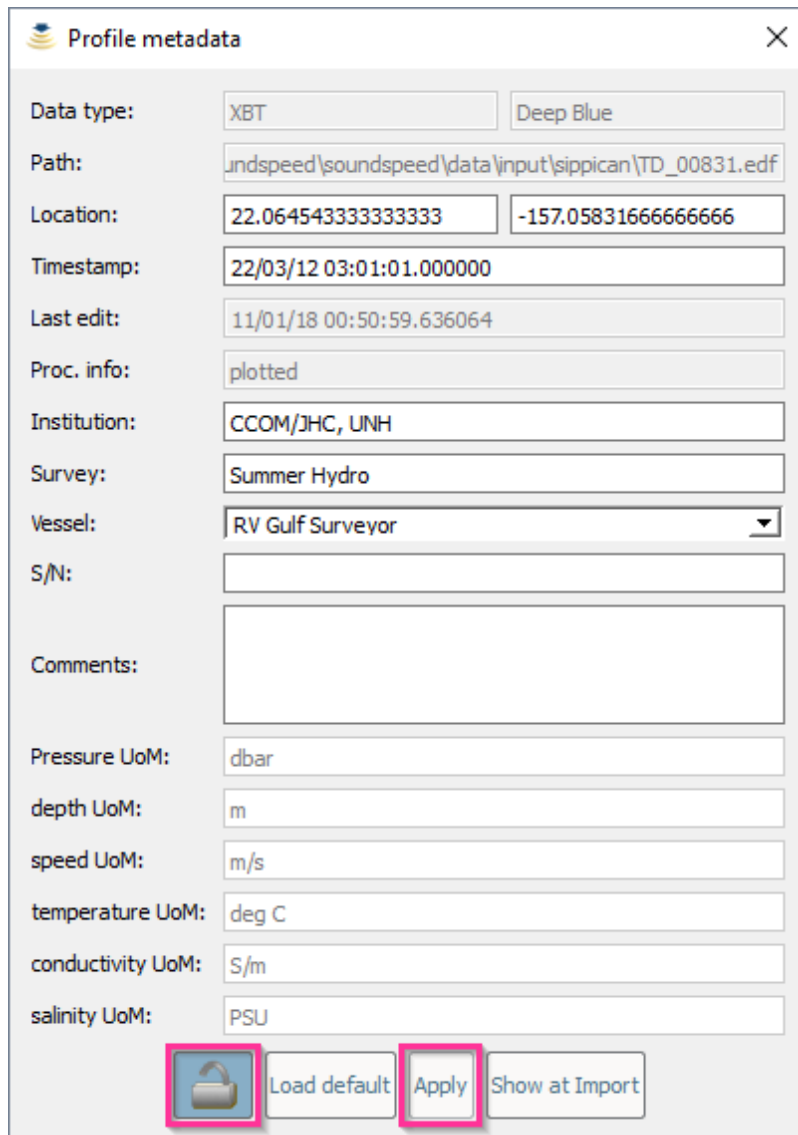


Fig. 2.34: Button to access the *Metadata* widget.

It is also possible to manually edit several of the metadata entries (Fig. 2.35) and to force the visualization of the *Profile metadata* tool at the import time (Fig. 2.36).



The screenshot shows a window titled "Profile metadata" with a close button (X) in the top right corner. The window contains several input fields and buttons. The fields are arranged in a vertical list on the left, with corresponding input boxes on the right. The fields are: Data type (with a dropdown menu showing "XBT" and "Deep Blue"), Path (text box), Location (two text boxes for longitude and latitude), Timestamp (text box), Last edit (text box), Proc. info (text box), Institution (text box), Survey (text box), Vessel (dropdown menu showing "RV Gulf Surveyor"), S/N (text box), Comments (text area), Pressure UoM (text box), depth UoM (text box), speed UoM (text box), temperature UoM (text box), conductivity UoM (text box), and salinity UoM (text box). At the bottom of the window, there are four buttons: a lock icon button, "Load default", "Apply", and "Show at Import". The lock icon button and the "Apply" button are highlighted with red rectangles.

Data type:	XBT	Deep Blue
Path:	\\soundspeed\\soundspeed\\data\\input\\sippican\\TD_00831.edf	
Location:	22.06454333333333	-157.05831666666666
Timestamp:	22/03/12 03:01:01.000000	
Last edit:	11/01/18 00:50:59.636064	
Proc. info:	plotted	
Institution:	CCOM/JHC, UNH	
Survey:	Summer Hydro	
Vessel:	RV Gulf Surveyor	
S/N:		
Comments:		
Pressure UoM:	dbar	
depth UoM:	m	
speed UoM:	m/s	
temperature UoM:	deg C	
conductivity UoM:	S/m	
salinity UoM:	PSU	


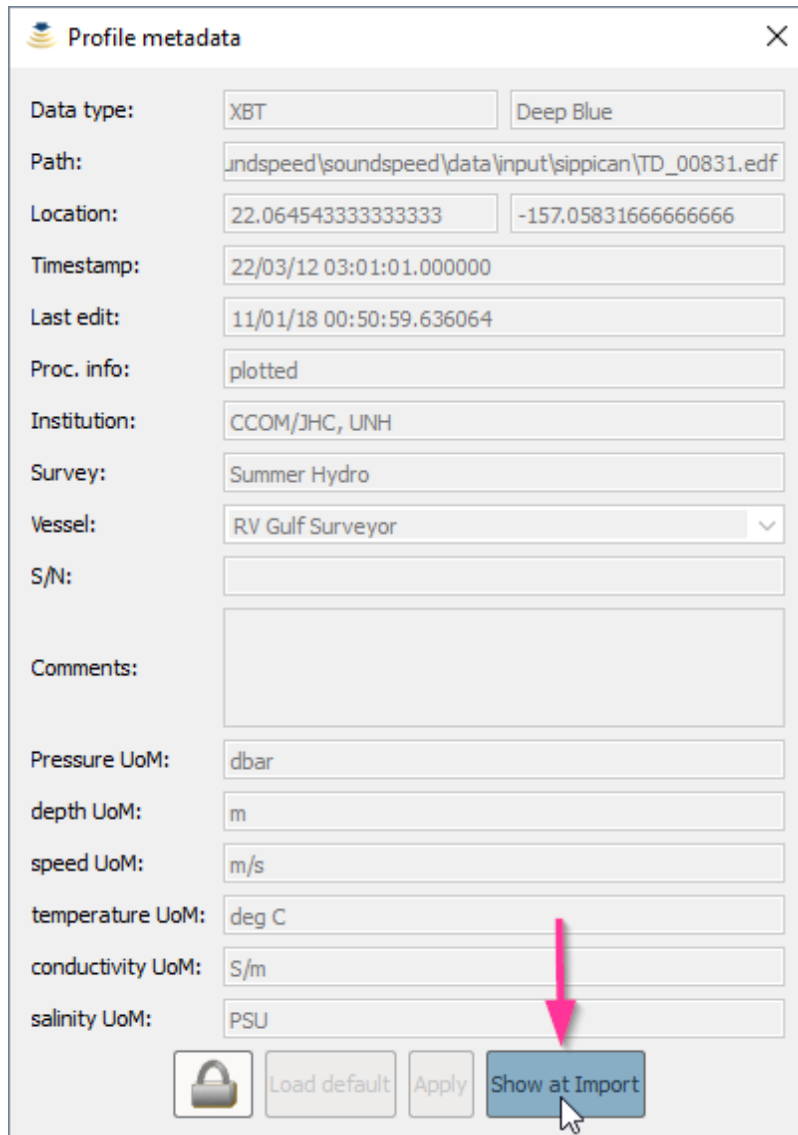
Buttons:  Load default Apply Show at Import

Fig. 2.35: The *Profile metadata* tool.



**Profile metadata**

Data type: XBT Deep Blue

Path: \soundspeed\data\input\sippican\TD\_00831.edf

Location: 22.06454333333333 -157.05831666666666

Timestamp: 22/03/12 03:01:01.000000

Last edit: 11/01/18 00:50:59.636064

Proc. info: plotted

Institution: CCOM/JHC, UNH

Survey: Summer Hydro

Vessel: RV Gulf Surveyor

S/N:

Comments:

Pressure UoM: dbar

depth UoM: m

speed UoM: m/s

temperature UoM: deg C

conductivity UoM: S/m

salinity UoM: PSU


 Load default Apply **Show at Import**

Fig. 2.36: 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. 2.37).

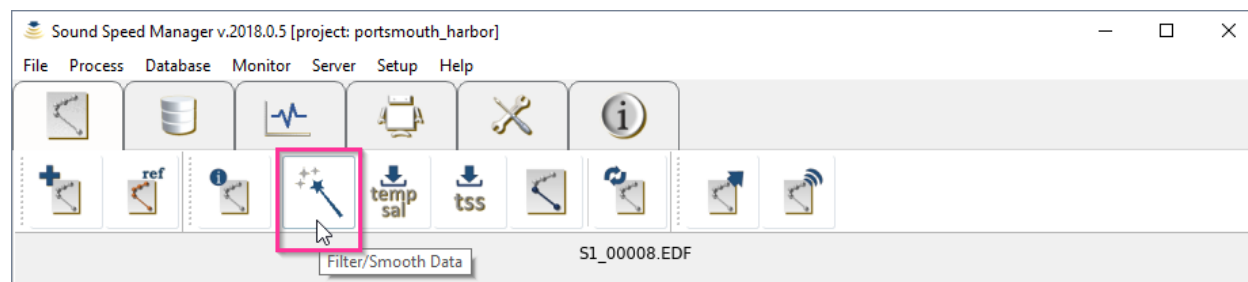


Fig. 2.37: The *Filter/Smooth Data* button in the *Editor* toolbar.

## 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. 2.38) 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*).



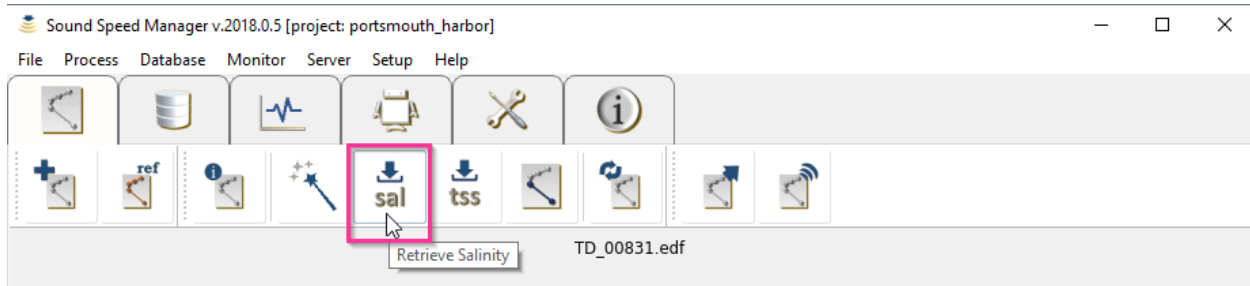


Fig. 2.38: The *Retrieve salinity* button in the *Editor* toolbar.

## 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. 2.39). The option is only active when an XSV cast is loaded.

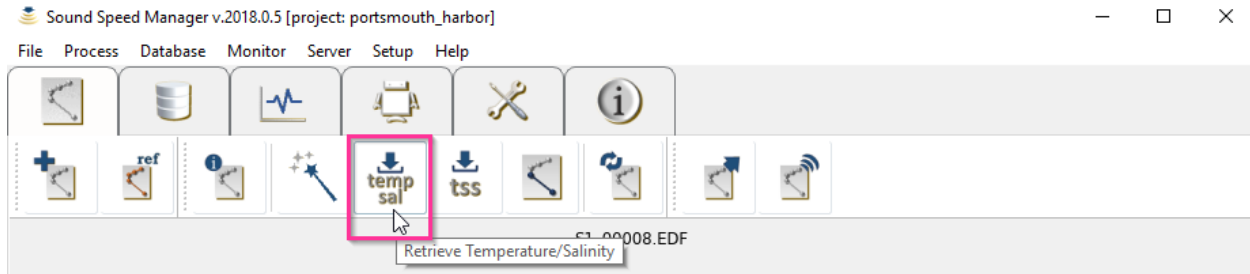


Fig. 2.39: The *Retrieve temperature/salinity* button in the *Editor* toolbar.

**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. 2.40).

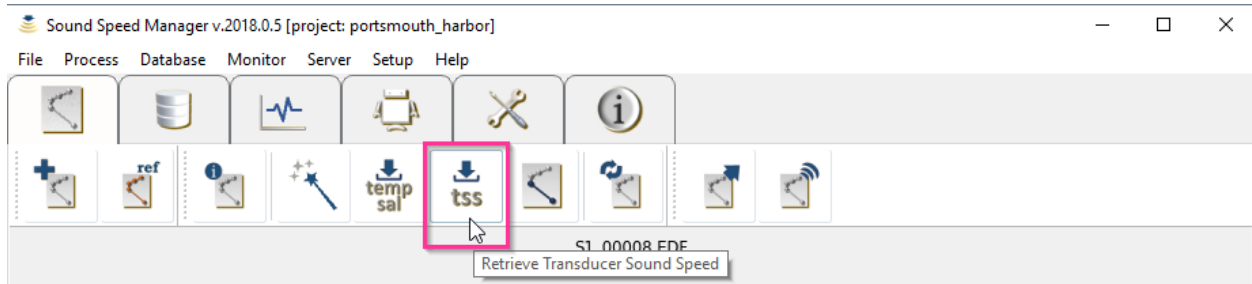


Fig. 2.40: The *Retrieve Surface Sound Speed* button in the *Editor* toolbar.

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 ( $\pm 0.1^\circ\text{C}$ , roughly equivalent to  $\pm 0.4 \text{ m/s}$ )
- 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. 2.41). 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.

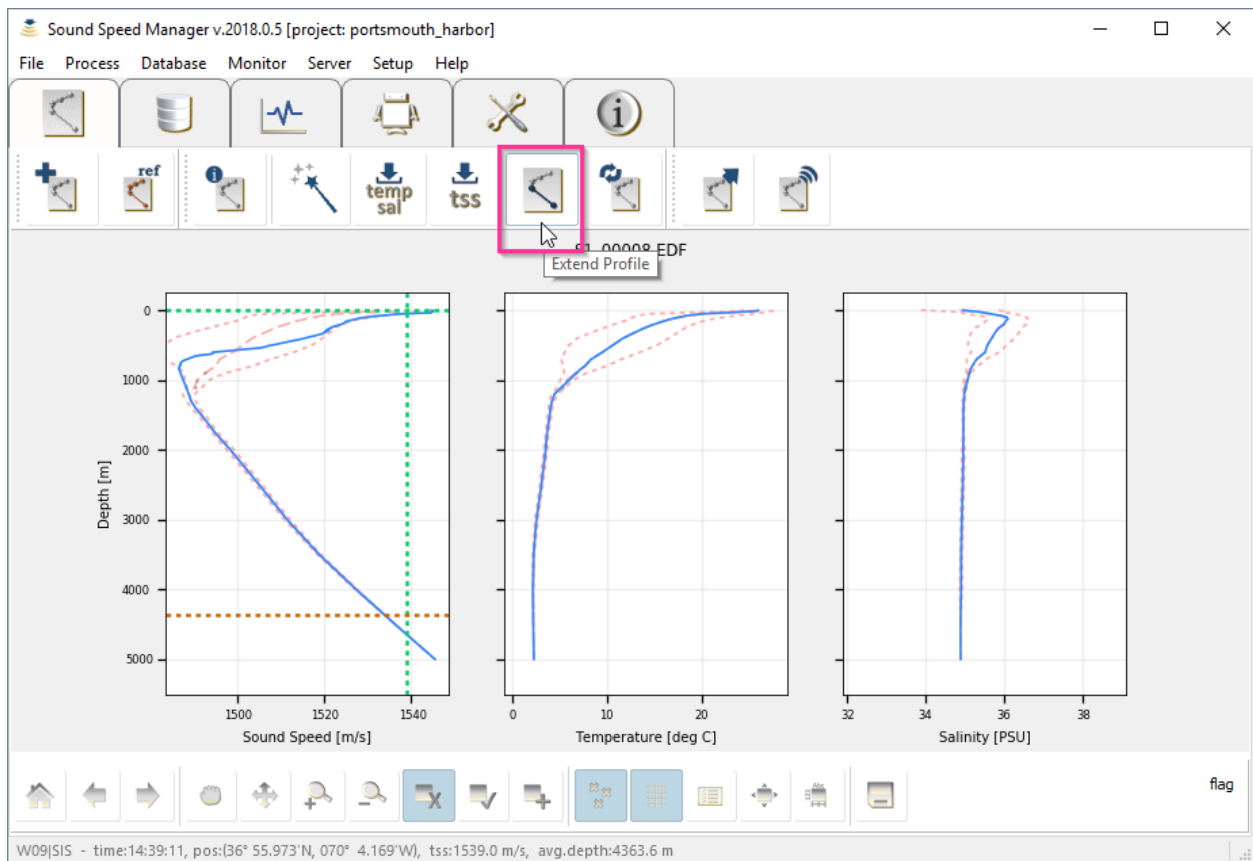



Fig. 2.41: The *Extend profile* button in the *Editor* toolbar.

## 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. 2.42) can be accessed under *Process/Automate Processing*.



The *Automated Processing Setup* dialog box is titled "Automated Processing Setup" and features a close button (X) in the top right corner. It is divided into two main sections: "Input file format:" and "Auto apply:". The "Input file format:" section contains a grid of buttons for selecting the input format. The "Auto apply:" section contains four dropdown menus, all currently set to "False", and an "OK" button at the bottom.

Input file format:		
Ask user	AML	AOML
CARIS	Castaway	Digibar Pro
Digibar S	ELAC	Hypack
Idronaut	ISS	Kongsberg
MVP	OceanScience	SAIV
SeaAndSun	Seabird	Sippican
Sonardyne	Turo	UNB
Valeport	Seabird CTD	

Auto apply:	
Smooth/filter profile data:	False
Retrieve salinity/temperature:	False
Retrieve transducer sound speed:	False
Extend profile data:	False

OK

Fig. 2.42: 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. 2.43).

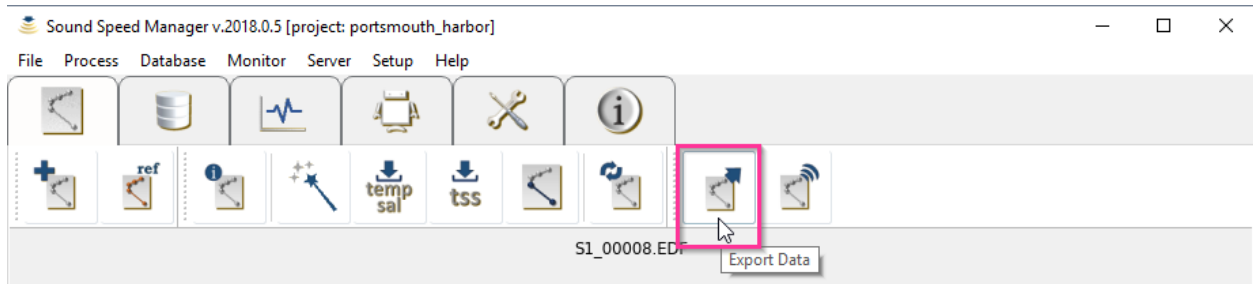


Fig. 2.43: The *Export data* button in the *Editor* toolbar.

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. 2.44).

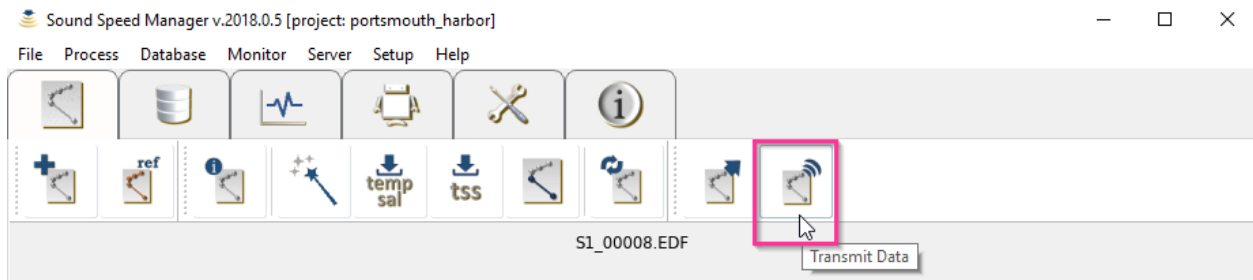


Fig. 2.44: The *Transmit data* button in the *Editor* toolbar.

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. 2.45).

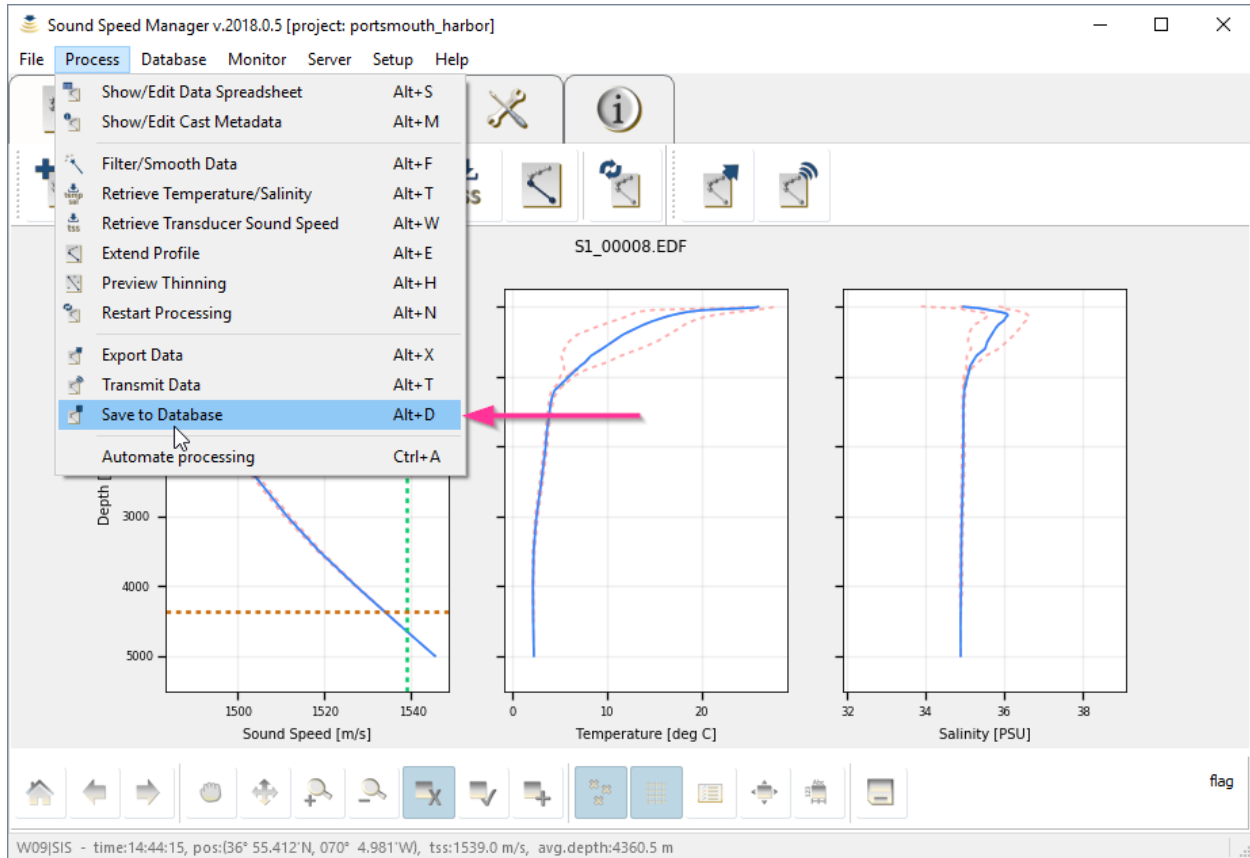


Fig. 2.45: The *Save to database* menu entry in the *Process* menu.

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. 2.46).

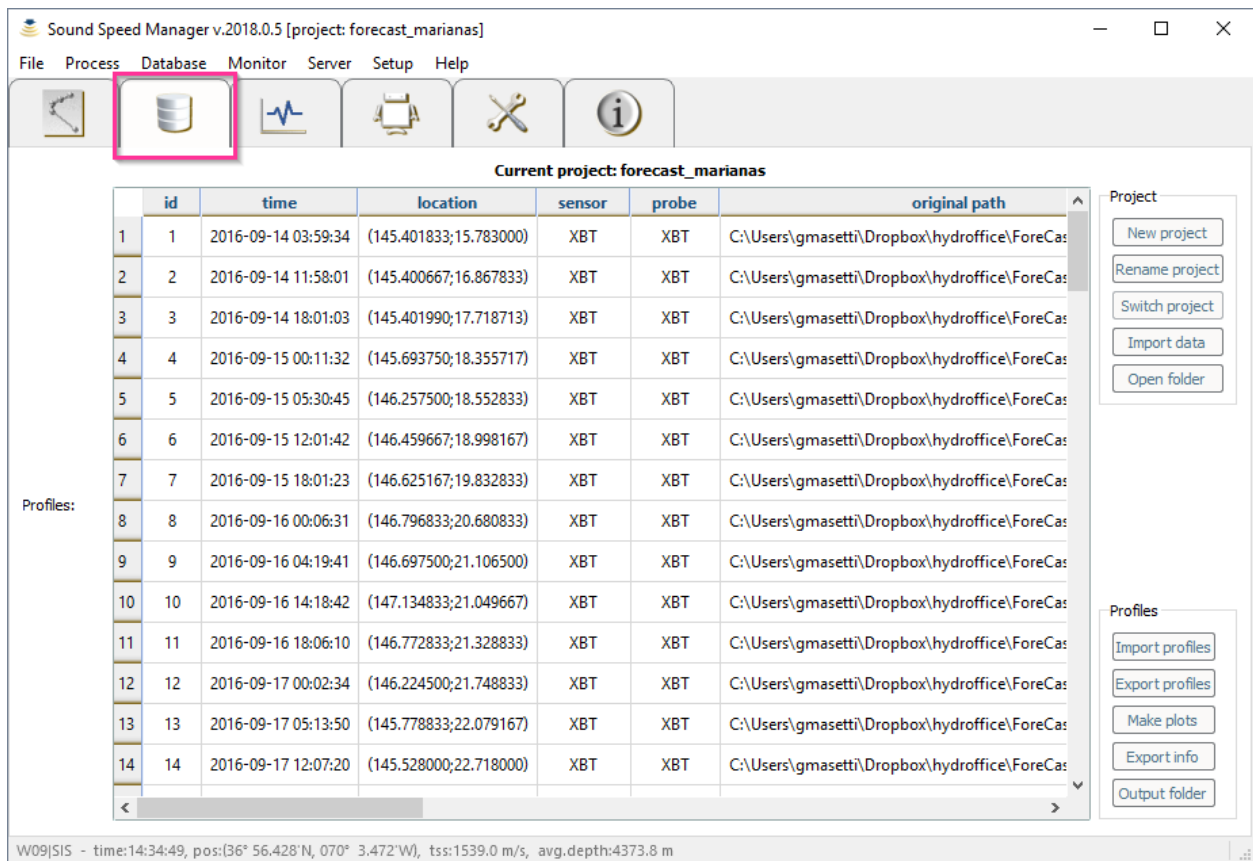


Fig. 2.46: The *Database* tab provides access to the collected profiles and related tools.

## Context menu

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

- Single-profile selection (Fig. 2.47).
- Pair-profile selection (Fig. 2.48).
- Multi-profile selection (Fig. 2.51).

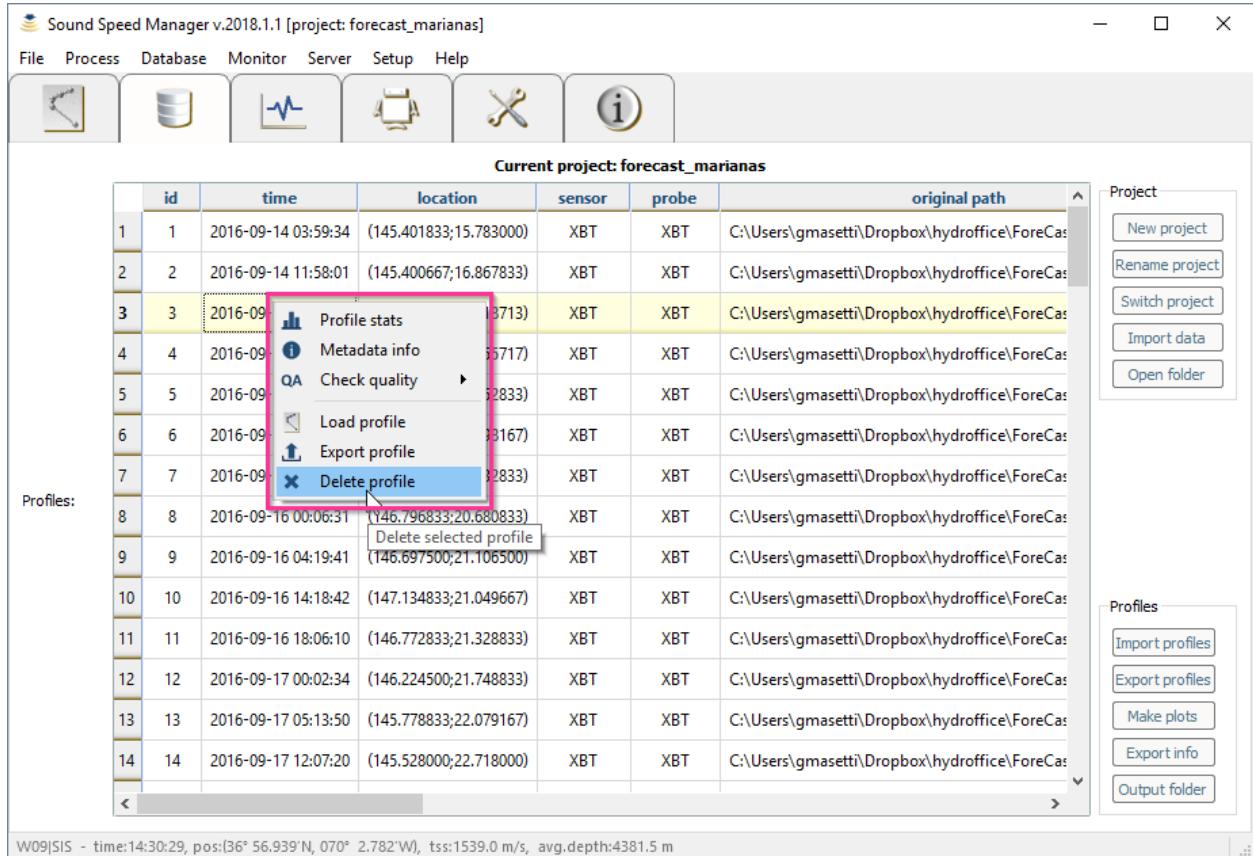


Fig. 2.47: The single-selection context menu provides functionalities specific to a single profile.

## Project and Profiles groups

The *Project* group provides functionalities 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. 2.52), you may:



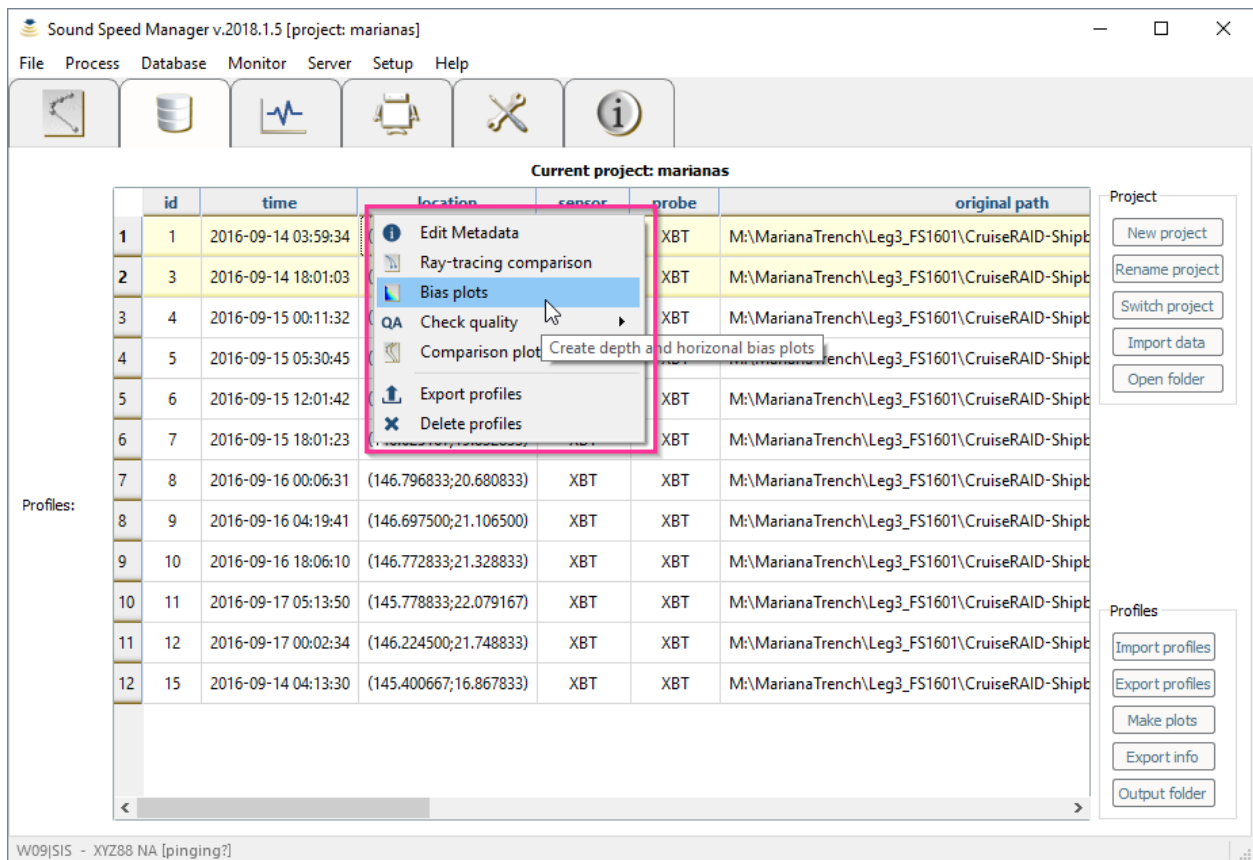


Fig. 2.48: The pair-selection context menu provides functionalities like ray-tracing comparison (Fig. 2.49) and bias plots (Fig. 2.50).

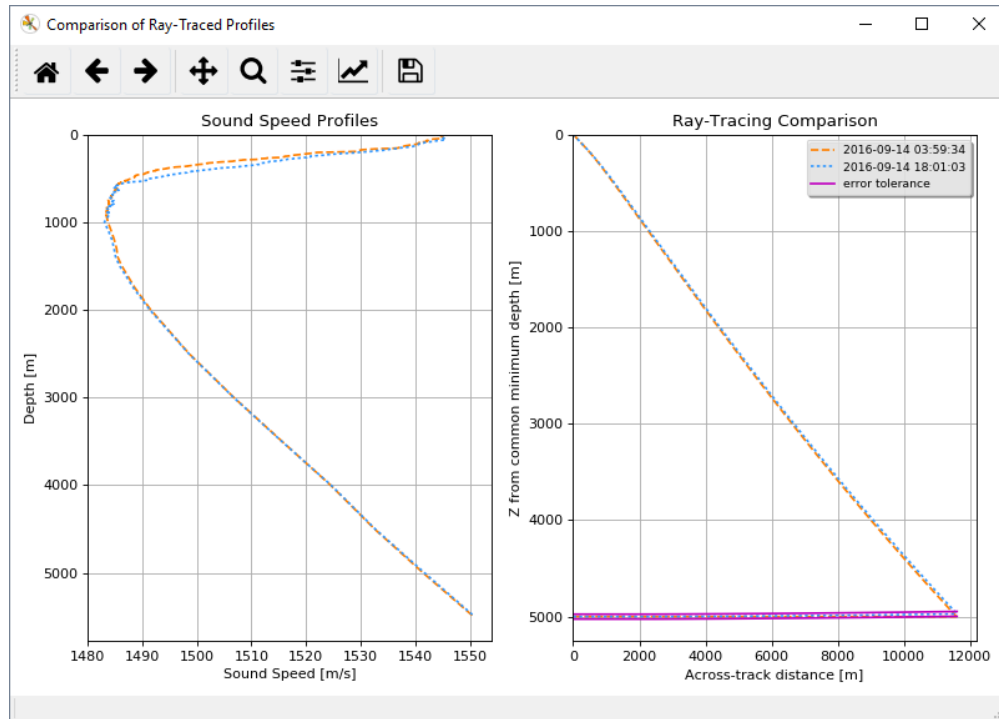


Fig. 2.49: The ray-tracing comparison between the pair of selected profiles.

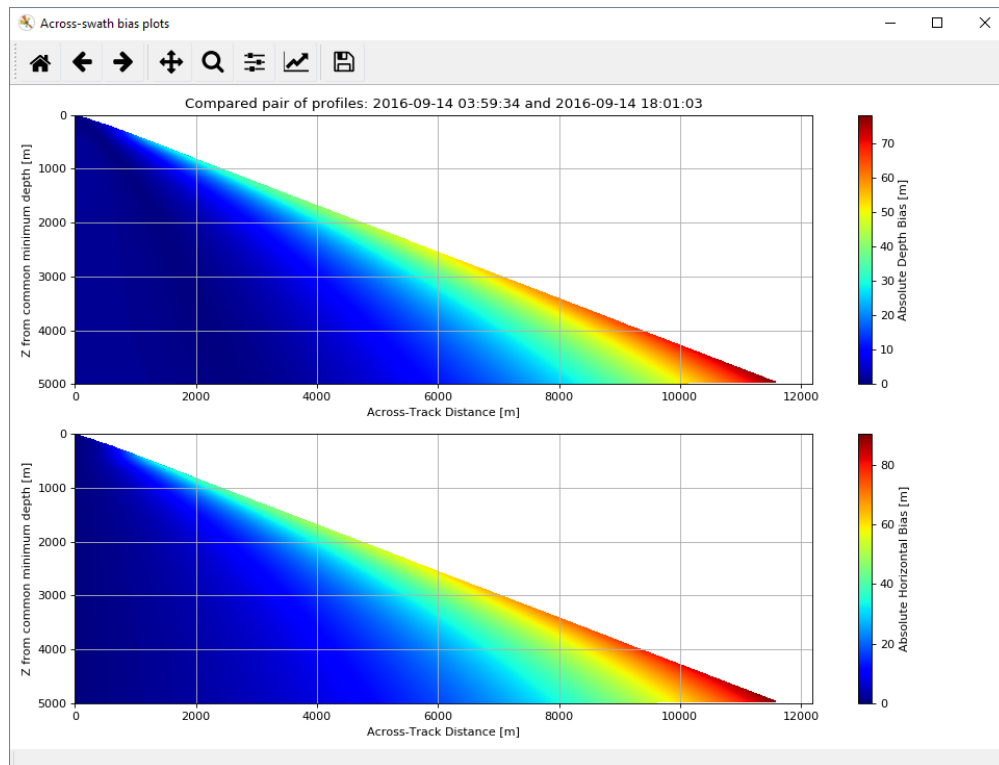


Fig. 2.50: The plots show the vertical and the horizontal bias using the pair of selected profiles.

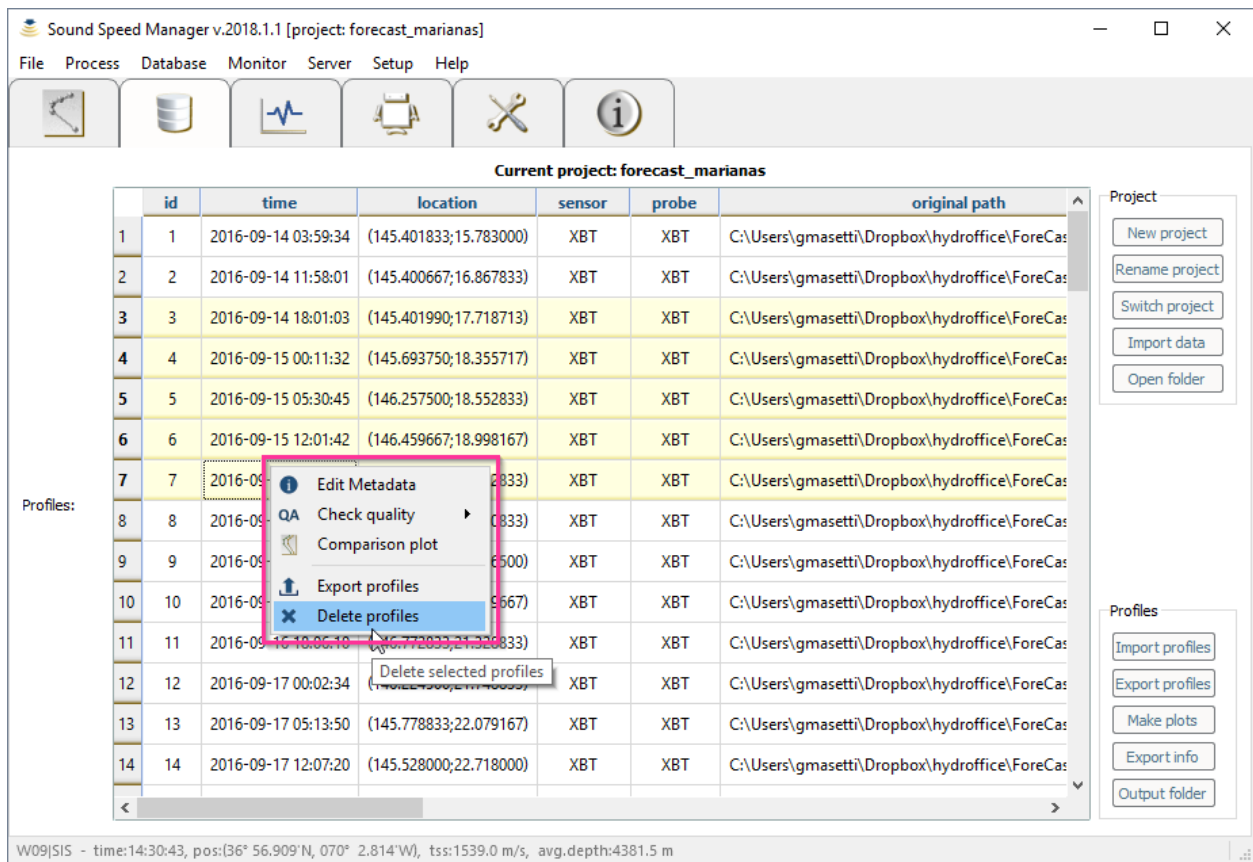


Fig. 2.51: The multi-selection context menu provides functionalities that apply to multiple profiles (e.g., editing common metadata fields for multiple profiles).

- Export the profile metadata in several geographic formats: csv, kml, shapefile (e.g., Fig. 2.53), and
- Create maps (Fig. 2.54) and plots (Fig. 2.55 and Fig. 2.56).

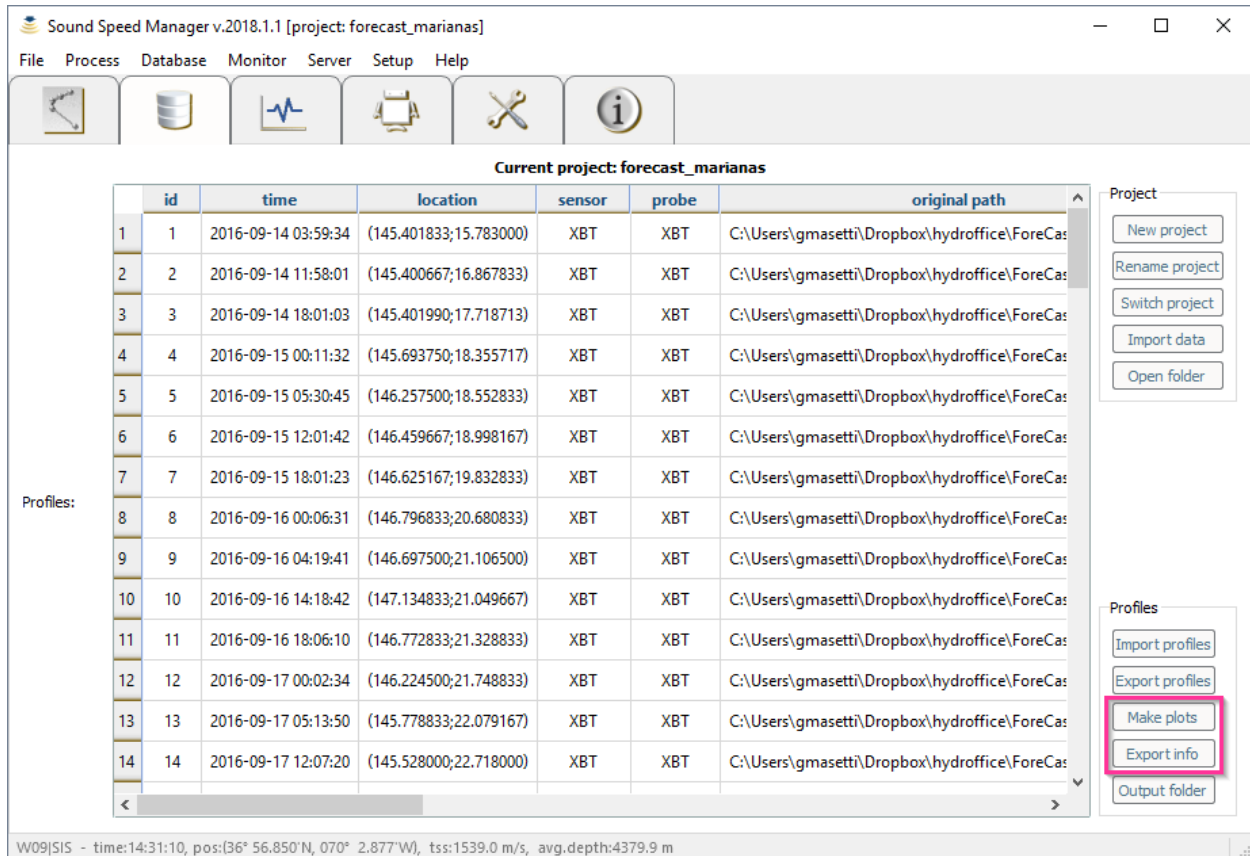


Fig. 2.52: The *Make plots* and *Export info* buttons in the *Profiles* group creates plots/maps and exports the metadata for all the profiles in the database.

## 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. 2.57). Database specific instructions for creating a profile are detailed in the sections below.

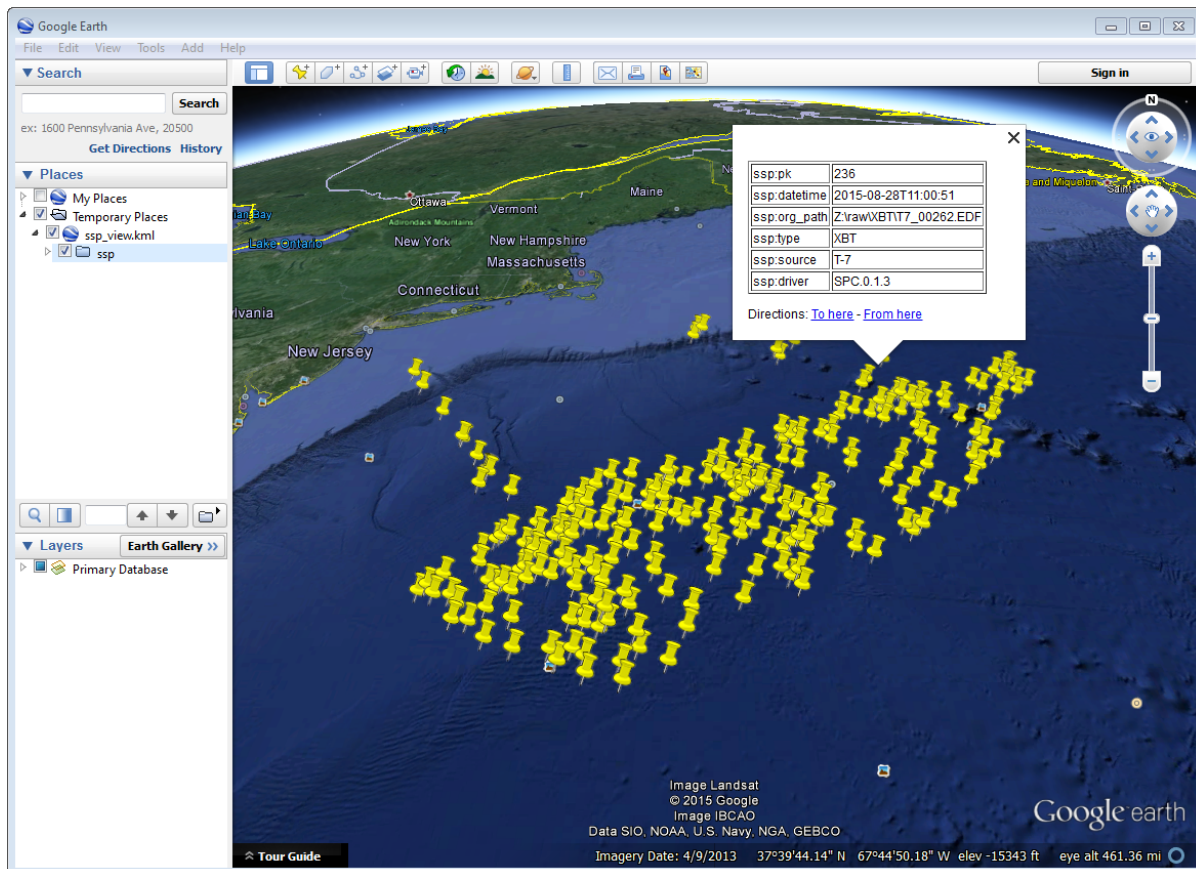


Fig. 2.53: Loading result of the exported metadata (kml format) in Google Earth.

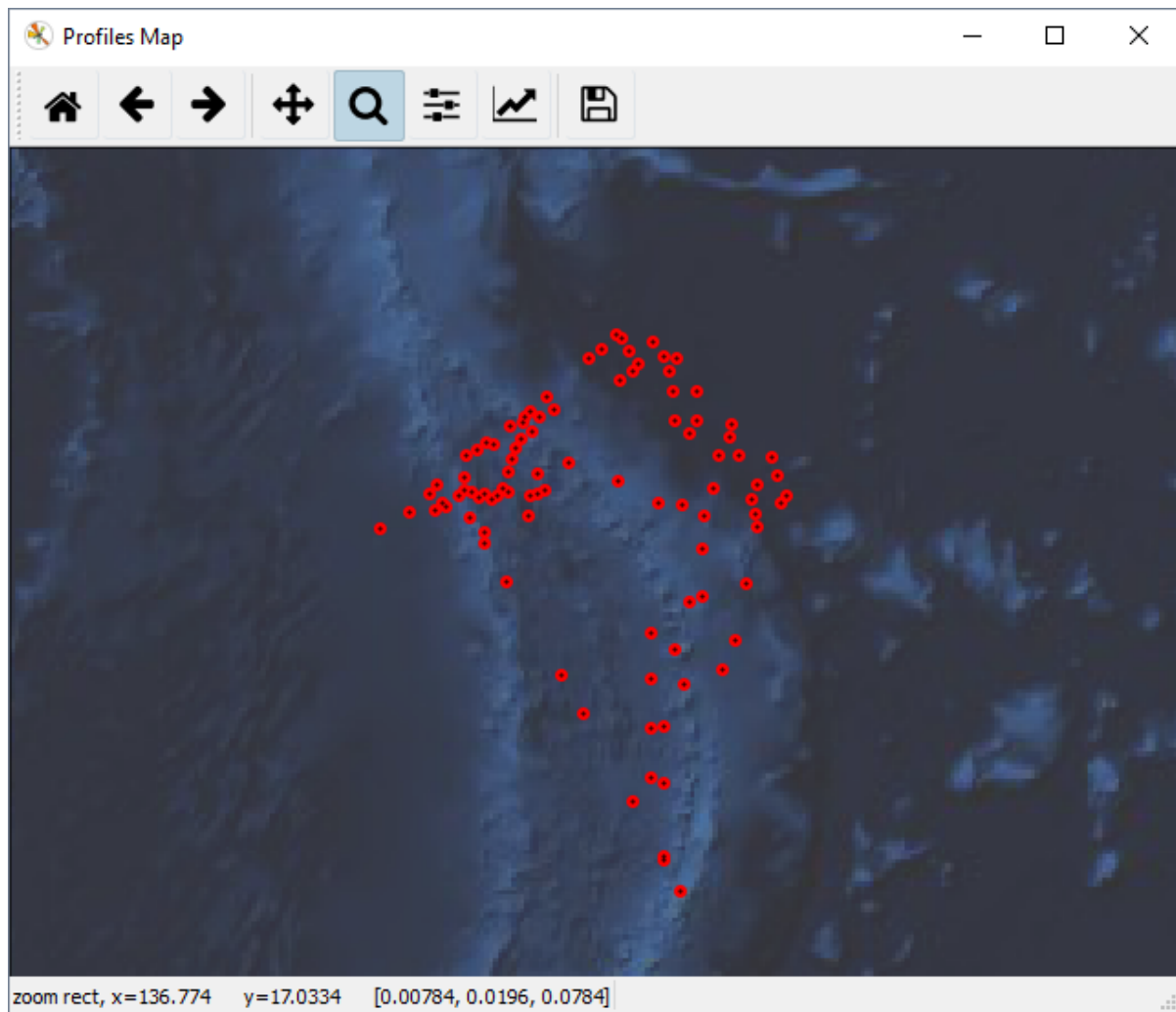


Fig. 2.54: Example of a map created from a stored SSP data set.

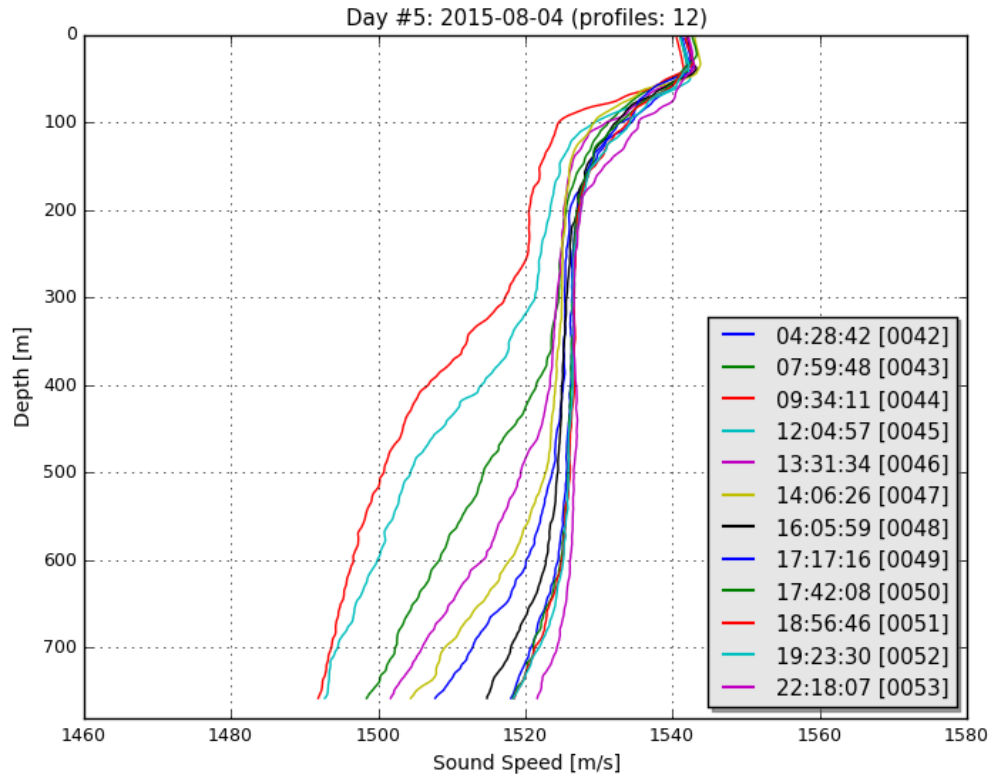


Fig. 2.55: Example of a daily plot that can be created from a stored SSP data set.

## 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.

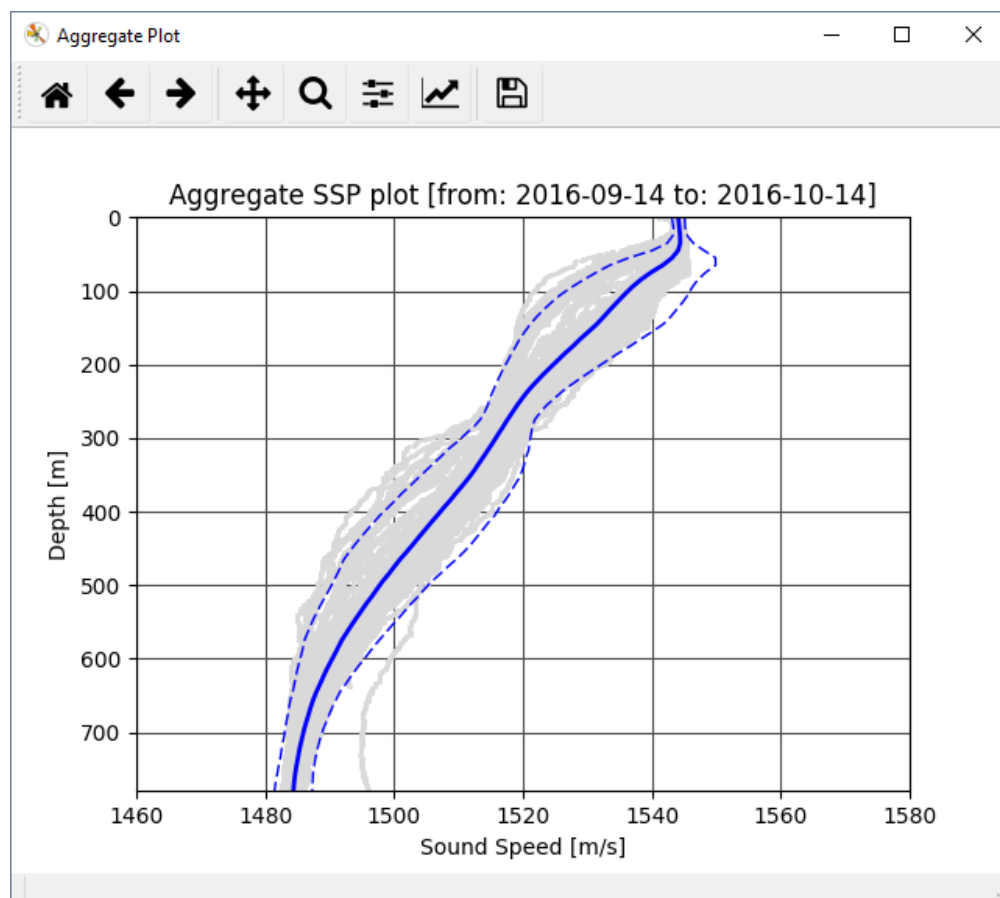


Fig. 2.56: Example of aggregate plot to study the sound speed variability during a selected time span.

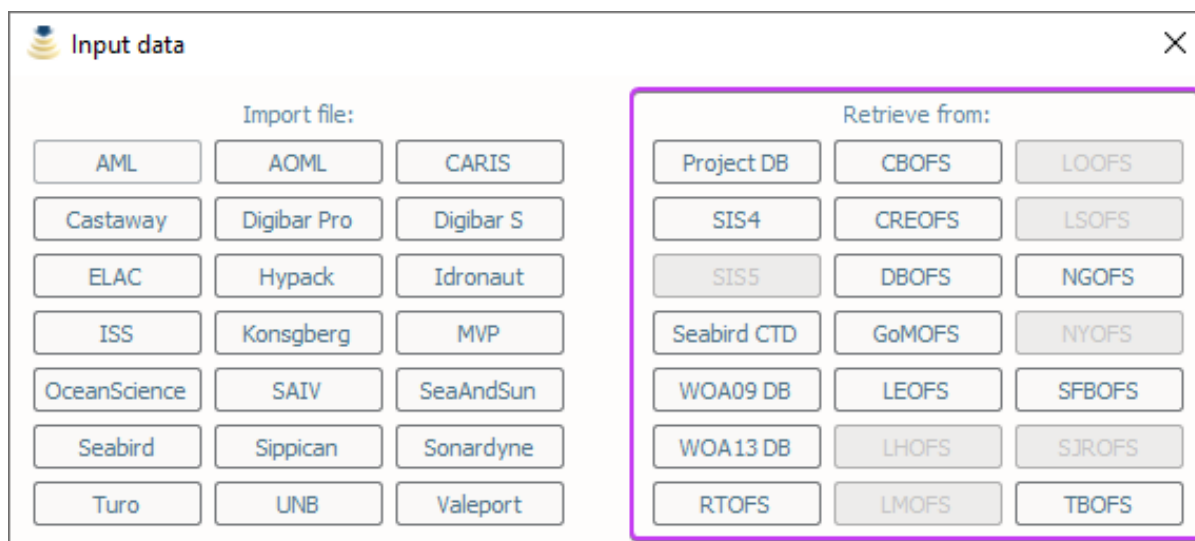


Fig. 2.57: The *Input data* button in the *Editor* toolbar.



- 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. 2.58*).

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. 2.59*). 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.

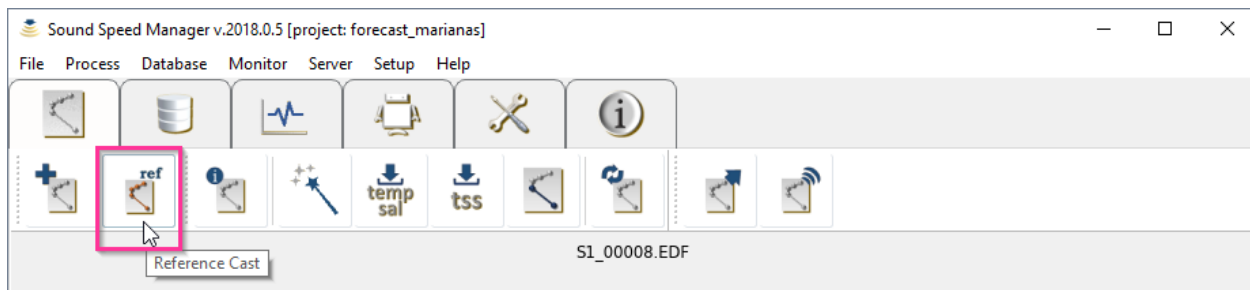


Fig. 2.58: The *Reference cast* button in the *Editor* toolbar.

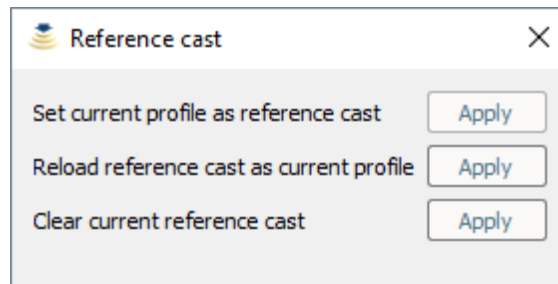


Fig. 2.59: The *Reference cast* tool.

### 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.

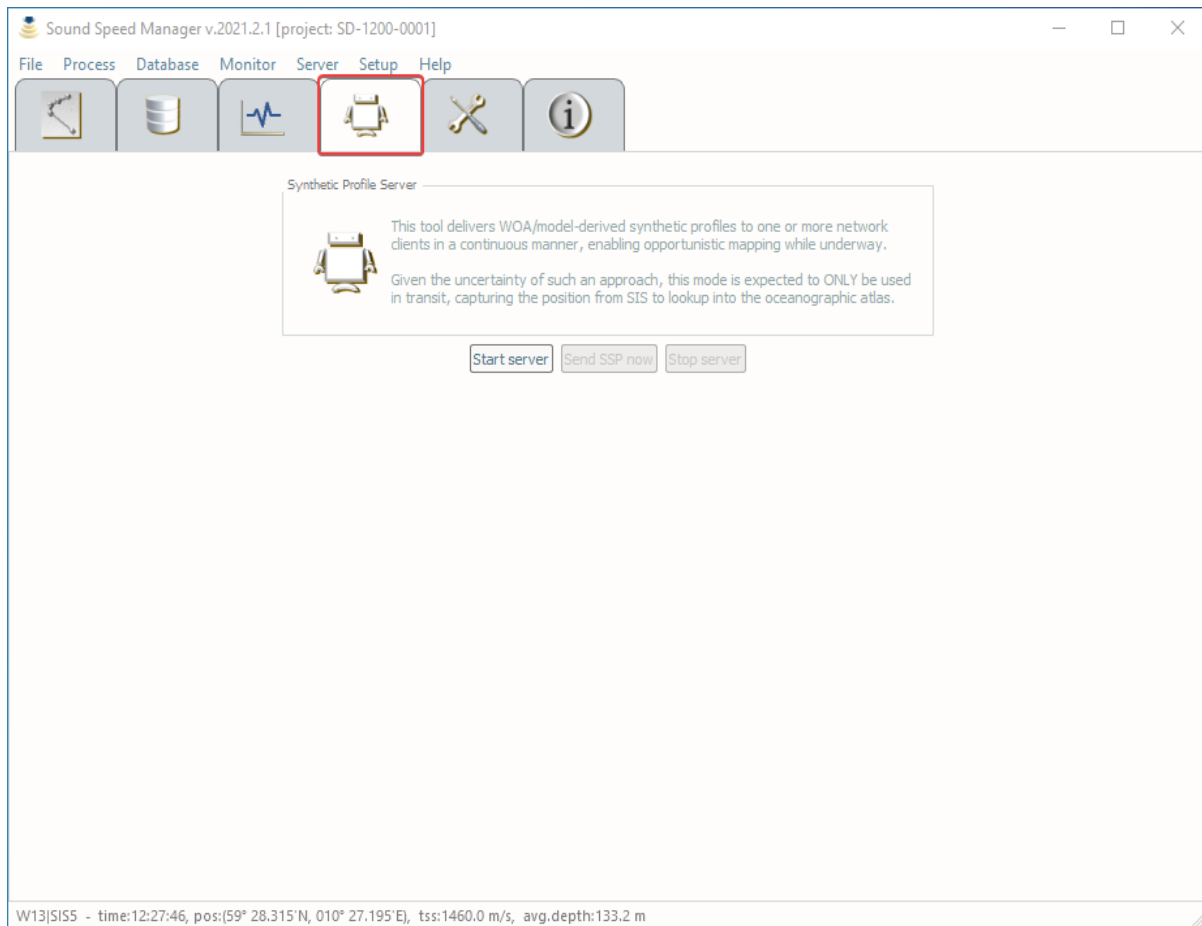


Fig. 2.60: The *Synthetic Profile Server* tab provides the controls to manage the *Server* mode.

### 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. 2.61).

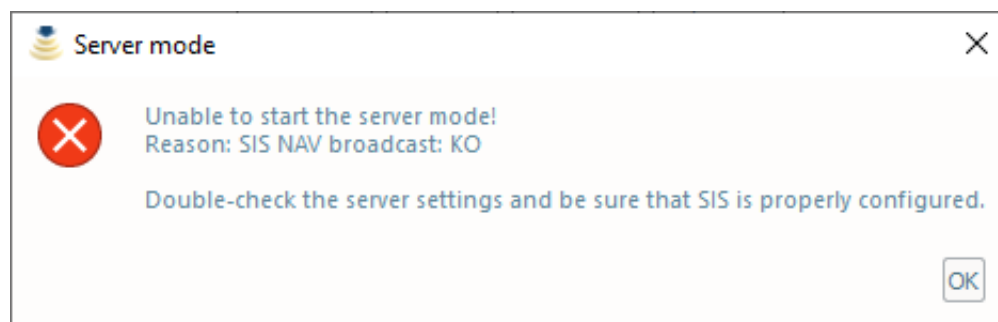


Fig. 2.61: An example of error message after the failure of one of the initialization checks for the *Server Mode*.

## How to use

The *Server Mode* is activated by clicking on the “Start server” button (Fig. 2.60).

---

**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. 2.60). Closing SSM will also stop the server.

### 2.4.3 Survey Data Monitor

The *Survey Data Monitor* (Fig. 2.62) 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).

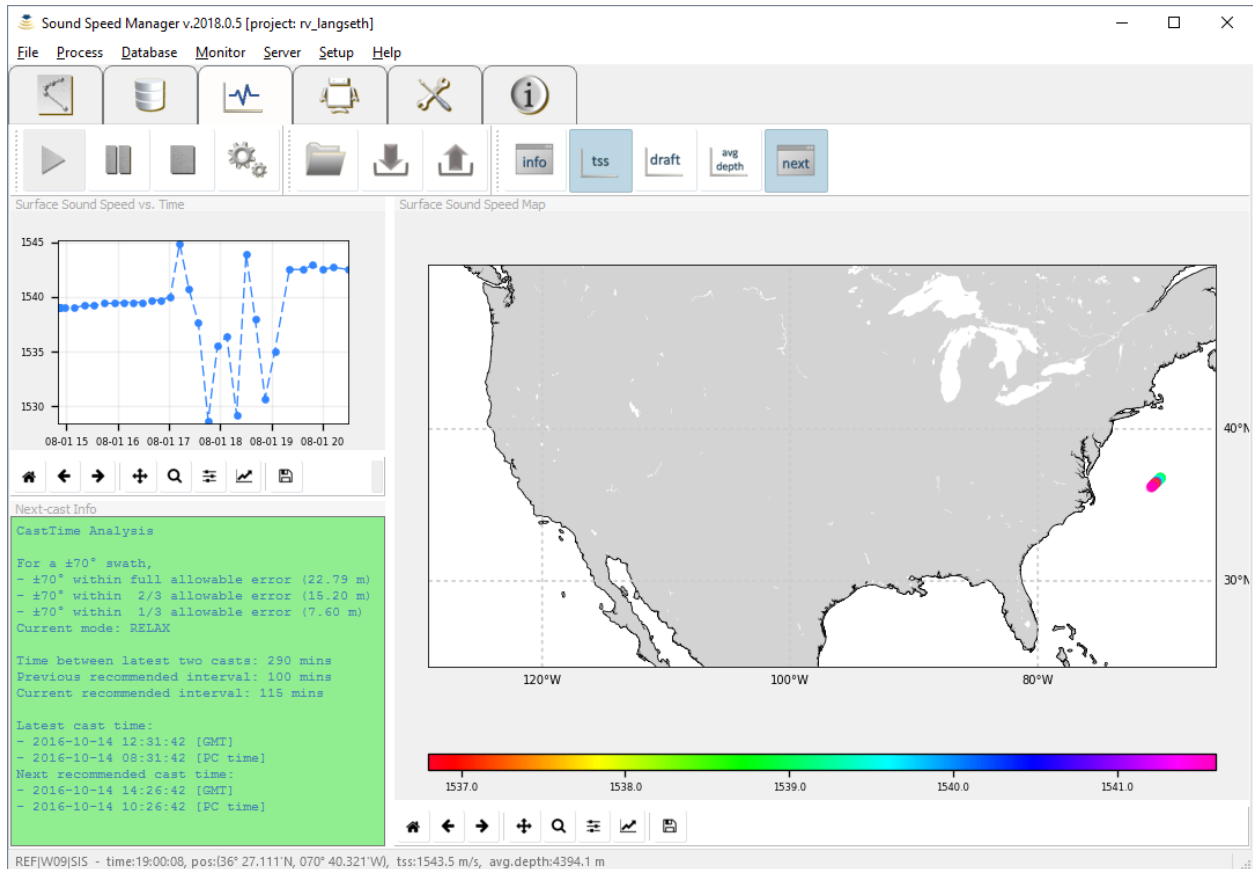


Fig. 2.62: Survey Data Monitor tab.

#### 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. 2.62) 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.

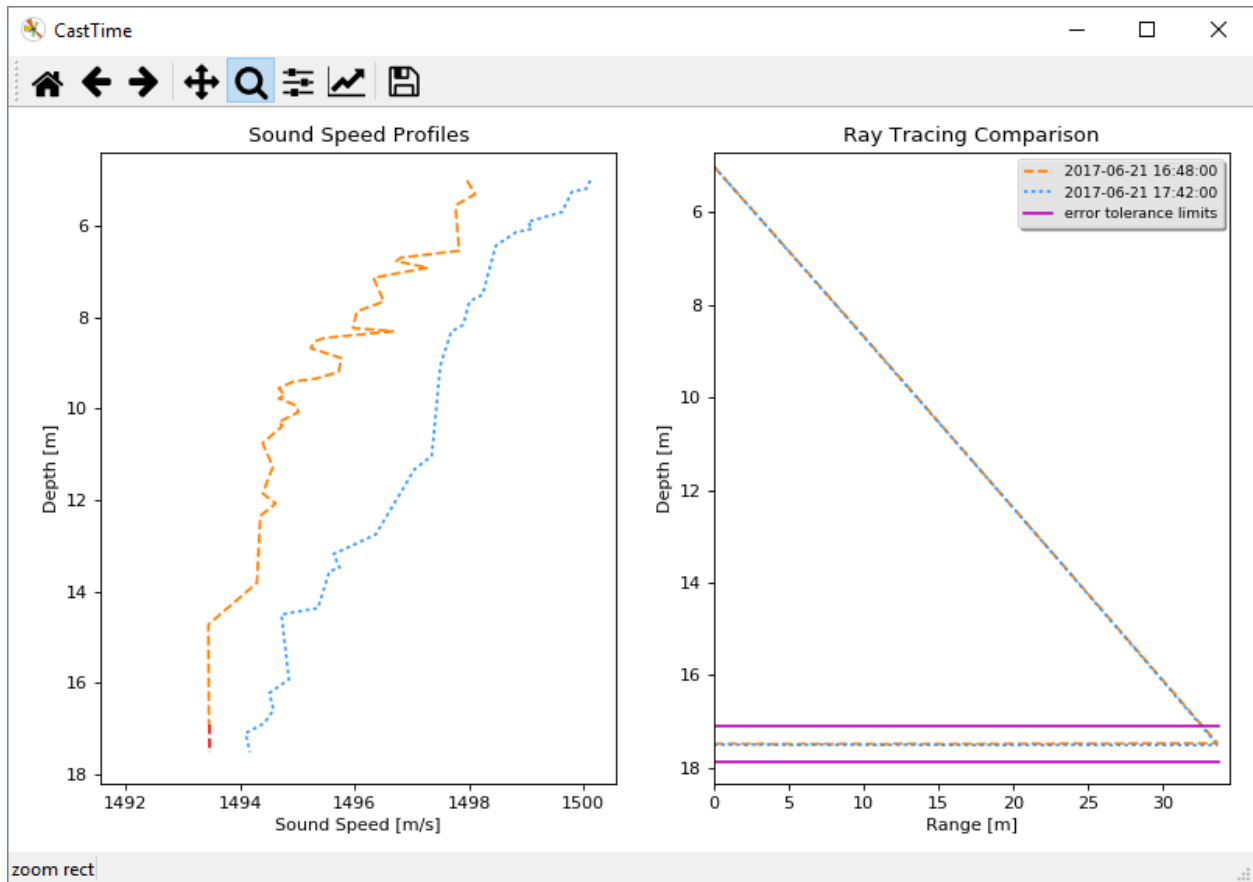


Fig. 2.63: Example of analysis plot to display the error tolerance limits (in magenta on the right pane) used by CastTime to estimate the next cast time.

### Data Monitor toolbar

The *Data Monitor* toolbar (Fig. 2.64) 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).

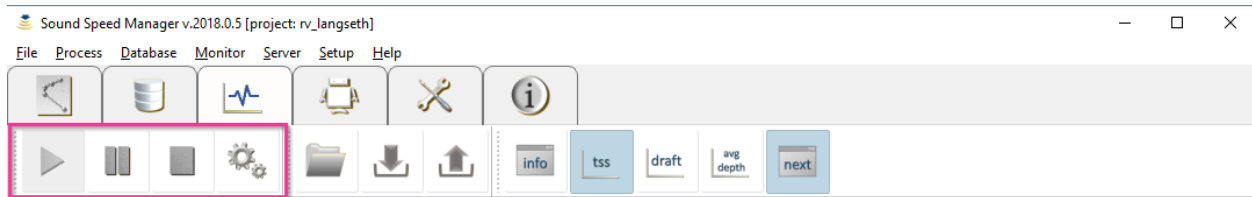


Fig. 2.64: In red, the *Data Monitor* toolbar controls to start, pause, or stop the data monitoring.

The *Options* button in the *Data Monitor* toolbar (Fig. 2.64) provides access to the setup, organized as follows:

- *General* tab (Fig. 2.65).
- *CastTime* tab (Fig. 2.66).
- *ForeCast* tab (*currently disabled*).
- *Plots* tab (Fig. 2.67).

---

**Note:** A high number of samples selected in the *Plots* tab (Fig. 2.67) may reduce the reactivity of Sound Speed Manager.

---

### Data Manager toolbar

The *Data Manager* toolbar (Fig. 2.68) provides functionalities to load previously collected data as well as to export such data in a few geospatial formats (Fig. 2.69).

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).

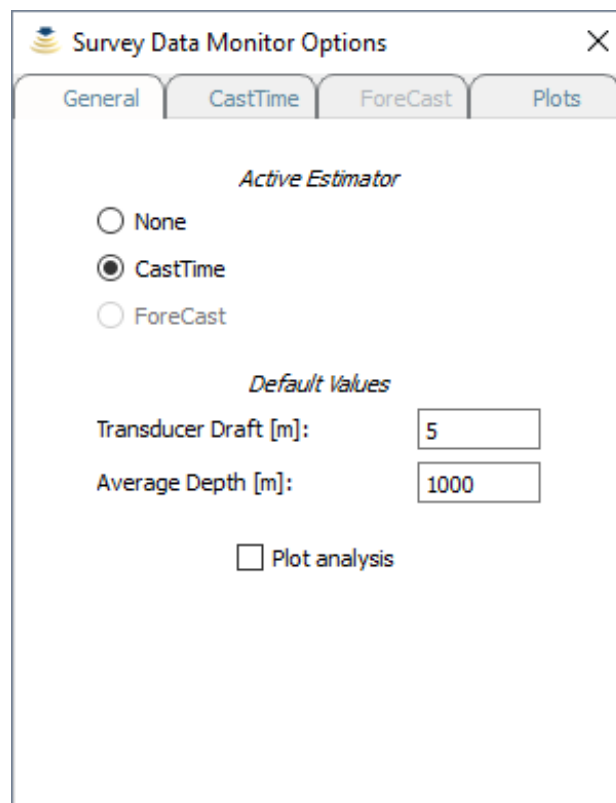
### Data Views toolbar

The *Data Views* toolbar (Fig. 2.70) 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:

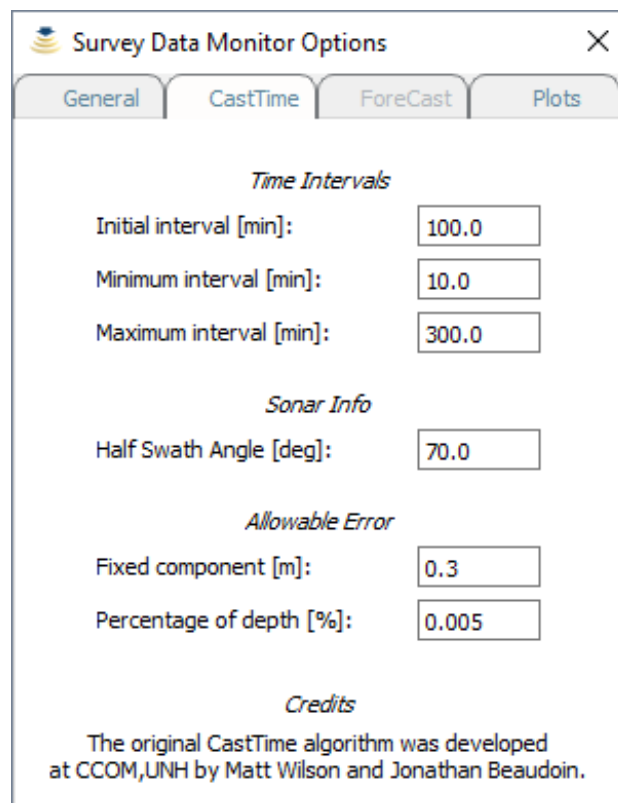
- *General Info* viewer.
- *Surface Sound Speed Map* plotter.
- *Surface Sound Speed vs. Time* plotter.





The image shows a dialog box titled "Survey Data Monitor Options" with a close button (X) in the top right corner. The dialog has four tabs: "General", "CastTime", "ForeCast", and "Plots". The "General" tab is currently selected. Inside the "General" tab, there is a section titled "Active Estimator" with three radio button options: "None", "CastTime" (which is selected), and "ForeCast". Below this is a section titled "Default Values" with two input fields: "Transducer Draft [m]" with the value "5" and "Average Depth [m]" with the value "1000". At the bottom of the "General" tab is a checkbox labeled "Plot analysis" which is currently unchecked.

Fig. 2.65: 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.



The image shows a software dialog box titled "Survey Data Monitor Options" with a close button (X) in the top right corner. The dialog has four tabs: "General", "CastTime" (which is selected and highlighted in blue), "ForeCast", and "Plots". The "CastTime" tab contains several settings organized into sections:

- Time Intervals**
  - Initial interval [min]: 100.0
  - Minimum interval [min]: 10.0
  - Maximum interval [min]: 300.0
- Sonar Info**
  - Half Swath Angle [deg]: 70.0
- Allowable Error**
  - Fixed component [m]: 0.3
  - Percentage of depth [%]: 0.005
- Credits**

The original CastTime algorithm was developed at CCOM, UNH by Matt Wilson and Jonathan Beaudoin.

Fig. 2.66: 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.

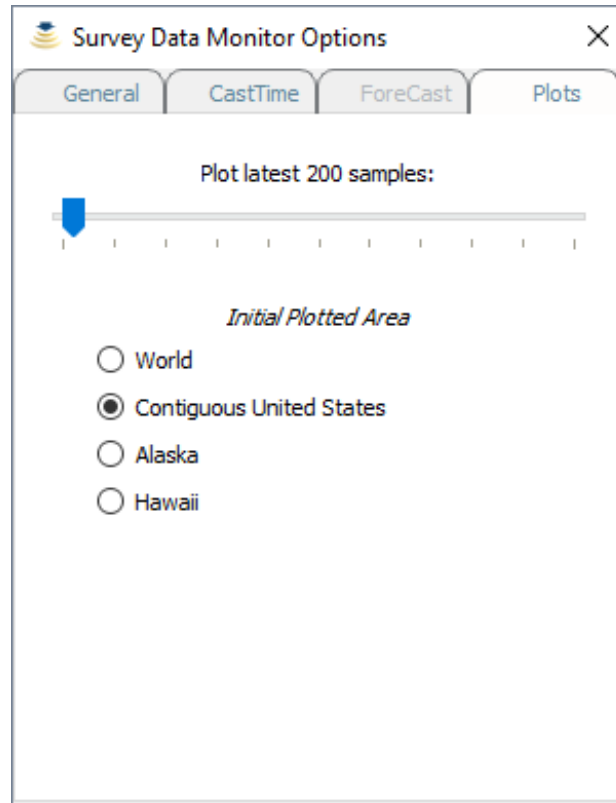


Fig. 2.67: This tab is used to change the number of samples displayed in the plotters. This value does not affect the storing in the survey database (.mon). It is also possible to select the initial plotted area (e.g., CONUS).

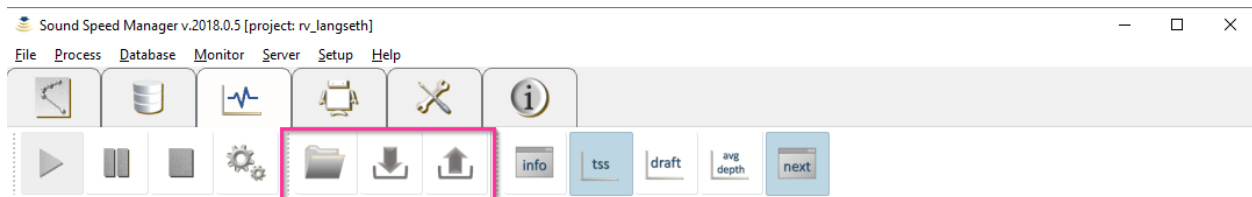


Fig. 2.68: In magenta, the *Data Manager* toolbar controls to open the output folder, to load data, and to export in various formats.

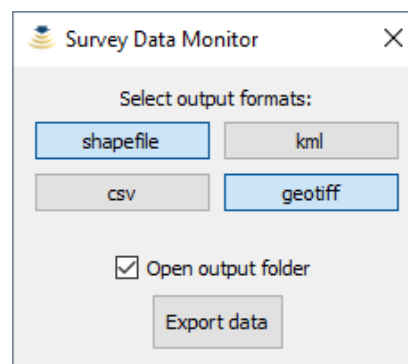


Fig. 2.69: The dialog shows the available export data formats.

- *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.

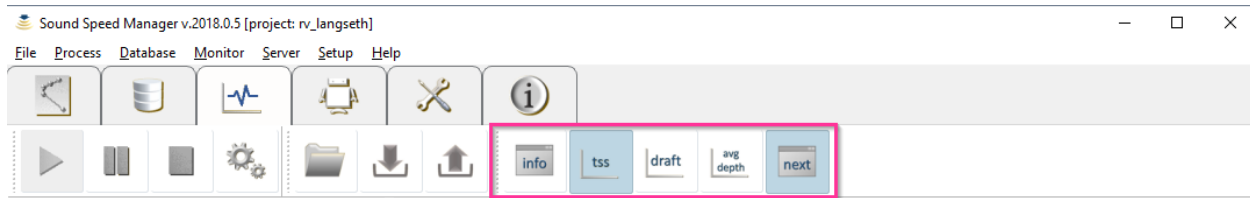


Fig. 2.70: In magenta, the *Data Views* toolbar controls to toggle the visualization of viewers and plotters.

The *Next-Cast Info* viewer (Fig. 2.71) displays textual information related to the latest analysis performed by the next-cast estimator (e.g., *CastTime*).

```

Next-cast Info
CastTime Analysis

For a ±70° swath,
- ±70° within full allowable error (0.39 m)
- ±70° within 2/3 allowable error (0.26 m)
- ±70° within 1/3 allowable error (0.13 m)
Current mode: RELAX

Time between latest two casts: 54 mins
Previous recommended interval: 10 mins
Current recommended interval: 12 mins

Latest cast time:
- 2017-06-21 17:42:00 [GMT]
- 2017-06-21 13:42:00 [PC time]
Next recommended cast time:
- 2017-06-21 17:53:30 [GMT]
- 2017-06-21 13:53:30 [PC time]
    
```

Fig. 2.71: 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.

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**Note:** For some examples on how to use the library: [https://github.com/hydrooffice/hyo2\\_soundspeed/tree/master/examples](https://github.com/hydrooffice/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](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
Northern Gulf of Mexico 2	NGOFS2	X
Tampa Bay	TBOFS	X
Lake Erie	LEOFS	X
Lake Michignan and Huron	LMHOFS	X
Lake Ontario	LOOFS	X
Lake Superior	LSOFS	X
Salish Sea and Columbia River	SSCOFS	X
San Francisco Bay	SFBOFS	X
West Coast	WCOFS	X
New York and New Jersey	NYOFS	
St. John's River	SJROFS	

### 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

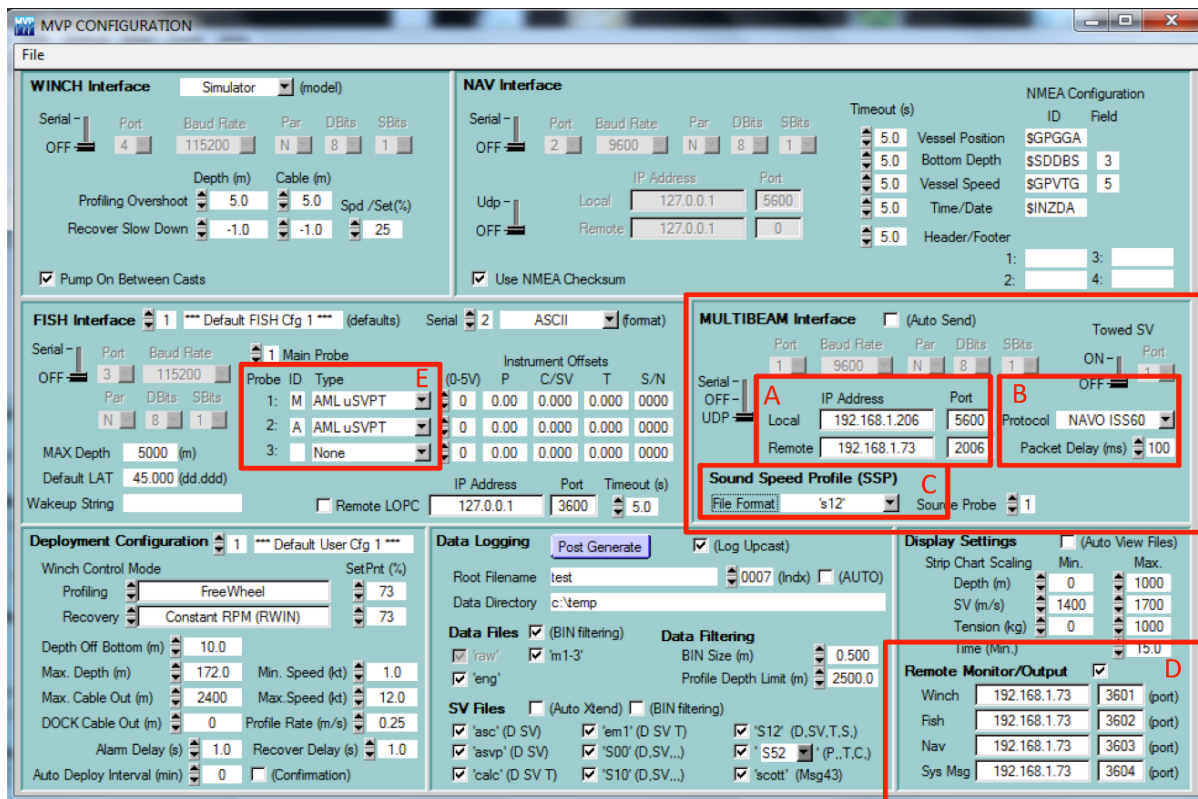


Fig. 2.72: Figure – MVP Controller configuration dialog. Boxes A through C are required for transmission of cast information. Box D can be configured to transmit sensor data.



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) 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 *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. 2.73](#) and [Fig. 2.74](#))

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. 2.78](#) 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.

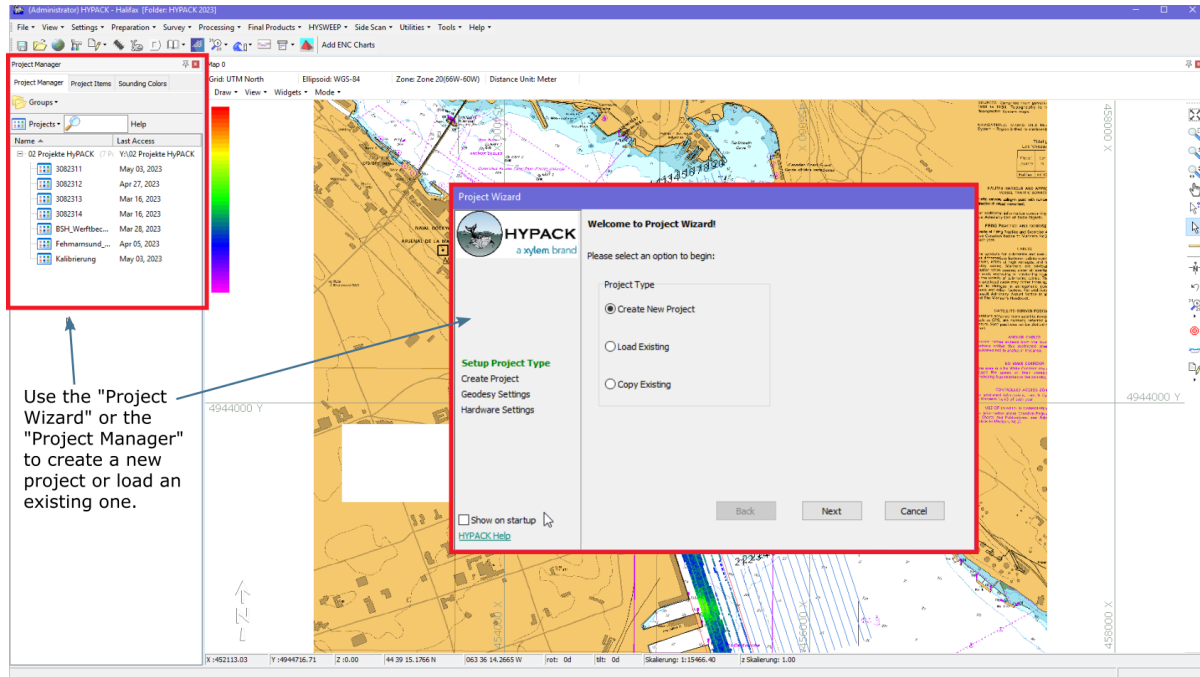


Fig. 2.73: The *HYPACK* Project Manager or the Project Wizard can be used to load or create a project.

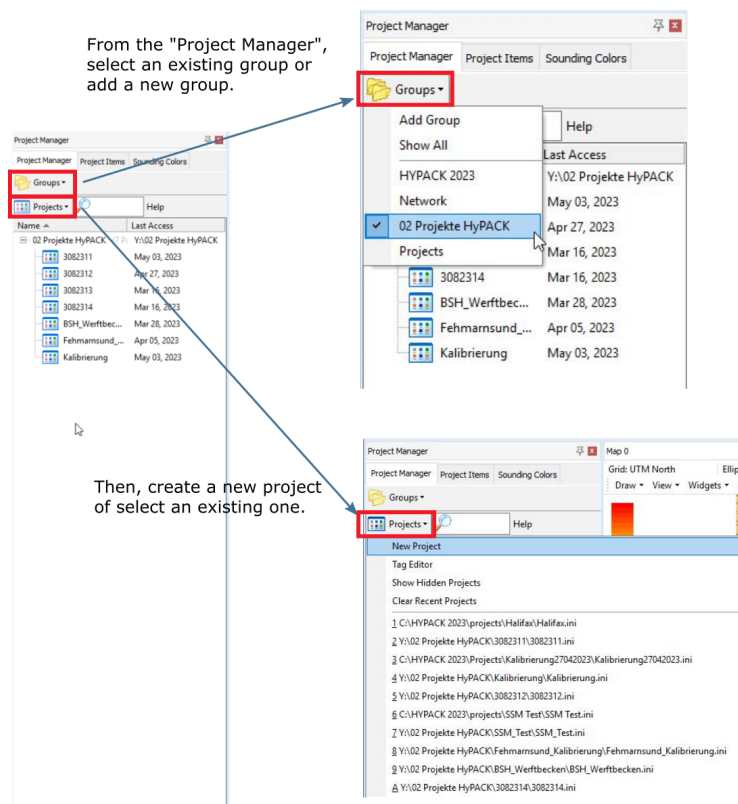


Fig. 2.74: Selecting or creating a *HYPACK* project from the Project Manager.

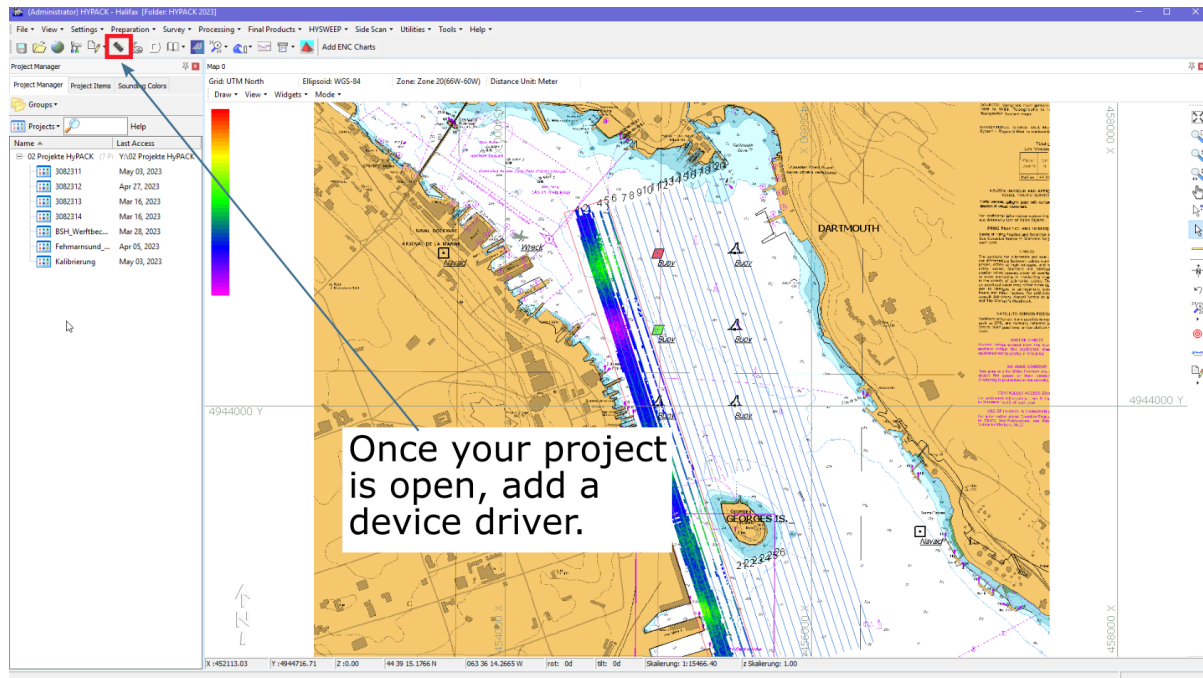


Fig. 2.75: Selecting the Add device button.

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. 2.81). An update of the “SV From Profile” value in Fig. 2.80 is also an indicator that *HYSWEEP Survey* has received a new cast.

If the MVP driver has been configured as per Fig. 2.78, a new sound velocity file should be visible in *HYPACK* (See Fig. 2.82). A target should be also be visible in both *HYPACK* (See Fig. 2.82) and in the *HYSWEEP Map* display (See Fig. 2.83).

## 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.

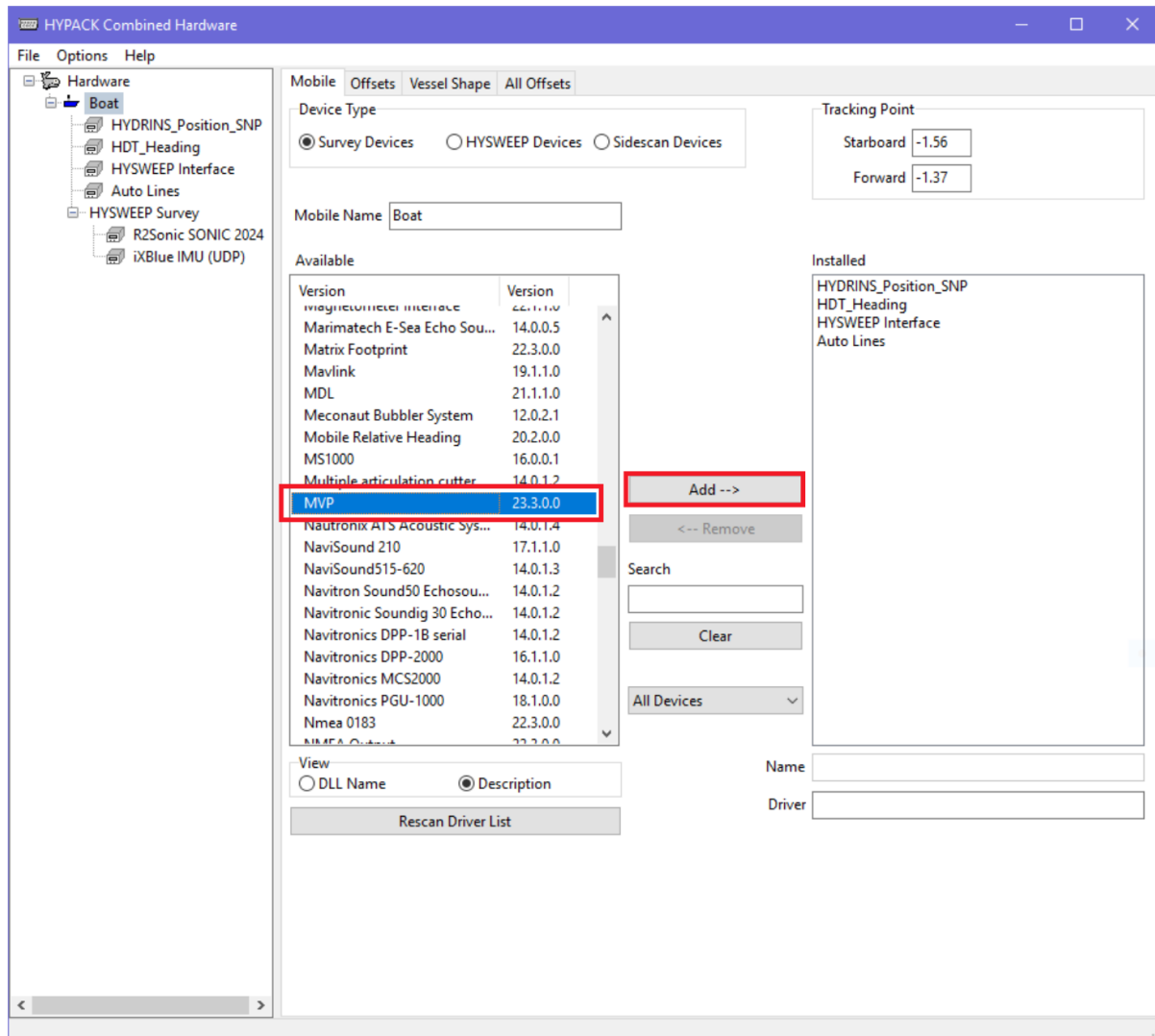


Fig. 2.76: Adding the MVP device driver.

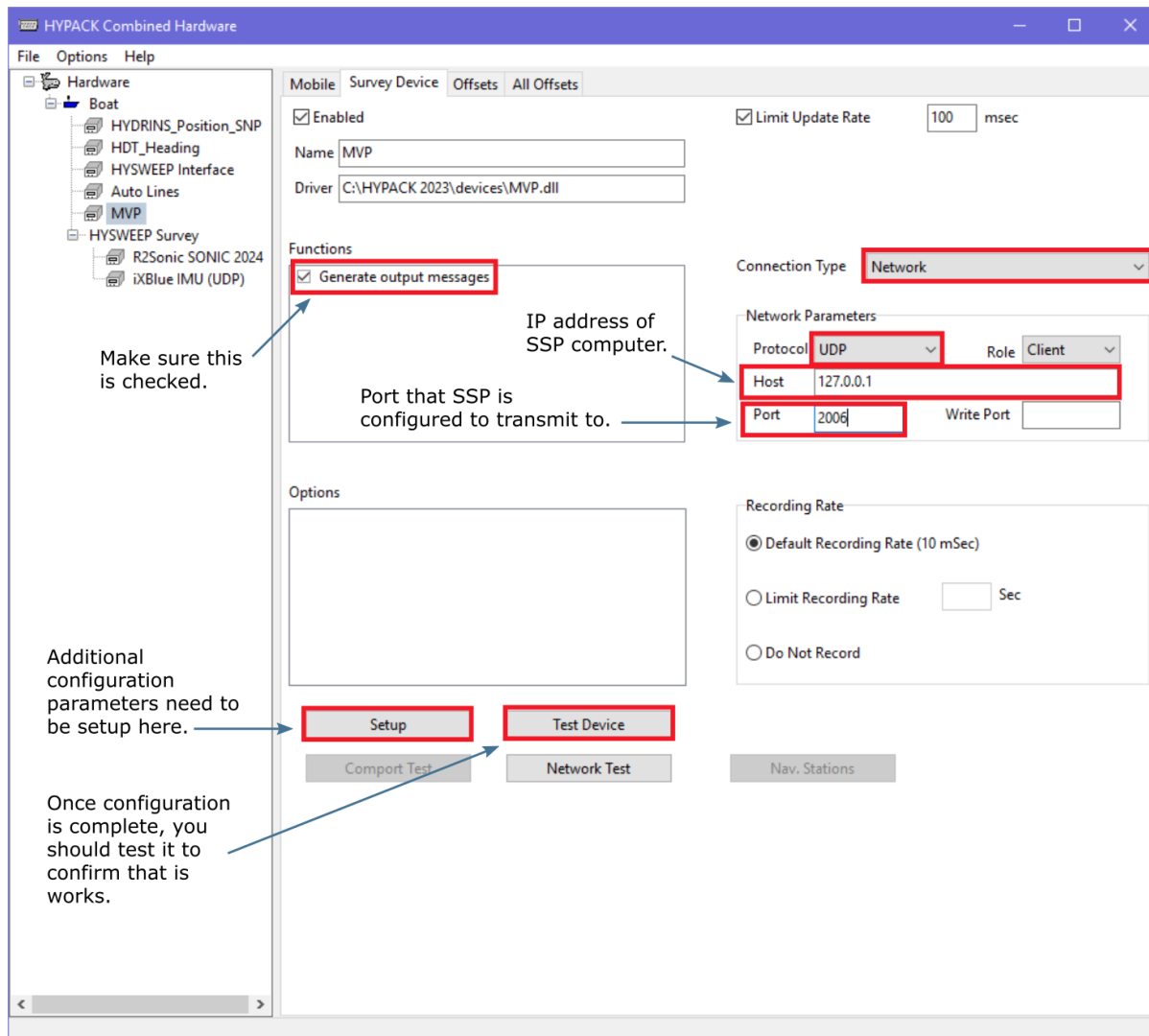


Fig. 2.77: Configuring the MVP driver. The network parameters of the driver are configured to use a UDP input protocol in a client role. The host IP address must match the address used by the computer running the *Sound Speed* package and the reception port must match the port configuration chosen in the package configuration file. The “Write Port” is left as zero.

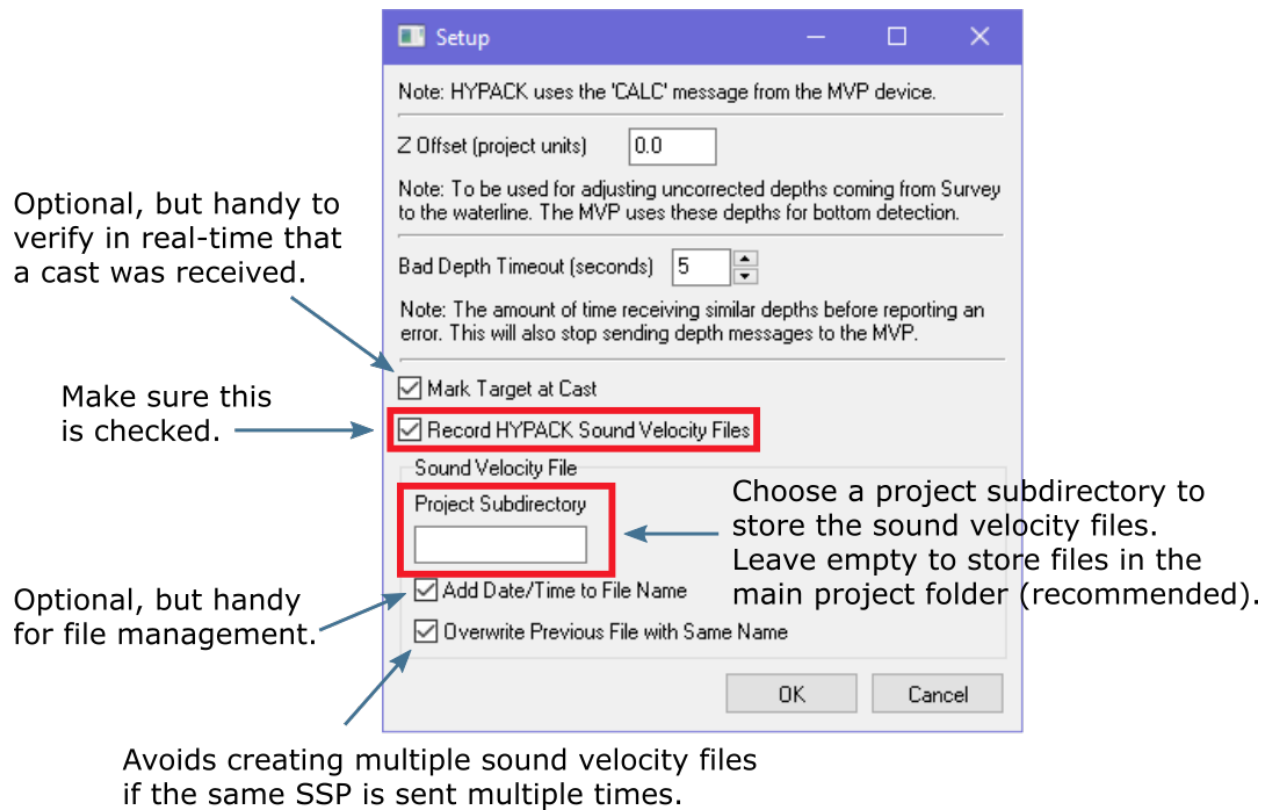


Fig. 2.78: Additional configuration of the MVP device driver.

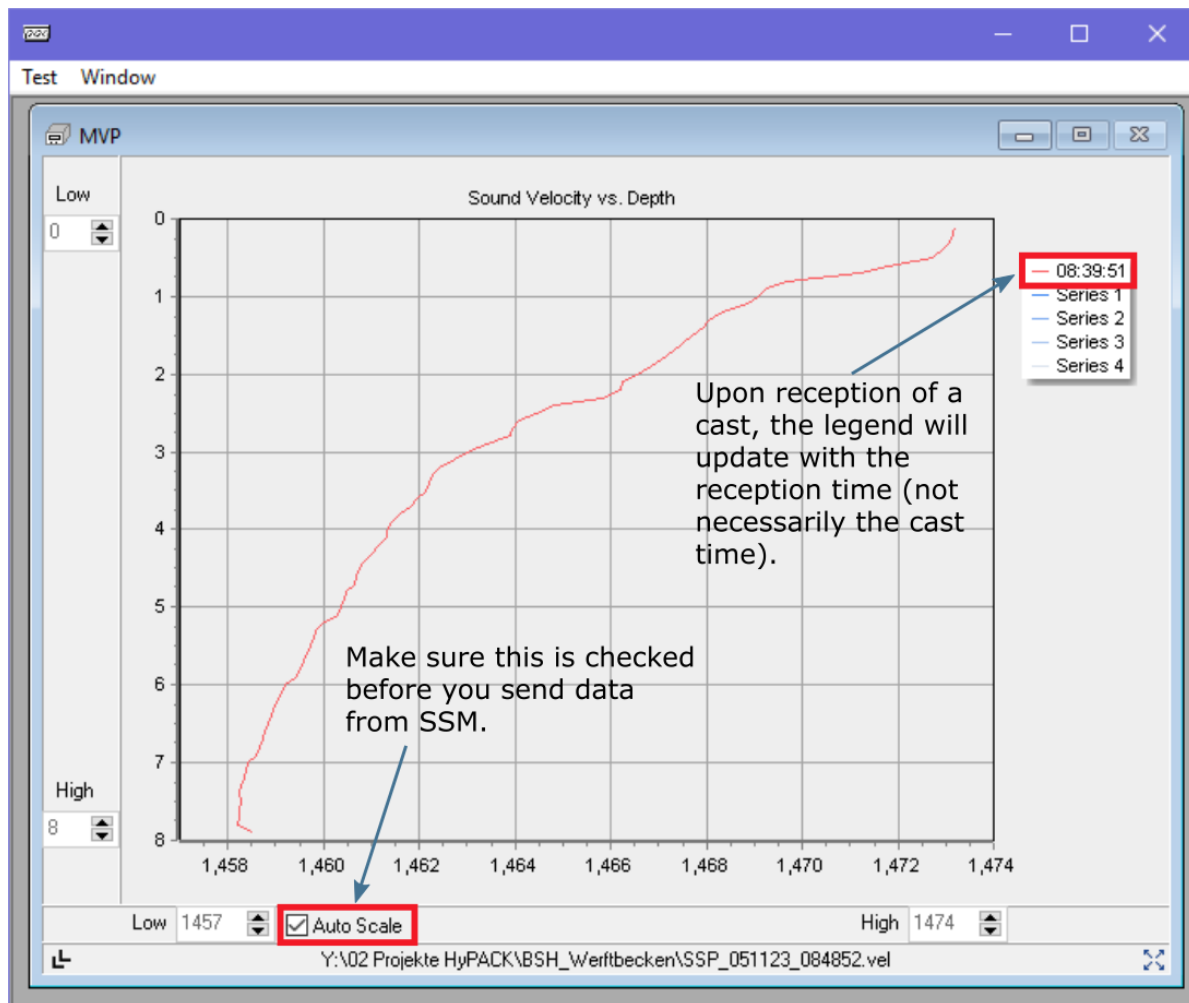


Fig. 2.79: Testing reception capabilities in *HYPACK*. After having loaded a sample cast into the *Sound Speed* package and sent it, the profile should be visualized in *HYPACK*.



HYSWEEP Survey - Offline

File View Matrix Targets Corrections Tools Patch Test Help

Nav Gyro MRU Multibeam Side Scan Devices

Depth	0.00	Time (Event)	00:00:00 (0)
Tide Corr	-4.02	Draft Correction	0.00
Heave	0.00	Roll	0.38
Pitch	-0.75	Heading	101.71
Easting	704277.34	Northing	5998455.43
SV From Profile	1426.0	SV From Sonar	0.0

☒ Boat Info ☐ Towfish Info

An update of this value confirms that a cast was received.

Fig. 2.80: In HYSWEEP Survey, an update of the “SV From Profile” field should occur after reception of a new cast.

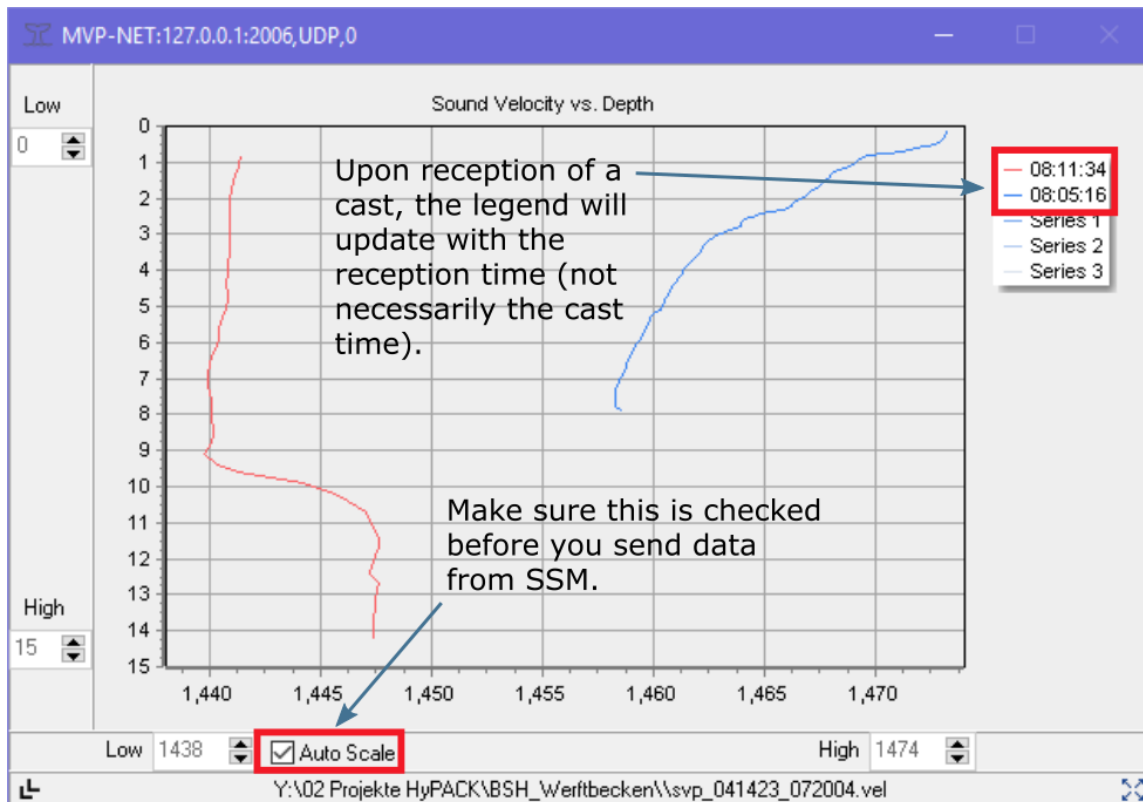


Fig. 2.81: In HYSWEEP, the MVP plot will display all received casts.

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

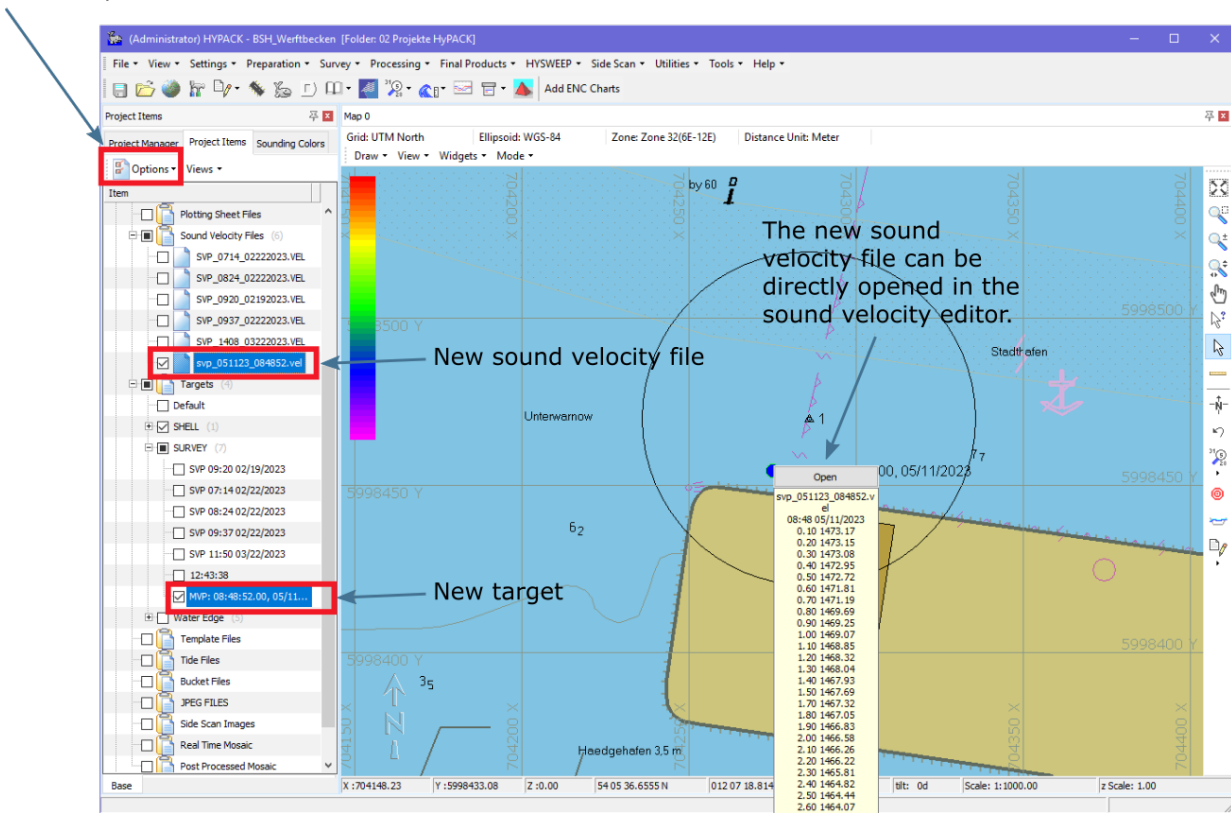


Fig. 2.82: In HYPACK, a new sound velocity file and a new target will appear if these options were selected in the MVP driver setup page.

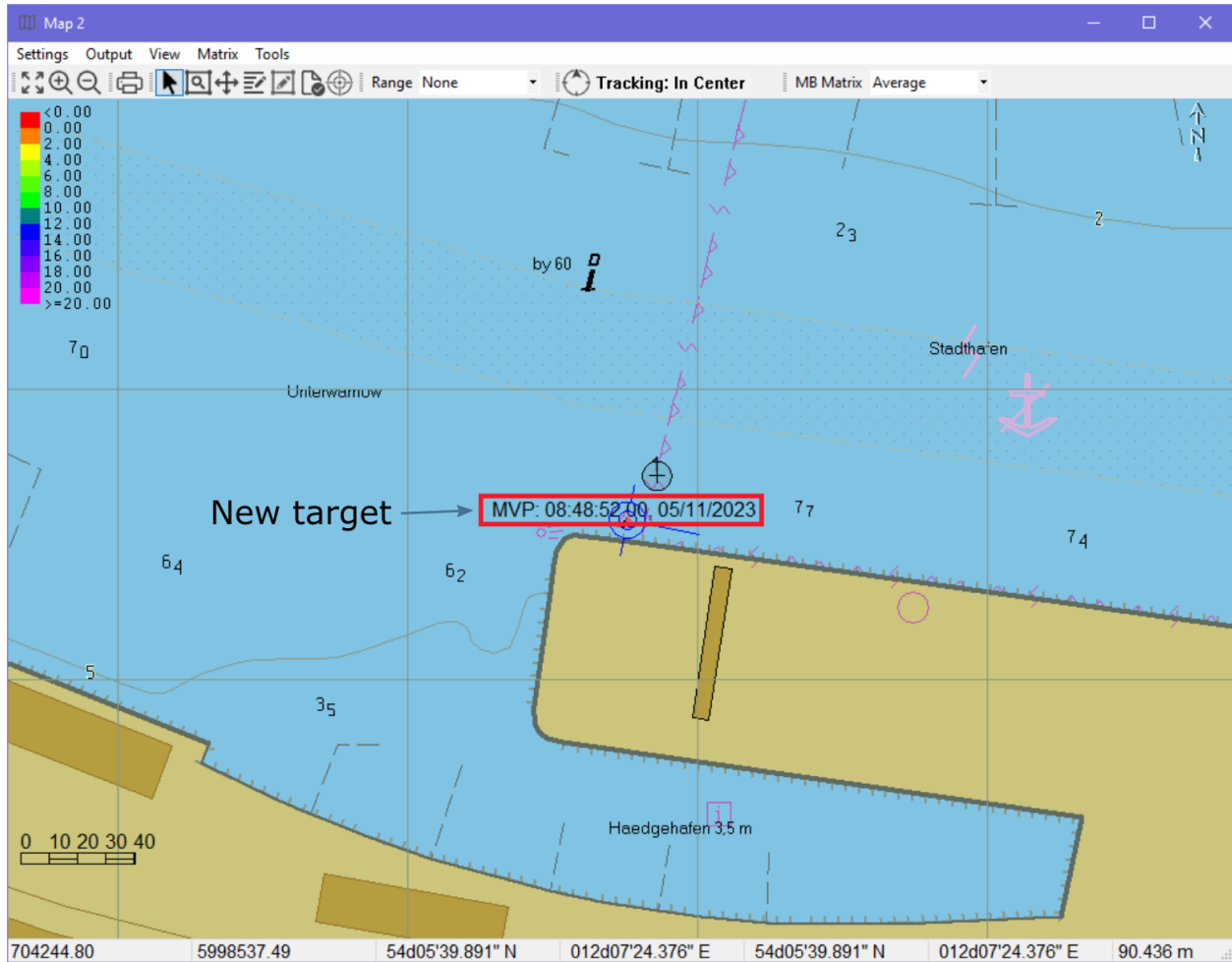


Fig. 2.83: In HYSWEEP, the new target corresponding to the received cast will be displayed in the Map view.

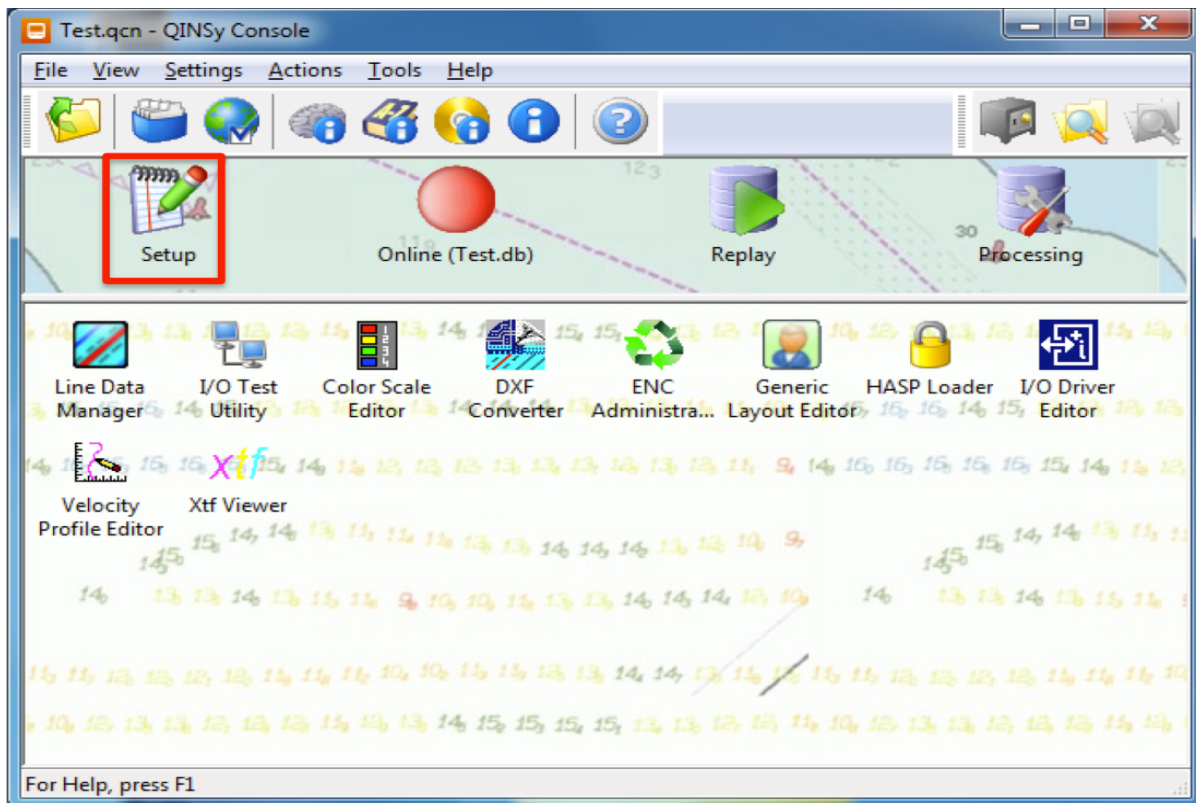


Fig. 2.84: Select *Setup* from the QINSy console after loading your project. Refer to QINSy documentation for information regarding setting up a project.

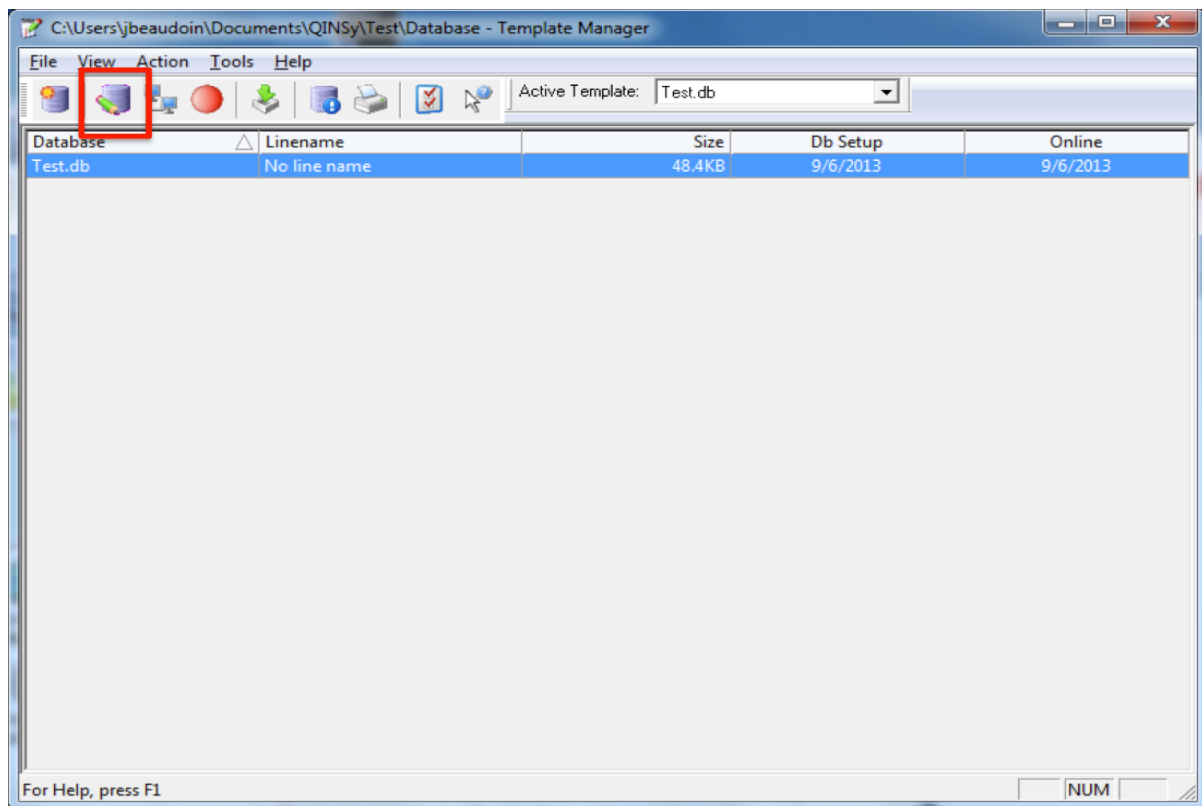


Fig. 2.85: Edit your project database

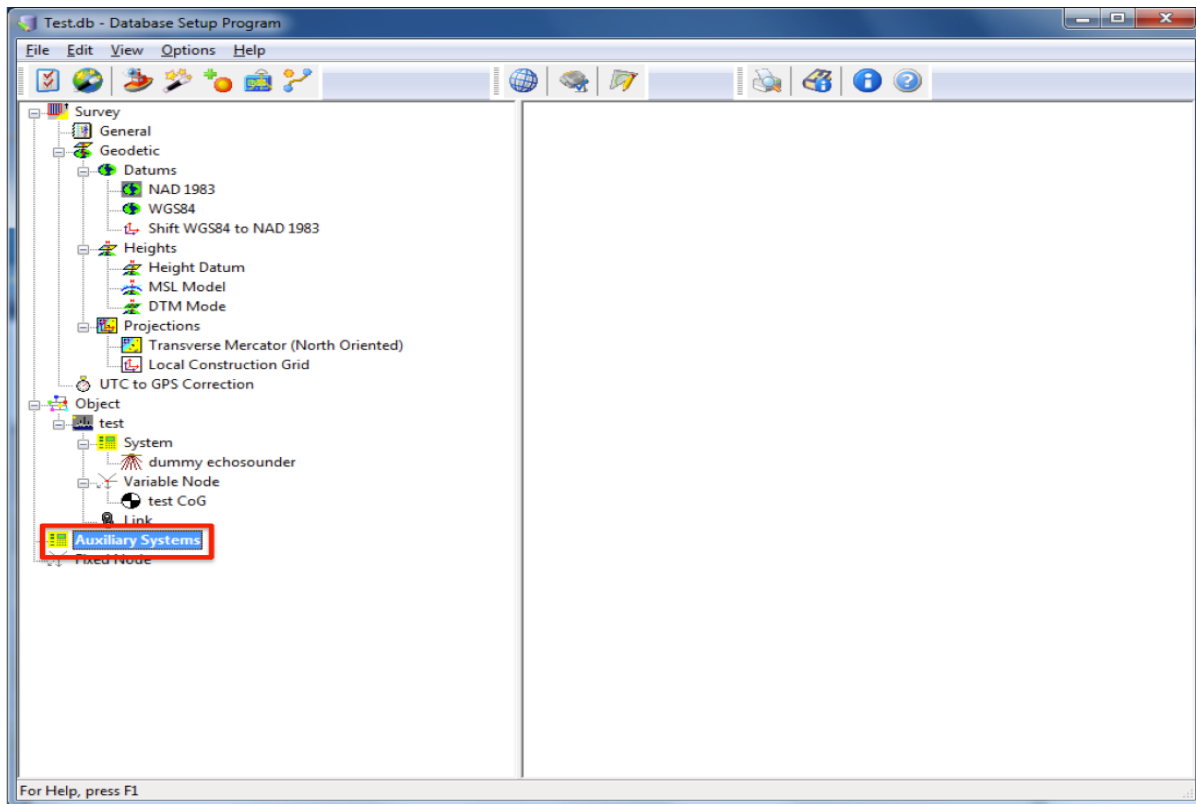


Fig. 2.86: Right click the *Auxiliary Systems* icon and select *New System*.

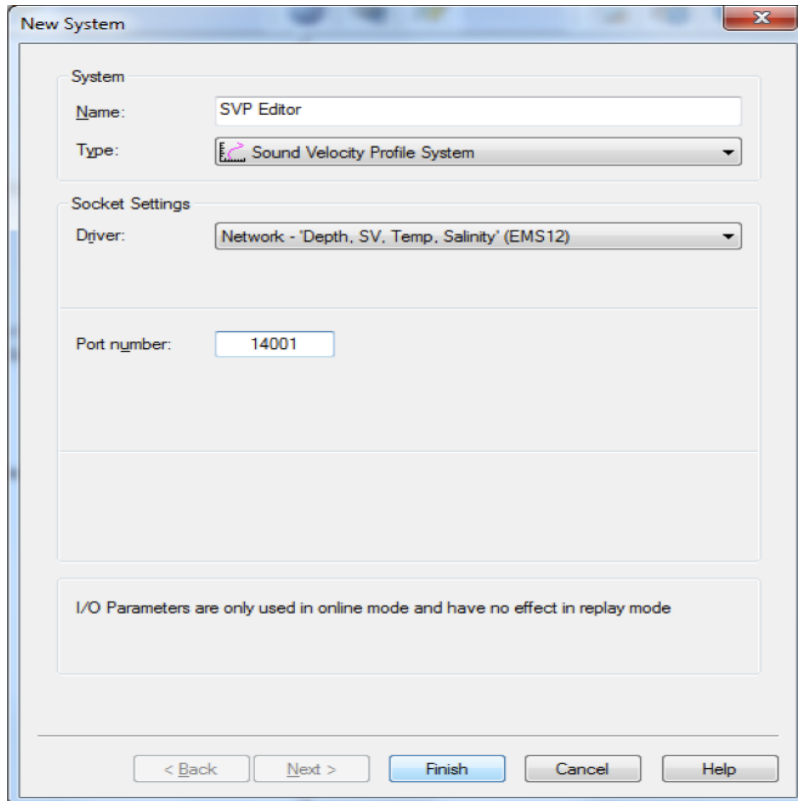


Fig. 2.87: Configure the new system as shown above. Choose the same port number that SSP package will be sending casts to (this is configured in the `__config__.db` file).

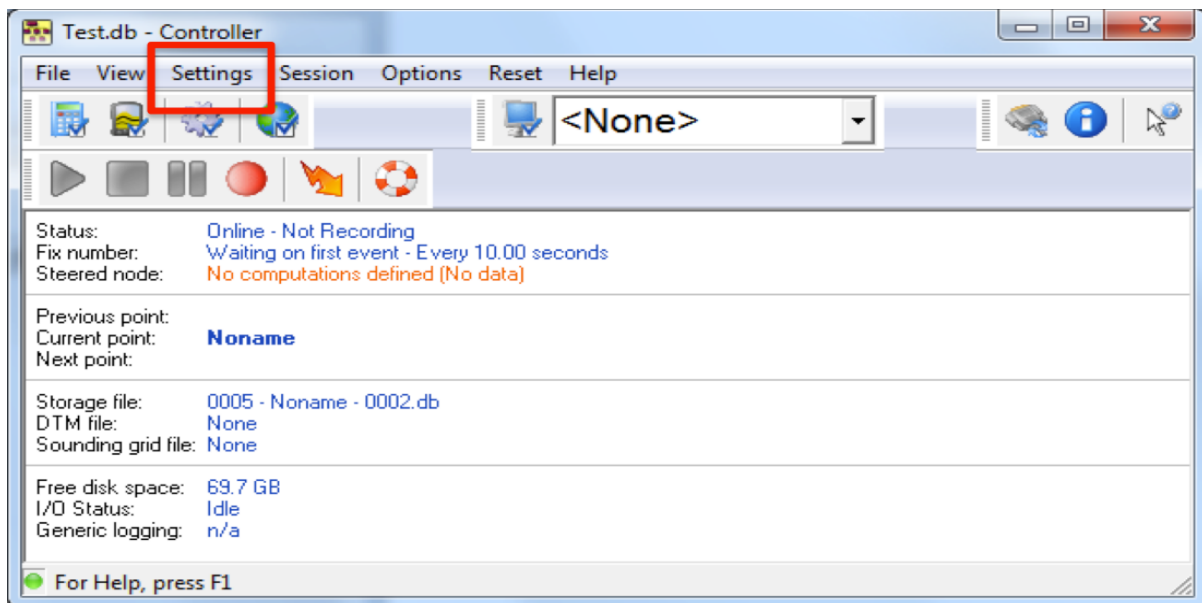


Fig. 2.88: Choose *Echosounder Settings* from the *Settings* menu. This will allow you to configure the behavior of QINSy when it receives new sound speed profiles from SSP package.

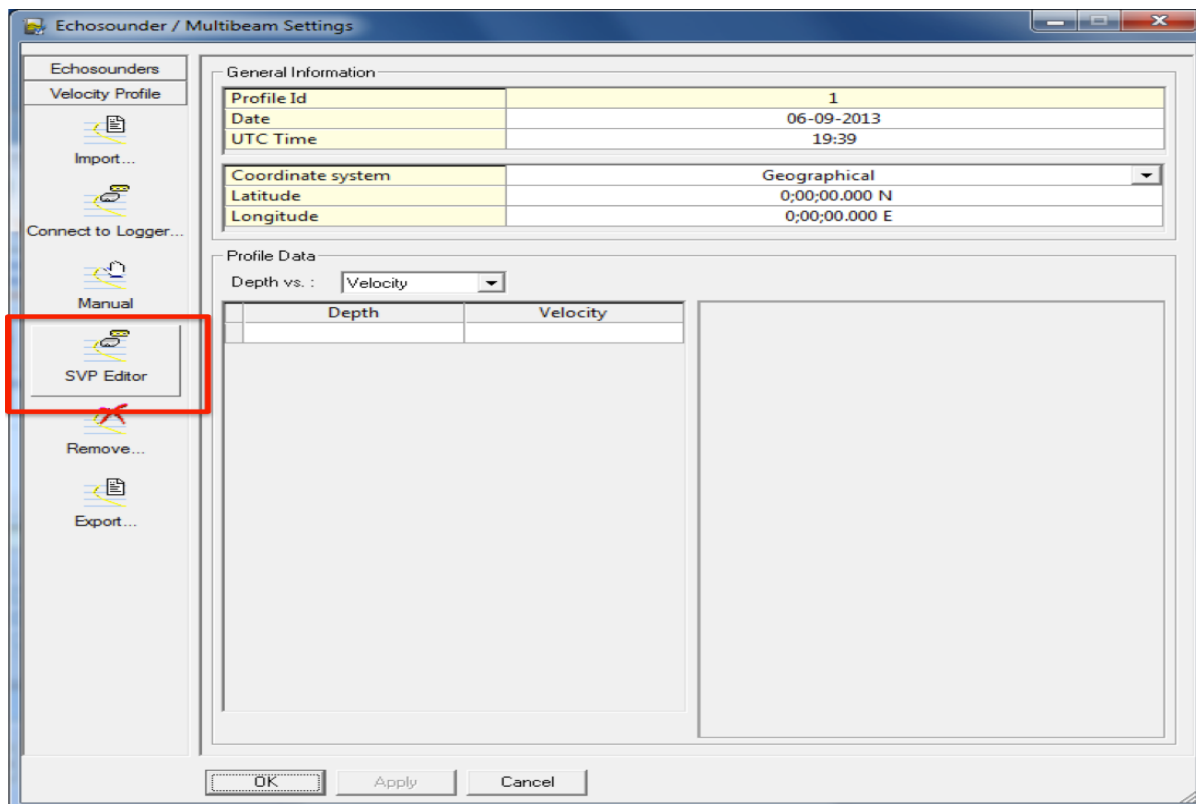


Fig. 2.89: Leftclick the icon for the *SVP Editor* device.



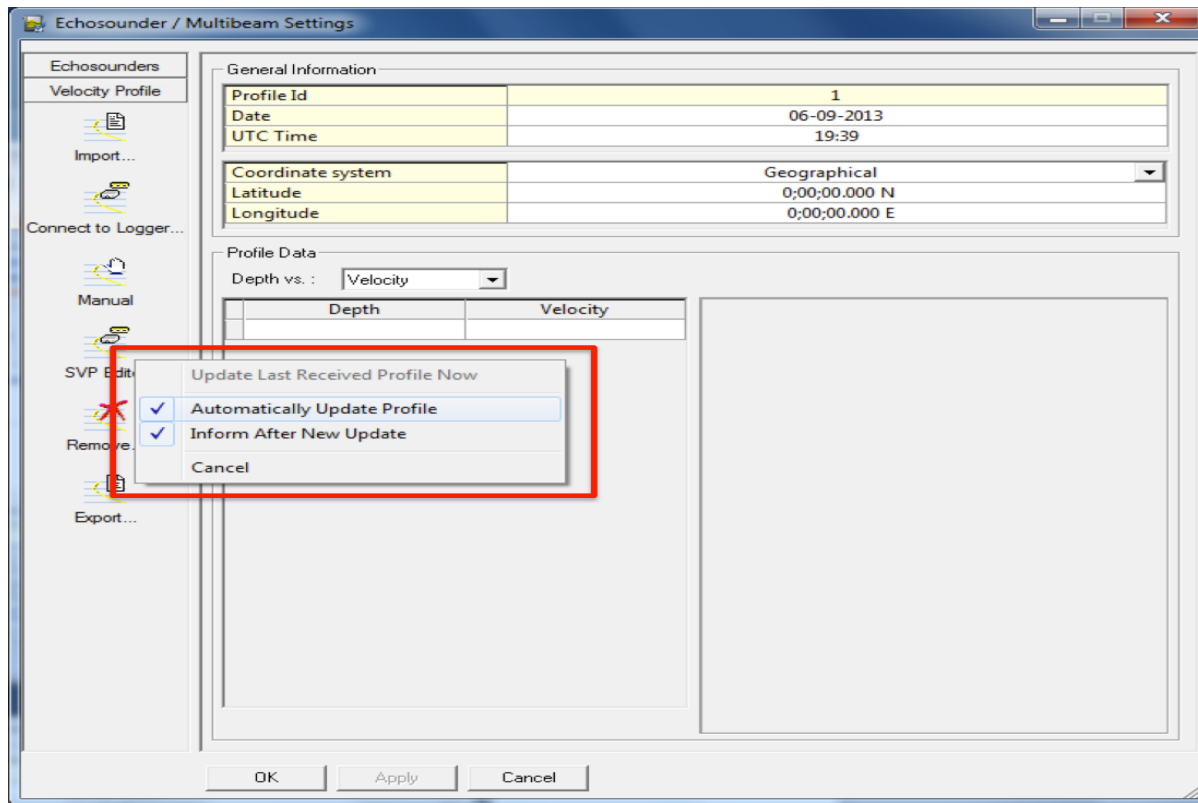


Fig. 2.90: Choose appropriate options to control QINSy's behavior when it receives casts from SSP package. If you plan to deliver casts using `ef:server_mode`, remember to set the "Automatically Update Profile" flag.

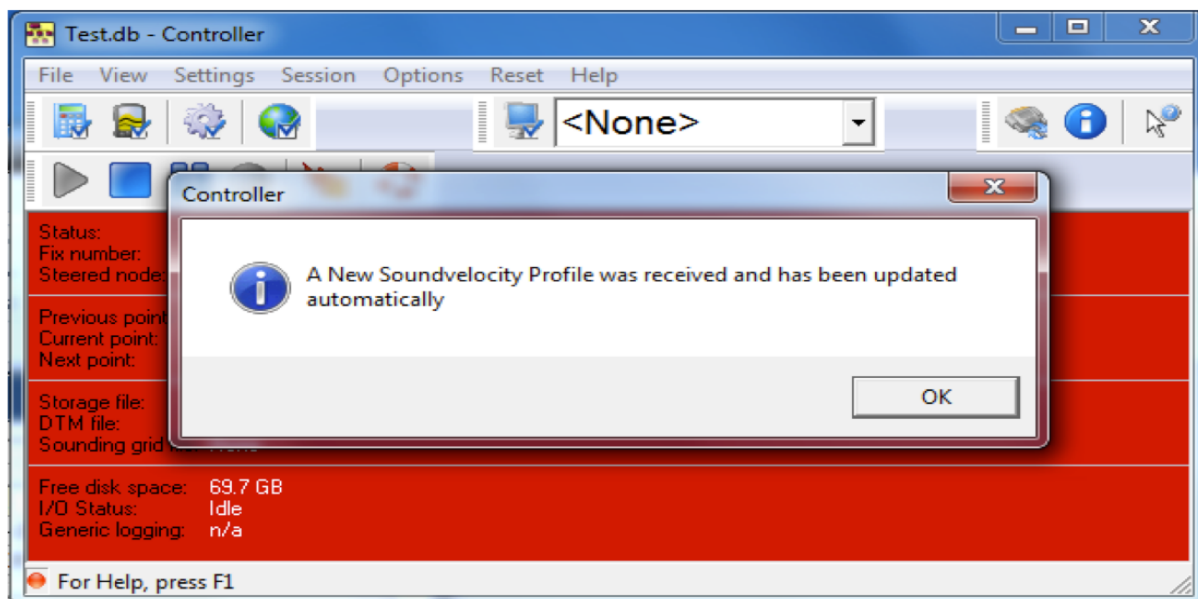


Fig. 2.91: With QINSy "online" and recording, send a test profile from SSP package. If you have chosen to be informed upon reception of a new cast, a message window will appear for acknowledgement.

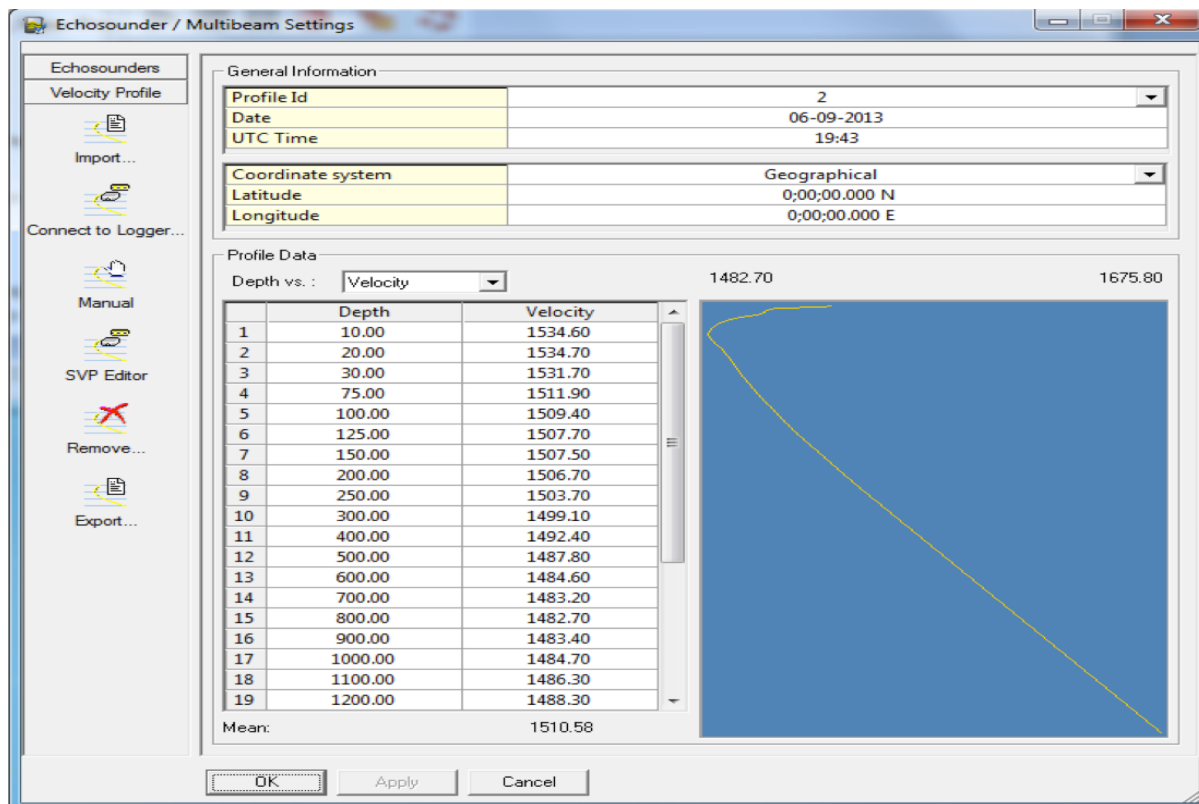


Fig. 2.92: By choosing *Echosounder Settings* from the *Settings* menu again, you can verify that the cast was received.

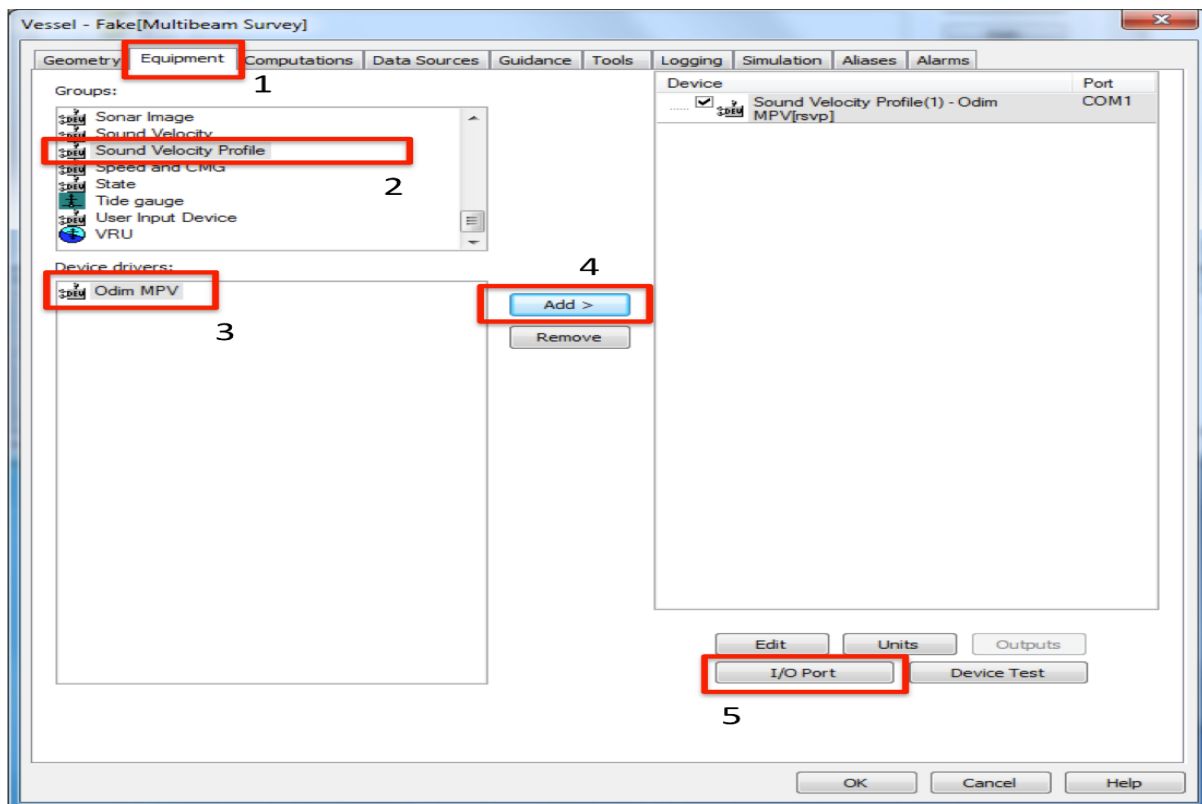


Fig. 2.93: Adding an MVP driver to PDS2000.

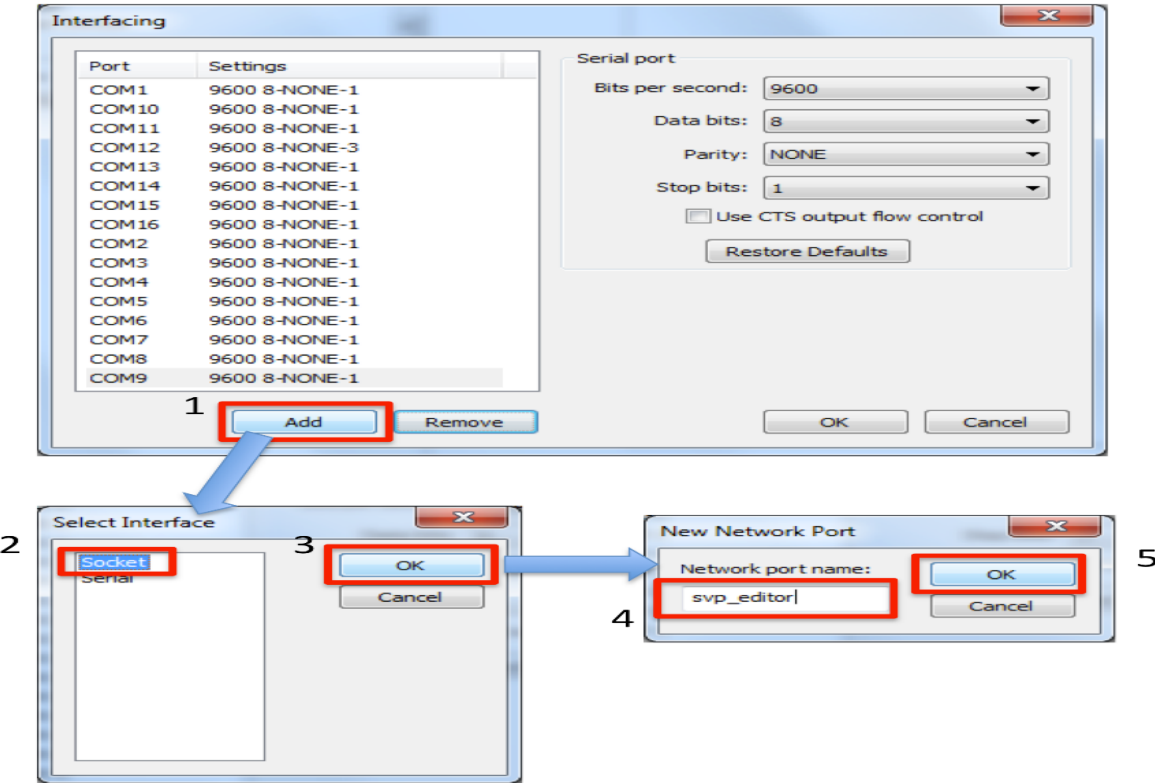


Fig. 2.94: Configuring the MVP driver for PDS2000.

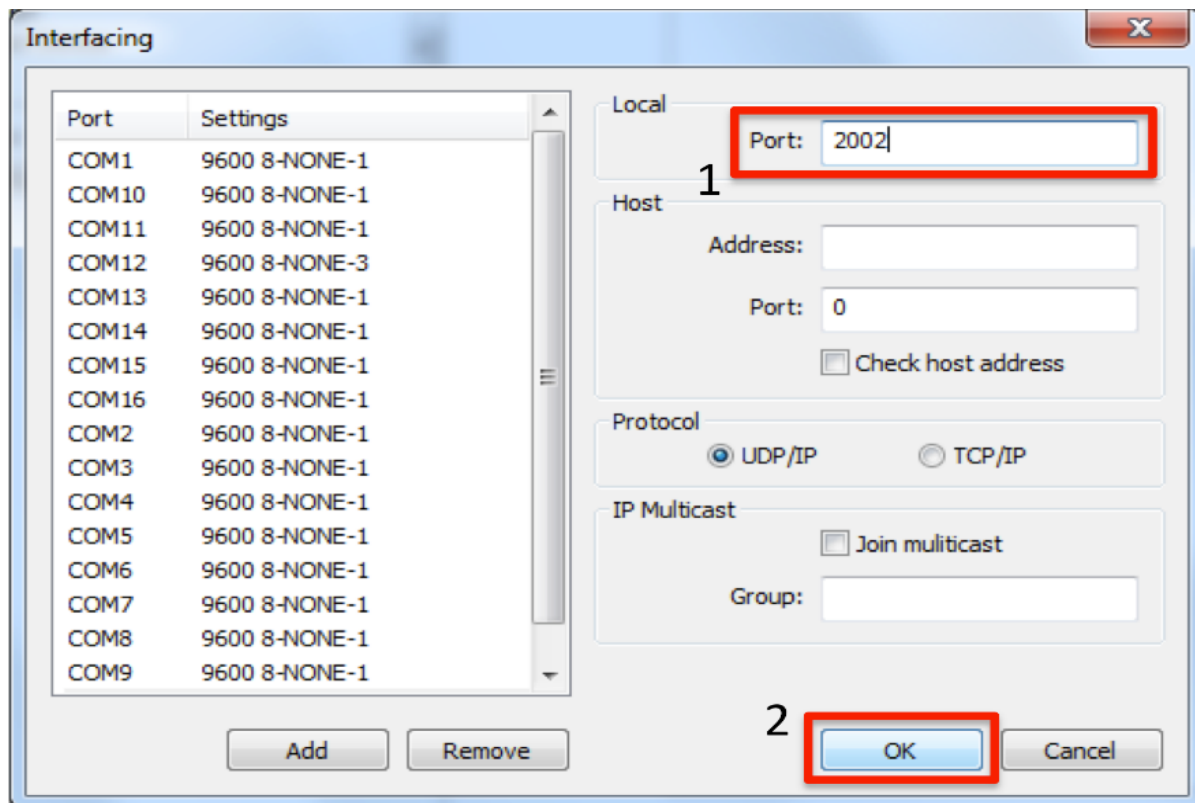


Fig. 2.95: Configuring an MVP driver for PDS2000. Be sure to scroll down in the list on the left side and choose the driver you added in the previous step before modifying the port number. The port number must match that which SSP package is sending data to (configured in the \_\_config\_\_.db file).

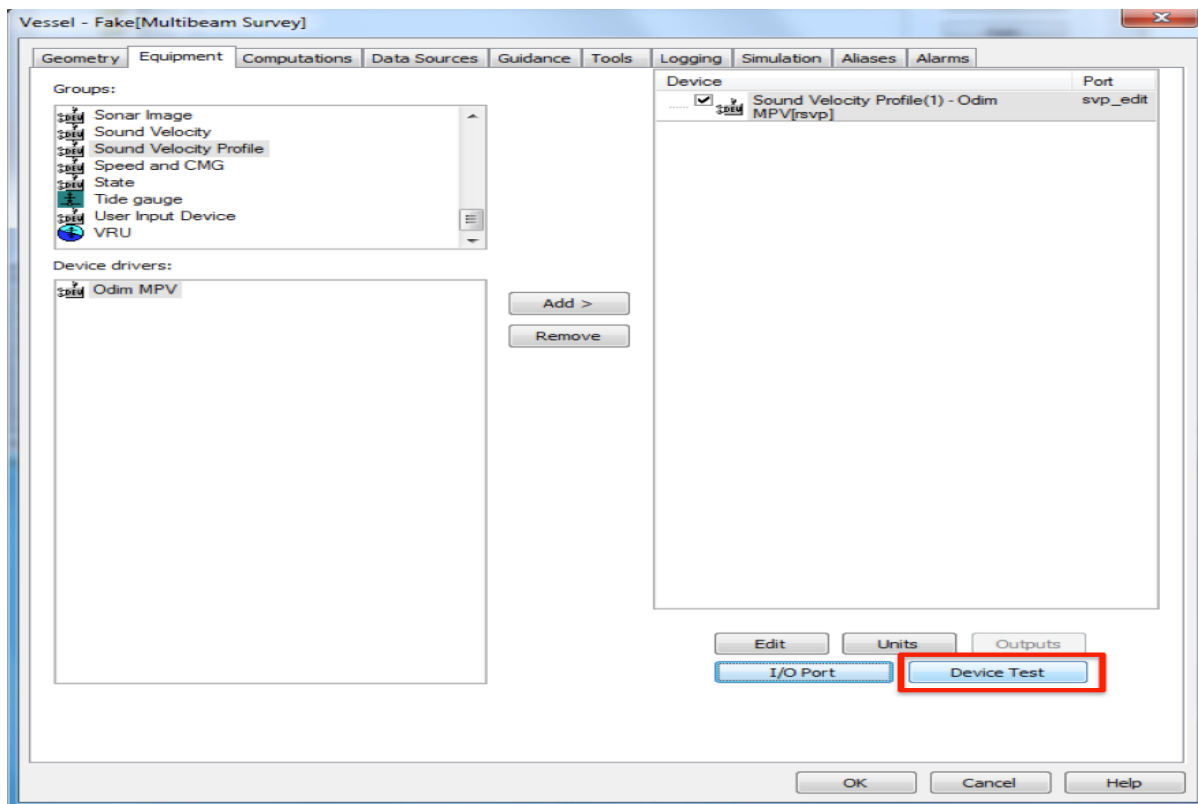


Fig. 2.96: After the driver is added, test the device to verify correct configuration of communication protocols.

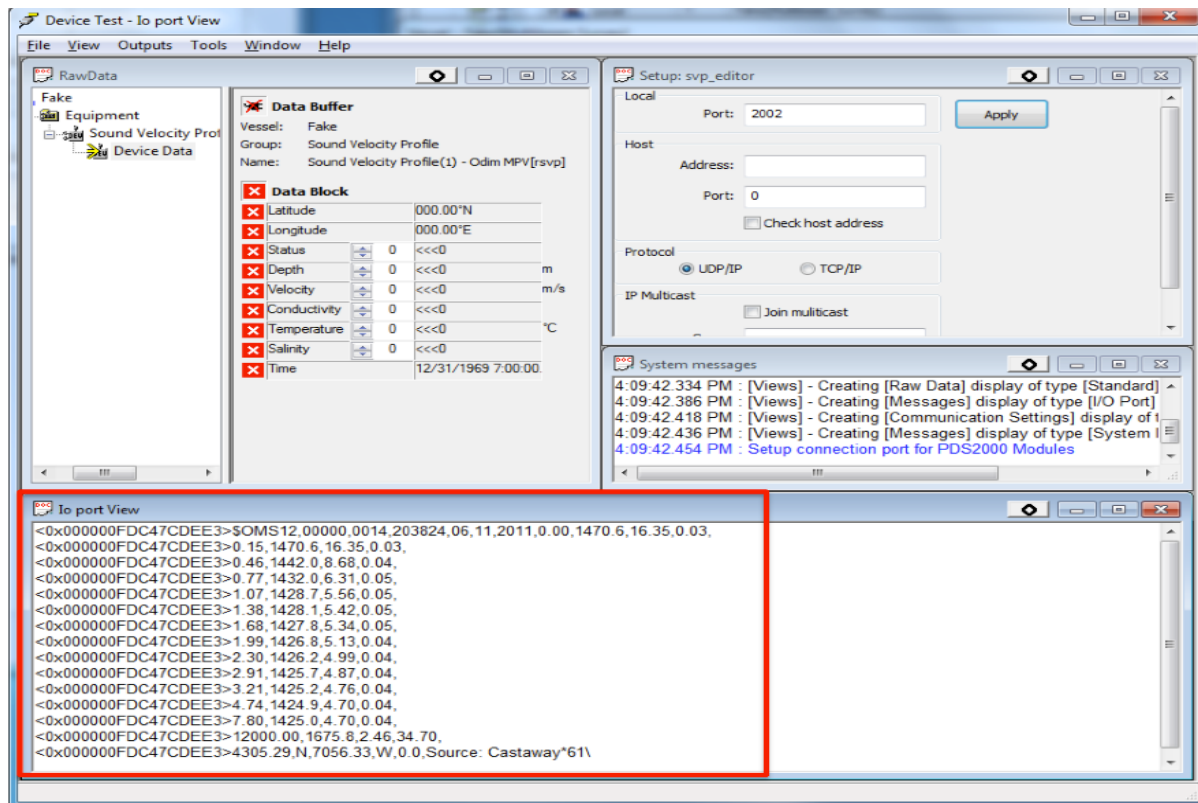


Fig. 2.97: With the device driver open, send a test cast from SSP package. The data should appear in the Io port View window. Be sure that the correct device driver is selected from the top left list window.

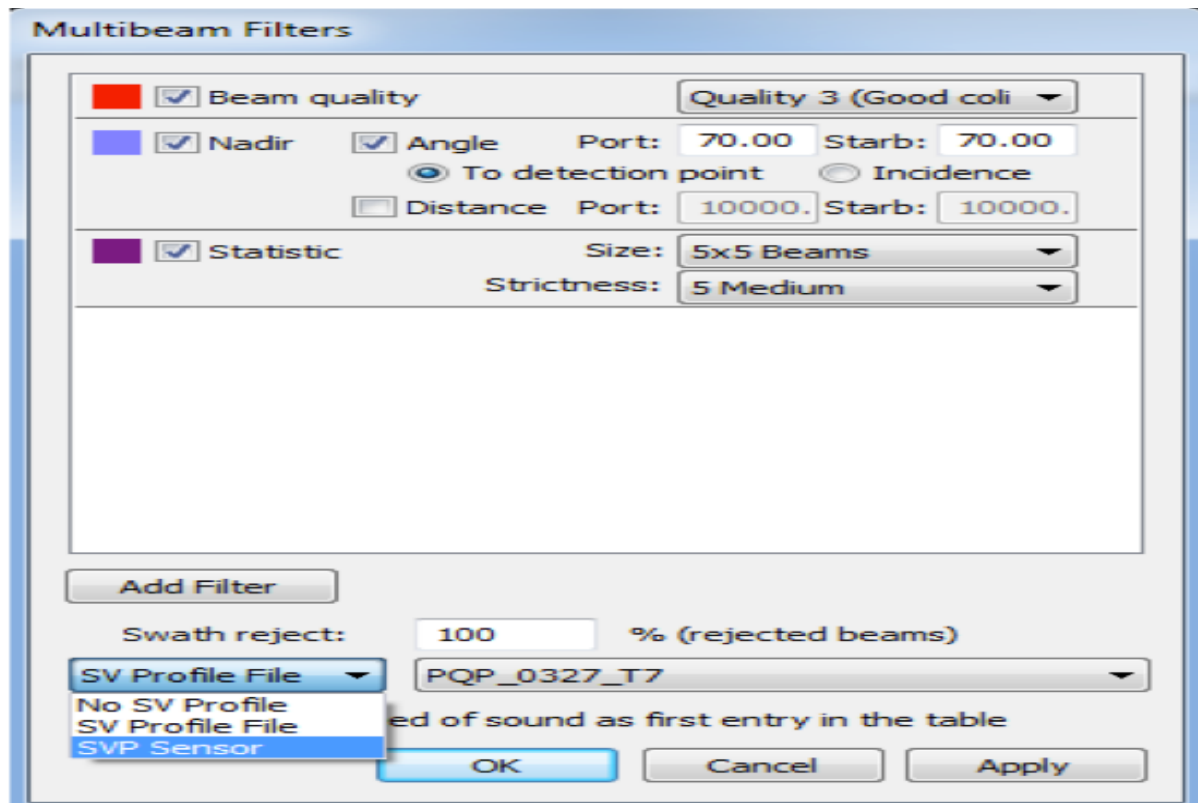


Fig. 2.98: While running PDS2000 in acquisition mode, right click in the multibeam raw profile display and choose “Multibeam filters”. Choose “SVP Sensor” as the source of sound speed profiles to be used.



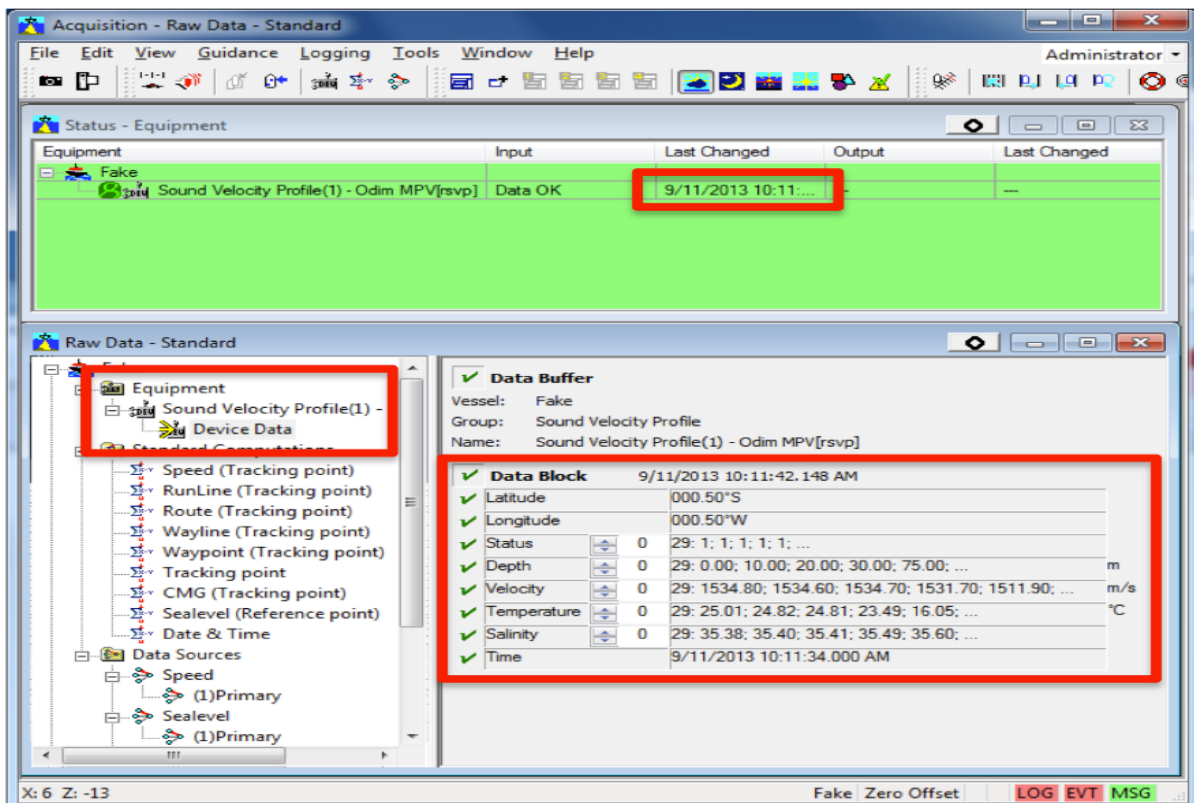


Fig. 2.99: While running PDS2000 in acquisition mode, you can verify reception in the Status displays and the “Raw Data” displays. Check the date, time, latitude, longitude against what you sent from SSP package.

## 2.7 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](#).

### 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. 2.100).

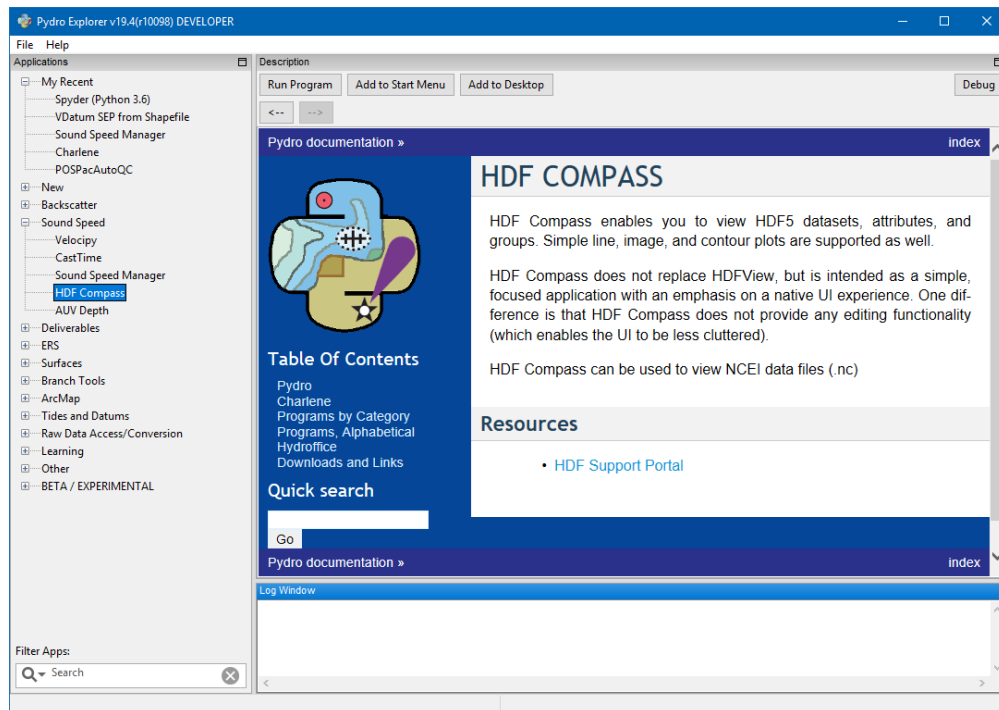


Fig. 2.100: Pydro Explorer Sound Speed Menu.

### 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. 2.101).

The default file extension filter, *HDF5 File* contains the NCEI .nc file extension (see Fig. 2.102).

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. 2.103).

Your .nc file attributes will open in a new window (see Fig. 2.104)

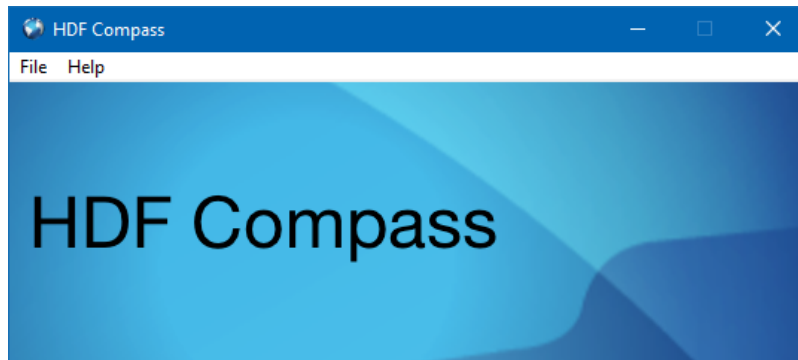


Fig. 2.101: HDF Compass Interface.

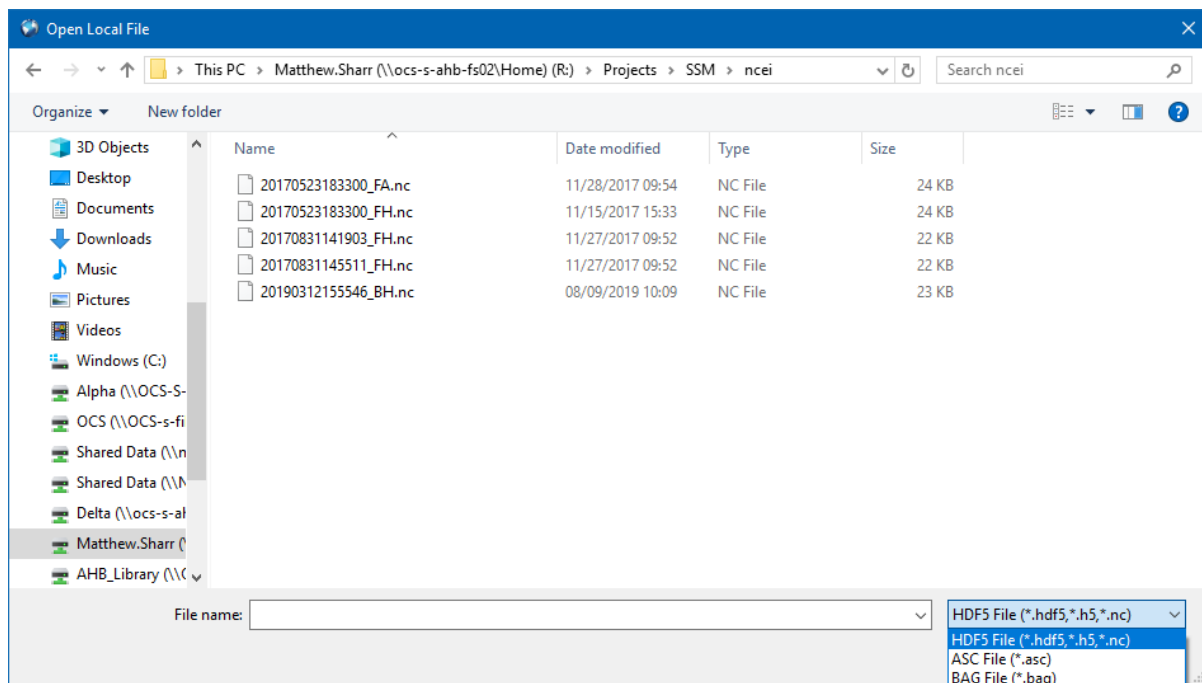


Fig. 2.102: HDF Compass Browse Dialog.

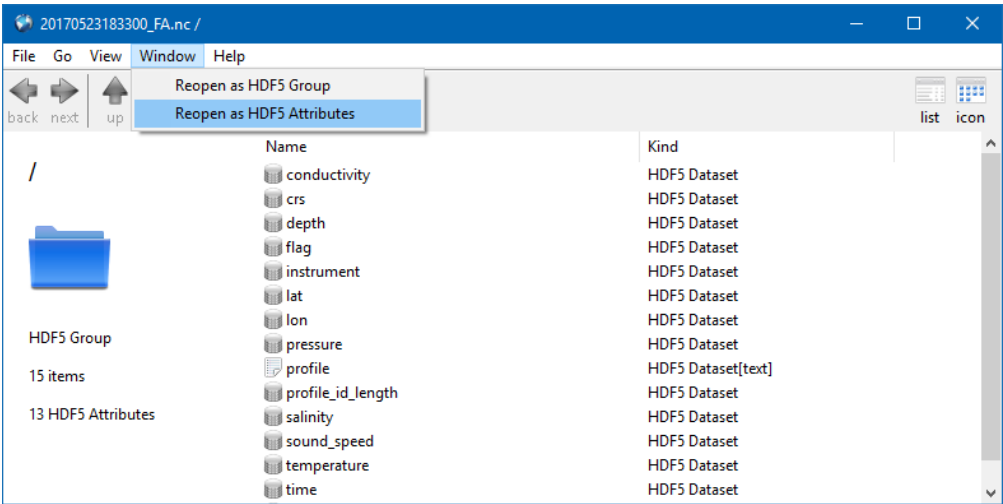


Fig. 2.103: HDF Compass HDF5 Window Menu.

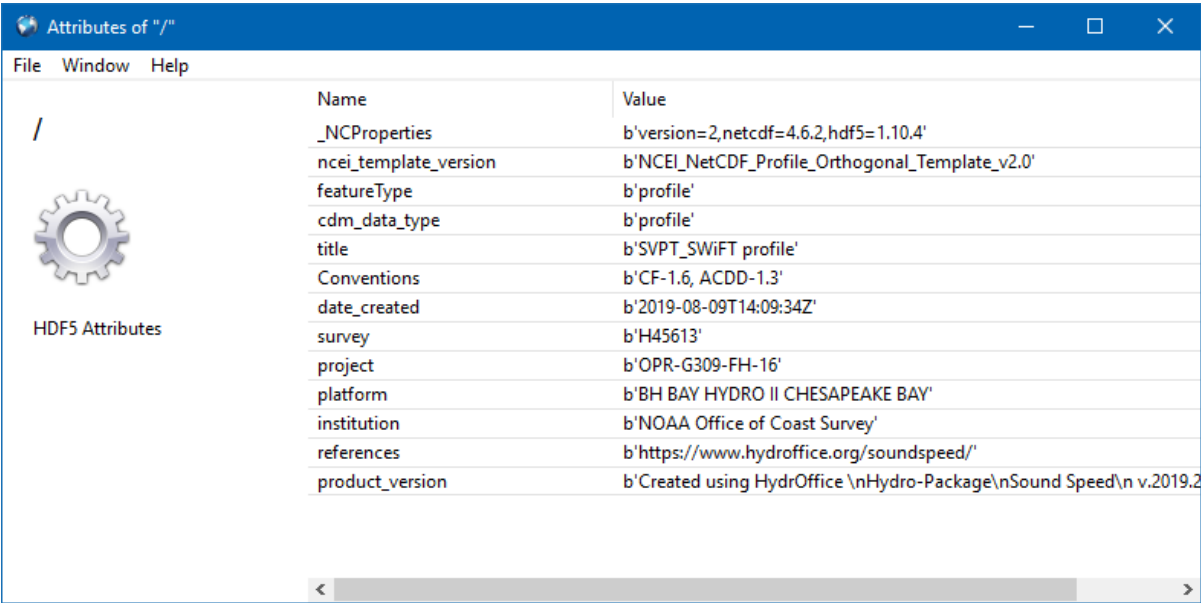


Fig. 2.104: HDF Compass .nc file Attributes.

## 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.

## 3.2 How to build the documentation

### 3.2.1 Requirements

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

- `pip install sphinx sphinx-autobuild sphinx-multiversion`

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`
  - `hydrooffice/soundspeed/__init__.py`
  - `hydrooffice/soundspeedmanager/__init__.py`
  - `hydrooffice/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



## 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

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**Note:** For the settings required on the SIS side, see *SIS v5 settings (through Data Distribution)*.

---

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).

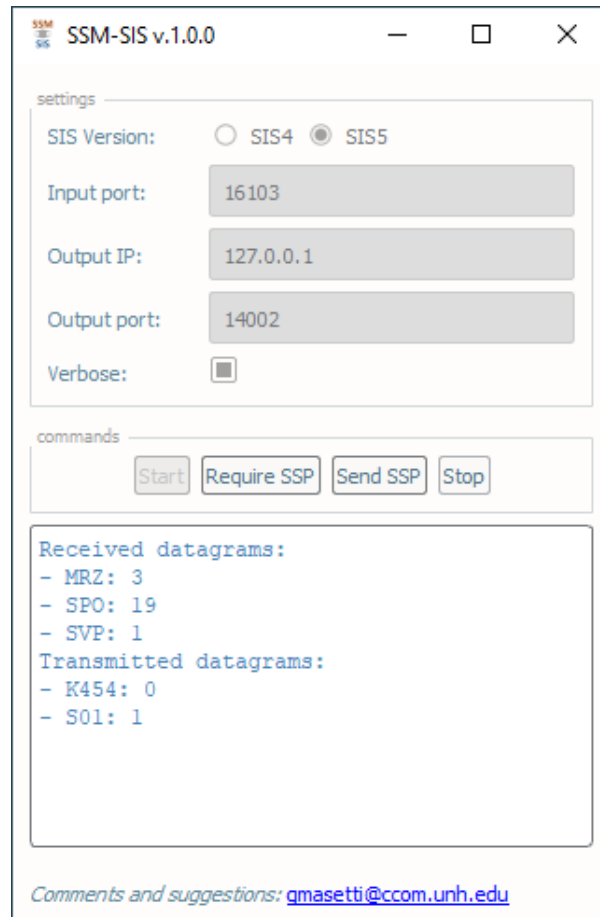


Fig. 4.2: The SSM-SIS app showing the results of the interaction with Kongsberg SIS5.



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