DORIS Software

New Tool to **Process Sound Velocity Profiles**

Hydrographic and geosciences surveys, using acoustic devices, need to use accurate water sound velocity profiles. Because the acoustic path depends on the sound velocity profile (SVP), the use of the most accurate SVP is one of the keys to conducting effective surveys (with multibeams, for instance). To date, the existing software available does not answer to both the needs of efficiency and simplicity (sometimes not so easy to operate, sometimes not so accurate). DORIS provides a handy freeware to post-process SVP for the hydrographic communities.

DORIS has embedded useful functionalities to provide an accurate post-process sound velocity profile, mainly, but not only, dedicated for multibeam echo sounders (MBES). Besides, some additional options are available, such as acoustic ray path simulation. This tool, designed by hydrographic operators, reads velocity files in the various formats of probe manufacturers and exports post-processed data in formats readable by commonly used acquisition and post-processing packages.

DORIS' Origin

For the last ten years, most on-board operators have used their manufacturers software or scientific programs to post-process raw profiles acquired by probes. This was the case at Ifremer, which used the CARAIBES Software suite at sea and, it was also the case at SHOM, which used Timica-Célérité, a dedicated software application. In 2014, after a benchmark of existing tools available on the market, such as the SVP Editor by UNH and tools provided by MBES manufacturers, both Ifremer and SHOM decided to collaborate on the development and implementation of a new software, in accordance with their operational and scientific needs. The goal was to deploy this tool by the end of 2015 in the joint hydrographic and oceanographic fleet, and perhaps on other vessels. The newly developed software, called 'DORIS', is based on these joint specifications, and is mainly focused on the accurate hydrographic requirements and validated formal methods for both institutes.

Formats readable by commonly used acquisition and post-processing packages

DORIS provides a complete suite of functionalities to load, display, modify and export the sound velocity collected by the main existing marine velocity probes, such as Sippican, NKE, Turo or Valeport. In addition, DORIS can use statistical databases such as Levitus, for instance, to extend the SVP collected by devices to the maximum depth and can export the results to a multibeam acquisition workstation on board (SIS for Kongsberg or PDS2000 for Reson). Drivers are included in the software allowing for easy

▲ *Figure 1: General structure of the DORIS workflow.*

▲ *Figure 2: Selection of raw data to be invalidated, by selection either on the graphical plot or inside the table.*

data exchange with main acquisition and post-processing software packages such as CARIS, SIS, RESON/PDS2000, HYPACK and others.

The Technical Environment

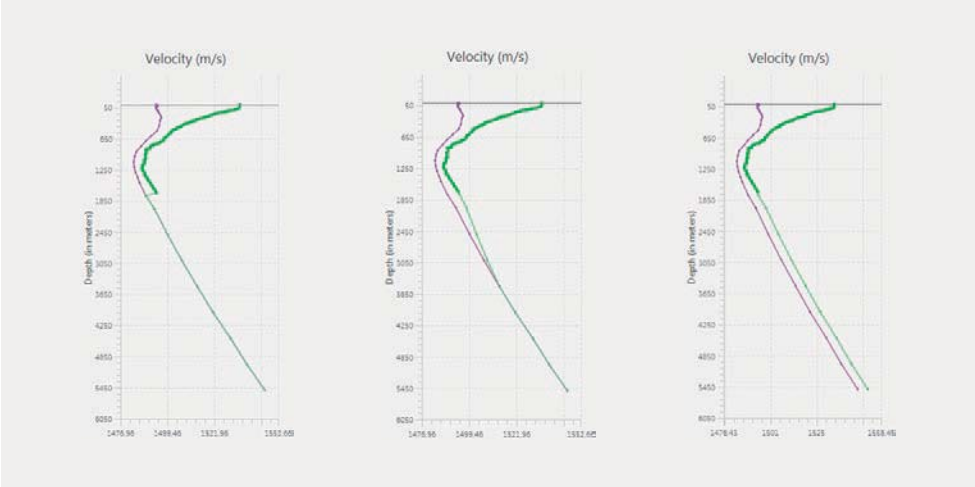
DORIS' setup is available for several common platforms such as Windows_x64 7, 8 and 10, Linux_x64 Debian, Fedora, Ubuntu and also for MacOSX.

The 'look & feel' of DORIS' application is a user-friendly design embedded application using the recent programming technologies of Java8 and JavaFx for the main interfaces.

The Existing Functionalities

The main functionalities of the DORIS workflow have been written by SHOM, with feedback from their surveyors. DORIS workflow is end-user dedicated, and divided into five major steps. Firstly, the data collected by probes is imported. The following formats are supported: Sippican (.edf), Valeport (.000 or .vpd), Turo (.nc), Seabird (.txt) and NKE (.cnv). Then, the raw SVP and its metadata are displayed and checked. Metadata can be modified if necessary, i.e. location of the probe launch, identification of the vessel, weather information, etc. Additional parameters can be set up to a CORIOLIS' workflow compliancy. CORIOLIS is a project which contributes to the French operational oceanography programme for in-situ observations; it is a part of the international ARGO programme. The graphic interface allows the user to validate or invalidate values interactively on their graphs or tables; both are interconnected.

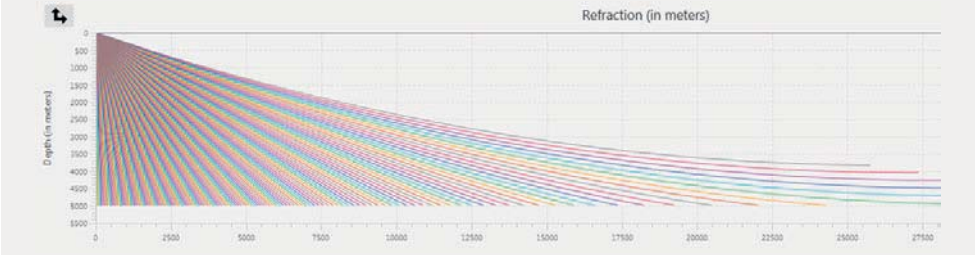
Subsequently, if the SVP does not reach the bottom, a 'climatological' profile from one of the existing databases can be loaded and the SVP can then be extended using these 'climatological' values. So far, two different databases can be read by DORIS interface: Levitus and ISAS (In Situ Analysis System). These databases provide statistical profiles that have been built previously by lab operators from Data centers reference. For instance, the ISAS database is managed by the Pole Ocean in France: this is an optimal interpolation tool developed to synthesise the global dataset of Argo profiles. Of course, the 'climatological' profile loaded is the one closest to the SVP. The interface shows the distance between the probe location and the profile loaded from the statistical database. Salinity, temperature and depth from statistical databases are used to compute the sound velocity, applying the algorithm



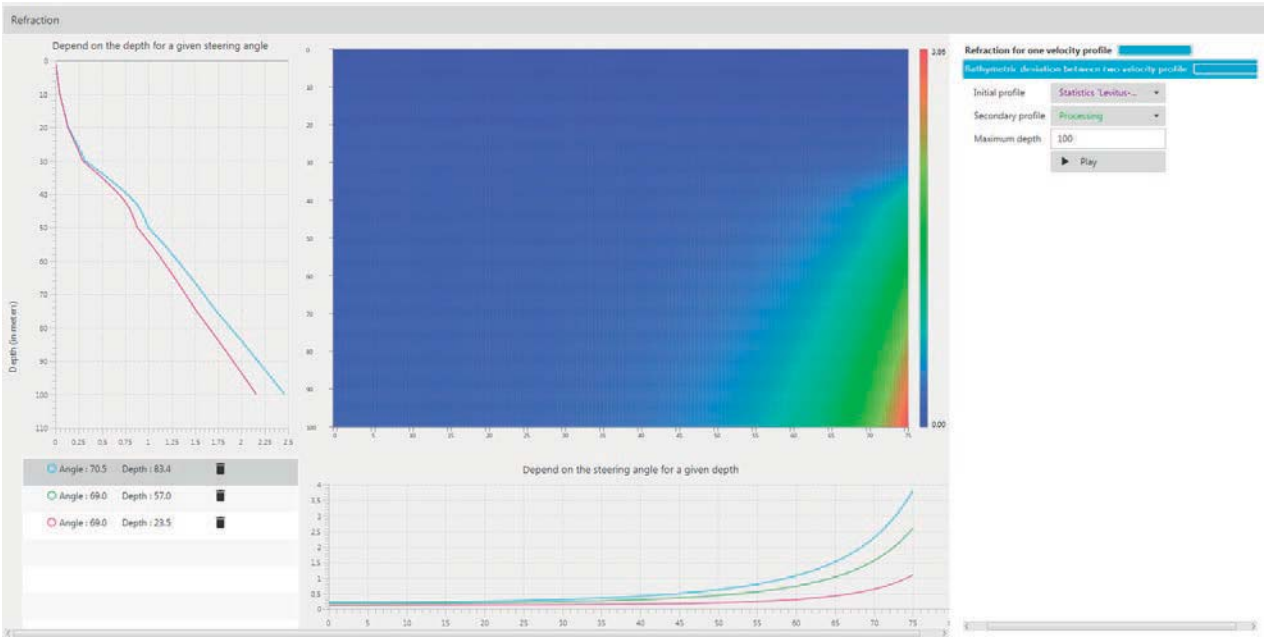
▲ *Figure 3: Direct - The lower end of the recorded SVP (green) is connected to the statistical profile (purple).*

▲ *Figure 4 : Progressive - the recorded SVP (green) is progressively linked to the statistical profile (purple).*

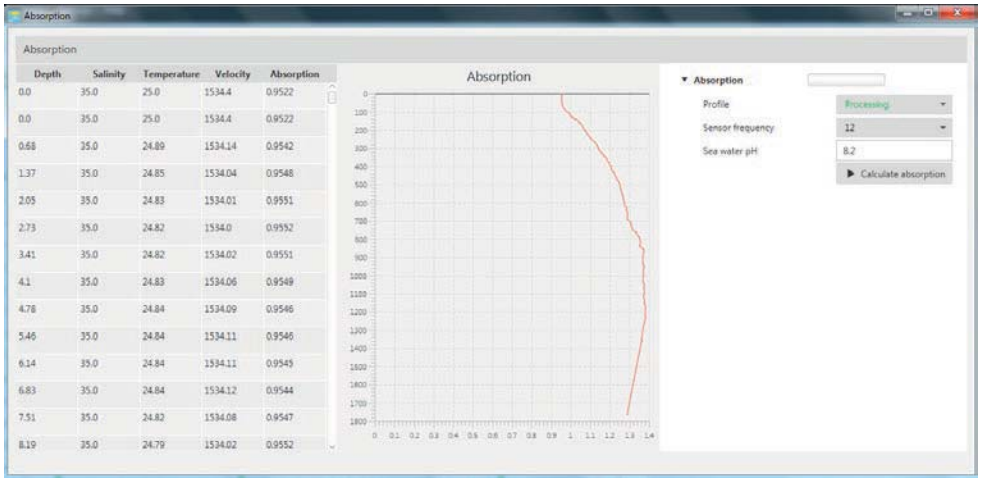
▲ *Figure 5: Shifted - The statistical profile (purple) is shifted for continuity with the recorded SVP (green).*



▲ *Figure 6: Example of acoustic ray-path plot as a function of depth and transmit angle.*



▲ *Figure 7: Display of the impact of a SVP change upon computed bathymetry vs depth and lateral range.*



◀ *Figure 8: Display of a seawater absorption profile computed from salinity and temperature data.*

previously set in the configuration window (Chen&Millero, DelGrosso or TOES-10). To extend the SVP correctly, using the climatological profile, three methods are available (direct, progressive or shifted). As a following step, extension of a maximum depth of the existing profile takes place, by increasing the depth assuming constant temperature and salinity (using dedicated algorithm). Typically this is done to extend up to 12,000 metres for the Kongsberg configurations.

Provides a complete suite of functionalities to load, display, modify and export the sound velocity

Once the SVP has been correctly extended to the right depth, the next step, due to the limitation of some echo sounders, is to reduce the number of SVP points. For this task, the Douglas-Peucker algorithm is used. A reduction factor is available to reach the expected number of points, according to the echo sounder capabilities.

Finally, the last task consists of exporting or sending the SVP to the acoustic system under a defined datagram. Major export formats are available under the options list: CARIS (svp), Hypack (vel), SIS (asvp), … The latter functionality uses a UDP datagram format which is compliant with the Kongsberg and Reson systems.

Advanced Functionalities

Two functionalities can be used by advanced users. The first one plots the acoustic ray path

computed from a selected sound velocity profile. The user can select either a loaded raw profile or a climatological one (from Levitus, for instance).
The second function provides a graph that computed the vertical deviation between two profiles for different depth and angles. Hence, impact of a new SVP can be estimated, and could help surveyors.

Qualification and Validation Aspects

The first version of DORIS has been available since June 2015 and tests are now being conducted at sea by SHOM on board RV *Beautemps-Beaupré* and by GENAVIR (Operator of the IRD and Ifremer oceanographic fleets) on board RV *Pourquoi pas?*. These are the first sea trials being undertaken by the hydrographic community. Other French operators are interested in DORIS, including IPEV (Institut Paul Emile Victor) after the refit of their vessel RV *Marion Dufresne*.
DORIS can be downloaded from the website (doris-svp.org), including documentation and a wiki. DORIS is available under a freeware licence contract.

Conclusion

DORIS is the result of close collaboration between SHOM and Ifremer and is a win-win situation, based on the need to renew old tools, with efficient and simple software, designed by end-users. DORIS has now been finalised with all the required features. The preliminary versions of the tool have been installed on different survey vessels for operational sea tests, and the first feedback from operators and scientists for various organisations is extremely positive and full deployment on both fleets, SHOM and Ifremer (almost 10 vessels), is expected in early 2016. Other hydrographic offices or research institutes are very welcome to use and evaluate this new software. Upgrades have already been identified for the next versions.

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Carrier	LAPEROUSE {LP010}
Date	18/11/2016
Time	18:11:16
Sequence	475
Serial number	01154928
Salinity (+N/-S)	42 ,47° N
Longitude (-E/-W)	7,6492°
Depth (m)	2700.0
Athmospheric pression (Hpa)	1015.2
Surface water temperature (°C)	16.9
Dry air temperature (°C)	19.5
Humid air temperature (°C)	13.8
TNMG	1330
Wind { direction (°) / strength (Knt) }	000/05
Swell { direction (°) / period (s) }	999/99
Sensor type	T-7
Sample number	--
Comment	Sea Tests

▲ *Table 1: List of the metadata available in DORIS.*

More Information

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Jean-Marc Sinquin is project manager for marine onboard software manufacturer Oceanographic Research Institute and has over 20 years' experience in IT marine solutions. He holds an engineering and IT computer science degree obtained from H.E.I. (Lille, France) in 1992 and a Masters degree in Software Development from ENSTB in 1994. He is currently working on many projects (CARAIBES, GLOBE,…) such as DORIS. For the last eight years he has been closely involved in the Eurofleets1, Geoseas and EMODnet projects.
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Christophe Vrignaud is an Engineer for the French Ministry of Defence. His main interest is related to underwater acoustics. Early in his career he focused on fishery acoustics. He has been in charge of the French Hydrographic and Oceanographic Service onboard acoustic systems since 2007. For SHOM, he mainly focuses on MBES qualifications and training of surveyors. He has been conducting multiple acceptance and qualification surveys at sea.
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Grégory Mathieu has served as a hydrographer for French hydrographic service (SHOM) since 2006. In 2010, he was promoted to administrator of the computer systems on board SHOM fleet vessels. Having participated in many campaigns at sea as a hydrographer, he now brings his expertise to various projects related to the collection and processing of data. DORIS is one of these projects and is carried out in collaboration with IFREMER.
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