

# Hydro

INTERNATIONAL

# Business Guide 2020

MARKET ANALYSIS | COMPANY PROFILES | INTERVIEWS | INDUSTRY INSIGHTS



**Will the Hydrographic Market Expand?  
Innovations for 2020  
Rate of Sea-level Rise Accelerates**



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## P. 11 Subsea Autonomy Is Moving Beyond Waypoints

The AUV has been the tool of choice for shallow-water MCM and EOD operations for a number of years. The coverage by popular news channels of unfortunate events, such as the MH370 tragedy, has also shown that the AUV has undisputedly become the tool of choice to carry out salvage operations at extreme depths.



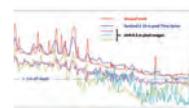
## P. 20 A view of hydrographic technology and the market for 2020

In the last decade, there has been a steady march towards the automation of hydrographic data collection. Jim Gardiner, a Research Scientist at Valeport, views the technical and commercial challenges in hydrographic operations.



## P. 23 The Hydrographers' Final Search for an Effective SDB System

It is widely and wrongly assumed that the world's coastal regions have been accurately surveyed by modern techniques and that the resulting nautical charts are an accurate reflection of the true nature of the seabed. This optimistic approach is not shared by the world's Hydrographic Offices or the International Hydrographic Organization. Hydrographers have a saying "the world is fully charted, it's a shame that so little is surveyed", and one could add, looking at venerable charts, so poorly surveyed.



## P. 27 Rate of Sea-level Rise Accelerates

With millions of people around the world at risk from rising seas, it is essential to continue measuring the changing height of the sea surface to ensure that decision-makers are equipped to take appropriate mitigating action. Copernicus Sentinel-6, a new satellite, will take the lead in charting sea-level change.



## P. 30 This is NOAA's Plan for Deep Ocean Mapping of US Waters

NOAA is using a systematic approach to map all US waters in support of Seabed 2030 objectives and to contribute to the complete mapping of the world's oceans in the next ten years. Mapping within US waters is a national goal that will only be accomplished through strong coordination and partnerships with other federal agencies, academia, and the private sector.



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## Cover Story

The team prepares for the first remotely operated vehicle dive. The photo was taken during the Windows to the Deep Expedition on the Southeast US Continental Margin. It was a two-part, 36-day telepresence-enabled expedition on NOAA Ship Okeanos Explorer. (Courtesy: NOAA Office of Ocean Exploration and Research, Deepwater Exploration of the Marianas)



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## The Only Way Is Up!



▲ Durk Haarsma.

The Hydro International 2020 Business Guide will try once again to provide some insights into the development of the international hydrographic market. Obviously, there's no such thing as one hydrographic market; there are several – both geographical as well as functional. There's a lot of mapping and surveying going on for purposes that were not served ten years ago and there's a lot of mapping and surveying going in regions where

these activities were not conducted before. The opposite might be true as well. But there are a few developments that are shaping the future of the hydrographic market, at least for the coming decade from 2021-2030 - a decade that has been declared by the United Nations as the Unesco Decade of Ocean Sciences for Sustainable Development.

The end of the decade, 2030, is also part of the ambition of that other big initiative that is underway, namely Seabed 2030. Seabed 2030 has the ambition to map the world's entire ocean floor. Both initiatives will have their impact on the growth of the mapping and surveying industry. Climate change is another big item on the global agenda that will shape the future: if we discover ways to solve energy challenges related to the ocean, the boost in activities will be enormous. The search for shorter, better and more efficient shipping routes is sustaining revenue for quite a few of the survey companies, as is the growing number of offshore wind parks.

On a geographical note, the dazzling growth of the economies in the East, namely India and China, will not only shape the future of the world, but also of the seas and industries relying on them. Anybody who has ever visited one of the megapolises on the coast of one of these countries will have been completely overwhelmed by their scale and undoubtedly must have been impressed by the astonishing achievements delivered, both in urban and coastal planning. And without a doubt, there's a lot of work being done offshore that we can't see and that Hydro International is unable to write about due to sensitivity, and yet it is shaping the economic model of the hydrographic market. It's a mix of positive and rather more gloomy factors that will boost this fine business of hydrography only one way: up!

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## Big Data, Satellites and Artificial Intelligence

Every year, Geomares, the publisher of Hydro International, analyses the user data and behaviour of thousands of members of our global hydrographic and oceanographic community. According to the latest findings of our survey on the use of big data, the application of satellites and artificial intelligence will influence the market and operational activities and are expected to leave their mark on hydrographic and oceanographic work in the coming decade.



▲ Cees van Dijk.

As in the last few years, market research and the opinions of our readers show that the USV market will continue to grow. With North America being the sector leader, the worldwide growing demand for USVs is related to a range of applications, e.g. ocean data and mapping, maritime security and protection of shallow waters. In the Asia-Pacific region, USVs are also intensively used to protect maritime assets, economic zones, maritime borders and deep-sea mining activities.

Compared to the American market, the development and manufacture of SUVs and ASVs in Europe is also undergoing turbulent development. In the September/October issue of our magazine, we published an article on the first circumnavigation of the Arctic waters by an unmanned surface vehicle. I also remember a report on the first crossing of the Dover Strait between the UK and France, one of the busiest seaways of the world, by an unmanned and remotely controlled vehicle. In the near future, our readers can expect strong growth in these kinds of expeditions.

For seafarers who fear that their jobs will be jeopardized, interesting new opportunities are arising due to the growing use of autonomous vessels. In this way, they will be able to exchange their position on the bridge for a job on shore, where they can determine the course of the UAVs with the aid of computers, screens and joysticks. Our annual questionnaire also shows that Hydro International readers expect AUVs, USVs and their applications to dominate the market increasingly.

Last year, in his Business Guide editorial, my predecessor Wim van Wegen predicted that the hydrographic industry would not be entering calm waters. He was expecting exciting times ahead and was obviously looking at it from a visionary perspective. I would like to add that 2020 will, in every sense, again be a challenging year for the hydrographic and oceanographic world.

*Cees van Dijk, content manager*  
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## Featured products, services and stories

Developments are progressing at a fast pace in the world of hydrography and oceanography. Constant innovations ensure a range of innovations. In this edition of our annual Business Guide, there is an overview of eye-catching products, services and the most popular stories. Visit [www.hydro-international.com](http://www.hydro-international.com) and read the full articles online.

## Live Transmissions from the Deep



Live transmissions from unexplored regions deep below the Indian Ocean have underlined the role of reliable, high-speed broadband at sea in expanding knowledge and promoting a more sustainable future.

Increasing our knowledge of the marine fauna that populates the depths and

the physical systems governing ocean behaviour is essential for a scientific community seeking to better understand climate change and assist political strategies to protect the underwater environment.

The remote setting creates challenges for scientists in what are increasingly collaborative endeavours, involving multi-disciplinary teams that are disparately located. Furthermore, researchers are often using advanced instruments that have never before been deployed in the field; if something goes wrong, troubleshooting can be a drawn-out and frustrating process.

► <https://bit.ly/33HX0gy>

## Interdisciplinary Team of Researchers

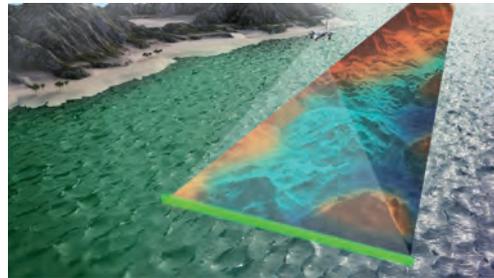


Organisms living in the dark ocean depths rely on the sun-filled surface for food, where phytoplankton can grow. In this regard, there are major fluctuations between warm and cold

years. For this reason, an interdisciplinary team of researchers, under chief scientist Dr Katja Metfies from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), will investigate the marine ecosystem in the survey area comprehensively; from the atmosphere to the water column, to the ocean floor.

► <https://bit.ly/34LS2AY>

## RAMMS Technology Benefits US Navy Mapping System



Fugro's collaboration with Areté to develop the Rapid Airborne Multibeam Mapping System (RAMMS) has resulted in improved maritime domain awareness for the US Navy. The

accomplishment, which was showcased recently during a Naval Oceanography event held at Southern Mississippi's Marine Research Center, demonstrates the value of federal investments in private-sector research, development and commercialisation efforts.

RAMMS is based on Areté's Pushbroom Imaging Littoral Lidar System (PILLS), an airborne seabed mapping capability developed through a US Navy Small Business Innovation Research (SBIR) programme. One of the primary, yet challenging, goals of SBIR programmes is transferring the benefits of federally funded innovations to the private sector. Areté achieved this goal by partnering with Fugro to develop and commercialise RAMMS. As a result, PILLS itself was improved, making it possible to deliver accurate and high-quality hydrographic mapping that can support numerous data applications, including updated nautical charts.

► <https://bit.ly/37YvT4k>

## High-Bandwidth Satellite Service in the Arctic



Kepler Communications, a Toronto (Canada) based communications company, is said to be the first to successfully deliver more than 100 Mbps broadband connectivity, via its nanosatellite network, to

scientists taking part in a massive research expedition in the Arctic region.

Kepler Communications, a pioneer in nanosatellite telecommunication services, has demonstrated the delivery of over 100Mbps connectivity in the Arctic region to the German icebreaker Polarstern, located at around 85 N and home to the MOSAiC scientific expedition. The demonstration marks the first time in history that the central Arctic has been successfully connected through a high-bandwidth satellite network.

Kepler's two polar-orbiting satellites are being used to transfer data for scientists taking part in MOSAiC, the most extensive research expedition ever to the North Pole. MOSAiC is an international expedition consisting of hundreds of scientists and operations crew, which will remain locked into the Arctic ice sheet to study the environment. The team will spend the next 12 months drifting along with the ice sheet, the purpose of the mission being to take the closest look ever at the effects of climate change on the Arctic.

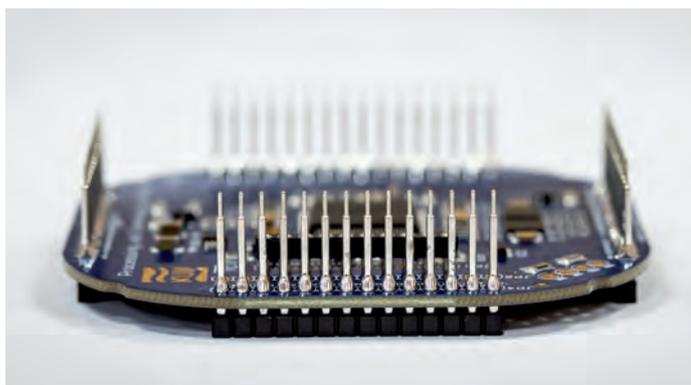
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## Innovative products

For this edition of our yearly Business Guide, we have made an editorial selection of some innovative products. In the regular issues of Hydro International, we choose new products worth highlighting. Don't miss this unique opportunity and send us your latest news on products and services.

### K.U.M. Timing Oscillator Module

TOM300 is a device for precise timestamps over long periods of time. It is a temperature controlled high-precision RTC and features a 32786 Hz watch crystal, which is permanently observed by an MCU. With machine learning techniques, the crystal error is kept within a very small range over a wide temperature range. The device also features a high speed internal clock, which can be used to generate high precision timestamps with a resolution of 1  $\mu$ s. This allows for a very low power consumption when the timestamp feature is not used. With its backup batteries, the time is kept for up to 5 years.



### EvoLogics S2C T 42/65 Underwater Acoustic Modem

S2C T tiny modems are the new generation of light and ultra-compact modems from EvoLogics. The new model T 42/65 features a fully-fledged S2C engine and is compatible with EvoLogics R- and M-modems of the same frequency. S2C T is a great fit for small AUVs and ROVs where seamless integration of hardware and software components is critical.



### All-in-one Solution for Hydrographic Survey



SBG Systems' Navsight Marine Solution offers three levels of performance, including the Ekinox and Apogee IMUs. The new Horizon IMU is based on a closed-loop FOG technology which enables ultra-low bias and noise levels, allowing robust and consistent performance even in low dynamics survey. Navsight comes as a Motion Reference Unit (MRU), providing roll, pitch, and heave or as a Navigation Solution with embedded tri-frequency GNSS receiver, or using an external one. Fusing inertial data with a satellite position in real-time, Navsight INS offers a continuous position in all conditions. Qinertia, SBG's in-house Post-Processing Kinematic (PPK) software, gives access to offline RTK corrections from more than 7,000 base stations located in 164 countries.

### Boost your ROV with Innova MiniMatrix

The Innova MiniMatrix is the response to a growing need for compact ROV systems carrying a larger spread of sensors. Based on the same technology as the successful Matrix MKII+, the MiniMatrix provides a plug and play interface



for a large array of sensors in an extremely compact package. Supporting most dual head multibeam systems available on the market, together with a large number of Ethernet and serial channels and options for analogue and HD video, the MiniMatrix is an ideal system for adding advanced survey capabilities with minimal weight and size requirements.

## Unmanned Surface Vehicle

Seafloor Systems introduces an innovative unmanned surface vehicle. Designed to be more versatile and fit more needs than ever before! Attend Oceanology in London, March 17-19, 2020, to get an exclusive look at this groundbreaking product, providing a single platform for complex bathymetric surveying. Seafloor continues to lead the development of USVs for high-resolution hydrographic survey and looks forward to introducing the next generation of portable USVs to the world's hydrographic community in March.

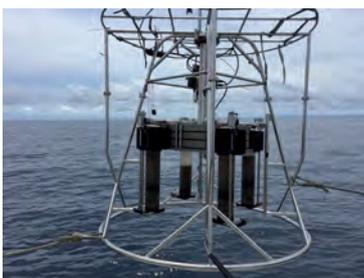


## Triple-hulled Vessel Design

The APACHE6 USV is an integrated solution for 3D bathymetric survey, underwater object positioning, offshore construction, underwater archaeology and wreck rescue. Built around a triple-hulled vessel design and optimized for the Norbit™ multibeam echosounder series, the APACHE6 provides a fully-autonomous survey mode powered by the field-proven CHCNAV absolute straight-line technology to follow a pre-determined course even in adverse current conditions.



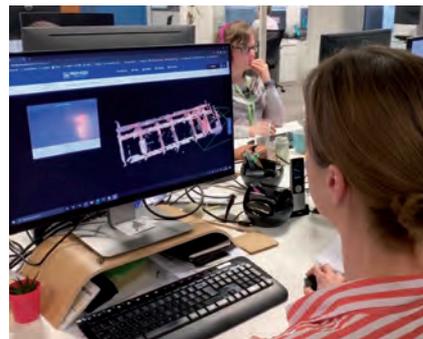
## Modified Multiple Corers for Collecting Sediment Samples



OSIL, a company that provides integrated systems for environmental monitoring in marine applications, introduces the Multiple Corer used for reliably collecting an undisturbed sediment sample from the seabed. It has the ability to consistently

collect up to 12 high quality samples simultaneously, including the sediment-water interface and benthic fauna, meaning it is the primary corer for environmental impact assessment worldwide. The sample preservation is achieved through hydrostatically damping to control the speed of descent of the core tubes into the sediment. OSIL can extend the corer frame to offer an increased sample tube length from the standard 600mm, (most recently for a sample tube length of 1200mm to provide a sediment sample 1000mm long and 200mm of overlying supernatant water), and the corers can easily be fitted with core tubes of varying diameters by swapping out the mounting assembly. The frame of the corer can also be split in two to facilitate shipments where height restrictions are a known issue. The system is constructed from stainless steel and features detachable core assemblies, which enables the core tubes to be removed from the corer for analysis or storage.

## Rovco Launches World's First Live 3D Subsea Streaming Technology



Subsea technology company Rovco (Bristol, UK) has launched 'SubSLAM Live', a 3D Streaming technology which allows users to video and live stream 3D underwater point clouds to any device in the world. The stereo camera technology system sends images and 3D

models of assets from the seabed to a computer browser in any location globally. This offers customers instantaneous access to information as an inspection or construction activity is taking place. The Bristol-headquartered firm trialled the technology earlier in the year with an oil and gas Super Major, at a renewable wind farm, and more recently in 0.5m of visibility at an ex-naval dockyard owned by Offshore Renewable Energy Catapult. During the final trials, the technology was lowered into a seawater-filled dock which contained sample assets from the subsea industry. Engineers were using Rovco's state-of-the-art stereo camera system to capture high-definition video, which allowed them to use the SLAM (Simultaneous Localisation and Mapping) system to build highly accurate 3D point cloud models, while staff back in their office, 300 miles away, directed the ROV while keeping track of the ROV location and operations via their phones and laptops. The calibrated stereo camera system model is automatically scaled.

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*Data Example from Norwegian Fjord (SES-2000 standard, 10 kHz)*

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*SES-2000 smart*

*SES-2000 standard*

- ▶ SBP for deep waters (500 – 11,000 m)

*SES-2000 deep*

*SES-2000 medium*

- ▶ SBP for unmanned vehicles

*SES-2000 autonomous*

*SES-2000 ROV*

## Underwater an AUV Must Rely Upon its Own Sensor Network

# Subsea Autonomy Is Moving Beyond Waypoints

The AUV has been the tool of choice for shallow-water MCM and EOD operations for a number of years. The coverage by popular news channels of unfortunate events, such as the MH370 tragedy, has also shown that the AUV has undisputedly become the tool of choice to carry out salvage operations at extreme depths.

The AUV has no physical link to the surface and the majority of missions are still pre-programmed by a human, which can be time consuming and error prone. Missions are normally a sequence of defined waypoints where the AUV may be required to carry out certain specific manoeuvres to achieve each waypoint.

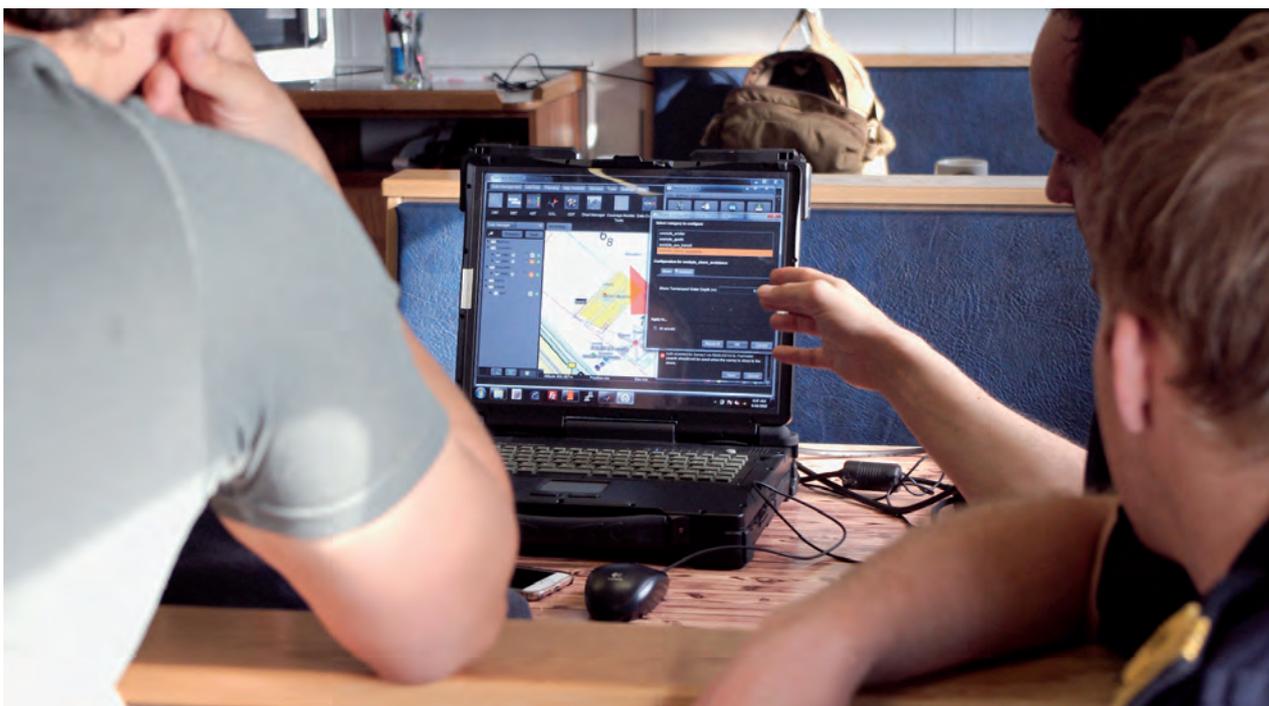
### RECOVERED AND ANALYSED

The AUV operator runs through specific checks to ensure that the AUV is ready before downloading the mission to the AUV's guidance

computer. The AUV is then launched and proceeds to run through each of the assigned waypoints. Once the mission is over, the AUV returns to a predetermined location and is recovered by the AUV operator. When the AUV is back on the vessel, the gathered data is recovered and analysed. This is also the time to swap or recharge the batteries. The next mission can be loaded and the process repeated.

The development of new AUV technology means that many operators are now seeking to

improve the range of tasks that AUVs can tackle and the length of their operation. For example, Oil and Gas is driving a requirement for infield AUV deployment, often as a hybrid AUV/ROV concept. In this scenario, an AUV can reside and operate an oilfield with varying levels of human interaction, with the long-term goal being that the AUV is able to carry out inspection and maintenance tasks. The industry has made significant strides towards this vision but much more work remains to be done. Another active example is the development of large diameter AUVs capable of being deployed



▲ A typical scene in planning missions, this time for multiple UUVs.

for extended periods of time and operating without any human intervention. In this case, it is mainly oceanographic and military requirements that are driving this technology.

### NO EASY USE OF WAYPOINTS

However, these new concepts do not fit easily into the concept of defining a mission as a series of pre-planned waypoints because the operator cannot know, in advance, everything that might occur during the mission. Picture 2 and Picture 3 provide examples where waypoints simply cannot be used. These mission profiles require true adaptive autonomy, where the AUV monitors its surroundings with a range of sensors (e.g. video, sonar, navigation, laser), interpreting the incoming information, matching this against mission goals, and making real-time decisions about the best course.

This rest of this article will look at some of the advances in perception, such as deep learning sensor processing, which are starting to allow truly adaptive autonomy to be deployed onto AUVs. The article will also consider where the technology needs to continue developing, and how this might fit alongside competing concerns such as safety, and security of subsea operations. There are two major challenges that differentiate subsea autonomy from any other domain: navigation and communication. The physical limitations of working underwater are well known, but the lack of global navigation information and the limits of underwater communication provide a unique challenge to subsea autonomy. These limitations also extend

to the sensing technology. As an example, it is possible to cheaply equip a hobbyist drone with a GPS and HD video camera, and have this data stream back to a ground control station. These drones are able to efficiently execute a waypoint-based mission with full human oversight. In contrast, when underwater, an AUV has no global navigation system to leverage and must rely upon its own sensor network to understand the environment around it, posing a far more challenging robotics problem.

### 'EYES AND EARS'

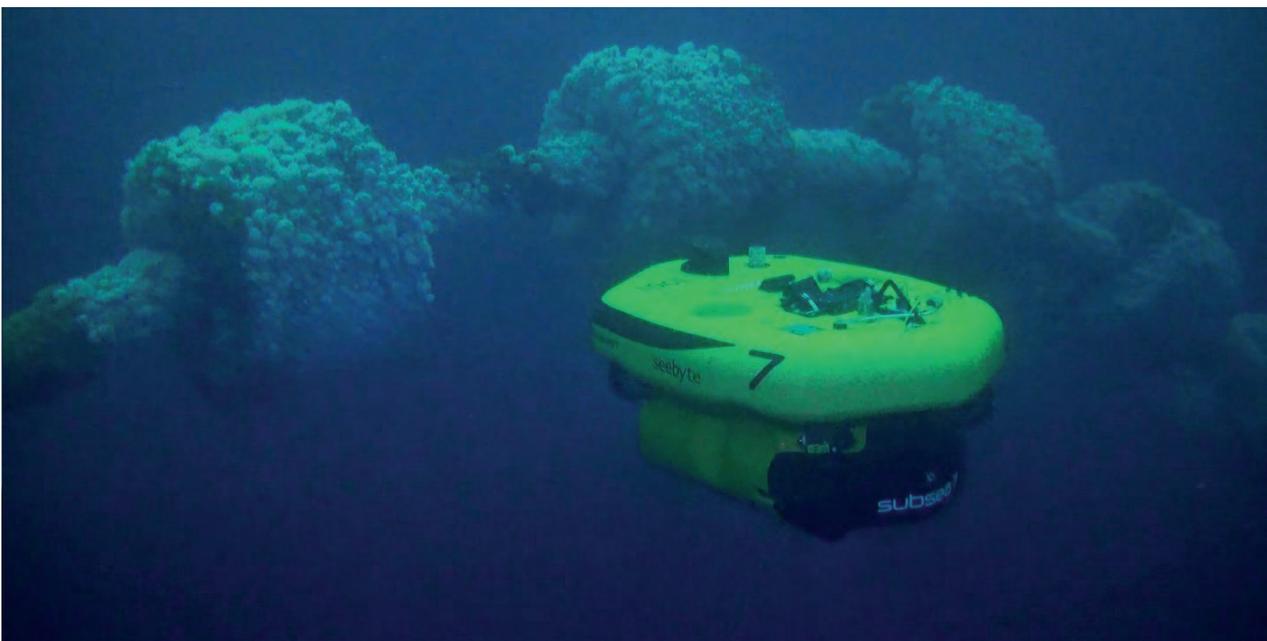
The AUV's perception and navigation algorithms on board the vehicle become the 'eyes and ears' of the AUV, helping it understand its local environment locate itself within that scene, and make decisions. Regardless of how often a human intervenes, or the sophistication of the vehicle autonomy engine, poor quality perception will almost inevitably lead to incorrect analysis, and mission failure.

The recent advances in artificial intelligence (AI) technology, largely driven by Silicon Valley technology companies, has revolutionised the performance of modern machine learning algorithms. Deep Learning is a good, and well publicized, example of these systems. This technique relies on using extensive data sets, tagged with features, that are fed into multi-layer (deep) neural networks. When the technology is applied correctly, there can be an order of magnitude improvement in the performance of the perception algorithm over historical approaches. SeeByte's ongoing work developing sonar-based

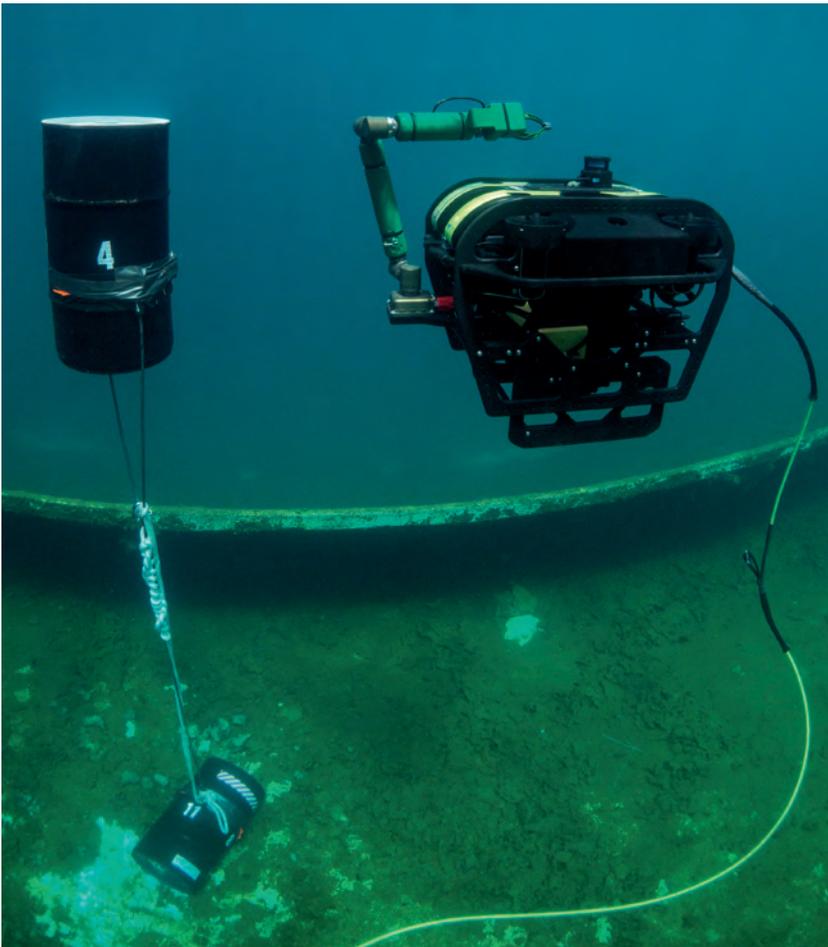
target detection and recognition algorithms has seen this level of improvement, with the most significant improvement seen in the reduction of false positives reported by the algorithm. There are undoubtedly numerous other advances in automated perception, from applications such as autonomous cars, that are also adaptable to the subsea domain and should eventually be leveraged.

However, developing the deep learning target detection and recognition algorithms flagged a potential issue in subsea applications – the volume of required data. Deep Learning approaches, like most modern AI algorithms, rely on terabytes of data for training. Ideally, the training images should contain possible variations in appearance of the objects being identified, including pose, lighting and environmental effects. The good news is that alongside Deep Learning, Silicon Valley has also advanced Deep Fake technology. This is the ability of multi-layer neural networks to learn how to "fake" data with remarkable degrees of accuracy.

SeeByte has pioneered the ability to take a small data set of real subsea images, and use this to train a Deep Fake system. The Deep Fake technology is then used to produce a much larger data set, allowing the Deep Learning target system to be trained on a mix of both the real and fake data. Picture 4 provides an example of fully synthetic side-scan. The improvements in performance were remarkable and the quality of perception, coupled with ever improving sensing technology, starts to allow



▲ Subsea 7's AUV performing a mid-water riser inspection using real-time sonar processing. (Courtesy: Subsea 7)



▲ A small ROV performing precise manoeuvres relative to an object in shallow water. (Courtesy: NIWC)

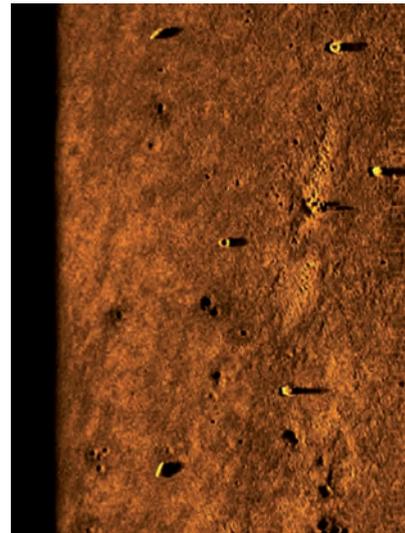
more adaptive AUV missions to be routinely used.

### DEEP LEARNING PERCEPTION

This example does raise one obvious concern because the deep learning perception is trained by the deep learning simulator. While the initial results offer a remarkable step improvement in performance, the difficulty is in understanding where and why the system will fail. This is normally termed predictability and explainability. There is significant research into these aspects of artificial intelligence, and it is hoped that the situation will improve as operator trust in autonomous systems is directly linked to predictability and explainability. This issue represents the broader problem of safety cases involved in deploying artificial intelligence. While the issue of safety cases is much more complex than a short article can address, it is clear that a gradual introduction of adaptive autonomy is going to be crucial to success. The best parallel is the autonomous car, which has been gradually introducing technology, starting with warning technologies (proximity detection), before moving to assist technology (adaptive

cruise control). These assist technologies are slowly increasing in complexity (automated lane assist), as trust and understanding of the systems grow.

Looking back through the history of the ROV introduces another aspect where technology needs to continue developing. The standardisation of many subsea interfaces, mainly mechanical and electrical, dramatically increased the number of tasks that an ROV could accomplish. This standardisation is now needed at the software component level, to allow better interoperability of AUV technology. This applies to software interfaces both within the vehicle and between other pieces of subsea equipment. Another way of looking at this is to take a practical example where a commercial company has carried out extensive investment that has led to the development of a riser inspection autonomy behaviour, and this has been demonstrated on a single AUV. Having invested heavily in this autonomy behaviour, it is preferable that this autonomy behaviour can be used wherever required. In the same manner that a different INS can be fitted to an ROV



▲ Fully synthetic side-scan image.

should the job require it, an AUV should also be capable of being fitted with the appropriate autonomy behaviours to perform the task. This standardisation is going to be a slow process, particularly given that autonomy technology is still maturing at a rapid rate. However, it is important that the broader industry acknowledges that flexibility is vital to the continued success of the AUV, and that building flexible toolkits of software technology is a crucial part of this success.

In conclusion, it is clear that the real value of AUV technology is finally starting to be realised in a broader set of operational circumstances. However, in a similar vein to the introduction of ROV technology in the 1970s, there needs to be a gradual maturing of the technology, with incremental improvements tackling additional scope step-by-step. ◀



**Chris Haworth** joined SeeByte in 2010 to help drive the transition of autonomy capability from research through to operational use. Chris is currently Commercial Director for SeeByte, and is responsible for the future direction of SeeByte's product portfolio.



**Gavin Irvine** has worked at SeeByte for over six years. He has been involved with the development of subsea autonomy, and is currently the Engineering Manager in charge of SeeByte's software development for Subsea 7's Autonomous Inspection Vehicle (AIV).



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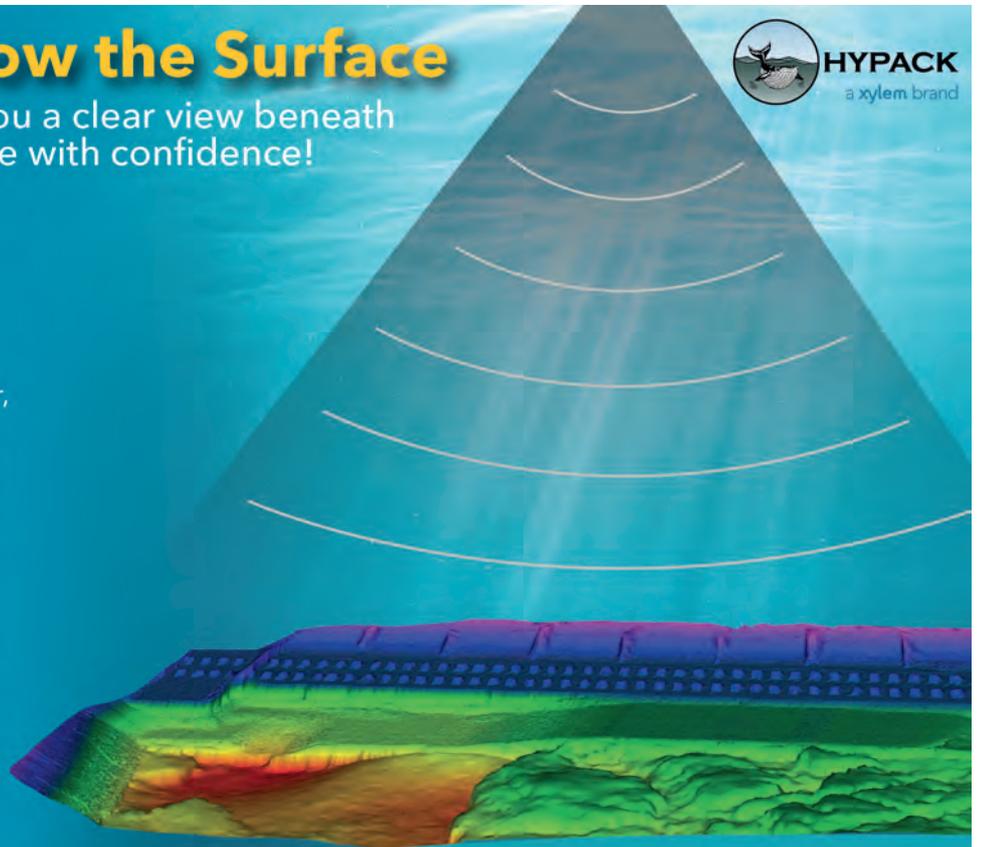
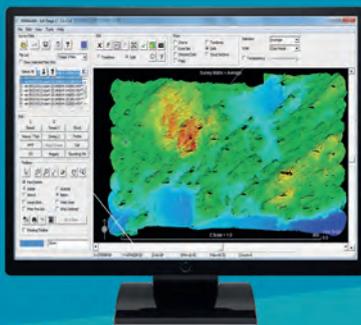
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## Growing Number of Initiatives on Fighting Floating Plastic

# Can We Stop the Pollution of Our Oceans?

Are we massively destroying our oceans? It's hard to imagine, but continuous flows of plastic and other waste are threatening the primary work area of hydrographers and oceanographers. I am saddened by reports of the drama that is taking place, but luckily there are many initiatives that will hopefully turn the tide. Here is an overview.

In 1950, the world's population of 2.5 billion produced 1.5 million tons of plastic; in 2016, a global population of more than 7 billion people produced over 320 million tons of plastic. This is set to double by 2034, according to Surfers Against Sewage, a community dedicated to the protection of oceans, waves, beaches and wildlife. If we continue to pollute at this rate, there will be more plastic than fish in the ocean by 2050.

There are approximately 51 trillion microscopic pieces of plastic in the seas, weighing 269,000 tons. That is about the same as 1,345 adult blue whales. And 500 times the number of stars in our galaxy. Two-thirds of the plastics come straight from land-based sources: litter being left on the beach or washed down rivers and drains or litter being dropped in towns and cities. It comes from industry spills, badly managed landfill sites and bins near the coast, or from being flushed down the toilet. The remainder is lost at sea, such as containers going overboard or lost fishing gear. Think about this: a plastic bag is used on average for 15 minutes, yet could take 100 to 300 years to fragment.

By analysing the waste found in the rivers and surrounding landscape, researchers were able to estimate that just ten river systems carry 90% of the plastic that ends up in the ocean. Eight of them are in Asia: the Yangtze; Indus; Yellow; Hai He; Ganges; Pearl; Amur; Mekong; and two in Africa, the Nile and the Niger.

### Initiatives and projects

Worldwide, there are several larger and minor initiatives and projects to rid rivers and oceans of plastics. One of them is the Clean Ocean Project, founded on the Canary Islands in 2000:



▲ Conveyor belt of the Interceptor in action in Malaysia (courtesy The Ocean Cleanup).

it is a donation-based NGO dedicated to raising awareness around the pollution of oceans. They also regularly organize beach cleanings and encourage the avoidance of plastic bags and other single-use plastic items.

Another one is The Ocean Cleanup, founded in 2013 by 18-year-old Boyan Slat from the Netherlands. The main purpose of this project is to intercept plastic waste and extract it from the seas. Recently, they launched the Interceptor, focused on cleaning rivers.

Also from the Netherlands is a project called The Bubble Barrier. It is a curtain of air bubbles, created by pumping compressed air through a perforated tube which is placed on the bottom of a canal. The rising bubbles form an upward

current, which brings the plastic to the surface of the water. The company claims that the Bubble Barrier does not interfere with shipping nor with the passing of wildlife.

The most notable initiative, at least where the appearance of the device is concerned, is Mr Trash Wheel. Sustainably powered and built to withstand the biggest storms, Mr Trash Wheel uses a unique blend of solar and hydro power to pull hundreds of tons of trash out of the water each year.

These are just a few of the projects and initiatives we have described in our magazine and on our website. In 2020, we'll follow the progress that is being made and we'll be happy to pay editorial attention to any new initiatives. ◀

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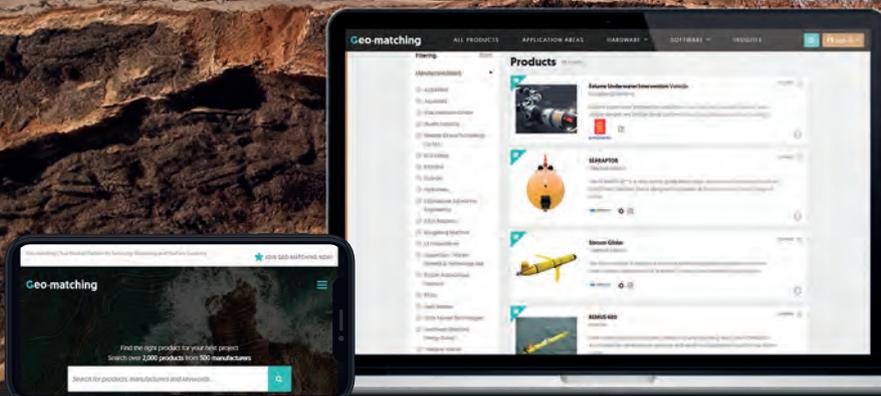
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## 5 Questions to...

# Mark Gundersen of Marine Advanced Robotics



Mark Gundersen is the CEO of Marine Advanced Robotics, a leading provider of maritime robots. He is on a mission to transform the maritime industry with Marine Advanced Robotics' WAM-V® technology: a data-enabling, agile, and affordable Autonomous Surface Vessel (ASV). WAM-Vs maximize ROI on existing ocean activities and open up new opportunities to collect the critical ocean data needed for science, commercial and government stakeholders. As CEO, Mark has focused on applying the benefits of the WAM-V technology to solve market needs and create new business models for ocean data collection. Mark has over 30 years of experience at sea in multiple locations across the globe. He has logged over 3,500 nm with the WAM-V technology. A graduate of Stanford University, Mark holds a patent on the WAM-V technology and is a member of the American Society of Naval Engineers. Mark, his wife and two children live aboard a boat in the Bay Area. His hobbies include boating, SCUBA diving, skiing, and snowboarding.

### What will be the most important hydrographic or oceanographic challenges in the near future?

From a big picture perspective, SeaBed 2030 is one of the most important hydrographic challenges. We need to leverage all the tools at our disposal to achieve this goal. I believe unmanned systems have to play a big role if we are going to make it.

### What is your impression of the evolvement of the hydrographic and oceanographic market in 2019?

Continuing automation of hydrographic survey equipment and software. However, at the end of the day, these are tools in the toolbox for hydrographers and we need to make sure we are getting their feedback, iterating and delivering the most useful tools we can.

### What will be the most challenging market circumstances in 2020?

From an ASV/USV manufacturer's perspective, I believe we have to make sure our solutions are affordable and that they don't increase the number of personnel required to operate. In

other words, the ROI has to be clear and substantial.

### How will your company address them?

This past summer we teamed up with eTrac, Inc., Sandpoint Hydrographic, QPS and R2Sonic to demonstrate a multi-vessel collaborative autonomy approach to hydrographic survey. Two of our WAM-V 16 ASVs worked autonomously with a crewed survey vessel on a NOAA hydrographic survey project in a true force multiplier role. We showed that the same size survey crew that would normally be on the crewed survey vessel could also manage the two WAM-V 16 ASVs and associated multibeam sonars. In 2020, we plan to add additional WAM-V ASVs to the swarm without increasing personnel.

### What is your vision on the advances in unmanned (sub)surface vehicle technology?

We see an immediate benefit to using our WAM-V ASVs in the force multiplier role. Crewed survey vessels can leverage our technology to greatly expand their data collection without increasing personnel.

#### Company Profile

Marine Advanced Robotics, Inc. (FKA Marine Advanced Research, Inc.) was founded in 2004 by a small group of Silicon Valley innovators. In 2007, the 100 ft (30 m) Proteus was launched in the San Francisco Bay, introducing the WAM-V (Wave Adaptive Modular Vessel) to the world. For the past decade, MAR has continued to design, manufacture, and refine the WAM-V technology. WAM-Vs currently operate in 10 countries and range in size from 2.5m to 30m in length and their capabilities include:

- Hydrography
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- Systems Delivery
- Oceanography
- Marine Salvage
- Dredging Surveys
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MAR is creating the future of marine robotics. Their WAM-V® is a technological leap forward in ASVs (Autonomous Surface Vessels) with proven effectiveness to support multiple marine industries. WAM-Vs increase operational capabilities, decrease risk, lower cost, save time and can be disassembled for economical shipping anywhere in the world.

## 5 Questions to...

# Dinesh Babu Sutti Omnath of K.U.M.

Dinesh Babu Sutti Omnath is now stepping in as Director of K.U.M. India. He will be looking to expand existing business opportunities in the science market and also looking at new and challenging opportunities in the Asian market.

Dinesh is the founder director of Samhitha Marine Private Limited, a professional business support service organisation based in Chennai, India and focused on the marine and oceanographic domain. It operates as a technical associate for world leading companies – helping them define strategy, business development and in-country support.

With 28+ years of diversified experience, gained from customers and associates, Dinesh believes the going will be challenging, but resourceful. His understanding of business is unique, from a global and Indian perspective; catering to needs and translating them to the requirement and approach, presenting the best of business cases.

“Strategizing is the key to success; our team offers required inputs on market intelligence to both customers and principals alike, enabling them to take appropriate decisions”, he says.

### **What will be the most important hydrographic or oceanographic challenges in the near future?**

Studying the ocean on a global scale poses new challenges, and opportunities will be one of them. Ocean observation on a global level will be possible when the oceanographers, hydrographers and governments around the world work together. Coastal measurements, alongside deep ocean observation, will be the need and challenge; managing data will be much more complex. Data management in the

cloud, with versatile software, will be the next paradigm shift.

### **What is your impression of the evolution of the hydrographic and oceanographic market in 2019?**

I think it is the evolution of many new autonomous measurement systems – AUV, ROV and ASV. This is a new market which is systemically evolving.

### **What will be the most challenging market circumstances in 2020?**

I expect these will involve consolidation. Many small companies are emerging and big companies may take this opportunity to consolidate their activities. Stabilisation and sustainable growth will be the challenge.

### **How will your company address them?**

K.U.M. is focused on its niche territory, Ocean Bottom Seismometers (OBS) and services. Rather than selling OBS in a niche market, our approach involves delivering turnkey and end-to-end solutions, leasing OBS and the delivery of data. We are confident this unique approach will help us get into new market segments that have not otherwise been tried and tested.

### **What is your vision on the advances in unmanned (sub)surface vehicle technology?**

The autonomous movement of otherwise stationary underwater observing systems: unlike



AUVs and ASVs, they need much more complex hardware and software, AI, and a robust mechanical and electronics interface. Innovation knows no bounds – we will try and make things that no-one else has made.

#### **Company Profile**

K.U.M. Umwelt- und Meerestechnik Kiel GmbH stands for innovative quality products, professional services and custom-built solutions in marine research. As a partner in maritime science and economics, this medium-sized company, founded in 1997 and located on the Baltic Sea, is in great demand internationally.

The continuous development of Ocean-Bottom-Seismometer-Systems for the detection of subsea seismic movements (seaquakes) is an important focus. The use of titanium, a light, corrosion-free, pressure-proof material of high quality, offers excellent conditions for deep-sea operations up to 6000m and more.

In addition, K.U.M. provides comprehensive services, including operators on research vessels, instrument training, individual consultancy and realization of special requirements in close collaboration with the customers. In doing so, the highly motivated and committed K.U.M.-team – some of whom have worked for more than 30 years in marine engineering – guarantee first-class services as well as innovative thinking and action.

## 5 Questions to...

# Thomas Buret of iXblue

Thomas Buret joined iXblue in 2002 as an R&D engineer and is now Chief Operating Officer of the company. He was previously in charge of iXblue's space and maritime activities and was head of the navigation department for over two years before moving on to his new role as COO in 2019.

### **What will be the most important hydrographic and oceanographic challenges in the near future?**

How do we cope with the challenges of efficiency? Competitiveness lies behind this term, of course, but improved safety, a smaller environmental footprint and enhanced technical capacities are also involved. We will have many challenges to overcome, and we can count upon the ongoing technological trends to help us out, but this will require a strong mobilization of all our assets: engineering, regulation, applicative expertise, and services. This is also the time for partnerships and collaboration rather than frontal competition.

### **What is your impression of the evolvement of the hydrographic and oceanographic market in 2019?**

Seen from iXblue, the market is growing! We have observed a steady increase in our customer's capacity to invest. It is an interesting time when the market requires competitiveness first, while still striving to push the boundaries of what is possible. Indeed, there is room for both incremental and disruptive improvements as long as they make a real difference and bring added value.

### **What will be the most challenging market circumstances in 2020?**

As I said, the market is growing while becoming more and more mature. We need to tackle new technical challenges as we are always required to push the limits of our technologies and conduct more efficient and safer operations. In order to do this, we have to introduce innovation to the

market quickly, while at the same time ensuring operational excellence.

### **How will your company address them?**

Through technological excellence. Indeed, iXblue has always been a step ahead in terms of performance and functionalities, and we are constantly progressing to keep this edge. Because we have complete mastery of all the components that are integrated into our systems, we are able to be agile and to push the limits of the technologies we develop to have them reach new peaks of performance. This is why we are considered as a leading actor in the autonomous revolution that is taking place today. Over the years, we have been providing reliable and robust solutions that have enhanced the autonomy of unmanned platforms, bringing about more efficiency and safety to the industry. iXblue indeed covers the full value chain of navigation, from the manufacturing of advanced sensors, such as inertial navigation systems, imagery solutions or subsea positioning systems, to navigation software and artificial intelligence algorithms. A perfect example of what we can achieve when putting all our technologies together, in order to bring added value to the market, is our own Unmanned Surface Vessel (USV) DriX, which has proved to be a real game changer in the geosciences and offshore industries.

### **What is your vision of the advances in unmanned (sub)surface vehicle technology?**

The market is now accepting the relevance of autonomous platforms in increasing the



efficiency of hydrographic and oceanographic operations. As a consequence, AUVs & USVs are constantly extending their operational capacities, and their field of operations. We have been directly observing and benefitting from this trend, following the amazing response by our customers to our DriX USV, which has proven to be a great and versatile platform for many operations, from hydrographic surveys to the monitoring of underwater assets. We remain convinced that we are still at the very beginning of the autonomous revolution and that we are very well placed to continue this journey with our customers.

#### **Company Profile**

iXblue is a global high-tech company specializing in the design and manufacturing of advanced marine, photonics and autonomy technologies. The group in-house expertise includes innovative systems and solutions devoted to inertial navigation, subsea positioning, underwater imaging, as well as shipbuilding and test & simulation. iXblue technologies support civil and defence customers in carrying out their sea, land and space operations with maximum safety, efficiency and reliability. Employing a workforce of 650 people worldwide, iXblue conducts its business in over 60 countries.

## A view of hydrographic technology and the market for 2020

# “Blue technology industries will help the expansion of the hydrographic market”

In the last decade, there has been a steady march towards the automation of hydrographic data collection. Jim Gardiner, a Research Scientist at Valeport, views the technical and commercial challenges in hydrographic operations.

In terms of multibeam technology, we've seen continual advancements from the main players such as Teledyne Reson, Kongsberg, R2Sonic and the emergence of Norbit. Alongside this, there has been a steady improvement of GPS, inertial positioning systems and acquisition/processing software. As the capability of these systems has improved, it has placed a focus on the importance of accurate and reliable sound

velocity data. To achieve accurate bathymetry, knowledge and understanding of your sound velocity environment is critical, particularly in coastal and estuarine environments.

### VENDOR AGNOSTIC

All multibeam systems need Sound Velocity data at the transceiver, some have chosen a tightly coupled solution, but most have opted to

stay vendor agnostic. Taking regular sound velocity profiles through the water column to correct for refraction has always required considerably more effort. Valeport developed its SWiFT Sound Velocity Profiler to make this process as simple as possible for the surveyor, whilst maintaining the quality required to meet the highest of survey specifications. A fundamental part of the design process was to eliminate or automate any repetitive steps. GPS was integrated to automatically geo-locate and time synchronize any data collected.

### AUTOMATIC PROFILE ACQUISITION

Bluetooth LE was chosen to allow for seamless and automatic connectivity with both PC and mobile platforms. Firmware and operating modes were simplified, alongside software providing automatic profile acquisition and translation into a wide range of industry data formats. Longer endurance was allowed for with a large battery capacity and ultra-low power sleep modes.

Stopping a vessel to take a profile is both time consuming and, in many cases, impractical. Deployment systems such as the Teledyne Oceanscience RapidCast winch allow for the automated acquisition of profiles whilst the vessel is underway and can be used with the SWiFT in shallow water, and the RapidPro SVT in deeper water to acquire profiles up to 500m depth whilst underway.

### TRADITIONAL HYDROGRAPHIC SURVEYOR

The features that have made the SWiFT popular with the traditional hydrographic surveyor have also made it popular with the new raft of autonomous survey vessel developers such as XOcean, Seafloor Systems and Unmanned Survey Solutions for integrations within unmanned survey platforms. Machine to Machine communications allow for interaction to take place between systems without human



▲ Profiling from an unmanned vessel presents its own set of unique challenges.



▲ The platform has an endurance of up to 18 days.

intervention, as developers strive for the ability to survey for extended periods in hostile environments, beyond the capabilities of traditional manned systems. Profiling from an unmanned vessel presents its own set of unique challenges and Valeport has been actively working with developers to overcome these issues.

#### ENVIRONMENT IMPACT

Valeport collaborated with XOCEAN's Irish sea mission in October 2018 to deliver a step change in the cost, environmental impact and safety of collecting data, with the specifically designed XO-450 platform. Valeport's MiniSVS and SWiFT SVP were used to enhance the resolution and accuracy of the multibeam system, which was operated from the USV in a range of weather conditions and sea states, as well as a variety of inshore and offshore locations. XOCEAN's mission demonstrated the platform had an endurance of up to 18 days and a range of 1,512 nautical miles, evidencing it as a flexible system capable of delivering data for a wide range of applications which was ideal for performing safe and cost-effective bathymetric survey work.

#### ACCESSIBILITY, PACKAGING AND INTERFACING

I think the driving force behind our product development for the hydrographic market will not solely be in the sensor technology, which we will always continue to refine and improve, but in accessibility, packaging and interfacing - improving the way our instruments can be interacted with by both human operators and machines. The SWiFT was our first instrument with rechargeable battery technology and looking to the future, the logical next step would be wireless charging, although this is not without some technical challenges. The adoption of technology from other industries (mobile phones particularly) is a double-edged sword.

It allows for ready and easy integration of technology such as GPS and Bluetooth, but technology moves so quickly that parts rapidly become obsolete and further development is required to keep up to date. Inevitably, as new blue technology industries continue to evolve, there's no doubt these sectors will help the continued expansion of the hydrographic market and fuel future innovation. ◀



**Jim Gardiner** is a Research Scientist at Valeport Ltd. He holds an MSc Applied Marine Science and a BSc (Hons) in Ocean Science – both from Plymouth University – and he is a Chartered Marine Scientist (IMarEST). Jim started his career as an Oceanographic Analyst at UKHO before joining Valeport as Product Manager in 2008. In 2017, he moved into a more R&D focused role as a Research Scientist, developing, testing and trialing new sensing technologies.  
✉ [jgardiner@valeport.co.uk](mailto:jgardiner@valeport.co.uk)

#### About Valeport

Valeport is a UK-based manufacturer of oceanographic and hydrographic instrumentation. The company designs and manufactures instrumentation for the oceanographic and hydrographic communities with a worldwide customer base that includes the defence, environmental, oil and gas, renewable energy, construction and dredging sectors. It has supplied to the subsea sector since it was established in 1969. Now an independent, family-owned business, Valeport employs more than 90 people from their base in Devon (UK) and works with a global network of agents.

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## The Hydrographers' final search for an effective SDB system

# Sentinel-2 Coastal Charting Worldwide

It is widely and wrongly assumed that the world's coastal regions have been accurately surveyed by modern techniques and that the resulting nautical charts are an accurate reflection of the true nature of the seabed. This optimistic approach is not shared by the world's Hydrographic Offices or the International Hydrographic Organization. Hydrographers have a saying "the world is fully charted, it's a shame that so little is surveyed", and one could add, looking at venerable charts, so poorly surveyed.

Hydrographic Offices and the IHO have been looking for years to find an affordable method to fill the coastal gaps still affecting large sections of the world, especially in developing countries that cannot practically rely either on costly ship-based sonar or on more reasonable Lidar surveys. Great hopes have been placed in the possibilities offered by Satellite Derived Bathymetry (SDB) which had been identified by Robert Ward, the former IHO President, as one of the two most promising survey methods for the future.

### FOUR TEST SITES FOR AN ESA PROJECT

The European Space Agency (ESA) Sentinel-2 Coastal Charting Worldwide project was conceived to research whether the Sentinel-2 constellation has the capacity to fully

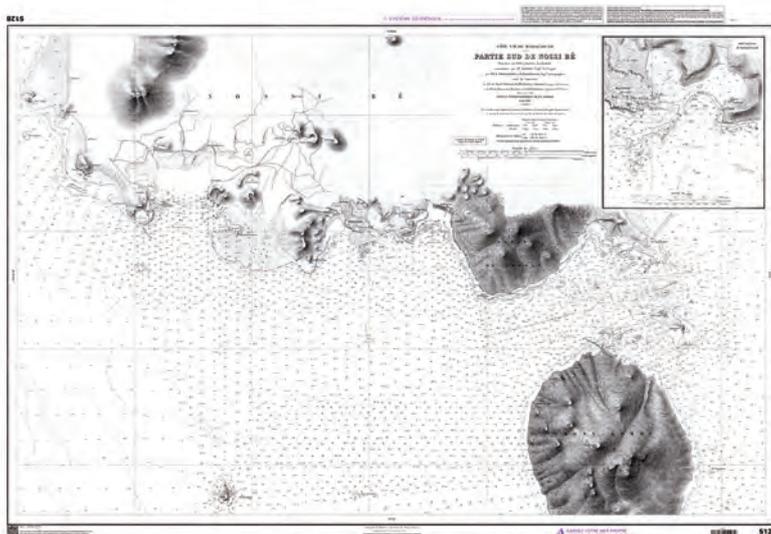
reconnoitre the coastal gaps with reliable results, which would be obtained at an affordable price.

Until recently, the exploitation of earth observation in the coastal domain had been limited by the difficulty of obtaining the right satellite image. For instance, in the early nineties, it could have taken SDB pioneers several years to select a unique, cloud-free, unglinted SPOT scene, qualified for further processing. With the advent of high-resolution imagery and a larger choice of commercial Very High Resolution (VHR) satellites, SDB providers were later able to offer "best available" services, but their costly solutions were prohibitive for many nations where such a service would deliver the greatest benefit and so the ARGANS

SDB team of hydrographers and EO scientists were determined to test other options.

VHR satellites yielding 0.5 metre resolution pixels with their associated costs might be desirable to depict parking lots and cadastral delineations, but they are not really adapted to marine coastal environments characterised by low signal-to-noise ratio (S/N) in remote sensing because of light attenuation in the water (the smaller the resolution, the smaller the S/N), and by broader natural structures, the smallest of which, e.g. coral pinnacles, are never smaller than 100 sq. metres. Thanks to this ESA project, ARGANS has focused on the latest available Copernicus constellation and has systematically compared Sentinel-2 Multi Spectral Imager (MSI) sensor performances against VHR imagery. Both systems have been found to deliver discrete but complementary results in some circumstances, but the Sentinel mission frequent revisit time has enabled unique insights to be achieved at a minimum cost.

The amazing conclusion of the ESA project is that what might have been considered as a cheap "good enough" solution in many cases prove to be much better than the "best available", due to the significant improvements brought by the Sentinel-2 constellation five days revisit time, coupled with its exceptionally calibrated 13 band MSI with excellent signal to noise ratios delivered by the sensors. Analysts are now provided with a large database of usable imagery over the coastal belt which has been demonstrated to deliver excellent results as exemplified by the cross section above. There is a constant trade-off between precision and accuracy delivered by the Sentinel mission at the expense of resolution, but the



▲ Nosy Be official chart, surveyed in 1899, published in 1902 and still in service.

stacking of images has demonstrated that this trade off very much favours the Sentinel approach.

**IS SDB PROPER SCIENCE OR RATHER THE ART OF PARAMETERISATION BY EXPERIENCED MARINE CARTOGRAPHERS?**

It should be stated at this stage that SDB is not a pure science, but the analysts' art of interpreting a most likely and probable reality, made by a system admitting an almost unlimited number of unknowns for three equations (atmospheric corrections, water column optical properties and seabed reflectance) provided by the satellite instruments' Blue, Green and Red spectral bands.

To make sense and choose the parameters most likely to provide a reliable solution, the ARGANS Ltd SDB team comprises a unique mix of mathematicians, expert marine remote sensing scientists, IHO qualified Charge hydrographers and maritime cartographers with a strong pedigree in the marine domain. This multidisciplinary approach ensures that an appropriate interpretive environment supports the scientific analysis and prioritises safety of navigation as recommended by the SOLAS Convention.

**THE FOUR IHO-COMPLIANT DEMONSTRATORS**

This ESA test study focused on four coastal regions with differing conditions delivering four demonstrator products. Puerto Morelos, Mexico, was selected to compare an existing chart produced by commercial VHR imagery. Nosy Be, Madagascar was selected as an area covered with an antiquated survey to test and exploit fully the Sentinel-2 data archive and apply ARGANS latest algorithms, the Statistical and DOP methods, only made possible by Copernicus.

Lampi Island, Myanmar, was chosen to show the effectiveness of SDB within turbid waters (an uncharted site previously used to test ESA's Sen2Coral project) and finally Coral Harbour, Canada, to explore how SDB with Sentinel-2 would perform in the Arctic waters of the Hudson Bay and the Northwest passage. The team employed two physics-based processors

both using the same Radiative Transfer Equations (RTE) which, when identically parameterised, yielded the same results for similar performances with an ordinary laptop, i.e. 15 minutes per model as opposed to 8 to 10 hours for a noisy 50 cm pixel VHR image.

**TWO NOVEL ALGORITHMS TO PROCESS AND VALIDATE SENTINEL-2 "PERFECT IMAGES"**

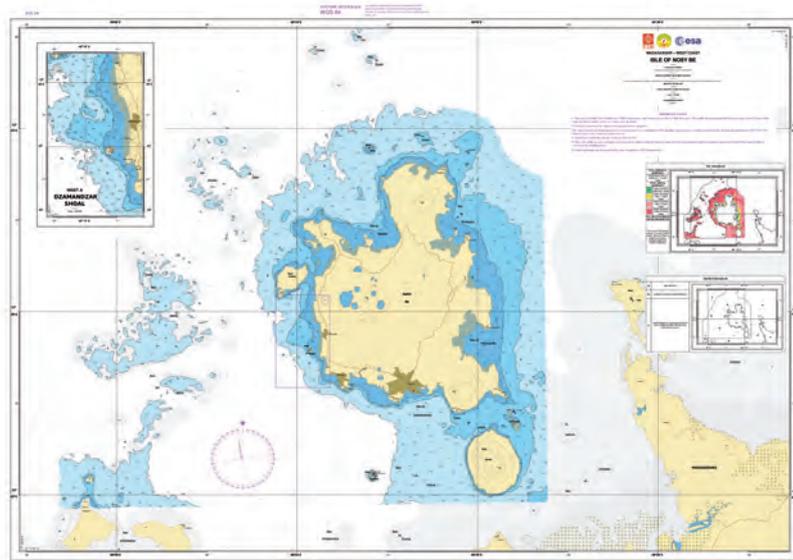
The "Statistical method" consists of calculating weighted averages over each specific site to produce one bathymetry data set from a large stack of normalised images, 53 in the Nosy Be test site.

Because of the existence of several possible solutions to the Radiometric Transfer Equations and the non-gaussian distribution of modeled

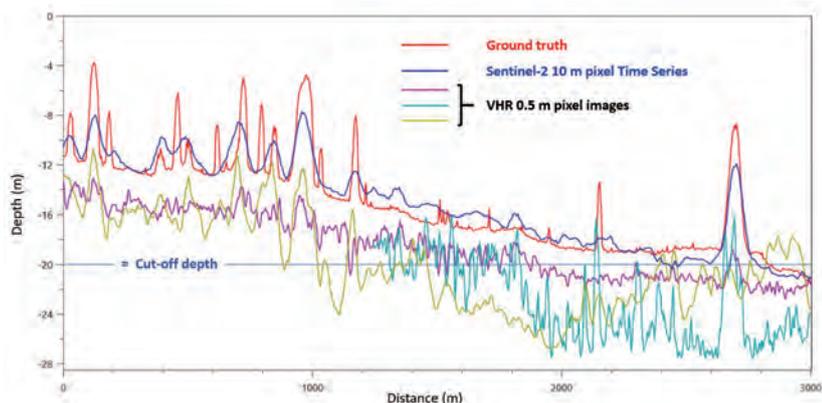
depths, validation criteria have to be applied, backed by mathematical developments and calculations of probabilities to provide occurrence percentages.

The "statistical method" allows ARGANS Ltd to take advantage of Sentinel-2's data catalogue and remove errors from sediment plumes, clouds and other anomalies to yield what the satellite community is starting to call the 'Perfect Image'.

To complement the statistical methodology, ARGANS Ltd has also developed the Depth of Penetration (DOP) algorithm as a validation tool to determine the theoretical maximum detection threshold, based purely on the colour of the ocean. As a very simple validation check, any modeled depth deeper than the local DOP



▲ The Nosy Be 2019 ESA Demonstrator charted in accordance with IHO standards.



▲ Statistically optimised Sentinel-2 cross section versus 0.5 metre pixels VHR images.

should be flagged, double-checked and most likely suppressed. DOP calculations measure the water transparency down to the “Secchi” extinction depth. This optical DOP threshold developed for satellites can be applied to active optical systems such as LIDAR and, as suggested by the IHO, could be extended globally to the C-55 Status of Hydrographic Surveying and Nautical Charting Worldwide to determine whether optical systems can be utilised.

### ABOUT THE COPERNICUS SENTINEL A & B CONSTELLATION

The Copernicus Sentinels are a fleet of dedicated EU-owned satellites, designed to

deliver the wealth of data and imagery that are central to the European Union’s Copernicus environmental programme. The European Commission leads and coordinates this programme, to improve the management of the environment, safeguarding lives every day. ESA is in charge of the space component, responsible for developing the family of Copernicus Sentinel satellites on behalf of the European Union and ensuring the flow of data for the Copernicus services, while the operations of the Copernicus Sentinels have been entrusted to ESA and EUMETSAT. ◀

#### Acknowledgements:

The work featured in this story was funded by a grant from ESA, with Dr Olivier Arino being the ESA Technical Officer; it was undertaken by the SDB team within ARGANS Ltd and led, amongst other senior specialists, by the Earth Observation scientist Joe Avis.



#### Joseph Avis MSc

Joseph Avis received his BSc in Physical Geography before completing his MSc in Remote Sensing and GIS at Aberystwyth University, Wales, UK, in

2017 and 2018 respectively. His MSc thesis was about researching the impact of suspended sediment on mangrove forests through remote sensing data. In 2018, Joseph joined ARGANS as a Junior Earth Observation Scientist where he worked on a range of Earth Observation projects. Joseph has since taken on the role of Technical Lead of ARGANS Satellite Derived Bathymetry projects working with ESA and a national hydrographic agency where he manages a small production team split between Plymouth, UK, Brest and Sophia-Antipolis, France. His interest lies within the application of remote sensing for hydrological and geomorphology applications.



#### Martin Jones FIMarEST, CMarSci,

During his military career, he was the senior policy lead negotiating the shared objectives for the Allied System for Geospatial Intelligence (ASG), a

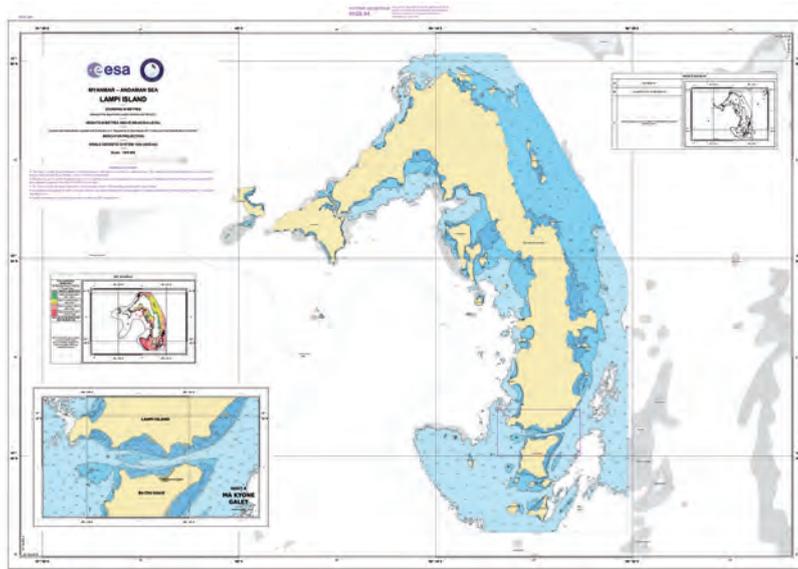
geospatial intelligence burden-sharing collaboration between the US, Australia, Canada and New Zealand. He provided governance and technical advice at ministerial level for the UK Hydrographic Office, represented MoD with respect to the Met Office inter-governmental Strategy Group, the National Aeronautical Information System within the Civil Aviation Authority and was the UK Board member to the EU Satellite Centre. During the first part of his naval career as an IHO Cat A Charge Hydrographer he commanded three warships, HMSML GLEANER, HMS QUORN and HMS ECHO. He is a Fellow of the Institute of Marine Engineers, Scientists and Technologists, a Chartered Marine Scientist and Younger Brother of Trinity House



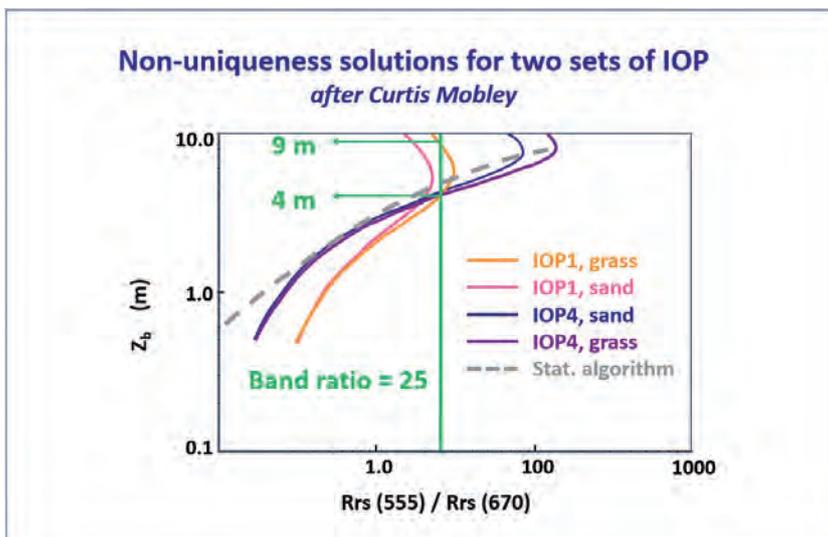
#### Jean Laporte, KLH,

A former Naval Aviator and senior Cat A Hydrographer, Jean Laporte is currently Chairman of the IHO Hydrographic Dictionary Working Group and ARGANS

Managing Director. He has spent most of his career as Charge Hydrographer in the French Hydrographic Office where he accumulated over 30 years’ experience in satellite derived bathymetry.



▲ The Lampi Island demonstrator charted in accordance with IHO standards.



▲ Different solutions due to Remote Sensing non-linear reflectance. (Courtesy Curtis Mobley)

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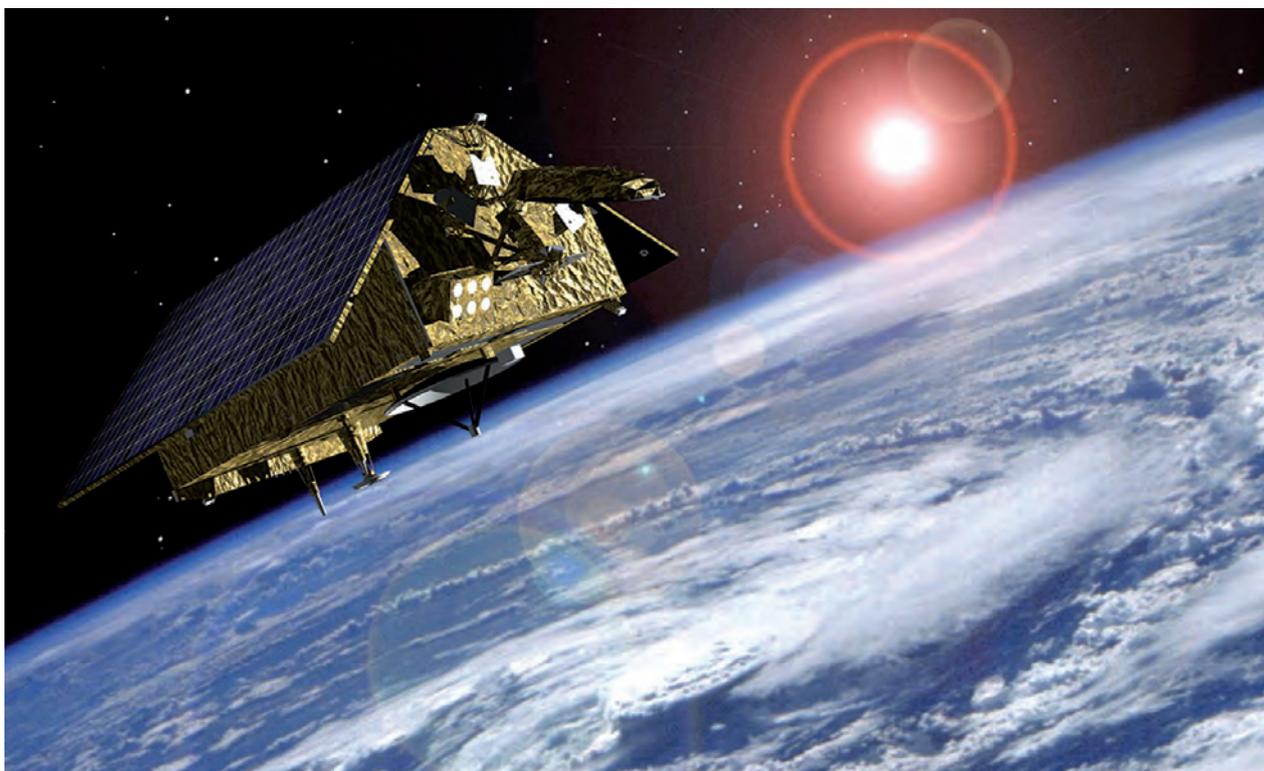
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## Copernicus Sentinel-6 Will Monitor the Oceans

# Rate of Sea-level Rise Accelerates

With millions of people around the world at risk from rising seas, it is essential to continue measuring the changing height of the sea surface to ensure that decision-makers are equipped to take appropriate mitigating action. Copernicus Sentinel-6, a new satellite, will take the lead in charting sea-level change.



Sentinel-6 carries a radar altimeter to provide high-precision and timely observations of the topography of the global ocean. This information is essential for the continued monitoring of changes in sea level, a key indicator of climate change. It is also essential for operational oceanography.

ESA's Director of Earth Observation Programmes, Josef Aschbacher, said at the presentation of the satellite in Germany in November 2019, "With global sea level rising at shocking rates, Copernicus Sentinel-6 will take the lead in providing systematic measurements of sea level so that the worrying trend in sea-level rise can be closely monitored and key information provided for important policy decisions."

### DIFFERENCES IN SEAWATER DENSITY

Previous missions have shown how the sea level rose by about 3.2mm on average a year between 1993 and 2018, but more alarmingly, that the rate of rise has been accelerating over the last few years. It is now rising at 4.8mm a year. However, this average number masks big differences as it is not rising at the same rate everywhere. In fact, while in some places it is rising as much as 10mm a year, in other places it is falling by 10mm a year. There are many reasons for this imbalance such as differences in local gravity, freshwater discharge from rivers and differences in seawater density.

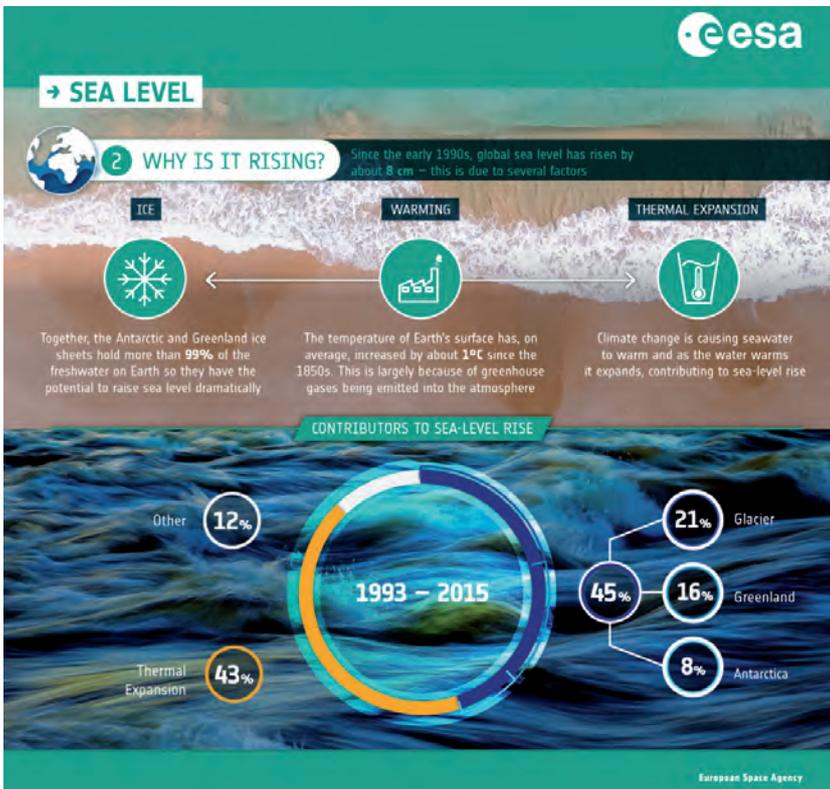
The information we get from satellites is essential for understanding how fast our seas are rising so that decision-makers are equipped to take appropriate mitigating action. Satellites

carrying altimeter instruments systematically measure the height of the sea surface so that sea-level rise can be closely monitored

### CONSEQUENCES OF CLIMATE CHANGE

Caused mainly by warming ocean waters, melting glaciers and diminishing ice sheets, sea-level rise is one of the most severe consequences of climate change. With millions of people around the world at risk from rising seas, it is essential to continue measuring the changing height of the sea surface so that decision-makers are equipped to take appropriate mitigating action.

Thermal expansion is the biggest single cause of sea-level rise as a consequence of climate

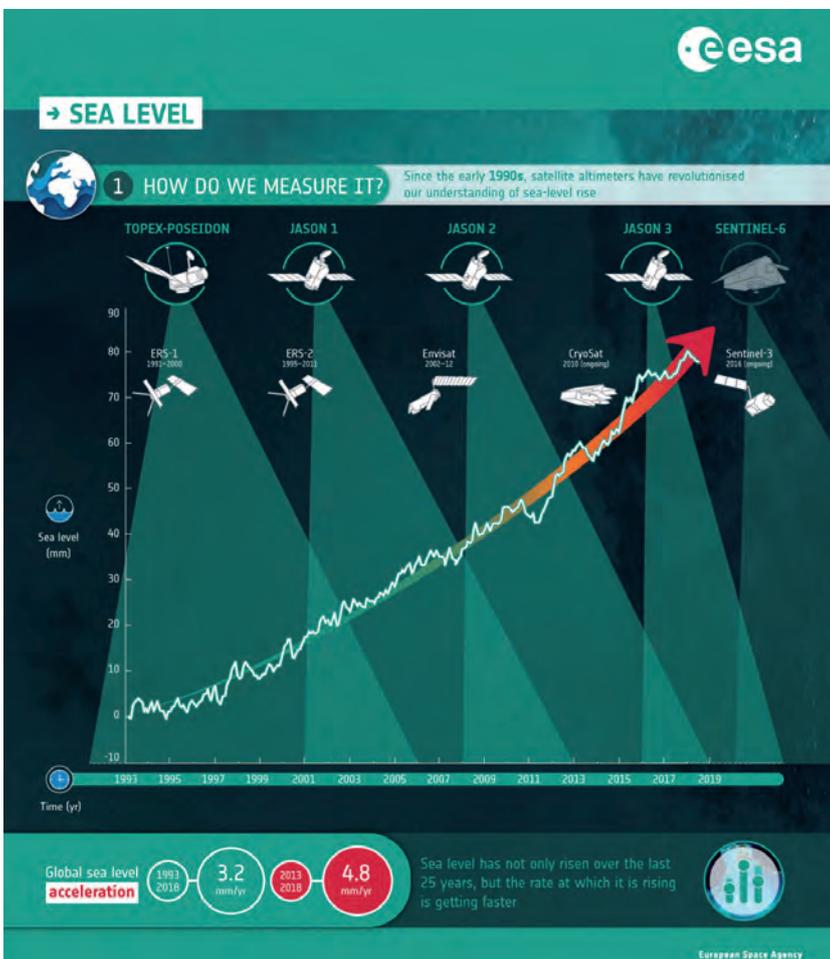


change, but ice loss from the continental glaciers and from the polar ice sheets is also one of the most critical drivers of our rising seas. Ice loss from glaciers, Greenland and Antarctica accounts for about 45% of sea-level rise. Another cause is discharge from waterbodies on land, but how much this contributes to sea-level rise is more uncertain. With many millions living in coastal communities around the world, sea-level rise is a major concern.

### SEA-SURFACE TOPOGRAPHY

The Copernicus Sentinel-6 satellite will map up to 95% of Earth's oceans every 10 days. The mission will use a radar altimeter to observe changes in sea-surface topography with centimetre precision, providing insights into global sea levels, the speed and direction of ocean currents and ocean heat storage.

These measurements are not only critical for monitoring our rising seas, but also for climate forecasting, sustainable ocean-resource management, coastal management and environmental protection, the fishing industry, and more.



### SEA LEVEL VARIABILITY

Sentinel-6 will map up to 95% of Earth's ice-free ocean every 10 days in order to monitor sea level variability. The radar altimeter will also measure the ocean surface topography – the hills and valleys of the ocean – that help us to map ocean currents. In addition, it will provide estimates of wind speed and wave height for maritime safety.

The mission builds on heritage from the Jason series of satellites, Copernicus Sentinel-3 and ESA's CryoSat mission. It will also complement ocean information from Sentinel-3, the other member of the Copernicus altimeter constellation.

### MEASURING THE HEIGHT OF THE OCEAN

Satellites carrying radar altimeters record the surface topography along the satellite's ground track. They precisely measure a satellite's height above water, land or ice by timing the interval between the transmission and reception of very short radar pulses. This is the only technology that can measure, systematically and globally, changes in the height of the ocean – and is therefore essential for monitoring sea-level rise.

Sentinel-6 is being realised in close cooperation between ESA, NASA, the European Commission, EUMETSAT and NOAA. The satellite will be launched in November 2020 from the Vandenberg Air Force Base in California, US on a Falcon-9. It will be the first time ESA cooperates, through NASA, with the private US aerospace manufacturer SpaceX, which was founded in 2002 by Elon Musk. ◀

(This article is based on the information from the ESA. Images courtesy ESA)

### Facts and Figures

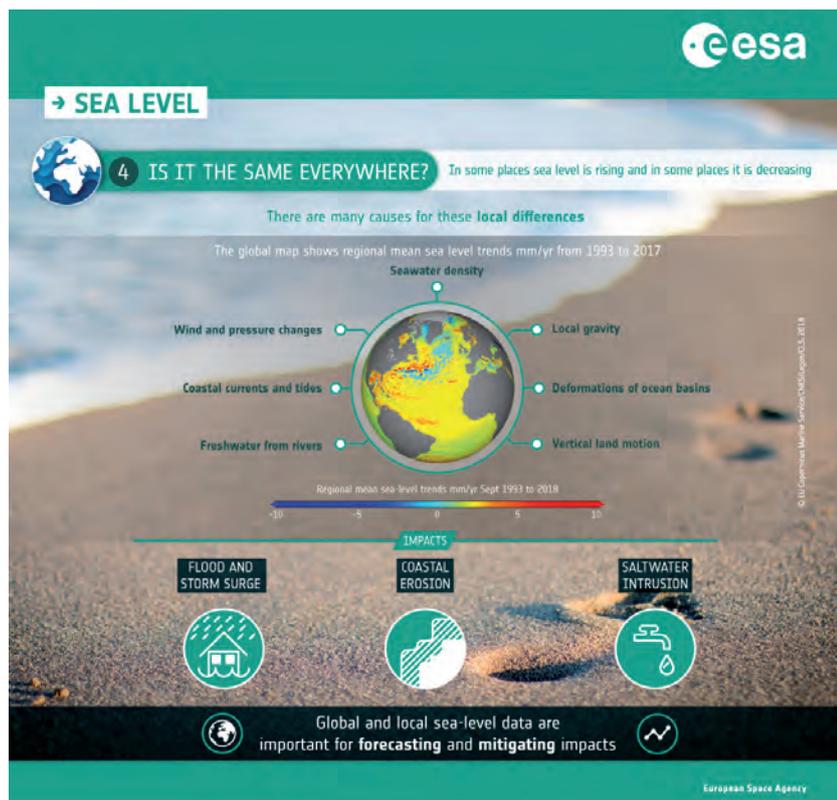
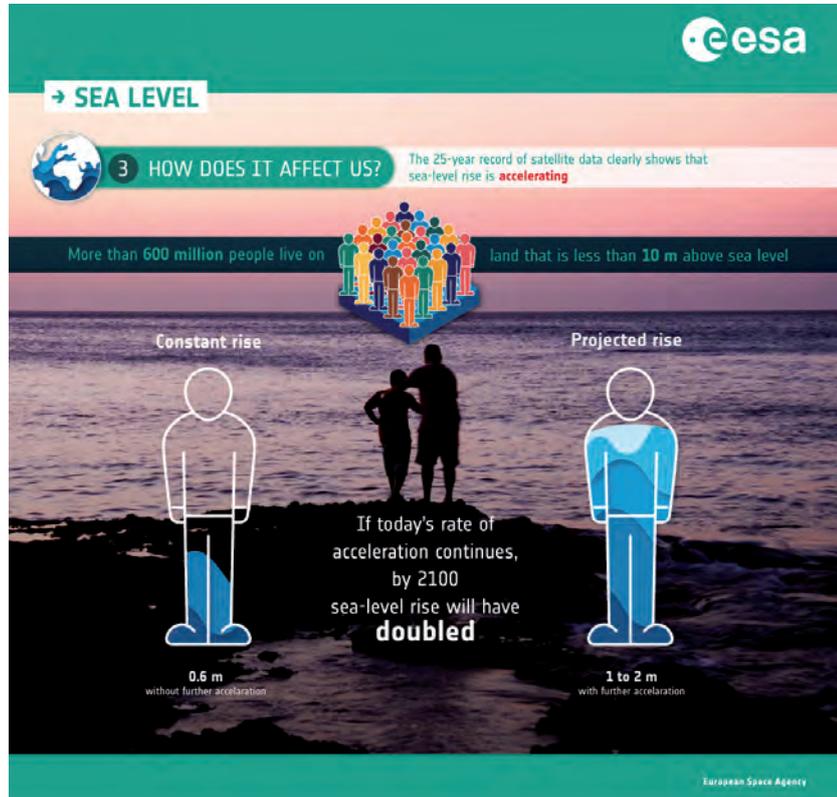
Global mean sea level has risen about 8–9 inches (21–24 centimetres) since 1880, with about a third of that coming in just the last two and a half decades. The rising water level is mostly due to a combination of meltwater from glaciers and ice sheets and thermal expansion of seawater as it warms. In 2018, global mean sea level was 3.2 inches (8.1 centimetres) above the 1993 average—the highest annual average in the satellite record (1993–present).

The global mean water level in the ocean rose by 0.14 inches (3.6 millimetres) per year from 2006–2015, which was 2.5 times the average rate of 0.06 inches (1.4 millimetres) per year throughout most of the twentieth century. By the end of the century, global mean sea level is likely to rise at least one foot (0.3 meters) above 2000 levels, even if greenhouse gas emissions follow a relatively low pathway in coming decades.

In some ocean basins, sea level rise has been as much as 6–8 inches (15–20 centimetres) since the start of the satellite record. Regional differences exist because of natural variability in the strength of winds and ocean currents, which influence how much and where the deeper layers of the ocean store heat. Past and future sea level rise at specific locations on land may be more or less than the global average due to local factors: ground settling, upstream flood control, erosion, regional ocean currents, and whether the land is still rebounding from the compressive weight of Ice Age glaciers. Source: National Ocean Service (U.S.)

### About the ESA

The European Space Agency (ESA) calls itself Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. ESA is an intergovernmental organization, created in 1975. [www.esa.int](http://www.esa.int).



Identifying and Filling Gaps in Bathymetric Coverage Deeper Than 200m

# This Is NOAA's Plan for Deep Ocean Mapping of US Waters

NOAA is using a systematic approach to map all US waters in support of Seabed 2030 objectives and to contribute to the complete mapping of the world's oceans in the next ten years. Mapping within US waters is a national goal that will only be accomplished through strong coordination and partnerships with other federal agencies, academia, and the private sector.



▲ Remotely operated vehicle Deep Discoverer being prepared for deployment on the Okeanos aft deck. (Courtesy: NOAA Office of Ocean Exploration and Research)



▲ Dataloggers in the ROV control room. (Courtesy: DEEP SEARCH 2019 - BOEM, USGS, NOAA)

The Nippon Foundation - General Bathymetric Chart of the Oceans (GEBCO) Seabed 2030 project has revitalized international and national interest in ocean floor mapping (Smith, 2018). Across US oceans, coasts, and Great Lakes waters, the National Oceanic and Atmospheric Administration (NOAA) is the primary agency responsible for seafloor mapping and nautical charting with several other federal, academic, and industry partners contributing seafloor mapping data within US waters.

Since its inception, the NOAA Office of Ocean Exploration and Research (OER) has been focused on using the best available technologies and methods to acquire baseline mapping of the deep ocean seafloor environment in areas that are unexplored. Working closely with NOAA's Office of Coast Survey (OCS), whose surveying and charting responsibilities span all US waters, other agencies, academia, and industry partners, OER is prioritizing baseline mapping activities as part of a larger NOAA mapping initiative.

NOAA is using a systematic approach to map all US waters in support of Seabed 2030 objectives and to contribute to the complete mapping of the world's oceans by 2030. NOAA is also

supporting efforts to compile all bathymetric data into the freely available GEBCO Ocean Map. OER operations are primarily focused on offshore environments deeper than 200m. As a fundamental component of exploration, OER views bathymetric data acquisition as a means to support further exploration efforts, resource identification, and improved understanding of deepwater ecosystems.

Recognizing the challenge in mapping such an expansive area, close coordination of future mapping efforts among various partners is paramount, as is discovery of data holdings that are not currently in publicly available archives. This article provides a synopsis of the current state of mapping of US waters deeper than 200m (>200m) to provide a benchmark against which progress can be measured. This work builds off of previously published analyses (Westington et al., 2018) and is focused on acquisition of mapping data in water depths >200m.

#### **DEFINING THE METRICS AND TRACKING**

The Seabed 2030 Project has an ambitious goal to map the world's oceans by 2030. In order to meet this timeline, it is critical to know the scope

of the work involved and align survey assets. With the release of GEBCO2019 (see additional resources below), the current state of global mapping is at approximately 15%, a 6% increase from analysis conducted the previous year (Mayer et al., 2018).

Inspired by these international efforts, in 2017, a team from NOAA OCS, National Centers for Environmental Information (NCEI), and the University of New Hampshire prepared a bathymetry coverage and gap analysis of sounding density and GIS map service to inform a US ocean and coastal mapping strategy for US waters and contribute to the international Seabed 2030 initiative. This Bathymetry Gap Analysis, which can be found on NOAA's GeoPlatform hosted at NCEI, evaluates the bathymetry data that are available through the IHO Data Center for Digital Bathymetry, (Westington et al., 2018). As of October 2018, only 43% of US oceans, coasts, and Great Lakes waters extending from shore to the US Exclusive Economic Zone (EEZ) limits are considered minimally mapped.

NOAA, in partnership with government, academia, and industry, is developing a coordinated approach to map all US oceans, coasts, and Great



▲ Camera focus of the main ROV HD camera. (Courtesy: NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas)

Lakes waters in support of Seabed 2030 objectives. With an emphasis on deep water exploration, NOAA OER seeks to achieve 100%

mapping of the deep ocean seafloor (>200m depth) by 2030. In order to identify the scope of work for this portion of US waters and set a

baseline to track progress, an evaluation of the US Bathymetry Gap Analysis was conducted. Methods were developed between NOAA OER, OCS, and NCEI to identify and compute the areas mapped for depths >200m. As of August 2019, approximately 49% of US waters >200m were estimated to be unmapped (51% mapped). For the purposes of this analysis, the area of US waters >200m depth were split into 13 regions for computational purposes.

This 49% reflects an area equal to ~5 million km<sup>2</sup> that remain unmapped and unexplored with the largest gaps in water depths between 5000m to 6000m (44 %). OER is using these analyses to help make decisions for future site selections for ocean exploration as well as collaborative partnership projects and funding opportunities.

As expected, the mapping data distribution is not uniform across the US EEZ regions. For the contiguous US regions (East Coast, West Coast, Gulf of Mexico), a higher percentage of US waters are mapped, in contrast to many areas in the Pacific and Alaska regions where there are large gaps in coverage. The remote locations of



▲ Remotely operated vehicle Deep Discoverer being recovered. (Courtesy: NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas)



▲ The remotely operated vehicle ROPOS control room on board NOAA Ship Henry B. Bigelow. (Courtesy: Peter Lawton)

these unmapped areas hinder dedicated mapping efforts. OER and partners focused on some of these regions in the Pacific Islands during a three-year campaign (2014 - 2017 Campaign to Address Pacific monument Science, Technology, & Ocean NEeds or CAPSTONE) which mapped ~ 364,000 km<sup>2</sup> of US waters, but overall, these regions remain poorly explored (for further details see Kennedy et al., 2019).

### CONTRIBUTIONS TO SEABED 2030

NOAA OER is leveraging its mission to explore our deep ocean and make ocean exploration data more accessible by filling mapping data gaps within US and international waters. Additionally, OER is providing critical deep-ocean data, information, and awareness needed to sustain and accelerate the economy, health, and security of our nation. The documentation of the systematic approach NOAA OER is using

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to identify mapping gaps in the seafloor (>200 m) over the next decade is an integral part of consistent reporting of metrics to help the US achieve its goal of mapping all US oceans, coasts, and Great Lakes waters by 2030. It is worth noting that while exploration activities are being prioritized within US waters this does not preclude OER from funding activities and supporting partnerships in ocean exploration efforts that are outside of US waters.

Mapping within US waters is a national goal that will only be accomplished through strong coordination and partnerships with other federal agencies, academia, and the private sector. As NOAA rises to meet the objectives set forth in Seabed 2030, an alignment of partnerships, initiatives, and technologies are coalescing to meet these goals. Over the next decade, OER will incorporate a blended solution that explores a variety of modalities, funding mechanisms, and technologies, leveraging fit-for-use applications for deep ocean exploration. NOAA OER is prioritizing the systematic mapping of US waters in deep water areas that remain unexplored and, with its NOAA partners in OCS, plans to consistently track progress towards fully mapping the US oceans, coasts, and Great Lakes waters. ◀



**Rachel Medley** is Chief of the Expedition and Exploration Division within NOAA's Office of Ocean Exploration and Research (OER). She previously worked for NOAA's Office of Coast Survey for 12 years before joining OER in 2018. Ms. Medley received her MS in Ocean Mapping and IHO-Category A certification from the University of New Hampshire, CCOM/JHC in 2009.



**Mashkoor Malik** is a Physical Scientist (Hydrographer) with NOAA Office of Ocean Exploration and Research. Mr. Malik received his MS in Ocean Mapping and IHO Category A certification from the University of New Hampshire, CCOM/JHC in 2005.



**Jesse Varner** has been a GIS specialist at NOAA's National Centers for Environmental Information (NCEI) in Boulder, Colorado for 12 years. He has a degree in Computer Science from the University of Colorado, and is interested in geospatial web services, interactive web maps, and cartography.

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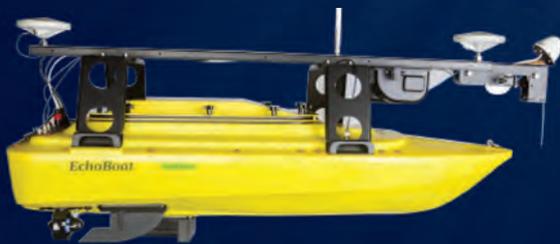


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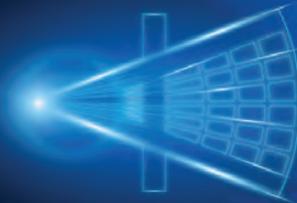
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# EvoLogics



**About us**

EvoLogics GmbH is a German high-tech enterprise, founded in 2000 by a group of leading international scientists and R&D experts. The company is on a mission to develop innovative technologies for maritime and offshore industries through interdisciplinary cooperation between engineering and life sciences.

EvoLogics' core values are rooted in bionic concepts that combine state-of-the-art engineering with the best ideas found in nature. The team took a bionic approach when solving the common problems of transmitting data in a dynamic underwater environment.

The resulting S2C spread-spectrum communication

technology became the basis for the company's commercial line. Over the past 10 years, it has grown into a whole "ecosystem" of products that includes several series of underwater acoustic modems, positioning systems and novel robotic solutions. Research and innovation remain the cornerstones of EvoLogics - the company is active in multiple national and international R&D projects that drive the development of new technologies.

**Advanced communication and positioning - the S2C technology**

EvoLogics offers highly reliable, flexible and cost-effective solutions for multiple underwater communication, positioning, navigation and

monitoring applications. EvoLogics' acoustic telemetry provides an independent bidirectional data link with simultaneous positioning, broadcasting and networking.

S2C-based systems have been carefully designed for operations in harsh underwater conditions and are enhanced with special algorithms for signal processing and data management. The company's extensive experience with sensor integration means it can provide customers with turnkey solutions that range from accurate positioning systems for subsea assets to underwater acoustic sensor networks for monitoring multiple environmental parameters and remotely controlling complex processes from the surface.

EvoLogics GmbH, Ackerstr. 76, 13355, Berlin, Germany, Tel: +49 30 46 79 862 0, sales@evolitics.de, evolitics.de

# Fugro Marinestar



**Marinestar GNSS**

Marinestar high performance positioning products and services delivered to you by Fugro Satellite Positioning are able to meet a varied range of applications in dredging & marine construction, wind farm installation, cable lay, naval and hydrographic/oceanographic surveys.

Marinestar GNSS delivers up to 6cm (vertical, sigma

2) accuracy in high availability, using seven overlapping L-band satellite beams. Via NTRIP, your corrections can be internet delivered as an extra back up path over your fleet broadband or even Iridium link.

With GPS, GLONASS, Beidou and Galileo constellations, redundancies as well as precision gains are made available. One of our most recent

developments is the fixing of GPS constellation ambiguities, leading to the G2+ or G4+ L-band service.

Our redundant infrastructure and unrivalled 24/7 global customer support make this precise positioning service exactly the tool you need! When positioning counts.....count on Marinestar!

Fugro Marinestar, Dillenburgsingel 69, 2263 HW, Leidschendam, The Netherlands, Tel: +31703170960, marinestar@fugro.com, www.fugro.com/marinestar

# HYPACK



HYPACK, A Xylem Brand has been developing HYPACK, HYSWEEP, and DREDGEPACK software solutions since 1984. With over 30 years' experience, and over 10,000 users, HYPACK is a leading provider of hydrographic and dredging software worldwide, supporting over 400 different sensors and devices!

HYPACK provides simple-to-use tools to design your survey, acquire and process your data, and create the required final products. HYPACK provides all you need for single beam, side scan, magnetometer, and sub-bottom surveys. Powerful 64-bit editing tools enable you to quickly review and clean your data in preparation for your final output. Modules to create

electronic navigational charts, calculate volumes, and generate DXF contours and side scan mosaics are all part of the package.

HYSWEEP is the add-on module for calibration, data collection and processing for your multibeam sonar and LiDAR systems. Supporting nearly all multibeam sonars on the market, you can acquire backscatter, intensity and water column simultaneously with bathymetry. Online real-time CLOUD displays show the system in operation. In the 64-bit HYSWEEP EDITOR you can process large data sets efficiently, analysing your data with CUBE, Wobble Analysis, and Beam Angle Test. Grid your data and calculate your output for your project requirements: average,

mode, median, standard deviation and more. Export to ASCII XYZ, LAS, matrix files and other custom formats.

DREDGEPACK enables you to monitor and track digging operations for all dredge types. DREDGEPACK monitors the position and depth of the cutting tool in real time and re-maps the bottom based on the depth and location of the digging tool. The colour-coded depth information is displayed in plan and profile views to show the "As Surveyed" and the "As Dredged" depths for millions of cells. This enables you to maximize digging efficiency and precision to reduce the risk of dredging errors and provide a record of digging operations.

HYPACK, USA Office, 56 Bradley Street, CT 06457, Middletown, USA, Tel: +1(860)635-1500, hypack@hypack.com, www.hypack.com

## INNOMAR Technologie



INNOMAR Technologie GmbH has been providing innovative and high-quality underwater acoustic survey equipment and associated software tailored to customer requirements for more than 20 years.

The INNOMAR narrow-beam parametric sub-bottom profilers (SBP), with more than 400 units sold, provide unequalled high-resolution sub-seafloor data with excellent penetration in water depths between less than one metre and full ocean depth (more than 11,000 metres). Applications include the geophysical imaging of sediments and sub-seabed structures for dredging purposes, for route and

offshore site surveys and mapping buried pipelines or cables.

All INNOMAR SBP models feature a narrow sound beam to provide excellent data quality while minimizing the risk of affecting marine mammals. The delivery includes a user-friendly data acquisition software, a data export tool and a dedicated post-processing software. Transmit pulse properties can easily be adjusted to fit specific survey requirements.

Transducers are available for over the side pole-mounting as well as for installation in the vessel's hull. There are also 'INNOMAR SES-2000' models

incorporating a narrow-beam parametric sub-bottom profiler and a dual-frequency side-scan sonar for simultaneous operation in shallow waters.

Multi-transducer SBP models for both surface vessel and underwater vehicle operation are providing high data density suitable for 3D sub-seafloor visualisation, boulder and UXO detection as well as tracking of buried pipelines or cables. The latest shallow-water model 'INNOMAR SES-2000 smart' is perfectly suited for small boats and ASV/USV integration, as in the 'INNOMAR SES-2000 autonomous' USV.

INNOMAR Technologie GmbH, Schutower Ringstr. 4, 18069, Rostock, Germany, Tel: +49 381 44079 0, info@innomar.com, www.innomar.com

## Innova



Innova is a leading supplier of services, equipment and engineered solutions with more than 20 years of know-how in the subsea industry. Our business idea is to combine operational experience, engineering skills and a reliable supply chain to deliver high quality products and services.

### We are passionate about technology

Our experienced staff provide a unique combination of technical expertise within multiple disciplines, such as mechatronics, hydraulics, electronics, control systems and software. Our vision is to be the

leading provider of advanced solutions for harsh environments to demanding customers worldwide. We aim to collaborate closely with our clients, ideally working as an extension of their team.

### Customer service is our core value

It's not just about supplying a product: we're here to help you all the way, from early concept phase to installation, testing and operation. We provide 24-hour support for all our supplied equipment, and an international presence through our supplier network all over the world.

The rental team can assist you in finding the best solution for your business according to your specific requirements. Our rental pool offers a variety of subsea equipment, including ROV tooling, survey systems, multiplexers and a lot more.

The Matrix is our fibre optic multiplexer solution, providing a simple plug and play interface for a large array of sensors and equipment to any remotely operated system. All functions are controlled from the 19" rack mount topside controller with touchscreen interface and web-based remote control.

Innova AS, Jakob Askelandsvei 13, 4314, Sandnes, Norway, Tel: +4751961700

## iXblue



iXblue is a global high-tech company specializing in the design and manufacturing of advanced marine, photonics and autonomy technologies. The group in-house expertise includes innovative systems and solutions devoted to inertial navigation, subsea positioning, underwater imaging, as well as

shipbuilding and test and simulation. iXblue technologies support Civil and Defence customers in carrying out their sea, land and space operations with maximum safety, efficiency and reliability.

iXblue is recognized throughout the industry for its pioneering work on the development of fibre-optic

gyroscope (FOG) technology which has revolutionized inertial navigation systems in the last decade, providing unequalled performance and cost of ownership benefits.

Employing a workforce of 650 people worldwide, iXblue conducts its business in over 60 countries.

iXblue, 34 rue de la Croix de Fer, 78105 Saint-Germain en Laye, France, Tel: +33 1 30 08 88 88, contact@ixblue.com, www.ixblue.com



# TECHNICAL B2B MARKETING

## WWW.GEOMARES-MARKETING.COM

## Klein Marine Systems



Celebrating over 50 years in the marine technology industry, Klein Marine Systems, Inc. continues to be a world-leading sensor technology manufacturer of high-resolution side scan sonar equipment and radar-based security and surveillance systems. Klein Marine continues to lead the industry with the development of side scan, bathymetry and sub-bottom profiler systems to support undersea search and survey. Introduced earlier this year, MA-X technology is a cost-effective solution to filling

the nadir gap that is characteristic of traditional side scan sonar. By seamlessly covering the nadir region, MA-X based products eliminate the need for overlapping survey lines, resulting in an estimated 40% increase in efficiency. Klein Marine Systems has developed a worldwide reputation of excellence in the industry by providing quality products and excellent customer service. Klein sonar systems are deployed by government agencies, navies, port authorities, surveyors, oil companies and universities

worldwide. Visit our website to see the entire line of Klein sonar systems and discover how Klein is Making the Oceans Transparent!  
[www.KleinMarineSystems.com](http://www.KleinMarineSystems.com)  
To contact Klein Marine, please feel free to email: [Sales@KleinMarineSystems.com](mailto:Sales@KleinMarineSystems.com)  
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Klein Marine Systems, 11 Klein Dr., NH 03079, Salem, USA, Tel: +1 603-893-6131, [Sales@KleinMarineSystems.com](mailto:Sales@KleinMarineSystems.com), [www.kleinmarinesystems.com](http://www.kleinmarinesystems.com)

## Kongsberg Maritime



Serving the energy, survey, underwater construction, fishery and aquaculture, naval and marine research communities globally, Kongsberg Maritime's subsea portfolio includes everything from underwater robots and transponders to hydroacoustic sonar systems and cloud-based infrastructure for data storage and analysis. Developed from an expert knowledge-base in underwater engineering and hydroacoustics, the company's world-class subsea portfolio includes de facto industry standard single and multibeam echo sounders, sonars, underwater vehicles and subsea transponders and positioning systems, in addition to

advanced software and solutions for defence customers. It's this extensive portfolio and unmatched experience that enables Kongsberg Maritime to provide innovative and integrated solutions that bring more efficiency, reliability and performance to any subsea operations. In line with other marine sectors, Kongsberg Maritime is also at the forefront of digitalisation for subsea applications. Mapping Cloud, which provides easy storage of different types of data within the Cloud, offers an accessible and practical means of uploading and distributing real-time data, which can be

subsequently made available to use in diverse applications and products. KONGSBERG solutions, including underwater modems and transponders, and ship to shore networks powered by the unique Maritime Broadband Radio (MBR) technology, enable fast and low-latency data transfer, with no airtime costs to send any amount of data. The company continues to excel in new developments, having unveiled two advanced USVs and a new generation of its HUGIN AUV between December 2018 and July 2019.

Kongsberg Maritime AS - Subsea Division, Division of Kongsberg Group, Strandpromenaden 50 (P.O. Box 111), N-3191, Horten, Norway, Tel: +47 33 03 41 00, Fax: +47 33 04 47 53, [km.sales@kongsberg.com](mailto:km.sales@kongsberg.com), [www.kongsberg.com](http://www.kongsberg.com)

## K.U.M. – Deep Sea Specialists



K.U.M. Umwelt- und Meerestechnik Kiel GmbH stands for innovative quality products, professional services and custom-built solutions in marine research. As a competent partner in maritime science and economics, this medium-sized company, founded in 1997 and located on the Baltic Sea, is in great demand internationally. The continuous development of Ocean-Bottom-

Seismometer-Systems for the detection of subsea seismic movements (seaquakes) is an important focus. The use of titanium, a light, corrosion-free, pressure-proof material of high quality, offers excellent conditions for deep-sea operations up to 6000m and more. All devices, from the smallest screw to complete instrument carriers, are available in titanium. In addition, K.U.M. provides comprehensive

services, including operators on research vessels, instrument training, individual consultancy and realization of special requirements in close collaboration with the customers. In doing so, the highly motivated and committed K.U.M.-team – some of whom have worked for more than 30 years in marine engineering – guarantee first-class services as well as innovative thinking and action.

K.U.M. Umwelt- und Meeres-technik Kiel GmbH, Wischhofstr. 1-3, Gebäude 15/16, 24148, Kiel, Germany, Tel: +49 431 72092-20, Fax: +49 431 72092-20, [kum@kum-kiel.de](mailto:kum@kum-kiel.de), <https://kum-kiel.de/en/home/>

# FOR SMART HYDROGRAPHIC COMPANIES

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# Leica Geosystems



## High-resolution airborne systems for efficient bathymetric survey

Leica Geosystems, part of Hexagon, revolutionised airborne bathymetric survey by introducing the Leica Chiroptera 4X, a high-resolution capture technology, delivering four times the point density and increasing data collection efficiency. The higher point density allows customers to deliver more detailed data products at reduced operational costs. For typical bathymetric LiDAR end user specifications, the flight costs can be reduced by 50%. The new technology also increases the depth penetration by up to 10% while not affecting turbid water performance or accuracy.

## Seamless data from water to land

With bathymetric and topographic sensors integrated in the survey systems, the Chiroptera 4X collects seamless data from land to a water depth of 25 metres. When fitted with the HawkEye 4X deep bathymetric module, the water penetration depths can be increased to 50m.

## Integrated processing of LiDAR data

The Leica LiDAR Survey Studio (Leica LSS) software allows simultaneous processing and quality assurance of all sensor data, therefore increasing productivity. Users can quickly create coverage

plots, check accuracy and point density, visualise the data in 3D, review and extract Q/A reports. Tools such as automatic calibration, data classification, water refraction correction, data cleaning, turbid water enhancement, point cloud colourisation, point cloud matching, import of reference points, and quality assurance statistics analysis are fully integrated.

Leica Geosystems, part of Hexagon, Klubbhusgatan 15, 553 03, Jönköping, Sweden, Tel: +46 361 966 80, info.gsd@leica-geosystems.com, www.leica-geosystems.com/chiroptera-4x

# Marine Advanced Robotics



## Our Mission

We are creating the future of marine robotics for the Blue Economy. Our WAM-V® is a technological leap forward in ASVs (Autonomous Surface Vessels) with proven effectiveness to support multiple marine industries. WAM-Vs increase operational capabilities, decrease risk, lower cost, save time and can be disassembled for economical shipment anywhere in the world.

## Our Technology

The Wave Adaptive Modular Vessel (WAM-V) is an innovative class of watercraft using unique technology that radically improves seagoing

capabilities. The articulating system uses springs, shocks and ball joints to minimize structural loading. The result is an ultra-light vessel that can perform in sea conditions where an ordinary boat of similar size could no longer operate.

## Our Capabilities

- Hydrography
- Remote Observation
- Systems Delivery
- Oceanography
- Marine Salvage
- Dredging Surveys
- Habitat Study

- Disaster Response
- Marine Infrastructure Inspections

## About Us

Marine Advanced Robotics, Inc. (FKA Marine Advanced Research, Inc.) was founded in 2004 by a small group of Silicon Valley innovators. In 2007, the 100 ft (30 m) Proteus was launched in the San Francisco Bay, introducing the WAM-V (Wave Adaptive Modular Vessel) to the world. For the past decade, we have continued to design, manufacture, and refine the WAM-V technology. WAM-Vs currently operate in 10 countries and range in size from 2.5 m to 30 m in length.

Marine Advanced Robotics, Richmond Field Station, 1301 South 46th Street, Bldg. 300A, 94804-4600, Richmond, California, USA, Tel: +1-510-232-1685, info@wam-v.com, www.wam-v.com

# QPS



Quality Positioning Services BV (QPS), headquartered in Zeist, the Netherlands, is an independent software design company founded in 1986. QPS subsidiary offices are located in Canada, the USA and the UK.

QPS are experts in maritime geomatics software and services. QPS solutions are used across a variety of industries, including hydrographic surveying, offshore construction, chart production, and piloting. Marine construction solutions are highly focused on oil and gas, offshore wind farms, and the dredging industry. Services include on-site and on-board

training, setup, and support. With the highest capabilities and industry-renowned stability, QPS keeps even the most complex jobs running smoothly.

- Qinsy is a software suite used for survey planning, acquisition and real-time processing for many types of maritime geomatics surveys, ranging from simple singlebeam surveys up to complex offshore construction works.
- Qimera is an evolution in hydrographic data processing, simple and easy to use while still offering the most advanced and cutting-edge tools.

- Fledermaus is an interactive 4D geospatial analysis software. With movie-making tools and integrated video playback, it is the gold standard for presentation and communication.
- Qarto offers rapid, automated ENC production from high-resolution source bathymetry. It is the tool of choice for some of the busiest ports in the world to maximise navigable waters.
- Qastor is a precise navigation software for piloting and docking. With under-keel clearance and real-time information updates, it is the ultimate in maritime safety.

The Netherlands: Handelsweg 6 – 2, 3707 NH Zeist, The Netherlands, Tel: +31 306 941 200, https://qps.nl/, sales@qps.nl  
 USA: One New Hampshire Ave., Suite 125, Portsmouth, New Hampshire 03801, United States of America, Tel: +1 603 431 1773, https://qps.nl/, sales@qps.nl

# RIEGL – Topo-Bathymetric Airborne Laser Scanners and Systems

RIEGL is an international leading provider of cutting-edge Waveform-LiDAR technology in airborne, mobile, terrestrial, and unmanned laser scanning solutions for surveying.

For combined hydrographic and topographic surveying, RIEGL offers the fully integrated airborne laser scanning systems VQ-880-G II and VQ-880-GH, ideally suited for coastline and shallow water mapping, riverbed profiling, measurement of aggradation zones, hydro-archaeological surveying, etc. These turnkey surveying systems include a high-end IMU/GNSS unit, an RGB camera, and an integrated

infrared laser scanner. The integrated improved infrared laser scanner complements the data from the green laser scanner and supports the detection of the water surface. The compact and robust housing is compliant with typical aircraft hatches and stabilized platforms. Additionally, the VQ-880-GH's form factor with reduced height is specifically optimized for helicopter integration. The compact RIEGL VQ-840-G Topo-Bathymetric Airborne Laser Scanner offers more than two Secchi depths of water penetration. The scanner provides high spatial resolution due to a measurement rate of up to

200 kHz and a selectable laser beam divergence.

Its low weight of just 12 kg allows integration in various aircraft platforms, including UAVs. The BathyCopter, a small-UAV-based airborne laser scanning system for bathymetric surveying, is ideally suited for generating profiles of rivers or water reservoirs. The robust and reliable platform design integrates the RIEGL BDF-1 bathymetric depth finder - with tilt compensator, IMU/GNSS unit, control unit, and up to two digital cameras - on RIEGL's RICOPTER.



RIEGL, Riedenburgerstrasse 48, A-3580, Horn, Austria, Tel: +43 2982 4211, office@riegl.com, www.riegl.com

# SBG Systems

SBG Systems is a leading supplier of compact, high-performance and cost-effective inertial motion sensing solutions. Our Motion Sensors and Inertial Navigation Systems are ideal for hydrographic applications, ship motion monitoring, Lidar and Buoy orientation and positioning; ROV & AUV control; camera stabilisation, and antenna tracking. They include our all-in-one Navsight Solution dedicated to hydrographic survey in all conditions.

Highly versatile, Navsight comes as a Motion Reference Unit (MRU), providing roll, pitch, and heave or as a full Navigation Solution with embedded tri-frequency GNSS receiver, or using an external one. Fusing inertial data with satellite position in real-time, Navsight INS offers a continuous position in all conditions, such as surveying under a bridge, or during GNSS outages due to coastal infrastructures (buildings, harbour cranes, etc.).

Completing the Navsight offer, Qinertia, SBG's in-house Post-Processing Kinematic (PPK) software, gives access to offline RTK corrections from more than 7,000 base stations located in 164 countries. Trajectory and orientation are then greatly improved by processing inertial data and raw GNSS observables in forward and backward directions.



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# Seafloor Systems

Seafloor Systems Inc. provides solutions for all of your various hydrographic surveying needs. We can provide USVs, ASVs, Single Beam Sonars, Multibeam Sonars, ADCPs, Side-scan, GNSS, Sub-bottom, SVP/SVS/CTD, and rental solutions for applications. Seafloor continues to innovate in the

survey grade echosounder and unmanned surface vehicle sectors, having introduced the first hot-swappable transducer well technology for the EchoBoat in 2017, which enables the user to quickly swap sonar modules without removing the vehicle from the water. Modules include a multibeam

echosounder with integrated IMU, sidescan sonar, single beam echosounder, ADCP, and sub-bottom profiler. With proven technology and proven solutions as well as unparalleled customer service, Seafloor is the go-to supplier for portable, rugged, and quality hydrographic survey instrumentation.



Seafloor Systems, Inc., 4415 Commodity Way, CA 95682, Shingle Springs, USA, Tel: 530-677-1019, info@seafloorsystems.com, www.seafloorsystems.com

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## Sercel Underwater Acoustics



Sercel Underwater Acoustics develops and markets underwater data transmission systems and marine instrumentation for oceanographic engineering, scientific community, military and oil & gas applications.

The company's products include underwater acoustic communication & positioning systems, passive acoustic monitoring & marine mammal detection systems, ocean bottom seismometers, mooring monitoring beacons, acoustic transducers & hydrophones.

### MATS 3G ACOUSTIC MODEM

MATS 3G is an underwater acoustic modem that offers a single solution for all underwater

communication needs. Its state-of-the-art DSP technology ensures long-range and reliable communication and makes it ideal for AUV (Autonomous Underwater Vehicle) communication.

### QUIETSEA PASSIVE MONITORING

QuietSea's passive acoustic monitoring (PAM) system is designed to detect the presence of marine mammals during offshore operations.

### GEOTAG UNDERWATER POSITIONING

GeoTag is an acoustic positioning system that has been designed to work with any ocean bottom or transition zone seismic equipment down to 500 metres deep. GeoTag is the smallest acoustic

transponder on the market, allowing flexible and cost effective operations due to its ability to be stored on a reel and deployed by a mechanical squirter.

### BASM/BABS MOORING MONITORING

Designed to retrieve a buoy in the event of a mooring line break, BABS alerts owners to a line breakage by transmitting a signal to ARGOS satellites, while BASM monitors any underwater equipment that may surface by transmitting through the same ARGOS satellite system.

<https://www.sercel.com/services/Pages/SERCEL%20UNDERWATER%20ACOUSTICS.aspx>  
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Sercel, 16, rue de Bel Air, 44474, Carquefou, France, Tel: (33) 2 40 30 11 81, sales.nantes@sercel.com, www.sercel.com

## Teledyne CARIS



For over 40 years, Teledyne CARIS™ has been making software designed for the marine GIS community. Not only renowned for its product, but also for outstanding customer service, Teledyne CARIS offers a comprehensive level of support through training sessions and consulting, online technical support, email and multilingual telephone support.

Developed in cooperation with hydrographic clients and universities, the CARIS™ toolset provides clients

with resource optimisation and a true operational advantage. Known for the Ping-to-Chart™ solution, we offer a comprehensive portfolio of products, from the processing of the echo sounder ping to the production and distribution of the chart.

The newest product in the toolset, CARIS Onboard™, is a near real-time and autonomous data processing package which has been developed with autonomous underwater vehicles (AUVs) and unmanned surface vehicles (USVs) in mind. This

solution acts as a force multiplier when used on survey vessels, by fitting seamlessly into the Ping-to-Chart suite of software, and reducing the overall product creation timeline.

Find out why CARIS software is selected by national mapping and charting agencies, survey companies, port and waterway authorities, oil and gas companies, and academic institutions worldwide by visiting [www.teledynecaris.com](http://www.teledynecaris.com).

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## Valeport



Valeport provides leading-edge marine sensing and monitoring solutions. We are a leading UK manufacturer of hydrographic and oceanographic instrumentation which includes: CTD & Multiparameter, Sound Velocity, Current Meters, Environmental Sensors, Echosounders & Bathymetry, Tide Gauges, Wave Recorders and Software.

Valeport has supplied the subsea sector since 1969 and supporting hydrographic survey with the latest technology is our prime aim. Our multi-parameter

profiler, SWIFTplus, has recently been upgraded to operate down to 500m as standard, providing enhanced versatility and deployment. The profiler now offers an increased pressure accuracy from 0.5% to 0.01%, fitting only one 50bar pressure transducer.

The SWIFTplus uses Valeport's world-leading high accuracy sensor technology to combine sensors for multiple profiles in a single drop and provide seamless data transfer for instant use. SWIFTplus incorporates turbidity or fluorometer observations

with sound speed, temperature and pressure sensor technology to also provide computed conductivity, salinity and density, coupled with the convenience of Bluetooth connectivity, rechargeable battery and an integral GPS module to geo-locate each profile.

Find out more about Valeport's portfolio and why we are selected by leading environmental, defence, oil & gas, renewable energy, coast and shallow water management, ports & harbours, dredging, civil engineering and scientific research organizations worldwide.

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