MARINE TECHNOLOGY REPORTER

October 2018

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Gliders step up in the

Hunt for Hydrocarbons

Voices

Cui Weicheng, Shanghai Ocean University

Ocean Observation

Persistent Profiling in the Greater Agulhas Current

Instrumentation

Seismic from Below

Volume 61 Number 8

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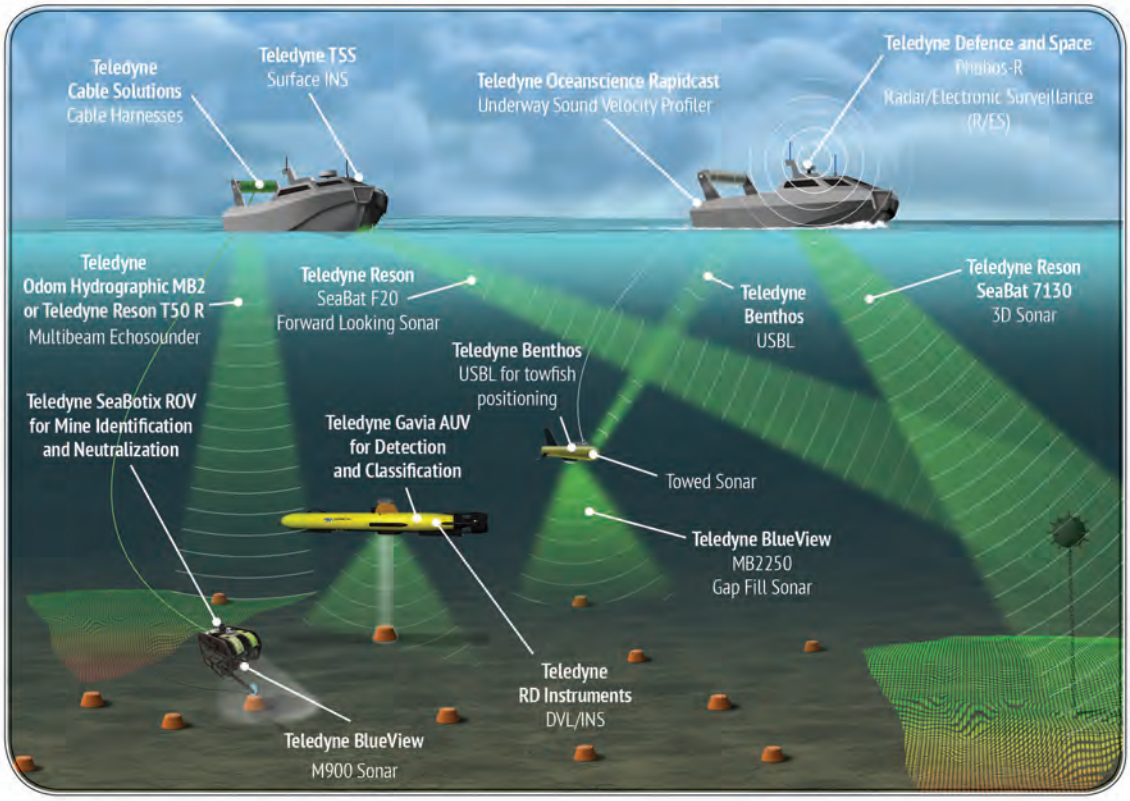

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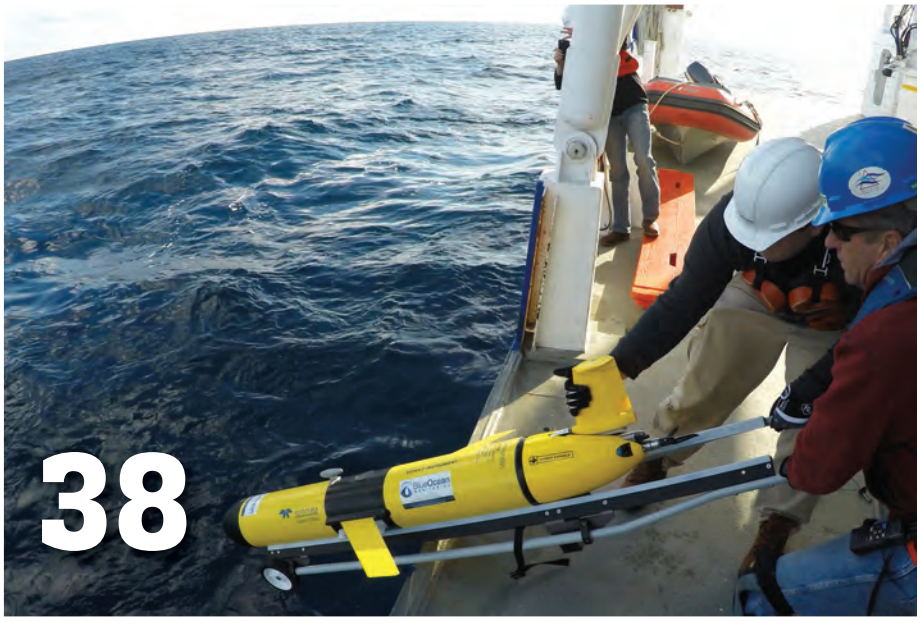
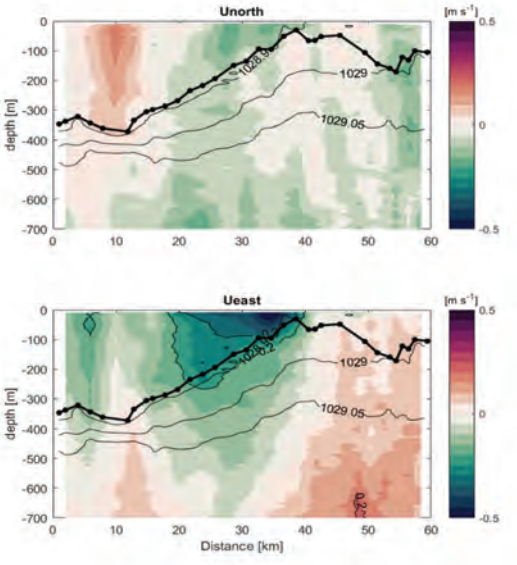
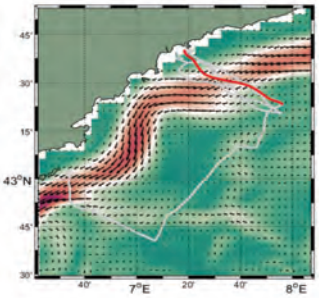


Credit: Blue Ocean Monitoring





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Editor's Note

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With the volume of copy that passes my desk across five print titles, nine websites and a dozen eNewsletters, I must admit that sometimes I feel like a hamster on the wheel … running at top speed but going nowhere. Then a story gets dropped on my desk from the likes of **Kevin Hardy**, a long-time colleague who is familiar to many of you, that makes me literally stop, breath and think. This month we profile in full Professor **Cui Weicheng**, Shanghai Ocean University, Director Hadal Science and Technology Research Center (HAST) and co-founder, Rainbowfish Ocean Technology Company. Professor Cui Weichang, who you might remember was profiled in short in the July/August edition of MTR as "Number Four" in our *Top 10 Ocean Influencers* profiles is a fascinating character in many regards. His story starts on page 10 and extends to page 20, so I won't blow the plot in this space, but his story is one on innovation, both in science, technology and global business, and is a worthy read.

As we prepare for yet another busy travel season, starting this month with Oceans in Charleston and extending to Blue Tech Week in November in San Diego (see preview on page 46), then back again to San Diego in February 2019 for Oceanology International Americas – with plenty of stops in between – this 'Ocean Observation' edition is a great one to reflect on the rapidity of technology maturation in this sector. The collective strides in autonomy, connectivity technology – and perhaps equally important the acceptance and deployment of these technologies – is progressing at a staggering pace both below and above the water. This is displayed in practical terms courtesy of **Elaine Maslin's** feature this month, Hunting Hydrocarbons starting on page 38, which discusses how subsea gliders are taking to the oceans for a wider array of hunts with greater accuracy.

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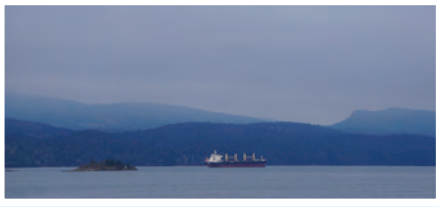
The Ocean Cleanup Kicks Off

The Ocean Cleanup

A first-of-its-kind floating ocean cleanup system is undergoing a final round of testing before it begins removing plastic pollution from the Great Pacific Garbage Patch halfway between Hawaii and California. The system developed by the Dutch nonprofit The Ocean Cleanup was launched from San Francisco Bay on September 8 and towed 350 nautical miles by the vessel Maersk Launcher to an offshore test site.

https://www.marinetechnologynews.com/news/ocean-cleanup-kicks-564750

Canada Studies Enviro Impact of Shipping

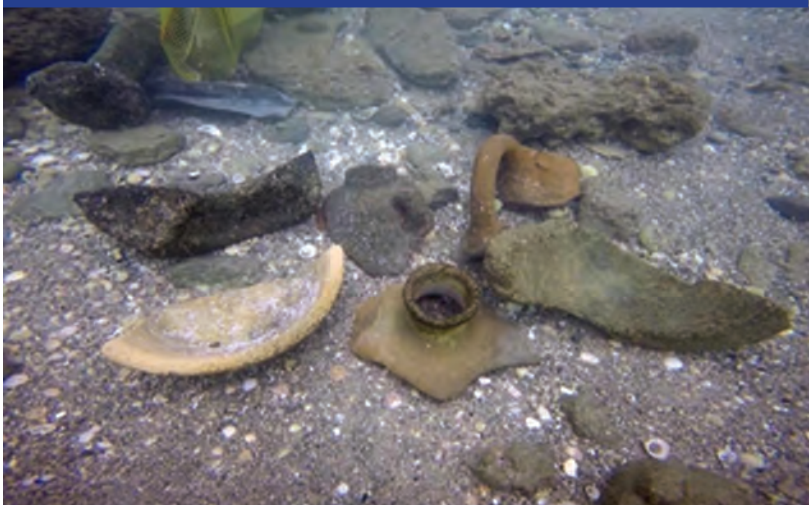


Eric Haun

The Government of Canada is acting to preserve and restore marine ecosystems that are vulnerable to increased marine shipping and development. Transport Canada has awarded a contract to ESSA Technologies Ltd. under the Oceans Protection Plan to look at methodologies and tools to assess the cumulative impacts of marine shipping on coastal marine ecosystems.

https://www.marinetechnologynews.com/news/canada-study-shipping-environmental-564687

Ancient Relics Found in Subsea Pipeline Route



Credit Israel Antiquities Authority

Underwater archaeologists have been scouring the seabed where a gas pipeline is being built off Israel's coast in a bid to preserve relics near a 5,000-year-old port which once was a key trade hub for the Mediterranean's ancient civilizations. The pipeline from the deep-sea Leviathan gas field that is due to begin production late next year comes ashore near Dor Beach in northern Israel.

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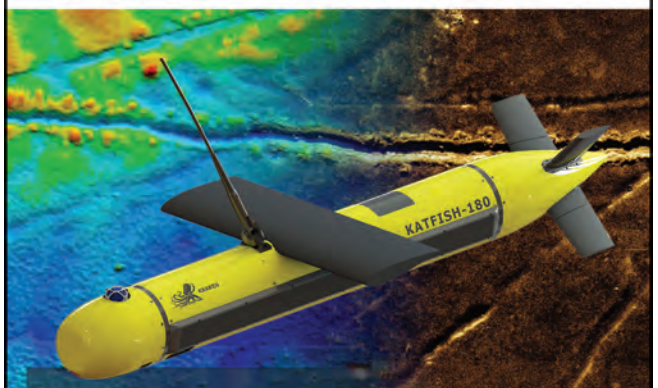

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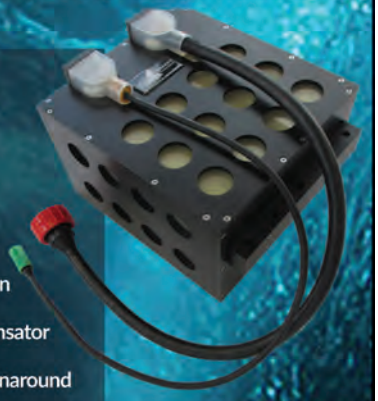

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Image: Professor Cui Weicheng, Shanghai Ocean University

Professor CUI WEICHENG

Shanghai Ocean University, Director, Hadal Science and Technology Research Center (HAST), Co-Founder, Rainbowfish Ocean Technology Company

By Kevin Hardy, ScD, Global Ocean Design, San Diego

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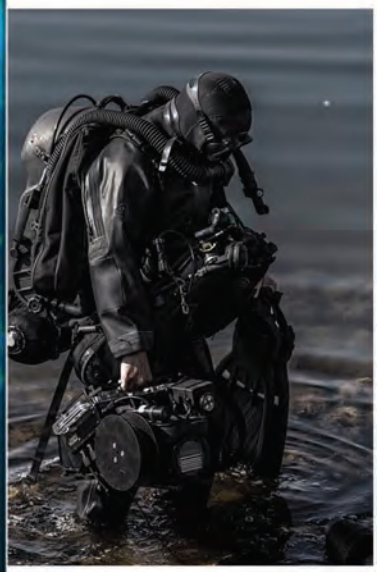

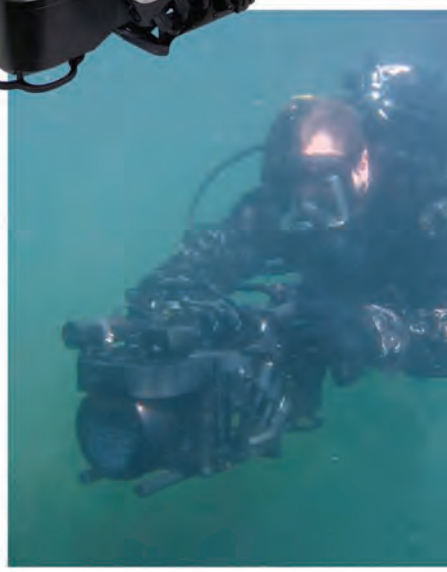

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Professor Cui Weicheng,

Director of Shanghai Ocean University's Hadal Science and Technology Center (HAST), Lingang (New City), Pudong District, is one of those leading and influencing the development of advanced deep-sea technology. He is on an extraordinary mission to build a fleet of manned and unmanned vehicles capable of routine dives to the bottom of any ocean trench. His approach to solving the basic start-up funding problem is likely the first in the Chinese experience, using government-private-public partnerships seen in other parts of the world. He travels extensively and spends many hours meeting with potential and current sponsors from academia, the Chinese national government, the Shanghai government, and private investors, both foreign and domestic.

Over the course of his career, Professor Cui was project leader and first deputy chief designer of the 7000m Jiaolong 3-man submersible (HOV), now operated by the National Deep Sea Center, State Oceanic Administration, Quingdao, Shandong province. The Jiaolong has made 151 dives, reaching a record depth for an active submersible program of 7,062m (23,169ft), piloted by Cui himself.

Cui has already made test dives of an 11,000m Autonomous Remote Vehicle (ARV), and three different 11,000m Hadal Landers that incorporate both foreign and domestic components. His team is in the process of building two new Generation 2 benthic landers. Cui's team at HAST has tested a new 4500m ARGO-like "Floater" using a 17-inch glass sphere for the housing and flotation, with the variable ballast pod on the keel. A surface ship can track the "Floater" using a miniaturized USBL system. Production to meet global scientific demand is being considered.

The 7000m Jiaolong submersible

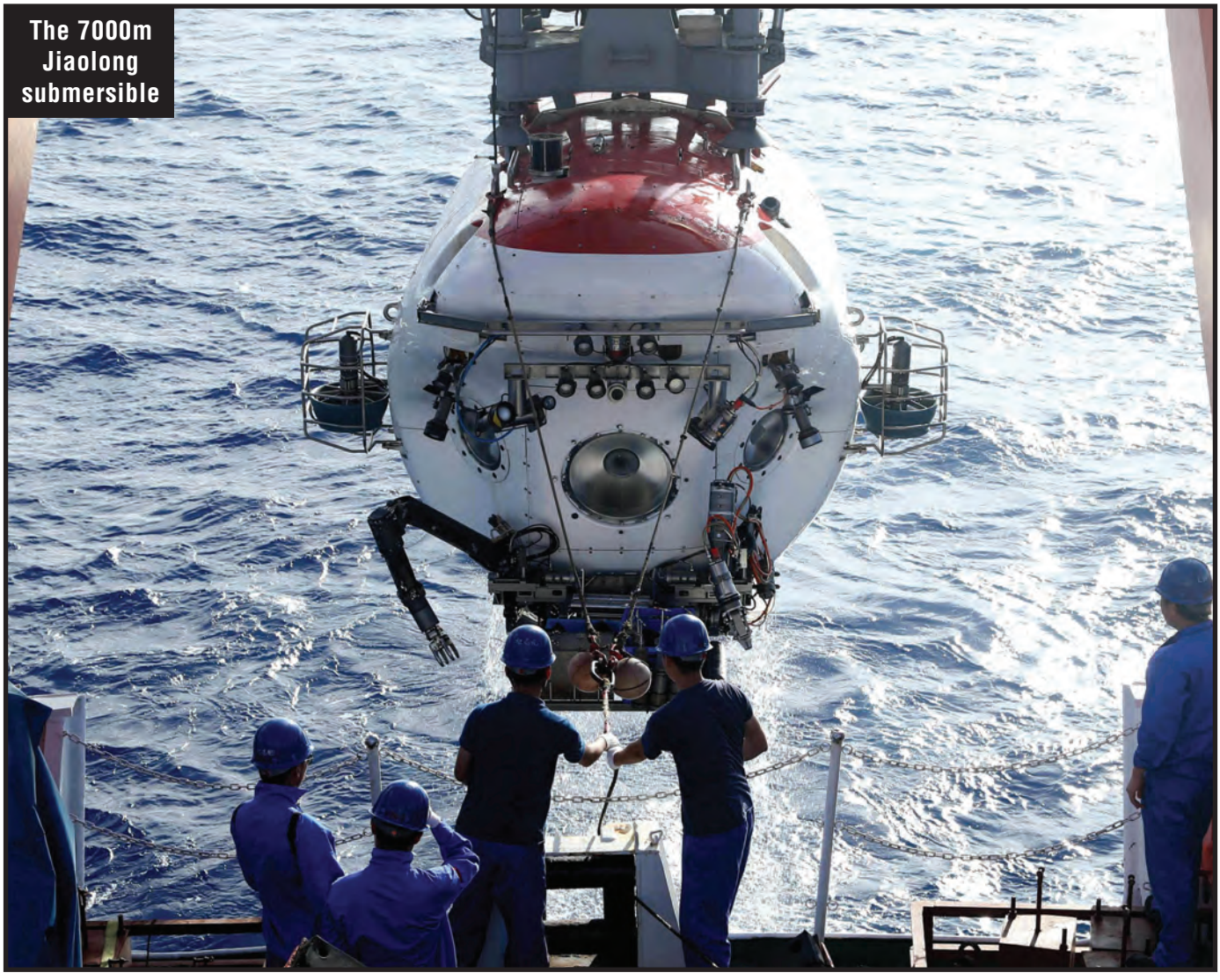

Image: Professor Cui Weicheng, Shanghai Ocean University

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In addition to the manned and unmanned vehicles, Professor Cui used his training in ship design to work with Shanghai ship builders to construct two surface support ships for his manned and unmanned vehicles, what Cui refers to as "movable laboratories." These are the 97 m (318 ft) "RV Zhangjian", named for the founder of SHOU and launched in 2016, and a smaller SWATH surface support ship "RV Shen Gua" named for the famous Chinese scientist from the Ming Dynasty who first described the magnetic compass, and launched in June 2018. A third vessel, an ice-hardened mothership has been designed, with no specific plans for construction.

Those practiced in the arts will recognize the many difficult engineering challenges that have to be mastered in order to bring these quite different and complex systems on-line. Cui, conscious of his training in both engineering and Buddhism, has done it with gentleness, hard work, inventiveness, and months at sea each year.

"Cui is driven by an unseen clock, drawn by some distant land, perhaps the sound of internal waves breaking on a hadal shore. His mind keeps working while his body sleeps," observed Kevin Hardy, ScD, Global Ocean Design.

Another measure of Cui's influence is in the work done by his students, whom he guided through their PhDs to develop their natural talents, and his trusted colleagues. His students have brought to operational status a submarine crew Rescue Bell, and a 500m ADS (Advanced Diving System), that functions like a Newtsuit. Cui started and passed to colleagues the development of 4500m manned submersible, named "Shen Hai Yong Shi," or "Deepsea Warrior". Professor Cui modestly accepts no credit for this work.

Image: Professor Cui Weicheng, Shanghai Ocean University

Professor Cui Weicheng receiving the title "National Hero of China," from PRC President Xi Jinping, following his successful dives to over 7,000m in the submersible Jiaolong.

Cui is currently leading the development of the 11km 3-man Rainbowfish submersible. Theoretical and real models of acrylic windows have been tested to destruction, improving his understanding, and offering guidance for revisions to accepted international standards. Likewise, scale model HSS spheres, made in Finland and China, have been tested to destruction in the high-pressure chambers at HAST. These tests have improved understanding of materials and processes that could further change accepted design practice. He has proposed a clever "nested pressure chamber" design, with a personnel sphere inside a first pressure chamber, inside a second pressure chamber, in order to reach hadal pressures with only a 10ksi step in pressure across each of the two pressure chamber walls.

Also unique to modern China is Cui's entrepreneurial technology-transfer mechanism that links HAST with the commercial Rainbowfish Ocean Technology Company (http://www.rainbowfish11000.com/). Cui's college friend, Dr. Wu Xin, is the Rainbowfish Company managing director. The company plans to charge customers to use its research ship and submarines, and is targeting three groups, said Dr. Wu.

"The first is definitely the scientists who are interested in studying deep-sea science and technology. The second group is offshore marine geophysical resource companies, such as offshore oil and seafloor minerals. The last is tourists and adventurers who want to go down themselves to have a look at what's going on there," Wu said.

Professor Cui said moving away from state-funded research can provide more freedom. Government-funded projects can be bureaucratic and slow, he feels. "I think our government hasn't found the optimal method to manage large scientific programs just yet. They need to think about this when they are considering the direction of scientific reform," he said.

In implementing their business plan, Rainbowfish has acquired Graham Hawkes' Deepflight Submarine Company, and is starting production of six new Deepflight tourist submers-

Image: Professor Cui Weicheng, Shanghai Ocean University

ibles, upgraded from a 2-man to a 3-man crew. Dr. Wu has negotiated contracts with Five-star hotels in beautiful ocean side locations to operate tourist submarines as a way of raising immediate capital. They will be operated and maintained by Rainbowfish employees.

Rainbowfish has also embarked on design and construction of twin 4-man 6km rated submersibles, similar to the Russian MIRs, for possible use in China's mining claim in the Clarion-Clipperton Zone (CCZ) manganese nodule fields. Cui has allocated some of his attention to advising this experienced team as well.

Supporting Cui's imperatives, the Chinese government is building a dedicated pier and breakwater for his large mothership to operate near the Rainbowfish production facility in the port city of Ningbo-Zhoushan.

Cui extends his influence in innovative theoretical and engineering approaches to advanced ocean technology by sharing his ideas with PhD candidate students, junior faculty, and now, with Rainbowfish, to employees.

With a commitment to global sustainability and academic collaboration, Cui has assembled an advisory board of some of the world's most preeminent figures in deep ocean science and technology, including Bathyscaph Trieste pilot #1 Dr. Don Walsh, Dr. Sylvia Earle who brings her Ocean Everest advocacy, Russia's MIR Program Director Dr. Anatoly Sagalevich, DEEPSEA CHALLENGER co-designer and explorer James Cameron, WHOI's Andy Bowen, Newcastle University's Dr. Alan Jamison, Scripps Institution's Dr. Douglas Bartlett, and other distinguished scientists and engineers.

In addition to starting the HAST program at Shanghai Ocean University, Cui is advising a start-up group founding Westlake University, the first private university in China. He has been appointed as a chair professor beginning Sept.1, 2018. "It will be like CalTech in Los Angeles," Cui said. Both Chinese universities will support the HAST program in the future.

At Commencement exercises at Shanghai Ocean University

In development, the Rainbowfish 3-man 11km hadal submersible.

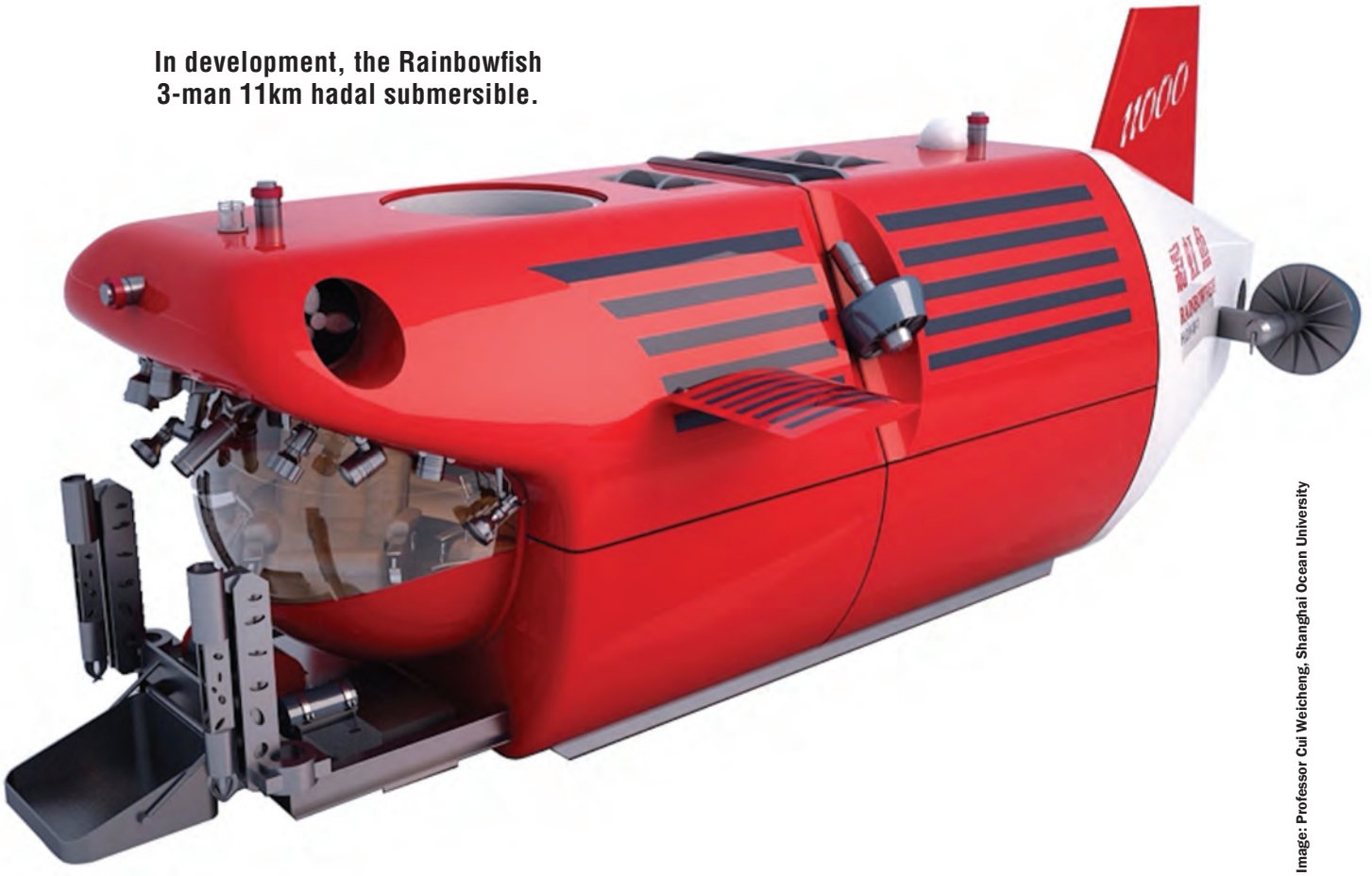

Image: Professor Cui Weicheng, Shanghai Ocean University

this June, guest speaker Kevin Hardy recalled the U.S. Navy's 1960 exploits with its bathyscaph Trieste, and added, "Today, brave explorers, men and women, led by Prof. Cui Weicheng, choose to challenge the deep waters again. They will be successful in their quest."

Cui imagines a hybrid-vehicle that can be operated as an ROV, an AUV, or a manned submersible. "The technology challenges are straightforward, with lots of room for new invention," said Kevin Hardy, who built unmanned hadal landers at the Scripps Institution of Oceanography, for James Cameron's DEEPSEA CHALLENGE Expedition, and other international hadal research projects. "Weicheng has the determination to get this done. His influence may ultimately be felt in the funding priorities of nations who once led in hadal exploration: France, Russia, Italy, and the United States."

Directly, and through his advisors, Cui has invited the world ocean science community to join him in the exploration of the unknown worlds hidden in the depths.

Says Professor Cui, "Through innovative approaches and advanced technologies we are committed to taking up the challenge of exploring and protecting the ocean's deepest places. We strive to advance humankind's understanding of the unknown deep sea world and set a course of conservation for future generations to navigate."

Image: Professor Cui Weicheng, Shanghai Ocean University

The submersible mother ship RV Zhangjian at launch March, 2016.

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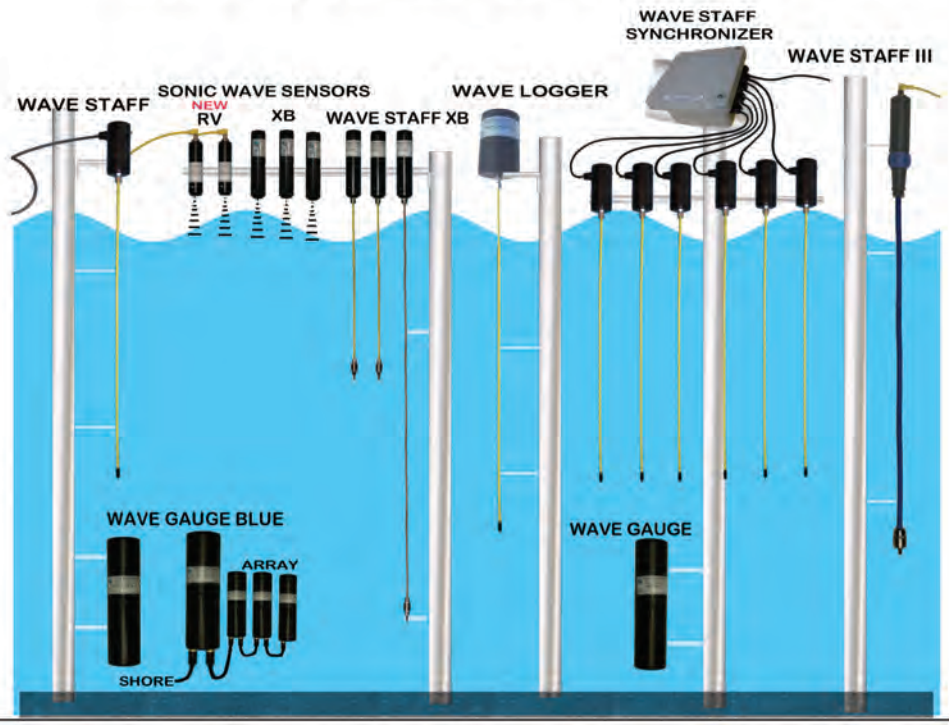

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Credit: J. Vorneveld in Morris et al. (SAEON) 2017

Two Decades of Moored ADCPs off Southern Africa

By Peter Spain Ph.D., Teledyne RD Instruments

Greater Agulhas Current

For the last two decades, the energetic and deep currents off southern Africa have seen persistent scrutiny. Found on the western edge of the South Indian Ocean, the Agulhas Current system exhibits complex circulation patterns — retroflection, meandering, and rings. They show large variability from year-to-year. Plus these flows mediate exchanges between three of the world's major oceans: Indian, Atlantic, and Southern.

Even more important, the Greater Agulhas Current is now suspected to influence the global climate system. Its role is to precondition waters that later enter the downwelling part of the global overturning circulation.

Measuring these currents has been challenging. To capture their extent,

measurements need to reach deep. To resolve changes over time, measurements need to be sustained. And to survive, persistent measurement methods need to withstand the energy of these powerful currents. For example, surface drifters, floats, and gliders are quickly swept away.

Programs making long-term measurements of major ocean currents rely on resilient moorings. And for measuring strong currents in the upper ocean, these moorings carry ADCPs.

In this report, we review several consecutive campaigns over two decades that used Teledyne RDI ADCPs to measure the Greater Agulhas Current. To help capture this incredibly dynamic system, each campaign fixed ADCPs atop mooring lines and on the seabed as part of extensive observational arrays.

For a decade, Dutch scientists focused on the strength, variability, and structure of upstream flows feeding the Agulhas.

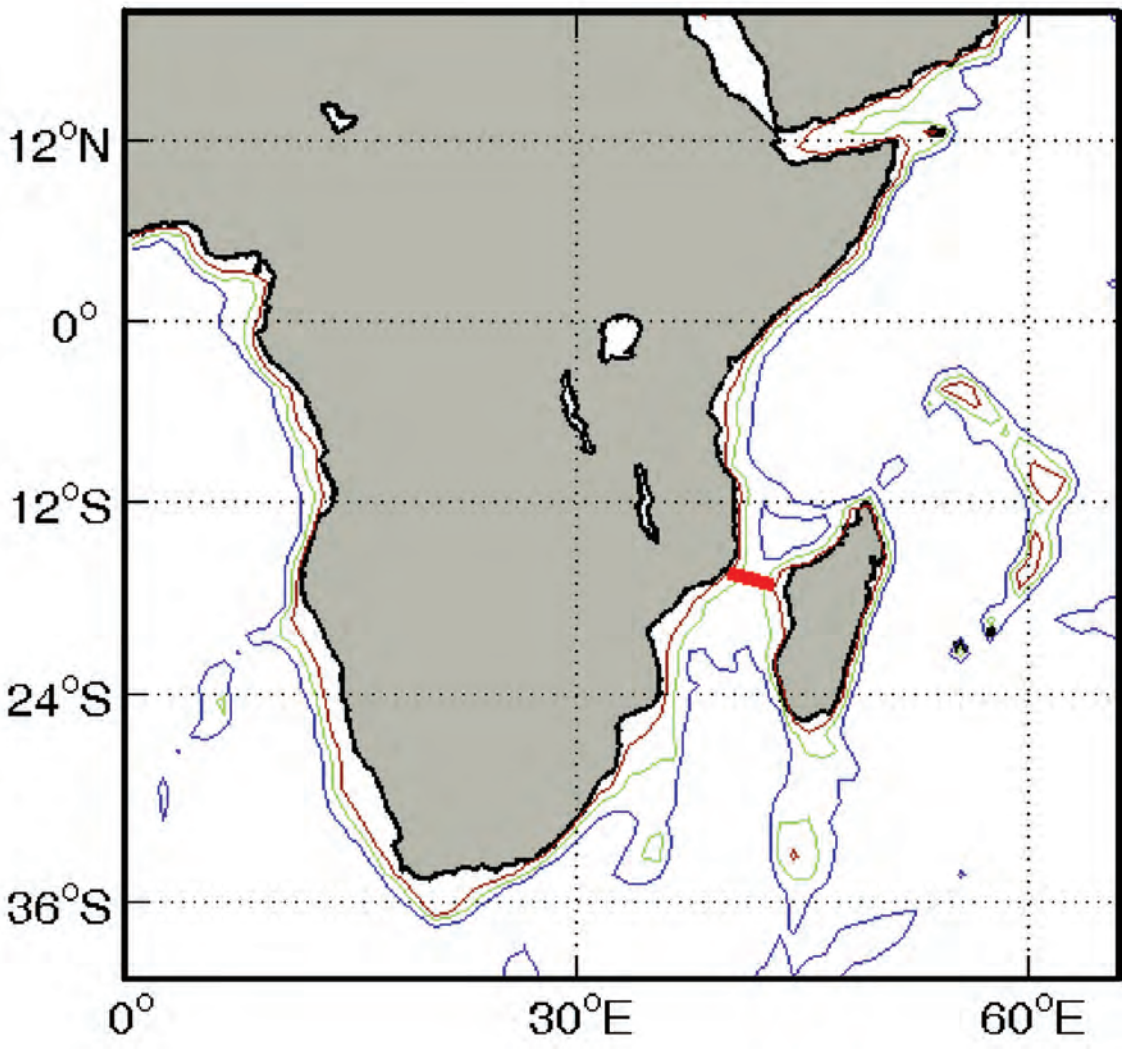
Later, off the south-east corner of South Africa, US researchers completed the Agulhas Current Time-Series Experiment (ACT) that monitored for three years. One use of their data was ground-truth to create a long-term satellite-based index for changes in the Agulhas Current.

And now, an ongoing multinational program continues the work—Agulhas System Climate Array (ASCA). It is collecting persistent observations for at least five years to explore regional and global impacts—notably climate matters.

Extensive & Persistent Current Monitoring off Southern Africa

The Agulhas Current streams poleward off the east coast of southern Africa. This major current exerts diverse influence—locally and globally. For southern Africa, the Agulhas affects things from marine transport and regional weather to local biodiversity. More globally, the Agulhas water properties are now linked to earth's climate system.

About one-sixth of the volume carried by the Agulhas leaves the Indian Ocean for the Atlantic. Paleo studies suggest that amount has varied over eons. Below the tip of South Africa, meanders in the Agulhas close off and morph into large-diameter rings. These rings propagate far westward into the central S. Atlantic. They provide a source of warmer and saltier wa-



Credit: H. Ridderinkhof (NIOZ) 2006. https://goo.gl/FrCL2b

Fig. 2
Location of LOCO moored array in Mozambique Channel.

ters to the returning limb of the global overturning circulation.

The upshot for climate studies is a heightened interest in how these rings vary. Related research has considered what triggers their antecedent—meanders in the Agulhas. In turn, this fixed attention on eddies entering the Agulhas system farther upstream.

To unravel this complexity, the Greater Agulhas Current system has been scrutinized with extensive and persistent moored arrays for the last two decades. A critical element was capturing the volume transported by strong currents in the upper ocean. For this reason, many of the mooring lines were topped with uplooking Teledyne RDI ADCPs.

On a side note—ADCPs have a long history in these waters. In the mid-1980s, Prof. Fritz Schott (University of Miami) made early use of uplooking ADCPs atop moorings off Africa, including the E. Madagascar Current.

Agulhas Current Sources Experiment (ACSEX): 2000-2001

By the late 1990s, scientists were uncertain that a continuous boundary flow existed off Mozambique to supply the Agulhas. To clarify the issue, Dutch scientists conducted the Agulhas Current Sources Experiment (ACSEX) in 2000-2001. The study was performed by NIOZ (Netherlands Institute for Sea Research) and its partners. The project focused on the strength, variability, and structure of currents.

Seven moorings spanned the Mozambique Channel for one year. Uplooking ADCPs were installed at 500 m depth on the western side where a boundary current might be expected. A compelling finding was that the amount and direction of water transported through the Channel fluctuated remarkably—much larger than the year-long average value. The researchers concluded that there was no persistent Mozambique Current.

Water mass and property transport through the Channel were due to a regular train of large (300-km diameter) eddies moving southward. The passage of these eddies was clear in the ADCP and current meter data. This helped interpret satellite data.

The combined analysis reinforced ideas that eddies drifting southward were dynamic catalysts. Not only do they spark mesoscale variability in the Agulhas Current but they affect the volume of water transferred into the Atlantic.

Long-term Ocean Climate Observations (LOCO): 2003–2012

Due to its intriguing findings, ACSEX became a springboard for a much longer observational study. This was a component of the Dutch global-research program titled Long-term Ocean Climate Observations (LOCO).

Beginning in 2003, NIOZ and its partners installed seven deep moorings at 17° S, across the narrowest part of the Mozambique Channel. The LOCO project redeployed the extensive mooring array several times. The full array was sustained for seven years and a reduced array even longer.

The upper 500 m contained the strongest currents. In the initial array design, six of the moorings were topped with upward 75 kHz ADCPs from Teledyne RDI. On the western side of the Channel, moorings had near-bed ADCPs to see an Undercurrent, which is directed equatorward.

The data set spans many years with consistently impressive spatial coverage across the Mozambique Channel. As the available record lengthened, the Dutch scientists examined different facets of volume transport through the Channel. In particular, this longevity is needed to see links with remote current systems in equatorial and Indonesian regions.

The researchers discerned that variability in the transport could be sorted into three categories. For shorter time scales, the recurring large eddies passing southward dominate changes in transport. These estimates became more statistically reliable when based on the longer data record.

For seasonal periods, modest changes in flow volumes were linked to wind-stress patterns over the Indian Ocean basin.

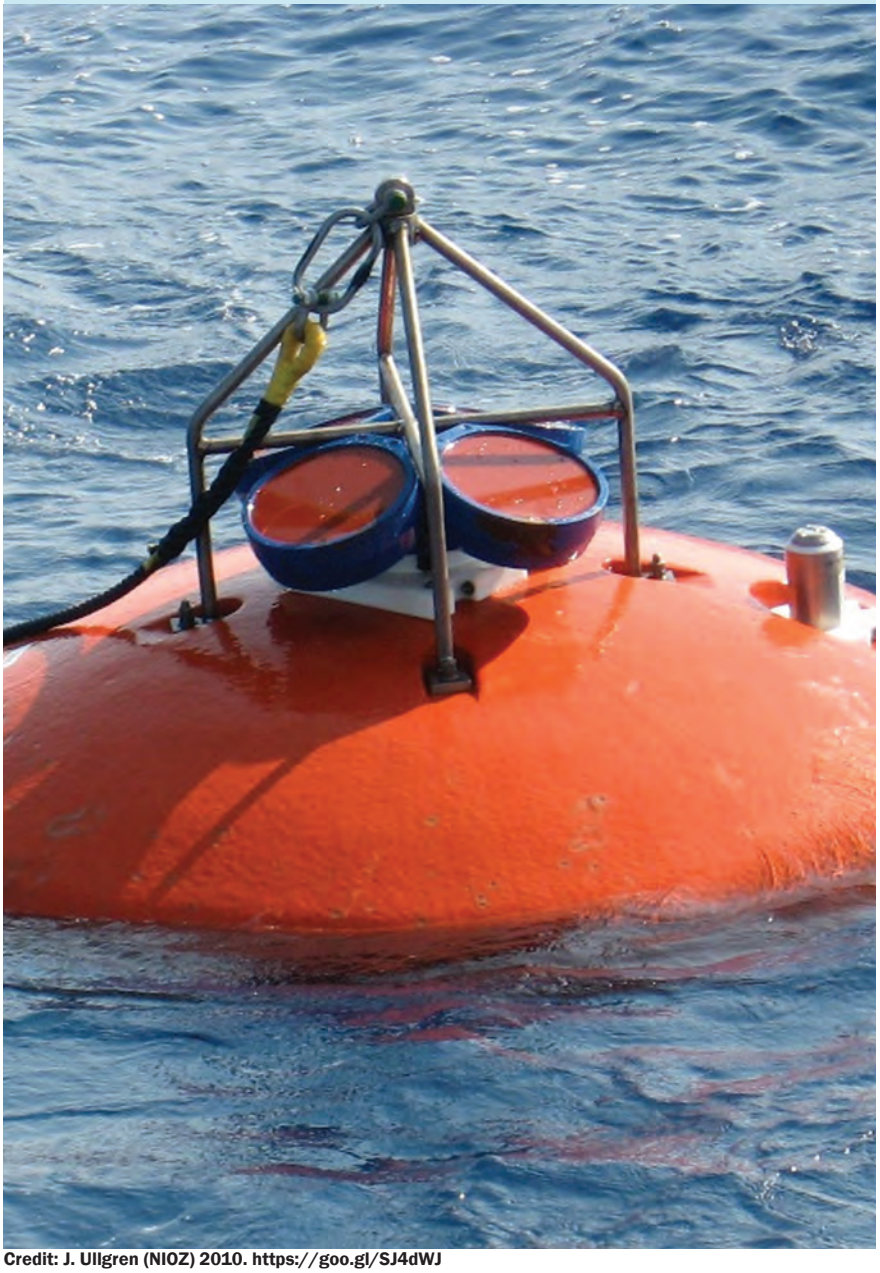
At interannual time scales, changes much larger than seasonal variations were found. These swings in volume transport were attributed to large-scale climate fluctuations. The latter are identified by a regional climate index—IOD (Indian

Fig. 1

Teledyne RDI ADCPs seated in Top Buoys of ASCA Mooring Array.

Credit: SAEON Egagasini Node. http://asca.dirisa.org/

The Greater Agulhas Current system has been scrutinized with extensive and persistent moored arrays for the last two decades. A critical element was capturing the volume transported by strong currents in the upper ocean. For this reason, many of the mooring lines were topped with uplooking Teledyne RDI ADCPs.



Credit: J. Ullgren (NIOZ) 2010. https://goo.gl/SJ4dWJ

Ocean Dipole).

Exposing the details of this subtle climate connection was possible due to the long duration of the data set. Notably, a lag of almost 12 months was found between changes in the IOD climate index and corresponding variation in water volumes supplied to the Agulhas Current.

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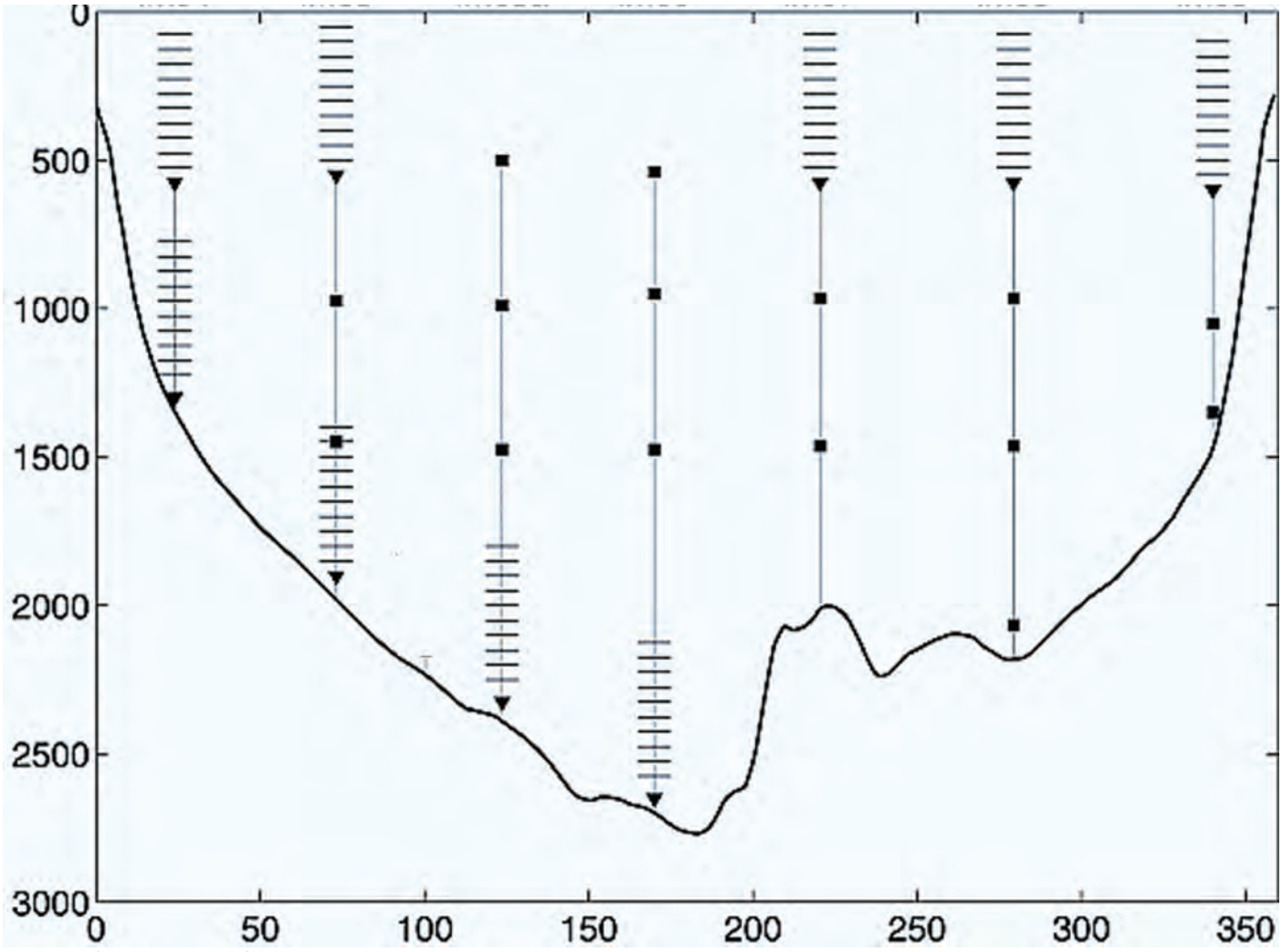
This validation with the moored measurements was essential for the scientists to be able to use the altimeter data as a 20-year index of the Current's transport. This index offered a much longer record for examining seasonal and interannual changes in the Current.

Of significance was the response of the Agulhas to intensifying global wind patterns since the 1990s. The mean flow of the Agulhas has not increased. This finding is at odds with

Fig. 3

A later setting of LOCO moorings in Mozambique Channel. ADCP profiles are indicated. Scales: depth (m), distance(km).



Adapted from H. Ridderinkhof et al. (NIOZ) 2010. https://doi.org/10.1029/2009JC005619

some theoretical expectations. Rather, the distribution of the current field is now broader—attributed to enhanced eddy action.

One knock-on effect is greater exchange of water properties with coastal waters. Such changes in the nutrient supply could affect regional fisheries.

Agulhas System Climate Array (ASCA): 2015—present

Beginning in 2015, the Agulhas System Climate Array (ASCA) occupies the same transect as ACT, near 34°S. The project includes scientists from several nations. They aim to collect persistent observations of the Agulhas Current for at least five years.

The ASCA array includes nine moorings reaching 200 km offshore. In deep water are seven tall moorings to 4500 m. Closer to shore are two seabed moorings near 100 m depth. The latter use 300 kHz ADCPs whereas the deep moorings carry 75 kHz Long Ranger ADCPs.

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Looking Ahead

The influence of major ocean currents on our living environment—from hurricanes to earth's climate—is now more widely appreciated. Yet developing this understanding has been—and remains—challenging.

A mix of methods is needed to clarify the long-term effects of global warming. Moored arrays in major ocean currents provide an essential ingredient. Insights have come from researchers using computer models and satellite-based observations. And drifters, gliders, and floats can provide snapshots. Yet there is no substitute for hanging around in these deep and energetic flows.

For scientists to see long-term trends and large-scale connections, these moored arrays must collect sustained time series. Their instrumentation and mooring lines must be resilient. And high-speed upper-ocean currents must be measured. For all these ocean-observing requirements, Teledyne RDI ADCPs remain a uniquely relevant solution.

Seabed Geosolutions' Ocean Bottom Seismic & Manta OBN

*All images courtesy of SBGS

By Claudio Paschoa

The acquisition of seismic data using nodes placed on the sea floor, Ocean Bottom Seismic (OBS) and its use in deep water with Ocean Bottom Nodes (OBN) have been growing rapidly in recent years due to considerable cost savings resulting from innovations in technology and operational concepts. ***Claudio Paschoa****, Marine Technology Reporter's correspondent in Brazil spoke to* ***Stephan Midenet, CEO of Seabed Geosolutions*** *about OBS technology in general and OBN operations in Brazil.*

OCEAN BOTTOM SEISMIC (OBS) TECHNOLOGY

OBS technology has been around for academic applications since before World War II. The first use of the technology by the oil industry was in the late 1990s when OBS units were deployed to record long offset refraction data for improved velocity mapping west of the Shetland Isles. One of the first commercial reflection OBS survey was undertaken in 2003/4 by Seabird Exploration for Pemex over the Canterel/Sihil field offshore Mexico. The node technology used for this survey was developed in Norway, following ground breaking research undertaken by Statoil (recently renamed Equinor) with their SUMIC (SUbsea seisMIC) ocean bottom four component cable system.

"For many years the superior quality of OBS data over towed streamer data, even wide azimuth streamer data, has been widely accepted in the oil and gas industry. With the advent of "third generation" nodes – both lighter and smaller, as well as lower cost – and improved node deployment and recovery rates the costs of acquiring full azimuth/long offset OBS data have significantly been reduced. When simultaneous sources are also brought into the equation these costs drop even further, to the extent that applying OBS for exploration rather than its traditional role for appraisal and development is com-

ing into play," said Midenet.

In addition to cost reductions, other factors have contributed to this advance: its superior wave field sampling ability - very long offsets, complete azimuth sampling and low signal to noise ratio; minimum impact on sampling in areas obstructed by offshore platforms and engineering structures submerged or installed in the seabed. Also, of fundamental importance, OBS operations are characterized by their relatively low environmental impact. It should also be noted that the demand for OBN projects in deep water plays increased during the recent crisis in oil prices, as they had a lower cost, compared to the seismic acquisition projects using streamers.

"The better physics of OBS acquisition – stationary receivers placed in the lower noise environment of the sea floor, no limits to the offsets and azimuths between the seismic sources and the seabed receivers, 4-component (4-C) sensors – results in better seismic data quality than can be acquired with towed streamers," said Midenet. "Ocean bottom data acquired with geophones and hydrophones, first described in the 1950s, was the original marine broadband acquisition technique and was used extensively in the 1980s, predating towed streamer broadband methods by more than 20 years. The combination of vector (geophone) and scalar (hydrophone) sensors allows the down-going reflection from the sea surface, known as the sea surface ghost, to be removed thus providing wider frequency data at both low frequencies – important for seismic inversion and full waveform inversion (FWI) – and high frequencies – necessary for improved resolution."

OBC VS. OBN

The fundamental difference between Ocean Bottom Cable (OBC) and Ocean Bottom Node (OBN) is that the traditional sources of technical downtime in OBC – terminations, connectors, power distribution and data telemetry – have been eliminated in designing the node to be a battery powered 4-channel flash memory autonomous seismic data recording unit. The removal of the need for power distribution and data telemetry allows for complete freedom in the spacing between receivers and the improvement in reliability resulting from the removal of connectors and terminations, it also allows many more receiver stations to be deployed. These two elements have fundamentally improved the operational performance of OBN compared to OBC which in turn has made OBS data much more cost effective.

A view of the versatile arrangement on the Hugin Explorer - Seabed Geosolutions' node handling and source vessel.

MANTA OBN

"The principal objective for the development of our next generation ocean bottom node technology has been to deliver a smaller, lower cost node which delivers the highest quality seismic data while allowing for wider adoption by the industry," said Midenet. "The smaller volume, lighter weight of third generation nodes allows for much faster node deployment and recovery. This in turn means we can use simultaneous sources to reduce the shot duration needed for a given survey by 50% or more, substantially reducing survey costs. Further improvements in node handling efficiency through automation will allow more and more sources to be used, driving costs down to the point that OBN will be used for exploration as well as appraisal and development objectives."

OBN IN BRAZIL

Historically, OBN costs have been higher than narrow azimuth (NAZ) towed streamer acquisition, but the improved cost efficiencies arising from both third-generation nodes, improved node handling and deployment/recovery and simultaneous sources have reduced full azimuth long offset OBN costs to the point that they are very comparable with wide azimuth (WAZ) towed streamer costs. "Taking into account the environmental constraints offshore Brazil regarding the use of closely spaced seismic sources, OBN offers a unique solution for the full azimuth data needed to deliver the data quality needed to develop the pre-salt reservoirs offshore Brazil," said Midenet. "Three OBN surveys have been acquired offshore Brazil and, at the time of writing this, a fourth is being finalized to allow the fifth to commence." Globally there have been more than 360 OBN surveys since 2005 (source: Rystad Energy Research and Analysis, June 2018).

"To improve OBN survey efficiency and reduce costs, a number of surveys worldwide have been acquired using simultaneous sources. For this to be applied offshore Brazil will require either a change in the current environmental concerns regarding the proximity of seismic sources or alternative energy sources to be employed," said Midenet. "While there have been some promising developments in this area recently, these are far from being operationally proven and thus the goal of reducing OBN costs to encourage wider application and uptake will take some time unless the environmental concerns can be

addressed. The cost per square kilometer for an equivalent operation in 2018 is approximately 40-45 percent of what it was five years ago. We see continuing demand for future projects both in 2019 and beyond. The first thing our Brazilian clients say to us is that the quality of the OBN data we have acquired for them is outstanding. They have been very positive, too, about the operational performance of the crews which have been operating through the most difficult weather conditions offshore Brazil."

OBN AUTOMATION

Seabed Geosolutions are continually increasing the level of automation in all areas of their operations to reduce HSE exposure and improve both operational performance and geophysical data quality. "We have been working with partners on the development of an autonomous OBN system called SpiceRack. The results of a 20-vehicle test, conducted in 2017, were presented at the 2017 SEG Annual Meeting in Houston. The operational model for both shallow and deep water utilizes the same technology and methodology, so we anticipate being able to conduct a deep water test of this technology shortly after we have successfully completed the shallow water test," said Midenet.

NOAW TECHNOLOGY

"Node-On-A-Wire (NOAW) is an automated technology for node deployment in water depths less than 700-1000m. Historically in such water depths, OBC technology with dense receiver spacings – 25m/50m – was

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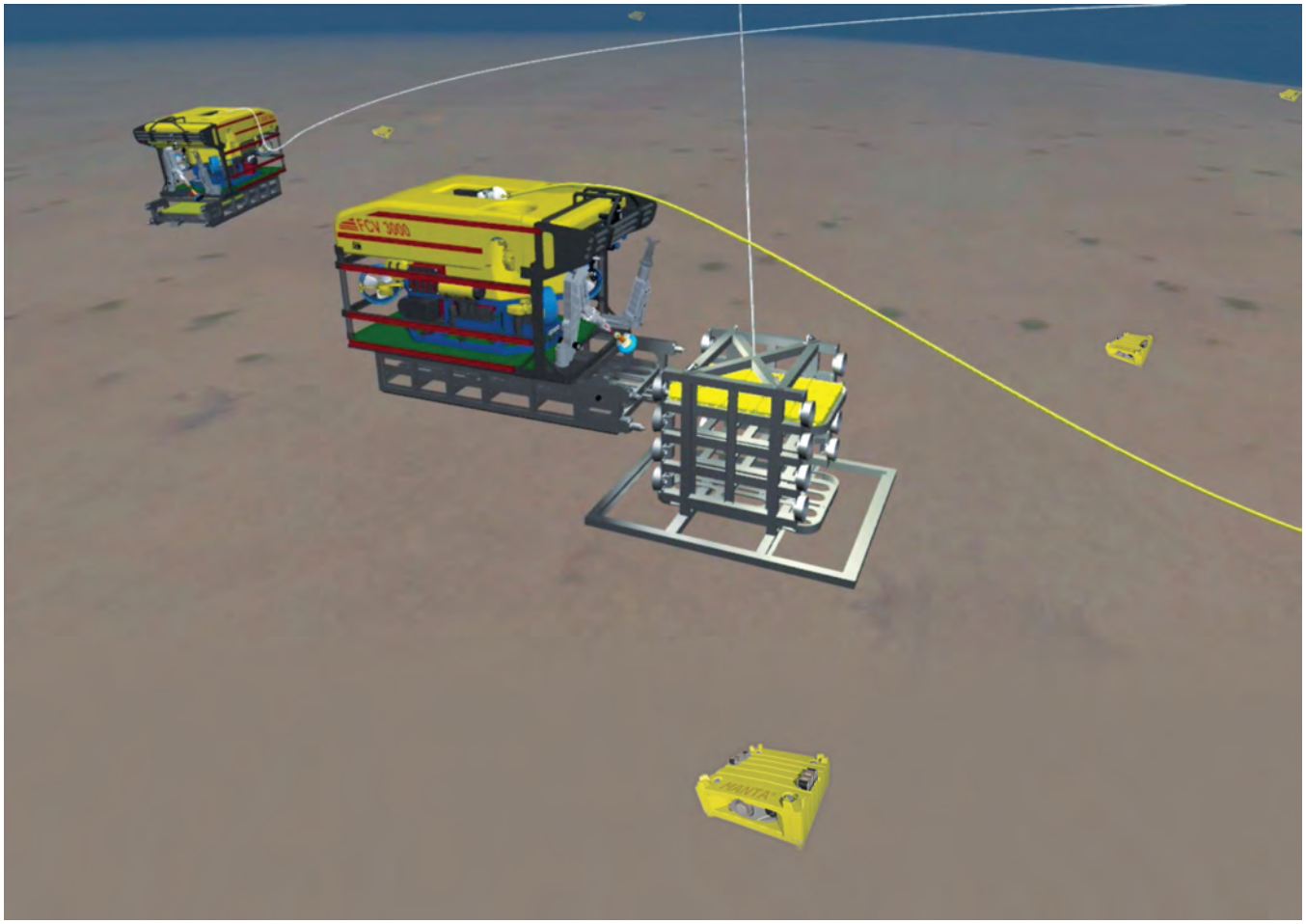
– Stephan Midenet, CEO of Seabed Geosolutions

employed. Seabed Geosolutions' NOAW system was designed to deploy such dense receiver configurations rapidly whilst minimizing HSE exposure and risk," said Midenet. "It is a fully containerized system that we can install in a few days on a suitably equipped vessel of opportunity, thus reducing mobilization/demobilization costs. For potential applications offshore Brazil where such dense receiver OBC surveys have been acquired in the past, we would consider the relative efficiency we can achieve with remotely operated vehicle (ROV) deployed nodes, due to the challenges of operating NOAW solutions in such deep waters, especially given the demanding positional requirements for 4D surveys."

With the ongoing revival of the oil and gas marked in Brazil, due in part to increased offshore tenders, especially at promising pre-salt reservoirs and the recent rise in oil prices, there will consequently be an increase in seismic acquisition along the lengthy Brazilian coast. National Operator, Petrobras, is already investing in re-acquiring seismic data in the pre-salt portions of the maturing Campos Basin, which has been developed almost solely through post-salt reservoirs. Petrobras and other major players are also developing major deep water reservoirs such as Libra, Carcará and Sapinhoá, were OBN technology may be used both for reservoir appraisal, exploration and for fine-tuning production development.

Seabed Geosolutions was established in 2013 as a joint venture between Fugro (60%) and CGG (40%) – uniting Fugro's ocean bottom node expertise with CGG's ocean bottom cable, node and transition zone operational experience. With headquarters in Leidschendam in the Netherlands, and offices in Houston, Dubai, Massy and Kuala Lumpur, Seabed Geosolutions has acquired more than 38,000 km2 of 3D ocean bottom seismic data since 2005.



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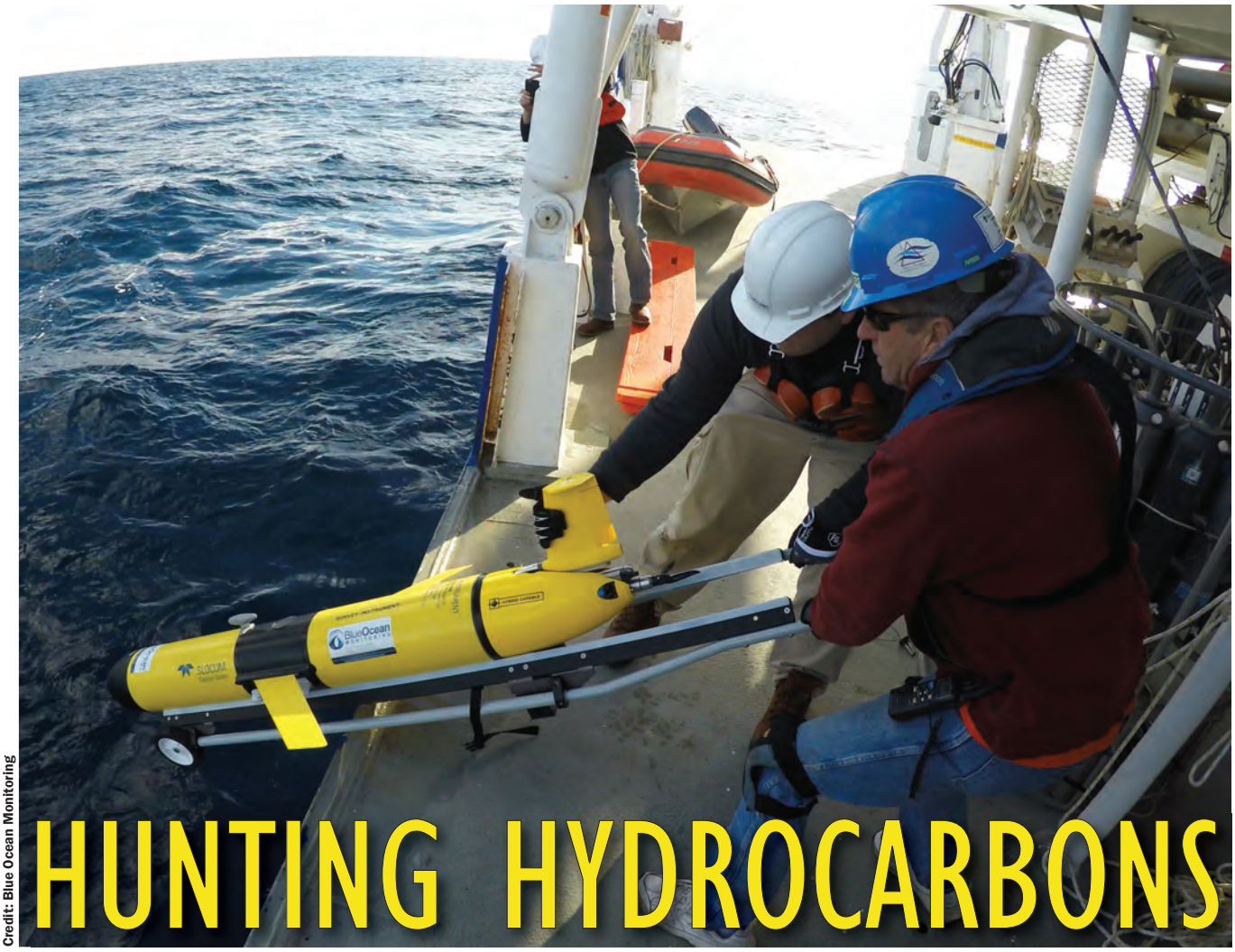


Credit: Blue Ocean Monitoring

HUNTING HYDROCARBONS

Subsea glides are taking to the oceans to hunt for an ever wider array of anthropomorphic and chemical signatures to an ever greater accuracy.

Elaine Maslin reports

Ocean glider systems are maturing. Since emerging in the 2000s, they've opened up new possibilities for ocean observation and monitoring. But, these possibilities are continuing to expand, including to gas seep surveys, leak detection, mammal monitoring and oil spill monitoring, for the offshore oil and gas industry.

The primary attraction of ocean gliders is their ability to stay at sea for months, monitoring wide areas in remote locations down to significant depths. This is because they're mode of propulsion is energy efficient. Rather than using a propeller to move through the water, gliders use changes in buoyancy which is converted into horizontal motion by fixed wings, creating a "saw-tooth" shaped trajectory through the water in depths down to 6000m. To communicate the data they collect, they usually surface and use satellite or radio communication, which also allows them to receive missions and correct their positions.

Using Teledyne Webb Research Slocum Gliders, Australia-based Blue Ocean Monitoring has been building its track record in the use of subsea gliders, including expanding the range of missions possible with these vehicles, to tasks such as drilling plume and produced water discharge monitoring and oil spill response activities offshore Australia.

Ramsay Lind, General Manager – EMEA, at Blue Ocean Monitoring, says the company is the largest owner of Slocum Gliders, which weigh 50-60kg, operate for up to 120 days, payload dependent, and are light enough to be deployed over the side of a vessel. The Slocum G2 Glider can operate down to 1000m and for 4000-6000km, with alkaline batteries (600-1500km with alkaline), for up to six months (30 days

with alkaline), traveling at up to 2kt. Positional accuracy can be supported using a Doppler velocity log (DVL) and magnetometers.

Working with Canada-based JASCO Applied Sciences, Blue Ocean has been doing passive acoustic monitoring (PAM) projects to aid environmental and anthropogenic monitoring during seismic surveys and, it hopes soon, also around offshore wind piling operations monitoring. For PAM operations, broad spectrum hydrophones are mounted to the gliders to record low and high frequency acoustics from marine life.

Blue Ocean's first PAM survey was in 2016, offshore Western Australia, during 3D seismic acquisition operations. The glider was deployed in the survey area and traversed four days, covering about 30km/day, depending on the current, before performing simultaneous operations with the seismic vessel. The glider, operating in about 200m water depth, had two payloads: a CTD (conductivity, temperature and pressure, i.e. depth) sensor and JASCO hydrophones, which picked up the sounds of the shots, as well as sounds from dolphins, at 10hz, and Omura Whales.

Blue Ocean has also integrated fluorometers into the sensor payload, for a geochemical survey in the Gulf of Papua, offshore Papua New Guinea in the South Pacific. The Davaria project was a multi-client speculative data shoot, to gather evidence of hydrocarbon seeps, using a glider equipped with two fluorometers (Wetlabs SeaOWL and Turner C3).

Then, in 2017, the firm undertook the self-funded Yampi Geochemical Glider Survey, a research and development project in the Browse Basin, off Australia's northwest coast, to detect gas seeps. This time the survey incorporated the use of methane sensor technology, which have been used on AUVs, but not on underwater gliders before, to give greater detail about the hydrocarbons detected. The Franatech laser methane sensor "high-grades" the information gathered, says Lind. An oxygen sensor was also added.

During the 14-day Yampi project,

"Combining PAM and geochemical sensing into single surveys will be a further step in understanding the cost benefits associated with this type of force multiplier."

– Ramsay Lind, General Manager – EMEA, at Blue Ocean Monitoring

again at 200m water depth, the glider was guided over a well-known seep, near the Cornea oil and gas field. A fluorometer primarily detecting FDOM (fluorescent dissolved organic matter) values was used to detect and help analyse what type of hydrocarbons were present alongside a laser methane sensor.

Results from the survey showed a background dissolved methane concentration of 3 to 4 volumes per million (vpm) as well as distinct plumes measuring 30 to 84 vpm. The highest concentration plume was detected at 160 vpm, reflecting existing Geoscience Australia data.

During this project, near real-time communication systems and adaptive management of the glider was also tested, using satellite communications when the glider surfaced, enabling pilots in Australia or the US (depending on the time of day) to guide the glider to investigate anomalies in greater detail, and inform the survey plan.

Having proved the capabilities of using the glider for seep detection, Blue Ocean has taken the concept a step further this year, by using multiple gliders for a single survey. In a project in May, in the US Gulf of Mexico, four gliders were used together, supported by USBL positioning (for position accuracy) from a manned surface vessel. The gliders were mounted with PAM, CTD sensors, FDOM fluorometer, laser methane and METS methane sensors and a Sonardyne USBL system.

USBL positioning helps to mitigate positioning error says Lind, as well as enabling two-way communications. “Going forward, we want to deploy unmanned surface vessels which would be in communications with more glider platforms,” says Lind. “We’re also looking at options for mass spectrometer integration for purposes of hydrocarbon

One of Blue Ocean Monitoring’s Slocum gliders fitted with a hydrophone.

fingerprinting and multiple hydrophones to gain directionality alongside real time PAM processing capabilities."

The firm is already deploying single gliders fitted with multiple hydrophones, to aid in understanding the directionality of acoustic signals to be ascertained. The next step is to use multiple gliders fitted with hydrophones that are tracked with USBL systems to provide far wider area coverage, with greater accuracy directionality, and capable of providing more accuracy around noise source geolocation. Blue Ocean is looking to trial this system in 2019.

For offshore wind construction operations, Blue Ocean is looking at taking take part in a pilot study, to understand piling operations from a remote, dynamic platform and monitor marine mammal activity before during and after these events. The proof-of-concept study is due to take place in Europe with a large-scale offshore wind operator. "Combining PAM and geochemical sensing into single surveys will be a further step in understanding the cost benefits associated with this type of force multiplier," says Lind.

Blue Ocean is also working on integrating JASCO's OceanObserver system, which would enable a modicum of real time data processing on board the glider. "As stands, processing for PAM data on board a glider platform can involve some 375,000 samples per second," says Lind, "which is a lot of number crunching. With this software, some of the processing can be carried out on board the Glider, enabling real-time detection of marine mammals for instance."

The firm also has a number of studies due to take place in Europe and further afield by the end of this year, involving PAM and fluorometer measurement campaigns.

SeaExplorer Underwater Glider: A New Tool to Measure Water Velocity; Glider-based ADCPs yielding promising results for measuring depth-resolved currents profiles in open-waters.

By Orens Pasqueron de Fommervault, Florent Besson & Philippe Lattes

Autonomous underwater gliders are beginning to prove their large potential in modern oceanography and have an increasingly important place in ocean monitoring studies. The SeaExplorer glider, developed and commercialized by Alseamar, is a buoyancy-controlled UUV. By changing its buoyancy, it moves through the water column down to a depth of 1000m, coming periodically to the surface for data transmission. Over the past 10 years, the SeaExplorer has been used to make a variety of measurements in both coastal and deep-sea environments. It has been deployed to characterize water masses properties, to study biological processes and to track dissolved hydrocarbons through the water column.

In 2017 a new sensor dedicated to water velocity measurements was integrated to the platform in the framework of a research project conducted by Alseamar together with the entity in charge of metocean discipline in TOTAL SA. The sensor is a 1 megahertz Acoustic Doppler Current Profiler (ADCP) commercialized by Nortek AS. This ADCP was a good match for the SeaExplorer glider due to its low power consumption, and for its ability to let users create and transmit telemetry files, small subsets of the data, in real time when the glider surfaces and transmits via Iridium. The full data remains on board and can be retrieved when the glider is recovered. With this ADCP, users are able to run long glider missions and transmit data in real time.

Figure 1. Deployment of a SeaExplorer glider equipped with a Nortek ADCP.

Water velocity observations are of great interest in oceanography. They provide valuable information on ocean mixing and dispersion, processes that control the distribution of many parameters (e.g. phytoplankton and nutrients concentrations, suspended matter, pollutants). Currents also transfer significant amounts of heat and thus play important roles in determining the climate of various regions. In that sense, there is also a need for in situ ocean currents measurements for modelling and weather forecast purposes. Water velocity observations are also critical to better characterize metocean conditions for new assets of the oil & gas industry or directly in support of their offshore activities.

In this short overview we present water velocity measurements acquired in deep waters by the SeaExplorer. This opens new perspectives in ocean research and monitoring.

A CHALLENGING MEASUREMENT

ADCPs determine water velocity by transmitting a sound pulse and measuring the acoustic Doppler shift signal returning from scattering material in the water column. Raw velocity measurements are thus relative to ADCP transducers and differ from absolute water velocities by including vehicle displacement. Consequently, to determine absolute water velocity, one theoretically needs to know the underwater motion of the platform. For gliders operating in shallow water with downward-looking ADCPs, bottom tracking can be used to obtain this information, by referencing ADCP data with the bottom. If bottom tracking is unavailable, i.e. in open ocean or if the ADCP is in upward-looking configuration, other methods must be used and the measurement is much more challenging.

DATA PROCESSING

The Nortek AD2CP was specifically developed for glider applications. In particular, the instrument uses a four-beam transducers head compensated for pitch angle of the glider. This way velocity data can be acquired during both the descent and the ascent which yields a complete dataset for post-processing. The ADCP was programmed to emit an acoustic signal (4 averaged pings) every ten seconds. For each averaged ping, data were recorded by the ADCP at discrete depth intervals (30 cells) of 1m resolution (cell size). This leads to a usable range of 15 to 30 m, depending on water masses properties. Raw along-beam velocities were converted into an earth-based reference system using rotation matrices and compass angles measurements (heading, pitch and roll).

The underlying assumption in using an ADCP mounted on a glider is that one can use successive overlapping velocity profiles to obtain a full ocean depth velocity pro-

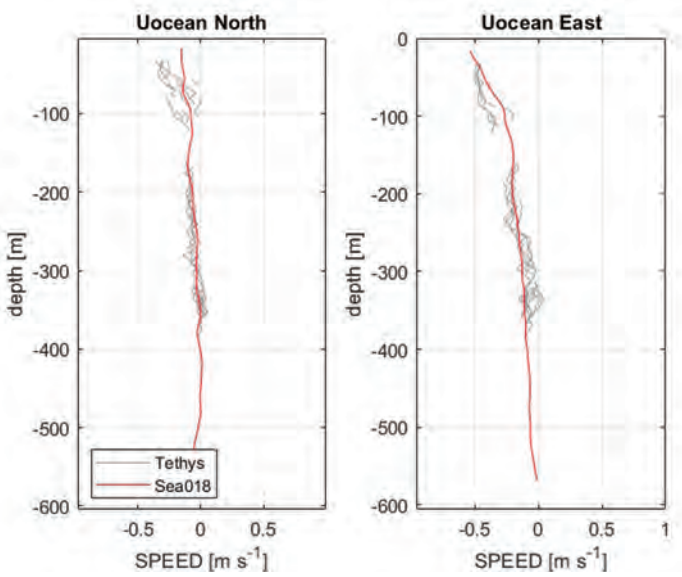


Figure 2. Comparison between R/V Tethys II ADCP measurements and Glider ADCP profile.

file. One method to remove unknown glider motions is the "shear method". Taking the vertical difference of raw water velocities for each ensemble provides the shear values between cells and removes glider motion and the depth average (barotropic) constant. Overlapping shear values were averaged over a given interval, set at 2 m in our processing, to determine a mean shear profile for a dive. This profile was then vertically integrated to obtain a baroclinic velocity profile. During our missions, most of the time, bottom-tracking data were not available because gliders were operating in deep-waters (bottom depth > 1000 m). Hence, the baroclinic profile was referenced using the displacement of the glider between two surfacing, known through GPS position, to obtain the barotropic profile. Finally, the absolute water velocity profile was obtained by summing the baroclinic and the barotropic profile.

CASE STUDY: THE MEDITERRANEAN SEA

Five ADCP-glider missions were conducted by Alseamar in the Northwestern Mediterranean Sea, off the French coast, in the last eight months. We present the results of two of them. The first one took place in February 2018, and the second one in July 2018. To improve the profiling rate, gliders were programmed to dive to 700 m depth. In this configuration, two consecutive surfacings were separated by around three hours, and were around three kilometers apart. The area where gliders were deployed is widely studied as part of the Mediterranean Observing System (MOOSE, www.moose-network.fr). In particular, Alseamar's gliders performed transects between the time-series station Boussole and Nice harbor which is a reference line, monthly monitored by the R/V Tethys II equipped with a 75 kHz ADCP. Since 2007, the transect is also regularly occupied by gliders but it is the first time one of them was deployed with an ADCP.

The first objective of the missions was to validate our processing of glider-mounted ADCP data. To this end, glider measurements were compared with in situ ship-ADCP data from the R/V Tethys II, kindly processed and provided by the DT-INSU data center (http://www.dt.insu.cnrs.fr/spip.php?article35). A profile-to-profile comparison showed a very good accordance between glider and ship-data. The mean difference was found to be 1.5 cm.s-1, which is very satisfactory.

Data also showed that gliders were perfectly capable of catching interesting and known features of the Northwestern Mediterranean Sea. For example, the Northern current, a permanent flow that results from the large-scale thermohaline circulation of the Mediterranean Sea, was regularly sampled. In the transect presented here, the flow had a westward direction and reached a maximum velocity of 60 cm.s-1, which agrees with model simulations. The Northern current was located at around 30 km distance from the coast and had a maximum vertical extend of 300 m depth on the North edge. At 40 km, the current dropped below 10 cm.s-1. The comparison between ADCP data and other conventional measurements, concomitantly acquired by the glider (temperature, salinity, dissolved oxygen, chlorophyll), also highlights the predominant impact of the current on the vertical distribution of physical and biological parameters. In particular, a coherence between the vertical distribution of current velocity and the density field was observed. The Northern current separates the area into light coastal waters and an open-water with higher surface densities.

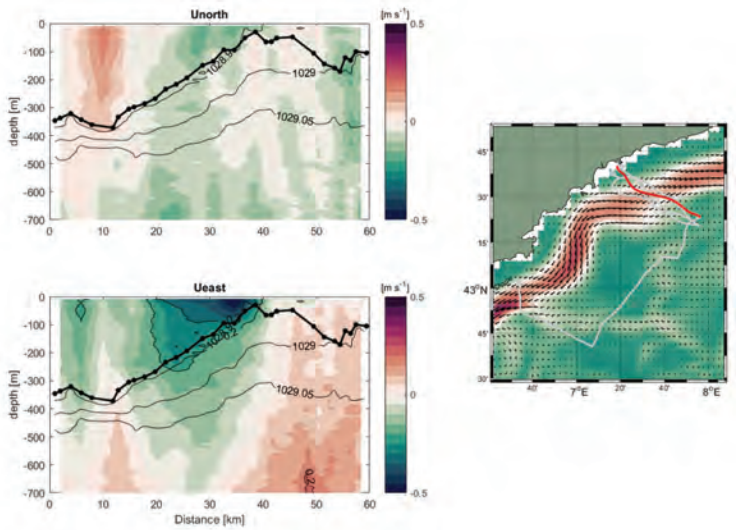


Figure 3. Glider-ADCP data acquired during the mission conducted in February 2018. The trajectory is superimposed on surface currents estimated by the NEMO v3.6 model (data downloaded on www.marine.copernicus.eu).

Another interesting feature was a cyclonic-like structure observed at the margin of the Northern current, which results from current instabilities. Such structures of few kilometers and short duration are hardly detectable from other means (e.g. ship, satellite) and almost impossible to forecast with numerical simulations.

CONCLUSION

The success of these missions highlights the reliability of measuring accurate depth-resolved water velocity profiles with SeaExplorer gliders. Measuring water currents from a glider has many benefits. Data can be obtained in near-real-time, with a high vertical resolution (in the order of 1 m) and up to 1000 m depth (unlike a ship-mounted ADCP which has a depth range of around 400 m). Velocity profiles may also be very useful to interpret other variables measured by gliders and to study physical-biological interaction at unexplored scales. This also opens new perspectives for metocean applications and can help for characterization of conditions in support of offshore operations.

Other deployments are planned to start soon, in various area around the globe.

ACKNOWLEDGMENTS

The authors acknowledge the financial support from TOTAL and Naval Group. We are also grateful to Céline Heyndrickx (DT-INSU, CNRS) for providing processed ship-ADCP data and to Vincent Taillandier (LOV-CNRS), Louis Prieur (LOV-CNRS), Fréderic Marin (IRD), Yann Le Page (Alseamar) and Laurent Beguery (Alseamar) for their scientific assistance.

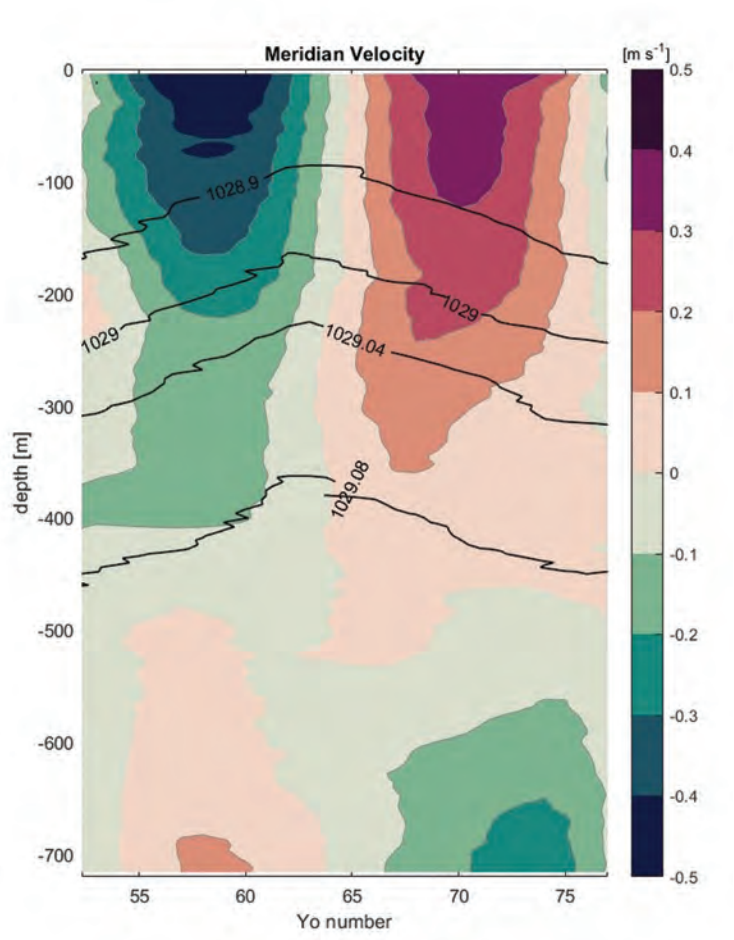


Figure 4. Glider-ADCP data acquired during the mission conducted in July 2018. Only data acquired during the period when the glider was sampling the cyclonic structure are plotted.

10th Annual Blue Tech Week

"UN Sustainable Development Goals – Industry Solutions"

MTR interviews Michael Jones, the ubiquitous leader of The Maritime Alliance and the architect of the Blue Tech Week in San Diego.

By Greg Trauthwein

For MTR readers not familiar with BlueTech Week, please give a synopsis in a sentence or two.

The Maritime Alliance (TMA) creates a Blue Voice via unique events, information sharing, national & international outreach, networking, research, and workforce development. The 10th annual BlueTech Week (BTW) scheduled for Nov. 5-9, 2018 in San Diego is a series of 7 networking events over 5 days that brings together representatives of the Triple Helix – academia/education; industry; and policy makers – from around the world.

BlueTech Week has certainly evolved over the years. What's new for the 2018 event?

Every year we have a different theme for BTW. This year it is "UN Sustainable Development Goals & Industry Solutions." We continue to grow, add new industry tracks, and attract attendees, clusters and companies from more countries. From BTW2016 we moved to a new venue for BTW2017, which we outgrew in one year, so we will be in a new, larger venue for BTW2018! Information is available at www.bluetechweek.org.

All Photos Courtesy The Maritime Alliance, photo by Ron Estevez

Blue Tech Week brings global leaders in the subsea space to San Diego for a week of conferences, demonstrations, meetings and social networking.

How is this event most the same ... and most different ... than the event you started in 2008?

BTW is always focused on the TMA Mission, which is "Promoting Sustainable, Science-Based Ocean & Water Industries". It is about balancing conservation and smart economic growth… and on "Promoting BlueTech and Blue Jobs®." That is a constant. On the difference side, we have developed a much stronger focus on BlueTech clusters globally and on developing investment capital for the industry. We have also grown dramatically. We started with perhaps 120 attendees in the first year and expect 550+ individual attendees this year representing academia/education, companies, clusters, and policy makers from 20+ countries.

You have multiple days, multiple venues and multiple events. A difficult question for sure, but what do you consider to be your 'show-stopper' this year?

It is impossible to say we have a "show-stopper" because each of the 7 events over 5 days are important in different ways to different stakeholders, which is also why the events are "unbundled". The 4th annual "by invitation" BlueTech Cluster Convening will bring together 20+ existing and in-formation clusters – probably the largest BlueTech cluster gathering in the world – to discuss Best Practices and collaboration. The Marine Debris Solutions day co-hosted with Scripps Institution of Oceanography on Nov. 6 will focus on innovative industry solutions to four big issues: Plastics in the Ocean; Sunken Vessels and Unexploded Ordinance; Oil Detection and Cleanup; and Fishing & Netting Gear Alternative Solutions. The BlueTech Summit & Tech Expo on Nov. 7-8 will feature 4 Plenary Sessions with an amazing array of speakers, 4 tracks with 6 panels each, and 40 exhibitors – more than ever before. And the 3rd annual BlueTech Investor Day is attracting more investors than ever before.

We know that your reach is global, but looking in your own backyard and Southern California, can you give your insights on how this region, this cluster, has evolved over the last decade?

With 3.3 million inhabitants, San Diego is California's second-most populous county and the fifth-most populous in the United States. There is an amazing array of government, industry, military and university assets in the region. In addition, looking at the larger Cali-Baja region – there are about 7 million inhabitants. TMA has played a crucial role in helping develop an increasingly unified regional Blue Voice. This includes a process to create a TMA Baja chapter with partners in northern Baja California, Mexico. And most importantly, BlueTech companies are increasingly collaborating and assisting each other – truly a "rising tide raises all boats" story.

Aside from geography, what other factors contribute to making SoCal ripe as a marine technology hub?

The presence of the US Navy, research facilities starting with world renowned Scripps Institution of Oceanography, an amazing harbor with deep water near offshore, and a large concentrated grouping of BlueTech companies benefit the San Diego region. TMA has played a lead role in organizing this regional industry…but we look at our "good fortune" as an opportunity to help create a model for the country and internationally.

I know from participating in this event for years that it is a 'labor of love' for you personally, with the emphasis on "labor." When you look at this event and what it has become, what do you find: The most challenging?

The most challenging is that there is still too little recognition of the importance of the ocean to the future of all living

creatures on earth. We also believe that it makes sense for BlueTech clusters to include companies active in the ocean and water tech industries – BlueTech companies sell across both.

The most rewarding?

There is an increasing awareness of the importance of the Blue Economy and BlueTech, and of the critical role of BlueTech clusters to develop Blue Voices region-by-region, country-by-country. It is BlueTech that allows us to find the problems that humans have created over thousands of years – throwing stuff in the ocean and overusing water resources – and it is BlueTech that is critical to provide the solutions. I am particularly proud of our growing national and international member base, of our extensive educational outreach and partnerships that are critical to develop needed technical workers and the entrepreneurs of the future, and of the growing BlueTech Cluster Alliance, which promotes collaboration among 10 BlueTech clusters from 8 countries today.

10th Annual Blue Tech Week

November 5-9, 2018, San Diego, California

"United Nations Sustainable Development Goals – Industry Solutions"

BlueTech Week 2018 "at-a-glance"

- 7 events in 5 days
- 500+ attendees representing senior executives from academia, industry and government
- Tech Expo with around 40+ table-tops ($600 per company, not including registration)
- 80+ speakers
- 100+ companies (95 companies in 2017)
- 18+ BlueTech clusters or clusters-in-formation
- 16+ countries represented
- 20+ companies in the PitchFest
- Separate Maritime Gala Dinner & Awards Ceremony
- Unbundled daily event fee includes hosted breakfast, breaks, lunch and hosted reception

www.bluetechweek.org

Damen Floats out Australian Icebreaker

Damen

Aussie Icebreaker Floats Out

The new Antarctic Supply Research Vessel (ASRV) RSV Nuyina currently under construction at Damen Shipyards Galati in Romania has been floated out and maneuvered 250 meters to a quayside berth where the ongoing construction and outfitting process will take place.

Damen is building the 160-meter-long icebreaking vessel for Serco subsidiary DMS Maritime on behalf of the Australian Department of the Environment and Energy. The multi-mission vessel will keep Australia's three permanent research stations on the Antarctic continent and its research station on Macquarie Island supplied with cargo, equipment and personnel. Additionally, it will serve as a fully equipped research laboratory facility for up to 116 scientific staff.

Construction of the vessel began in August 2017. Building from the keel up, the build process has reached the fourth deck level in that time. Now that the vessel is afloat, construction will continue with the positioning of prefabricated superstructure blocks, bringing the finished vessel to its full 10-deck height of just over 50 meters.

The construction process is calling on input from two different Damen yards: Damen Schelde Naval Shipbuilding in the Netherlands is providing engineering and project management services, and Damen Shipyards Galati is carrying out vessel construction and outfitting tasks.

Oceanographic Icebreaker Kronprins Haakon Delivered

A new icebreaking research vessel built for the Norwegian governmental body for oceanographic research and fishing, was delivered earlier this year in Norway.

After the building process was completed at Fincantieri's Integrated shipyard of Riva Trigoso and Muggiano in Italy, the new vessel, named Kronprins Haakon, sailed to the Vard Langsten shipyard in Norway for final tests and preparation for delivery to the Institute of Marine Research (IMR).

The 9,000-gross-ton icebreaker is more than 100 meters long, 21 wide and can reach speeds up to 15 knots. She is able to move independently through ice up to one meter thick. She is built to ensure minimum environmental impact and reduced underwater noise, so as to allow studies on fish and marine mammals.

Although specifically tailored to the Arctic, Kronprins Haakon will be able to carry out oceanographic and hydrographic research activities in any area of operation. The vessel features a range of state-of-the-art sensors and equipment for performing various scientific tasks such as geology, geophysics, chemistry and seismology studies. The vessel will conduct missions on a global scale and will be used to study the modalities and consequences of climate change in the Arctic environment.

At the bow, the ship's hangar is able to accommodate two helicopters and is equipped with complex instrumentation able to investigate the morphology

Oceanographic Icebreaker Kronprins Haakon

Photo: Photo: Øystein Mikelborg / Norwegian Polar Institute

UCONN's RV Recommissioned

Photo: Peter Morenus/UConn

and geology of the seabed. The vessel can accommodate 55 people, including research personnel, students and crew, in 38 cabins and is outfitted with the highest comfort standards for passenger ships.

UCONN's RV Recommissioned

The University of Connecticut's 19-year-old ship RV Connecticut has been recommissioned following a total makeover that increased its length from 76 feet to 90 feet. The work performed over the past year doubled the laboratory space on board and increased the number of bunks from 12 to 18, allowing for missions at sea of up to 14 days.

The R/V Connecticut has been used extensively over the years by UConn researchers in addition to other groups that have chartered it, including the U.S. Navy, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and the Woods Hole Oceanographic Institution. In its previous five years of service, the ship spent 474 days at sea and traveled 38,721 miles. UConn's Department of Marine Sciences, which is housed at Avery Point, has 55 undergraduate majors and 40 graduate students, with 20 tenure/tenure track faculty. During the past 18 months, the faculty of the department have been awarded over $10 million in federal and state grant support.

OSU Names New RV

The first new Regional Class Research Vessel being constructed with funds from the National Science Foundation to bolster the nation's aging U.S. Academic Research Fleet now has a name. The Oregon State University-bound research ship will be called Taani, a word used by the Siletz people meaning "offshore." Under construction by Gulf Island Shipyards, LLC in Louisiana, the vessel is scheduled for delivery to OSU in the spring of 2021, and will be fully operational after a year of outfitting and testing.

The National Science Foundation selected Oregon State in 2013 to lead the design, shipyard selection, construction and transition to operations phases for as many as three new regional class vessels for the academic fleet. Subsequently, the National Science Board – the oversight body for the National Science Foundation – authorized as much as $365 million for the project.

Last summer, the NSF awarded OSU a grant of $121.88 million to launch the construction of the first vessel, which was the largest grant in the university's history. This summer, the grant was supplemented with an additional $88 million to proceed with the contract for the second vessel.

Taani will replace the Research Vessel (R/V) Oceanus, which in 2012 was transferred to Oregon State from Woods Hole Oceanographic Institution to replace OSU's Wecoma, which was retired. The name "Wecoma" comes from a Chinook term meaning "sea."

The official keel laying for R/V Taani will be in November of 2018. The ves-

OSU Names New RV

sel will be 199 feet long with a range of approximately 7,000 nautical miles. It will have berths for 16 scientists and 13 crew members, and will be able to stay out at sea for about 21 days before returning to port. Its cruising speed will be 11.5 knots, with a maximum speed of 13 knots.

VIMS' New Vessel Launched

The 93-foot research vessel R/V Virgina was launched for the Virginia Institute of Marine Science (VIMS) after 18 months of construction by Meridien Maritime Reparation of Matane, Quebec.

The primary mission of the VIMS's fleet of research vessels is to provide inshore and offshore work platforms for the support of fisheries related oceanographic research projects. The new vessel designed by JMS Naval Architects is capable of conducting fisheries assessments of a much greater capacity, in deeper waters, and with a larger science complement. The Virginia will greatly expand VIMS's capability to perform general oceanographic research in the Chesapeake Bay and the mid-Atlantic near coastal waters. The state-of-the-art research vessel offers enormous capability in a small package that is also economic to build and operate.

The design offers flexibility in science outfitting allowing for high utilization and affordable operating day rates. The vessel is easily adaptable to evolving scientific research areas such as offshore oil & gas exploration surveys, wind energy development surveys, environmental impact studies, and the servicing of ocean observing systems.

Oceanographic outfitting includes very large Wet and Dry Labs which have been designed for maximum flexibility to accommodate the many types of science that the vessel is expected to conduct. The 1,000 square foot main working deck allows for a 20 long ton science payload and provides a significant working platform for conducting fishing operations, over-the-side sampling and coring activities. There is also ample room and services to install a 20 foot science van for specialized science missions. The new research vessel will take advantage of the latest technology through an extensive array of acoustic instrumentation for the gathering and processing of data in support of fisheries research, oceanography and geophysical sciences.The aft deck is fitted with a stern A-Frame with an 8,000 lb safe working load for over the stern lifting operations and a side mounted J-Frame with an 4,000 lb safe working load for conducting CTD operations. The principal fishing arrangement consists of a pair of trawl net reels and a pair of trawl winches with 4,000 lb linear pull with 355 fathoms of 3/8" wire to support small mesh (200 mm net) bottom trawl surveys inshore and nearshore waters. An electric CTD (Conductivity, Temperature, and Depth) winch with 2,000 m of 0.322" wire will also be fitted for operation from the side mounted J-Frame. There is also a knuckle boom deck crane with a 2,240 lbs capacity at a 33 foot reach to support load handling operations.

VIMS' New Vessel Launched

Image: The Glosten Associates

JMS Naval Architects

UK's New Survey Ship Magpie Debuts

The Royal Navy's newest survey vessel HMS Magpie made her way up the Kingsbridge Estuary on her maiden visit to her affiliated town Salcombe. The newest addition to the RN's hydrographic squadron spent three days at sea under the White Ensign for the first time as her crew get to know how the survey ship handles.

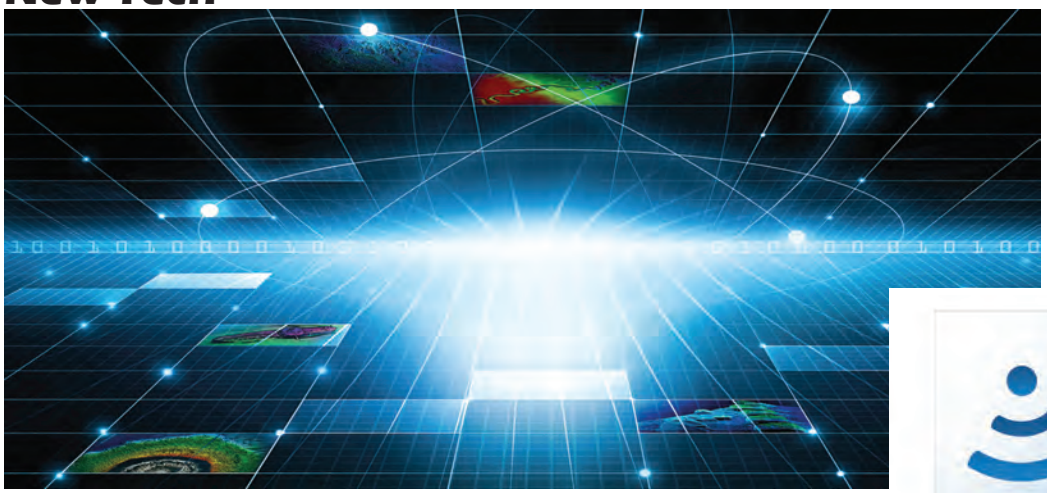
A replacement for HMS Gleaner which retired earlier in 2018 after 35 years' service, the 18-meter catamaran Magpie was commissioned in June – the first of numerous new small craft the RN is acquiring to replacing aging work/support boats.

It's Magpie's task to survey the places other parts of the RN Hydrographic Squadron cannot reach thanks to her size and shallow draft. That chiefly means updating charts of UK ports, harbors and waterways. In addition, she acts as an extra pair of eyes in home waters for anything untoward happening.

Royal Navy

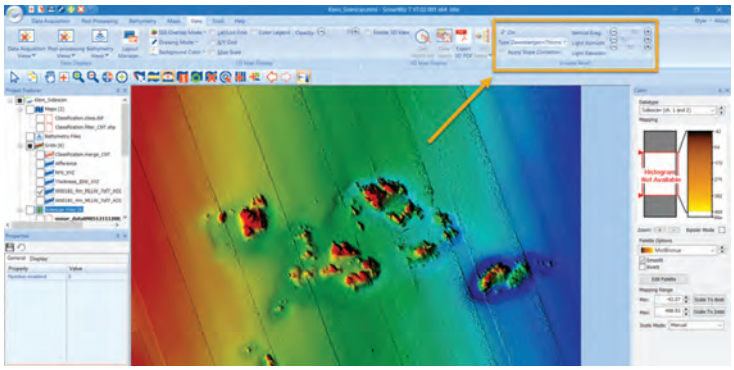
UK's New Survey Ship Magpie

Kongsberg's Mapping Cloud



HIPS and SIPS 11.0

Chesapeake's SonarWiz 7.2



Chesapeake's SonarWiz 7.2

Chesapeake Technology released SonarWiz 7.2 in August 2018. The update features many enhancements and new functionality, including a new Report Template built to generate 3D scenes for each of your bathymetric contacts. Shaded Relief is enabled in waterfall displays and contact reports for improved interpretation of bathymetric data. A new import filter is available for LiDAR data that can filter out unwanted data before the points are brought into the project. The SonarWiz Helm Display has been enhanced with a new altitude window display, new recording status icons and the bathymetry display now matches SonarWiz settings. R2Sonic TruePix imagery can be imported by the SonarWiz sidescan processing engine, though bathymetric information is lost. The Plan View has a new Color Legend option which can be enabled in the 2D Map Display group of the View menu. Dongle-free license (DFL) options give users the ability to use SonarWiz without any dedicated security hardware.

Kongsberg's Mapping Cloud

Kongsberg has unveiled its new data handling solution, Mapping Cloud, which provides easy storage of different types of data within the Cloud, offering an accessible and practical means of uploading and distributing real-time survey data, which can be subsequently made available to use in diverse applications and products. Mapping Cloud enables existing PC applications to be run in a Virtual Machine (VM) environment, and allows users to efficiently manage data processing, archiving and sharing with partners and customers through web browsers. By sharing secure data that can be worked on simultaneously, colleagues in different locations can share the workload and potentially generate invaluable insights. KONGSBERG's partnerships with Geocap and Earth Analytic presents a virtually limitless selection of online mapping, spatial analytics and GIS applications for end users, all directly available from their web browser courtesy of Mapping Cloud's all-purpose functionality.

HIPS and SIPS 11.0

Teledyne CARIS released HIPS and SIPS 11.0, introducing several improvements that make it easier to start new projects and process data, as well as an enhanced user experience while interacting with survey data. HIPS and SIPS now supports Drag and Drop for raw sensor files, and Version 11.0 also offers one-step processing. Interface changes in HIPS and SIPS 11.0 improve data interaction and provide a consistent user experience across the CARIS product line with enhanced filtering, grouping, and display set-up properties. Dynamic or Static layers for tracklines allows the user to create a rule-based layer using any of the trackline attributes.

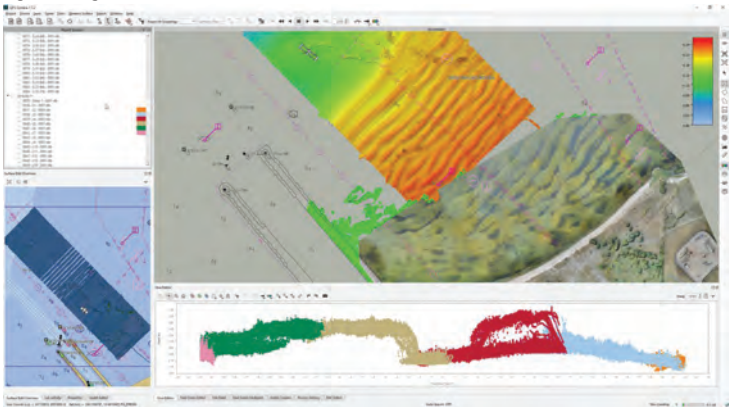
Qimera 1.7.2

QPS released Qimera 1.7.2 early in order to address a problem affecting certain Processed Points unloading workflows. The release also includes several new features. QPS said it fixed a serious bug found in Qimera 1.7.0 and 1.7.1 that affects the unloading of edits to certain

MassaSonic

Castrol Control Fluid

QPS' Qimera 1.7.2



Processed Points file formats. SVPs can now be exported as ASCII, Caris, and Hypack formats. This functionality is available from the Export dropdown menu. Hypack version 3 SVPs can now be imported. Version 3 of this format includes the SVP position, previous versions did not. Certain Processed Points file, such as FAU and LAS, can now have data excluded from import when they are brought into Qimera. This results in smaller QPDs and less display clutter for nuisance soundings that users may not want to see at all. Filter options vary between file types. Images linked to an ENC feature are now separated by a semi colon rather than a comma. Omniviewer will now correctly read the surface sound speed from GSF files that have new sensor specific subrecords.

MBMAX64 Multifrequency Update

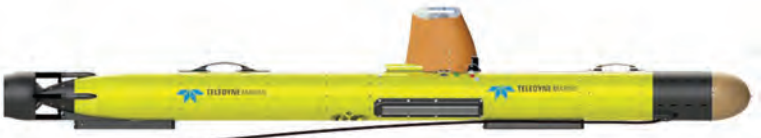
HYPACK's multibeam editor has been updated for multiple frequency surveys. Soundings can be color-coded by frequency and individual frequencies can be enabled and disabled as desired. The processing is not complicated and leads to interesting analysis. The multibeam sonar is from R2Sonic and it provides multifrequency soundings in a way that's easy to work with. Transmit frequency cycles from 100 to 200 to 400 KHz (then repeats), changing every ping. MBMAX64 now supports R2Sonic multi-frequency depth data, with color-coding and frequency enable / disable capabilities. Volume comparison between frequencies shows what can be done with MBMAX64 / HYPACK TIN MODEL and the R2Sonic multifrequency sonar.

MassaSonic: Command the Ocean - Harness the Sound

The MassaSonic TR-1075 Series consists of rugged high-power underwater transducers designed to operate in the 2.5 to 10 kHz frequency range. They are ideal for use in bottom mapping and sub-bottom profiling applications. The transducers are designed to be driven with a maximum input power of 600 Watts using up to a 30% duty cycle, or 200 Watts maximum for continuous operation. The MassaSonic TR-1055 Family of Transducers was developed for the oceanographic community for high-power, deep-water transponder applications covering the frequency range from 8-16 kHz. The transducers employ lead zirconate titanate as the active element contained within an oil-filled butyl rubber housing which is attached to a hard coated (anodic) aluminum mounting flange.

Castrol Control Fluid

Castrol launched its next-gen subsea control fluid, Castrol Transaqua SP, a formulation designed to simplify subsea operations and offer enhanced system protection. Castrol Transaqua SP is designed to be compatible with a wide range of elastomers, plastics, metals and completion fluids. This compatibility with completion fluids is especially important during well installation activities, when fluid mixing may occur potentially leading to line blockages.



Teledyne Gavia: ASW Training Target Module

Improved DVL Bottom-tracking

MEMS Gyro Surveying Service

Fugro Launches RAMMS

Fugro introduced a new bathymetric lidar system that delivers industry-leading depth penetration and point densities for nearshore and coastal mapping. Known as RAMMS (Rapid Airborne Multibeam Mapping System), the field-proven technology promises to deliver an efficient and cost-effective solution, dramatically improving upon other bathymetric lidar mapping capabilities.

ASW Training Target Module

AUV manufacturer Teledyne Gavia recently delivered a Sonar Transponder Module (STM) for ASW training to an undisclosed military customer. The STM module made by Scanmatic AS of Norway and integrated into a Gavia payload module is capable of receiving and retransmitting sonar signals for training sonar operators. The STM consists of a flooded transducer compartment, an electronic compartment and a hydrophone that is towed behind the Gavia AUV. The STM is programmable to emulate different types of realistic submarine target characteristics including sizes and speeds for cost effective and reusable ASW training applications.

Improved DVL Bottom-tracking

Teledyne RD Instruments (TRDI) has released a new proprietary Extended Range Tracking (XRT) option which is capable of extending the bottom tracking range of its' Pathfinder and Pioneer Doppler Velocity Logs (DVL) by 60 percent. According to the manufacturer, this development allows users to attain bottom lock faster and more efficiently than ever before. Teledyne RDI's DVLs provide precision navigation solutions for subsea vehicles. The new XRT option is available with new DVL sales, or as a fast and easy, firmware upgrade for customers with existing Pathfinder or Pioneer DVLs.

Rutter: Sigma S6 V9.2.0

Rutter Inc. has released the latest update to the Rutter sigma S6 product line, version 9.2.0, for general availability. It is also available as an upgrade on existing systems for qualifying customers. Rutter's proprietary radar data processing system interprets data from both conventional marine navigational and coastal surveillance radars, providing enhanced radar imagery and state of the art detection, tracking, and measurement capabilities. The sigma S6 suite includes the sigma S6 Ice Navigator, sigma S6 Small Target Surveillance, sigma S6 Oil Spill Detection system, and sigma S6 WaMoS II Wave and Surface Current system.

MEMS Gyro Surveying Service

Schlumberger introduced the GyroSphere MEMS gyro-while-drilling service at Offshore Northern Seas (ONS). The GyroSphere sensor performs gyro surveys faster than conventional systems and avoids the need for recalibration between runs. Solid-state technology enables the GyroSphere sensor to withstand the downhole shock and vibration that occur during drilling beyond the limits of current gyro technologies. Additionally, the GyroSphere service can reduce gyro survey uncertainty by up to 45 percent, providing more accurate access to smaller reservoir targets.

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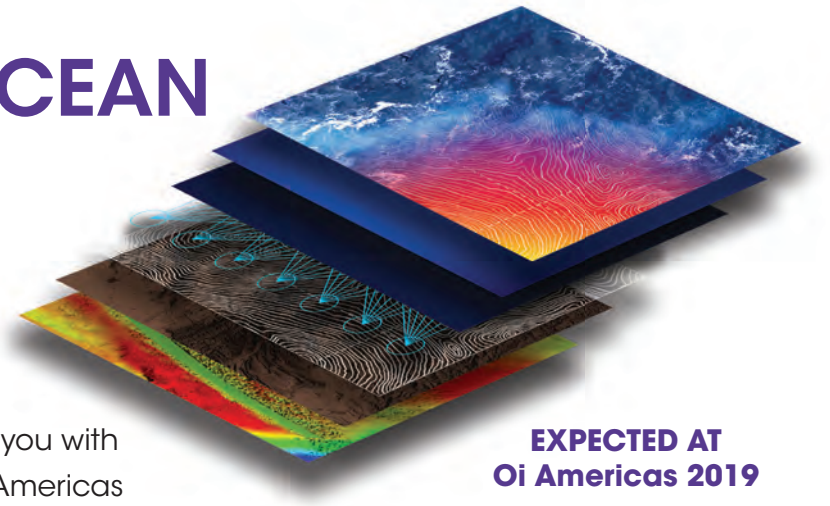

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Smith Named Head of UTEC

Paul Smith has been appointed group managing director at off- and onshore survey company UTEC Survey, part of subsea services group Acteon. Smith took over from previous managing director Stuart Cameron on August 20 and will lead UTEC from its headquarters within the Acteon building in Aberdeen, U.K. In addition, UTEC appointed Nadir Rahmatullah as the commercial and strategy director of its Middle East and Caspian operations. He was most recently MD of UTEC StarNet.

Furze Promoted at Teledyne

Teledyne Marine – Vehicles promoted Pete Furze to Director, Navy Program Development – Vehicles. Furze has most recently been Teledyne Marine's Product Line Manager for APEX profiling floats where his leadership has grown Teledyne's market presence and customer satisfaction. Furze is a retired U.S. Navy captain with 30years in the Navy meteorology and oceanography community. He served afloat and ashore, including command of the Joint Typhoon Warning Center and Commander, Undersea Surveillance. Since transition in 2009, Furze has worked with small and large businesses, including the role of Contract Program Manager at NOAA's National Data Buoy Center while with CSC Applied Technologies.

Neptune Appoints Haatvedt, Chilcott

Neptune Energy Group made two key senior appointments based in London. Gro Gunleiksrud Haatvedt is joining Neptune as Vice President and Group Head of Exploration, and Amanda Chilcott will take up the position of Group Human Resources Director.

Haatvedt joins Neptune from Aker BP ASA where she has been SVP for Exploration for the last four years. Chilcott joins Neptune from Aggreko Plc where she was Human Resources Director of the Power Solutions division.

L3 Technologies Acquires ASV

L3 Technologies acquired unmanned surface vessel (USV) and autonomous vessel control systems company ASV Global, LLC, effective September 20. According to L3, the acquisition enhances its spectrum of unmanned maritime capabilities, including integrated antisubmarine warfare (ASW) solutions, future surface combatant unmanned offboard sensors, and integrated unmanned surface and undersea vessel (USV/UUV) operations.

The new company will be known as L3 ASV.

Based in Louisiana and the U.K., L3 ASV delivers surface vessels in a range of sizes, currently from 10 to 42 feet, with proprietary software and control systems and proven unmanned system autonomy architectures.

The company's autonomy systems are consistent with the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) published by the International Maritime Organization.

Ashtead Appoints Steele

Global subsea equipment specialist Ashtead Technology appointed Stephen Steele as corporate development director based at the company's U.K. headquarters in Aberdeen. Steele brings more than 20 years of oil and gas experience, having served most recently as vice president of i-Tech Services at Subsea 7.

UKHO Appoints Armour

The UK Hydrographic Office (UKHO) appointed Cathrine Armour as the new Director of its Customer Division to support the office's development as a marine geospatial information agency. She joins the UKHO from Catapult's South West Centre of Excellence in Satellite Applications.

Nemeth Joins BIRNS

BIRNS, Inc. appointed Abel Nemeth as Manufacturing Engineer at the company's headquarters. Nemeth brings more than 25 years of expertise to the position, having served previously in senior engineering roles for a range of companies and clients from SpaceX and Pentair Aquatic Systems to Genentech.

Sonardyne Promotes Auld

Sonardyne International Ltd. named Stephen Auld as its new Global Business Manager for Subsea Asset Monitoring. He takes over for Stephen Fasham, who has been promoted to a newly created role within the business focusing on growth and investment opportunities.

Steele

Ashtead

Nameth

Bims

Ward

Huntington Ingalls Industries

Bolcar

Huntington Ingalls Industries

Before joining Sonardyne in June 2017, Auld was Business Development Manager at Liquid Robotics Oil and Gas. He was previously Managing Director at CodaOctopus Products Ltd.

Ward, Bolcar Promoted at NNS

Huntington Ingalls Industries (HII) announced leadership changes to the submarine construction programs at its Newport News Shipbuilding division. Jason Ward has been promoted to vice president of Columbia-class submarine construction. Dave Bolcar, who served as vice president of all submarine construction, encompassing both the Virginia- and Columbia-class submarine programs, has assumed the role of vice president of Virginia-class submarine construction.

Enpro Subsea Expands

Enpro Subsea appointed Francesco Santoro as its strategic consultant in South America. Primarily based in Rio de Janeiro, Santoro has more than 40 years' experience in the oil and gas industry, where he has previously undertaken leadership roles at Petrobras, Technip and Oceaneering.

Applied Acoustics Grows

Applied Acoustics Engineering said it has expanded its engineering department and is looking to add even more team members as part of growth plans underway at the Great Yarmouth, U.K. based firm. Recent BSc Electronic Engineering graduate Will Oakey has joined the production area, while Will Shave, another BSc qualified engineer, is working on new developments in the company's seismic profiling systems, and HND qualified Sean Evans is using his 30 years of technical expertise to improve the quality and build of the latest sparker systems.

Danos Hires Blades

Oilfield service provider Danos hired Rafe Blades as sales manager. Based out of the company's Gray, La. headquarters, Blades is responsible for overseeing sales strategies to maintain and expand the company's customer base, as well as management of the sales team. He has 10 years' sales experience.

Unique Group Acquires Water Weights

Unique Group completed its acquisition of the Aberdeen-headquartered, load-testing equipment provider Water Weights.

WHOI: OBSIC Location

The National Science Foundation (NSF) announced that the Woods Hole Oceanographic Institution (WHOI) will operate the new Ocean Bottom Seismograph Instrument Center (OBSIC), which will provide seafloor seismographs and technical support to the U.S. academic community. The OBSIC replaces the Ocean Bottom Seismograph Instrument Pool and will be housed at WHOI under a 5-year cooperative agreement, with John Collins serving as Director.

Briggs Marine

Left to right: Scott Christie, President, Foreshore; Dominic Gerelle, Vice President, Foreshore Technologies; Craig English, Operations Director of Subsea Services at Briggs Marine

Briggs Marine Acquires Canadian Companies

U.K. based marine services company the Briggs Group announced it has acquired a consortium of three marine companies in Canada: underwater survey and inspection company Foreshore Technologies Inc, Balanced Environmental Services Inc. and Ocean Tech Constructors Inc. The three companies are based in North Vancouver, B.C. and have been trading for 25 years.

ARA: Ohmsett Operator

Applied Research Associates, Inc. (ARA) was selected by the Department of Interior's Bureau of Safety and Environmental Enforcement (BSEE) to operate and maintain the Ohmsett National Oil Spill Response Research and Renewable Energy Test Facility. ARA will support BSEE in creating an environment to accelerate oil spill response science and technology innovations, as

Santoro

Enpro

Blades

Danos

Unique Group Acquires Water Weights

Unique Group

Alan Milne, MD, Water Weights; with Graham Brading, Group Director - Buoyancy & Ballast at Unique Group.

well as other applications for the unique test facility. During this contract period of one base year and four option years, ARA will be instrumental in managing the five-year refurbishment project scheduled for the summer of 2020. During this time, the tank will be drained, seals replaced, surfaces pressure washed and painted, as well as other maintenance tasks.

CCOM at UNH Partners with FarSounder

The Coastal and Ocean Mapping (CCOM) at the Joint Hydrographic Center at the University of New Hampshire has added 3D forward-looking sonar technology expert FarSounder as a partner in its Industrial Associates Program. With the addition of FarSounder's technology, students in the CCOM program have the opportunity of hands on experience with this unique technology and the potential to apply the data collected to their research.

All IOOS Regional Networks NOAA-certified

NOAA has certified the last of 11 Integrated Ocean Observing System (IOOS) regional associations as Regional Information Coordination Entities. Data coming from all IOOS partners now adheres to common federal collection, storage and management standards, meaning it can be integrated with other data, and help make "big data" research and development possible.

Hydra and the Offshore Upturn

Offshore and subsea construction company Hydra said it has entered into the saturation diving market in anticipation of an offshore oil and gas sector rebound. Trevor Davis, president and CEO, said Hydra has converted its flagship vessel Subsea Responder and acquired a modular 200msw/12-man saturation diving system to prepare for new projects as the oil and gas industry experiences an upturn.

Novacavi Supports Metal Monitoring

Novacavi's custom cable solutions have been chosen for the new Idronaut VIP Deep Blue probe for the monitoring of trace metals in the aquatic ecosystems down to 4,000m depth.

Swire Seabed Wins Wintershall Deal

Swire Seabed has secured a framework agreement with Wintershall Norge AS for the provision of marine subsea services (MSS) in the North Sea. The agreement will commence this year and has a duration of three years plus four yearly options, the subsea services firm said. The work scope includes the supply of vessel and services which encompasses survey, IMR and light construction.

Pipetech Wins Nexen Project

Pipetech won a project with operator Nexen to deliver Active Caisson Management on its Scott platform. Pipetech completed the first stage to remove internal scale build up from a 42 inch produced water caisson on the platform, located 188km from Aberdeen, while it remained in operation. The scope also includes ongoing inspection and monitoring. The Aqua Milling technology was deployed 27 meters above sea level and recovered back to the 1.5 inch entry point, mitigating any chance of blockages. In total, the project took eight days to complete with a full camera inspection conducted during a planned outage to further confirm the results of the cleaning.

Point Resources Extends Contract with Aker

Point Resources has executed the remaining part of the option for the maintenance and modifications contract with Aker Solutions. The EPC O&M contract was first signed in June 2012, covering the Jotun A, Jotun B, Balder and Ringhorne operating facilities in the North Sea. The contract extension starts at year-end and runs until June 2022.

ASV Delivered for Post-hurricane Survey

A new autonomous surface vehicle (ASV) has been delivered to the U.S. Army Corp of Engineers for rapid post-hurricane hydrographic survey in the Caribbean. Use of the SeaRobotics Corporation's 3.6-meter, collapsible ASV will allow rapid deployment and completion of the hydrographic surveys necessary to reopen infrastructure enabling delivery of life saving goods and services.

ISE Sells AUV to China

Canadian underwater systems and robotics manufacturer International Submarine Engineering Ltd. (ISE) sold its latest ISE Explorer autonomous underwater vehicle (AUV) to China Ocean Mineral Resource R&D Association (COMRA).

Platform Mooring Connectors Supplied for Windfloat Atlantic Project

First Subsea is supplying platform mooring connectors (PMC) to Windplus SA, developer of the 25MW WindFloat Atlantic Project floating wind farm under development offshore northern Portugal. The project comprises three WindFloat 8MW WTG platforms, each with a mooring system made up of three catenary mooring lines, connected to drag embedded anchors. First Subsea will supply nine PMCs, each with a 5500 kN MBL, to connect wind turbine generator platforms to mooring lines at a water depth of 85-100m.

Rutter Wave and Current Monitoring System Recertified

After extensive testing, the sigma S6 WaMoS II Wave and Surface Current Monitoring System was recertified by DNV GL in May of this year. The system was certified compliant with IEC 60945 Ed. 4 (2002-08) maritime navigation and IEC 62288 Ed. 2.0 (2014-07) radio-communication equipment and systems for Wave Monitoring Systems.

Riptide Establishes Canadian Subsidiary

U.S.-based autonomous undersea vehicle (AUV) manufacturer Riptide Autonomous Solutions announced its first international expansion with the creation of Riptide Autonomous Solutions Canada, headquartered in Halifax, Nova Scotia. Leonard Baker has been named Riptide Canada's Director.

Riptide

Sonardyne Aids NSWC Testing

Sonardyne Inc. has been chosen by the U.S. Naval Surface Warfare Center (NSWC), Carderock Division for testing subsea systems and underwater vehicles in development for the Navy and wider maritime industry. Sonardyne's Ranger 2 Ultra Short Baseline (USBL) acoustic tracking system, complete with a GyroUSBL transceiver, Nano and Wideband Sub-Mini 6 Plus (WSM 6+) transponders will enable operators to track the precise underwater position of any subsea system or UUV that comes through the SFOMF for testing.

The U.S. Naval Surface Warfare Center Carderock Division's South Florida Ocean Measurement Facility.

Sonardyne

Exocetus Delivers First Glider to Johns Hopkins APL

Connecticut-based Exocetus Autonomous Systems delivered its first MOD2 Glider to Johns Hopkins University Applied Physics Laboratory (APL). The vehicle, delivered this summer, was purchased as part of an internal research and development project which intends to explore a diverse set of applications for the vehicle.

Exocetus

Fugro Begins Project at Baltic Eagle Wind Farm

Fugro has commenced a marine site characterization program at Iberdrola's Baltic Eagle Offshore Wind Farm, in German waters of the Baltic Sea. Under a contract worth over 10 million, Fugro will undertake a UXO survey to clear the investigation sites, followed by a geotechnical seabed investigation and borehole drilling. The workscope also includes a program of standard and advanced laboratory testing.

Fugro

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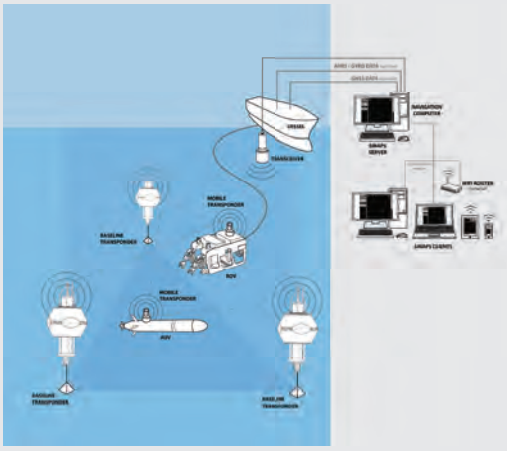

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