

TOTAL OCEAN MARKET COVERAGE 2019

JANUARY

Annual Review & Forecast / Buyers Guide/Directory

****Oceanology International Americas**, February 25-27,
San Diego, CA

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

****U.S. HYDRO 2019**, March 18-21, Biloxi, MS

****Ocean Business**, April 9-11, Southampton, U.K.

MARCH

Electronic Charting/Vessel Management/Ports &
Harbors/Dredging/Homeland Security

****AUVSI XPONENTIAL 2019**, April 29-May 2, Chicago, IL

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

****Offshore Technology Conference**, May 6-9, Houston, TX

****UDT 2019**, May 13-15, Stockholm, Sweden

MAY

Communications, Telemetry, Data Processing

****BlueTech Expo**, June 4-5, Washington, DC

****Oceans '19 MTS/IEEE Marseille**, June 17-20, Marseille, France

****CLEAN PACIFIC 2019**, June 18-20, Vancouver, Canada

JUNE

Seafloor Mapping/Sonar Systems/Vessels

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

****SEG 2019**, September 15-20, San Antonio, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

****Offshore Energy 2019**, October 7-9, Amsterdam, The Netherlands

****CLEAN GULF 2019**, October 28-30, New Orleans, LA

****Oceans '19 MTS/IEEE Seattle**, October 28-31, Seattle, WA

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

****International Water Conference**, November 10-14, Orlando, FL

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

Diving, Underwater Vehicles & Imaging

****Underwater Intervention 2020**, February 4-6, 2020,
New Orleans, LA

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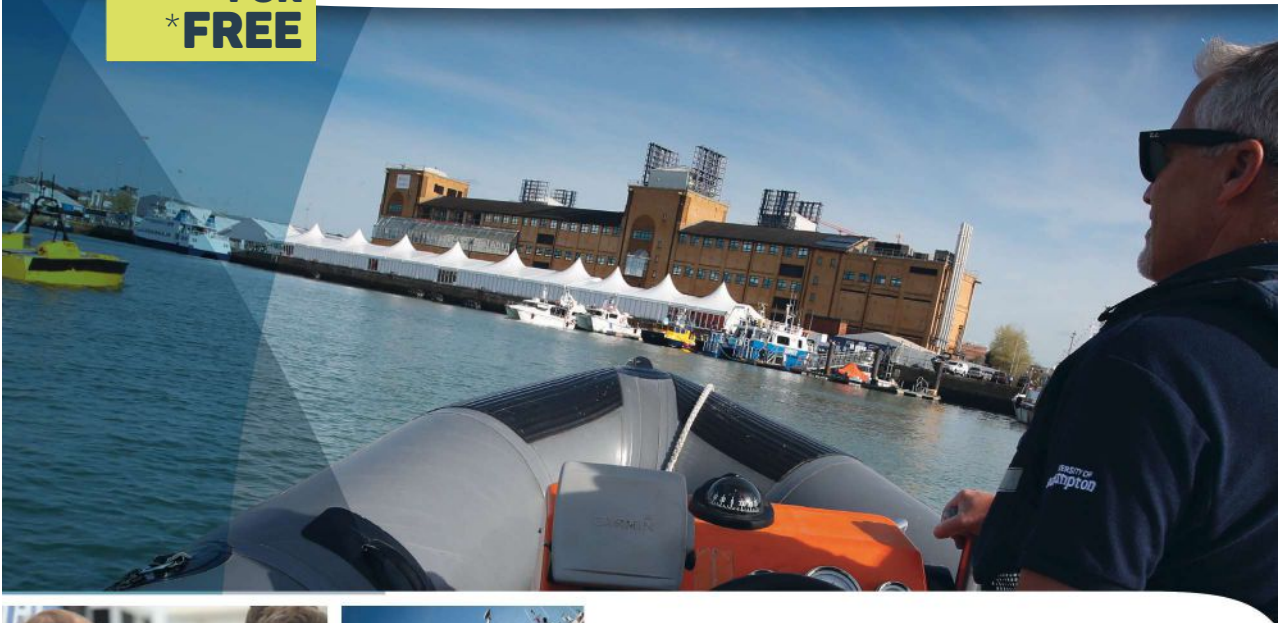
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Nortek's field engineer Tom Christian A. Mortensen preparing the deployment of a Signature500 ADCP by the Lofoten archipelago in northern Norway. The purpose of the deployment was to record currents and waves created by a strong tidal flow near the islands in Lofoten. (Credit: Raymond Engmark)

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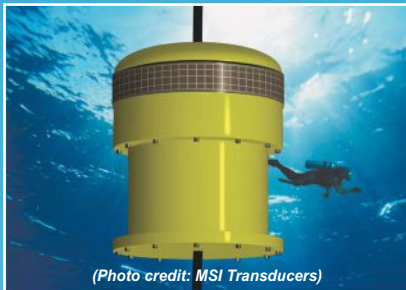
OceanSocial in the exhibit hall - 8th floor of Newseum
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SAAB AUV-62 (photo credit: Saab Seaeye)



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OK, Google: Find the Humpback Whales

What do you do when you have too much data? It's a rare question for scientists, and rarer still when the subjects are elusive animals like whales and dolphins (cetaceans). Marine mammals can be very difficult to detect visually, with many species spending little time at the water's surface. However, all cetaceans make some sort of vocalization, and sound can travel quite far in water. Acoustic methods are therefore well suited to studying many species and have become increasingly utilized in cetacean research over the last few decades.

At NOAA's Pacific Islands Fisheries Science Center, we monitor the health and status of cetacean species of the U.S. Pacific Islands, a vast area. One of our primary tools is a network of single-hydrophone, seafloor-mounted audio recorders called High-frequency Acoustic Recording Packages (HARPs), which are deployed for months to years. Currently, our network extends to 13 different sites, several of which have been monitored for more than a decade. We have collected more than 200 TB of data, or almost 170,000 hr. of recordings. In more relatable terms, that's 19 years of audio. This volume of data presents quite the analytical challenge.

To address this data overload, scientists have been working to develop automatic ways of detecting and classifying cetacean vocalizations. But the ocean is a noisy place, with lots of environmental, anthropogenic and biological sounds. Also, whale vocalizations can sound very different depending on a variety of factors. Humpback whales in particular present a difficult detection challenge. They sing complex songs that change over time, with separate populations singing different songs. So far all automated detection methods come with caveats: poor detection rates, lots of user-input requirements or high false-detection rates.

In the commercial sector, however, there have been recent advancements in artificial intelligence and deep-machine learning. Many of these advances have come from Google's Artificial Intelligence group—the people who taught your phone to listen and speak back to you. With this in mind, we asked the Google team if they were interested in teaching computers to speak whale, too. They were very enthusiastic to apply machine-learning techniques to whale conservation.

We sent them our audio data along with a collection of "training labels," or humpback whale calls that were marked by a human. They used these labels to teach the computer to recognize humpback song. In a very short time, they sent us back time stamps of humpback song in our data. It turns out that their computers are pretty good at recognizing whale! The computer isn't perfected yet—we still need to give it more training for some sites—but it is already doing far better than we expected.

There is so much we can learn from these data. In the U.S. Pacific, very little is known about humpback whale presence, seasonality, daily singing behavior, or population structure outside of the main Hawaiian Islands. Because our data set spans more than a decade, knowing when and where humpback whales are singing will give us information on whether or not the animals have changed their distribution over the years, especially in relation to increasing human activity in some areas.

We're now interested in teaching the computer to find other species of cetaceans in our recordings, as well as expanding out to other regions. Perhaps in the future, Google can develop a tool for scientists that is widely applicable to different vocalization and data types. For now, we are excited about the powerful possibilities of collaboration with a commercial company and the rapid advancement possible when leveraging the resources of big tech for difficult science problems. **ST**

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)) US Arctic CubeSats Launched. The U.S. Coast Guard Research, Development, Test, and Evaluation Program, in partnership with the Department of Homeland Security (DHS) Science and Technology Directorate, has launched two 6U CubeSats from Vandenberg Air Force Base, California. The launch is part of the Polar Scout project to evaluate the effectiveness of space-based sensors in support of Arctic search-and-rescue missions. Knowledge gained from this demonstration will be used to inform satellite technology recommendations for many potential applications in the Coast Guard and across DHS. The CubeSats, dubbed “Yukon” and “Kodiak,” were economically launched into a low-Earth polar orbit on Spaceflight’s dedicated ride-share mission, SSO-A: SmallSat Express, with other spacecraft from 17 different countries. Developed as a potential capability bridge between the current 20-year-old international search-and-rescue architecture and its future successor, CubeSats serve as a much smaller, more cost-efficient solution that can be easily implemented over a short period of time. Each are only about the size of a shoebox. DHS will begin testing and demonstrations using emergency distress beacons in the Arctic in early 2019 and will continue through the summer. The Polar Scout project is providing valuable insight on the process, cost and feasibility of acquiring and using organic satellites. As Coast Guard missions become more challenging and complex, the use of small and inexpensive satellites has the potential for great impact.

)) Real-World Testing, Scaling for Blockchain Fuels Assurance Platform. Maritime Blockchain Labs (MBL), a partnership between Lloyd’s Register Foundation and BLOC to explore the use of blockchain for the assurance and safety of critical infrastructure and to drive new business models for the global maritime industry, announced that its first demonstrator project, a fuel provenance register for the maritime sector to provide trusted information about fuel origin, journey and characteristics, is progressing toward commercialization with further development and scaling of the solution, capturing fuel deliveries and associated verified data into the system. The new phase of development was to start in January 2019. A prototype digital system has already been developed.

)) EU Copernicus-Backed Research Highlights Ocean Health Decline. New research shows dramatic changes in the extent of sea ice at the poles, huge variations in the ocean circulation in the Atlantic, and a sharp increase in carbon uptake, according to a new report published as a supplement of the *Journal of Operational Oceanography*. The Copernicus Marine Service Ocean State Report charts physical changes taking place in the world’s ocean over several decades. With particular focus on the more pronounced variations recorded in 2016, the second edition arrives in the wake of a number of record-breaking extreme weather events across Europe. The Copernicus Marine Service has also published a summary of the report designed to boost ocean literacy among the general public and decision makers. The interaction between oceans and the atmosphere plays a key role in the Earth’s climate system, so a deeper understanding is critical to develop an effective response to global climate change. The report draws attention to the rising heat content of the global ocean and the European regional seas. New research indicates that the volume of sea ice in the Arctic is declining by an estimated 15.4 percent per decade. The report also chronicles the large variations in the Atlantic Meridional Overturning Circulation (AMOC) that circulates water throughout the Atlantic. Furthermore, the report reveals a sharp uptake in the amount of CO₂ absorbed from the atmosphere and stored by the ocean since the beginning of the 2000s, causing troublesome ocean acidification.

)) US to Develop Energy-Water Desalination Hub. The U.S. Department of Energy (DOE) announced \$100 million to establish an Energy-Water Desalination Hub to address water security issues in the U.S. The hub will focus on early-stage R&D for desalination to provide low-cost alternatives that treat nontraditional water sources such as seawater, brackish water and produced waters for use in municipal and industrial water supplies or to serve other water resource needs. Successful research can reduce demand on stressed freshwater supplies. DOE will fund one new five-year award, subject to appropriations. The hub will work on four technical topic areas: materials research and development; new processes research and development; modeling and simulation tools; and integrated data and analysis.

)) Report on Transition to Electric, Hybrid Vessels. Since the early 2010s, sales of pure electric and hybrid vessels have grown steadily, driven by the need to reduce local pollution of NO_x, SO_x and particulate matter in a handful of emission control areas. Vessel operators have turned to low-sulphur fuels such as LNG to comply, as well as invested in scrubbers to clean tail-pipe gases before they are released. Others have invested in electric and hybrid powertrains, and the new IDTechEx Research report “Electric and Hybrid Boats and Ships 2019 - 2029” expects this to accelerate after 2020 when global sulphur regulations are enforced by the International Maritime Organization. Another strong driver, particularly for commercial vessels, is fuel economy. Many commercial vessels are installed with oversized engines to handle peaks in power demand. By adding batteries to handle transient loads, engines can be downsized and set to run consistently at high load, for which they were designed to run efficiently. Depending on the vessel type, the resultant fuel savings can reach 10 to 30 percent. **ST**

LiDAR for Wind Measurement

ZX LiDAR for Oil, Gas, Offshore Wind Industries Handles Storm Winds

By Daniel Mendelsohn • Carey Nolan

Accurate measurement of the vertical profile of wind offshore has become increasingly important in planning, design and operations, from existing offshore oil and gas to support for the nascent wind energy industry. Until recently, measuring the vertical profile of wind was difficult, requiring a tower to the desired measurement height, with single-point anemometers deployed along its length. The issues associated with point measurement devices can be addressed through remote sensing, with laser Doppler anemometer light detection and ranging (LiDAR) systems to measure the vertical wind profile from the deck of a platform or stable buoy system.

LiDAR has obviated the need for a tower and reduced the uncertainties introduced by traditional single-point anemometers, which can often suffer from bad positioning (obstruction) and lack of calibration. The technology is relatively new to operational use, and continued verification of its robustness and accuracy is necessary. Two new LiDAR applications will be discussed below, focusing first on the oil and gas industry and second on the offshore wind industry.

Oil, Gas Application

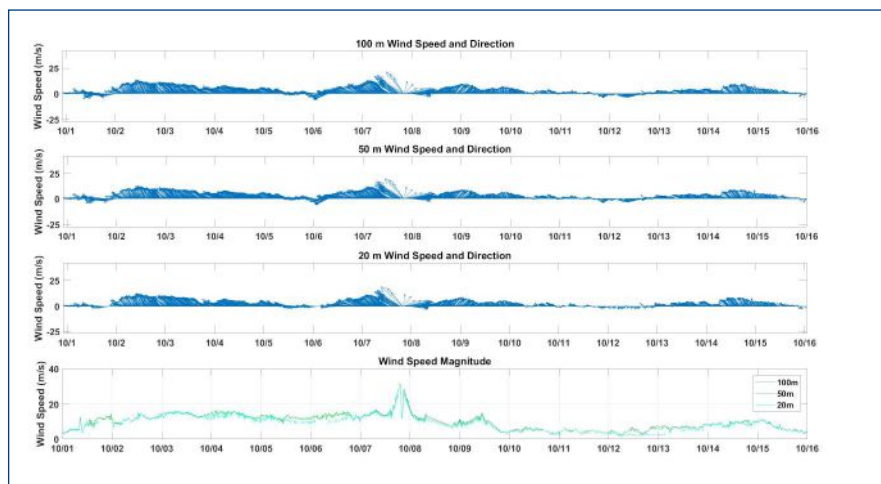
Shell Exploration and Production Corp. (Shell E&P) operates a network of offshore installations in the north and central Gulf of Mexico. These platforms have maintained a number of oceanographic sensors for many years in support of operations and for long-term engineering (fatigue) and physical dy-

namics studies. The primary instruments have included deep-profiling and surface-horizontal-profiling ADCPs. Shell E&P has recently expanded its meteorological and oceanographic (metocean) observation capacity on several oil and gas platforms in the Gulf of Mexico to include both LiDAR wind profilers and microwave radars, in addition to existing ocean current profilers. These sensors are intended to integrate with the onboard marine information and advisory systems.

Tension-leg platform (TLP) Ursa and nearby TLP Olympus reside in the Mississippi Canyon portion of the Gulf of Mexico and are now host to ZX LiDAR (formerly ZephIR) ZX 300M systems. To date, more than a year's worth of LiDAR data have been collected, observing a



(Top) Tension leg platform Ursa in the Gulf of Mexico and an installed LiDAR unit on a Shell TLP. (Bottom) LiDAR wind speed and direction observations on TLP Ursa in the Gulf of Mexico October 2017.



full range of meteorological and oceanographic conditions representative of the region.

As a part of that data set, and for the first time, a hurricane was observed by a LiDAR wind profiler on an off-shore platform in the Gulf of Mexico, with the passing of Hurricane Nate on October 7, 2017. These observations were evaluated, an analysis of the hurricane's effect on conditions in the Gulf were assessed, and the ability of the system to successfully capture extreme conditions was examined. The wind profile through the first 100 m was collected from a deck-mounted system.

Wind measurements with the ZX 300M LiDAR are based on the emission of an eye-safe infrared laser beam, scanned via a rotating prism in a cone of half-angle 30°. Around 50 measurements of line-of-sight velocity are obtained during each 1-sec. scan; these values are combined to derive a wind vector at a series of heights, defined as part of the LiDAR deployment. Sequential sampling of returned laser energy is analyzed at different heights (1-sec. intervals) to derive wind speed and direction over 10 (customizable) measurement levels, up to 300 m above the instrument, with intervals generally ranging from 10 to 20 m. The TLP-based LiDAR systems were set to record through the first 100 m above the instrument, using a 10-m bin size, on a 10-min. averaging period. Reflected energy from moving particles and water droplets is analyzed to determine speed and direction of wind movement in a profile above the instrument face. LiDAR systems have been determined as comparable to cup anemometer mast arrangements; however, installation consideration must include local obstructions and associated turbulence, which adds variability to time-series data.

Example LiDAR observations at TLP Ursa of the mean wind speed (10-min. average) and direction at three representative levels (100, 50 and 20 m) for the first half of

October 2017 show that between October 2 and 7 the wind was predominantly from the Southeast, with a shift to the West on October 5 at all three levels, with a magnitude of approximately 15 m/s.

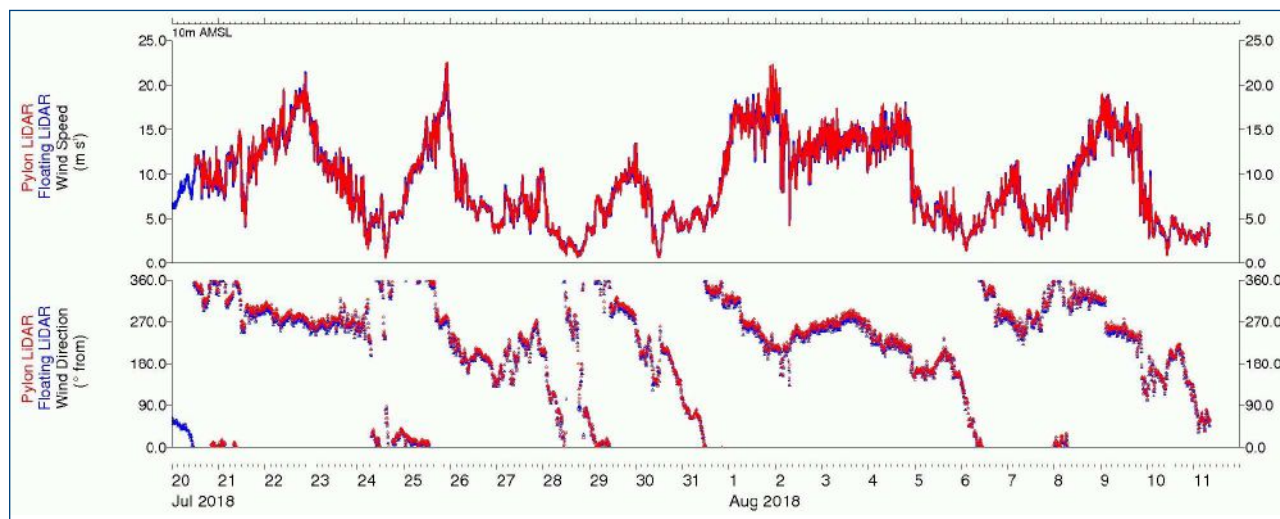
On October 7, the wind increased to a sustained 35 m/s (40 m/s max) by 1900 hr., still from the Southeast, decreasing to 12 m/s by 2000 hr. and back up to 30 m/s by 2100 hr., but now from the West. This chain of events indicates the passage of the hurricane, including the eye, marked by the drop in velocity and the abrupt change in direction, almost directly over TLP Ursa. There is little directional or speed variability between 20 and 100 m, and even less between 50 and 100 m.

Close inspection of the magnitude time series at the height of the storm showed that there were intermittent periods where the signal was dropped, but not at all layers simultaneously. Each 10-min. measurement at each level is individually assessed for data quality. The recorded data appear to have been filtered because of a breakdown in the assumption of uniform flow around the scan at the individual levels. This is possibly a consequence of the interaction of the flow with the platform structure, which depends on measurement height and wind speed and direction during that averaging period. There may have been some correlation with rainfall intensity, but it is not considered the cause of the filtering.

One of the benefits of the wind vertical profile observation made possible by the LiDAR remote-sensing system is the ability to derive wind shear from the measured data. Wind shear is a change in wind speed and/or direction over a short distance and can occur either horizontally or vertically, most often associated with strong temperature inversions, density gradients or surface drag. Vertical shear is normal near the ground and can have the most serious effect on an aircraft (helicopter, in this case), as well as drastically alter lift, indicated airspeed and thrust requirements. When the change in wind speed



(Top) RPS LiDAR buoy being towed to site and deployed on its mooring. (Bottom) Wind speed overlay plot measured during the trial by the LiDAR buoy (blue) and the reference LiDAR (red) for the duration of the deployment.

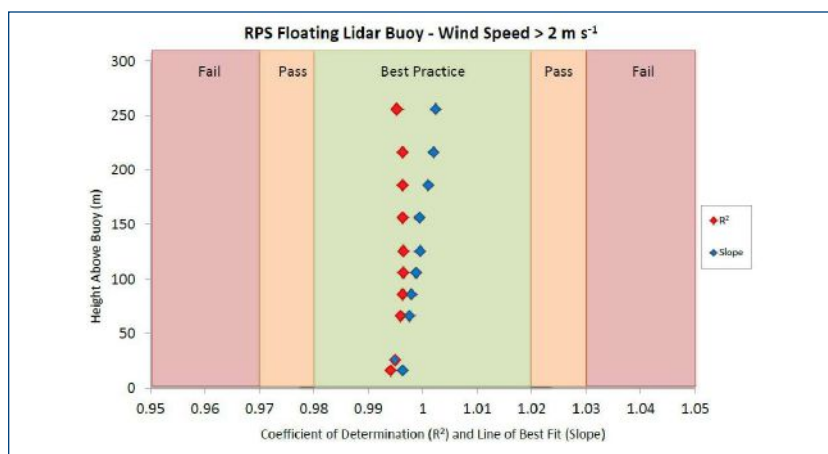


and direction is pronounced, severe turbulence can be expected.

The ZX LiDAR can also calculate turbulence intensity (TI). Mechanical turbulence is defined as the friction between the air and the ground, especially irregular terrain and man-made obstacles, causing eddies and, therefore, turbulence at lower levels, as is the case in the air around and above the rig structure. The stronger the wind speed (generally a surface wind of 10 m/s or higher is required for significant turbulence), the rougher the terrain, and the more unstable the air, the greater the turbulence. The TI is a useful variable in wind resource assessment, including site assessment and wind generator turbine selection.

Offshore Wind

RPS has purpose-designed and built a LiDAR buoy solution capable of measuring offshore wind profiles almost anywhere in the world. Combining the latest ZX 300M LiDAR with RPS's toroidal buoy hull



RPS LiDAR 4.5 buoy validation results for wind speed greater than 2 m/s, showing both the slope (line of best fit) and the coefficient of determination.

design, the first two buoys have been built and deployed for Equinor ASA.

This LiDAR buoy is zero emission, utilizing solar and wind energy to power the LiDAR and charge its main and standby data-logging and communication systems. This zero-emission design helps to meet the stringent environmental de-

mands often associated with renewable wind energy projects.

One of the issues associated with buoy-mounted LiDAR systems is their ability to accurately measure upper-layer wind speed and direction in high-wave environments, due to motion of the laser signals. To test this performance, the RPS LiDAR buoy was recently deployed off Perth, Australia, for a validation test over a six-week winter period. During this deployment, a number of harsh storms struck the region, resulting in rigorous testing conditions for the LiDAR buoy performance. Nearby—150 m from the LiDAR buoy location—a secondary ZX 300M LiDAR unit was installed three weeks into the deployment on a fixed navigation beacon, which provided excellent reference wind data for the second half of the deployment (three weeks) of overlapping measurements.

In order for wind measurements from the LiDAR buoy to be commercially acceptable in the wind financing industry, the 10-min. averaged wind data output from the LiDAR required statistical analysis as part of the Carbon Trust Offshore Wind Accelerator Roadmap for the Commercial Acceptance of Floating LiDAR Technology Version 2.0 (OWA Roadmap). Fortunately, because the ZX LiDAR 300M is already accepted for use in bankable wind speed and energy assessments in simple terrain, the roadmap allows for fixed LiDAR to be used

as the reference data source. Test results were analyzed from 19 to 259 m above sea level. The maximum 10-min. averaged winds during the validation period peaked at 25 m/s, and the full range of wind directions was experienced. Total significant wave height (H_s) exceeded 4.2 m during storm conditions. Data transmission was 100 percent during this period.

Over this time, the validation of the LiDAR buoy against the reference LiDAR was excellent at all measurement heights: For wind speed, regression lines of best fit had slopes between 0.99 and 1.01 and coefficients of determination greater than 0.99 (with a value of 1 indicating perfect correlation between instruments) for all heights. For wind direction, slopes were between 0.97 and 0.99, with coefficients of determination greater than 0.99 for all heights. These metrics easily met all key performance indicators (KPIs) recommended in the OWA Roadmap.

RPS has since deployed this validated LiDAR buoy offshore New York as part of a renewable wind energy project for Equinor ASA. A second LiDAR buoy is also undergoing validation against the Met Mast off Blythe in the U.K. to be fully accredited according to the OWA Roadmap guidelines.

Additional construction and further development of the RPS LiDAR buoy is underway to meet the rapid expansion of the renewable wind energy sector.

Between our rig platform installation and servicing and our LiDAR buoy technology, RPS is committed to

engaging and innovating within the industries to provide reliable, accurate and cost-effective support for both engineering design and real-time operations through the use of ZX LiDAR technology.

Acknowledgments

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Carey Nolan has more than six years' experience in the management, quality control and interpretation of metocean data and writing measurement reports. He is also involved in fieldwork, deploying various oceanographic instrumentation across the globe. Originally from RPS in Perth, Australia, he is currently based in the RPS Houston Metocean Science and Technology office.



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Ocean Business 2019

Ocean Business is firmly established as one of the most important international events in the ocean technology calendar. In 2019, it will take place at the National Oceanography Centre in Southampton, U.K., from April 9 to 11. The bulk of Ocean Business is free to attend, and the show is expected to attract more than 5,000 visitors from more than 60 countries.

Exhibition

At the very heart of Ocean Business is a three-day exhibition of more than 360 companies, bringing together the world's leading manufacturers and service providers in the industry. The purpose-built exhibition center is located directly on the waterfront at the National Oceanography Centre in Southampton and provides visitors with the opportunity to see companies displaying the very latest in the industry, all under one roof.

Latest Tech, Services

More than just a static exhibition, Ocean Business provides visitors with a rare opportunity to test-drive equipment and systems with more than 180 hr. of free-to-attend training and demonstration sessions. Live demonstrations of cutting-edge ocean technology will take place back to back on board vessels, in dockside waters, in the test tank and in classrooms, giving visitors a chance to see the latest products firsthand in their real environment.

Due to a rapid growth in autonomy within the industry, new for 2019 is a floating pontoon specifically designed to accommodate the mobilization of autonomous vehicles. As well as this new dockside facility, there will be an extra classroom session to optimize learning.

Keep up to Date

Many organizations choose Ocean Business as the place to hold co-located events. Attendees will be able to participate in a variety of high-profile meetings and associated industry events held by leading organizations, plus keep abreast of the latest developments in the world of ocean technology; all free to attend.



Offshore Survey

Offshore Survey, a two-day conference designed to provide valuable insight into the technology, operations and business issues in the global field of offshore surveying, is back due to popular demand. Topics include: Subsea Positioning; Hydrographic and Seabed Systems; Survey Operations; Data Processing and Visualization; and Industry and Professional Issues.

The full conference program is available to view online at oceanbusiness.com.

Network, Socialize

Another highlight of the show is the social program, which offers great networking opportunities, starting with free welcome drinks the night before the show opens and the popular wine trail on the opening day.

New for the 2019 show is a stunning waterside venue for the Ocean Business dinner. Southampton's Harbour Hotel offers guests the opportunity to network with colleagues old and new while enjoying views across the harbor.

Career Opportunities

Running alongside Ocean Business is Ocean Careers, offering advice and career opportunities within the ocean technology, marine science and offshore industries. Incorporating a mix of one-on-one meetings and presentations from industry leaders, Ocean Careers is an interactive event designed for those looking to move into the industry. Whether your skills are in engineering, science or mathematics, Ocean Careers can help you realize how these skills can be utilized in this vast, exciting, forward-thinking and extremely diverse industry.

Registration

The Ocean Business exhibition, training and demonstrations, co-located events, Ocean Careers and many social events are free to attend by registering online at oceanbusiness.com/register. There is a fee to attend the conference and dinner. Visitors are encouraged to register online in advance to beat the queues on site. **ST**



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Photo: Karelian Research Centre,
Russian Academy of Sciences Laboratory of Hydrophysics

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Measuring Arctic Ice

SIMBA Derives Snow, Ice Measurements from Temperature Profiles

By Phillip Thompson • Keith Jackson • Bin Cheng

The global impact of climate change on sea ice is most dramatically observed in the Arctic, where warming has been shown to be twice as fast as the global average. These changes are principally observed and monitored by way of three key measures: sea ice extent (SIE), sea ice concentration (SIC) and sea ice thickness (SIT). The development of technologies for accurate monitoring of these parameters is of central importance because of the pivotal role that sea ice in the Polar oceans plays in influencing global climate.

Monitoring to date has revealed that average sea ice thickness in the Arctic has reduced significantly over the past 30 years, with winter Arctic ice extent decreasing by about 3 percent per decade. It is anticipated that the continued decline of sea ice cover will result in an almost complete lack of summer sea ice by late season 2050.

Snow and ice thickness can be accurately measured by manually drilling holes, but in recent years sea ice measurements have been made by space-borne observation techniques, such as satellite radar altimetry (Cryosat). However, single physical measurements do not produce information on ice development over time or any indication of its condition. Satellite altimetry can take repeated thickness measurements over time, but this allows little to be deduced about the processes influencing the development of the ice or its condition at any point in time.

To constantly monitor the ice and provide information on its thickness, condition and the environmental forces acting on it, an in-situ instrument is required. To satisfy this requirement, several autonomous ice-tethered observational platforms have been developed and deployed in the Arctic since the last decade. The primary ice mass balance buoy (IMB) was developed by the U.S. Cold Regions Research and Engineering Laboratory (CRREL) jointly with MetOcean Ltd. in 2003. These devices, which use acoustic sounders mounted in the air and beneath the bottom of the ice, have been successfully deployed on thick ice floe to monitor snow and ice thickness in the Arctic Ocean.

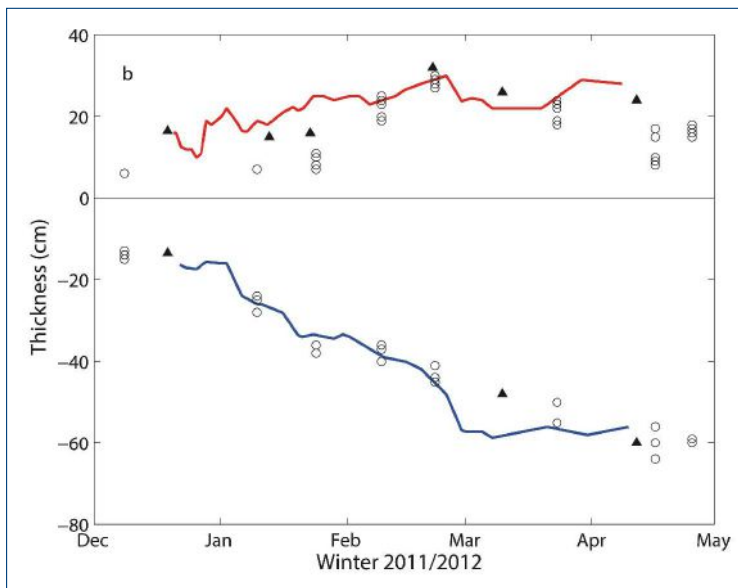
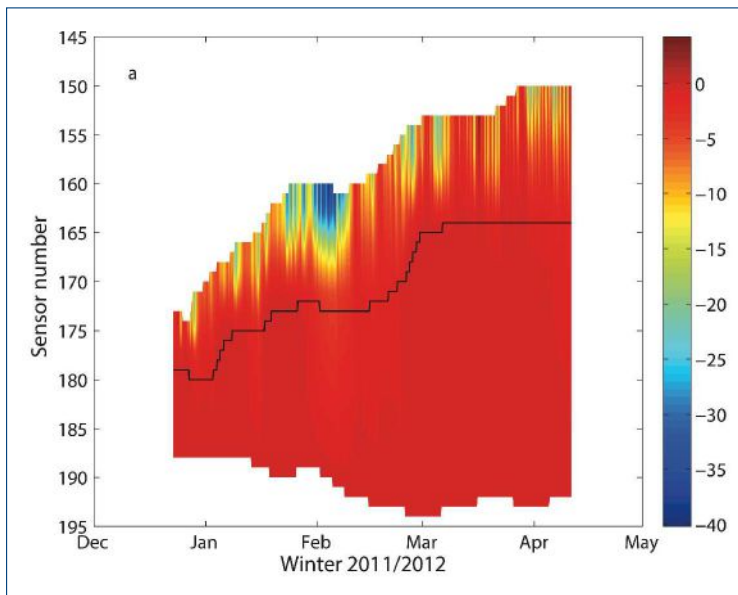
SIMBA

In 2009, an alternative type of IMB was developed by SAMS Research Services Ltd. (SRSL), based at the Scottish Association for Marine Science (SAMS) in the U.K. This type of IMB, named the "Snow and Ice Mass Balance Array" (SIMBA) comprises a high-resolution thermistor string, which is embedded within the snow/ice profile. Snow and ice thickness measurement is derived from temperature profiles. This enables the devices to be used for real-time snow depth or ice thickness monitoring (growth and decay) and energy balance studies in seasonally ice-covered seas, lakes and Polar Regions.

A novel feature of the SIMBA sensor chain is the incorporation of heaters mounted next to the temperature-sensing elements. Gentle heating over a short space of time can indicate what medium a sensor lies within by the variations in temperature (e.g., large variations indicate snow, compared to ice). The heated profiles can greatly enhance the detection of the interfaces between air, snow, ice and water.

The simple and low-cost design of the SIMBA technology makes it possible to deploy an array of IMBs and achieve a greater spatial resolution. Multiple deployments also reduce the risk of project failure due to loss/dropout of a single in-situ device.

SIMBA units comprise an autonomous platform and a chain of digital temperature chip sensors. The instrument is compact and easy to deploy via a 5-cm auger hole. A standard SIMBA chain is capable of providing a temperature profile across 4.8 m of length, with temperature readings made every 2 cm accurate to $\pm 0.0625^{\circ}\text{C}$ (various lengths possible). The units also incorporate data telemetry (via Iridium SBD for remote regions or GSM where available), have built-in GPS for tracking sea ice movement, a magnetometer and accelerometer for tilt and floe rotation, and a barometer for surface air pressure. An internal and external sensor monitors local ambient air and equipment enclosure temperatures. Transmitted data can be collected, pre-processed and



(Top) SIMBA-measured snow and ice temperature fields winter 2011/2012. The snow-ice interface is marked as a black line. (Bottom) SIMBA-data-derived snow and ice thickness applying snow-ice interface as zero reference level. The symbols are snow and ice thickness measured near the SIMBA site (triangles) and at regular measurement sites (circles).

displayed by a dedicated server at SRSL, allowing users to monitor a system and download data using a simple web interface.

The data obtained are suited to process model evaluation (e.g., determination of ice-ocean energy exchange) for weather forecasting in Polar Regions and for monitoring of sea ice thickness/state for transport and shipping applications. Generally, interpretation of SIMBA data has been a manual process but some recent work on automated processing and interpretation has shown promising results.

SIMBA Deployment

Multiple SIMBA deployment studies have been carried out through collaboration between SRSL and the Finnish Meteorological Institute (FMI). The first of these was in Orajärvi Lake in northern Finland, with a view to scaling up deployment to cover the Baltic Sea. The goal of the project was to enable ships sailing on the Baltic Sea to have access to real-time information on ice movements and to facilitate long-range sea ice forecasting.

Lake ice is a sensitive indicator of climate change, therefore, the data from this first study were useful in terms of climate change science as well as technology development. The first buoy was deployed by FMI at Orajärvi in winter 2009/2010.

The in-situ SIMBA device measured the vertical temperature profile from water through ice and snow, up to the air. Heating elements run a 2-min.-long heating cycle mode once a day. The air-snow interface can be identified based on the fact that a number of sensors located in the air have approximately the same temperature (i.e., vertical temperature gradient is small). Based on the same principle, the sensors located in water yield similar temperatures near the bottom of the ice.

The snow-ice interface location can be estimated by investigating the temperature perturbations due to the sensor heating.

The in-situ temperature readings were made four times a day, and the sensor heating temperature was measured once per day. The temperature profiles were obtained in real time on a daily basis by Iridium transmission. The drill-hole snow and ice thickness measurements were conducted every second week during the winter season. The data were then compared with the SIMBA-derived snow and ice thickness.

The snow and ice thickness derived from the SIMBA data are in reasonable agreement with in-situ observations for this case. The mean bias error (MBE) between the SIMBA and borehole measurements was -0.7 cm for snow thickness and 1.7 cm for ice thickness.

The SIMBA was redeployed in winter 2011/2012 and successfully operated through the following winter season. SIMBA units have since been deployed successively in four winter seasons, from 2011 to 2014.

In recent years, many SIMBAs have been deployed in the Arctic Ocean through various international sea ice research cruises. Through several international collaborations from 2012 to 2014, two SIMBA units were deployed by *Polarstern* (the icebreaker of Alfred Wegener Institute, Germany), and two more during a *Polarstern* Arctic cruise.

A large number of SIMBAs were also deployed by the Chinese icebreaker RV *Xuelong* during the Chinese National Arctic Research Expedition (CHINARE) program in 2014.

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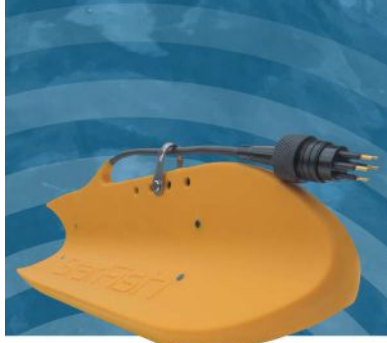
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Analysis, Interpretation

Currently, there is no reliable algorithm to automatically retrieve snow and ice thickness from SIMBA temperature profiles. Analysis of snow and ice thickness data from SIMBA temperature profiles is a largely manual process, done on a case-by-case basis for different studies.

Most recently, an automated algorithm has been developed to process SIMBA temperature data. The principle of the algorithm is based on heat-flux continuation through the air-snow-ice-water system with a SIMBA thermistor sensor maximum reading resolution of 1/16 of a degree Celsius. The initial snow-ice-water interface positions are required as input. The results from the algorithm are then compared with manual analyses, in-situ borehole measurements and numerical model simulation. The errors are larger when snow and ice warms and the vertical temperature gradient is small.

Product Development

Since 2012, SRSL has sold 230 SIMBA units, with approximately 60 percent of units purchased for Arctic deployment.

During this time, the following product developments have been made to update and improve the technology: up to 21 user-configurable options activated through SD card or remote programming; data recorded regularly and transmitted via email with location and positioning information by Iridium satellite and GSM; revised web interface for status monitoring and observing live data; user LED status indicator for easy start-up and system diagnostics (with fault codes); temperature data every 2 cm along thermistor chain of optional length/depth, with excellent long-term drift and re-engineered for greater reliability; heated and cooled profile capability (eight configurable options) to provide information on thermal characteristics and floe velocity; environmental/air temperature and pressure data; addition of accelerometer and magnetometer to monitor physical processes in the

ice, e.g., breakup; and improved GPS reports to analyze floe drift to 2-m accuracy.

The detection of the snow-ice interface remains a challenge, even for IMBs with acoustic sounders, especially in boreal lakes and seasonal ice-covered seas. The snow-ice interface is changing in Polar Regions, specifically the formation of snow/ice due to refreezing of slush in early winter and the formation of superimposed ice due to refreezing of melting snow.

SRSL is further developing SIMBA to improve snow-ice and snow-air interface detection with the Snow SIMBA trials in Scotland looking at the measurement of snow-air interface, temperature gradient and snow density for avalanche and flood forecasting.

SIMBA's cost-cutting design has prompted greater utilization in the Arctic Ocean through a joint effort by SIMBA customers. SIMBA data storage and analyses are largely conducted by individual customers or based on partnership/consortium collaboration.

SRSL plans to establish a common SIMBA data hub. Partners are welcome to join this hub by uploading SIMBA data, which can be very valuable as part of the Integrated Arctic Observation System (IN-TAROS). **ST**

Phillip Thompson is the SIMBA production engineer at SAMS Research Services Ltd. (SRSL), tasked with building and developing the SIMBA units and supporting customers. He has a background in electronic control systems and the automotive sector as a process engineer. Thompson has worked on SIMBA development for more than six years and holds a Six Sigma Green Belt.

Keith Jackson is a chartered electronic engineer with broad experience within industry and academia of engineering design and education. He was formerly head of technology at SAMS, where he developed the SIMBA 10 years ago. He has since worked on the design of mechanical systems for benthic science. He continues to support SIMBA development in conjunction with SRSL.

Bin Cheng is a senior scientist in the Finnish Meteorological Institute. He has developed a high-resolution thermodynamic snow-ice model (HIGHTSI), which has been applied in Baltic Sea ice services and research projects. He has field experience on the deployment of SIMBA in boreal lake and seasonal ice-covered seas and Polar oceans.

U.S. Hydro 2019

U.S. Hydro 2019 will take place at the Beau Rivage Resort and Casino in Biloxi, Mississippi. Workshops are scheduled on March 18 and technical sessions on March 19 to 21.

This event follows from the 2017 conference that convened in Moody Gardens in Galveston, Texas.

U.S. Hydro is a biannual conference hosted by the Hydrographic Society of America (THSOA), which alternates with the Canadian Hydrographic Association (CHA) in hosting hydrographic conferences in North America.

The 2019 conference theme is “Our Changing Oceans and Coasts: Driving Innovation in Charting.” RAdm. Shepard Smith, director of NOAA’s Office of Coast Survey, is the keynote speaker.

The exhibit hall and technical presentations hall will be co-located, allowing for maximum interaction and networking discussions with exhibitors and presenters. In addition, the conference center is located near the piers, not far from the exhibit hall and where exhibitors will have the opportunity to showcase their vessels and products for on-water demonstrations.

In 2019, there will be room for some 80 exhibitors, including industry leaders in survey services, software and hardware. Government, media and academia will also be represented at the exhibition.

Past Conferences

In 2015 and 2017, the conference attracted high-level keynote speakers, including U.S. Sen. Sheldon Whitehouse of Rhode Island, head of the Senate Oceans Caucus; Robert Cardillo, director of the U.S. National Geospatial-Intelligence Agency; RAdm. Gerd Glang, former U.S. national hydrographer and director of NOAA Office of Coast Survey; RAdm. Timothy Gallaudet, former hydrographer of the Navy and commander of Naval Oceanography and Meteorology Command; Robert Ward, president of the Directing Committee of the International Hydrographic Bureau; Captain Jorge Viso, president of the American Pilots’ Association; and Bill Shedd,



U.S. HYDRO 2019
MARCH 19-21 BILOXI, MS



senior geophysicist at the U.S. Bureau of Ocean Energy Management.

In 2017, there were nearly 600 attendees and 80 technical presentations and lightning-round presentations, plus five workshops. Three renowned hydrographers were inducted into the THSOA Hall of Fame: Dr. David Wells, Jerry Mills and Larry Mayer.

A major ingredient for the success of the conference is the exhibitors. At the last show, on-water demonstrations showcased the latest survey and data-collection technology from companies including: ASV Global, Applenix, Chris Ransome & Associates, iLinks Geosolutions, Kongsberg, Measutronics, Norbit, SEAHORSE Geomatics, Survey Equipment Services and Teledyne Marine.

Participation by academia is growing at each conference. THSOA’s Student Outreach Program brought 13 students to the 2017 conference. They were awarded full travel, per-diem and conference fees, given a one-day class in hydrography, and assigned a mentor. A student poster session featured 16 posters at the conference.

2019 Highlights

In addition to the keynote speaker, the opening ceremony will include the induction of two renowned hydrographers into the THSOA Hall of Fame.

This year’s conference will have eight workshops (thsoa.org/2019-Workshops), 80 exhibits, technical presentations, poster-board technical displays, on-the-water demonstrations (including autonomous boat and drone demos), and social/networking events.

Exhibitors include: TDI-Brooks International, Survey Equipment Services, Chustz Surveying, the University of Southern Mississippi, and the U.S. Naval Meteorology and Oceanography Command. For a complete list of exhibitors, visit thsoa.org/Exhibit.

The Accompanying Persons Program will offer the opportunity to visit attractions in Biloxi, including the Maritime and Seafood Industry Museum, the Mississippi Gulf Coast Museum, Stennis Space Center and Ship Island.

To learn more, visit thsoa.org/US-Hydro-2019. **ST**

Kinematic PPP-AR in Antarctic

Comparing Methods for Precise Positioning

By Mert Bezcioglu • Dr. Cemal Ozer Yigit • Dr. Ahmed El-Mowafy

Precise kinematic positioning is important for marine applications such as oceanography, tidal variation, hydrographic surveying, seafloor geophysics and monitoring, marine geodesy, attitude control of ships, and tsunami early-warning systems. Traditional high-precision, relative GNSS (global navigation satellite system) positioning methods require the use of a dedicated base (reference) station onshore. However, this approach has a limited applicability in the Antarctic due to the high cost and weather limitations involved in establishing and maintaining such stations. In addition, the real-time kinematic positioning method (RTK) requires that the distance between the base and the user be limited to less than 15 km.

In the absence of a continuously operating base station, and when using a single receiver—a method known as SPP (single-point positioning)—positioning accuracy can be limited to several meters.

To overcome these limitations, the GNSS-PPP (precise point positioning) method can be used as an alternative to the relative positioning method, as it can provide 3D positioning with centimeter/decimeter-level accuracy and precision on a global scale.

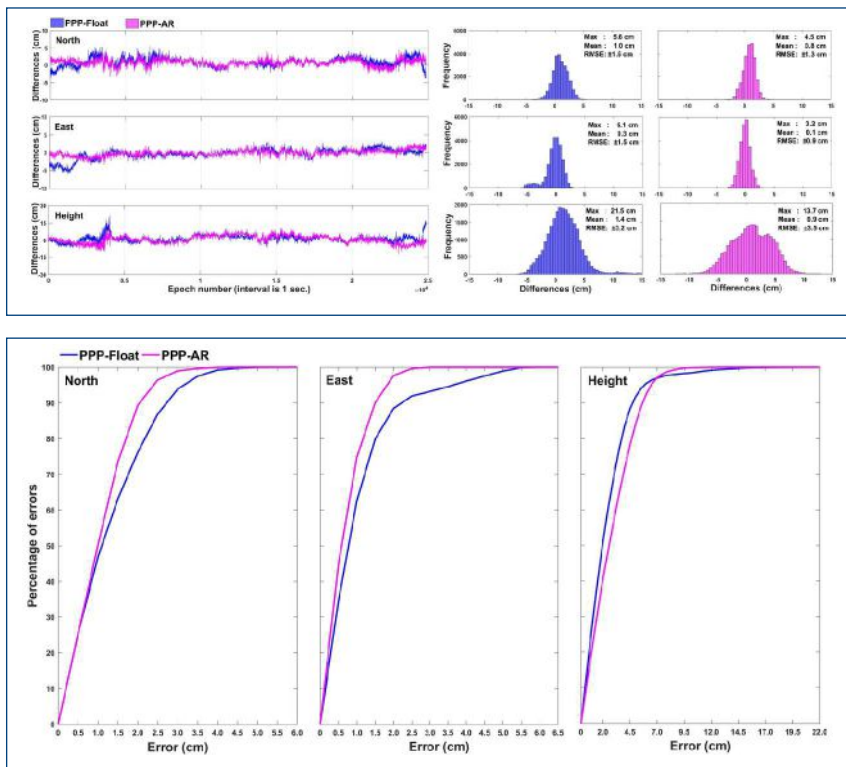
Unlike relative GNSS positioning, GNSS-PPP works autonomously and does not require a reference station. Therefore, it requires less logistics, which is desirable in the Antarctic's harsh environment. In addition, it fa-

cilitates positioning for offshore applications.

However, GNSS-PPP needs precise satellite orbits and clock-correction data to carry out absolute positioning using observations collected by a single GNSS receiver. Since the high-accuracy satellite orbit and clock products are readily available for both real-time and post-mission applications, the use of kinematic GNSS-PPP for the precise positioning of marine platforms has increased over the last decade because it is efficient and cost-effective. The precise post-mission orbits and clock products are available free of charge from IGS and MGEX. Real-time products include the IGS RTS (International GNSS Service, Real-Time Service) and the Japanese MADOCA (Multi-GNSS Advanced Demonstration Tool for Orbit and Clock Analysis). In addition to the open-access products, there are commercial products such as Trimble RTX (Real Time eXtended), Fugro G2 and NovAtel TerraStar.

Photos from field experiment and trajectory of the boat.





(Top) Time history and histogram of differences between PPP-float/PPP-AR and relative methods. **(Bottom)** Cumulative distribution of positioning errors.

Conventional PPP with float has already been extensively tested. The PPP-float method requires about 30 min. for the ambiguities to stabilize and the position solution precision to converge to, and maintain, horizontal accuracy of 10 cm.

In recent years, PPP with ambiguity resolution (PPP-AR) has been developed to improve the accuracy of the estimated coordinates and to shorten the convergence period. Several PPP-AR models, such as the decoupled-clock model, single-difference uncalibrated hardware delay between satellites and PPP-RTK, came about in the past decade.

Nowadays, there are many online services that provide PPP-float post-processing capability without the need for owning specialized software or an experienced user. These services include CSRS-PPP, GAPS, magicGNSS and APSS, developed by leading research services such as the Canadian Geodetic Survey of Natural Resources Canada, University of New Brunswick, GMV Aerospace and Defence, and NASA's Jet Propulsion Laboratory, respectively. For instance, in the CSRS-PPP service, the user uploads the collected GNSS observation files in the generic RINEX (receiver independent exchange) format and receives the solution with information on its precision in a few minutes with some useful diagnostic statistics.

The CSRS-PPP service allows 1-Hz or higher-frequency solution and uses the best satellite orbit and clock products of IGS (final, rapid and ultra-rapid) or the CSRS products, depending on the epoch of the last ob-

servation and the time of a user's data submission. Code and phase observations from a dual-frequency GNSS receiver are used in an ionospheric-free combination. The processing also includes cycle-slip detection and repair, applying satellite and receiver antenna phase center offsets and an ocean-loading correction. In August 2018, the CSRS-PPP service modernized its processing engine to include PPP-AR with added single-frequency PPP positioning using code and phase observations.

In our study, the positioning accuracy performance of the improved PPP-AR undifferenced single receiver technique, which should allow for more accurate results and faster convergence than PPP-float, is evaluated through a long-period kinematic test in one of the most difficult marine environments: Antarctica. The kinematic experiment was carried out in February 2018 at Livingston Island. This study marks the first time the perfor-

mances of PPP-float and PPP-AR have been compared in the Antarctic.

The Experiment

To evaluate the performance of the kinematic PPP-AR and PPP-float methods on marine platforms, two dual-frequency GNSS receivers, Topcon HiPer Pro, were employed. To establish a reference trajectory for evaluation of the PPP accuracy, one of the GNSS receivers was set up onshore and used as a base station for relative kinematic GNSS positioning, while the rover receiver comprised the second GNSS receiver, which was mounted on the boat. The data from the rover receiver was re-processed in the PPP-AR and PPP-float modes autonomously, i.e., without the use of the base station data.

The kinematic experiment started from the Bulgarian Antarctic research station (base) on Livingston Island. The GNSS receiver attached on the boat was kept stationary for approximately 25 min. in order to achieve an integer ambiguity-fixed and a stable float-ambiguity solution for PPP-AR and PPP-float solutions, respectively, after which the boat started traveling. The total duration of the experiment was approximately 7 hr.

Due to the tide, the boat was stranded and kept moored for about 4 hr. at Hannah Point. Therefore, GNSS observations collected in the experiment contain both kinematic and stationary data. When the tide came in and the conditions were suitable for sailing, the boat returned to the Bulgarian Antarctic base, passing through the Spanish Antarctic base. The total route was approximately 25 km. The maximum distance between the boat and the base station was about 12 km.

During testing, both GPS and GLONASS satellite observations were collected. On average, eight GPS and



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“The positioning performance of the kinematic GNSS PPP-AR method was evaluated for the first time in the Antarctic marine environment.”

eight GLONASS satellites were visible. A satellite elevation cut-off angle of 10° was selected, and GNSS observations were recorded at a 1-Hz (1 sps) sampling rate.

GNSS Data Processing, Results

GNSS observations were processed using the traditional (PPP-float) and modernized (PPP-AR) version of the CSRS-PPP service based on IGS final orbit and clock products. The reference trajectory computed from relative positioning of GNSS data was processed using Leica Geo Office 3.0 software. Similar to PPP, a solution based on using a linear combination of two carrier phases (L1 and L2) observations was employed to eliminate the first-order ionosphere effect. The broadcast navigation ephemeris was used for orbit computation in the post-processed relative kinematic solution.

The accuracy of PPP-AR and PPP-float methods was assessed by studying positioning errors, determined as the difference between their solutions after convergence and the reference trajectory obtained from the relative kinematic positioning solution. The mean error, root mean square error (RMSE), maximum error and cumulative error distribution were chosen as performance metrics for PPP solution accuracy.

The RMSE values obtained from the PPP-AR solution were smaller than those of the PPP-float solution for East and North (horizontal) components, whereas the RMSE of the height component for PPP-float is slightly better than PPP-AR. Similarly, the mean errors in PPP-AR were smaller than those of the PPP-float. However, when considering the maximum error values, the North, East and height components for PPP-AR solutions were smaller than 4.5, 3.2 and 13.7 cm at all times, respectively, while those values for PPP-float were 5.6, 6.1 and 21.5 cm at all times.

As expected, the results indicate that the PPP-AR method outperforms the traditional PPP-float method. Furthermore, when compared to cumulative error distributions obtained from PPP-AR and PPP-float, the superiority of PPP-AR to PPP-float solutions, especially for horizontal components, can be clearly observed. Moreover, the PPP-AR solution converged faster than the PPP-float.

Conclusion

In this study, the positioning performance of the kinematic GNSS PPP-AR method was evaluated for the first time in the Antarctic marine environment. The results

obtained from PPP-AR were compared with the traditional PPP-float method and with a reference trajectory obtained from ambiguity-fixed relative positioning. The test demonstrated that both PPP-AR and PPP-float methods provided positioning within centimeter-to-decimeter-level accuracy for horizontal and height components. However, PPP-AR yielded more accurate results than PPP-float, with a faster convergence.

Results of this study indicate that the use of PPP-AR will open the door for improved and reliable precise positioning for many marine applications, in particular for offshore implementation. The achieved positioning accuracy is suitable for applications such as marine geodesy, engineering, navigation, construction, cable and pipeline laying, port works, precise hydrographic measurement, oceanography, and coastal management.

Acknowledgments

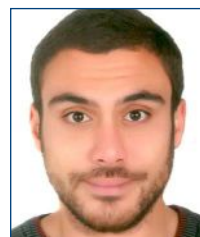
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References

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Dr. Cemal Ozer Yigit is an associate professor in the Geomatics Engineering Department at Gebze Technical University and a visiting professor at Curtin University, Australia. He obtained his Ph.D. in geomatics engineering from Selcuk University in 2010. His research interest is high-rate GNSS-PPP and deformation monitoring.



Dr. Ahmed El-Mowafy is an associate professor in the school of Earth and Planetary Sciences, Curtin University. He obtained his Ph.D. in geomatics engineering from the University of Calgary in 1995. His current research interest is precise positioning, estimation theory and positioning integrity monitoring.



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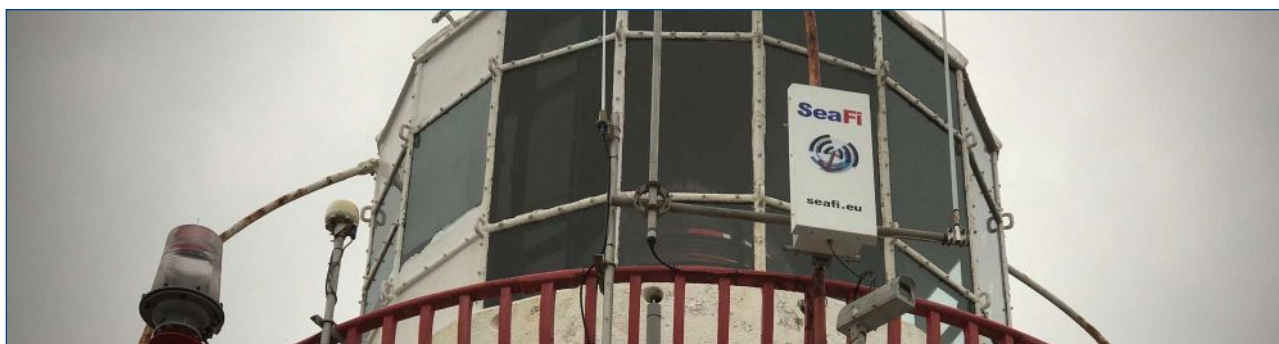
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Wi-Fi from Ship to Shore

SeaFi Demonstrates World's First in Ship-to-Shore Data Transfer

By Arnaud Disant • Dr. Sean McSweeney • Karl Grabe



The SeaFi project started in 2012 based on a simple question: How would you offload large quantities of data from ships to shore and vice versa if you couldn't use conventional solutions such as satellite communications or cellular data?

In 2013, the first prototype solutions were produced, and by 2014 SeaFi had become a commercial reality with early adopter Port of Cork; that same year, it started receiving awards from the maritime community.

Sea-Tech Evolution Ltd. is a Cork, Ireland-based company specializing in maritime communications that formally set a world record on June 6, 2018 for the longest wireless microwave transmission at sea, between a ship underway and a lighthouse, using its in-house-developed SeaFi communication system. This breakthrough in maritime telecommunication could change the way you retrieve data at sea in the forthcoming years.

In some cases, data buoys may offer the possibility of optical-fiber connection, but there are currently only two practical options when dealing with big data on a ship at sea: satellite or cellular, though neither were designed for real-time marine big data. SeaFi offers a new option specifically designed for marine big data environments.



(Top) Roche's Point Lighthouse is situated at the entrance to Cork Harbour, Ireland. In 2013, it became the first lighthouse to transmit data, as well as beaming light. Microwaves and light behave similarly at sea. (Bottom) Designed to survive in hostile environments, SeaFi S360 acts as a relay between a coastal station and the LAN on board a ship. The load balancer can be coupled with satellite communications, and communications will switch automatically from satellite to SeaFi and vice versa depending on signal availability and throughput.

The first prototypes simply aimed to connect a local service vessel (tug) to the internet. But with support from the Irish Naval Service, sea trials involving offshore patrol vessels, RIBs and UAVs showed greater potential.



By 2014, the concept of a wireless maritime area network was born and, with it, a new way of building smarter, cost-effective ports and intelligent coastlines, as well as offshore renewable and salvage operations, without compromising throughput, security or data transfers.

If you think you know Wi-Fi because you have countless instances of devices connecting on a local area network (LAN) on your mind, think again—long-distance Wi-Fi is a whole different game that only gets more challenging when it takes place at sea, where reflection happens on a moving surface, refraction and diffraction are constant and unpredictable, hardware must survive in the harshest conditions, and software failing will be a matter of life and death if a diver must be sent down to troubleshoot.

SeaFi in a Nutshell

SeaFi facilitates the creation of private networks in ports and coastal areas by enabling microwave connections where it matters without relying on conventional telecommunications. These networks are used to connect lighthouses, maritime wind turbines, offshore drilling platforms, sea tugs, gantry cranes, data collection buoys, wave energy converters and much more. But it can also work in ship-to-ship mode and be combined with satellite communications to connect ships during salvage operations, for example.

SeaFi is an S-band radio system; “S” stands for “short” wave. Don’t confuse this with the short-wave radio band, which is much lower in frequency. It’s operating on the 2.4-gigahertz frequency, which works a little like Marconi’s telegraph system, using coastal stations (connection points) and embarked stations at sea, delivering point-to-point and point-to-multipoint omnidirectional connections at distances up to 45 km between stations,



depending on local factors. SeaFi is based on industry standards like TCP/IP and 802.11, while its antennas are designed to withstand the harshest conditions of the maritime environment, including humidity, salinity, rain fade, rolling, pitching and wind.

Most of the large population of men and women working at sea do so for eight to 10 months of the year, barely seeing their families. In addition to crew on commercial vessels, they include those who defend our coasts against multiple forms of trafficking and fight to protect the marine ecosystem. Besides improving security and business efficiency and providing much lower communication costs, for all these people, SeaFi represents the possibility of greatly improving links with their families during long absences.

SeaFi also offers the possibility of improving the quality of real-time data from sea. It even provides a new life for the world’s 18,600 lighthouses: Originally designed to guide ships into ports, lighthouses today could connect an area of approximately 2,500 sq. km via SeaFi. For Port of Cork, since 2014, SeaFi has been an efficient and affordable way of connecting tugs to the engineering office, while Port of Waterford has been using SeaFi for the past two years to connect seafarers and contractors.

3G/4G Networks, Satcom Limitations

Invented to face the growing demand for data from smartphones, the 3G/4G cellular network is expensive to

“Lining up irrefutable evidence of an invisible point at sea where intangible events occur on a ship wasn’t easy.”

put in place and so is primarily used in large-population areas. 3G/4G’s availability at sea is purely coincidental and is very unreliable, as it was never designed for this type of use. So, when networks become overloaded (saturated networks phenomenon), the units most remote from the mast are generally the first to be disconnected from the network. This occurs each year in the Mediterranean with the summer migrations, when millions of people post their holidays in real time on social networks from the beaches, resulting in delays for real-time maritime data.

The Iridium satellite system is theoretically based on 80 satellites, each one the size of a microwave oven. The first generation of satellites was put in orbit between 1997 and 2002 (at a cost of \$5 billion), and the remaining 66 (plus six for contingency purposes) are now reaching the end of their life in orbit, waiting for the new generation to take over. Technically, satellite is a Wi-Fi system where the base station access point (the satellite) is 700 km away from the vessels (the station), allowing communication under the horizon. The last satellite was built in 2002 to support 1,100 concurrent telephone calls; today,

it must face much more traffic, including data, which reduces the current capacity to 550 calls, though the current contention rate is sometimes estimated at 400:1. So, satellites designed when the smartphone that you use to read this article did not exist must now face the era of the all-connected Internet of Things (IoT).

Setting a World Record

A scientific offshore experiment, conducted by SEA-Tech under the scrutiny of maritime professionals, is set to enter the record books. The purpose of the experiment was to achieve a world record for the furthest maritime broadband transmission without a satellite or cellular network, using the SeaFi wireless maritime communication system between a moving ship and a lighthouse.

Lining up irrefutable evidence of an invisible point at sea where intangible events occur on a ship wasn’t easy. The Guinness World Book of Records insisted on an internet connection, which was unnecessary and gave an extra layer of difficulty because internet had to be brought to shore before being sent to sea (although a wireless link can work without internet, therefore, internet has no

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impact on the distance the radio signal will travel). To define the furthest point at sea where the internet connection is still usable while a ship is moving at a speed of 10 kt. and radio waves are traveling at the speed of light, SEA-Tech Evolution had to design meaningful tests and appoint carefully selected reputable witnesses, including academic staff from Cork Institute of Technology (CIT), the National Maritime College of Ireland (NMCI) and University College Dublin (UCD) to encompass a wide array of skills, from maritime and mathematics to technology. Witnesses' observations were recorded independently from each other, often without witnesses being aware of the overlap, which allowed cross-verification of observations.

Article co-author Dr. Sean McSweeney (Department of Computer Science, CIT) and Sean O'Callaghan (NMCI) were tasked with conducting a thorough inspection at Roches Point Lighthouse SeaFi coastal station to establish that the lighthouse and the ship that would take part in the experiment were not connected to each other by any other system except a wireless radio link. Immediately after the inspection, the lighthouse was closed and keys kept by the Commissioners of Irish Lights until mathematician Professor Frederic Dias (UCD) witnessed the operations in the lighthouse with SeaFi coastal operator Theophile Buysens from France. Dias calculated the distance between stations in real time.

Article co-author Karl Grabe (Department of Computer Science, CIT) and Captain Bill Kavanagh (NMCI) inspected the SeaFi ship station on board Mainport's OSV *Ocean Spey* in Ringaskiddy deepwater berth prior to departure. Both men inspected the bridge and the mast of the ship to search for any trace of connectivity other than the SeaFi radio link before leaving the ship under the watchful eye of CIT graduate Captain Mark Sloan and Chief Officer James Darwin. Port of Cork Electrician Steve Hogan assisted on board *Ocean Spey* to ensure all ran smoothly.

The SeaFi ship station operator was article co-author Arnaud Disant, a marine data communications lecturer at NMCI and marine ICT engineer working with Port of Cork, Port of Waterford and Rosslare Europort. For the past decade, Disant has been developing SeaFi with maritime professionals, pilots and the Irish Naval Service.

On the fourth bell of the afternoon watch (1400 hr.), *Ocean Spey* left port, setting course south of Roche's Point Lighthouse in Cork Harbour. For several hours, every 15 min., the operator on the bridge of *Ocean Spey* sent emails to the expert witnesses from CIT, NMCI and UCD and made Skype calls to them. O'Callaghan, Grabe and McSweeney confirmed in real time that the emails originated from the SeaFi ship station and each email sent to shore from the ship was delivered without satellite or cellular connection.

At exactly 1631 hr., Roches Point issued one last message to the ship station. At 1632 hr. the SeaFi ship station on *Ocean Spey* went silent after 2.5 hr. of uninterrupted transmission. *Ocean Spey* was identified at this time by Irish Naval Service vessel LÉ *James Joyce*, which was patrolling southwest of *Ocean Spey*'s position. Lt.




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Commander Brett, commanding officer of *James Joyce*, confirmed Dias's reporting of the position of *Ocean Spey* at latitude 51 30.05 N, longitude 008 03.70 W—19.4 nautical mi. from Roches Point (35.9 km) at the time the last transmission was made.

Evidence of this record distance for a maritime wireless transmission has been sent to the Guinness World Book of Records. The submission was supported by a written testimonial from each individual, independent expert witness.

The Future

SEA-Tech's world-record transmission demonstrates that wireless 802.11 is a commercially viable solution at sea. However, it would be ludicrous to think that one solution will serve all needs.

Instead, the future lies in interconnections of systems such as SeaFi with satellite, or LoRa with SeaFi and satellite, each delivering data to the next level and so addressing the specific issues of marine data communication in coastal environments and offshore on oil and gas platforms.

The IoT revolution has started on land, with Gartner predicting 20.4 billion connected devices by 2020, but marine data communications is still in its infancy, partly because of the reluctant adoption of ICT on board ships and buoys but also because of the education factor necessitating change management and retraining of crew both at sea and on land.

SeaFi offers minimal installation and operating costs, while providing improved service over current state-of-the-art technology. Developing a SeaFi wireless maritime area network is a local initiative involving local harbor and lighthouse authorities together with the expertise of SEA-Tech Evolution. Feasibility studies have started in Europe and Latin America, so it's only a matter of time before SeaFi becomes synonymous with Wi-Fi at sea.

Acknowledgments

The authors would like to thank Diarmuid Holland for his contribution to this article. Holland started working on SeaFi in 2014 while completing a master's in marine renewable energy engineering. **ST**

Arnaud Disant is a marine ICT engineer with SEA-Tech Evolution and the inventor of SeaFi. He is a lecturer at the National Maritime College of Ireland and writes and speaks frequently on maritime IT and communications topics and the future of marine technology. SEA-Tech Evolution has built a strong reputation for delivering Marine ICT projects in Ireland and overseas.

Dr. Sean McSweeney is a lecturer in information security and the Internet of Things (IoT) in the Department of Computer Science at Cork Institute of Technology. His research is in security for enterprise and future networks and sensor platforms for WSNs. McSweeney is also a principal investigator of the Ríomh research group at CIT (cs.cit.ie/riomh).

Karl Grabe is a retired lecturer at the Cork Institute of Technology who specializes in mobile app development and desktop user interfaces. He has a master's in electrical engineering science and has worked as a software developer and engineering manager at Apple Inc. in Cork, Ireland, and Cupertino, California, and a manager at Motorola Cork.



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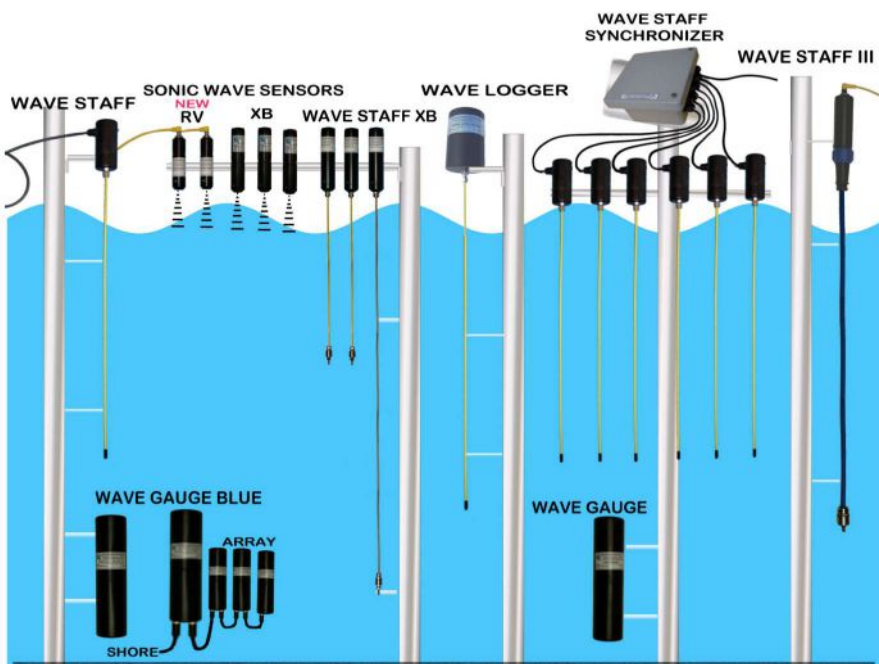
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The diagram illustrates a comprehensive ocean sensing system. On the left, a 'SHORE' unit is connected to a 'WAVE GAUGE BLUE' and an 'ARRAY' of sensors. In the water, there are several 'WAVE STAFF' units, each equipped with 'SONIC WAVE SENSORS' (labeled 'NEW RV' and 'XB'). A 'WAVE LOGGER' is also shown. On the right, a 'WAVE STAFF III' is connected to a 'WAVE GAUGE' and a 'WAVE STAFF SYNCHRONIZER' unit. The entire system is designed for monitoring waves, tides, and levels in various aquatic environments.

international

Scottish Company Invests in ROV Technology

Aberdeen-based Subsea Technology & Rentals has made a significant investment in Teledyne Marine offshore construction and geophysical technology, including the first four new TOGS1 AHRS/INS units, a surface Saturn AHRS, RESON SeaBat T50-S subsea multibeam sonars and multiple TSS HydroPACT 440 pipe trackers and RDI DVLs. Subsea Technology & Rentals provides services including mission-critical solutions to support offshore survey, ROV, IRM, positioning, environmental and subsea construction sectors.

Survey Company Acquires Corrosion Expert

Acteon Group acquired subsea corrosion specialist Deepwater Corrosion Services, which offers subsea corrosion control for all asset types, including oil and gas platforms and wind turbines. The company operates in the U.S., U.K., Brazil, Norway and Australia. It has installed offshore cathodic protection systems and provides corrosion investigation and subsea inspection services.

Ship Scrubber Manufacturer Opens in Shanghai

Yara Marine Technologies has officially opened its new office in Shanghai to meet increasing demand for exhaust gas cleaning systems for newbuilds and retrofit projects. The new office will support a local team spanning

the value chain in sales, engineering, procurement and service and commissioning in addition to local support functions. The company produces inline scrubbers of nickel alloy material with optional corrosion guarantee.

MacArtney Continues Strategic Partnership with SeaTech China

Since 2005, MacArtney has worked in cooperation with SeaTech China Co. Ltd., a distributor of high-tech underwater technology in China with cooperative relationships with scientific research institutes. SeaTech is the sole distributor of SubConn and OptoLink connectors for MacArtney in China over the last decade. MacArtney Singapore has developed an exclusive strategic partnership with SeaTech, and the companies will continue the exclusive agreement.

Bridge is Complete In Arctic Norway

The Hålogaland bridge in Narvik, Norway, the longest suspension bridge within the Arctic Circle, opened in December 2018. The construction was coated with Jotun protective solutions for long-lasting anti-corrosion in fluctuating temperatures and winds in excess of 80 mph. The bridge spans 1,533 m across the Romsbak Fjord; it cost \$418 million and took five years to build. Constructed from 30 sections with 7,000 t of bridge deck, it is vital infrastructure within the far north of Norway.



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New Tools for Offshore Workflow Efficiency

Subsea laser LiDAR technology and 3D data visualization company 3D at Depth Inc. is expanding several global office locations and launching services to increase efficiency for offshore oil fields throughout the workflow from design through decommissioning. The product line includes terrestrial dimensional control to support subsea data collection, subsea tooling design, remote sensing and real-time LiDAR data collection.

Korean Commission Clears Acquisition of Norwegian Offshore Solutions Company

MacGregor received a clearance decision from the South Korean Fair Trade Commission on the company's acquisition of the marine and offshore businesses of TTS Group ASA, a Norwegian provider of handling solutions and access systems for offshore marine industries. MacGregor announced approval from a German regulator in November 2018 but is still waiting for approval from the competition authority in China. MacGregor expects to close the transaction in the first quarter of 2019.

Chartered Marine Scientists Will Add Hydrography Descriptor to Their Titles

The Institute of Marine Engineering, Science and Technology, IMarEST, launched a new hydrography descriptor for its chartered marine scientist register to allow hydrographers to distinguish themselves by using CMarSci(Hydrography) after their name. No such designation has previously existed, and the IMarEST is the only organization that can offer the chartered marine scientist register. The hydrography post-nominal has been introduced to reflect the increasing importance of the discipline.

Enpro Moves to UK, Reports Global Activity

Enpro Subsea moved to new U.K. headquarters, reporting a 100 percent increase in international projects. Enpro flow access module (FAM) technology allows use of standard subsea trees and manifolds while enabling future integration of metering, flow assurance, data acquisition and hydraulic intervention. Enpro flow intervention services (FIS) technology has been deployed on multi-well hydraulic intervention campaigns in West Africa, and the company will deliver its 15 ksi deepwater FIS in 2019 through Scottish funding. It is also contracted for support in decommissioning of North Sea gravity base structures.

Europe's Largest Multimodal Operator Joins Electric Ship Project for Lower Emissions

Samskip is now lead partner in Seashuttle, a project seeking to bring emissions-free, autonomous container ships to market. The award of €6 million of Norwegian government money to Project Seashuttle is for development of two all-electric ships to connect Poland, Swedish west coast ports and the Oslo fjord. The vessels will use hydrogen fuel cells for their propulsion power. Seashuttle is one of six initiatives in PILOT-E, a €100 million-plus scheme to bring solutions for the climate-neutral industries of the future to market more quickly. **ST**



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Fugro Receives Compass Industrial Award

Fugro received the Marine Technology Society (MTS) 2018 Compass Industrial Award, co-sponsored by the publisher of *Sea Technology*, for outstanding private sector contributions to marine science and technology. MTS cited the company's legacy of marine survey innovation and its support of the Seabed 2030 Project. David Millar, Fugro's government accounts director for the Americas region, accepted the award.

Beacon Dives Deep to Avoid Signal Blocking

EdgeTech delivered an emergency recovery beacon (ERB), a programmable acoustic command transmitter and transponder in a 6,000-m-rated nickel aluminum bronze alloy housing that can be lowered from the side of a vessel below any surface noise, shipboard noise or thermoclines. The ERB is programmed through a serial port, and it can transmit EdgeTech LF BACS enable, disable and release commands at a pre-programmed rate. The ERB can be used as a transducer to get below a thermocline that may block acoustic signals for release.

New Tenants Join COVE in Canada

Ottawa-based sensor developer RBR joined the Centre for Ocean Ventures & Entrepreneurship (COVE), a

collaborative facility for applied innovation located in Nova Scotia, Canada. RBR creates sensors to track water parameters—temperature, depth, salinity, dissolved gases, pH and others. The office location at COVE allows RBR to network and collaborate with commercial, academic and government clients, as well as the global organizations attending scientific and industrial events.

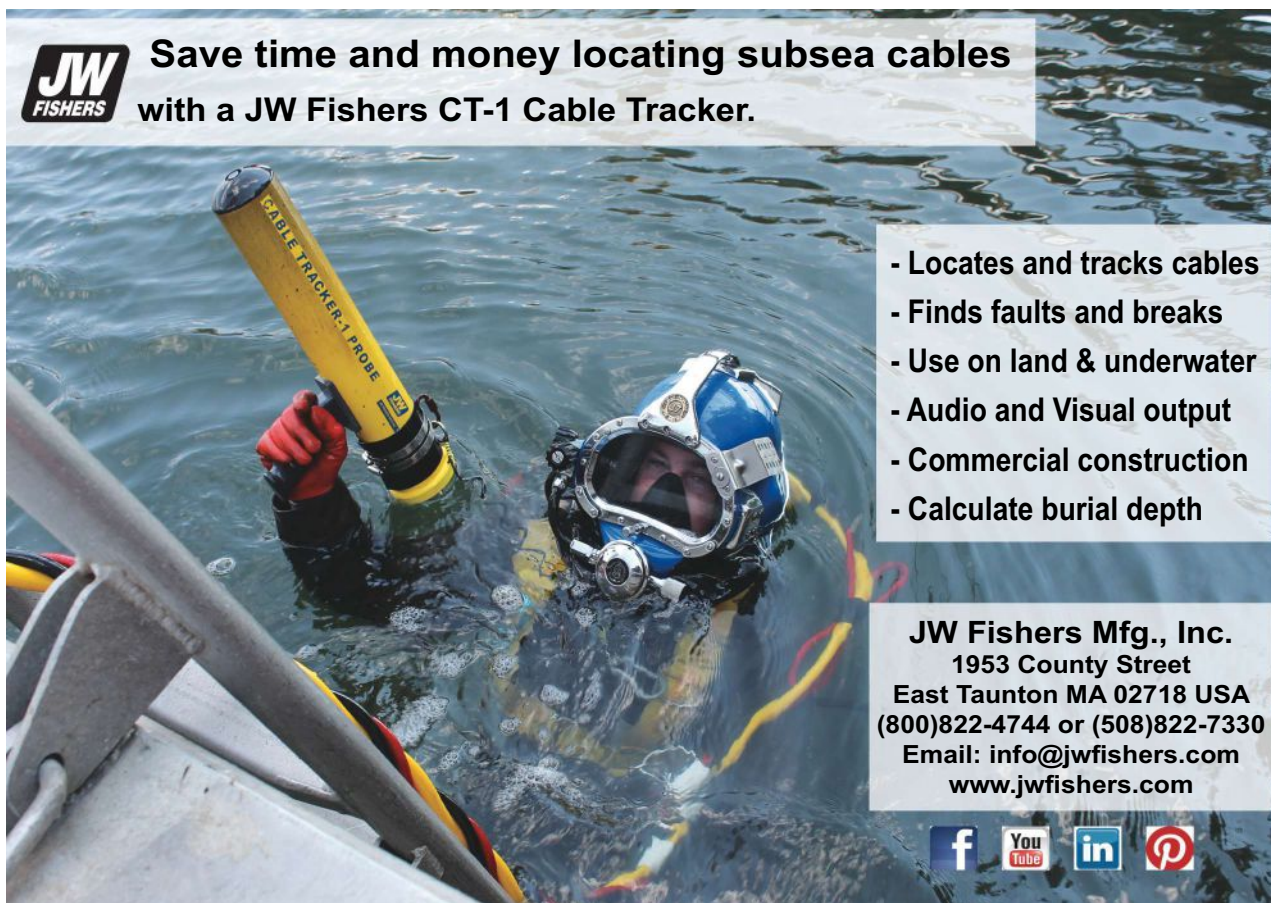
Precise Design and NSBA have also become tenants of COVE.

Fuel Available on Pacific Coast by Columbia River

World Fuel Services (WFS) has a new U.S. physical bunker supply operation and is fully operational in the Columbia River, servicing Portland, Vancouver, Kalama, Longview, Rainier and Astoria in Oregon and Washington states. By partnering with Harley Marine Companies Pacific Terminal Services and Olympic Tug and Barge, WFS will offer RMG 380 and MGO 0.1 percent sulphur by dual-product barge on the Pacific Northwest Coast.

Moody's Affirms Panama Canal Stable Rating

Moody's Investors Service reaffirmed the Panama Canal Authority's A2 long-term rating with a stable outlook, based on its position as an infrastructure asset with a unique geographic advantage and business model and its strong historical operational and financial performance. ACP had better than anticipated financial metrics, driven by the successful operations of the Expanded Panama Canal.



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Sea Machines Establishes Global Dealer Network

Boston-based Sea Machines Robotics has closed a \$10 million series A investment, one of the largest venture rounds for a marine- and maritime-focused technology company, bringing the total capital Sea Machines has raised to \$12.5 million. The company also created a dealer program that includes strategic partners who sell, install and service the company's line of command and control systems for workboats. The dealer network initially includes builders located in the U.S., Canada, U.K., Netherlands, United Arab Emirates and Singapore.

Canaveral Port Bonds Given Stable Ratings

The Canaveral Port Authority's planned issuance of a series of bonds for approximately \$75 million in proceeds has been reviewed and assigned favorable ratings by two nationally recognized statistical rating organizations. Fitch Ratings assigned an A rating to Canaveral Port Authority (CPA) port revenue bonds, Series 2018 A&B. Fitch also affirmed its rating on \$63 million in outstanding Port Facilities Revenue Bonds. Moody's Investors Service assigned an A2 rating to CPA's issuance of Port Improvement Revenue Bonds, Series 2018A (AMT) and Port Improvement Revenue bonds, Series 2018B (Non-AMT).

BWTS Electrochlorination System Approved

De Nora, a supplier of electrochlorination equipment, received type approval from the U.S. Coast Guard (USCG) for its BALPURE ballast water treatment system. The BALPURE system is approved for both safe area and hazardous zone installations for internationally trading vessels, including U.S.-flagged ones.

In De Nora's system, 0.5 to 1 percent of the seawater flow entering the ballast line is channeled into the electrochemical unit, and the necessary amount of hypochlorite to treat the water is generated in the slipstream and then mixed to the full volume of ballast water.

US Applied Physics Laboratory Receives UXO Detection Platform

A MacArtney FOCUS 3 instrumentation platform for underwater data acquisition and inspection is on its way from Esbjerg, Denmark, to the Applied Physics Laboratory (APL) at the University of Washington in the U.S. The FOCUS 3 will be used to develop and test new methods for UXO detection and classification. With funding from the Environmental Security Technology Certification Program and the new device, APL can detect an object and provide high-resolution imaging, spectral response and accurate position of the object using sonar technology.

Conservation X Tech Prize Winners Modify Nanolander for Underwater VR

Global Ocean Design helped modify and adapt one of its Nanolandings for one of the Conservation X Tech Prize challenge teams. The SubC Imaging prototype 360° camera mounted on a modified Nanolander was deployed off San Diego. The team Real Deep Conservation VR won the grand prize for its easy-to-use deep-sea camera trap for filming in virtual reality underwater. **ST**

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Indian Monsoons Affect Atlantic Hurricanes

Strong monsoons in the Indian Ocean can induce easterly winds that push Atlantic Ocean hurricanes westward, increasing the likelihood they'll make landfall in the Americas, the American Geophysical Union reported. A new study finds that in years when summer rainstorms in India are stronger, Atlantic hurricanes move further westward toward land. In years where the rains aren't as strong, hurricanes tend to curve northward earlier and fizzle out in the north Atlantic Ocean.

This discovery could help scientists better predict the path of hurricanes.

Reuters Series Shines Light On Climate Change in Ocean

In the last few decades, oceans have undergone unprecedented warming. Reuters reporters and

photographers reveal this natural disaster in the series "Ocean Shock": reuters.com/investigates/special-report/ocean-shock-warming.

Among the findings are that fish are moving 10 times farther on average than land animals affected by rising temperatures, and warming waters are stressing tropical nations, but the aquaculture industry is adding to the pressure on fisheries; roughly 20 percent of the world's wild-caught fish are ground up to make fishmeal.

360° Video from Salish Sea Expedition

Researchers captured 360° images down to nearly 1,000 ft. near Friday Harbor in the San Juan Islands during the 2018 Salish Sea Survey Expedition. The Boxfish 360 camera from Oceans 360, a nonprofit to increase awareness of the oceans' importance, was mounted to the exterior of Cyclops 1, a five-per-

son manned submersible owned and operated by OceanGate. The expedition, conducted in September 2018, included seven dives over five days to allow three teams of scientists to observe the feeding strategies of deep-sea red urchins, document the sand-wave habitat of Pacific sand lances, and assess the potential impacts of scientific trawling on the ecosystem.

Environmental Think-Tank For Market-Based Solutions

UC Santa Barbara's Bren School of Environmental Science & Management has launched the Environmental Market Solutions Lab (emLab), a "think-and-do tank" that will develop market-based solutions to address urgent environmental problems.

The emLab will follow the approach developed by UC Santa Barbara's Sustainable Fisheries Group, which has successfully combined academic and pragmatic considerations for ocean challenges over the past 12 years.



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Link Between Climate Change, Ancient Civilization's Demise

More than 4,000 years ago, the Harappa culture thrived in the Indus River Valley (now Pakistan and northwestern India), where they built sophisticated cities, invented sewage systems predating ancient Rome's, and engaged in long-distance trade with Mesopotamia. Yet by 1,800 B.C.E., Harappans had abandoned their cities for smaller villages in the Himalayan foothills.

A new study from the Woods Hole Oceanographic Institution found evidence that climate change likely drove the Harappans to resettle far away. Starting roughly 2,500 B.C.E., a shift in temperatures and weather patterns over the Indus Valley caused summer monsoon rains to gradually dry up, making agriculture difficult or impossible near Harappan cities.

First TRIAXUS ROTV in Chinese Ocean Science Market

MacArtney Singapore has delivered a TRIAXUS ROTV with cus-

tomized sensor payload to the Chinese Academy of Science (CAS) for oceanographic research projects in the South China Sea. This TRIAXUS ROTV is the first to enter the Chinese ocean science market.

The sensor payload comprises a Teledyne RDI ADCP, Sea-Bird 911 CTD with dissolved oxygen sensor, and a WET Labs ECO fluorometer.

Rangers Collect Arctic Data

Researchers from Fisheries and Oceans Canada have partnered with the Canadian Rangers to collect winter oceanographic data across the Arctic Ocean; measurements scientists wouldn't have otherwise been able to achieve.

The Rangers, reservists in the Canadian military in remote communities, plan the week-long expeditions alongside the researchers and manage the logistics involved in profiling RBRconcerto CTDs into scientifically interesting parts of the Arctic Ocean. "The underlying philosophy is that people with experiential knowledge of place have

something to offer science," said Eddy Carmack, who led the inception of the program, called Canadian Rangers Ocean Watch (CROW).

New Tool for Acoustic Backscatter Measurements

A new tool to measure both sediment concentration and size is being built by ASL Environmental Sciences Inc. The multifrequency ultrasonic device (MUD) is based on ASL's acoustic zooplankton fish profiler (AZFP). The MUD and AZFP echosounders can be configured with up to four frequencies, ranging from 38 kHz to 2 MHz.

The MUD prototype is based on higher frequencies (200 and 769 kHz, 1.2 and 2.0 MHz) for a broad range of particle-size discrimination. While the AZFP is a high-gain device for low scattering conditions and the greatest possible range, the MUD echosounder is a lower gain system for higher backscatter regimes such as the bottom or high concentrations of suspended sediment. **ST**



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STR Buys Fusion 2 LBL, INS Software

Subsea Technology and Rentals (STR) has become the first company to invest in Sonardyne International Ltd.'s new long baseline (LBL) and inertial navigation system (INS) software, Fusion 2. STR will upgrade its existing 6G hardware to Sonardyne's new 6 "plus" variants, which, combined with Fusion 2, will make marine survey and offshore construction projects faster and easier than ever.

Fusion 2 features Wideband 3, which enables sensor telemetry data (e.g., pressure, depth, temperature) to be embedded in navigation (ranging) telemetry data, meaning there are no pauses in tracking when installing subsea structures, giving operators awareness at all times and reducing risk.

MacArtney, Kongsberg Supply Sensors for Morocco Vessel

MacArtney France, as a representative of Kongsberg Maritime, has supplied the sensor package for PIRIOU, shipbuilders and naval engineers supplying the Royal Moroccan Navy.

After a long partnership with SHOM, the French Service Hydrographique et Océanographique de la Marine, the King of Morocco commissioned a new hydrographic vessel for the Royal Moroccan Navy. This vessel will map Morocco's Exclusive Expansion Zone (EEZ), an area of up to 200 nautical mi. to be explored and utilized for marine resources, including energy production from water and wind, as outlined by the United Nations Convention on the Law of the Sea.

The MacArtney package included EdgeTech side scan sonars and sound velocity sensors and profilers from Valeport.

Consortium for Blockchain-Based Certification

Maritime Blockchain Labs (MBL), founded by blockchain technology and governance experts BLOC and the Lloyd's Register Foundation (LRF), has established a consortium that will pilot a blockchain-based seafarer certification system. The project aims to streamline and expedite processes that can be marred by a lack of verification for safety documentation, paper-based certificate management and a lack of access to validated safety and training certifications of seafarers. These factors can lead to significant issues for crew management agencies, ship operators, and regulatory and port authorities for securing and insuring crew.

The second of three demonstrator projects funded by LRF, this consortium brings together stakeholders who either rely on or support crew certification.

Upon validation and scaling, the final solution would enable seafarers to manage their certificate repository from original issuance; maritime administrations to manage the renewal and endorsement across jurisdictions; crew management organizations to manage seafarers for crewing of vessels; and vessel owners to receive an overview of their crew, certificates and endorsements. **ST**



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Integrated Swath Bathymetry

The EdgeTech 6205s is a fully integrated swath bathymetry and dual-frequency side scan sonar system that produces real-time, high-resolution, side scan imagery and three-dimensional maps of the seafloor using multiphase echosounder technology. EdgeTech.

Wide-Angle Sonar

WASSP (Wide Angle Sonar Seafloor Profiler) generation three multibeam CHIRP sonar with a fully digital DRX transceiver provides a real-time, 3D, high-resolution view, with simultaneous recording of bathymetry and seafloor hardness. Furuno USA Inc.

Microplastics Sampler

A large volume water sampler allows collection of suspended and

sinking particles. A total 50-liter sample includes the upper 5 liters for positively buoyant plastics, 40 liters drained for neutrally buoyant materials, and a lower section with a flat bottom chamber for photographing and subsampling. Ocean Scientific International Ltd.

SubC Software Updates

Version 2.6.5 Rayfin software includes strobe compensation, NTP time sync, API scripting, digital PTZ, Ethernet streaming, UDP comms, ultraoptics for wide angle, skate laser line support, a new aux device and expansion ports. SubC Imaging.

Accelerometer, Pressure Sensor

Model 352A59 ICP teardrop accelerometer with a transducer electronic data sheet has a single axis to

minimize the effects of mass loading on small devices with an integral M3 connector. Model 105C ICP piezoelectric pressure sensor with integral lead wires yields a resonant frequency > 250 kHz. PCB Piezotronics Inc.

Rugged Flood Lights



RokLUME 280 and 380 LED flood lights for extreme environments are available in three beam styles: close range, long range and pencil beam. They are IP 6K8 immersible, IP 6K9K dust-proof and sealed against high-pressure washing with high-impact hard-coated PC lenses. Hella marine Inc.

Cable Sets, Connectors and Inlets

100A series pin and sleeve cable sets, connectors and inlets are IP69K-rated for water and dust ingress protection. They have a V-0 flammability rating and chemical-resistant, UV-stabilized PBT housings. They are available in 125/250-V and 30Y 120/208-V configurations. Hubbell Marine Electrical Products.

360° Underwater Drone

360-ROV is a 360° spherical, modular ROV and lighting system that uses eight HD cameras to create a live-streaming spherical video. It carries more than 74,000 lumens of light, has modular design for part replacement and works with VR and AR headsets. SWL Robotics.

Remote Vessel Surveillance System

ZigBoat provides access to critical vessel information using a Gateway core with inbuilt GSM/3G module. It accommodates unlimited sensors placed throughout the vessel, accessed via QR code and mobile app. Options include wireless video surveillance and push notifications. Glomex Marine Antennas USA Corp.

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Stretch-Resistant Rigging

Three new double-braid running rigging lines, XLS3, MLX3 and GPX for racing, are built on a unified framework using tailor-made materials. Manufacturing includes testing elastic stiffness of rope, its resistance to stretch under load, as an additional component of strength. Samson Rope Technologies Inc.

Modular Chillers for 300' Ships



BlueCool Q-Series is controlled by one central system with cooling capacity of 500 to 1,500 kBTU/h, 42 to 126 t. and 360 to 690 V. P-Series offers 30,000 to 572,000 kBTU/h, 2.5 to 48-t cooling with 360 to 690 V, soft start, and cool-only and tropical versions. It can be configured with CAN-bus. Webasto Thermo & Comfort North America.

Dimmable LED Rope Light

A 10-ft. weatherproof LED rope light is equipped with an encapsulated inline transformer for 120- to 277-V input and a wireless remote, ideal for boat docks, shipyards and as a perimeter lighting system. Solid-state LEDs last 100,000 hr. Larson Electronics LLC.

Cybersecurity Dashboard

Dashboard monitors cybersecurity of all protected systems, allowing shipboard and shore-side staff to evaluate fleetwide system data, even offline. The endpoint system gathers information from ECDIS, radar and MCS systems, with on-board access to data both online and offline. Naval Dome Ltd.

Offshore Wind Service Vessel

The Fast Crew Supplier (FCS) 3410 service accommodation and transfer vessel (SATV) is designed for operations in the developing North American offshore wind market. It

features Twin Axe bow design for optimized sea-keeping behavior and is 6 m longer than previous models. Damen Shipyards Group.

Deep-Sampling Option



A 7,000-m deep option for WTS-LV samplers is available on the standard, dual-filter and high-capacity WTS-LV models. Dual-filter models have 142-mm vertical-intake filter holders for parallel filtration. McLane Research Laboratories Inc.

VHF Radios with GPS

Raymarine VHF radios include the compact Ray53, full-sized Ray63 and the multifunction Ray73 with AIS. They are full-function VHF radios with Class D digital selective

calling, each with GPS receiver and connection point for optional GPS/GNSS antenna. FLIR Systems Inc.

Fuel Data Processing Network

FUELNET Generation 5 allows collection, storage, tracking and processing of crucial weather data metrics that are activity time-stamped and linked to vessel geolocation. Nautical Control Solutions LP.

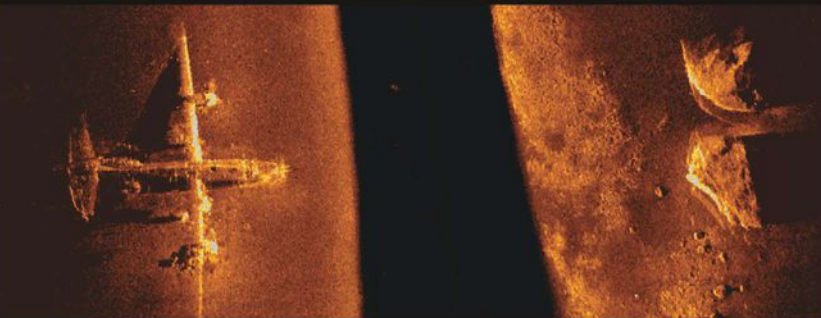
Compact GNSS Receiver

A mosaic GNSS receiver supports more than 30 signals from six GNSS constellations, L-band and various satellite-based augmentation systems. A multiband module tracking all GNSS satellites, it will support future GNSS signals. Septentrio.

Precision Excavator

The Carrera E 3D motion-controlled precision flow excavation spread includes a 630+ kW, all-electric deepwater excavator with ROV DP technology and 3D motion control for precision and minimum seabed disturbance. Seatools. **ST**

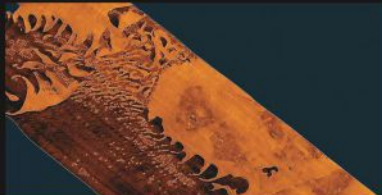
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contracts

Fairbanks Morse, Beloit, Wisconsin, will supply engines for U.S. Navy ships including LCS 27, LPD 29 and LPD 30 and the main propulsion diesel engines for the new U.S. Coast Guard offshore patrol cutter. U.S. Navy.

L3 OceanServer, Fall River, Massachusetts, received a contract for an Iver3 UUV with mine countermeasure and automatic target recognition capabilities, as well as INS, bathymetry and side scan sonar. U.S. Marine Corps Systems Command.

Oceaneering International Inc., Houston, Texas, secured a three-year provision of inspection enactment services contract with an engineering and production services division in the Western Hemisphere, expanding service with two additional North Sea facilities. Petrofac.

Alfa Laval, Lund, Sweden, signed a fleet agreement that covers a range of PureBallast 3 system types, as well as deckhouses and a service agreement, for ballast treatment throughout a Turkish fleet. Advantage Tankers & Advantage Products.

Damen Shipyards Group, Gorinchem, Netherlands, will deliver a Damen ASD Tug 2811 in the first quarter of 2019. The stock vessel will be named "E-Two." An additional FiFi1 system and aft winch will be installed. EMAR Offshore Services.

Transocean Ltd., Steinhausen, Switzerland, signed a rig design, construction and five-year drilling contract. The rig will be the first ultradeepwater floater rated for 20,000 psi operations and is expected to commence operations in the Gulf of Mexico in 2021. Chevron USA Inc.

Great Lakes Dredge & Dock Corp., Oak Brook, Illinois, signed a \$93 million contract award for dredging to deepen the entrance of the Cor-

pus Christi ship channel, with completion expected in early 2020. Port of Corpus Christi.

Elbit Systems Ltd., Haifa, Israel, received a \$15 million contract to supply a comprehensive solution for the FPSO platform of the offshore Karish-Tanin gas fields. Energean Israel Ltd.

Korean Register, Busan, South Korea, signed an agreement for the IACS classification society to provide inventory of hazardous materials services across a fleet of container vessels, bulk carriers, conbulklers, car carriers and tankers. NSC Group.

TechnipFMC, Paris, France, will manufacture, deliver and install subsea equipment through an integrated engineering, procurement, construction and installation contract for the Atlantis Phase 3 project. BP plc. **ST**

meetings

MARCH

March 3-5—World Congress on Maritime Heritage, Singapore. c.walker@morganmarketcomm.com or <https://wcmh2019.com>.

March 5-7—Subsea Tieback, San Antonio, Texas. 713-963-6251, gailk@pennwell.com or www.subseatiebackforum.com.

March 5-7—World Ocean Summit, Abu Dhabi, United Arab Emirates. oceansummit@economist.com or www.woi.economist.com.

March 10-13—IEEE/OES Currents, Waves, Technology Measurement and Applications Workshop, San Diego, California. 508-289-2456, jrjzoli@whoi.edu or cwtm2019.org.

March 13-15—World Congress on Maritime Heritage, Singapore. WCMH2019@worldexpress.com.sg.

March 18-21—U.S. HYDRO, Biloxi, Mississippi. 832-687-5570, melissa@thsoa.org or <https://thsoa.org/US-Hydro-2019>.

APRIL

April 1-3—Waterpower Week, Washington, D.C. 918-831-9560, andrea.harner@clarionevents.com or www.waterpowerweek.com.

April 2-4—MCE Deepwater Development, London, England. 281-491-5900, Bo.Howard@questoffshore.com or mcedd.com.

April 8-11—SubOptic, New Orleans, Louisiana. 703-444-0845, knielsen@stfevents.com or www.suboptic2019.com.

April 9-10—Intelligent Ships Symposium, Philadelphia, Pennsylvania. asnehq@navalengineers.org or www.navalengineers.org/Symposia/Intelligent-Ships-Symposium-2019.

April 9-11—Ocean Business, Southampton, England. +44 (0)1453 836363, hdavis@divcom.co.uk or www.oceanbusiness.com.

April 10-11—Offshore Survey, Southampton, England. +44 (0)1453 836363, info@oceanbusiness.com or <https://bit.ly/2Q735Bj>.

April 15-19—MTS International Buoy Workshop, Hobart, Australia. MTSevents@mtsociety.org or www.whoi.edu/buoyworkshop/2019.

April 26-27—Inland Ocean Action Summit, Dallas, Texas. cevans@inlandoceancoalition.org or <https://earthx.org/ocean>.

April 29-May 2—AUVSI XPONENTIAL, Chicago, Illinois. 571-255-7786, tmcMahon@auvsi.org or www.xponential.org.

MAY

May 6-9—Offshore Technology Conference, Houston, Texas. <http://2019.otcnet.org>.

For more industry meetings, visit sea-technology.com/meetings. **ST**

people

Planet Ocean Ltd. hired **Aaron Clark** as a technical scientific sales engineer based at its Camberley headquarters. Clark graduated from the University of Portsmouth with honors in marine biology and qualified as one of the youngest scuba divers in the U.K.



Carl Mancuso joined Teledyne Marine as the director of product line management for Teledyne Benthos. Teledyne Oceanscience promoted **Shannon Searing** to inside sales and customer support manager for the SeaBotix and Oceanscience divisions of the Teledyne Marine-Vehicles group.



Once an elite amateur golfer who played for Denmark's national team, **Michael Behrens** has been hired as the new chief commercial officer for MacArtney Underwater Technology at its Esbjerg, Denmark headquarters.

Mote Marine Laboratory hired **Dr. Cynthia Heil** as director of its new Red Tide Institute, focused on studying Florida red tide mitigation and control technologies for coastal communities affected by challenging harmful algal blooms (HABs).

Chesapeake Technology Inc. appointed **Harold Orlinsky** as general manager. He began his career as a NOAA Corps officer and spent 25 years in the hydrographic field, most recently as GM of HYPACK.

The Navy League of the United States named retired 13th Master Chief Petty Officer of the Navy **Michael D. Stevens** as its executive director. Beginning his career at the Aviation Structural Mechanic Ap-

prentice School in Millington, Tennessee, Stevens spent 33 years in the U.S. Navy.

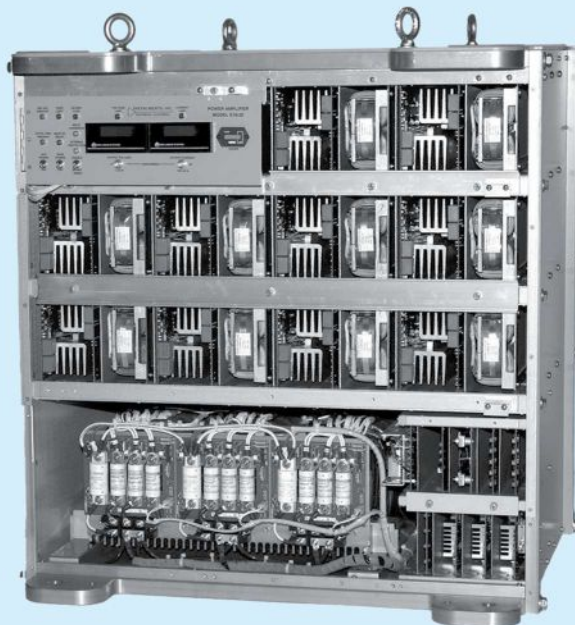
Andre Rose joined the International Marine Contractors Association (IMCA) as technical adviser of competence and training, remote systems and ROV. Rose spent 18 years in the ROV industry, including as a pilot/technician, superintendent and ROV manager. He spent 19

years with the Royal Navy's Fleet Air Arm, working with rotary and fixed-wing aircraft.

Gardline appointed **Christiaan Vermeijden** as chief executive officer. He was previously CEO at Norway-based Electromagnetic Geoservices ASA (EMGS), was on the executive management team and served as global offshore geotechnical director at Fugro N.V. **ST**

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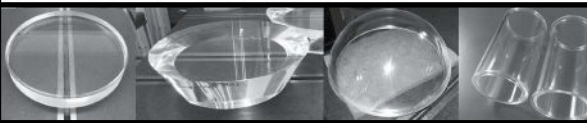


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Let's Reframe Cybersecurity as an Operational Issue—Andrew R. Lee

Andrew R. Lee is a partner with Jones Walker LLP in New Orleans and co-chairs its Privacy and Data Security Group. He advises clients on cybersecurity, records retention and electronic discovery. He assists with processes and programs related to the security of sensitive corporate data, recovery after cyber intrusions, litigation hold procedures, and electronic discovery of data in legal proceedings and internal investigations.



From New Orleans' waterfront pedestrian paths and park benches, the Mississippi River often looks placid and calm. Vessels ply these waters with stately grace, moving up and down the river and in and out of the Port of New Orleans as if performing a well-rehearsed ballet.

Experienced mariners, however, can tell you that the Mississippi is filled with threats—both hidden and obvious: strong currents, a changing riverbed, dangerous obstructions and high traffic. To ensure the safe movement of passengers and cargo, vessel owners and operators, ports and other industry participants have invested heavily in personnel training, top-of-the-line technology, and other tools and tactics that help minimize risks.

When it comes to maritime cybersecurity, the dangers are equally great. Unfortunately, the industry has not responded with equal force.

In mid-2018, Jones Walker LLP commissioned its first-ever Maritime Cybersecurity Survey to gain an in-depth understanding of the current "cybersecurity state of the maritime union," identify readiness gaps, and develop guidance for cost-effective, high-impact solutions that companies could implement almost immediately.

Skipping to the punch line, the maritime industry is aware of—and woefully underprepared for—potential cyberattacks. For example,

78 percent of large-company (more than 400 employees) respondents and 38 percent of all respondents reported that their companies were subject to a cyberattack within the prior year; only 36 percent of respondents reported that their companies were prepared for a cyberattack, but—revealing disconnect—69 percent believed that the industry, overall, was prepared; and nearly two-thirds reported that they were ill-prepared to address the negative public opinion and media coverage that often follow a cyber incident, and seven out of 10 expressed a lack of confidence in their ability to handle the aftermath of an event that involved the loss of sensitive or confidential intellectual property or business information.

The smaller the company, the less likely it was to take steps to prevent or prepare for a cyberattack. Of companies with 49 or fewer employees, only six percent indicated that they were prepared to meet cybersecurity challenges. Companies with 50 to 400 employees were only marginally more prepared; four out of five reported taking few or no steps to protect themselves.

On a more positive note, the adage "once bitten, twice shy" seems to describe maritime companies. While the learning curve may have been steep and painful, our results showed that there was a correlation between having been the target of a cyberattack and higher levels of preparedness for future incidents. Among companies that had been targeted by a successful or attempted breach, 73 percent of respondents reported that they were currently prepared to prevent or withstand another intrusion.

It should be noted that many of the respondents who reported that they had never sustained a breach also lacked the technology to determine whether or not such a breach had, indeed, occurred. We can hope that many such companies

have not had their data or systems compromised; realistically, however, there is a strong likelihood that at least some of them are simply unaware that they have transformed from a "potential victim" to an "actual" one.

A key motivation for conducting this survey was to help pinpoint areas in which maritime companies could take action, now and over the mid-term. Stakeholders must shift at least some of the focus from physical threats to information threats.

Perhaps the most important step companies can take is to reframe cybersecurity as an operational issue, instead of an information technology one. Software and systems are important tools in preventing cyberattacks, but many of the largest data breaches have been the result of simple human behaviors: unmanaged use of thumb drives and other portable data-storage options, failure to change passwords regularly, carelessly taking the phishing email bait, and unfettered access to company networks via mobile devices. Developing smart policies and providing effective training on cybersecurity processes can go a long way toward preventing future incidents.

Companies should consider increasing their cybersecurity budgets. According to our survey, more than a quarter of respondent companies had no resources allocated at all to cybersecurity. On an encouraging note, however, the majority of respondents from companies of all sizes indicated that their cybersecurity budgets will increase in the coming year.

Given the clear risks—to profits, resources, the environment and even human lives—it is our hope that this momentum toward greater cybersecurity preparedness will gather strength. If so, maritime companies will be as nimble at avoiding cyber threats as they are at navigating the waterways. **ST**

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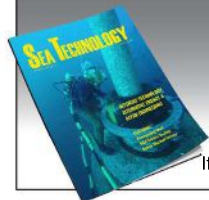
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SMART SUBSEA SOLUTIONS

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions available

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, **new S2CM-HS high-speed modem**, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

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