ARGOS FORUM

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INNOVATIONS IN OCEAN SCIENCE

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CONTENTS

Innovations in Ocean Science

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EDITORIAL

By Robert A. Weller
Senior Scientist, Woods Hole Oceanographic Institution / Co-Chair, OceanSITES

The ocean plays a major role in weather and climate, and timely monitoring of meteorology and air-sea exchanges of heat, freshwater, momentum and other properties at the sea surface and of the state and variability of the water column is of growing importance.

The ocean drives the atmosphere from below via exchanges of heat and energy. As the ocean warms, thermal expansion raises sea level and ecosystem change occurs. The ocean stores much of the carbon dioxide produced by burning fossil fuels, but the seawater becomes more acidic.

Internationally, a major success story has been the deployment of moorings in the tropics around the world. With Argos satellite telemetry their data support improved forecasts of phenomena such as El Niño and the Indian Monsoon.

Yet much of the ocean remains data sparse, and away from land in the mid and high latitudes, there are few moorings reporting surface and ocean data. The impacts on society of ocean variability and change outside the tropics will be significant. An international commitment to a truly global array of ocean time series stations reporting in real time via satellite telemetry is needed to improve prediction and adapt to or mitigate these impacts.

Some progress should be noted, such as the Australian IMOS time series station south of Tasmania and the U.S. National Science Foundation's Ocean Observatory Initiative, just now installing sites in the South Pacific at 55°S, in the South Atlantic at 42°S. Success for the future demands more progress and international cooperation on operations and maintenance of such sites, on continuing innovation on satellite data telemetry capabilities, and on data archiving and distribution methods and facilities.

All ARGOS publications are available at:
www.argos-system.org

EXPLORING THE POSSIBILITY OF USING ARGO FLOAT DATA TO VALIDATE BATHYMETRIC DATA

By TVS Udaya Bhaskar, Indian National Centre for Ocean Information Services (INCOIS)

Ocean bathymetry is one of the major factors which control dynamic processes such as oceanic currents, coastal upwelling, tides, tsunamis, and internal waves. Bathymetric datasets also form a major input for ocean models. Accurate water depth information is necessary when studying ocean dynamics. A variety of bathymetric datasets with different coverages, resolutions, and accuracies are now available. While the quality and resolution of such datasets have improved greatly for open oceans as satellite-altimetry data become available in the late 1990s, large uncertainties still remain for bathymetries in shallow waters where the spatial scale of bottom features are small. Further refinement of bathymetric datasets for shallow regions is necessary to improve the overall performance of ocean models. Argo float data may provide a new source for validating these data, as Udaya Bhaskar explains.

The Argo Program

Argo is an international program aimed at seeding the global ocean with 3000 profiling floats which measure temperature and salinity from surface to 2000 meters depth. As these floats are autonomous and tend to drift with the currents while at the surface and at parking depth, they are prone to beaching or grounding. Though such instances are rare, the data from such floats when grounded can be used to cross compare the bathymetry at the location. Such an attempt was made with the help of a Argo float (WMO 2901253) deployed by the Indian National Centre for Ocean Information Services (INCOIS).

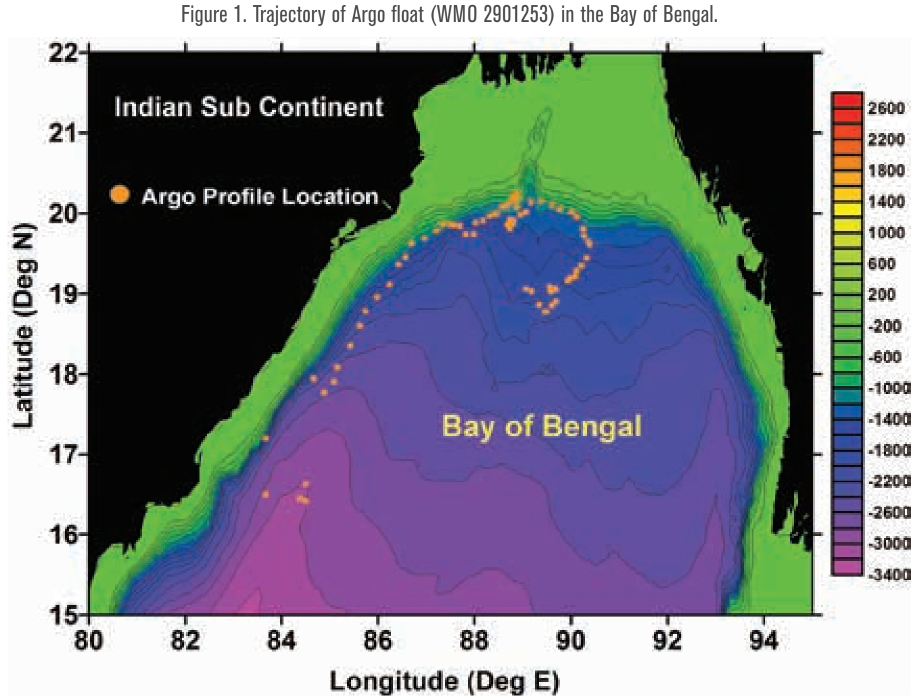
Deployment of an Argo float by an Indian research team.

Using Argo floats to contribute to bathymetry studies

This APEX-9A float was deployed in the northern Bay of Bengal (90° E, 19° N) and interestingly, it was found to travel along the edge of continental shelf and slope along which the bottom depth data is obtained. Fig 1 shows the trajectory of the float during its life time. The profiling depth data (which was originally set to 2000 dbars) from this float which can be considered as bathymetry was obtained based on the location information fixed by the ARGOS satellites.

The location class (set by the Argos satellites) information is also used for obtaining the correct position while obtaining the depth data. The pressure data recorded by the Argo float is converted to depth using Saunders et al., (1981) algorithm before undertaking comparison. The data thus obtained is compared with existing best available bathy datasets namely modified Etopo2, GEBCO, Smith and Sanwell.

Figure 1. Trajectory of Argo float (WMO 2901253) in the Bay of Bengal.



Correcting the bottom depths

The modified Etopo2 is generated by Sindhu details of which can be obtained from Sindhu et al., (2007). While the GEBCO data is obtained from http://gebco.net, Smith and Sandwell data is obtained from http://gcmd.gsfc.nasa.gov.

Figure 2a shows the comparison of ocean depth data obtained from the Argo float with the three bathymetry datasets.

Fig 2b shows the difference of the three bathymetry datasets with respect to Argo observations. From the figure it is observed that on the whole the three bathymetry datasets are underestimating the depth measured by the Argo float.

However there are places where the Smith & Sandwell is observed to outperform other datasets. From this analysis one can deduce that, long period data sets accumulated from the Argo observation program, can be used to correct the bathymetry of the world oceans.

TVS UDAYA BHASKAR
Udaya Bhaskar is a scientist at the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, India. At INCOIS he is responsible for processing and Quality control in both Real-Time and Delayed Mode for all floats deployed by INCOIS as a part of the Indian Argo program. He is also responsible for the Argo Regional Centre (ARC) activities of Indian Ocean.

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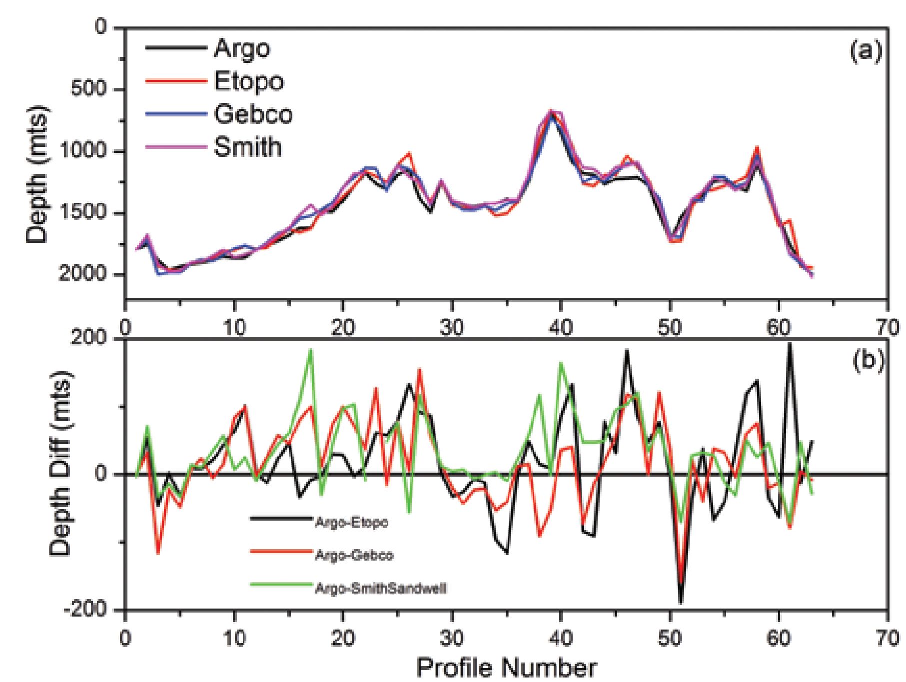


◄ Figure 2. Bathymetry comparison between Argo float depth and Modified Etopo2, GEBCO and Smith & Sandwell obtained along the trajectory.

OBSERVING THE SOUTHERN OCEAN AND BEYOND WITH AN EXTREMELY LONG-LIVED DRIFTING BUOY

By Graeme Ball, Sergey Motyzhev, Eugene Lunev and Alexey Tolstosheev

The Southern Ocean is the birth place of many weather systems and is therefore of great meteorological importance to Australia. This vast expanse of water dotted with a few small islands is all that separates Australia from the Antarctic and weather observations from this area are highly valued. The number of ships travelling in the Southern Ocean, particularly at higher latitudes, is small which places a very high reliance on drifting buoy observations. The SVP-B buoy (WMO No. 56531, Argos PTT 67381), deployed by the Australian Bureau of Meteorology in 2006 provided surprising observations of the Southern Ocean and beyond for nearly 8 years, as Graeme Ball explains.

Despite limited opportunities, caused by the low number of Antarctic re-supply ships leaving from an Australian port, the Bureau of Meteorology regularly deploys 3-5 Bureau-funded, barometer-equipped surface velocity program buoys (SVP-B) each year. These deployments are planned to be upstream from Australia to maximise the period that data from the buoys will be of direct benefit to the Bureau.

Vital information for ocean forecasts and warning

The mean sea-level pressure and sea-surface temperature reported by the buoys improves our knowledge of the present weather situation and assists in the preparation of ocean forecasts and warning. This is vital in meeting the Bureau's obligations to the International Convention for the Safety of Life at Sea (SOLAS).
A favoured location of the Bureau to deploy buoys is near Heard Island, a small Australian sub-Antarctic island near 50S 70E. One of the many buoys to have been deployed near Heard Island was a Marlin-Yug SVP-B buoy (WMO No. 56531, Argos PTT 67381) that was deployed on 2 December 2006 near 50S 74E.

From the Southern Ocean to the Pacific Ocean gyre

This particular buoy exhibited a different behaviour to that seen from other buoys deployed in the same region. Instead of continuing to track quickly eastward and pass to the south of Cape Horn, its trajectory changed soon after entering the Pacific Ocean and it began to track slightly towards the northeast. This track continued until its meteorological sensors failed after 954 days of operation on 12 July 2009 near 41S 103E, at which time the Bureau stopped the buoy reporting on the Global Telecommunication System (GTS).

The buoy continued to report its position through the Argos System well after the meteorological sensors failed. The trajectory plot [Figure 2] shows the buoy eventually becoming caught in a westward current before becoming trapped in a central Pacific Ocean gyre. From deployment until it finally stopped transmitting, the buoy was tracked for 2,800 days through the Argos System.

SVP-B buoys awaiting deployment

ABOUT THE BUOY

By Sergey Motyzhev, Eugene Lunev and Alexey Tolstosheev

The Marlin-Yug SVP-B buoy (WMO No. 56531, Argos PTT 67381) that was deployed on 2 December 2006 near Heard Island (50S 74E) was a standard 40 cm-hull drifting buoy with alkaline batteries and a "Holey Sock" drogue.

The buoy electronics are based on the Argos Platform Transmitter Terminal (PTT) MT105A (Fig.1), certified by CLS in 2004. The output power of PTT is 1.4 W. The sensor block has the MM400 data logger with individual calibrated sea surface temperature and air pressure sensors as well as barometric port with vertical membrane. The PTT, sensors block and buoy as a whole are the product of Marlin-Yug company. Marlin-Yug develops and manufacturers all of the components in-house, as this is the best way to guarantee an extremely operational device with optimal performances. As an example, the Argos PTT has an ultra-low-power microcontroller, which controls not only PTT functions, but supports all other parts and represents the "heart" of the buoy system. Moreover, the microcontroller feels the position of the surface float relative to sea surface thanks to a submergence sensor and tries to prevent "wasted" Argos messages when buoy is submerged.

Fig. 1 – Argos Platform Transmitter Terminal MT105A

Figure 2. SVP-B buoy (WMO No. 56531, Argos PTT 67381) was deployed on 2 December 2006. The meteorological sensors failed after 954 days of operation on 12 July 2009, but the buoy continued to send position information via the Argos system until 2 August 2014, for a total of 2,800 days.

GRAEME BALL

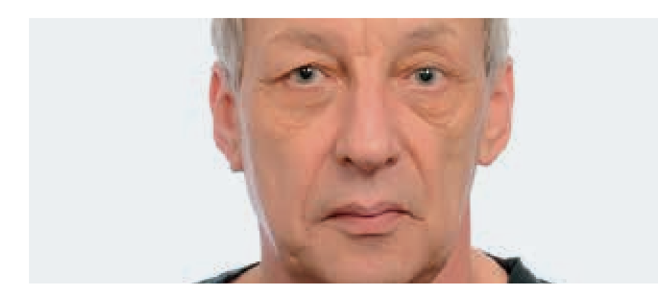
Graeme Ball is the manager of the Marine Operations Group for the Australian Bureau of Meteorology. His responsibilities include managing the Bureau's operational marine networks, including the Australian Voluntary Observing Ships, Ship of Opportunity Programme, Meteorological Drifting Buoys, Argo Profiling Floats, Waverider Buoys and Coastal Sea-Level Network.
His current international activities include serving as Chair of the JCOMM Ship Observations Team (SOT) and as Vice-Chair (Southern Hemisphere) of the JCOMM Data Buoy Cooperation Panel (DBCP). He formerly served as Chair of the International Buoy Programme for the Indian Ocean (IBPIO), an action group of the DBCP.

SERGEY MOTYZHEV

Sergey Motyzhev is Director of Marlin-Yug, Ltd. He is the scientific, engineering and financial manager of the company. Dr. Motyzhev studied theoretical engineering at Sevastopol State University before obtaining his doctor of science degree in oceanography from the Marine Hydrophysical Institute.

EUGENE LUNEV

Eugene Lunev is a Designer at Marlin Yug's R&D department. His responsibilities include embedded firmware and digital design. He studied theoretical engineering at Sevastopol State University before obtaining his PhD in oceanography from the Marine Hydrophysical Institute.



ALEXEY TOLSTOSHEEV

Alexey Tolstosheev a Designer at Marlin Yug's R&D department. His responsibilities include sensors, measuring tools, and analog design. He studied theoretical engineering at Sevastopol State University before obtaining his PhD in oceanography from the Marine Hydrophysical Institute.

ELEPHANT SEALS AS AN INNOVATIVE SOURCE OF IN-SITU OBSERVATIONS IN THE SOUTHERN OCEAN

An elephant seal with an Argos tag that allows it to measure temperature and salinity profiles during its underwater dives.

© Christophe Guinet, CEBC

By Fabien Roquet, Stéphane Blain, Christophe Guinet, and Gilles Reverdin

Reprinted article used with permission from the authors, “Elephant Seals Help us to Better Observe the Southern Ocean”, Mercator Ocean – Quarterly Newsletter Special Issue with Coriolis, April 2014.

Advances in animal tag technology mean that scientists can increasingly rely on ocean observations provided by marine mammals in regions of the globe that are difficult to observe. This is particularly true in the Southern Ocean, where 550 seals equipped with Argos tags have collected more than 240,000 temperature and salinity profiles over the period 2004-2013. These data, as well as fluorescence profiles, also collected by seals, are an essential source of in situ observations in the Southern Ocean. In this article, adapted from their recent paper, “Elephant Seals Help us to Better Observe the Southern Ocean”, published in the Mercator Ocean Quarterly Newsletter, April 2014, F. Roquet, S. Blain, C. Guinet, and G. Reverdin highlight two scientific studies that explain the important contribution of elephant seals to ocean climate science.

Observing the Southern Ocean

The Southern Ocean plays a fundamental role in regulating the global climate. This ocean also contains a rich and highly productive ecosystem, potentially vulnerable to climate change. Very large national and international efforts are directed towards the modeling of physical oceanographic processes to predict the response of the Southern Ocean to global climate change and the role played by the large-scale ocean climate processes. However, these modeling efforts are greatly limited by the lack of in situ measurements, especially at high latitudes and during winter months.

How to gather observations

The standard data that are needed to study ocean circulation are vertical profiles of temperature and salinity, from which we can deduce the density of seawater. These are collected with CTD (Conductivity-Temperature-Depth) sensors that are usually deployed on research vessels or, more recently, on autonomous Argo profilers. The use of conventional research vessels to collect these data is very expensive, and does not guarantee access to areas where sea ice is found at the surface of the ocean during the winter months. A recent alternative is the use of autonomous Argo floats. However, this technology is not easy to use in glaciated areas.

The oceanographer’s best friend

In this context, the collection of hydrographic profiles from CTDs mounted on marine mammals is very advantageous. The choice of species, gender or age can be done to selectively obtain data in particularly under-sampled areas such as under the sea ice or on continental shelves. Among marine mammals, elephant seals are particularly well-adapted to providing observations. Indeed, they are able to continuously dive to great depths (590 ± 200 m, with maxima around 2000 m) for long durations (average length of a dive 25 ± 15 min, maximum 80 min).

Efficient ocean profilers

Profiles of temperature and salinity collected by Antarctic seals and transmitted through the Argos system, although less accurate than those obtained by Argo profilers or oceanographic vessels, are now the main source of oceanographic data available for the southern part of the Southern Ocean. A unique international collaboration involving German, American, Australian, Brazilian, British, Norwegian, South African and French teams yielded more than 240,000 profiles collected by 550 seals with Argos tags from a dozen different sites in the Antarctic area over the period 2004-2013 (Fig. 1). The data they have collected in the period between 2004-2013 have been edited, corrected, and validated using other in-situ profiles, and are made available to the entire scientific community.

Validating models of mixed layer properties and circulation patterns

In a recent study to objectively assess the contribution of seal-derived data in the observation of the Southern Ocean conducted by Roquet et al., 2013, in the scientific journal Geophysical Research Letters, it was found that including seal-derived data substantially modifies the estimated surface mixed-layer properties and circulation patterns within and south of the Antarctic Circumpolar Current. In particular, a decrease in surface temperatures near the Antarctic continent and a substantial increase in salinity west of the Antarctic Peninsula were found in the seal-constrained estimate. These differences were linked to changes in the behavior and extent of the estimated sea ice cover, with an overall increase of 10% in sea-ice extent. Agreement with independent satellite observations of sea-ice concentration was improved, especially along the East Antarctic shelf where there is a large concentration of seal data.

Collecting chlorophyll data with marine mammals

In addition to this discovery, as part of the IPSOS-SEAL project, 23 elephant seals from the Kerguelen Islands were equipped with Argos CTD combined with a Cyclops 7 fluorometer (Turner design) over a three year period starting in 2007. The Sea Mammal Research Unit in Scotland developed these tags with a strong contribution from the French scientific community, in particular for the optimization of transmitted data compression methods, the quality control of data collected, and the fluorescence sensor. Over 2000 temperature/salinity/fluorescence profiles w ere collected, sampling nearly all months of the year. Analysis of these data made it possible to construct the first climatology of the mixed layer depth and the amount of chlorophyll that it contains. This lead to two important discoveries outlined by Blain et al in Geophysical Research Letters.

Conclusion

Argos tag instrumented seals have now demonstrated their ability to collect data in places where access is difficult, if not impossible, offering an attractive and original interdisciplinary approach that benefits both biologists and climatologists. A growing number of studies focus on the Southern Ocean mainly because of issues related to climate change and the importance of the ocean in large global climate balance. In this context the contribution of these data is of particular interest to the scientific community with a potential that remains largely unexplored.

Starting in May 2015, a one-of-the-kind web portal named MEOP (Mammal Exploring the Ocean from Pole to Pole) will provide operational access the full international database of validated ocean observations collected by marine mammals such as seals, sea lions, and turtles.

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For the original article:
http://www.mercator-ocean.fr/fre/actualites-agenda/newsletter/ newsletter-Newsletter-50-Special-Issue-jointly-coordinated-by- Mercator-Ocean-and-Coriolis-focusing-on-Ocean-Observations

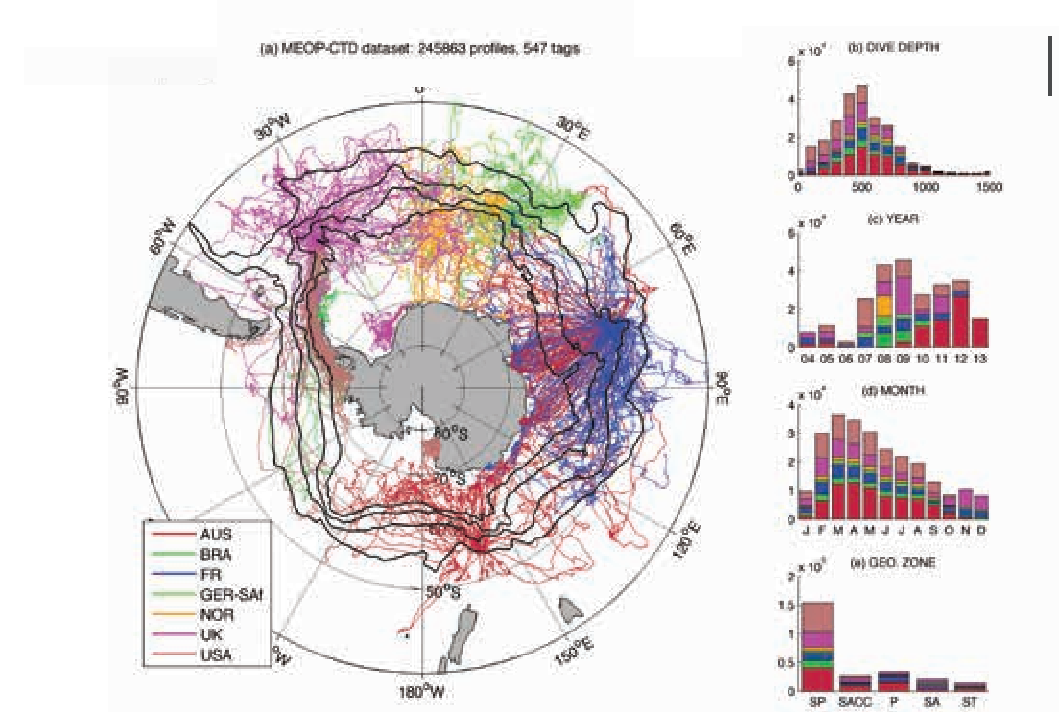


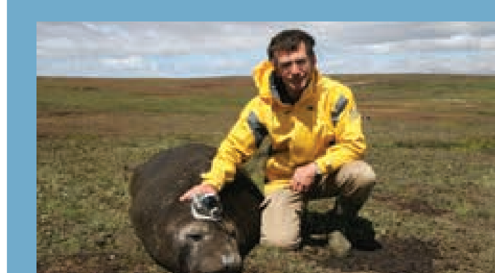
Figure 1: Distribution of T/S profiles currently present in the MEOP-CTD database. The four black lines on the map delimit natural geographical zones: (from north to south) Sub-Tropical, Sub-Antarctic, Polar, Southern ACC, and Sub Polar zones. A large majority of profiles were sampled in the subpolar zone, during fall/winter seasons.

FABIEN ROQUET

Fabien Roquet is a physical oceanographer at the Department of Meteorology of the Stockholm University (Sweden). He has been greatly involved in the elephant seal instrumentation program for more than 10 years now. His main goal is to develop a better understanding of the Southern Ocean circulation and its role on the climate system using a combination of improved observations and numerical models.

STÉPHANE BLAIN

Stéphane Blain is professor of marine biogeochemistry at the University Pierre et Marie Curie and is working at the laboratoire d’océanograpie microbienne at Banyuls /mer (France). His reseach is focused on the functioning of the biological pump of CO2 in the ocean. He has been working for 20 years in the Southern Ocean to investigate the link between iron and carbon cycles.



CHRISTOPHE GUINET

Christophe Guinet is a senior research scientist at the Centre d’Etudes Biologiques de Chizé, CNRS-Université de La Rochelle. His main research investigate how oceanographic conditions, but also fisheries, influences the foraging efficiency of a number of marine mammal. The combined collection of oceanographic and ecological data on elephant seals provide a unique data set to investigate these relationships. For the last 30 years, most of his work was conducted within the support of the French Polar Institute (IPEV) from the French Subantarctic Islands.

GILLES REVERDIN

Gilles Reverdin is a senior research scientist at CNRS. His work focusing on ocean and air-sea data is done at LOCEAN, a Paris-based research laboratory. Gilles Reverdin is currently the scientific coordinator of CORIOLIS (CORIOLIS integrates national French activities related to in-situ measurements for operational oceanography and climate research).

"ARGO DAY": TRANSFORMING THE IMOCA 60S OF THE BARCELONA WORLD RACE INTO VOLUNTEER SHIPS

Photo courtesy of Cheminées Poujoulat/BWR

By Martin Kramp, JCOMMOPS

Photo courtesy of JCOMMOPS

The Barcelona World Race is the first professional ocean race to require skippers to launch Argo floats as part of their scientific program. But the synergy between ocean racing and ocean science is the wave of the future, allowing the sailing community to share their passion and give back to the ocean, while providing the international research community with a new source of volunteer ships to launch ocean instruments in zones that are otherwise hard to reach (namely the Equatorial seas and the Southern Ocean). In the above photo, taken in Paris in December 2014, executives of IOC-UNESCO and the IMOCA 60 class announced an even deeper cooperation. In the future, more sailing events around the world will be involved.

Photo courtesy of Gilles Martin-Raget/BWR

On Friday, January 23rd, 2015, eight additional Argo floats where launched into the Southern Atlantic Ocean, as part of an unprecedented collaboration between the skippers of the Barcelona World Race, JCOMMOPS, IOC-UNESCO, CORIOLIS and Fundació Navegació Oceànica Barcelona (FNOB). In this ground-breaking partnership between professional sailing and ocean science, the skippers of the Barcelona World Race launched a total of eight Argos ARVOR-L CTD profiling floats into the Southern Atlantic Ocean, to join the 3,600+ other Argo floats already operating in the world's oceans as part of the Argo international ocean observation network.

How it works

Each IMOCA 60 set sail with a 19.5 kg weight handicap: The profiling floats, manufactured by NKE and provided by the French oceanography research consortium, Coriolis, are 1.7 metres tall, weigh 19.5 kg, and were stored onboard since the skippers left Barcelona on December 31st.

The launch spot was chosen in the little-travelled and less sampled waters of the southern hemisphere, in the middle of the Southern Atlantic Ocean, to ensure a good spatial distribution in the existing array.

Contributing to ocean and climate research

The profiling floats collect very accurate data on sea temperature and salinity levels from depths of 2,000 metres right up to the sea's surface. The information collected will then be transmitted via the Argos satellite system to the CLS processing center.

CLS then distributes the data to Coriolis center for quality controls and analysis by international ocean research networks. This information is fundamental for oceanographic study of the behavior of huge masses of water, a key part of understanding the evolution of the planet's climate.

A complete scientific program

The Barcelona World Race is the first ocean race in history to require skippers to deploy Argo floats. The deployment of Argo floats is just one aspect of the scientific program implemented by the race organizers and coordinated by IOC-UNESCO.

For further reading:

About the Barcelona World Race: http://www.barcelonaworldrace.org/en/

About the Argo program: http://www.argo.net/

Access to data: http://www.coriolis.eu.org/Data-Products/Maps-corner/Argo-Projects/France/Barcelona-World-Race

For a photo library: http://photo.barcelonaworldrace.org/

Figure 1: Map of the trajectories of the IMOCA 60s of the Barcelona World Race. The colored icons represent the deployment of Argo floats on Argo Day. The name of the yachts along with the WMO float ID number are displayed in white. The purple color represents the ice exclusion zone. CLS provides the official ice tracking services for the Barcelona World Race and participated in the definition of the ice exclusion zone prior to the race departure.

FINDING A LOST GLIDER IN THE SOUTHERN OCEAN

By Bastien Queste, Centre for Ocean and Atmospheric Sciences, University of East Anglia

The Amundsen Sea off the coast of West Antarctica is a mostly ice-covered sea, of critical importance to understanding climate change. In this zone, seawater can freeze quickly to form sea ice, potentially trapping expensive oceanographic equipment. Scientists working here must be inventive, tenacious and prepared, as in this successful tale of a Seaglider rescue.

In February 2014, a research team from the University of East Anglia deployed two Seagliders in the Amundsen Sea, to study the water salinity, temperature, and oxygen levels. The gliders use the Iridium satellite communication system for data relay, but the University team systematically attaches a robust SPOT-5 Argos tag to the antenna, in case of any malfunction with the Iridium system.

After several days, communication with one of the two gliders became difficult. The glider was still diving but it was unable to transmit data and the GPS positions were increasingly unreliable. After 24 hours, the glider stopped sending data via Iridium altogether. Only the Argos positions were still being received, with a 30 minute delay via ArgosWeb.

Finding the glider in a sea of ice

Prepared for a scenario featuring the loss of communication with a glider, the research team had brought recovery equipment including the CLS Argos goniometer (RXG134).

To minimize the time spent searching at sea, the bridge officers used directional information from a Skymast directional antenna in conjunction with signals from the CLS Argos goniometer and measurements of wind direction, to estimate a rough position and began a creeping line search.

As the vessel got closer to the last reported Argos position, the directional antenna became increasingly unreliable. However the CLS Argos goniometer was useful, receiving two Argos fixes in 15 minutes, giving the captain and crew confidence that they were on the right track.

Perseverance and good equipment

The Seaglider was found after three and a half hours of intense search efforts, in difficult conditions including subzero temperatures and iceberg-dotted waters.

Upon recovery, the glider's antenna was encased in a block of ice, but the glider was otherwise undamaged. Thanks to the Argos SPOT 5 transmitter attached to the antenna, an inventive mix of direction-finding technologies, and the crew's perseverance, the Seaglider and its precious data were recovered.

The Seaglider found with the Argos goniometer in February 2014. A block of ice had formed on the sea glider's antenna, stopping communication with the Iridium system.

From left to right: Prof. Karen Heywood, Ms. Louise Biddle, Dr. Gillian Damerell, Dr. Bastien Queste, Mr. Stephen Woodward.

Dr. Bastien Queste and the UEA Glider research group are part of the Centre for Ocean and Atmospheric Sciences of the University of East Anglia. They have been using gliders around the world since 2010. The data they collect are made available in real-time, via the website: http://ueaglider.uea.ac.uk.

COAS Centre for Ocean and Atmospheric Sciences

UEA University of East Anglia

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