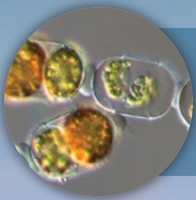
IMOS
marinematters
Integrated **Marine Observing** System
ISSUE 29 | MARCH 2018



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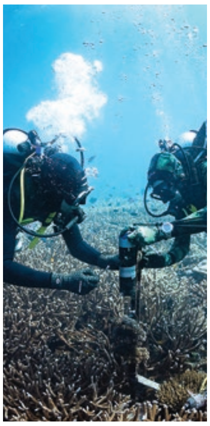
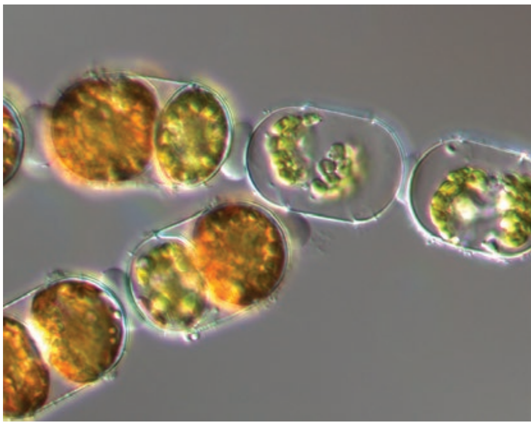
Marine microbial data supports innovative research collecting whale blow microbiota.

New research using a drone to capture whale snot could provide an indication of whale health.

Vanessa Pirotta, Macquarie University

director's corner





Welcome to the first edition of Marine Matters for 2018.

The year has begun on a positive note with a highly successful Annual Planning Meeting held in Hobart on 26-28 February. With an ongoing commitment by Australian Government to the National Collaborative Research Infrastructure Strategy (NCRIS), and NCRIS funding secure to June 2019, the IMOS community was able to start thinking about the longer-term future with renewed confidence. The meeting had two major themes - sustaining and developing IMOS capability, and planning for use and impact. There were ~120 people in attendance, which was a record high. In addition to the core community involved in running the program on a daily basis, there was strong representation from our research partners and operational partners. It was also a pleasure to have several colleagues from New Zealand and South Africa in attendance. The agenda and presentations are available on the **IMOS website**.

One of the issues associated with recent uncertainty about future funding has been the inability to invest in new technologies. It is now time for IMOS to put more emphasis on technology scanning, assessing readiness, and considering pilot projects to evaluate new technologies which could be brought into our observing system over time. A dedicated session was held at the Annual Planning Meeting to discuss these issues.

Some of the exciting technologies that we can potentially utilise are featured in this edition. The new Autonomous Underwater Vehicle (AUV) technology developed by the Australian Centre for Field Robotics at University of Sydney is ready to be piloted in the IMOS integrated benthic monitoring program, and there is a lot of anticipation within the user community. Our partners at the Australian Institute of Marine Science (AIMS) are experimenting with the use of autonomous surface vehicles called 'wave gliders', and our colleagues at CSIRO are developing *in situ* microbial sampling devices. It is important for IMOS to engage with groups that are proving these concepts, and they may present opportunities for next generation pilot activities when funding is available.

Another theme in this edition is the great progress being made in assembling large data sets and developing value added products. Two new Nature Scientific Data papers have just been published, for chlorophyll *a* and acoustic telemetry. These are fantastic resources that simply would not exist without our sustained observing system and focus on data access through the Australian Ocean Data Network (AODN). The new atlas of Australian regional seas based on satellite Sea Surface Temperature (SST) is a great new product that we believe will have wide utility. We are particularly grateful to the 'SSTAARS' team that undertook this work. They started with a problem to solve for a specific project, but decided to implement a solution that required a lot more work but produced a much bigger, better product for the whole community. It is this spirit of collaboration that makes IMOS so successful.

We hope you enjoy reading this edition of Marine Matters.

Tim Moltmann

Lea Walpole

NEWS

Launch of the new-look IMOS website

We released our new-look IMOS website last month. Check it out and let us know what you think:

communication@imos.org.au

Dr Gary Meyers, the inaugural IMOS Director, honoured at a special session at the AMOS 2018 conference

The 25th Australian Meteorological and Oceanographic Society (AMOS) National Conference was held in early February at the University of NSW.

AMOS held the joint conference with the American Meteorological Society, which hosts the 12th International Conference for Southern Hemisphere Meteorology and Oceanography, AMOS-ICSHMO 2018.

The session in honour of Gary Meyers was titled "Variability and change in the Indo-Pacific & Australian regional seas" and was co-chaired by Caroline Ummenhofer, Helen Phillips, and Tim Moltmann.

Dr Meyers was an eminent oceanographer at the CSIRO in Hobart for many years before taking up the role of Director for the Integrated Marine Observing System (IMOS) at the University of Tasmania in 2007. His contributions have been instrumental in advancing research on a wide variety of topics, such as understanding the circulations in the Indian and Pacific Oceans, the Indonesian Throughflow, and the role of the Indian Ocean in regional climate variability and change. Gary also played a pivotal role in establishing IMOS to provide a sustained ocean observing system in the Indian and Pacific Oceans and regional seas around Australia.

Gary was an active AMOS member throughout his career. He received the AMOS Medal in 2006 and served on the AMOS-Tasmania committee in 2014 and 2015. The AMOS Early Career Research Award has been re-named the Meyers Medal to recognise Gary's generosity as a mentor to early-career researchers and to commemorate his profound contributions to oceanographic and climate research of the tropical Pacific and Indian Oceans.

The current IMOS Director Tim Moltmann gave a presentation titled "Building on the Legacy of Gary Myers, Inaugural Director of Australia's Integrated Marine Observing System"

His talk outlined:

- the history of Australian ocean observing, and the role of Gary Meyers,
- the establishment phase of IMOS under Gary's leadership,
- the principles instilled by Gary as the foundation Director
  – societal benefit,
  – open data access,
  – international collaboration, and
  – sustained observation.
- and the future of IMOS, Gary's legacy.

In closing his presentation Tim shared a quote from his first Marine Matters newsletter Director's corner in July 2009:

Bruce Miller 3/2006

Dr Gary Myers and XBT CSIRO Hobart.

"I would like to publicly express my gratitude to Gary Meyers for a fantastic job as the inaugural IMOS Director. Gary is a founding father of ocean observing in Australia, and the IMOS role provided a fitting crescendo to an outstanding career. His wisdom, patience and persistence have put us on a very sound footing for the future, and we all owe him a great debt. Thanks Gary."

National IMOS community gathers in Hobart for the IMOS Annual Planning Meeting

The IMOS Annual Planning Meeting had a record high attendance of ~120 people, which included the core IMOS community involved in running the program on a daily basis, and strong representation from our research partners and operational partners. We also welcomed several colleagues from New Zealand and South Africa to this year's meeting.

The meeting held in Hobart on 26–28 February had two major themes – sustaining and developing IMOS capability, and planning for use and impact.

Topics related to the themes were interspersed across the agenda. Major topics included:

1. Sustaining and developing IMOS capability

- **Facilities** – Updates were provided for selected Facilities (Argo, Ocean Gliders, Autonomous Underwater Vehicles, Ocean Radar), where there was a need to inform and/or seek input from the national community. The Facility-specific Acoustic Telemetry and Ocean Colour Radiometry Task Teams have wrapped up and provided final reports.
- **QA/QC by variable** – Following an initial audit of QA/QC by variable across all Facilities, an implementation plan has been developed to address identified issues. Status of the implementation plan was reviewed.
- **New Technologies** – It is time for IMOS to place some emphasis on technology scanning, assessing readiness, and considering pilot projects to evaluate new technologies which could be brought into our observing system over time.

2. Planning for use and impact

- **IMOS Strategy** – The concept of planning for use and impact is new to IMOS, so we discussed this shift at a whole-of-community level.
- **Value added products** – A new SST climatology was featured, and further discussion held on the potential for IMOS to underpin periodic assessment of 'State and trends of Australia's ocean environment'.
- **Modelling and Operational use** – A report on the Australian Forum for Operational Oceanography (FOO) 2017 (including working group activity) was provided, along with plans for Australian Coastal and Oceans Modelling and Observations (ACOMO) Workshop 2018. The future of the Marine Virtual Laboratory (MARVL) was also discussed.
- **Academia and Research Training** – Consideration was given to use of IMOS research infrastructure by ARC-funded projects and initiatives, and opportunities to enhance the role of IMOS observations and data in advancing a 'marine' STEM agenda.

Investigating new technology for sustained observing of the marine environment

With an ongoing commitment by Australian Government to the National Collaborative Research Infrastructure Strategy (NCRIS), and NCRIS funding secure to June 2019, the IMOS community is able to put more emphasis on technology scanning, assessing readiness, and considering pilot projects to evaluate new technologies which could be brought into our observing system over time. As mentioned above a dedicated session was held at the Annual Planning Meeting to discuss these issues.

As a research infrastructure, IMOS will continue to be heavily invested in mature Facilities. The platforms and sensors we deploy need to return good data so that it can be used to undertake, science, research and teaching. IMOS will also invest in pilot Facilities to test the utility of platforms and sensors in light of new scientific understanding, technological innovation, and new requirements. Pilots need to be evaluated and matured if successful or discontinued if not.

As a research infrastructure, IMOS will not invest in proof-of-concept Facilities *per se*. However, we do want to engage with communities involved in proving new concepts that are highly relevant to the objectives of IMOS as these are the 'laboratories' that will produce next generation pilots.

Some of the exciting technologies that we can potentially utilise include:

- The new Autonomous Underwater Vehicle (AUV) technology developed by the Australian Centre for Field Robotics at University of Sydney is ready to be piloted in the IMOS integrated benthic monitoring program, and there is a lot of anticipation within the user community.
- Our partners at the Australian Institute of Marine Science (AIMS) are experimenting with the use of autonomous surface vehicles called 'wave gliders', and
- Our colleagues at CSIRO are developing *in situ* microbial sampling devices.

NextGen AUV trialled in Hawaii as part of a coordinated robotics expedition

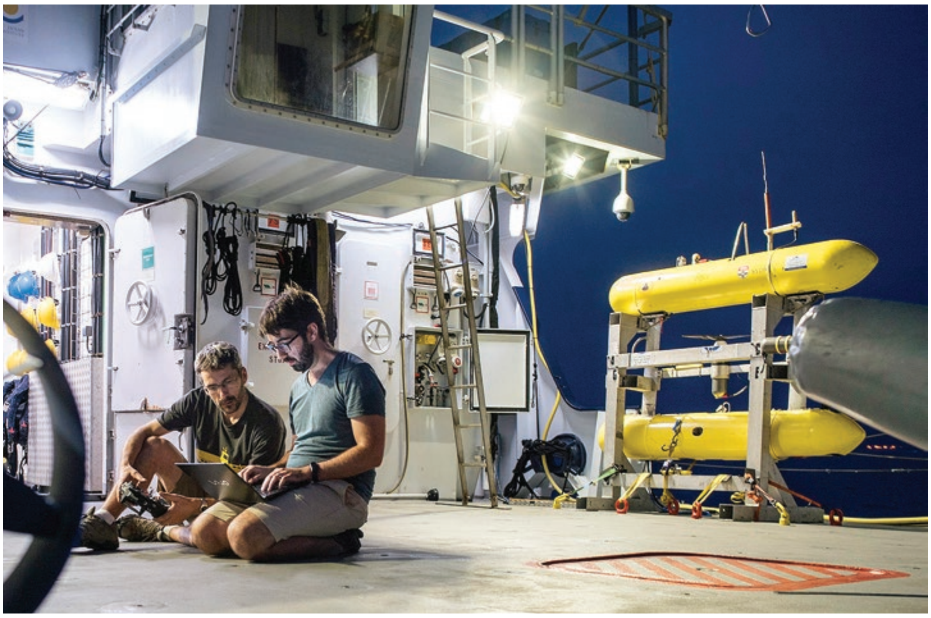
In January, Professor Stefan Williams and Dr Oscar Pizarro from the Australian Centre for Field Robotics at University of Sydney and the IMOS AUV Facility, joined a group of engineers, roboticists and oceanographers from Woods Hole Oceanographic Institution, Massachusetts Institute of Technology, University of Rhode Island, and University of Michigan on board the Schmidt Ocean Institute RV *Falkor* in the ocean off Maui, Hawaii.

The various groups on the Coordinated Robotics voyage worked on developing a new cost-effective and efficient underwater robotics program. The ultimate goal of the research is the development of autonomous ocean mapping systems capable of scaling up in a cost-effective manner. The 21-day voyage was dedicated to the goal of characterizing the distribution of reefs by deploying a fleet of autonomous vehicles using automated planning and scheduling tools.

For the Coordinated Robotics voyage, the Australian group brought several different robots: including the AUV Sirius which is the vehicle that has done all of the IMOS benthic monitoring so far; the newest vehicle NextGen; and the mini-vehicle Iver.

Autonomous Underwater Vehicle (AUV) Sirius is the largest vehicle. It was purchased from Woods Hole

Deborah Smith, Schmidt Ocean Institute.



Mónika Naranjo González

Stefan Williams and Lachlan Toohey on the RV *Falkor* during the Coordinated Robotics voyage.

Oceanographic Institution twelve years ago, and it has been used to perform benthic monitoring at selected locations on Australia's continental shelf.

Sirius can hover and navigate relatively rough terrain, operate for up to 8 hours, and collect high resolution stereo imaging data. While flying, it measures temperature, salinity, and water quality (by detecting dissolved organic matter, turbidity, and fluorescence). Sirius also has a multibeam sonar and a ADCP current profiler.

However, one of limitations is its size: It weighs 250 kg, which demands a big ship for its deployment. This limitation gave the team enough reason to begin working on their newest creation, temporarily called NextGen.

"We have a brand new AUV which has capabilities that are somewhere in between Sirius and the Iver, which is capable of hovering and sitting and working over rough terrain," Professor Williams explains.

"The new AUV is smaller than Sirius and easier to deploy, but it is brand new, so we have to make sure that all the subsystems are working, including checking what the data quality is like."

The new vehicle has all of those capabilities, yet at about 100 kg, it has no need of a ship as large as *Falkor* to be deployed.

Finally, there is the simplest vehicle, the Iver. "The Iver is smaller. It weighs about 35 kg, so it can be deployed from a small boat. One or two people can lift it in and put it in the water. It is torpedo shaped with fins."

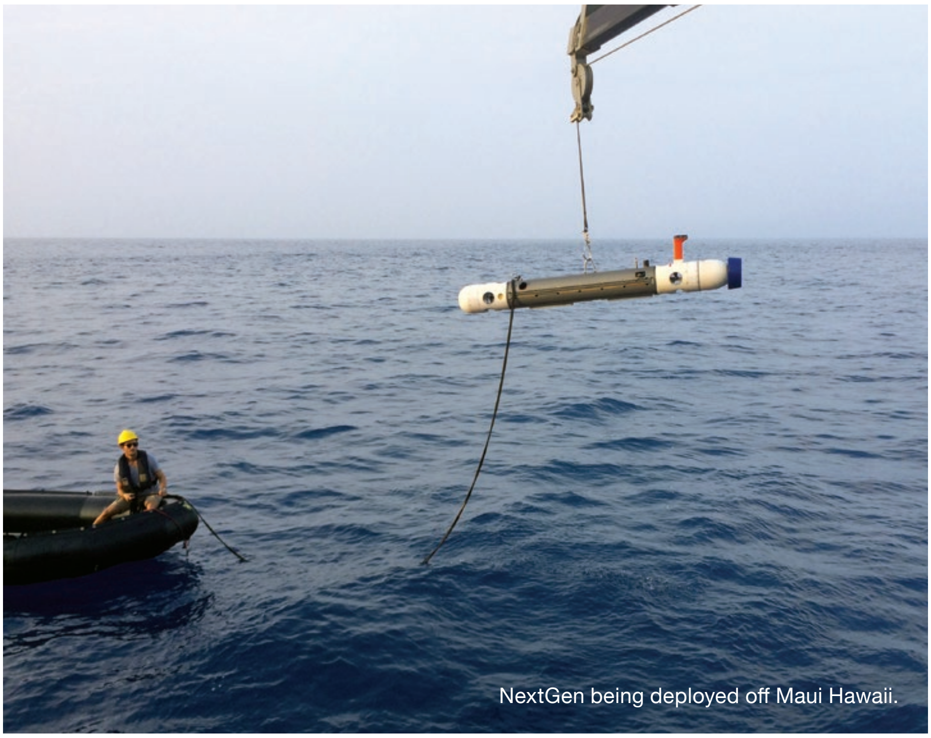
One of the Iver's limitations is that it can't hover, only move forward. "Because of this, it is not well suited for very rough terrain with cliffs or obstacles," Professor Williams explains. "It is faster, it has better resolution cameras than Sirius, it can cover more ground, so if it's relatively flat, we can cover a lot more ground with it."

Over the course of the three-week voyage, several different robots were deployed constantly, pushing their autonomy and capacities. The researchers left the Coordinated Robotics voyage with all the experience and exchanges they were able to share on board, as well as results from experiments taking technology a step further at the service of science.

"All these techniques we are developing and demonstrating will help build our ability to understand the oceans. Having more observations is critical to having good science," says Dr Pizarro.

"Having more observations is critical to have good science. If the observations are done in ways that are cheaper and that don't require so many experts and manpower on the field, we will have a more comprehensive view of what is happening – how things are changing in the oceans. Hopefully, that will empower us to make wiser decisions and policies in the future."

*This story was originally published on the Schmidt Ocean Institute cruise log (**https://schmidtocean.org/cruise-log-post/a-happy-marriage/** and **https://schmidtocean.org/cruise-log-post/tech-and-science/**), and was written by Mónika Naranjo González.*



Stefan Williams, the University of Sydney

NextGen being deployed off Maui Hawaii.

The Liquid Robotics' Wave Glider – a multi-purpose platform for ocean and shelf observations – lessons from the Great Barrier Reef.

WRITTEN BY: SCOTT BAINBRIDGE, AIMS

Wave Gliders, wave powered autonomous surface robots, are a proven ocean surface observing platform but their use in shallower complex reef and shelf environments is largely untested. AIMS, as part of the Q-IMOS Node, deployed a Liquid Robotics Wave Glider in the central Great Barrier Reef (GBR) and undertook a series of tests to simulate transect based data, such as currently obtained from underway vessels and, via station keeping mode, the ability of the platform to provide data equivalent to a fixed mooring.

AIMS, with Boeing, Liquid Robotics and the Queensland Department of Science, Information Technology and Innovation (DSITI), set out to test the utility of the Wave Glider platform for a range of inshore and cross-shelf tasks in the central Great Barrier Reef in September 2017, covering 200nm within the reef matrix.

The Wave Glider provided real time data every 10 minutes along 200nm of between reef transects over seven days collecting oceanographic data which was validated against a fixed wave-rider buoy and the Yongala National Reference Station mooring.

The Wave Glider represents a unique platform for shallow reef and shelf environments due to:

- low (effectively zero) operational cost once deployed;
- long deployment cycle (months);
- the ability to re-task the platform or adaptively sample based on observed events or mission priorities;
- use of standard oceanographic instruments and methods, and;
- continuous position information and abundant power.

The results show that the Wave Glider is able to perform as well as underway vessel-based observations and provides a good representation of static mooring based surface observations. The platform is operationally proven and represents a level of technology and operational readiness that makes it suitable for routine coastal and shelf based IMOS missions.

The mission demonstrated the value and capability of the Wave Glider as a cross-shelf platform. The flexibility in sensors systems, in its ability to undertake repeat and adaptive sampling missions, to capture data equivalent to existing IMOS data streams, and the level of technology readiness inherent in the product and its supporting systems, means that we believe it represents a potential valuable platform for IMOS.

Automated Measuring of Marine Microbial Diversity

Measuring biodiversity across the vastness of the oceans remains challenging. Genomics methods that have been developed recently enable the description of complex microbial communities based on DNA extracted from small samples. Importantly, many species can be detected from DNA in cells shed naturally into the environment without needing to sample individuals directly.

The Environmental Genomics Team with Engineering and Technology at CSIRO Oceans and Atmosphere have been working to develop a range of hardware to assist scientists better understand the marine environment using DNA analysis.

The Wave-Glider ready for deployment at AIMS.

Scott Bainbridge, AIMS

"We have two platforms which can be deployed to perform autonomous filtration of water samples in situ. The autonomous nature of these devices allows sampling to be performed at a much higher frequency and over longer periods than has previously been possible or practical with manual sampling," says Dr Lev Bodrossy, leader of the Environmental Genomics Team.

Often logistical limitations such as weather, sampling location access and the cost of field work has prevented the sort of sampling schemes which are now possible with these devices. The instruments can be placed in a single location or distributed over a wider area. Sampling can be coordinated to proceed as required without the need for field staff to be present at the sampling location. The team is also currently developing the web-based control of these devices so sampling can be triggered remotely by any computer with internet connection.

The two DNA techniques that are used, PCR and Next generation sequencing, allow for greater flexibility in the analysis of the samples that are collected.

"The sample can be specifically targeted and quantified for particular organisms, as we have done for faecal indicator bacteria and aquaculture pests, or it can also be used for community analysis to track how the total biological community is changing over time," Dr Bodrossy explains.

In addition to these sampling devices, which are already being deployed, the team is working on automated analysis instruments. These instruments will combine the sampling functionality of the above devices but also preform the DNA analysis in situ with the capability to send real-time results to the end user.

"This technology is still in the research phase but potentially offers tremendous benefits to those wanting real-time information to support management of marine waters for public health, aquaculture and environmental monitoring," says Dr Pascal Craw, Research Scientist in the Environmental Genomics Team.

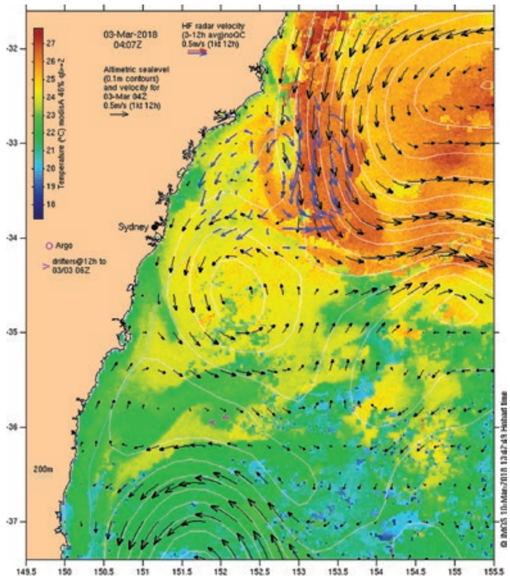
"For example, oyster farmers monitoring for Harmful Algal Blooms or councils monitoring drinking and recreational water quality."

Newcastle radar monitoring the EAC separation point

The new ocean radar (CODAR) system installed on the NSW coast, with funding from NSW State Government, is providing data in the East Australian Current 'separation zone'.

The radar system installed off Newcastle late last year is working well, as demonstrated by this map for 3 March 2018, in which the radar currents are overlain on a Sea Surface Temperature image as well as geostrophic currents from altimetry.

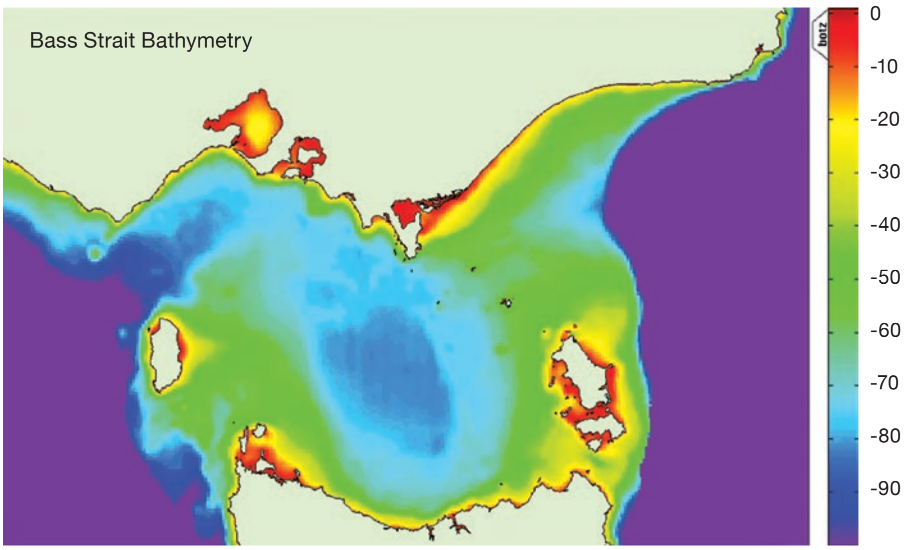
All three data streams reveal the main flow of the East Australian Current (EAC) separating from the shelf and heading off towards New Zealand. However, only the ocean radar and the SST imagery, can resolve the details of the submesoscale eddies between the EAC and the continental shelf.



Bass Strait Glider Reveals the Ancient Bassian Lake

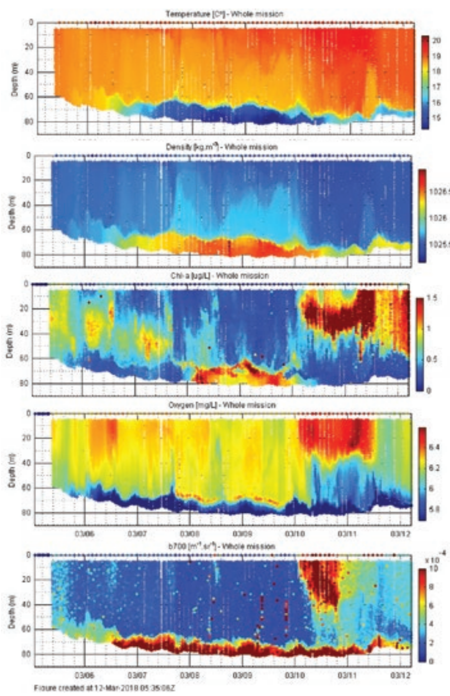
WRITTEN BY: MARK BAIRD

The IMOS Ocean Glider Facility has launched the third annual glider across Bass Strait. It has just completed the transect, and the presence of a dense cold pool in the deepest part of Bass Strait is evident. The centre of Bass Strait (right) is deeper than its surrounds and would have formed a large fresh-water lake when Bass Strait was exposed 15,000+ years ago. Nowadays the deepest part of Bass Strait is 80 m deep with the deepest outlet to the north at 70 m. Thus, the ancient lake continues to act as a place where water can collect – in this case, dense Bass Strait water.



During winter, strong winds and surface cooling create a well-mixed dense water mass in Bass Strait that gradually becomes denser than water of the Tasman Sea to the east because the cooling is confined to the depth of the strait. Once the density difference becomes large enough in the winter, the cold dense pool exits Bass Strait as a bottom density current at the north-eastern side.

This year, the Bass Strait glider has traversed the lake and found a cold, dense pool of water which is low in oxygen, most likely a remnant of last winter. This bottom layer at 70-80 m was the portion of Bass Strait water that could not exit last winter because of the 70 m deep ridge across the eastern edge of Bass Strait. High chlorophyll-a indicates a bloom has occurred in the deep water where both nutrients and some light are present. The oxygen maximum just above the interface shows the bloom is growing. But once winter comes, they will be mixed to the surface and then flow northward out of Bass Strait. Only the unlucky ones will get trapped for another summer - perhaps to be seen by the fourth Bass Strait glider.



Western Australian IMOS: Change of Node leadership for WAIMOS

Associate Professor Nicole Jones from the University of Western Australia is the new Node Leader, with Professor David Antoine of Curtin University and Dr Ming Feng of CSIRO remaining as Deputy Node Leaders of the WAIMOS science node.

Associate Professor Jones has always been passionate about understanding and protecting the natural environment; in particular the ocean. It led to Associate Professor Jones pursuing Environmental Engineering at the University of Western Australia and then a masters and PhD at Stanford University.

Associate Professor Jones' research focus is environmental and geophysical fluid dynamics, in particular the interaction between the physics and biogeochemistry in natural aquatic environments.
She uses a combination of field and laboratory observations and numerical modelling to study topics such as:

- The elucidation of internal wave generation, propagation and dissipation.
- The role of complex topography in circulation and mixing in a macro-tidal environment.
- The role of non-linear internal waves in stimulating primary productivity.
- The ocean response to tropical cyclone forcing.
- The influence of whitecapping waves on the vertical structure of turbulence in shallow water environments.
- The hydrodynamic control of phytoplankton loss to the benthos in estuarine environments.
- Plume dispersion on fringing coral reefs.
- The development of field techniques for studying environmental fluid mechanics.

One project Associate Professor Jones and her colleagues is currently working on is focused on Ocean Mixing.

"Ocean circulation models are necessary to forecast ocean behaviour and variability; however, both global and regional ocean models suffer from an inadequate description of ocean mixing at scales below the model resolution," says Associate Professor Jones.

"Our project will remove this key uncertainty in model performance by correctly defining ocean mixing, allowing ocean models to predict more accurately global ocean circulation, the response to climate change, and the vertical mixing and transport of pollutants and tracers."

IMOS would like to welcome Nicole to the position of Node leader, and our thanks goes to outgoing WAIMOS node leader Associate Professor Julian Partridge for his contribution to the science node.

Associate Professor Nicole Jones.

Southern Australian IMOS:

SAIMOS moorings on display as part of the SARDI Open Day

IMOS moorings formed part of the display at the South Australian Research and Development Institute (SARDI) Aquatic Sciences Open Day in November. Visitors of all ages had the opportunity to tour the purpose-built marine and freshwater research facility, including observing the laboratories and research vessels and equipment, watch science presentations, explore live fish displays and enjoy the interactive touch tanks. The event demonstrated how science supports South Australia's economy and helps keep our oceans and rivers healthy.

Megan Archer, SARDI

SARDI staff Ana Redondo Rodriguez and Paul Malthouse with the mooring display.

New South Wales-IMOS:

NRS Marine Microbial observatories support innovative research collecting whale blow microbiota.

WRITTEN BY: VANESSA PIROTTA AND MARTIN OSTROWSKI

Sampling the microbes living in whale blow could provide an indicator of the health of migrating whale populations. Researchers from Macquarie University Marine Research Centre, led by PhD student Vanessa Pirotta, assembled an array of experts including microbiologists, marine biologists and a drone pilot and engineer Alastair Smith from Heliguy Pty. Ltd. This resulted in the design and development of purpose built waterproof drones for sampling whale blow using a non-invasive collection technique.

Over a two-day period, the drones were used to collect 57 samples of exhaled breath condensate, or ‘blow’ from northward migrating humpback whales off Sydney. The drone collection technique eliminates the need to make close boat approaches which are dangerous for both the whales and scientists.

Lead author Vanessa Pirotta said “this is not only a much safer alternative to close vessel-based sampling but was also shown to be non-invasive, as there was no behavioural response to our drones”.

However, the challenge was not as simple as flying a drone over the top of a whale. Project microbiologist Dr Martin Ostrowski explained “microbes are everywhere, they are in seawater, air, dust, on the skin and in the breath of the scientists on the boat”.

To effectively target microbes living in whale blow the team designed a flip-lid sampler loaded with a sterile petri dish. The petri dish remained closed while the drone tracked each whale and opened briefly while flying through the blow just as the whale exhaled.

Preliminary data on seawater microbes obtained from the IMOS Port Hacking National Reference Station (NRS) allowed the researchers to gauge the success of the technique. “One of the unexpected challenges was extracting the DNA from a very small amount of sample material, typically we captured a fine spray equal to 2-3 drops of whale snot with each flight”.

Access to the Bioplatforms Australia/ IMOS Marine Microbes data for an annual cycle enabled the team to accurately determine which bacterial species were characteristic of seawater in the area and then precisely identify the species living in whale breath.

The drone in action collecting whale blow.

Rob Harcourt, Macquarie University

This work provides a baseline of the microorganisms found in a healthy whale population and an efficient, safe method to continue screening migrating whale populations for respiratory diseases.

"Microbes are an intrinsic component of the health of all levels of marine ecosystems" says Dr Ostrowski, "baseline genomic data being produced as part of the Bioplatforms Australia-IMOS partnership will provide us with the framework to test the next generation of sensitive ecosystem diagnostic tools". The team of researchers are currently developing methods to analyse viruses, hormones, and other chemicals that may allow us to integrate a range of indicators of whale health.

Reference: Pirotta V, Smith A, Ostrowski M, Russell D, Jonsen ID, Grech A and Harcourt R (2017) An Economical Custom-Built Drone for Assessing Whale Health. Front. Mar. Sci. 4:425. doi: 10.3389/fmars.2017.00425

DRONE PERMITTING STATEMENT:

The use of drones around wildlife is restricted and closer approach to marine mammals using drones is only permitted under a scientific licence and with Civil Aviation Safety Authority approval. Current restrictions when approaching a marine mammal in an unmanned aircraft (including drones) without a scientific licence specify that aircraft must maintain a height at least 100 metres above the animal/s and also maintain a 100 metres horizontal radius away from the animal/s, under the ***Biodiversity Conservation Regulation 2017*** *which came into effect on 25 August 2017.*

Vanessa Pirotta, Macquarie University

National Mooring Network new database:

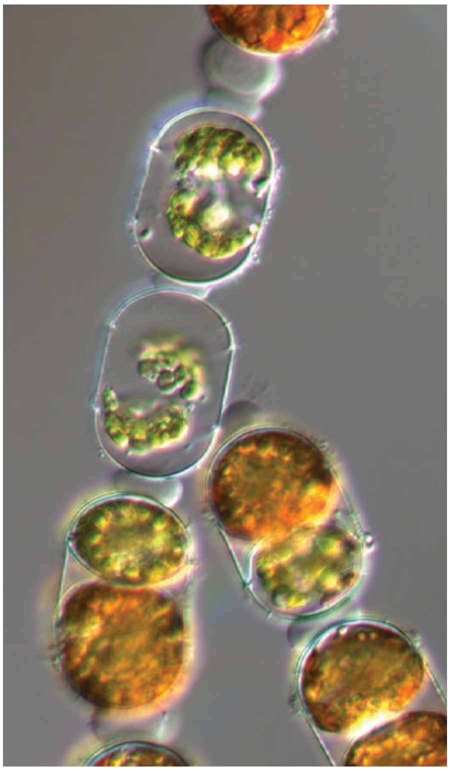
173, 333 chlorophyll *a* records from Australian waters published in Nature Scientific Data

The Australian Chlorophyll *a* Database collates data since 1965 and is available via the Australian Ocean Data Network (AODN) Portal.

The team behind the publication of The Australian Phytoplankton Database as a data descriptor paper in 2016, and its corresponding accessibility on the AODN Portal (Data paper collection and the ongoing collection), has now published the related Australian Chlorophyll *a* Database (1965 - 2017) in Scientific Data.

The data from this collection is accessed on the **AODN Portal**.

Chlorophyll *a* is the most commonly used indicator of phytoplankton biomass in the marine environment. It is relatively simple and cost effective to measure when compared to phytoplankton abundance and is thus routinely included in many surveys. This data collection collates 173,333 records of chlorophyll *a* collected since 1965 from Australian waters, gathered from researchers, students, government bodies, state agencies, councils and databases.


Ian Jameson, CSIRO

In Australian waters chlorophyll *a* concentrations are generally lowest in the tropical and subtropical oceanic regions (0.05-0.5 µgL–1) and higher in the Southern Ocean and temperate regions (up to 1.5 µgL–1). In coastal zones, the chlorophyll *a* concentration can fluctuate greatly as phytoplankton blooms develop, peak and crash.

The coastal station at Port Hacking, project number P782 in our database, is a good example where chlorophyll *a* concentrations typically vary between 0.1–8.0 µgL–1 over an annual cycle, with peaks sometimes up to 15 µgL–1 at 20–40 m depth coinciding with phytoplankton blooms.

In inshore estuaries and bays, high chlorophyll *a* values can also indicate the system is eutrophic with elevated nutrient levels from terrestrial run off. Chlorophyll *a* is therefore used in several water quality monitoring programs across the country (e.g. project number P1072 Ecosystem Health Monitoring Program in Moreton Bay, Queensland, Australia).

Concentrations of chlorophyll *a* also vary throughout the oceans with oceanographic features such as upwelling and fronts which drive nutrients towards surface layers and thus enhance chlorophyll *a* levels.

The database includes Chlorophyll *a* data from the IMOS National Reference Stations moorings.

The Australian Chlorophyll *a* Database will be maintained and updated through the CSIRO data centre, with periodic updates sent to the Australian Ocean Data network (AODN); (a new "ongoing" data collection will be available in the future from the AODN Portal). This snapshot of the Australian Chlorophyll *a* Database at the time of this publication has been assigned a DOI and will be maintained in perpetuity by the AODN.

The full paper: Claire H Davies, Penelope Ajani *et al*. A database of marine phytoplankton abundance, biomass and species composition in Australian waters. *Scientific Data*, February 2018. https://www.nature.com/articles/sdata201818

Satellite Remote Sensing and AODN:

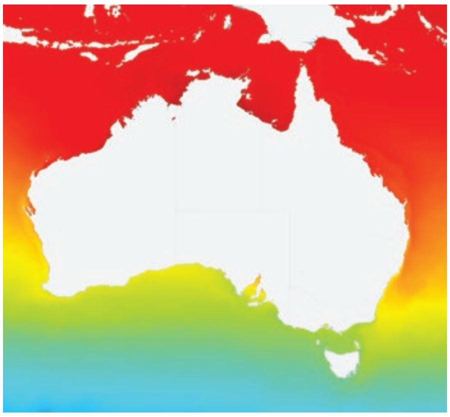
New data product – SST Atlas of Australian Regional Seas (SSTAARS)

The new SST Atlas of Australian Regional Seas (SSTAARS) uses 25 years of Advanced High Resolution Radiometer (AVHRR) data from NOAA Polar Orbiting Environmental Satellites received by six Australian and two Antarctic reception stations to construct a detailed climatology of sea surface temperature at 20 cm depth around Australasia.

The data have been processed following international GHRSST protocols to help reduce instrument bias using *in situ* data, with only night-time nearly cloud-free data used to reduce diurnal bias and cloud contamination. A pixel-wise climatology (with four annual sinusoids) and linear trend are fit to the data using a robust technique, and monthly non-seasonal percentiles also derived.

The resulting atlas, SSTAARS, has a spatial resolution of ~2km, and thus reveals unprecedented detail of regional oceanographic phenomena, including tidally-driven entrainment cooling over shelves and reef flats, wind-driven upwelling, shelf winter water fronts, cold river plumes, the footprint of the seasonal boundary current flows and standing mesoscale features in the major offshore currents.

The atlas (and associated statistics) will provide a benchmark for high-resolution ocean modellers and be a resource for ecosystem studies where temperatures, and their extremes, impact on ocean chemistry, species ranges and distribution.



Animal Tracking and AODN:

New continental-scale data from the IMOS animal tracking system maps a decade of widespread marine species movement

The data published in January in the prestigious Nature Journal Scientific Data, has tracked the whereabouts of 117 marine species, ranging from sharks and saltwater crocs all the way to sea turtles and sea cows (dugongs), off the shores of Australia.

The new continental-scale marine animal tracking dataset has been published from the Integrated Marine Observing System's Animal Tracking Facility, based on a permanent network of acoustic signal receivers installed in coastal waters around Australia, shedding light on the movements of some of our most majestic and dangerous sea creatures.

The resulting dataset consists of detections collected over 10 years by 3,777 tags deployed on 117 marine species, including sharks, crocodiles, fish and dugongs, with distances travelled by the animals ranging from a few to thousands of kilometres.

The data is helping to unravel the widespread movements of Australian marine species, the researchers say, and provide insight into the natural habitats, distributions and changing behaviours of these animals in the face of climate change.

"The established IMOS Animal Tracking Facility network (which is operated by the Sydney Institute of Marine Science), consisting of nearly 2,000 receiving stations located around the country, allowed us to track 3,777 Australian sea animals, including some of Australia's most iconic species, such as great white sharks, green sea turtles and tunas," explained lead author Dr Xavier Hoenner from the AODN Facility of IMOS.

"We collected and quality controlled 49.6 million acoustic detections from these tagged animals, which has given us insights into how far they moved, ranging from only a few kilometres to thousands, their preferred habitats and how their movements vary over time," added Hoenner.

It has been known for some time that climate change is causing oceans around Australia to be warmer further south, meaning many marine species are also shifting south, altering their habitual movements and feeding habits.

"The data gives an in-depth picture of the behaviour of these animals over the ten years of the study enabling us to predict how behaviour might change in the future. For example, in the case of bull sharks – a species we tracked that is known to be potentially dangerous - research has shown that they move within warmer waters, meaning it is important that we understand how they modify their movements in response to changes in ocean conditions and processes," explained Professor Rob Harcourt from Macquarie University, who is the Leader of the Animal Tracking Facility at IMOS.

The researchers say that the data is a powerful addition to their centralised national database, and hope that the results will also foster future investigations by other marine research groups.

"In this study we were able to validate our tracking data by developing an open-source, state of the art algorithm that identifies background noise signals and anomalous movements, thus strengthening considerably the quality and re-usability of our dataset. The data is available through the online Australian Ocean Data Network Portal, making it a very valuable resource for comparing the behaviour of marine animals today and in the future. We are also going to add the data to public marine species location databases to improve existing biodiversity records and enhance existing geographical distribution maps for Australian sea species," Professor Harcourt concluded.

The full paper: Hoenner, Xavier; Huveneers, Charlie; Steckenreuter, Andre; Simpfendorfer, Colin; Tattersall, Katherine; Jaine, Fabrice; Atkins, Natalia; Babcock, Russ; Brodie, Stephanie; Burgess, Jonathan; Campbell, Hamish; Heupel, Michelle; Pasquer, Benedicte; Proctor, Roger; Taylor, Matthew D; Udyawer, Vinay; Harcourt, Robert. **Australia's continental-scale acoustic tracking database and its automated quality control process**. *Scientific Data*. February 2018.

Fabrice Jaine, SIMS

Researchers from the Sydney Institute of Marine Science servicing the IMOS acoustic telemetry network.

Postgraduate Student | **Tanziha Mahjabin**

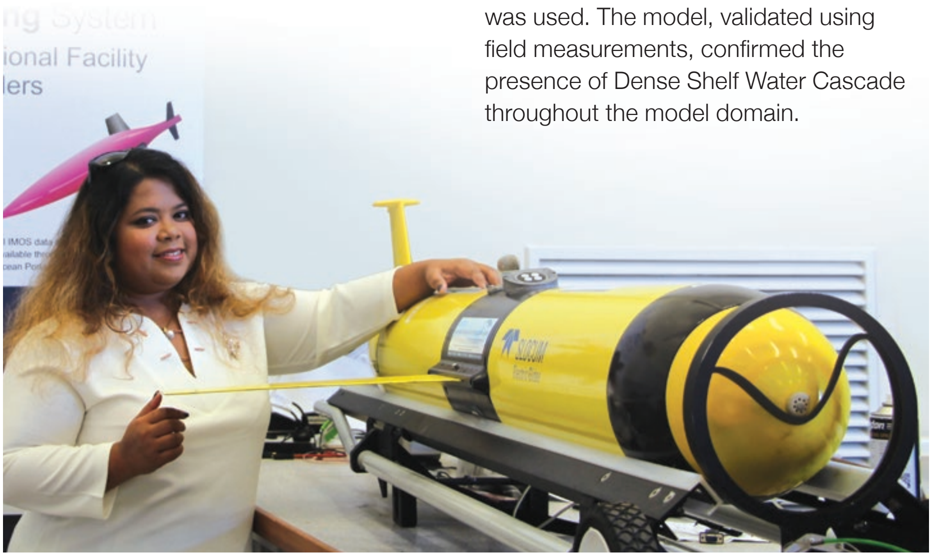
PROJECT TITLE:

Occurrence and controls on Dense Shelf Water Cascades around Australia

Ocean Graduate School and the UWA Oceans Institute, The University of Western Australia

The coastal ocean is the interface between the deep water ocean environment and the terrestrial system and acts as the receiving basin for input of suspended and dissolved matter that includes nutrients, biota and pollutants.

Processes that control the transport and mixing between the coastal and offshore waters are therefore important to maintain healthy coastal ecosystems and is the subject of Tanziha's postgraduate study with reference to Australian coastal waters.



Along Australian continental shelves, high evaporation during summer and cooling during winter result in a cross-shelf density gradient that drives gravity currents transporting denser water offshore along the sea bed. This process is defined as Dense Shelf Water Cascade.

Multi-year transects (192) of IMOS Ocean Glider data from eight contrasting regions around Australia confirmed the existence of Dense Shelf Water Cascade as a regular occurrence during autumn and winter periods (see figure below).

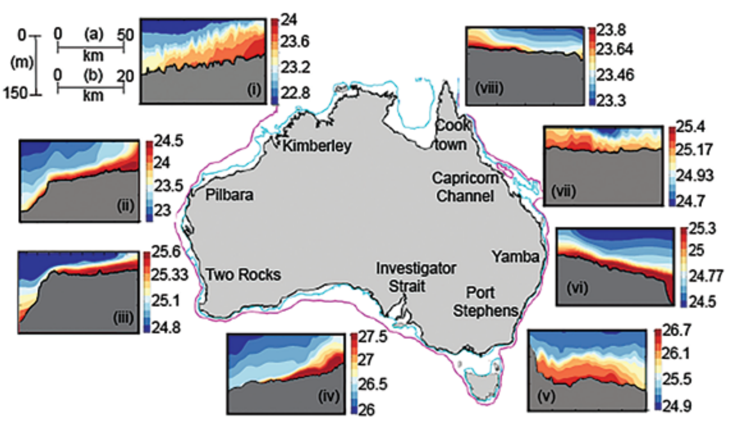
The main parameters controlling Dense Shelf Water Cascade were identified as buoyancy input (cross-shelf density gradient) and vertical mixing through wind and tidal action. To examine the spatial variability of Dense Shelf Water Cascade along the Perth Metropolitan continental shelf region, a three-dimensional hydrodynamic model was used. The model, validated using field measurements, confirmed the presence of Dense Shelf Water Cascade throughout the model domain.

Although there was gradual cooling of coastal waters during autumn and winter, there were periods of rapid heat loss during the passage of storm systems. During these periods the cross-shelf density gradients were enhanced and generated strong Dense Shelf Water Cascade. Onshore winds associated with cold fronts enhanced the Dense Shelf Water Cascade.

Field and numerical model results confirmed the cross-shelf density gradient as the dominant forcing mechanism for Dense Shelf Water Cascade formation. The influence of tidal mixing was small even in regions of high tidal range. In contrast, wind effects had a strong influence through: (1) inhibiting Dense Shelf Water Cascade through vertical mixing; and, (2) enhancing during onshore winds.

Dense Shelf Water Cascade play an important role in ecological and biogeochemical processes in Australian waters through the transport of dissolved and suspended materials offshore.

Tanziha graduated as a Civil Engineer in Bangladesh, where she received her Bachelor degree from Khulna University of Engineering and Technology. She received scholarship for doing PhD in UWA and joined Ocean Graduate School and UWA Oceans Institute. She received the Congratulatory Award as a Finalist in the Postgrad Category from UNESCO/ IMarEST Western Australian Marine Studies Awards in 2015. She is student member of the UWA Young Engineers, Australian Water Association, The Oceanography Society and IMarEST.



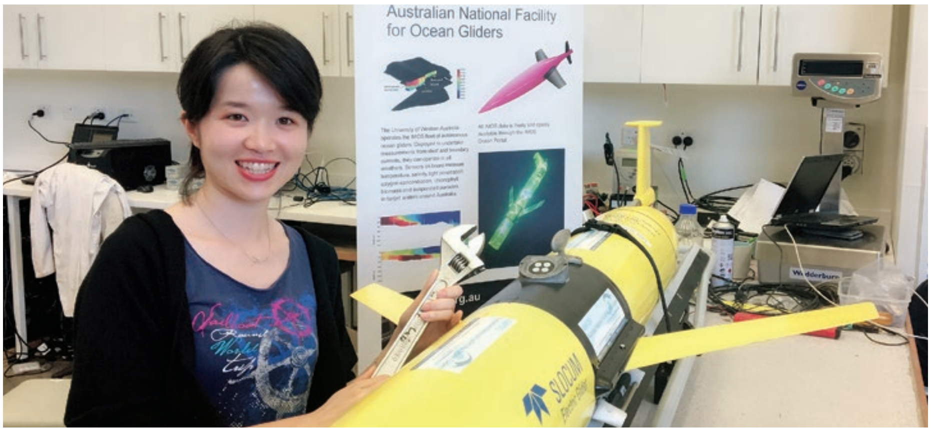
The Occurrence of Dense Shelf Water Cascades in eight different locations around Australia: (i) Kimberley; (ii) Pilbara; (iii) Two Rocks; (iv) Investigator Strait; (v) Port Stephens; (vi) Yamba; (vii) Capricorn Channel; (viii) Cooktown. All density profiles (σT) for different locations have same depth upto 150 m. Kimberley, Pilbara, Investigator Strait, Port Stephens and Capricorn Channel are upto 50 km from the shore (scale a applicable); and Two Rocks, Yamba and Cooktown are upto 20 km (scale b applicable). Scales are provided at the top left corner.

Postgraduate Student | **Miaoju (Mia) Chen**

PROJECT TITLE:

Chlorophyll response to physical forcing on the Rottnest Continental Shelf

Oceans Graduate School & The UWA Ocean Institute, The University of Western Australia



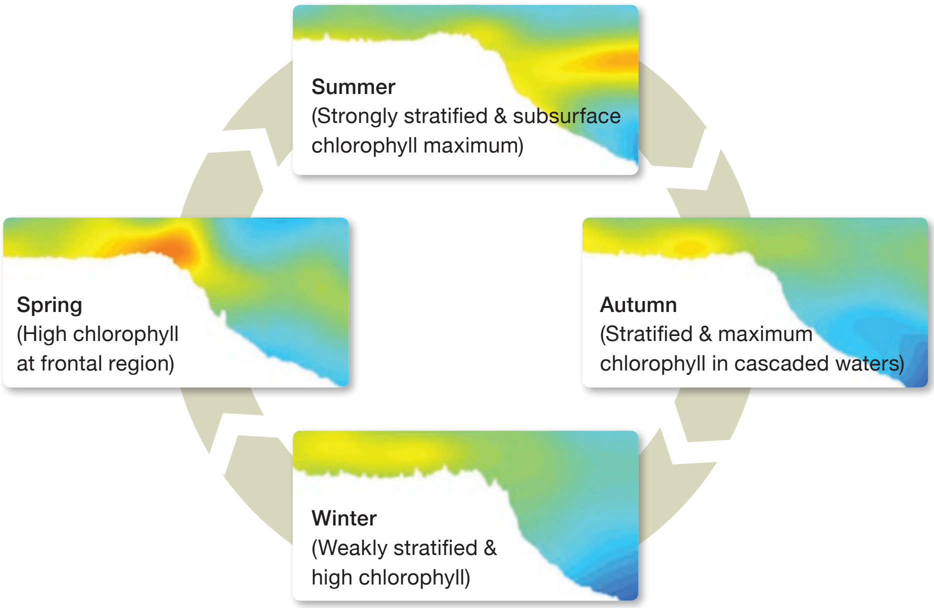
Physical and biological properties of the ocean are essential for the growth and distribution of marine organisms. Although many studies have evaluated the physical and biological properties of coastal waters off south-western Australia, fine spatial and temporal scale features of these parameters have not been well characterized due to short sampling periods and limited spatial resolution.

In Miaoju's postgraduate study, an IMOS ocean glider dataset, obtained from the Rottnest continental shelf between 2009 and 2016 was used to examine linkages between chlorophyll fluorescence distribution and physical forcing over a range of temporal scales. The results indicated that temperature, salinity and chlorophyll exhibited distinct seasonal and inter-annual variability.

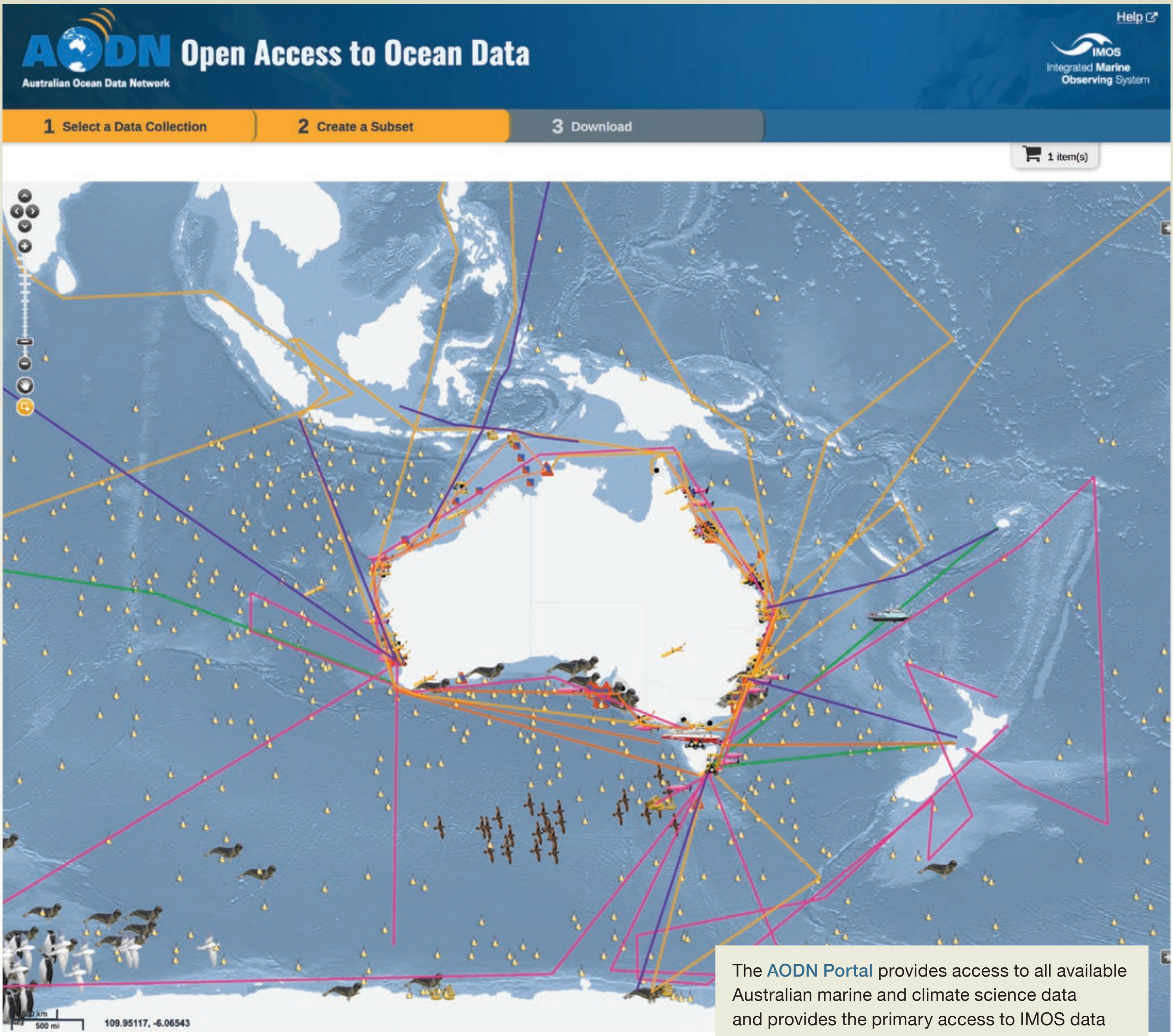
In deeper waters, the subsurface chlorophyll maximum was the major feature during spring and summer due to vertical stratification. On the inner shelf, chlorophyll concentrations were maximum during autumn and winter, with dense shelf water cascades being the dominant physical feature. Chlorophyll values were higher in 2011 (the year of the strongest La Niña), coincided with lower salinity and warmer waters, compared to that between 2012 and 2015.

The study region is close to the critical latitude where the local inertial period and the diurnal sea breeze forcing coincide to generate near-inertial waves. During summer these large (~50 m) oscillations of the thermocline resulted in upwelling/downwelling at diurnal scales, with a corresponding response in the chlorophyll concentration. In winter, higher chlorophyll levels were observed ~1-3 days after the passage of storms subsequent to sediment re-suspension. It is concluded that chlorophyll variability in the region is closely related to physical forcing at time scales ranging from hours to years.

Miaoju (Mia) is from China,and received her Master degree from Nanyang Technological University in Singapore. Six years ago, she worked as Research Assistant at Nanyang Environment & water Institute (NEWRI), Singapore. Two years later, she received the International Postgraduate Research Scholarship (IPRS) and Australia Postgraduate Award (APA) for her PhD in UWA.



Schematic diagram showing the seasonal variability of water column properties and chlorophyll.



The AODN Portal provides access to all available Australian marine and climate science data and provides the primary access to IMOS data including access to the IMOS metadata.

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For more information about IMOS please visit the website www.imos.org.au

IMOS

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