marinematters

IMOS

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Integrated **Marine Observing** System

IMOS News

> For more news from all the IMOS Facilities check the IMOS website **imos.org.au/news.html**

Combined effort results in successful deployment

The IMOS Animal Tagging and Monitoring facility deployed its first acoustic monitoring units in Tasmania last year. These are the southernmost units in Australian waters to date and are located off Cape Barren Island in Bass Strait and around Maria Island off Tasmania's east coast.

This is an international collaboration with Canada, which has provided receivers as part of the Ocean Tracking Network.

The Animal Tagging and Monitoring team worked with the Institute for Marine and Antarctic Studies (IMAS) to deploy 38 units at Cape Barren Island in October 2012. This was done with help from the research vessel *Challenger* and its crew. The vessel was loaded with all equipment in Hobart and met by the team two days later in Bicheno on Tasmania's east coast – the last suitable harbour for them to board. From Bicheno they had to steam for another 30 hours or so to reach their final destination, the east coast of Cape Barren Island.

Andrew Boomer from AATAMS was aboard the *Challenger*, and provided his account of the trip:

"As expected we were greeted by the Roaring Forties and had to seek shelter in one of the leeward bays," he said.

"Even though the next few days were still pretty windy we managed to deploy all 38 units in water depths ranging from 17 to 128 m.

"The excellent cooperation between all team members made this trip a great success.

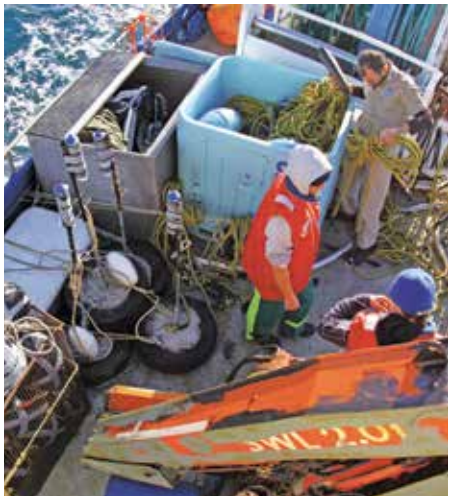
"After the bracket mounted with the acoustic release and the recording unit were attached to the mooring line on-board the vessel it had to be attached to the anchor chain. While streaming out the mooring line, the skipper got us to the right location to finally deploy the whole unit."

The acoustic array (curtain) at Maria Island was first deployed in February 2012 and recovered and redeployed in January 2013. This curtain consists of five shallow water units between the coast and the island that are serviced by divers and another 21 deep water stations east of the island to the shelf. The latter range from 60 to 120 m.

"Unfortunately, we realised that even though the location of the array is within a no-trawling zone, some of the units were lost due to trawling activity. During this servicing we relied on strong cooperation between Animal Tagging and Monitoring, IMAS, and the *Challenger* crew.

"After two long days on the water we were able to recover and redeploy all units and were excited to discover what detections we had made."

Jayson Semmens (IMAS) has advised that an initial investigation of around 700 detections revealed 13 individual animals were recorded representing five chondrichthyan species including seven gill sharks, elephant fish, smooth rays, school sharks, and eagle rays – all of which were tagged in Pittwater, southeast Tasmania.



Clockwise from top: Research vessel *Challenger*; AATAMS diver; onboard *Challenger*.

director's corner

Welcome to the first edition of Marine Matters for 2013. It promises to be both an exciting and challenging year for the IMOS research and stakeholder community.

International collaboration is a theme in a number of the stories featured. The IMOS national system is strongly connected to global endeavours and we can now see benefits flowing from work with international colleagues, as well as contributions being made by Australian scientists to global knowledge and understanding.

Support from the Canadian-led Ocean Tracking Network (OTN) has enabled deployment of two very large acoustic curtains off the east coast of Tasmania, stretching 50 to 60 kilometres from the coast to the edge of the continental shelf. This is a scale of activity that wouldn't have been possible without IMOS/OTN collaboration. Australia's involvement in a new, global high frequency radar network is also expected to be very beneficial over the long term. We are currently a small player in international terms, but ocean radar has significant potential to grow in this country given the scale of development around our coastline and the importance of robust, real time data on surface currents, waves and winds. It's pleasing to see this potential being explored in our Student Profile.

There are featured publications with international co-authors on Antarctic Bottom Water formation using seal tagging data, and on the 2011 marine heatwave along the WA coast. As IMOS continues to build its international profile, more and more such collaborations are occurring. These stories also serve to highlight the opportunities for new science and unexpected results that can only be derived through sustained observing and open access to data.

The value of IMOS real time data is evident in stories on sensor network 'dashboards' for GBR Island Research Stations, and an ocean glider that continued to operate in the path of Tropical Cyclone Rusty. The dramatic increase in sampling frequency provided by these technologies is enabling scientists to uncover ocean features that were previously undetectable, improving our ability to understand variability and change.

The major challenge to be addressed this year is sustained operation. IMOS has been awarded a further $7.2 million of Australian Government research infrastructure funding under an interim program called the Collaborative Research Infrastructure Scheme (CRIS). These additional resources are very welcome, and represent another vote of confidence for IMOS as an essential element of the national research infrastructure. However they will only extend operations by 15 months, to September 2014, and are insufficient to continue the program at its current level of operation. All IMOS partners have been working very hard to minimise the impacts of reduced funding in 2013-14, but we will have to pull back to a much lower level of activity over that period.

As an island nation, Australia's future depends on having appropriate levels of information about what's actually happening in the oceans around us, including how anthropogenic change and natural variability are affecting our climate and weather, and our marine ecosystems and industries. Your interest and support in helping to make the case for adequate and sustained funding of the national, integrated marine observing system is greatly appreciated.

Tim Moltmann


Photo: Steve Rintoul

IMOS Director visits South Australian marine science community

In early March, IMOS Director Mr Tim Moltmann visited South Australia to meet with key stakeholders and the broader marine science community.

He held discussions with Associate Professor Ian Menz at Flinders University to determine continuing collaboration arrangements and then met with Prof Gavin Begg, Research Chief of the South Australian Research and Development Institute (SARDI).

Mr Moltmann delivered a presentation to various members of the marine science community comprising representatives from SARDI, SA-IMOS, Flinders University, the University of Adelaide, the Department of Environment, Water and Natural Resources and the Defence Science and Technology Organisation.

The presentation outlined IMOS achievements to date, short-term challenges and long-term opportunities. The SA-IMOS Node Leader Associate Professor, John Middleton, provided an update on Node activities, which was followed by discussion and networking.

Above: Mr Tim Moltmann and Assoc. Prof John Middleton.

Below: Mr Tim Moltmann, Dr Simon Goldsworthy (SARDI Aquatic Sciences), Dr Adrian Jones (DSTO).

Group on Earth Observation: Global High Frequency Radar Network Component

The Group on Earth Observations (GEO) is coordinating efforts to build a Global Earth Observation System of Systems (GEOSS). The GEO Work Plan 2012-2015 endorsed a task to plan a Global HF Radar Network for data sharing and delivery and to promote the proliferation of HF radar surface current velocity measurements.

GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialised countries. It is a voluntary partnership of governments and international organisations, providing a framework within which these partners can develop new projects and coordinate their strategies and investments.

These high-level meetings recognised that international collaboration is essential for exploiting the growing potential of Earth observations to support decision making in an increasingly complex and environmentally stressed world.

As of March 2012, GEO's members include 88 governments and the European Commission. In addition, 67 intergovernmental, international, and regional organisations with a mandate in Earth observation or related issues have been recognised as participating organisations.

The Global High Frequency Radar Network task has been distributed across two areas:

IN-01 Earth Observing Systems

- C1 Development, Maintenance and Coordination of Surface-based Observing Networks (*in situ* and airborne)
  - Promote rapid development of a global high frequency radar network to measure coastal surface currents (see also SB-01)

SB-01 Oceans and Society: Blue Planet

- C2 Operational Systems for Monitoring of Marine and Coastal Ecosystems
  - Promote rapid development of a global high frequency radar network to measure coastal surface currents. High frequency radar is recognised as a cost-effective solution to augment *in situ* measurements and provide increased spatial and temporal resolution

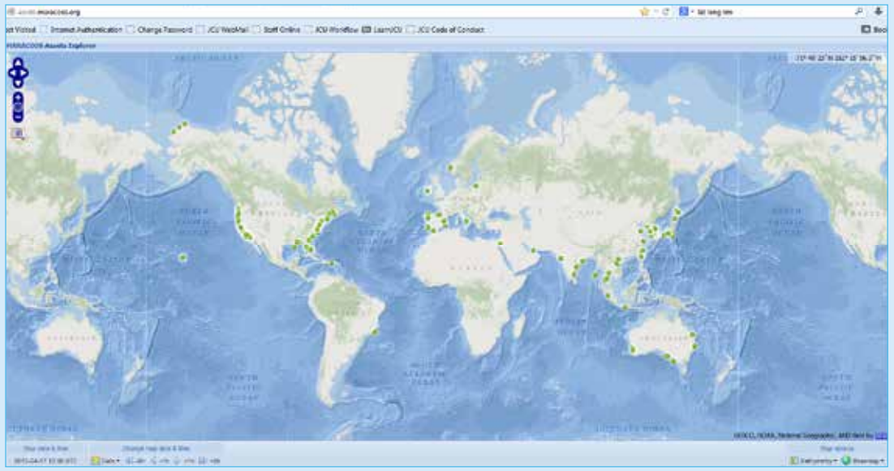
The HF radar task is being steered by NOAA with co-chairs: Enrique Alvarez-Fanjul (Puertos del Estado, Spain), Jack Harlan (NOAA, USA), Lucy Wyatt (IMOS ACORN facility, JCU, Australia). More details can be found on http://www.ioos.noaa.gov/globalhfr/welcome.html

A more complete map of sites of HF radar systems around the world can be seen on http://assets.maracoos.org/

The long-term goals are:

- to make HF radar data available in a single standardised format in near real time
- to develop a worldwide QA/QC standard
- to develop easy-to-use standard products
- to assure HF radar data assimilation in ocean and ecosystem modelling
- to develop emerging uses of HF radar in the areas of ecosystem, tsunami, and climate.

The next meeting will be held at the MTS/IEEE Oceans '13 Conference – June 11, 2013, Bergen, Norway. NOAA is also organising a GEO/GOOS/Blue Planet town hall meeting at the same conference, on advancing the understanding on the importance of ocean observing. Lucy Wyatt will represent IMOS at that meeting.



The locations of Australia's HF radar systems.

Delivering Knowledge – use of data 'dashboards' at the Island Research Stations

Dashboards are now being used to make data from island-based marine research stations more accessible.

The Tropical Marine Network (TMN) comprises four of IMOS' seven deployment sites for Wireless Sensor Networks. The Heron Island and One Tree Island stations in the southern Great Barrier Reef, Orpheus Island in the central GBR and Lizard Island in the north are all part of a network of island-based marine research stations that make up the TMN: http://www.tmnonline.net/

The TMN is a partner in the IMOS Wireless Sensor Network facility. The design of the sensor networks has been optimised to deliver real time environmental data to support the work of the researchers at the stations. In order to facilitate this uptake and use, specially designed web-based data dashboards have been developed that hold and display the last month's data. The dashboards re-direct back to the IMOS Ocean Portal for more complex or historical queries along with providing links to the other IMOS data relevant to the locations.

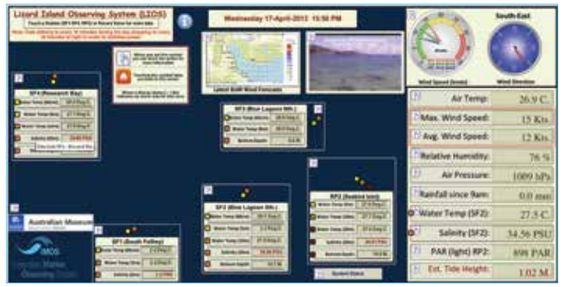
The dashboards display current data as real time values and graphs for the last month, derived values such as tide heights for key locations (passages into and out of the stations) and other data (including wind forecasts).

The ability to customise the display of the data directly delivers value to the researchers and to the stations. The data is used for routine operations of boating activities, planning logistics and monitoring conditions through the use of cameras. For the researchers it provides essential environmental contexts to the experimental work being undertaken as well as providing baseline data to monitor and understand change.

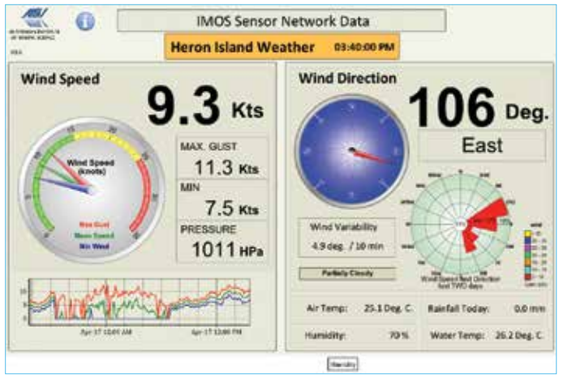
(*See Lizard Island and Heron Island Weather*)

The IMOS work has been used in other related projects such as the National Environmental Research Program's project in the Torres Strait, monitoring ocean temperatures and conditions as indicators of potential coral bleaching. In this case a generalised display has been built for the local radio station, which broadcasts the ocean and coral bleaching data on a daily basis. Displays are being built for community centres to enable greater access to the data in a form and context that makes sense to the local community. The sea-faring nature of these island communities means they value the up-to-date meteorological and ocean data that the systems provide. It also engages the community by sharing information about local ecosystems and how these may be impacted by future change.

(*See Torres Strait NERP Data Display*)



LIZARD ISLAND



HERON ISLAND WEATHER

TORRES STRAIT NERP DATA DISPLAY

The IMOS approach has been to build observing infrastructure to meet specific scientific research plans. For the Queensland Integrated Marine Observing System (Q-IMOS) Node, part of this is related to coral bleaching and the occurrence and impact of high temperature events. The use of targeted customised data displays allows for the data to be contextualised, for example showing current conditions against longer term baselines allows for events to be identified and highlighted, giving increased freedom to interact directly with the data. This forms a 'front-end' to the more generalised IMOS Ocean Portal with the data displays linking to the Portal for historical data.

For more information, please contact Scott Bainbridge on (07) 4753 4377 or email s.bainbridge@aims.gov.au

Marine Nation 2025 *Marine Science for Australia's Blue Economy*

A new framework outlining the potential for Australia's marine territory to contribute approximately $100 billion annually to the nation's economy by 2025 has been launched at Parliament House, Canberra.

Marine Nation 2025: Marine Science to Support Australia's Blue Economy, prepared by tthe Oceans Policy Science Advisory Group (OPSAG)* and launched by Chris Bowen, Minister for Tertiary Education, Skills, Science and Research, highlights the potential of Australia's oceans and the challenges and opportunities involved in managing our vast maritime resource.

"Australia's oceans are a critical part of our economy and will play a vital role in our future prosperity," Mr Bowen said.

"With an estimated economic value of around $42 billion in 2009-10, it is critical that we manage our oceans in a sustainable and sensible way.

"*Marine Nation 2025* provides a framework to start a national discussion on how we can better benefit from our oceans while preserving their health for future generations."

IMOS Director Tim Moltmann, who is a member of OPSAG, attended the launch.

"It's vitally important that OPSAG takes responsibility for national leadership in this way," he said.

"Marine science supports Australia's 'triple bottom line' in many ways. This is a great strength, but it can also be a vulnerability as there's no single champion for marine issues in our national system. *Marine Nation 2025* provides a clear view of how nationally coordinated marine science will support the development of Australia's 'blue economy' to its full potential."

The report outlines six major challenges facing Australia's marine environment:

- sovereignty, national security and natural hazards
- energy security
- food security
- biodiversity and ecosystem conservation
- climate change
- resource allocation.

Above: Minister Bowen and John Gunn.

* The Australian Government's Oceans Policy Science Advisory Group (OPSAG) promotes co-ordination and information sharing between Australian Government marine science agencies and the broader Australian marine science community.

For more information see http://www.aims.gov.au/opsag

Unexpected benefits from IMOS seal ecology project

IMOS observations from seals have helped to uncover a 30-year Antarctic Bottom Water (AABW) mystery. The research, published in Nature Geoscience, found a stream coming from the intense sea ice formation in the Cape Darnley Polynya, north west of the Amery Ice Shelf.

Sensor-equipped seals have revealed the AABW, a key source of cold, dense water that helps regulate the Earth's climate. Known to originate from three sources, a fourth undiscovered source had long been speculated.

The tagged seals relay information via satellite as they surface. The observations are collected by IMOS, which makes the data publicly available for use by Australian scientists and their international collaborators.

IMOS Director Mr Tim Moltmann said that this is a great example of the benefit Australia derives from having an integrated marine observing system that makes all of its data available.

"We funded the tagging of these seals to address completely different scientific objectives. However, scientists were able to access and reuse the data in their work, and it's contributed to a very significant discovery," he said.

Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) CEO Tony Press said the research demonstrates the important role that IMOS plays in the broad ocean sciences community.

"Data made publicly available in real or near-real time can be used by scientists outside that particular research project. Here is an excellent example of the serendipity that can result – a breakthrough in solving a difficult oceanography puzzle using data derived from a research project on seal ecology."

Co-lead author Dr Guy Williams, a sea-ice specialist at the ACE CRC said that the seals provided integral information.

"The seals went to an area of the coastline that no ship was ever going to get to, particularly in the middle of winter, and measured the most extreme dense shelf water anywhere around Antarctica.

"Several of the seals foraged on the continental slope as far down as 1800 m, punching through into a layer of this dense water cascading down to the abyss.

"They gave us very rare and valuable wintertime measurements of this process," he said.

The findings of this research open the door for further discoveries of AABW production from the other polynya regions around the Antarctic coastline.

Photos Iain Field, Macquarie University.

Cyclone encounters for gliders

An algal bloom stirred up by Tropical Cyclone Rusty was so big that it was clearly visible from space. NASA and satellite images show the bloom, which was equivalent in size to Tasmania.

For the first time in Australia, scientists were able to measure properties of the ocean such as turbidity during a tropical cyclone, using a remote-controlled underwater glider. Designed to withstand extreme weather and equipped with a variety of sensors, they move horizontally through the water while collecting vertical profiles and sending the data back to base via satellite in near-real time.

The measurements were collected as the glider made its routine quarterly journey from Broome north towards Scott Reef, about 200 kilometres offshore.

As Tropical Cyclone Rusty crossed the Pilbara coast, the turbidity levels exceeded the maximum range of the instruments.

“We’ve deployed gliders on about 150 missions over the past 4–5 years all around Australia and none of them had turbidity levels beyond our instrument range from the surface right down to the sea floor”, says Professor Charitha Pattiaratchi from the University of Western Australia, who leads the IMOS Ocean Glider Facility.

The high turbidity levels were due to sediment and organic matter being stirred up, or re-suspended, from the sea floor at 30 metres depth. Turbidity is caused by the action of both waves and currents, and the data collected shows that the speed of the ocean currents almost doubled.

Nutrients were stirred up from the sea floor, resulting in a bloom of phytoplankton, which was evident by an increase in the chlorophyll concentrations.

“We’ve not been able to collect this type of data until now. Normally we take samples from a ship or a boat but it is not possible to be on board a research vessel in 125 km/hour winds. The glider gives us an opportunity to collect data under extreme conditions. We couldn’t have done it otherwise. Satellites provide us information on the ocean surface conditions but gliders tell us what’s happening below the surface,” Prof Pattiaratchi said.

Meanwhile on the east coast, an autonomous profiling glider with an optical nitrate sensor was deployed near Heron Island in the southern Great Barrier Reef as ex-cyclone Oswald passed through. It sent decimated samples of data in near real time during the mission, but was later lost, likely due to ship strike.

A poster of the deployment was presented at the Collaborative on Oceanographic Chemical Analysis (COCA) workshop held at the University of Hawaii by Dr Karen Wild-Allen, Lindsay MacDonald and Mr Simon Allen.

“Repeat transects confirm the influence of coastal freshwater across the shelf and the introduction of chlorophyll and nitrate to surface waters,” Dr Wild-Allen said.

The trio concluded the poster stating “these glider data provide a remarkable insight into the evolving subsurface dynamics of the shelf during the passage of a severe tropical storm. The data will be used to assess the skill of the CSIRO eReefs hydrodynamic, sediment and bigeochemical model of the region with further deployments forming a key component of our near real time modeling system.”

Photo: NASA

IMOS Postgraduate **Student Profile**

Students using IMOS data for their postgraduate research

Jennifer Maria Penton

University of Western Australia

Project: *The effects of wind forcing on surface currents on the continental shelf surrounding Rottnest Islandz*

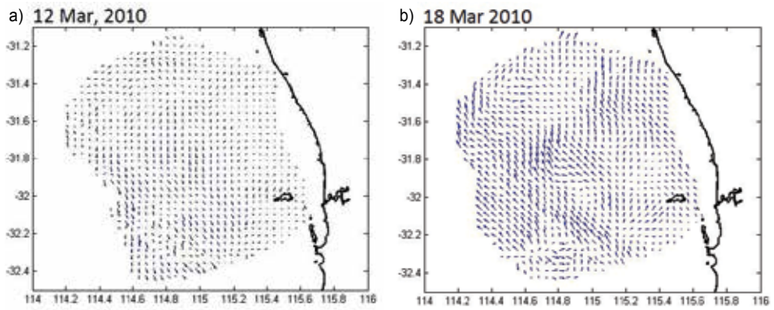
Data is provided by The Australian Coastal Ocean Radar Network. The data used is collected from the phased array system located at the Perth Canyon Site (with two stations: Leighton Beach, Guilderton). The transmit frequency is 8.d125 MHz, allowing for a maximum range of 180 km.

Surface currents play a major role in the distribution of contaminants, the connectivity of marine populations, and can influence the vertical and horizontal distribution of nutrients within the water column.

My research aims to determine the effects of sea breeze-wind patterns on the climatology of the surface currents on the continental shelf surrounding Rottnest Island, Western Australia. The alternating wind patterns allow for full cyclic rotations of wind direction, permitting the interpretation of the effect of the wind on the surface currents. It was found that the surface currents only clearly follow the northbound Capes Current in times when the Fremantle Doctor sets in.

Surface currents react within an hour to a change of wind direction, allowing southerly currents to dominate during strong northerly sea breezes, often followed by mixed currents dominated by eddies in the inter-lying times.

Further research will allow for the investigation of the climatology of sub-mesoscale and mesoscale eddies as well as the influence the wind patterns have on the abundance and intensity of the eddies.



a) Example of southerly currents from a 6h average on the 12th of March, 2010
b) Example of northerly currents from a 6h average on the 18th of March, 2010.

Ningaloo Niño

Abnormal climatic conditions in the Indian and Pacific Oceans during the 2010-2011 La Niña event combined to create the extreme marine heatwave seen off the Western Australia coast in 2011, according to a paper published last week in Nature Scientific Reports.

Lead author Dr Ming Feng, from CSIRO's Wealth from Oceans Flagship, says the marine heatwave was driven by unusual features in the Leeuwin Current – a warm ocean current which flows southwards near the west coast of Australia – which was affected by extreme ocean and atmospheric conditions in the Pacific and Indian Ocean during the 2010-2011 La Niña.

"Record easterly wind in the eastern Pacific and record northerly wind in the southeast Indian Ocean combined to produce an unseasonable surge of the southward-flowing Leeuwin Current and extreme ocean warming off the west coast of Australia," Dr Feng said.

Water temperatures were recorded by satellite, robotic Argo profilers and continental shelf moorings operated as part of IMOS. During the heatwave water temperatures were more than 3º C above long-term seasonal averages, climbing up to 5º C above for a two-week period at the peak of the event, and causing widespread impacts on marine ecology, including fish kills and coral bleaching.

The seasonal sea surface temperature warming off the west coast of Australia has been termed a '*Ningaloo Niño*', an analogy to other eastern continental boundary current warming phenomena such as El Niño in the Pacific and the Benguela Niño in the Atlantic.

"Understanding the factors that influence the formation of events like the 2011 Ningaloo Niño is a vital first step in preparing for impacts from extreme warming events in the future," said Dr. Feng.

Co-author, Dr Michael McPhaden of the Pacific Marine Environmental Laboratory, NOAA, said the research demonstrated the significance of far-away events to our own backyard.

"Nature always finds a way to surprise us and the Ningaloo Niño is just the latest episode in this continuing saga.

"This is research that matters to society because it tells us that what happens in your backyard can be influenced by events happening in far away places and at times in the distant past," Dr McPhaden said.

Read the full article on the IMOS website www.imos.org.au

Annual Planning Meeting overview

IMOS held its Annual Planning Meeting in early February, with more than 80 members of the IMOS community coming together to share experiences and plan for the year ahead.

IMOS Chair Ian Poiner opened the meeting, followed by an introduction and Collaborative Research Infrastructure Scheme update from Director Mr Tim Moltmann.

Held over three days, the Sydney-based event included presentations from each node and facility, along with special presentations on *Australian Marine Zooplankton guide and atlas* and *Plankton 2012: state of the oceans around Australia*.

In addition to the full-schedule of talks, attendees enjoyed an evening cruise on Sydney Harbour.

Attendees at the IMOS Annual Planning Meeting.

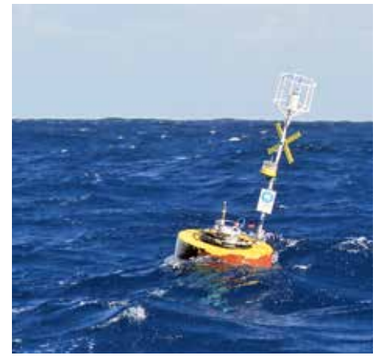
National Reference Stations update

The North Stradbroke Island National Reference Station weathered severe storms earlier this year, demonstrating its strength and robustness in difficult conditions. All telemetry sources (atmospheric loggers) were still operating after a persistent storm front/ex-cyclone of more than five days.

The data shows heavy swell impact – seven metre seas over a period of days. Other nearby wave-riding data sources reached 10 metres above normal sea height on large waves – an incredible feat considering the mooring is situated in only 60 metres of water. Included in the data is a 50 knot (90 km/h) wind speed recorded 1.5 metres off the sea surface.

The NRS's ability to survive the elements while still delivering data at 15-minute intervals is impressive, as is the data retrieved.

NRS team recovering subsurface instrument arrangement.



NRS surface telemetry buoy located off North Stradbroke Island.

100 glider deployments

The Ocean Gliders facility has reached a milestone, celebrating its 100th dataset from a glider deployment being uploaded to the portal.

The gliders provide a unique opportunity to effectively measure the boundary currents off Australia – the main link between open-ocean and coastal processes. The Ocean Gliders facility operates a number of gliders with target regions including the Coral Sea, East Australian Current off New South Wales and Tasmania, Southern Ocean southwest of Tasmania and the Leeuwin and Capes Currents off Western Australia.

The gliders have collected valuable data used on a wide range of research projects. This milestone has not been without challenges – including shark bites and a cyclone in recent months.

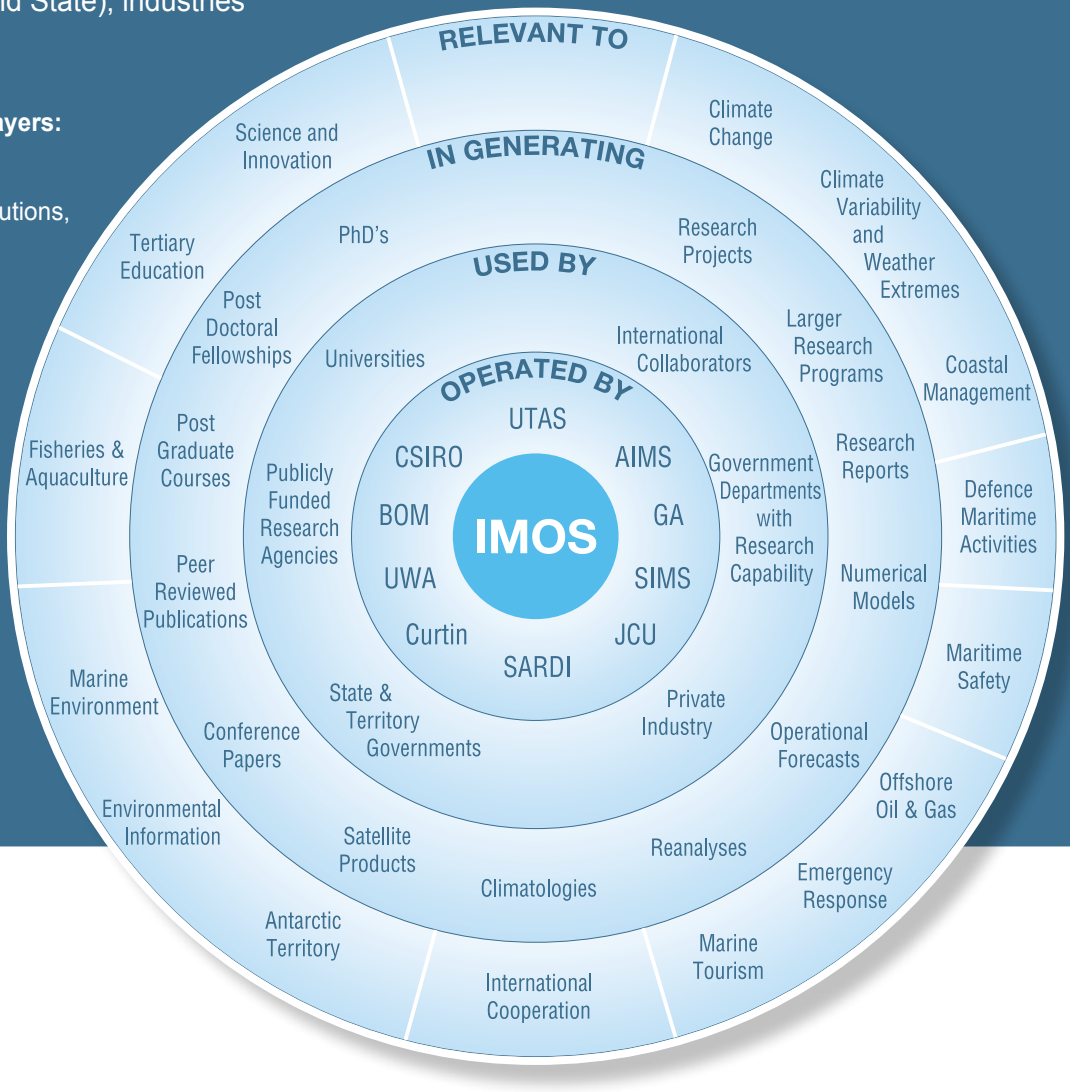
Congratulations to all involved.

Deployment of Ocean Gliders.

IMOS has developed a 'circle diagram' to capture the complexity of engagement for IMOS as a broadly based research infrastructure program delivering to a national community, undertaking research of relevance across government portfolios (Federal and State), industries and communities.

The diagram has five layers:

1. IMOS at the core,
2. the ten operating institutions,
3. the broader research community,
4. various pathways for uptake and use of IMOS data and products, and
5. portfolios of relevance and impact.



Director
Mr Tim Moltmann
Tim.Moltmann@imos.org.au

Project Manager
Mrs Jo Neilson
Jo.Neilson@utas.edu.au

Communications Manager
Frances Hutchinson
Frances.Hutchinson@utas.edu.au

Project Officer
Dr Shavawn Donoghue
Shavawn.Donoghue@utas.edu.au

Personal Assistant
Miss Donna Chilcott
Donna.Chilcott@utas.edu.au

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

General enquiries:
Integrated Marine Observing System (IMOS),
University of Tasmania, Private Bag 110, Hobart, TAS, 7001
• +61 (03) 6226 7549 T • +61 (03) 6226 2107 F

Australian Government
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