marinematters

IMOS

issue three January 2008

Integrated Marine Observing System

IMOS News

(Photo courtesy of Chris Kidd)

Australia-first as satellite laser system probes space from Tasmania

IMOS has contributed to an international Satellite Laser Ranging (SLR) system which has been set up at Burnie on the North-West coast of Tasmania during December 2007 for a period of 5 months. The SLR data combined with other local data will permit calibration of sea level measurements from the newest altimetric satellite. Satellite sea level plays a crucial role in understanding climate change of the ocean and sea level rise. The SLR system complements an array of scientific instruments in the water around Burnie and is the only SLR system in the Southern hemisphere. IMOS has provided funds for the GPS buoy deployments and ocean moorings in Bass Strait.

AUV – Deployed at Ningaloo and Great Barrier Reef

The Autonomous Underwater Vehicle (AUV) has been on board the Australian Institute of Marine Science (AIMS) R/V Cape Ferguson on two cruises. A series of trials were undertaken to assess benthic habitats off the Ningaloo Reef, WA. These trials were aimed at evaluating the effectiveness of using the AUV for conducting biodiversity assessment in waters beyond diver depths. The focus on these deployments was to document sponge habitats in 40m-80m depths and exploring canyons up to 250m depth. More recently, the AUV was part of a three week research cruise aboard the R/V Southern Surveyor documenting drowned shelf edge reefs at multiple sites in four areas along the Great Barrier Reef.

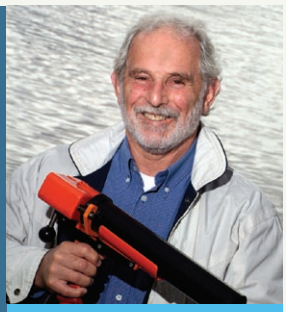
Argo 3000

The Argo ocean observing array has reached its initial target of operating 3000 robotic floats worldwide. The Argo array has been deployed by collaboration of more than 30 countries plus the European Union. Now that the target has been reached and an effective data delivery system has been built the next challenge is to maintain the full array for a decade in a pre-operational "sustained maintenance" phase. See Issue 2 for more information on Argo Australia.

New IMOS Website to be launched in January

The new improved IMOS website will be launched in January; Katy Hill has been working with the company Tweezy to set up a user friendly website that will be centrally managed by the IMOS office. The site will use a Content Management System that allows each node/facility to edit certain sections of the site. The IMOS website is essential for promoting our achievements, so please help us to keep it up to date, informative, relevant and interesting. For more information please email Marian.McGowen@utas.edu.au.

director's corner



Dr Gary Meyers

It's been almost a year since the first annual meeting of IMOS Facility and Node Leaders, and the second meeting is next month. The year seems to have gone by too quickly, probably for all of us. A large effort went into finishing the contracts and the subcontracts to operators to establish IMOS. Now from the perspective of the IMOS Office we see a lot of equipment being ordered, and some measurements are being made. The purpose of the second annual meeting is briefly to report the progress made in implementing the Facilities (including any impediments we've encountered) and to outline the Business Plan for 2008/09 (including the infrastructure that will be established and the access to data that will be available by mid-2009).

During the first year I have had the opportunity to present an overview of IMOS on several occasions. An issue that attracts a lot of attention is our set of principles, especially the ideas around service to the community and free, open and timely exchange of data. I like to say that it isn't just a bunch of words, but a real commitment that all the IMOS players have made willingly, even enthusiastically. While all of us directly involved in IMOS know our

Principles, I think it is a good idea to state them here for all of the newsletter readers.

The IMOS Principles are naturally fashioned after the NCRIS Principles as articlulated in the NCRIS Roadmap, but enhanced as required for a marine observing system. The IMOS Principles are:

- Service – IMOS is a national system and will provide a service that broadly supports marine research to maximise the contributions of R&D to economic development, national security, social wellbeing and environmental sustainability.
- Data-streams – IMOS data will be delivered freely, openly, in a timely manner, preferably in near real time. Success will be measured in terms of the quality and quantity of data that IMOS delivers, the number of users and the quality of research-results produced with IMOS data.
- Integration – IMOS will deploy a nationally coordinated, multi-platform system to take advantage of the synergies between instruments, and to provide a comprehensive description of the ocean, as a contribution to national and international programs.
- Sustainability – The real value of IMOS will only emerge if systematic, repeated data collection continues for a long time to see the full range of climate variation and change. Sustained streams of data are integrally related to conservation and sustainable development of the marine environment.

Collecting data that provides a service to the research community and giving data away before writing a science-paper are ideas that have been maturing in the marine community for over a decade. Anyone who has thought about sustaining such an expensive endeavour as ocean-observation soon realises that this is the minimum price we have to pay.

At this stage most of the effort in IMOS is directed toward establishing the infrastructure. In the next fiscal year, however, we intend to put a greater effort into promoting the use of IMOS data. In some cases, such as data from the Ships of Opportunity (SOOP) Facility, the Argo Facility and the Acoustic Tagging Facility (AATAMS), the data have already been used to produce important new scientific results. Many of the Facilities however are using instrumentation that is totally new to Australia, opening new horizons to research especially with regard to ecosystems over the continental shelf. For the research community, now is the time to start thinking about what you can do with these new data streams, and possibly include this work in research proposals to ARC and other organizations. The IMOS Office would be happy to provide additional information to support research planning, upon request.

Sub-contracts with research organisations are all signed

The sub-contracts with the nine research organisations (CSIRO, Australian Institute of Marine Science, Sydney Institute of Marine Science, South Australian Research and Development Institute, Geoscience Australia, James Cook University, University of Western Australia, Bureau of Meteorology and Curtin University of Technology) have now all been signed. Funding can now flow to these organisations for the IMOS facilities. Thank you to Andrea McAuliffe (University of Tasmania Legal Officer) for her advice and time spent on the IMOS contracts which has been much appreciated.

2006/07 Annual Progress Report (APR) and 2007/08 Annual Business Plan (ABP) have been approved by DIISR

The first IMOS Annual Progress Report (APR) for 2006/07 was submitted to DIISR, following approval by the Advisory Board on the 25th September. The report included an overview of the status of IMOS, and a description of the activities undertaken by each facility and node. Thank you to all the Facility, Sub-Facility and Node leaders who provided Facility and Node reports and the Implementation Panel for writing the research infrastructure section. Both the APR and the ABP have now been officially accepted by DIISR. The APR can be viewed on the IMOS website at: www.imos.org.au (the ABP is confidential and available for IMOS members only).

IMOS Annual Planning Meeting at Glenelg

The second IMOS Annual Planning Meeting will be held on 18-20th February 2008 at Glenelg, SA. It will be an opportunity to discuss the status of each Facility and Node, the ABP 08/09, Communication Plan, as well as other technical and administrative issues. Invitees include the IMOS Advisory Board, Committee members and Facility leaders.

Andrea Grosvenor and Jesusa Aguilar from DIISR visit Hobart

Andrea and Jesusa visited Hobart on the 6-7th December. As well as having a tour of the R/V Southern Surveyor they met with the IMOS office and Jo Laybourn-Parry (Pro Vice-Chancellor for Research), at UTAS. At CSIRO Marine and Atmospheric Research, Andrea and Jesusa got to check out the Argo Floats, moorings, a glider being prepared for deployment and discuss the Satellite Remote Sensing facility and Bluelink. We have been advised that following the change of government, NCRIS has now moved to Science and Research Division of the newly formed Department of Innovation, Industry, Science and Research (DIISR).

By Tamsyn Jones

Acoustic Tagging & Monitoring – Dr Rob Harcourt

For decades, researchers have been using telemetry technologies such as radio-tagging and tracking collars with great success to study the lives and habits of a variety of species – from freshwater species like catfish and carp to terrestrial species ranging from wolves and wildcats to migratory birds and even snakes. Marine species, however, have largely eluded this technological insight, due to some formidable challenges the oceans have presented: notably, the unique inaccessibility of the vast marine terrain; and the difficulty of doing traditional radio telemetry in the deep oceans.

"On land, scientists know where elk or bears roam, what their daily habits are, how far they go from home," said Dr. Richard Starr of the University of California Sea Grant Program to the annual meeting of the American Association for the Advancement of Science (AAAS) in 2004. "But until recently we haven't had the tools to study daily movements of marine fishes."

Marine scientists have had to piece together these movements from limited data, relying on chance to land tagged fish in fishermen's nets, or the fishermen themselves to report recovered tags.

But now, the lives of elusive marine species will soon become more public – as well as their response to overfishing, climate change, and shifting ocean conditions – thanks to a $4.1 million ocean tracking system about to go online in Australian coastal waters.

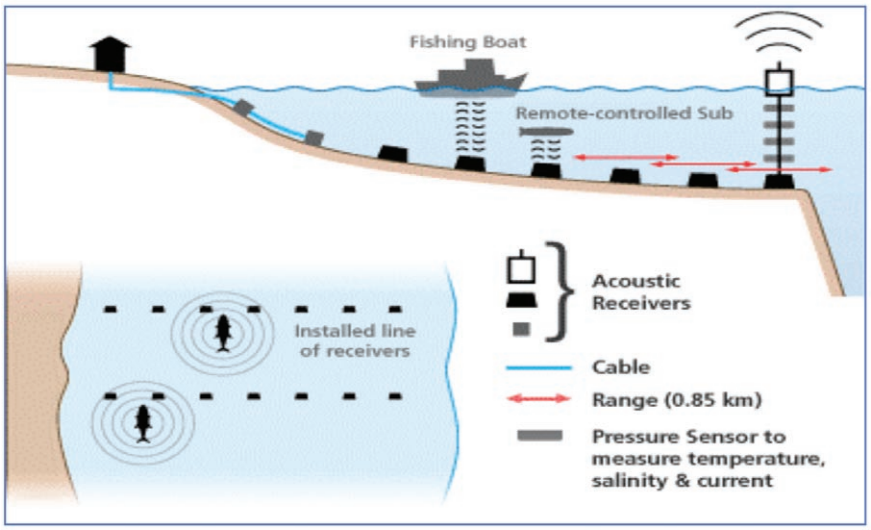


Diagram of how the new Australian Acoustic Tracking and Monitoring System (AATAMS) works. Acoustic receivers are placed on the sea floor at 1 km intervals from shore to the shelf edge. When tagged sea creatures swim within 500 meters of a receiver, real-time data (location, time and date) is automatically recorded, along with measurements of ambient ocean properties (temperature, depth, and salinity) via additional attached sensors. Depending on the specific tag model, data is either remotely uploaded to a central server or recovered via ships on site. The new system will enable study of long-distance movements essential for informed marine management and provide vital clues about the effects of climate change on marine life.

A Real-Time Ocean Tracking System

The Australian Acoustic Tagging and Monitoring System (AATAMS) – established in January as one of IMOS's 11 principal programmes – has recently started to deploy the new monitoring arrays on the sea floor off Ningaloo Reef in Western Australia. Featuring recent innovations in acoustic tracking technology – smaller, specially designed tags and underwater receivers – the new arrays are poised to transform our knowledge of some marine species' migratory behaviour and their ocean habitats.

Lower cost, reduced labor demands and a more expedient means of retrieving data will make a small scientific revolution in the seas. The new, real-time data will provide an understanding of the distance and speed at which migratory species travel, whether environmental factors affect their migratory instincts, and the sort of habitats the species select for stopping over. Better knowledge will lead to better management of Australia's fisheries, resources, and reserves.

Monitoring Marine Migrators

Dr. Rob Harcourt, director of marine science at Macquarie University in Sydney and the project leader of AATAMS, says that the shortage of data on migratory marine species has left researchers and managers ill-equipped to make informed decisions.

"There are many animals where management will be greatly enhanced when we know more about their movements, including sharks and tuna," he says.

Whale sharks, grey nurse sharks, and great white sharks, for instance, all migrate vast distances every year. They are protected or endangered in Australia, but Harcourt says that with current tracking methods, "it is very difficult for scientists to collect data about fundamental aspects of their lives."

The Southern Bluefin Tuna is one of Australia's most valuable commerical fisheries, ranked among the nation's top five seafood exports at close to (AU) $300 million per year, according to Australia's Department of Foreign Affairs and Trade. Yet, for years the population has been in steep decline and it's now at historic lows. Lack of knowledge about the movements of individual tuna has hindered efforts to estimate stock size and the effects of fishing, and thus to optimally manage the fishery.

AATAMS overcomes some of the technological obstacles to ocean tracking of these species. AATAMS will make it feasible to quantify habitat dynamics near Australia and large-scale migration patterns – without the costly, labor-intensive field work once required.

"Basically, we're putting in a network of receivers that will allow individual [animals] to be tracked over long distances," Harcourt says.

AATAMS Joins a Global Network

Importantly, through AATAMS, Australia will also become part of a larger, international tracking network initiated in Canada. The Ocean Tracking Network (OTN) – headquartered at Dalhousie University in Nova Scotia – has a boldly ambitious aim: to create a global undersea tracking network that can comprehensively monitor sea life in all the world's oceans, and help answer pressing questions about the status of the seas in a climate-changing world. It's being achieved primarily by fostering strong international partnerships, integrating regional tracking programs like AATAMS, and creating a central database where ongoing data can be stored and shared.

Dr. Ron O'Dor, a Dalhousie University biologist who's heading the network, says that by "wiring up the world" through the OTN, that nations will be able to work towards "smarter fisheries management, better sea life conservation measures, and the potential of abundant, sustainable stocks of commercial fish."

Southern Bluefin Tuna migration map, illustrating the highly migratory nature of the species. The fish is one of Australia's most valuable commercial fisheries, yet stocks have significantly declined since the 1960s, underscoring the importance of a tagging program capable of tracking the species' long-range movements. AATAMS combined with data from other countries will track Southern Bluefin Tuna as they travel east and west near the Great Australian Bight, a key segment of their annual migration route. Researchers hope to learn more about movements within these vast "tuna highways," and the number of individuals entering and exiting Australian waters (*Map courtesy of the CSIRO*).

AATAMS at the National Level

Within Australia, AATAMS will serve on two levels: as both a regional arm of the OTN working towards a global perspective on marine life, and also as the national facility for marine tracking on a smaller continental scale. The system is being operated by the Sydney Institute of Marine Research (SIMS) – a joint research partnership among four Sydney area universities (Macquarie University, the University of New South Wales, the University of Sydney, and the University of Technology, Sydney), based at Sydney's Chowder Bay. As a Facility in IMOS, AATAMS will be setting up three permanent tracking arrays around Australia: the first near Ningaloo Reef, which stretches 290 km along WA's Coral Coast; the second along the SA coast near Kangaroo Island—Eyre Peninsula and the Bonney Coast; and the third along Australia's east coast from Coff's Harbour to Sydney.

Ningaloo Reef Ecosystem Tracking Array: The first arrays were installed in WA along Ninglaoo Reef, a unique near-shore coral reef ecosystem. Ningaloo Reef is Australia's largest fringing coral reef system – and the only large reef in the world found in such close proximity to a continental land mass (at its nearest point, the reef is only about 100 metres from shore).

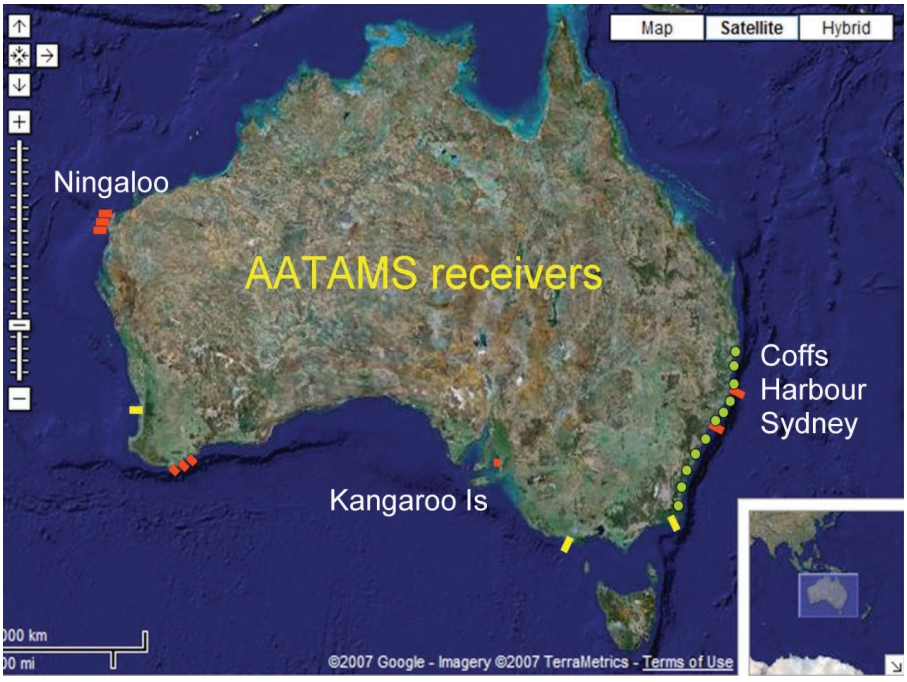
This proximity, and the reef's species diversity, place the reef in a delicate balance between its conservation value and its economic value as a popular ecotourist destination.

Much of the reef's marine biodiversity is protected within Ningaloo Marine Park, but proposals in recent years to develop additional tourist infrastructure and a resort near the reef have sparked intense debate and controversy over the reef's management. To shed light on this debate and help form the most sustainable management plan, researchers need answers to some key ecological questions, such as:

- how well the marine park is working as a refuge for important migratory commercial and endangered species;
- the effects of ecotourism with iconic megafauna, like manta rays, dugongs and whale sharks;
- and the nature of habitat use and trophic links between keystone reef predators, such as snapper and great hammerhead sharks, and their prey.

To address these questions AATAMS will install three separate curtain arrays along the reef near Tantabiddi, Point Cloates, and Point Maud, which will offer a northern, middle, and southern vantage, respectively, on the movements and interactions of several species, including a range of shark and ray species, as well as dugongs, whale sharks, and green and loggerhead turtles.

"The [AATAMS] curtains will help us understand species interactions and determine whether the Marine Protected Area is effective," Harcourt says.



Locations of the three permanent acoustic tracking arrays that will be installed by AATAMS: 1). Off Ningaloo Reef in WA to study species hierarchies and food chains, as well as issues in relation to management of Ningaloo Marine Park; 2). Near SA's Kangaroo Island-Eyre Peninsula and Bonney Coast to study long-range movements of tuna and white sharks; and 3). Off the NSW coast, from Coffs Harbour to Sydney, focusing on the effects of the East Australia Current on marine species and their habitats. Red are the AATAMS and existing CSIRO receivers, yellow are OTN receivers and green are NSW DPI receivers.

South Australia Arrays: AATAMS will install a second set of arrays off the coasts of two key South Australian ecosystems: Eyre Peninsula, near Kangaroo Island, and the Bonney Coast. Great white sharks and southern bluefin tuna will be the primary tagging subjects. In early 2007, the CSIRO's Dr Alistair Hobday, a senior research scientist specialising in pelagic fisheries, tagged 130 juvenile southern bluefin tuna in WA to test tuna migration routes. Using cross-shelf acoustic arrays similar to those AATAMS will install, he released tagged tuna at three different points and tracked the number of tuna that swam across the innermost array towards South Australia. AATAMS will extend this tagging effort east of the Great Australian Bight, using an earlier model of receivers (which requires on-site data uploads directly from the receivers) mounted on ocean moorings to gather more information on the tuna's travels.

In addition, researchers hope to learn more about the movements of the widely distributed but rare Great White Shark, a species that takes 12-18 years to mature and only reproduces once every two to three years. Though it's found worldwide in temperate and sub-tropical regions of both hemispheres, data indicates that the shark's global population has declined between 60 to 95 percent since 1950, according to Australia's Department of Environment and Water Resources. AATAMS will extend the ongoing research on white sharks that CSIRO and others have done.

East Coast Arrays: The third set of tracking arrays will be deployed along Australia's east coast to study species interactions and large-scale north-south migrations in relation to the East Australian Current (EAC) – Australia's largest near-coast ocean current, and a major influence over the marine ecosystems of the east coast. This year, AATAMS will install two curtain arrays consisting of 30 receivers each – at Coffs Harbour and near Sydney – to study the endangered black cod, several species of sharks, the giant cuttlefish, black bream, and mulloway, a popular sport fish.

Working in conjunction with two tracking efforts already underway – an OTN curtain off Mallacoota and several receivers set up by the New South Wales Department of Primary Industries to monitor the critically endangered grey nurse shark – these arrays will provide complete coverage for animals with large north-south migrations along Australia's east coast.

The Origins of AATAMS

The AATAMS technology itself, though highly innovative, is not completely new. Developed in Canada, both AATAMS and the OTN are based on advancements in acoustic telemetry developed and tested through two regional projects: the Pacific Ocean Shelf Tracking Project (POST), based in Vancouver, and the Tagging of Pacific Pelagics (TOPP) project, a collaborative effort of many researchers working to tag and track top predator species in the Pacific Ocean. Both got their start around 2000 as part of the larger Census of Marine Life, a 10-year collaboration of more than 2,000 scientists in 80 nations around the world trying to assess and explain the diversity, distribution, and abundance of marine life in the oceans.

Heidi Lydersen of the Pacific Ocean Shelf Tracking (POST) project – a North America based tracking program that helped pave the way for AATAMS – prepares some VR3 receivers (encased in the aqua tubing near the top) to be deployed. (Photo courtesy of POST).

Technological Challenges

There are some challenges and limitations to the AATAMS technology. Site selection can be key to a successful system. The underwater topography needs to be assessed, as well as the human uses within the study region. Boat traffic can cause noise pollution, and heavy fishing near an array can lead to loss of receivers. "You have to take into account where people are trawling," Harcourt says. "You actually have to talk to the fishermen in the area."

There are also logistical challenges related to the main research questions. Arrays can be configured in different ways, from "grid" and "fisheries" formats to "gate" and "curtain" formats. The research questions and desired data will affect how receivers are deployed. AATAMS will be using curtain arrays, which are deployed in lines from shore to the shelf edge. This design helps track directionality of movement and is useful for keeping tabs on longer-range movements.

While the technology isn't new, to Australia the AATAMS concept is:

it represents the first effort to create a truly nationally integrated marine tracking system.

The infrastructure AATAMS is setting up through IMOS will serve as a much-needed national network helping researchers further their knowledge of marine species in the ocean. The potential benefits to science and conservation are not small.

AATAMS hosted a Vemco and acoustic telemetry workshop in Sydney on the 21-23 November at SIMS. The workshop focused on Vemco equipment and techniques for using it, and discussed how to deploy equipment, analyse data, and determine the best array set-ups and designs. It was a huge success with over 50 scientists attending.

Harcourt concludes, "We want a national program because the notion is to be able to put the infrastructure in place to let us look at things that are national in level. So, if people put a tag on an animal, and if it then swims out of range to South Australia, we'll be able to track it."

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IMOS PhD **Student Profile**

This is the first of several articles about students using IMOS data for their PhD research

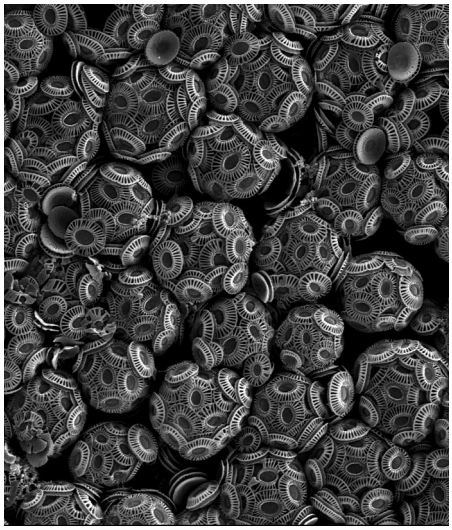
Joana Cubillos

School of Plant Science
University of Tasmania

Project Title: *Coccolithophores assemblages from the Last glacial Maximum to Holocene and calcification patterns in relation to current and future oceanographic processes*

Joana's PhD project aims to study changes in the calcification of Coccolithophorids through time, using fossil records and current sediment trap samples. Her project will improve our understanding of past coccolithophorid assemblages in the Southern Ocean and their response to various environmental conditions. With the current trend in ocean acidification, changes in nanoplankton assemblages and distribution in the Southern Ocean are expected. There is already evidence of a shift South in the distribution of the coccolithophorid *Emiliania huxleyi*, (Cubillos *et al*. 2007) and implications of these changes are yet to be understood.

Joana hopes that the fossil record could provide an insight into changes in calcification throughout the Holocene, and possibly whether the amount of calcite in coccoliths has undergone any change throughout the industrial era. For this, Joana will study the Coccolithophorid *Calcidiscus leptoporus*, using morphometric analysis and weight estimate by birefringence. The fossil record will be compared with sediment trap samples from the IMOS facility Southern Ocean Automated Time Series Observations (SOTS), in order to evaluate levels of dissolution of the core and also reveal any connection between past assemblage patterns and seasonality. She will also use the sediment trap samples to study the response of calcite intake of *Calcidiscus leptoporus* to seasonality.



Scanning Electron Microscope photo of *Emiliania huxleyi*, a calcareous nanoplankton species found in the Southern Ocean.

Joana Cubillos at the French base Dumont d'Urville in Antarctica during field work for her study of *Emiliania huxleyi*.

For more information:
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Cubillos JC, Wright SW, Nash G, de Salas MF, Griffiths B, Tilbrook B, Poisson A and Hallegraeff GM (2007) Calcification morphotypes of the coccolithophorid *Emiliania huxleyi* in the Southern Ocean: changes in 2001 to 2006 compared to historical data. Marine Ecology Progress Series, 348, pp. 47-54.

For more information about IMOS please visit the website

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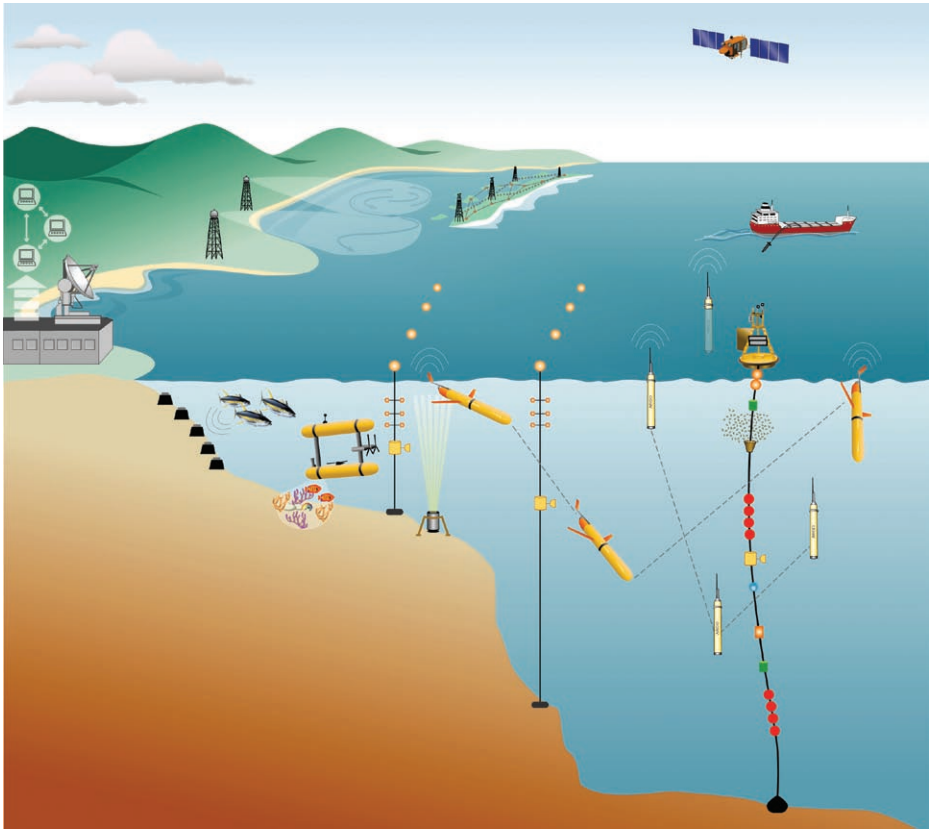

Diagram illustrating how the national IMOS program works. IMOS integrates several independent technologies and instruments, ranging from moored sensors and deep sea autonomous floats to acoustic tracking devices, radar imagery and remote satellites, among others, into research infrastructure covering a vast swath of Australia's large coastal and deep water marine territory. IMOS will generate critical data needed to support a diverse range of marine research projects.

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IMOS is an initiative of the Australian Government being conducted as part of the National Collaborative Research Infrastructure Strategy
www.ncris.dest.gov.au/capabilities/integrated_marine_observing_system.htm

This issue of marine matters has been compiled by Dr Marian McGowen.
The AATAMS feature article was written by Ms Tamsyn Jones.