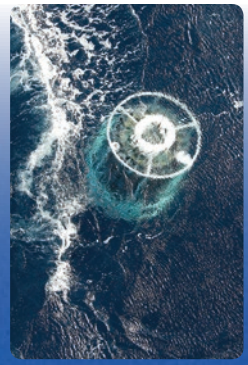
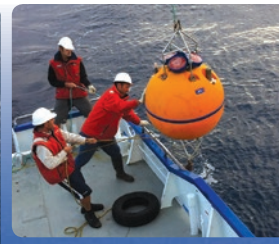
highlights 2015-2016

IMOS Integrated **Marine Observing** System





Overview

Tim Moltmann
IMOS Director

This Annual Highlights document covers the tenth year of IMOS operation. A related document entitled “From Observations to Impact” has been prepared to celebrate the first decade of IMOS. However, we believe it is also important to continue the Annual Highlights series so as to provide accountability for the 2015-16 year.

Sustaining IMOS over ten years to date has enabled us to build big data sets to do big science. Highlights include use of Argo profiling float data to track and understand the ocean’s role in the planetary energy balance, use of surface carbon measurements to provide new information about the ocean’s role as a carbon sink, and integrated biophysical observations documenting the impacts of ocean warming on marine ecosystems including the iconic Great Barrier Reef.

As an island continent, ocean circulation is particularly important for Australia’s climate and weather, the productivity of its marine ecosystems, and the intensity of ocean interactions with coastal infrastructure. Highlights include a world-first dataset on Southern Ocean wave climate, unprecedented measurements of East Australian Current transport, and new understanding of how warm water from the tropical Pacific Ocean finds its way to Ningaloo Reef in Western Australia.

IMOS is a research infrastructure operating national, collaborative facilities. The power of this way of working can be seen in the discovery of dense water shelf cascades in northwest West Australia, north Queensland, New South Wales and South Australia. The importance of this continental shelf process was previously unknown. The discovery that it is actually widespread could not have been made without a national ocean glider facility. New insights into movement of bull sharks between Sydney Harbour and the Great Barrier Reef were similarly enabled by the IMOS national animal tracking network.

Increasing emphasis is being placed on extracting maximum value from our datasets, and adding additional value through analyses and products. Highlights include new datasets published in the Nature *Scientific Data* journal, and publication of Plankton 2015, the first ever comprehensive report on the state of Australia’s ocean as seen through the eyes of plankton.

As a research infrastructure, IMOS must maintain a consistent standard of delivery. Observations and data have to be made available for use by the community if we are going to enable great science with high impact. Funding agreements with the Department of Education & Training included 236 milestones for the 2015-16 year. Of this total, 90% were achieved in full with the remaining 10% in progress at 30 June 2016. This provides hard evidence of the outstanding job being done by all partners who collaborate in operating this large, complex, national research infrastructure. Together they are making IMOS work.

The Australian Government’s ongoing commitment to the National Collaborative Research Infrastructure Strategy (NCRIS) provides a pathway for IMOS to be sustained into a second decade. This is a very welcome development. The Australian marine science community is strongly engaged with development of the 2016 National Research Infrastructure Roadmap which will guide future investment.

We hope you enjoy reading this IMOS Annual Highlights document for 2015–16, and thank you for your continued support.

How does IMOS work?

IMOS is designed to be a fully integrated, national system, observing at ocean basin and regional scales, covering physical, chemical and biological variables.

IMOS Facilities, operated by eight different institutions within the National Innovation System, are funded to deploy equipment and deliver data streams for use by the entire Australian marine and climate science community and its international collaborators.

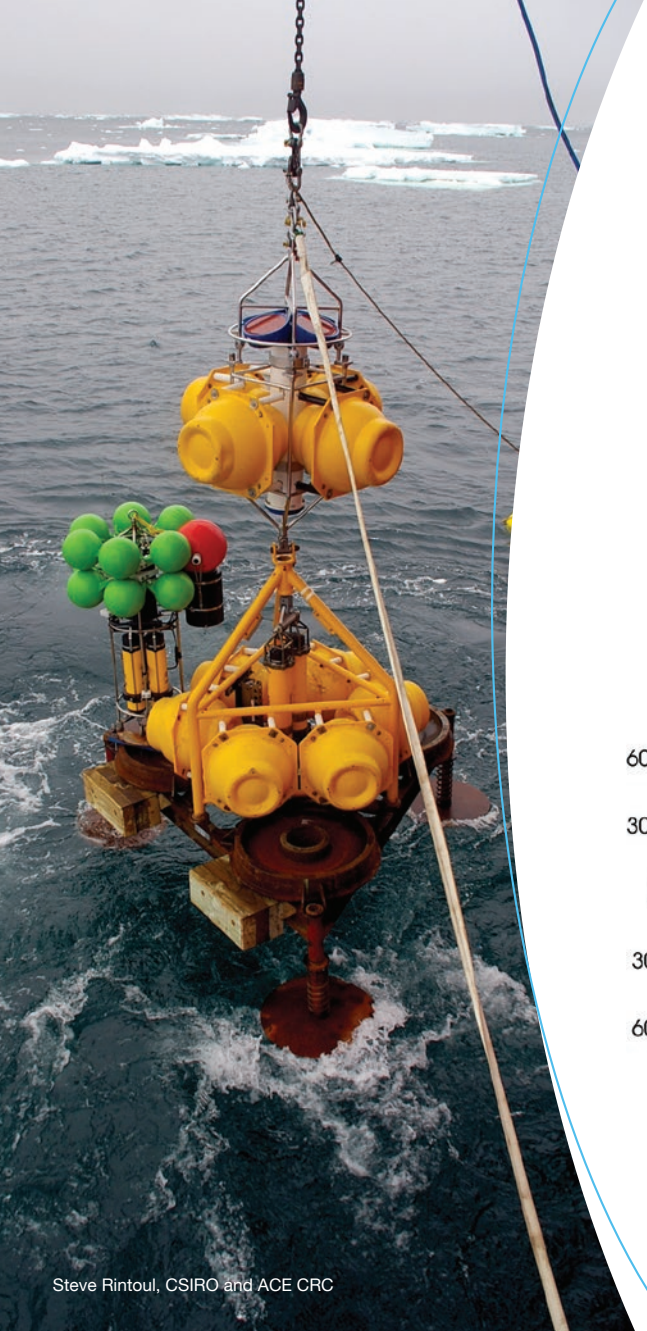
IMOS observations are guided by science planning undertaken collaboratively across Nodes of the Australian marine and climate science community. There are five major research themes that unify IMOS science plans and related observations: long-term ocean change; climate variability and weather extremes; boundary currents; continental shelf and coastal processes; and ecosystem responses. This annual highlights document is arranged by these major research themes to provide a clear focus on need, capability and impact.

The observations and data streams are collected via ten technology platforms, or Facilities:

- Argo floats
- Ships of opportunity
- Deep water moorings
- Ocean gliders
- Autonomous underwater vehicles
- National mooring network
- Ocean radar
- Animal tracking
- Wireless sensor networks
- Satellite remote sensing

The Australian Ocean Data Network (AODN) Portal (https://portal.aodn.org.au/) allows marine and climate scientists and other users to discover and explore data streams from all of these Facilities.

The IMOS 'circle diagram' which is designed to be read from inside to out, illustrates how the system is operated by selected institutions but available for use by the entire community through open data access, generating a wide range of outputs that are relevant across portfolios and sectors.



Steve Rintoul, CSIRO and ACE CRC

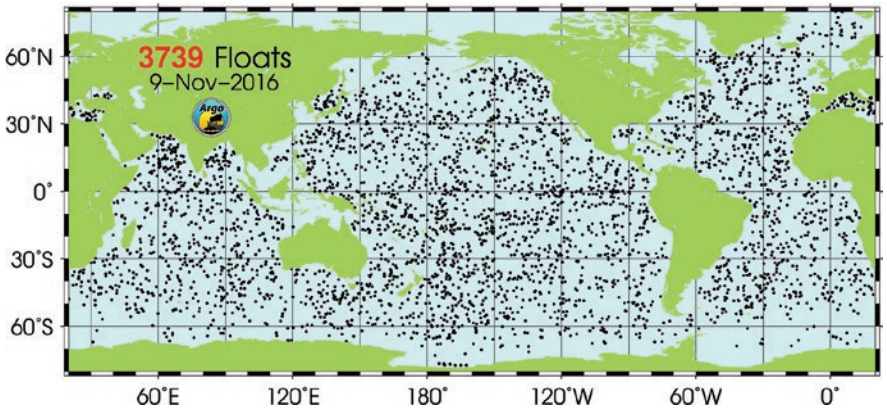
Long-term ocean change

NEED

Tracking and understanding the processes by which heat and carbon are sequestered into the global oceans is essential for monitoring rates of global change, and for informing Earth system models that are being used to project future climate. Tracking and understanding ocean salinity is also essential for monitoring changes in the global hydrological cycle, as most precipitation and evaporation occurs over the ocean surface where few historical observations are available. To complete the picture, observations of the global ocean circulation determine the distribution of these properties in the ocean.

CAPABILITY

Within IMOS, estimates of long-term change are drawn from observations of temperature, salinity, carbon and general ocean circulation delivered by Argo floats (to 2000m depth), ships of opportunity (expendable bathythermographs or XBTs in the upper 700m, and surface carbon fluxes), moorings (deep water and continental shelf), ocean gliders (to 1000m depth), animal tracking (in high latitudes), and satellite remote sensing of sea surface temperature (SST), ocean colour and altimetry.



Current status of the global Argo array.

Argo website
www.argo.ucsd.edu

Argo floats	Ships of opportunity	Deep water moorings	Ocean gliders	Autonomous underwater vehicles	National mooring network	Ocean radar	Animal tracking	Wireless sensor networks	Satellite remote sensing	IMOS OceanCurrent
✔	✔	✔	✔		✔		✔		✔	

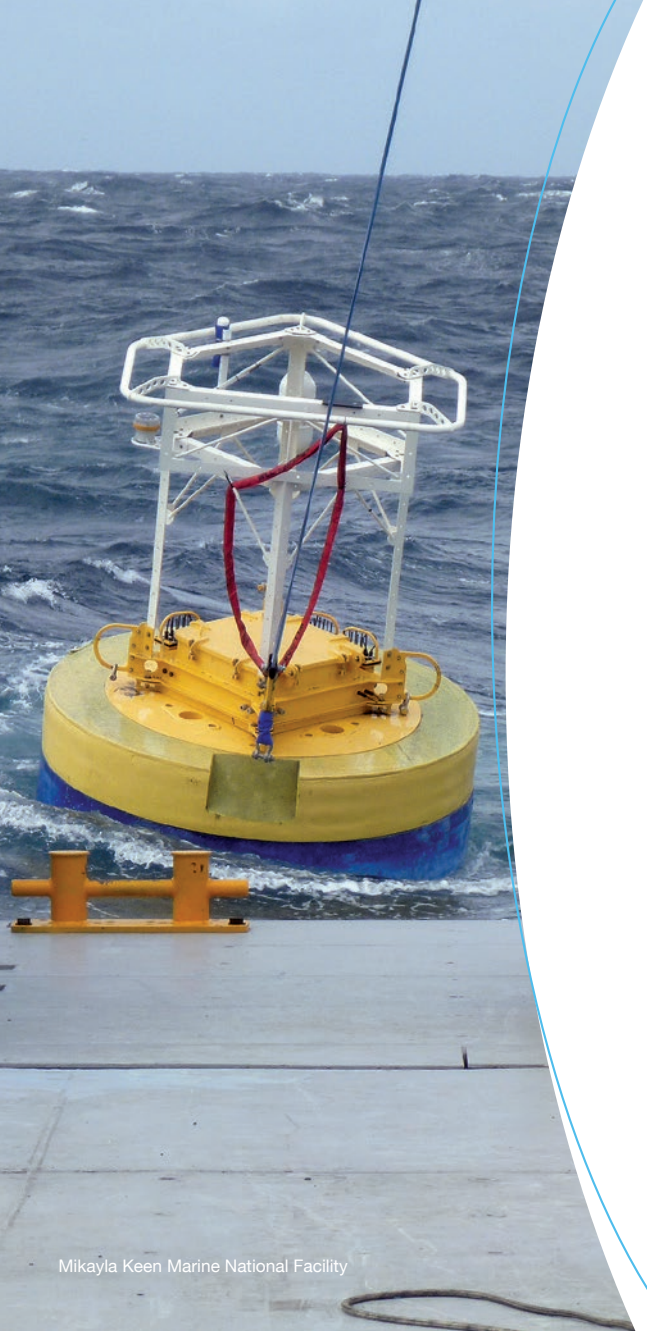
2015–16 Impact

The ocean plays a crucial role in determining the climate of the planet. A recent review published in *Nature Climate Change* demonstrates how the fifteen years of ocean observations taken by the global Argo array has provided a foundation for tracking and understanding the ocean's role in the planetary energy balance. IMOS provides the cornerstone investment for Australia's ongoing participation in the global Argo program, which has resulted in ~10% of the global array of 3,700 floats delivering a continuous data stream for the Australian region. The Argo data is particularly useful for examining ocean changes on timescales of decades and longer. The observed increase in ocean heat content in the upper 700 m over the past 40 years, inferred from Argo and hydrographic observations, is the dominant term in the global inventory of heating changes, with over 90% of the excess heat in the climate system being stored in the oceans. Without Argo, it is unlikely that such a conclusion could have been drawn.

Biogeochemical data collected as part of the IMOS Ships of Opportunity Facility has contributed to a study published in *Science* that demonstrates that the Southern Ocean carbon sink has been reinvigorated. Previous studies had suggested that the Southern Ocean carbon sink had weakened in recent decades. This had wide-reaching implications for climate, because the Southern Ocean accounts for about 40% of the global oceanic uptake of anthropogenic CO_2, thereby removing a disproportionally large share of anthropogenic CO_2 from the atmosphere. The study used multi-decadal analyses of surface ocean CO_2 observations to show that the weakening trend had stopped around 2002, and by 2012 the Southern Ocean had regained its expected strength. The large decadal variations in the Earth's most important sink for anthropogenic CO_2 suggest a dynamic ocean carbon cycle that is more variable than previously thought.

Seasonal and interannual variation of the mixed layer salinity in the south-east tropical Indian Ocean was analysed in another study using satellite observations, historical data and data assimilating ocean model outputs. Output from version 3p5 of the Bluelink Reanalysis, which incorporates IMOS data from Argo floats, XBT and satellite SST, was used to estimate the effects of eddy fluxes and to assess the composite analyses results. The study found the annual cycles of mixed layer salinity in this region of the Indian Ocean were driven by air-sea freshwater fluxes and the Indonesian Throughflow (ITF) and Leeuwin Current advection. On the interannual-scale El Niño events are typically associated with saltier (fresher) mixed layer salinity. Both local rainfall and the ITF transport anomalies are responsible for the interannual mixed layer salinity variation in the Indonesian-Australian Basin. A better understanding of mixed layer salinity is important not only for the marine ecosystems and fisheries in the region as they are particularly sensitive to upper ocean variability, but also for being an indicator for changes in the global climate and hydrological cycle.

Australian Antarctic Division



Mikayla Keen Marine National Facility

Climate variability and weather extremes

NEED

There are three major, coupled ocean–atmospheric modes which account for a significant portion of Australian seasonal climate variability – El Niño/Southern Oscillation (ENSO), Indian Ocean Dipole (IOD) and Southern Annular Mode (SAM). Upper ocean thermal distribution is the largest source of predictability at seasonal timescales for all coupled modes, due to the large thermal inertia of the ocean and its predictable dynamics.

CAPABILITY

Observations needed to understand upper ocean thermal distribution and inform seasonal and climate models include: broad scale upper ocean temperature and salinity structure; well-resolved time series in the equatorial oceans; and global wind, air–sea exchange (fluxes) and sea level measurements. These observations come from Argo floats, ships of opportunity (XBT, SST and air–sea fluxes), deep water moorings (Southern Ocean flux station) and satellite remote sensing SST and altimetry.

Bleached coral.

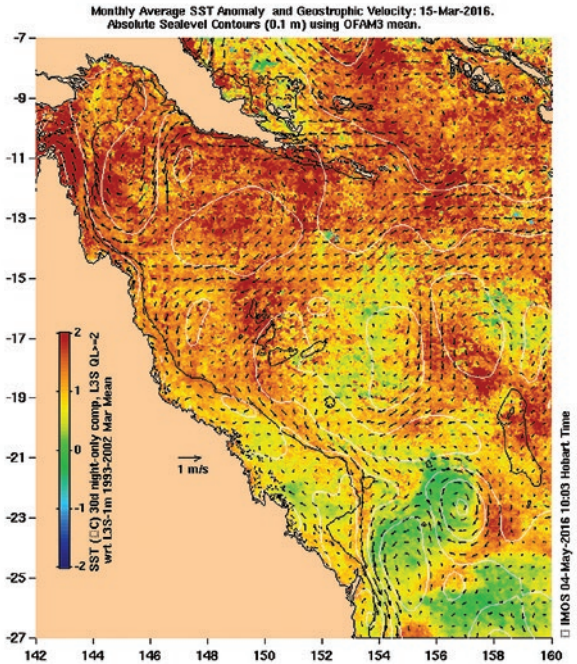
AIMS

Argo floats	Ships of opportunity	Deep water moorings	Ocean gliders	Autonomous underwater vehicles	National mooring network	Ocean radar	Animal tracking	Wireless sensor networks	Satellite remote sensing	IMOS OceanCurrent
✔	✔	✔							✔	✔

2015–16 Impact

2015 was the warmest year on record for the globe since reliable global surface air temperature records began in 1880. The oceans surrounding Australia have also warmed, and in early 2016 the Great Barrier Reef was subjected to the highest sea surface temperatures (SSTs) on record. The monthly average SST anomaly for March was greater than 1°C for much of the Central GBR, and reaching 2°C for the Northern GBR, clearly seen on the monthly average SST anomaly maps from IMOS *OceanCurrent*. This marine heatwave led to widespread severe coral bleaching and subsequent mortality. Aerial and in-water surveys have recorded up to 50% mortality north of Lizard Island, reducing to 16% southwards from Lizard to Tully. Since October 2015, IMOS and CSIRO ocean gliders traversed the region, tracking the seasonal evolution of coastal waters. By sampling the water column in a see-saw manner, the gliders can reveal how deep the warming extends. By April 2016 glider observations indicated water throughout the water column on the inner shelf was still warmer than historical observations. Whilst the 2016 bleaching event was linked to the 2015-16 El Niño, the local weather and oceanographic processes also played an important part to the bleaching patterns. Warming of the global oceans has led to a greater prevalence of marine heatwaves, highlighting the need for continuous ocean observations.

IMOS covers the breadth of Australia's ocean territory – from observing marine heatwaves in the tropics to waves deep in the Southern Ocean. A recent study provided the first wave analysis from the Southern Ocean Flux Station. The deep water mooring at this site was established by IMOS. The Southern Ocean is known to play an important role in the climate system, cycling heat, carbon and nutrients. Waves modulate the air-sea fluxes and exchanged properties are redistributed primarily via the Antarctic Circumpolar Current. The high latitude and absence of land barriers allow strong winds to blow over unlimited fetches, creating ideal conditions for severe wave generation. The waves generated in this region have far reaching effects, contributing to the wave climate in all the major ocean basins. Westerly winds are consistently strong at the mooring site, and this was reflected in the consistent wave statistics which showed little variation across the deployments. The maximum significant wave height obtained in the 705 days of observations was 13.41 m. The data set will be valuable for the calibration of future wave models in the Southern Hemisphere.



Monthly average SST anomaly for March 2016.

Image from IMOS *OceanCurrent*

Australian Institute of Marine Science

Boundary currents

NEED

The waters around Australia form a complex intersection of the Pacific and Indian Oceans. There are two major boundary current systems; the East Australian Current (EAC) on the east coast and the Leeuwin Current on the west coast. There are also two major interbasin flows connecting these ocean regions; the Indonesian Throughflow, between the western Pacific and the northeast Indian Ocean, and the Tasman Outflow by which the EAC penetrates into the Indian Ocean. These current systems have a central role in transferring heat, salt and nutrients into the coastal region. They vary on interannual and longer time scales, influenced by the major modes of climate variability (e.g. ENSO). The boundary current systems are therefore crucial to understanding local manifestations of global ocean processes and their influence on regional marine ecosystems.

CAPABILITY

Monitoring boundary currents demands multiple observational techniques within IMOS. Shelf and Deep water moorings are being deployed in the narrowest and most coherent sections of the Indonesian Throughflow and EAC to monitor fluxes of heat, mass and salt. Ocean gliders, ocean radars and national reference station moorings are being used to look at boundary current dynamics and their interaction with circulation on the continental shelf. Argo floats and ships of opportunity are providing broad scale context and drivers, with satellite remote sensing altimetry and SST providing broad spatial and temporal resolution.

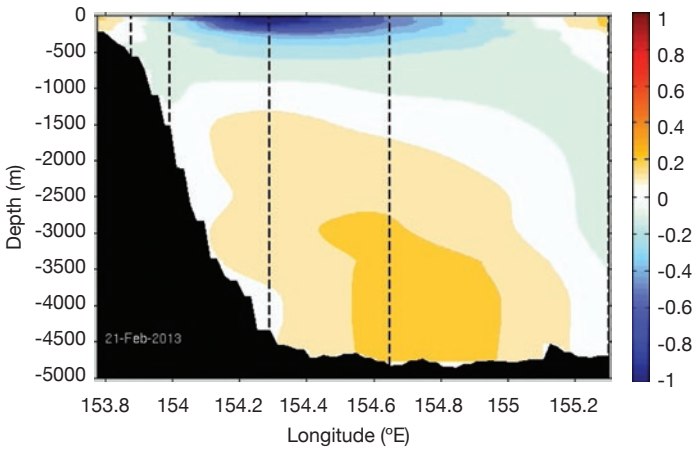
Warrick Glynn, IMOS

Argo floats	Ships of opportunity	Deep water moorings	Ocean gliders	Autonomous underwater vehicles	National mooring network	Ocean radar	Animal tracking	Wireless sensor networks	Satellite remote sensing	IMOS OceanCurrent
✔	✔	✔	✔		✔	✔			✔	✔

2015–16 Impact

Prior to IMOS, Australian oceanographers lacked a sustained time series of full-depth observations of the East Australian Current (EAC) across its entire width and of sufficient duration to resolve seasonal, interannual and decadal signals. IMOS filled this observational gap by deploying a full-depth current meter and property (temperature and salinity) mooring array extending from the continental shelf to the abyssal waters across the EAC off the coast of Brisbane. Data from the first deployment (April 2012–August 2013) of the mooring array provide a significant advance in our understanding of the system and begin to expose its complexity. The first estimates of the mean and variability of the EAC property transport at 27°S were presented in a study published earlier this year, finding an 18-month mean southward mass transport above 2000m is 22.1 ± 7.5Sv (1 sverdrup = $10^6 m^3 s^{-1}$). The mean, southward heat transport and flow-weighted temperature above 2000m are 1.35 ± 0.42PW (1 petawatt = 10^{15}W) and 15.33°C, respectively. Sustained monitoring of the EAC will further improve our understanding of the impacts and influences of the large-scale remotely driven variability of the EAC and the response of the Australian east coast slope and shelf circulation systems.

IMOS observations have also helped to understand the impact of a freshening of the Indonesian Throughflow (ITF) on the Leeuwin Current during the La Niña event of 2010-11 in another study. The ITF and Leeuwin Current heat transports are important for regional climate and marine ecosystems. The study used Argo data, mooring data from the IMOS Rottnest National Reference Station and ocean reanalysis products (BRAN 3p5) to quantify the temporal evolution and the spatial distribution of the freshening signals in the southeast Indian Ocean during the 2010-11 La Niña and associated Ningaloo Niño events. Excessive precipitation drove freshening of the ITF and the surface waters of the southeast Indian Ocean. These unusually low salinity waters were carried westward by the ITF and the South Equatorial Current and transmitted into the interior Indian Ocean and southward by the Leeuwin Current, along the West Australian coast. The anomalous low-salinity water enhanced the Leeuwin Current volume transport by 30% during the evolution of the 2010-11 Ningaloo Niño, resulting in unprecedented warming off the coast of Western Australia. The coastal marine ecosystems were impacted by this warming, including damage to seagrass, invertebrate and fish populations.



Velocity throughout the water column as observed by the EAC Array for 21 Feb 2013, showing the array has captured the entire southward flow (in blue) of the EAC (in the upper 250m) and also a weak northward flow which extends for 2,000m at the bottom of the water column.

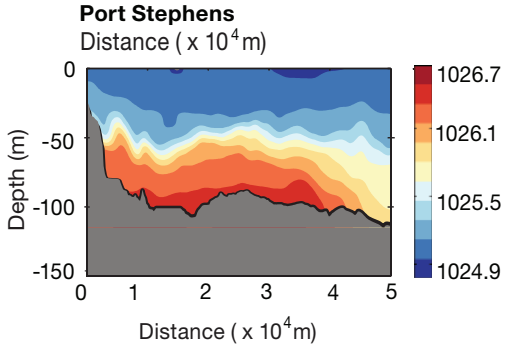
Bernadette Sloyan, CSIRO

Danny McLaughlan, CSIRO

Continental shelf and coastal processes

NEED

Australia has a large and varied continental shelf environment; broad and shallow in the tropical north and narrow on the subtropical east and west coasts. There are key processes occurring across this environment that provide a focus for observing connections between global ocean processes, boundary currents and biological responses on the continental shelf. These include encroachment of warm and cold core eddies, upwelling and downwelling systems, coastal currents, and wave climates.



CAPABILITY

IMOS is providing an extensive, national backbone around the continental shelf, as well as more intensive observations in regions of socio-economic and ecological significance e.g. coral reefs, biodiversity hotspots, population centres, and regional development hubs.
The backbone comprises a network of national reference station moorings, and national access to satellite remote sensing products, along with the IMOS national information infrastructure. The more intensive, region specific observations include a combination of shelf moorings, coastal ocean gliders, ocean radar (for currents and waves), and wireless sensor networks (on the Great Barrier Reef).

Dense shelf water cascade at Port Stephens.

Chari Pattiaratchi, UWA

Argo floats	Ships of opportunity	Deep water moorings	Ocean gliders	Autonomous underwater vehicles	National mooring network	Ocean radar	Animal tracking	Wireless sensor networks	Satellite remote sensing	IMOS OceanCurrent
			✔		✔	✔		✔	✔	✔

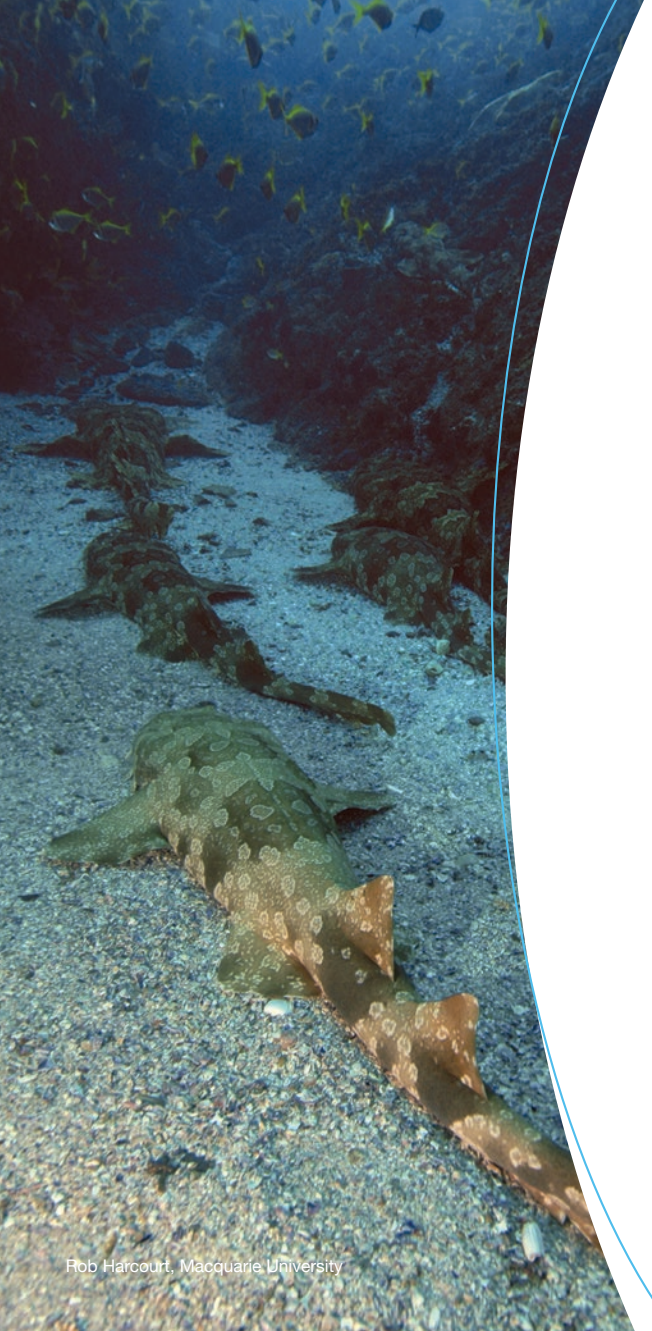
2015–16 Impact

IMOS technology has provided a step-change increase in our understanding of the ocean processes that occur around Australia's continental shelf and coastal zone.

Data collected by the IMOS fleet of ocean gliders has delivered new insight into a process known as dense shelf water cascades. These cascades are formed when evaporation in summer and subsequent cooling towards winter produce higher density waters closer to the coast that sink to the bottom and flow offshore across the continental shelf, interacting with the ocean currents. These slow moving cascades provide an effective mechanism for the transport of water, heat, salt, phytoplankton, nutrients and pollutants from shallow coastal regions into the deep ocean. Locally, they were first documented by ocean gliders in Western Australia at Two Rocks and the Pilbara. But analysis from over 100 ocean glider missions has confirmed the existence of the cascades at many places around Australia, including off the Kimberley coast, in the Great Barrier Reef, off Port Stephens in NSW and the Investigator Strait in South Australia. The use of ocean gliders enables the shelf waters to be sampled at high temporal and spatial resolution and also under weather conditions which would preclude traditional ship-borne measurements.

The continental shelf off North Western Australian is relatively wide, and up until recently the mean flow characteristics of water on the shelf in this region have not been well understood due to a paucity of direct year-long velocity measurements. Multi-year observations of the Holloway Current from the IMOS mooring array off the Pilbara continental shelf region of North Western Australia have been published this year. The moorings provided both physical (temperature, salinity, sea level and currents) and water quality (turbidity and chlorophyll) measurements, and represent the most complete dataset available for the North West Shelf. The Holloway Current showed strong seasonality and short intermittent reversals. The main features of the Holloway Current appear to be a continuous alongshore south-westward flow, annually the current transports ~ 1 Sv of lower salinity, higher temperature water from the tropical regions to North West Cape. The Holloway Current is at its maximum intensity (up to 2 Sv) during autumn/winter when the winds are either weak or the region is dominated by south-east trade winds.

Australia's large marine estate poses a difficulty for marine researchers; observational data is often too sparse to provide a complete picture of time and space variations in the marine environment. Increasingly model simulations supported by data are becoming fundamental to marine research. However, setting up models and bringing together the necessary data for initialisation, forcing and validation is a time-consuming activity, often taking months to achieve a starting point for the actual science. To overcome this barrier, the Australian ocean modelling community has developed the Web-based MARine Virtual Laboratory (WebMARVL). WebMARVL allows a user to quickly and easily configure an ocean general circulation or wave model through a simple interface, reducing the configuration time for a regional model to a few minutes. Through WebMARVL, a user is prompted to provide the basic options needed for model configuration, and once completed a series of data extraction, reprocessing and repackaging services are run, and a take-away bundle is prepared for download. Included in the take away bundle are all the available observations for the chose time-space domain, which draws on all the IMOS observations available in the Australian Ocean Data Network portal.



Rob Harcourt, Macquarie University

Ecosystem responses

NEED

Australia's large ocean territory, from the tropics to the Antarctic, encompasses a diverse range of marine ecosystems. IMOS is seeking to take an integrated approach, whereby measurements ranging from biogeochemistry through lower to higher trophic levels are undertaken across particular systems.

At basin scale, our initial focus is in the highly dynamic Southern Ocean. Seasonal changes in circulation, stratification and ice cover boost ecosystem production making this one of Australia's richest ecosystems, supporting the greatest density and biomass of apex predators to be found in Australian waters.

At regional and local scales, major boundary currents and continental shelf processes around Australia play a vital role in regulating the productivity, abundance, and distribution of marine ecosystems, both in the water column and on the sea floor. The warm boundary currents are generally nutrient poor, leading to marine systems of relatively low productivity. However, continental shelf processes, including cold core eddies and upwelling systems, cause localised peaks in productivity. These 'hotspots' are critical to supporting highly diverse fish, seabird, marine mammal and sea turtle populations within regions.

CAPABILITY

Ecosystem responses to variability and change need to be considered at all levels of the food web (trophic levels), from primary producers to apex predators. IMOS is observing ecosystem responses through an extensive, national backbone comprised of ships of opportunity (continuous plankton recorders, and echo sounders to estimate biomass), a network of national reference station moorings, and national access to satellite remote sensing ocean colour, along with the IMOS national information infrastructure. More intensive, region specific observations include a combination of animal tracking (acoustic arrays and satellite tagging), autonomous underwater vehicles (undertaking benthic surveys), deep water and shelf moorings (Southern Ocean time series, acidification moorings, noise loggers), ocean gliders, and wireless sensor networks.

Argo floats	Ships of opportunity	Deep water moorings	Ocean gliders	Autonomous underwater vehicles	National mooring network	Ocean radar	Animal tracking	Wireless sensor networks	Satellite remote sensing	IMOS OceanCurrent
	✔	✔	✔	✔	✔		✔	✔	✔	✔

2015–16 Impact

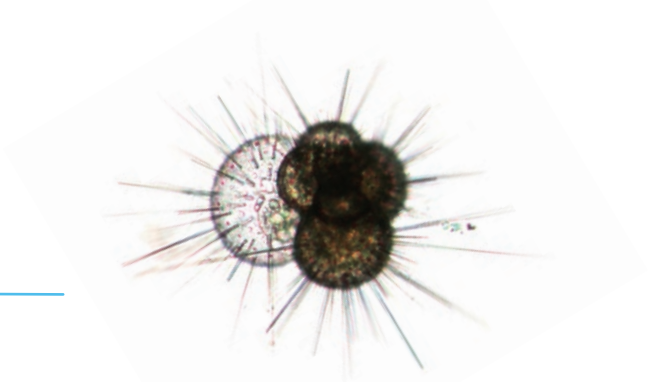
IMOS data continue to contribute to the study of marine organisms at all trophic levels, from primary producers to apex predators.

The release of Plankton 2015 is a national highlight, being the first ever comprehensive report on the state of Australia's ocean as seen through the eyes of plankton. Based on plankton data collected by IMOS through the Australian Continuous Plankton Recorder survey and the National Reference Station mooring program, the report provides a snapshot on the climate, state of global fisheries and marine ecosystem health and biodiversity. The information will enable reporting on the state of the marine environment to be more robust, reliable and useful.

Australian sea-floor survey data from the IMOS autonomous underwater vehicle (AUV) has been collated and published in the Nature journal *Scientific Data*. The data set consists of 9,874 annotated images all collected by the IMOS AUV between 2008-13. The dataset contains georeferenced benthic images and associated sensor data from around Australia's coastline, and has been annotated collaboratively by four research groups using a standardized labelling scheme. This type of data is of interest to marine scientists studying benthic habitats and organisms.

Data from IMOS acoustic receivers in Queensland has contributed to research that examines the residency patterns and migratory behavior of 33 adult bull sharks along the East coast of Australia. Both males and females were detected at the Great Barrier Reef (GBR) all year, however residency peaked between September and December. Individual sharks varied greatly in the way they used the reef, with some individuals leaving for long periods, whereas others stayed at the reef. 51% of the tagged sharks undertook migrations of up to 1,400km to other reefs or coastal habitats in Queensland and even New South Wales. Nearly all of these migrating sharks returned to the central GBR, highlighting its importance as a potential foraging ground. The findings suggest that adult bull sharks appear to be highly dependent on the coral reef resources, with only a portion of the female sharks undertaking seasonal migrations potentially to give birth. Understanding migratory behavior of the sharks is essential for assessing their risk to threats such as fishing and habitat degradation.

Another study using observations from IMOS acoustic receivers has revealed that spotted wobbegong sharks gather in social groups rather than associating randomly or according to the amount of food available.



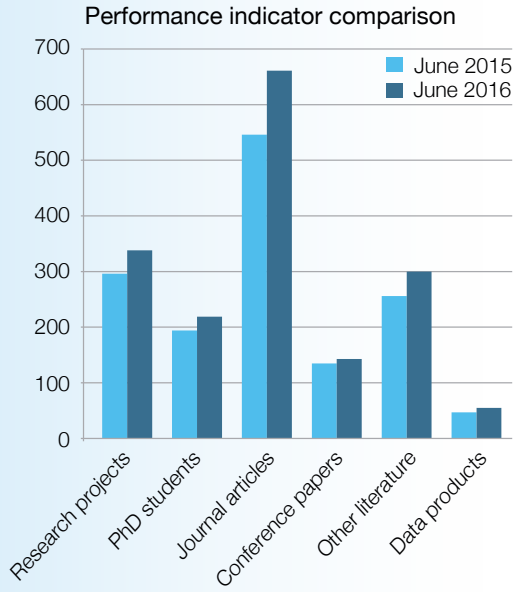
The study found that sharks grouped together with preferred partners, even in different areas across the reserve, while others never associated, the groupings were not sex- or age-related. The findings highlight the potentially damaging consequences of fishing on this shark, as instead of randomly catching individuals, important members of social networks could be removed.

IMOS has tagged elephant seals in the Southern Ocean since 2011, and the data is a major contributor to the Marine Mammals Exploring the Oceans Pole to Pole (MEOP) project. A major six-year circumpolar study using tracking data from the project tracked 287 seals across the Southern Ocean, provides an unprecedented insight into the life, behavior and distribution of southern elephant seals. Elephant seals spend more than 10-months of the year foraging at sea before returning to their breeding sites, and the researchers recorded individuals diving for up to 94-minutes to depths of 2389 metres, with the longest migration route reaching distances of 5482 kilometres. The data will help to inform conservation oriented management policies and actions while providing valuable information about factors which affect population trends.

Image: Julian Uribe-Palomino, CSIRO

Performance indicators

The uptake and use of IMOS data is measured by performance indicators related to research projects, postgraduate students, publications and products. They are fully listed on the IMOS website at **www.imos.org.au/imospublications.html**. Cumulative totals of the IMOS performance indicators at June 2015 and June 2016 are provided below:



Financial summary

A summary of the IMOS finance for 2015–16 is provided below:

FINANCIAL OVERVIEW	2015–16	2014–15
Balance at beginning of financial year	**1,015,629**	**15,703,528**
National Collaborative Research Infrastructure Strategy	13,963,000	6,859,017
Interest earnings	103,003	175,910
Income relating to Australian Government funds	**14,066,003**	**7,034,927**
Cash Co-investments	6,093,127	5,577,514
In-kind Co-investments	16,829,537	18,855,644
Total – Resources received	**36,988,667**	**31,468,085**
Capital / equipment purchases	2,486,979	2,930,388
Personnel	8,652,489	10,306,135
Other	4,187,175	8,075,420
Expenditure relating to Australian Government funds	**15,326,643**	**21,311,943**
Cash Co-investments	3,260,664	5,988,397
In-kind Co-investments	16,829,537	18,855,644
Total – Resources utilised	**35,416,844**	**46,155,984**
Balance at end of financial year	**2,587,452**	**1,015,629**

Operators
> Australian Institute of Marine Science
> Bureau of Meteorology
> Commonwealth Scientific and Industrial Research Organisation
> Curtin University
> South Australian Research and Development Institute
> Sydney Institute of Marine Science (University of New South Wales, University of Sydney, Macquarie University, University of Technology Sydney)
> University of Tasmania
> The University of Western Australia

Co-Investors
> Antarctic Climate and Ecosystems Cooperative Research Centre
> Atlantic Oceanographic and Meteorological Laboratory
> Austral Fisheries
> Australian Antarctic Division
> Australian Climate Change Science Program
> Bega Valley Shire Council
> Darwin Ports Corporation
> Department of Defence
> Department of Fisheries, WA
> Department of Primary Industries, NSW
> Environmental Protection Authority Victoria
> Flinders University
> Geoscience Australia
> James Cook University
> Marine National Facility
> Monash University
> National Center for Scientific Research, France
> National Institute of Water and Atmospheric Research, NZ
> National Oceanic and Atmospheric Administration, USA
> National eResearch Collaboration Tools and Resources
> Marine Park Authority, NSW
> Office of Environment and Heritage, NSW
> Office of Science and Research, NSW
> Parks, Vic
> Royal Australian Navy
> Schmidt Ocean Institute, USA
> Scripps Institution of Oceanography, USA
> Sealords, NZ
> Sydney Water Corporation
> Department of State Growth, Tas
> University of Melbourne

International Collaborators
> Scripps Institution of Oceanography
> National Oceanic and Atmospheric Administration
> National Aeronautics and Space Administration
> European Space Agency
> French National Centre for Scientific Research
> Ocean Tracking Network
> Sea Mammal Research Unit
> French Polar Institute
> First Institute of Oceanography
> National Institute of Water and Atmospheric Research
> Southern Ocean Observing System
> National Science Foundation (USA)
> Sealord

Research Partnerships
> Antarctic Climate and Ecosystems Cooperative Research Centre
> BlueLINK Ocean Forecasting
> National Environmental Science Programme Marine Biodiversity Hub
> National Environmental Science Programme Earth Systems and Climate Change Hub
> Reef 2050 Integrated Monitoring and Reporting Program
> eReefs
> Great Australian Bight Research Program
> Western Australian Marine Science Institution
> Fisheries Research and Development Corporation
> Australian Research Council

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NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

UNIVERSITY of TASMANIA

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is led by University of Tasmania in partnership with the Australian marine & climate science community.

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The Operators of the IMOS infrastructure are:

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CSIRO

Australian Government
Bureau of Meteorology

Government of South Australia

SARDI
South Australian Research and Development Institute

Australian Government

Australian Institute of Marine Science

The University of Western Australia

Curtin University

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