IMOS

marinematters

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Incredible new data from SWOT satellite mission

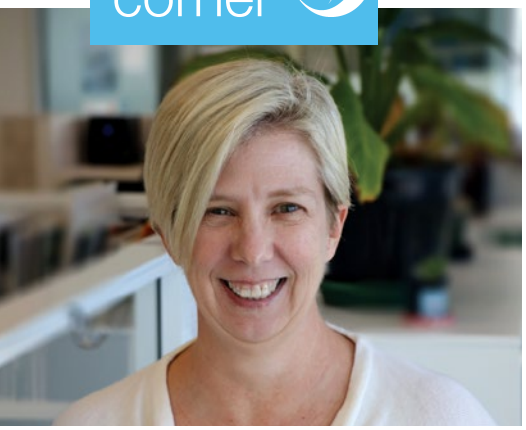
IMOS boosted by $63.5m of investment from the Australian Government

Biogeochemical Argo Float recovered from the Southern Ocean

New database reveals the microbial genomic diversity of the Great Barrier Reef

Benoit Legresy, CSIRO

director's corner



IMOS acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe and recognise their unique connection to land and sea. We pay our respects to Aboriginal and Torres Strait Islander peoples past and present.

Welcome to the December 2023 edition of *Marine Matters*

In this edition of *Marine Matters* we are celebrating some significant achievements for IMOS. The first of these is the milestone of having delivered over 1 billion ocean measurements! This is the result of many years of hard work by a lot of people so thank you all and well done. You can read more about this accomplishment and more in the 2022–23 Highlights document.

The second achievement is an increase in IMOS funding as a result of the 2023 NCRIS funding round. This outcome will help us expand some of our existing capabilities and bring some new elements into the program. One example of a potential new element of IMOS is the FishSOOP project we are currently trialling – you can read more about that initiative in this issue. The new funding accompanies a number of additions to and changes within the IMOS Office. We thank Paul van Ruth for his contributions to IMOS over the years and welcome several new staff to help us meet our forward goals.

This edition also includes a range of other updates and highlights. In particular, we would like to draw your attention to a number of data-driven initiatives designed to make data access and use easier for expert and non-expert users. We also continue to have excellent science built on IMOS observations such as the two papers featured in this issue. Please also take note of our future science leaders through the student features with Alex Shute being profiled in this edition.

As the end of the year approaches and we look back on everything that has been achieved this year I hope you enjoy this edition of Marine Matters.

Dr Michelle Heupel
IMOS Director

Ocean Beach (Tas), Lea Walpole

IMOS boosted by $63.5m of investment from the Australian Government

IMOS welcomes the ongoing funding through the 2023 Research Infrastructure Investment Plan.

The Department of Education has announced IMOS will receive $63.5m over four years under the National Collaborative Research Infrastructure Strategy (NCRIS), to address Australia's strategic science and research priorities.

The funding announced today includes $37m for new activities in IMOS including;

- Step-change observing,
- CoastRI,
- Data delivery uplift.

"IMOS is thrilled to receive ongoing funding from the Australian Government through the Research Infrastructure Investment Plan," says IMOS Director Michelle Heupel.

"The continued funding allows IMOS to underpin research that delivers benefits across Australian society, its environment and its economy."

IMOS provides world-leading environment and climate research infrastructure across Australia's ocean estate, able to respond and adapt to address challenges.

"The new investment will allow IMOS to grow and evolve as we establish new elements of the observing program and find innovative ways to deliver data to support and broaden our user base."

The IMOS Annual Highlights Document 2022–23 is available now

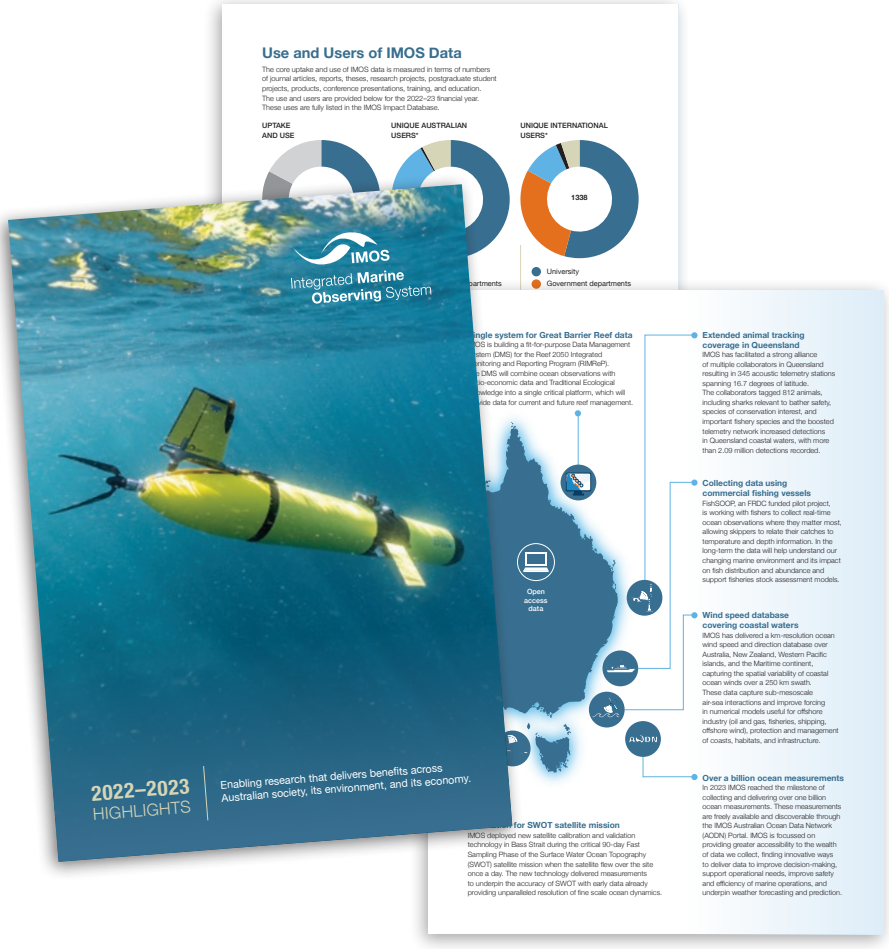
The document showcases the impact IMOS research infrastructure and data provides across the country.

In 2023 the Integrated Marine Observing System (IMOS) celebrates its 17th year of operation and the amazing milestone of having collected and delivered over one billion ocean measurements! This is a huge achievement and a tangible demonstration of what IMOS delivers for Australia and the world.

As you'll see in this year's highlights, IMOS observing capabilities have also gone from strength to strength in 2022–2023 through extensive use by universities, new partnerships with fishers and fisheries, breaking new ground in data delivery through development of a unique Data Management System to underpin the Reef 2050 Integrated and Reporting Program (RIMReP) for the Great Barrier Reef, supporting development of the Biological Ocean Observer platform to combine physical and biological data, and underpinning international ventures such as the new NASA Surface Water Ocean Topography (SWOT) satellite mission. IMOS also worked with Lisa Blair on her world record solo sail around Antarctica to collect a unique baseline microplastics dataset.

These are only a few of the many amazing achievements within IMOS and as always, IMOS extend sincere thanks to all of our partners, collaborators and supporters who help make IMOS successful. The success of IMOS is based on your efforts and contributions.

Please find the 2022–23 Annual Highlights document for Australia's Integrated Marine Observing System (IMOS) here. This web page has links to the pdf of the document, as well as more detailed information.



New staff join the IMOS office

The new funding accompanies a number of additions and changes within the IMOS Office.

Dr Fabrice Jaine appointed as the IMOS Principal Science Officer

Dr Fabrice Jaine has been involved with IMOS for over a decade in various capacities including as an end user of IMOS ocean observations, as a scientific officer, technical personnel and Deputy Leader for the IMOS Animal Tracking Facility, and as a member of the NSW IMOS Node steering committee.

Fabrice is a marine ecologist currently based at the Sydney Institute of Marine Science and Macquarie University with expertise in biophysical oceanography and animal tracking. His research interests have revolved around identifying habitat use patterns of marine species of management and conservation importance, and quantifying the influence of environmental variability, and specifically ocean dynamics and productivity, on the behaviour and distributions of animal populations.

Fabrice has spent the past seven years engaging IMOS stakeholders nationwide, optimising infrastructure deployments to fill knowledge gaps, fostering collaborative science, promoting best practices and data sharing among the Australian research community and pursuing opportunities to increase scientific relevance such as the development of new data products and tools that would address end user needs. Fabrice comes with a comprehensive understanding of the IMOS program and has worked closely with the AODN team to manage IMOS datasets and develop new IMOS data products.

Fabrice says "I'm excited about the opportunity to work with the IMOS Office and the broader IMOS community to deliver collaborative and sustained open-access observations that drive advances in ocean and climate science, industry, natural resource management, conservation and policy".

Fabrice commenced as the IMOS Principal Science Officer in early December.

IMOS farewells Dr Paul van Ruth

IMOS farewelled the current Principal Science Officer Dr Paul van Ruth at the end of November. Paul has played a critical role in IMOS, both as the Principal Science Officer and previously as a Node leader in the South Australian Node. Paul has helped advance IMOS priorities and strategies during his time in the team and has been a valuable member of both the Office and the IMOS community, and we sincerely thank him for everything he has done. We wish him all the best on the next stage of his career.

Julia Scott joins the IMOS office as the Communications Officer

Julia Scott has recently joined the IMOS team in Hobart as the Communications Officer.

Julia says "I've worked in communications for around fourteen years, and am passionate about contributing towards something positive in the wider community. My last two roles have been with not-for-profits, the most recent being Guide Dogs Tasmania (yes, there were dogs in the office). Prior to that, I worked for Cambridge University Press in Melbourne."

Julia will work closely with the Communications Manager, Marian Wiltshire, to ensure that as IMOS grows we ensure the impact of IMOS infrastructure is communicated and recognised by all of our stakeholders.

> *"I've worked in communications for around fourteen years, and am passionate about contributing towards something positive in the wider community.*

Dr Rebecca Zitoun appointed as Science Engagement Officer — Coastal Observing

Rebecca's expertise encompasses trace metal biogeochemistry, electrochemistry, ecotoxicology, ocean acidification, and paleoceanography. She holds a PhD in Marine Chemistry and a Postgraduate Diploma in Marine Science from the University of Otago (New Zealand), a MSc in Marine Environmental Science from the University of Oldenburg (Germany), and a BSc in Earth Sciences from the University of Frankfurt (Germany).

From 2020 to 2021, Rebecca Zitoun served as a Postdoctoral Researcher at the Royal Netherlands Institute for Sea Research (NIOZ), contributing to the project "Trace metals and the Arctic-Atlantic gateway in a changing world, local processes and global connections (MetalGate)." Between 2021 and 2023, she worked as a Postdoctoral Researcher at GEOMAR Helmholtz Centre for Ocean Research Kiel, focusing on trace metal biogeochemistry in hydrothermal environments and assessing the environmental impacts, particularly metal toxicity, of deep-sea mining activities. Rebecca has also worked as a consultant for the International Atomic Energy Agency (IAEA), providing expertise on marine issues, including trace metal analysis and marine plastics.

Beyond her research, Rebecca is committed to capacity building, Ocean Literacy, science-policy interfacing, and engaging Early Career Ocean Professionals (ECOPs). She has held and continues to hold significant positions, such as a Young Ambassador of the European Marine Board, Chair of the SCOR Committee for Capacity Development, Co-Chair Elect of the Ocean Best Practice System, and Co-Lead of the Ocean Literacy Task Team for the UN Decade ECOP Program.

The Science Engagement Officer – Coastal Observing will support the development of the IMOS CoastRI initiative and broader activities of the IMOS Office, by coordinating and engaging with coastal industry stakeholders.

Beyond her research, Rebecca is committed to capacity building, Ocean Literacy, science-policy interfacing, and engaging Early Career Ocean Professionals (ECOPs).

The IMOS office has also grown with recent additions to our Australian Ocean Data Network (AODN) team, and a few existing staff have moved into new roles within the AODN.

Dr Marty Hidas has taken up the new role in the team as the Senior Data Engineer. Marty will contribute to the development of our next-generation scientific data management systems for IMOS, as well as the generation and integration of data products.

Mr Raymond Ng has moved into the role of Senior Software Engineer. Raymond will manage a highly skilled team to build geospatial and web-based applications and services for the IMOS AODN.

Steve Qu is engaged as our UI/UX Designer. Steve is providing expertise in User Interface/User Experience design to produce new concepts for our public facing web applications.

Nandeesh Shirangala Bhujanga recently started as the Senior Cloud Engineer Nandeesh's role is to provide technical guidance for the DevOps engineers to support the needs of AODN's existing and future cloud infrastructure.

Huaizhi Dai (Havier) has joined to fill the role of Software Engineer. Havier is a member of the Development team supporting our existing applications and will assist in the development and rebuild of the AODN portal.

Tracey Hill has filled the role of Web UI Developer. Tracey is a member of the Development team providing expertise in front-end web application design, development and implementation. She will play a critical role in the rebuild of the AODN portal and other public facing web applications.

Guillaume Galibert left IMOS and his role as the Data Services Team Leader in August. We thank Guillaume for his immense contribution to IMOS and AODN in his 12 years with IMOS. **Benedicte Pasquer** has been acting in this role which oversees the Data Services Team whilst the recruitment process takes place.

Ian Knuckey, Fishwell Consulting.

FishSOOP (Fisheries Ships of Opportunity): a new FRDC project collecting oceanographic data from commercial fishing vessels

This collaborative pilot project is working with fishers to collect real-time ocean observations where they matter most.

IMOS is a partner of this Fisheries Research and Development Corporation (FRDC) funded pilot project (2022–007) with Fishwell Consulting and the University of New South Wales.

The FishSOOP project is working with fishers to collect real-time temperature and depth data by installing equipment on a network of commercial fishing vessels using a range of common fishing gear.

The project uses a compact, calibrated, low-cost temperature sensor (called the Moana sensor, manufactured by Zebra-Tech) that can be attached to many types of commercial fishing gear. It operates with minimal human intervention and communicates directly to a solar powered deck box.

Every day, fishing vessels operate broadly across the productive areas of Australia's Exclusive Economic Zone where we have few subsurface ocean measurements. The FishSOOP project is utilising this observing opportunity to cost-effectively increase the spatial and temporal resolution of subsurface temperature data in Australia's inshore, shelf, upper-slope, and offshore waters.

The data is currently returned to each fishing boat in near-real time, so skippers can relate their catches to temperature-at-depth information. The same data will also be collated to provide oceanographers with quality-controlled data on an unprecedented scale for ground-truthing coastal models and to improve analysis and forecasts of oceanic conditions.

In the long term, the data will help our understanding of the changing marine environment and its impact on fish distribution and abundance. It is hoped that the data will assist in standardising catch rates in fisheries stock assessment models.

The quality-controlled temperature-depth data will be publicly available through the IMOS Australian Ocean Data Network Portal for uptake and use in ways that support safe and efficient maritime operations, sustainable management of marine resources, and improved understanding of drivers of ecosystem change.

In the first six months of the project 14 commercial fishing vessels have been equipped with sensors. They cover a range of fishing vessels, including scallop dredges, tuna longline, shark gillnet, and otter board trawlers, with plans to deploy on lobster boats and prawn trawlers. In October the vessels collected more than 1000 profiles.

New way to visualise IMOS biological data: introducing the Biological Ocean Observer

The Biological Ocean Observer is a website that integrates, analyses and visualises data collected from IMOS platforms around Australia including the network of National Reference Stations, Continuous Plankton Recorders, Ships of Opportunity and coastal monitoring sites.

Access to online marine data streams has never been easier, however, the number of files and range of formatting creates complexities around data download, integration and visualisation – and not everyone has the necessary skills to make use of the data resources available. Jason Everett (University of Queensland, CSIRO and University of NSW) and Claire Davies (CSIRO), through the IMOS New Technology Proving capability, have developed the Biological Ocean Observer platform to simplify these processes for all data users.

The platform quickly allows the user to explore temporal and seasonal trends through plots for phytoplankton, zooplankton, larval fish and microbial data. In addition, the user can plot physical data collected at the National Reference Stations including biogeochemistry, CTD and nutrient parameters.

The Biological Ocean Observer uses internationally recognised programming frameworks (R and Shiny), with all code freely available, facilitating further development and collaboration within the community.

Exploring temporal trends

Scientists and policy makers commonly need to quantify temporal and seasonal trends at specific locations or within bioregions, to enable policy decisions. The Biological Ocean Observer allows users to quickly and easily plot these trends for both the IMOS National Reference Stations and Continuous Plankton Recorder tracks around Australia. The biological data includes observations of phytoplankton, zooplankton, larval fish and microbes.

Microbial Ocean Atlas

An important part of the Biological Ocean Observer platform is the Microbial Ocean Atlas. The Microbial Ocean Atlas has been created in partnership with fellow NCRIS capabilities the Australian Research Data Commons (ARDC) and Bioplatforms Australia. The Atlas integrates highly specialised genomic data with physical ocean data to ensure greater accessibility of molecular microbial data to a broad range of researchers.

Accessing non-biological data

In addition to the biological data the Biological Ocean Observer allows the user to plot the biogeochemistry, CTD and pigments from the IMOS National Reference Stations. Many of these data are depth-resolved to enable the creation of vertical profiles through the water column.

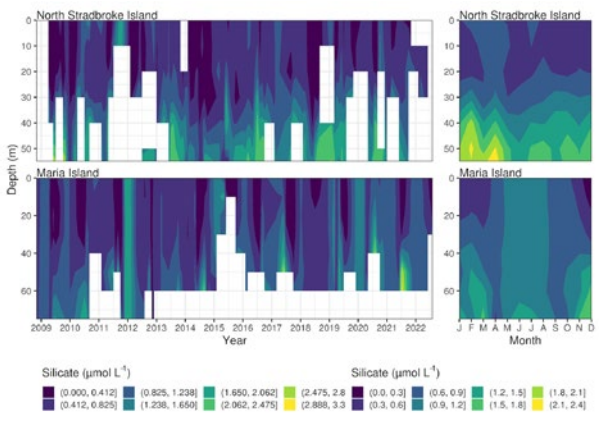
Who should use the Biological Ocean Observer?

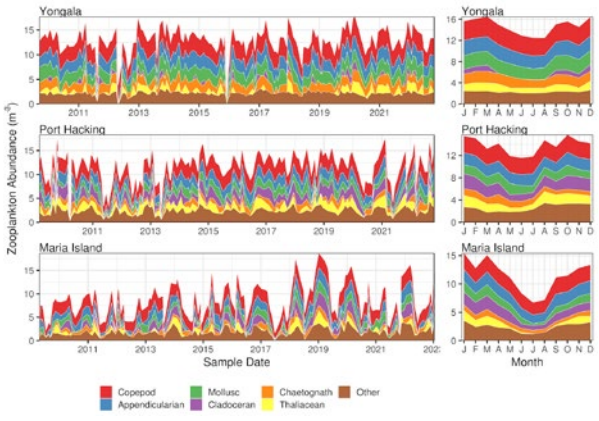
The platform is designed to be used by a broad range of stakeholders, including researchers, natural resource managers, policy makers, educators, students and the general public.

"IMOS is focussed on providing greater accessibility to the wealth of data we collect around Australia, and to finding innovative ways to deliver this data to support and broaden our user base," says IMOS Director Michelle Heupel.

"The IMOS Biological Ocean Observer makes it easier for marine scientists, marine industry users, policy makers and the broader public to view and analyse trends in biological data to help them understand the Australian ocean estate."

> Access the IMOS Biological Ocean Observer





Building a Data Management System for the Reef 2050 Integrated Monitoring and Reporting Program

A single system for connecting to Great Barrier Reef data.

IMOS is leading a project to deliver a fit-for purpose Data Management System (DMS) for the Reef 2050 Integrated Monitoring and Reporting Program (RIMReP).

The DMS will be critical infrastructure that underpins the Program to create a better understanding of what's happening on the Great Barrier Reef. Also, the DMS will be a critical service in support of RIMReP's Reef Knowledge System (https://reefknowledgesystem.gbrmpa.gov.au/)

The scoping phase for the DMS identified the size, scale and maturity of the data sets critical for inclusion in RIMReP. More than 150 unique datasets from over 70 organisations or programs were identified. Based on existing and anticipated use cases, 55 datasets were identified as a high priority: approximately 50% of these come from providers with good data infrastructure. Guided by prioritised use cases, the DMS will create automatic data ingestion pipelines for connecting and collecting data from the data provider.

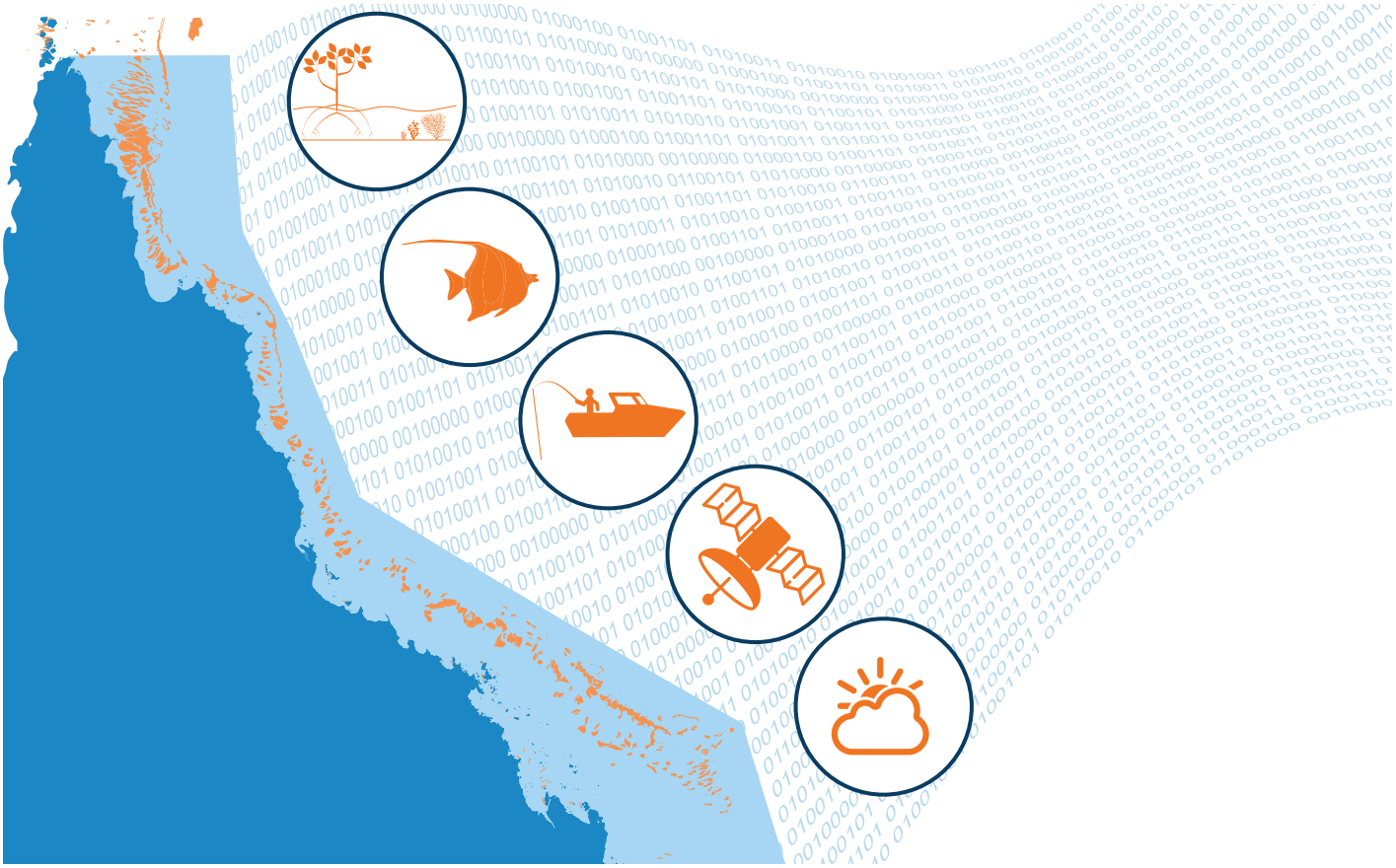
The DMS architecture is conceived as a scalable data-agnostic system based on data and metadata standards and built using open-source software. The system will collect data and metadata from data providers in an automated way, store/cache data collections, and provide the end user with a delivery mechanism through dedicated Application Programming Interface (API) services or direct connection to the cloud storage. The system is going into a production site by December 2023 and by June 2024 the DMS will be a fully operational system, providing the required data for current and future management needs.

The DMS will enable the Great Barrier Reef Marine Park Authority (Reef Authority) and its stakeholders to discover most of the data related to the Reef and will provide different options to extract the required data using simple filters like temporal range or geographical extent. The DMS team will provide extensive documentation, use case examples and training workshops to allow the users to make the most of the system.

The RIMReP Data Management System is funded by the partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation, and the Great Barrier Reef Marine Park Authority with support from the Integrated Marine Observing System.

> Download a factsheet to find out more about the DMS.

For more information write to info-dms@utas.edu.au or contact the Program Leader: IMOS Reef Data Services & Infrastructure Eduardo Klein Salas, Eduardo.kleinsalas@utas.edu.au



Data Management System (DMS) training workshops

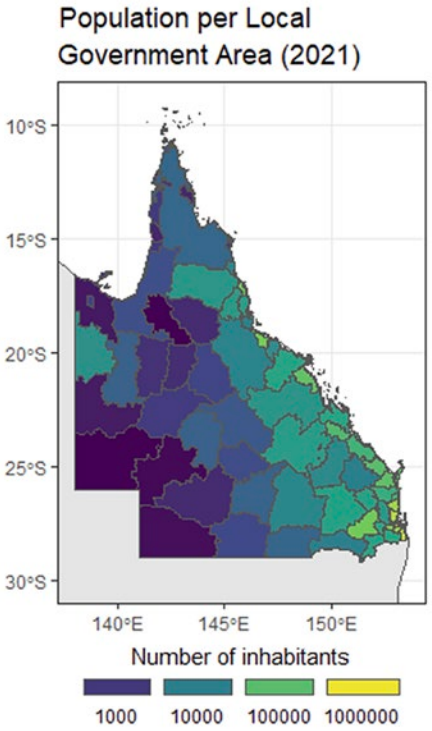
The IMOS Data Management System (DMS) team have recently run training workshops to allow users to make the most of the system.

The DMS Team prepared and conducted a full-day training workshop to exhibit access to and working with Human Use Dashboard data hosted within the DMS. Members of the Social Science/Science for Management Sections of The Reef Authority gathered in Townsville (and virtually) to participate in knowledge sharing and demonstrations. By the end of the training day, participants were able to connect to and use Australian Bureau of Statistics Census data and many administrative boundary layers to create a sample map (see figure at right).

The DMS project was also showcased at the 3rd Social Science of the Great Barrier Reef Symposium in Cairns on 11-12 September and delivered another workshop training session. With 18 participants across research, industry, government, and tourism disciplines, the DMS team demonstrated how to work with CSIRO's Socio-Economic Long Term Monitoring Program (SELTMP) data, one of the critical monitoring programs for the GBR.

To promote the use of the DMS services, the project maintains a public repository of notebook examples that can be reused and adapted to any particular data extraction/data analysis task. The notebooks are written in Python and in R languages, according to the preferences of our stakeholders.

The DMS is open to offer tailored training workshops to demonstrate the use of the project's services. If you are interested in one of the training session please reach out to the team at info-dms@utas.edu.au



DMS Program Leader Eduardo Klein Salas at a recent workshop.

Credit: GBRMPA

Biogeochemical Argo Floats: Float deployment and recovery on recent RV *Investigator* voyages

The team aboard the recent RV *Investigator* voyage IN2023_V06 deployed an IMOS biogeochemical (BGC) Argo float in the centre of a cyclonic (clockwise-rotating) cold core eddy.

The voyage was taking a closer look at the structure of East Australian Current (EAC) eddies, and the fronts that lie between them, to increase our understanding of their impact on the ocean, atmosphere and marine life in the East Australian Current (EAC) system.

The BGC Argo Float will profile twice daily initially, then revert to the standard Argo 2000m/10 day mission. In addition to temperature and salinity, the float is measuring dissolved nitrate, dissolved oxygen, phytoplankton chlorophyll and carbon, and the ocean light field. These measurements will help disentangle the influence of light and nutrient supply on phytoplankton growth in this cold-core eddy. After the RV *Investigator* left the eddy, the BGC-Argo data stream will provide a continuous record of the eddy's behaviour to be combined with satellite observations in coming weeks and months.

The voyage was a large interdisciplinary effort supported by several IMOS data streams: Core Argo floats funded by the Bureau of Meteorology in other eddies, nearshore data from the Ocean Glider and Ocean Radar facilities, and comprehensive real-time data, essential for planning, from IMOS OceanCurrent.

> Read more about the voyage

Written by Pete Strutton, Institute for Marine and Antarctic Science, and the science team on board the *RV Investigator* voyage IN2023_V06

Linda Gaskell, CSIRO MNF

Getting ready to deploy the Biogeochemical Argo float from L–R Craig Hanstein, Pete Strutton and Moninya Roughan.

The next RV *Investigator* voyage IN2023_V07 headed south of Tasmania to study the impact of eddies on the dynamics of the Antarctic Circumpolar Current (ACC). In a first for RV *Investigator*, a BGC Argo float was recovered from the Southern Ocean after its three-year mission sampling deep waters about 500 kilometres south of Tasmania.

BGC Argo float no.5906623 performed this cycle 290 times since it was released from RV *Investigator* on 12 December 2020. In nearly three years of continuous diving, the float provided valuable data on temperature, salinity, algal concentration, suspended matter, oxygen, nutrients, light available for primary production, and pH of sea water.

Dr Christina Schallenberg, a CSIRO scientist and leader of the IMOS Biogeochemical Argo sub-Facility, said the technology is essential for revealing how much carbon the ocean stores and how that might change in the future.

CSIRO's Jason Fazey, from the Marine National Facility, said the Argo float recovery net had been developed to enhance RV *Investigator*'s ability to support long-term ocean studies.

"We looked at systems other research organisations use, and worked with our Field Operations team to design a similar system that was customised for RV *Investigator*," Mr Fazey said.

"The recovery net is effectively a prototype we were testing operationally for the first time, having previously only conducted trials in the relatively sheltered Storm Bay, off Hobart - we didn't know how it would behave in the swell of the Southern Ocean.

"The recovery operation was a tricky dance between wind and currents to manoeuvre the ship into position. Once the float was moving alongside the ship, it took careful coordination between the bridge officers and the skilled deck crew to catch the two-metre long, 100-kilogram float with a small net.

"With a successful debut after a great team effort, we now have some ideas to refine the design and operation of the recovery device."

> Read more about the BGC Argo Float recovery

Written by Mark Horstman, Australian Antarctic Program Partnership.

The CSIRO RV Investigator is national research infrastructure supported by the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS). ■

Amelia Pearson

First BGC Argo Float recovered by RV *Investigator*.

Deep Water Moorings: Seasonal CO_2 cycle in the Southern Ocean amplified by increasing atmospheric carbon

Using data from the IMOS Southern Ocean Time Series moorings over the last decade, scientists have directly measured an increase in the magnitude of the ocean's seasonal cycle of carbon dioxide for the first time.

The new study, published recently in Frontiers in Marine Science, used the sustained observations from the IMOS Southern Ocean Time Series (SOTS) site in the Subantarctic zone between 2011 and 2021 to evaluate the seasonality and trends in surface ocean CO_2 partial pressure, or pCO_2.

The surface ocean pCO_2 is required to quantify the exchange of CO_2 between the atmosphere and the ocean. Variations in the ocean pCO_2 are caused by changes in temperature, ocean mixing, biological activity, and the concentration of CO_2 in the atmosphere.

The Southern Ocean (south of 30°S) plays a crucial role in the global carbon cycle, responsible for about 40% of the total global ocean uptake of human-induced CO_2 emissions, and 75% of the additional heat these emissions have trapped on Earth.

Lead author Dr Elizabeth Shadwick, a Principal Research Scientist at CSIRO, and Co-Leader of the IMOS-SOTS Facility, said the Subantarctic Zone (SAZ), roughly between the latitudes of 46° and 60° South, is a globally significant region for the uptake and storage of anthropogenic (human-induced) CO_2 from the atmosphere.

"This amplification of the seasonal cycle has been expected due to the uptake of anthropogenic carbon, but these are the first direct Southern Ocean observations to quantify it," Dr Shadwick said.

"Our research also found that the Subantarctic Zone is a net sink for atmospheric CO_2 over the nearly 10-year record, with trends revealing that the ocean pCO_2 may be increasing slightly faster than the atmosphere.

The slightly faster increase in the surface ocean pCO_2 (relative to the atmosphere) suggests that oceanic forcing, in addition the uptake of anthropogenic CO_2 from the atmosphere, may be contributing to the decadal change.

"The amplification of the seasonal cycle of surface ocean CO_2 may additionally be driven by short term local changes in ocean mixing and biological productivity," Dr Shadwick said.

Understanding the changes in pCO_2 seasonality is important for understanding the evolution of the Southern Ocean carbon sink, which has been the focus of many modelling studies given the scarcity of seasonally resolved observations.

"We are looking forward to our next voyage on CSIRO research vessel Investigator in 2024, which is essential for maintaining the IMOS moorings at this harsh and remote location in the Southern Ocean," Dr Shadwick said.

"Sustaining this time series of Southern Ocean observations is crucial as we continue to untangle the processes behind the changes in pCO_2 seasonality and the evolution of the Southern Ocean carbon sink.

The IMOS SOTS site is operated through a partnership between IMOS, CSIRO Marine National Facility, CSIRO, Bureau of Meteorology, and the Australian Antarctic Program Partnership (AAPP).

IMOS and the CSIRO Marine National Facility are national research infrastructure supported by the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS).

> Read the full paper ■

Max McGuire, CSIRO

Deployment of the Southern Ocean Time Series (SOTS) Deep water mooring from the RV *Investigator*.

Animal Tracking: Understanding environmental influences on yellowtail kingfish movements across south-eastern Australia

A recent study has used the Remora R package to identify environmental drivers of activity in acoustically-tagged yellowtail kingfish, *Seriola lalandi*, as well as connectivity across fisheries management jurisdictions via the IMOS Animal Tracking network of acoustic receivers.

Remora is a data product developed by the IMOS Animal Tracking Facility after receiving a Research Attraction and Acceleration Program grant from the Office of the New South Wales Chief Scientist & Engineer. Remora enables robust quality control and interactive visualisation of acoustic telemetry datasets, as well as the rapid extraction and integration of IMOS oceanographic measurements with spatiotemporal ecological data (e.g. animal tracking datasets, fisheries catch records, ecological survey records, etc.).

This new study by Thomas Clarke et al. used a network of 93 acoustic tracking receivers across south-eastern Australia to identify the effects of environmental conditions on the activity of the yellowtail kingfish, an economically important species with a crucial role in coastal and pelagic ecosystems and fisheries.

The research found that kingfish activity was strongly influenced by sea surface temperature and hour of day, with smaller effects from distance to nearest landmass and bathymetry. Activity also decreased during higher tides and periods of greater moon fraction.

This study demonstrates the usefulness of the IMOS continental network of acoustic receivers to detect and monitor highly mobile marine species, including species of management importance, across broad spatial scales.

Importantly, the study also enhances understanding of the ecology of this recreationally and commercial important species, through the use of the Remora toolkit, gaining a better understanding of the relationship between kingfish activity and environmental conditions across south-eastern Australia.

> Read the full paper

Phillip Colla, OceanLight

Satellite Remote Sensing: Incredible new data from SWOT satellite mission

Written by Christopher Watson, University of Tasmania, and Benoit Legresy, CSIRO

Early data shows incredible resolution as SWOT data product validation continues.

The Surface Water Ocean Topography (SWOT) satellite is providing a new lens into fine scale ocean dynamics never previously observed. Having completed its critical 90-day Fast Sampling Phase, first data provided to the science team reveals unparalleled resolution and data quality. The mission is now focused on validating data products prior to the first public release of data that will yield a step change in the observation of our oceans and inland waters.

The special 90-day calibration phase covered only certain tracks over the globe. By repeating these tracks every day, scientists can accurately calibrate and validate the data that follows. One of these tracks covered the IMOS Satellite Altimetry Calibration and Validation Facility in Bass Strait where leaders Dr Christopher Watson (University of Tasmania) and Dr Benoit Legresy (CSIRO) have been maintaining an array of instrumentation.

First results from Bass Strait were recently presented in meetings in Toulouse in September, and at the Ocean Surface Topography Science Team in Puerto Rico in early November 2023.

“The Bass Strait effort is a tour de force using state of the art in situ sensors relating coastal sea levels to SWOT measurements from space” said Lee-Lueng Fu, Ocean Lead Scientist from NASA/JPL.

“In situ data from Bass Strait is a great complement to what we have at our Californian validation site – it helps us understand the performance of this exciting new mission in the coastal domain.”

With investment from IMOS, CSIRO and the University of Tasmania, as well as a contribution from the French Space Agency (CNES), the Bass Strait facility continues its important role in satellite altimeter validation.

“The end of Fast Sampling is a major milestone for the mission and groups around the world – many teams have deployed sensors at key locations to assist in the validation effort” said Dr Watson.

Focusing on a key region of Bass Strait approximately 80 x 50 km in size, the IMOS team have developed new technologies to keep pace with SWOT.

“The low noise and high resolution of SWOT really demand new approaches to in situ measurements that underpin the validation process.” said Dr Legresy.

CSIRO has pioneered the development of advanced sub-surface instruments that enable the high frequency measurement of ocean properties including depth, temperature, salinity, currents and wave height.

On the ocean surface, the team at the University of Tasmania developed and deployed a suite of 9 surface buoys equipped with navigation equipment that accurately measures the sea surface height twice per second.

“Not only do these measure the ocean height, they tell us about the water content of the troposphere which is an important component of the SWOT measurements” said Dr Watson.

The key instrument on board SWOT is an interferometric radar instrument known as KaRIN – for the first time, KaRIN is able to measure wide swaths that capture the hills and valleys that make up the ocean surface.

“By observing ocean topography at such high resolution we’re able to gain insight into a host of ocean dynamic processes” said Dr Benoit Legresy.

“It’s been a busy time for the Bass Strait team – our technical personnel have a done a great job getting gear deployed and enabling us to be in the position of having such a unique dataset for characterising SWOT performance” said Dr Watson. “It’s really exciting to be working alongside young scientists discovering this incredible new data.” ■

SWOT in orbit (illustration).

© CNES

Benoit Legresy, CSIRO

Brand new CSIRO mooring packed with latest technology to ensure the ongoing calibration and validation of the SWOT satellite over its future science phase. In the lower right corner, one of three moorings just recovered after its deployment over the intense 90-day calibration phase of the mission.

Great Barrier Reef Microbial Genomic Database:
New database reveals the microbial genomic diversity of the Great Barrier Reef

A new open access database of microbial genomic data from across the Great Barrier Reef is available via the AODN Portal.

Marine microbes are microscopic single-celled organisms that live in marine environments, and include cellular life forms, such as bacteria, fungi, algae and plankton, and their accompanying viruses. Whilst marine microbes are tiny, they exist in very large numbers and can be found throughout the ocean, from the deepest parts up to the surface layers.

Microbes play a fundamental role in the functioning and stability of coral reefs and are often the first to respond to changes in the environment.

With coral reefs becoming increasingly threatened by localised impacts including declining water quality and pressures from climate change, shifts in the composition and function of microbial communities can provide crucial diagnostic information to the extent of these impacts.

The new open access database, called the Great Barrier Reef Genomics Database, contains microbial metagenomics sequencing reads of seawater collected from 48 reef sites across the Great Barrier Reef. Samples were collected by the Australian Institute of Marine Science (AIMS) across four of their Long-Term Monitoring Program (LTMP) field trips between November 2019-July 2020, combining water chemistry data, LTMP field surveys and microbial metagenomics data.

This database is a major part of the IMOS Great Barrier Reef Microbial Genomic Database project, which is funded by the Department of Environment and Science, Queensland through the Research Infrastructure Co-Investment Fund (RICF), and is operated by Australian Institute of Marine Science (AIMS) in partnership with the University of Queensland.

The project provides the first comprehensive open access repository of microbial DNA sequencing data from the region. With metagenomics sequencing data now available and quality filtered microbial genomes in preparation for release, this database will be invaluable to reef monitoring efforts and the international research community aiming to understand the contributions that microbes make to ecosystem processes on the Great Barrier Reef.

> Access the new database ■

Samantha Jaworski, AIMS

Marko Terzin with a seawater sample.

Ray Berkelmans, AIMS

Alex Shute

The influence of coastal upwelling & shelf geomorphology on the distribution of krill in south-eastern Australia

Coastal upwelling systems are among the most biologically productive marine regions on Earth. Changes in system dynamics can modify the spatiotemporal distributions of food resources, driving shifts in the distribution of commercially and ecologically important wildlife populations. South-eastern Australia hosts a large-scale, seasonally wind-driven coastal upwelling system known as the Great Southern Australian Coastal Upwelling System (hereafter, Great Southern Upwelling) (see Figure 1).

The Great Southern Upwelling season typically runs from November to April, during which nutrient-enriched upwelled waters drive increased phytoplankton production and zooplankton aggregation across the system. One important zooplankton species is coastal krill (*Nyctiphanes australis*), which provides a key food source for several commercially important and protected marine predators, including the pygmy blue whale (*Balaenoptera musculus brevicauda*). Currently, our understanding of coastal krill ecology in the Great Southern Upwelling is limited to studies at relatively fine spatial scales (< 50 km^2).

Alex's research aims to bridge this gap by integrating IMOS data streams with vessel-based surveys to investigate how upwelling dynamics influence krill spatial distributions across the Great Southern Upwelling.

Stage one of Alex's project utilizes data from the National Mooring Network, Ocean Glider, and Satellite Remote Sensing facilities to quantify the spatiotemporal variability of the Great Southern Upwelling (2002-Current). Simultaneously, Alex is developing a Python package for the objective analysis and classification of surface upwelling features for use in Australian waters.

Alex onboard the *Carol Maree* whilst taking part in VicIMOS servicing of the Bonney Mooring.

Stage two of the project involves a trans Bass Strait institutional collaborative approach targeting the scale of the upwelling system. In the upcoming season (2023/24), Deakin University will collaborate with SARDI, IMAS, the Blue Whale Study and Flinders University to survey the spatial distribution of coastal krill and environmental covariates across the Great Southern Upwelling.

Outputs from Alex's project will be used to develop species distribution models for the spatial management of krill predators in the Great Southern Upwelling.

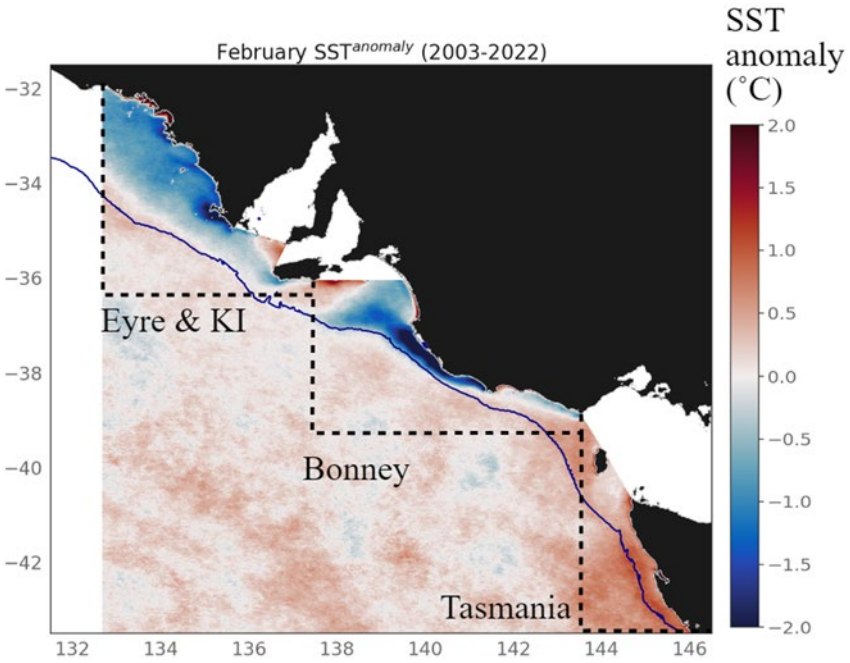
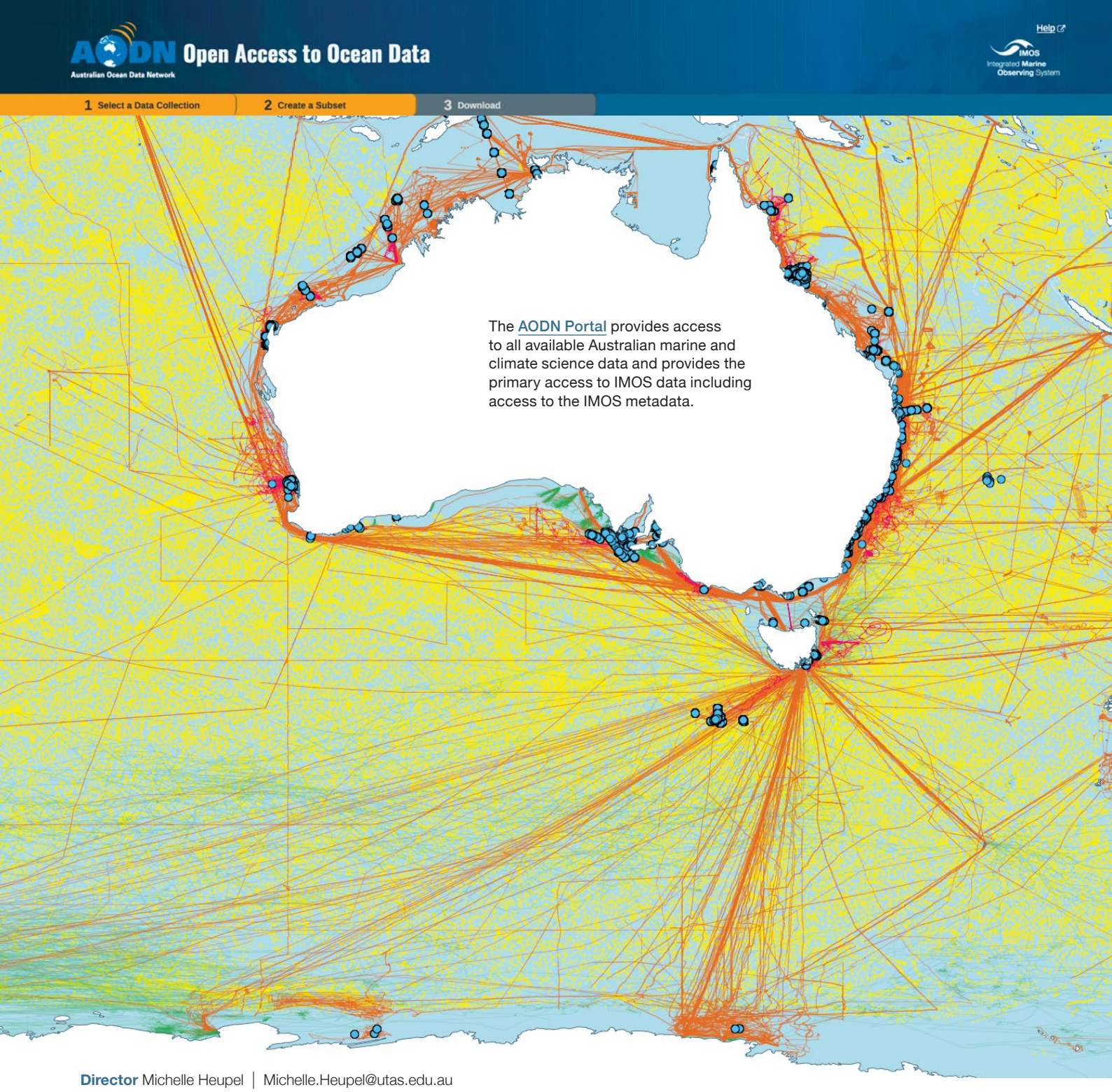


Figure 1: Climatology of SST anomaly 2003-2022 in the Great Southern Upwelling. Dashed boxes highlight the three sub-systems and focus regions of the project.



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