2026

IMOS
Integrated **Marine** **Observing** System

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

ACOMO

The Australian Coastal and Oceans Modelling and Observations Workshop

ABSTRACTS

Key Note

AI/ML: Is it just another tool or a revolution for prediction systems

Dr Gary Brassington, Flowershift

It is often difficult to form a complete vision of what will be the fruits of a revolution when you are in the middle of one, success is lumpy where certain problems map onto the new paradigm and advance rapidly while others less adapted fall out of favour. But nonetheless it is clear AI/ML is a disruptive revolution to the earth sciences and the prediction systems. The entire workflow of a traditional prediction system including the observation design can leverage AI/ML. AI/ML dramatically reduces the scale and complexity of earth science. Traditional approaches have typically seen it broken into sub-specialisations where lifetimes are spent to make genuine breakthroughs and few have the bandwidth to keep up with the best practices of all the sub-disciplines. AI/ML dramatically compresses the scale and complexity restoring a more complete picture of the cutting-edge developments, the vast array of models, computing architectures, data volumes and restores the opportunity to achieve genuinely novel results. In this talk, I will review the state of the art of AI/ML applied to ocean prediction and draw on my experiences at flowershift Pty. Ltd. with building out a sovereign prediction suite using these novel methods. With that foundation I will take a look at how well Australia is placed to take advantage of this revolution and speculate on the next steps.

From snapshot to system: Harnessing Micro-ROV technology for integrated reef and coastal science

Dr Gemma Galbraith, James Cook University

The complexity of marine ecosystems requires a multidisciplinary toolkit that captures both biodiversity and the physical drivers that shape them. This is particularly true along the shelf break and the slopes of outer reefs (typically 30–150m, the mesophotic zone), where in-situ observations or the installation of permanent monitoring instrumentation are logistically challenging. Micro-remotely operated vehicles (ROVs) are emerging as a solution to meet the demands of cost-effective marine ecological studies while offering a unique capacity to bridge gaps between broad-scale observational arrays and fine-scale habitat characteristics. This talk explores the application of micro-ROVs as versatile platforms for capturing snapshot environmental data. I will showcase recent projects where these technologies have been used to explore mesophotic reef habitats, discover new biodiversity records, and provide high-resolution data for the validation of downscaled hydrodynamic models. By fostering collaboration between ecologists and physical scientists, we can enhance our collective capacity to monitor, model, and safeguard our oceans in a changing climate.

Uncharted data: Maximising the value of existing ocean observations

Professor Nicole Jones, University of Western Australia

Despite substantial investment in moored, ship based, and autonomous platforms, the ocean remains sparsely sampled. A key challenge is therefore to extract greater value from the observations we already have—closing knowledge gaps and generating new, useful data products. In this talk, I will present several examples demonstrating how we have maximised the scientific return from both Integrated Marine Observing System (IMOS) data and our own targeted process based observations. First, we developed and validated a method to estimate six years of continuous turbulence quantities across a 200 m water column using IMOS mooring temperature records. Second, we built a probabilistic framework that derives robust climatologies from records far shorter than 30 years, enabling marine heatwave detection from subsurface temperature time series. Third, we created tools that merge drifter and ship based current meter observations to produce time varying velocity fields, revealing fine scale spatial variability. Finally, we constructed a model that retrieves surface currents from consecutive satellite sea surface temperature fields, producing near real-time estimates of surface currents. Together, these advances illustrate the substantial untapped potential within existing ocean observations and highlight opportunities to enhance the value of current and future observing efforts.

Oral Presentations

High-resolution numerical modelling of north Queensland ports: Enhancing tide and current representation in complex coastal environments

Dr Christelle Auguste, Dr Christelle Auguste, Mr Sebastien Mancini
Tidetech Pty Ltd

North Queensland's ports are characterized by shallow waters and complex bathymetry, posing significant challenges for accurate hydrodynamic modelling. This study presents the development and validation of a high-resolution numerical model using SCHISM with an unstructured grid approach. The outputs are processed to generate S-100 format files, supporting the transition to modern hydrographic data standards and enabling seamless integration with maritime navigation systems. This work demonstrates the value of high-resolution, unstructured grid modelling in addressing the hydrodynamic complexities of Australia's coastal environments, with direct applications for navigational safety and port operations.

A new regional coupled climate model in the ACCESS model family

Dr Ashley Barnes[1,2], Dr Paul Gregory[2,4], Dr Madeline Gamble-Rosevear[2,3], Associate Professor Paul Spence[2,3], Professor Julie Arblaster[1,2]
[1]Monash University, [2]ARC Centre of Excellence for 21st Century Weather, [3]University of Tasmania, [4]University of Melbourne

The ACCESS family of models has long included global ocean, atmosphere and coupled climate models. High resolution regional models are now being included, beginning with the regional atmosphere and ocean models ACCESS-rAM3 and ACCESS-rOM3 respectively. Work has now begun on a new coupled regional model, ACCESS-rCM3. Like rAM3 and rOM3, the new regional coupled model will be easily relocatable and reconfigurable to the user's domain of choice. So far, we have a working prototype, and are in the process of building the infrastructure to automatically set up model configurations. This meeting presents a great chance for us to learn what use cases people would have in mind for our model, so that we can best include the features most important for the climate modelling community. You can even come to us with ideas for a new regional coupled experiment, and we might be able to help make it a reality!

Spencer Gulf's warming, salinification, and shifting currents: Initial high-resolution projections from dynamical downscaling

Dr Hugo Bastos de Oliveira, Dr Mark Doubell
SARDI

Spencer Gulf is Australia's largest inverse estuary and an important component of South Australia's blue economy. Due to its importance, understanding future climate projections for this region is critical. The Gulf's circulation dynamics are shaped by restricted exchange with the shelf and winter density-driven flow, features that are often poorly resolved in climate models. As a first step toward a multi-model ensemble, this study employs dynamical downscaling of GFDL-ESM2M into a high-resolution (1 km) ocean model of Spencer Gulf, forced with operational products. Using the seasonal delta method, we analyse changes under RCP8.5 perturbations between a baseline (1976-2005) and end-of-century (2066-2095), while underpinned by model performance evaluated against six moorings. The projected clockwise circulation persists but with notable spatial changes: intensified flows in the west and weakened currents in the shallower eastern regions. Temperature perturbations ranged from 1.5-2.3°C and salinity increases of 0.25-1.2 g/kg. The northern Gulf experiences the most pronounced seasonal changes, with ~3°C warming in winter. Negative density perturbations peak during summer and autumn, linked to surface heat flux and the shallow areas. These findings have direct implications for aquaculture activity as well as desalination plant outfall management, underscoring the need for climate-informed strategies in Spencer Gulf.

Coupled modelling of tropical cyclones over the Northwest Shelf of Australia

Dr Chris Bladwell, Dr Stefan Zieger, Dr Frank Colberg, Dr Pavel Sakov
Bureau Of Meteorology

This talk presents a regional atmosphere-ocean-wave coupled modelling system developed for the Northwest Shelf of Western Australia. The impact of coupling is explored through a suite of experiments of severe tropical cyclone (TC) Veronica, which affected the region in March 2019. By constraining boundary layer energy, the coupled model produces realistic surface pressure and wind speeds when compared to an atmosphere-only model over the same domain. Our results show that the coupled system simulates the characteristic asymmetric structure of the TC, leading to better representation of extreme rainfall. We also discuss the development of an ocean data assimilation system over the Northwest Shelf domain.

Characteristics and drivers of the coastal equatorward countercurrent in the southeastern Australian shelf

Dr Claudio Cardoso, Prof Moninya Roughan
UNSW

The southeastern Australian shelf is strongly influenced by the East Australian Current (EAC) and the eddies shed from it. Yet recurrent equatorward flow is frequently observed inshore of the EAC southern extension (along southern NSW), despite receiving little attention to date. Here, we use a 10-year mooring record off Narooma, together with satellite observations, to characterise this coastal countercurrent and investigate its drivers. We detect equatorward flow events from ADCP data and extract key metrics that enable their classification into distinct event types differing in frequency, duration, vertical structure, northward extent, and water-mass properties. We show that this equatorward flow is not a single dynamical feature, but a recurrent manifestation arising from multiple mechanisms, including buoyancy-driven Bass Strait winter outflow, remotely forced shelf responses associated with wind-driven sea-level anomalies and coastal trapped waves, and local enhancement by cyclonic eddies. These results provide a new framework for interpreting coastal current variability and highlight the need to distinguish among the dynamical pathways that produce similar current manifestations. This has important implications for understanding along-shelf water-mass transport, with potential consequences for primary productivity and ecological connectivity in a region of rapid environmental change.

Shelf-break intrusions and cross-shelf exchange in the Central Great Barrier Reef

Dr Severine Choukroun[1], Dr Jodie Schlaefer[1], Dr Mathieu Mongin[2], Dr Jenny Skerrat[2], Dr Clothilde Langlais[2]
[1]James Cook University, [2]CSIRO Ocean & Atmosphere

Cross-shelf exchanges between the Coral Sea and the Great Barrier Reef (GBR) lagoon influence reef thermal structure and biogeochemistry, yet their variability and drivers remain poorly constrained. We investigate intermediate water intrusions in the central GBR (Palm Passage) using a combined observational–modelling framework spanning 2009–2024. Long-term Integrated Marine Observing System mooring observations are integrated with the eReefs hydrodynamic model hindcast to quantify both the occurrence and persistence of cross-shelf exchange. We develop new metrics to capture not only short-lived cooling events but also the sustained presence of intermediate waters. Intrusion conditions occur on average ~45% of the year, with strong interannual variability (28.9–62.8%). While individual events last ~6 days, the underlying intrusion state can persist for weeks. Intrusions are most frequent from October to March but can continue through winter when the East Australian Current (EAC) persists, with salinity providing a more reliable tracer than temperature during cooler months. Intrusions are strongly linked to the presence of the EAC, particularly when it is intensified and encroaches onto the shelf, promoting uplift and cross-shelf transport of intermediate waters, often under weak wind conditions. These results highlight the importance of sustained EAC-driven dynamics in shaping reef environments and potential thermal refugia.

Climate warming drives divergent larval supply trends in a connected marine population

Dr Katie Cresswell, Associate Prof Klaas Hartmann, Professor Sean Tracey
Institute For Marine And Antarctic Studies

Climate warming is changing marine population connectivity, but attributing long-term changes in larval supply to specific mechanisms remains difficult, especially for species with long pelagic larval durations. We examine these processes for the southern rock lobster (*Jasus edwardsii*), a temperate species with a pelagic larval duration of up to two years across southern Australia. Using a 30-year biophysical hindcast driven by the BRAN2020 ocean reanalysis, we couple a biologically parameterised Lagrangian dispersal model to identify the drivers of interannual settlement trends. The analysis revealed strong larval connectivity among regions, linking areas that experienced differing thermal conditions over time. Temperature-dependent larval mortality dominated settlement trends, outweighing the effects of both egg production and ocean transport. Warming produced divergent responses, with declining larval supply in warmer northern regions due to increased heat-related mortality, and increasing settlement at the cooler southern edge due to reduced cold-related mortality. Despite the dominance of temperature effects, the model indicated that relatively small increases in egg production could be sufficient to fully counterbalance the cumulative effects of the past three decades of warming on larval supply.

Validating satellite-derived training data for sea surface temperature downscaling using machine learning

Dr Ajitha Cyriac, Dr Chaojiao Sun, Dr Jim Greenwood, Dr Fabio Boschetti, Dr Richard Matear
CSIRO

Machine learning (ML) has become a powerful tool to produce robust high-resolution climate information by its ability to rapidly downscale coarse-resolution climate models. However, the effectiveness of ML approaches in climate applications is often constrained by the availability of high-resolution training data. This study explores the applicability of satellite-derived observations in training super-resolution deep learning architectures to downscale sea surface temperatures (SST) along the Australian coastline. We evaluate two models: one trained on observational satellite data and another on high-resolution numerical ocean simulations. Our results indicate that the observationally trained framework achieves comparable performance to its simulation-trained counterpart, establishing empirical satellite data as a robust, accessible alternative to computationally demanding model outputs. By validating these satellite-derived training sets, we provide a scalable framework for high-fidelity climate downscaling in data-sparse regions, offering a critical tool for assessing climate impacts on remote World Heritage sites such as the Great Barrier Reef and Ningaloo Coast.

Freshwater signals and salinity dynamics in Torres Strait

Dr Darren Engwirda, Dr Mike Herzfeld, Mr Richard Thomson, Dr Lachlan Phillips, Dr Laura Blamey
CSIRO

Torres Strait is a narrow, tidally-dominated waterbody between Australia and Papua New Guinea separating the Gulf of Carpentaria, Gulf of Papua, Northern Great Barrier Reef and Coral Sea. Punctuated by an array of shoals, islands and reefs, the Strait is a shallow shelf that gives rise to energetic quasi-barotropic circulation, with maximum current speeds exceeding 2m/s. In this work, the impact of freshwater inputs associated with river flows and precipitation is analysed — accounting for strong seasonal signals associated with the Northwest Monsoon. A peak freshening is found to occur within the Strait in late summer due to the confluence of remote river flows propagating eastward along the West Papuan coastal shelf, southerly outflow from the Fly River as well as intense local precipitation. These dynamics reverse during winter, leading to a salinity maximum in Torres Strait in early spring associated with the north-westerly displacement of saline coastal waters originating on the

Great Barrier Reef. Confirmed through a combination of high-resolution numerical modelling and mooring-based observations, the development and evolution of strong salinity fronts and freshwater plumes associated with this seasonal oscillation leads to a dynamically-rich circulation within the Strait that has implications for local ecosystem dynamics and reef health.

Assessing Bluelink's Relocatable Ocean Atmosphere Model (ROAM) using a wide range of physical oceanographic data, from IMOS and international space agencies.

Dr David Griffin
CSIRO

Our Relocatable Ocean Atmosphere Model sits between the Bluelink global ocean model and our littoral-scale models. As the name suggests, it is designed for rapid configuration in a user-specified area, for when the global model is not sufficient. With time being of the essence in such situations, users do not have much time to assess the likely accuracy of the model themselves. So part of our job is to teach them the limits of the model. To be equipped to do this, we assess many ROAM runs against a wide array of physical oceanographic data. The great thing about Australia is that we have so many oceanographic landscapes, where IMOS collects observations. This talk will focus on recent work off the NW, with a focus on internal tides.

New observational datasets enabling nationally consistent and locally relevant assessments of the impacts of sea-level rise on Australia's coasts

Dr Ben Hague
Bureau Of Meteorology

Sea level observations are critical for understanding coastal flooding hazards and verifying numerical coastal water level models. This presentation provides an overview of the Bureau of Meteorology's coastal sea level observational datasets and their use to understand regional impacts. The Australian National Collection of Homogenised Observations of Relative Sea Level (ANCHORS) comprises 38 tide gauge records from around Australia with at least 40 years' length. ANCHORS can robustly assess long-term changes in sea level and coastal flooding by leveraging methods that detect and correct errors in the data caused by non-geophysical factors. ANCHORS includes derived analyses to support hazard assessment including sea level means, maxima, trends, and trajectories, and current and future annual exceedance probabilities. The Estuary Water Elevation Research (EWER) dataset focuses on data comprises water level observations from 724 unique gauges across tidal environments, principally estuaries. While ANCHORS focuses on long-term changes at reference gauges, the high-density EWER dataset aims to capture the large water level variations observed in estuaries over short distances across a range of timescales. The dataset brings together disparate national and state agency records to improve coverage of these highly dynamic systems, which are often excluded from ocean-focused products used for coastal hazard analysis.

Hydrodynamic modelling of Macquarie Harbour, Tasmania

Dr Mike Herzfeld, Dr Darren Engwirda
CSIRO

Macquarie Harbour is a fjord-like waterbody on the west coast of Tasmania that is the only known habitat of the endangered Maugean Skate. The Skate's endangered status is partly attributed to anthropogenic stressors related to the oxygen budget in the harbour, and this talk examines the hydrodynamic controls that have the potential to regulate oxygen supply to the harbour. Being fjord-like in nature, Macquarie Harbour undergoes deep water renewal events commonly seen in mid-latitude fjords, where ocean water is tidally pumped through the narrow entrance, and owing to its greater density sinks to the harbour bottom as a density current. The lesser-known dynamics of tidal intrusion fronts and Leewirkung (lee effect) act to augment the injection and redistribution of water properties within the harbour. These dynamics are investigated through application of a three-dimensional unstructured model.

eSA-Marine and particle tracking: using a regional forecasting model to manage response to harmful algal blooms.

Dr Charles James
Office of Algal Bloom Research, SARDI

During the unprecedented harmful algal bloom that has been impacting South Australia since early 2025, the eSA-Marine forecasting system has been used to drive particle tracking studies and provide advice on the predicted movement of bloom outbreaks. This included hindcast simulations to investigate any potential anthropogenic sources for the initial bloom, 5-day forecasts using large scale tracking to provide regular public updates on potential bloom movements, and bespoke tracking at the requests of the aquaculture industry to help advise strategies to protect fish stocks. Examples from the particle tracking studies will be presented along with techniques developed to respond to a state-wide emergency in a timely manner.

Wide-swath satellite altimetry and novel subsurface observations improve predictions in a dynamic western boundary current

Dr Colette Kerry[1], Prof Moninya Roughan[1], Assoc Prof Shane Keating[1], Dr Marina Azaneu[1], Dr Gary Brassington[2]
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Predicting ocean dynamics requires the effective combination of numerical models and observations that resolve key processes at suitable time and space scales. Fine-scale oceanic features and the ocean's complex subsurface structure remain a significant source of uncertainty in coastal and regional models due to lack of observations at necessary scales. Recently-available observation platforms provide an unprecedented view of the ocean's fine-scale structure both at the surface (the SWOT satellite) and below the surface (Fishing Vessel Observation Network - FVON). Here we use advanced data-assimilation to demonstrate the impact of these novel observation types on dynamic ocean state estimates in an eddy-dominated western boundary current region, the East Australian Current. Observing System Experiments, compared against an unprecedented set of independent observations, show that the inclusion of SWOT and FVON data provide enhanced representation of ocean structure. We show that the inclusion of SWOT data improves model representation of the ocean surface across scales and of subsurface temperature as observed by FVON. Assimilating FVON data, that drastically increases subsurface information in the coastal and shelf region, significantly improves subsurface temperature representation. The results motivate the sustained collection of novel observations and their integration into regional ocean models for improved forecasts and projections.

Modelling support for reef-based larval restoration

Dr Clothilde Langlais[1], Dr Severine Choukroun[2], Mr Farhan Rizwi[1], Richard Thomson[1], Dr Darren Engwirda[1], Tim Heap[1], Jack Beardley[1]
[1]CSIRO, [2]JCU TRopWater

The Pilot Deployments Program (PDP), under the Reef Restoration and Adaptation Program (RRAP), is advancing coral reef intervention strategies from research trials to operational scale on the Great Barrier Reef (GBR). During the 2025–26 spawning season, hydrodynamic and particle-tracking models were used to guide spawn collection and larval release activities at three reef clusters: Agincourt and Elford reefs in the northern GBR, and the Keppel Island group in the south. To achieve fit-for-purpose resolution, we applied the eReefs modelling suite (https://www.ereefs.org.au/) by nesting reef cluster domains within the eReefs GBR model and implementing unstructured grids that transition smoothly from 200 m at the boundaries to 50 m at the reef scale. This approach enabled high-resolution forecasts tailored to restoration needs. We present the model design, the high-resolution domains, and the suite of daily visualization products delivered in near real-time to field teams, providing operational decision support during restoration deployments.

The oceanographic game change from the SWOT satellite

Dr Benoit Legresy[1,2,3], Dr Christopher Watson[4,2], Dr Yann-Treden Tranchant[2,4,1], Dr Gabriela Semolini-Pilo[1], Dr Andrea Hay[4]
[1]CSIRO, [2]IMOS, [3]AAPP, [4]University of Tasmania

The ocean topography swath-mapping SWOT satellite was designed to be a game changer in oceanography. Here we review the success from the satellite over the last 3 years and highlight the possibilities and limitations to its use and application to ocean and coastal processes. In this presentation we will show how it has exceeded the expected performance by a large margin; we confirm the exceptional low level of noise (3-8mm) with the IMOS Bass Strait in situ Satellite Altimetry facility; the clean radar measurements allow the mapping of the ocean's balanced motion down to the sub-mesoscale transition and produce readily complete geostrophic currents. The quality of the measurements led to the possibility of retrieving wave products of two kinds: swath mapped sea wave heights; very long wavelength swells that impact the coast. The learnings from our studies led to new products being now much more useful for standard ocean users. Upcoming products will make further improvements in the last km approaching the coast. A standard Sea Level and currents dataset is already available around Australia through the IMOS-OceanCurrent website. Overall the SWOT data are an amazing addition to ocean observing for uptake, use and benefit across the ACOMO community.

Deep Ekman return flow regulates seasonality of the Circumpolar Deep Water intrusions onto the continental shelf

Miss Yuhang Liu[1,2], Dr Maxim Nikurashin[1,2,3], Dr Beatriz Peña-Molino[2,4], Dr Paul Spence[1,2,3,5], Dr Laura Herraiz-Borreguero[2,4]
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Denman Glacier has exhibited acceleration and grounding line retreat in recent decades, with the grounding line retreating toward the deepest subglacial troughs on the Antarctic continental shelf. This retreat is primarily driven by intrusions of modified Circumpolar Deep Water (mCDW) from the Southern Ocean onto the continental shelf, which accesses the ice shelf cavity via the Denman Trough. While observations confirm the presence of mCDW within the trough, its seasonal variability and the mechanisms regulating its onshore intrusion remain poorly understood due to sparse observations. Using a high-resolution regional ocean model, we demonstrate that strengthened coastal easterly winds enhance shoreward Ekman transport, driving surface waters towards the coast and inducing a compensating return flow within the trough. This return flow steepens the ASF, thereby limiting the onshore intrusions of mCDW. Seasonally, the ASF transitions from a steep state in austral autumn to a more relaxed state in austral summer, facilitating increased mCDW intrusion during summer. As coastal easterly winds are projected to weaken over the coming century, the associated relaxation of the ASF may promote a transition from a Fresh Shelf to a Warm Shelf regime in East Antarctica, potentially accelerating East Antarctica ice sheet mass loss.

Shared workflows for cross-scale regional and coastal modelling in Australia

Dr Helen Macdonald, Dr Phellipe Couto, Dr Ashley Barnes, Dr Dougie Squire, Dr Elizabeth Ellison, Dr Pearse Buchanan, Fernando Sobral
ACCESS-NRI

We have been developing the next-generation ACCESS-OM3 (ocean numerical model) suite, featuring ocean and sea ice models (MOM6 and CICE6) and ocean biogeochemistry (WOMBAT-lite) models. These state-of-the-art developments are now being set-up into regional higher resolution configurations and combined with infrastructure to unlock shared development and analysis to better enable collaborations across model codes and oceanographic scales. An example of a regional 4km Australia-wide regional ocean model will be shown, along with a smaller WOMBAT-lite biogeochemical configuration. These models capture remotely generated oceanographic signals with the aim of investigating nesting strategies to capture cross-scale processes. There is a complex range of regional and coastal processes to be captured in ocean models which necessitates a diversity in ocean modelling codes used throughout Australia. Model agnostic workflows are being developed to enable effective collaboration across diverse modelling codes, processes and scales. Strategies to share configurations, development and analysis across the different modelling codes are also being formed. This currently includes workflows to develop, build and share regional MOM6 (ACCESS-rOM3) and ROMS model configurations and outputs with the capability to include other model codes in this workflow.

A 30-year free running hydrodynamic model (using ROMS v4.2) and daily climatology for identification of marine heatwaves and coldspells in the East Australian Current System.

Dr Robert A. B. Mason, Phellipe Couto, Dr Colette Kerry, Dr Claudio Cardoso, Dr Fernando Sobral, Prof Moninya Roughan
Coastal and Regional Oceanography Laboratory, University of New South Wales

Knowledge of the 4-Dimensional ocean structure is essential for detection of temperature extremes such as marine heatwaves and cold spells (MHW and MCS), as well as freshening and hypersaline anomalies. To understand the impacts of such events on the physical structure and biological functioning of the ocean, it is crucial to have a better spatiotemporal coverage than what is currently available from observations. Here, we use a high-resolution ocean model for the East Australian Current System over a 30-yr hindcast to create daily climatologies for marine temperature extremes and compound event studies. Comparisons with observations show good skill in reproducing mean fields and long-term trends. The model also captures the subsurface structure and intensity of MHW and MCS, although some discrepancies point to short-term variability associated with the East Australian Current and mesoscale eddies, whose exact positions are difficult to reproduce. A limitation is the representation of salinity in the upper 200 m of the coastal ocean, where observed low-salinity waters were not captured, highlighting the importance of including river discharge forcing in the future. These model-derived daily climatologies provide a valuable basis for future studies of marine extremes, compound events, and their ecological and physical impacts in southeastern Australia.

Going with the (better represented) flow: Lagrangian metrics for SWOT assimilation in the East Australian Current system

Mr Luke Matisons[1,2], Professor Moninya Roughan[1,2], Associate Professor Amandine Schaeffer[1,3]
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High-resolution sea-surface height observations from the Surface Water and Ocean Topography (SWOT) satellite have opened new opportunities for improving our understanding of multi-scale processes in ocean dynamics. Here, we present results from assimilating SWOT along-track altimetry into a regional ocean model of the East Australian Current (EAC) system, evaluating model performance based on Lagrangian skill score and eddy characterisation. Comparisons with observations from 24 independent surface drifters show that SWOT assimilation improves modelled velocity agreement and trajectory alignment, with the largest gains over free-running and traditionally-assimilating configurations occurring within two sampled mesoscale eddies – an anticyclone and a cyclone. Lagrangian eddy tracking further demonstrates that SWOT assimilation improves dynamic and kinematic representation of eddies, yielding higher Rossby numbers in both the anticyclone and cyclone, with additional marginal improvements to retention timescales and eddy center location estimates in the more coherent cyclone. These results establish SWOT data assimilation as a meaningful step toward improved ocean model applications and forecasting.

Revising GBR water quality targets using new observation and advanced modelling

Dr Mathieu Mongin[1], Dr Jane Waterhouse[2], Steven Lewis[3], Jennifer Skerratt[1], Shawn Darr[4], Gillian McCloskey[4], Zoe Bainbridge[4]
[1]CSIRO, [2]C2O Consulting Australia, [3]Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) James Cook University Australia, [4]Department of the Environment, Tourism, Science and Innovation Australia

The Great Barrier Reef is a globally significant ecosystem increasingly impacted by sediment and nutrient loads from river discharge since European settlement. Science-based load-reduction targets, first established in 2017, were updated in 2025 using improved monitoring data and more advanced catchment and marine modelling frameworks. While these advancements enhance system representation, they also highlight the inherent complexity of the region, showing that additional information does not necessarily simplify management decisions. The updated approach combines an extended 12-year modelling period and expanded river representation with a shift from grid-based threshold assessments to distribution-based analyses of chlorophyll-a within river plume footprints. This method captures spatial and temporal variability more effectively, reduces sensitivity to individual model cells, and enables a more robust evaluation of load-reduction scenarios. Results indicate that target determination depends strongly on the shape and separation of chlorophyll-a distributions across scenarios. Well-defined distributions allow stable and threshold-independent targets, whereas broader, overlapping distributions increase uncertainty and sensitivity to threshold selection. Overall, this framework improves the robustness of target setting while identifying cases where load reductions may yield limited water quality benefits, suggesting the need for region-specific management strategies.

Bridging collaborative ocean research model development onto shared operational forecast workflow: The South East Australian Coastal Ocean Forecast System (SEACOFS) pilot case

Mr Phellipe Pereira Couto[1], Dr Colette Kerry[1], Dr Helen Macdonald[2], Prof Moninya Roughan[1]
[1]Coastal and Regional Oceanography Lab, School of Biological Earth and Environmental Sciences, (UNSW), [2]Australian Earth System Simulator (ACCESS-NRI)

The Australian National Coastal Ocean Modelling System (ANCOMS) responds to the National Marine Science Plan 2015–2025 vision for a coordinated capability delivering actionable coastal ocean information to support research, industry, and decision-making. A key objective is fostering a collaborative, open-access modelling ecosystem built on shared configurations, reproducible workflows, and FAIR-aligned data practices. Drawing on COSIMA's community-of-practice model, this effort aims to better connect research model development with operational forecasting within a unified framework, the Coastal Modelling Commons. As a pilot test bed, the SEACOFS is being used to demonstrate how collaboratively developed research model configurations can be transitioned into a shared forecasting workflow. Recent progress includes coupling flexible research experiments with an automated pipeline for model execution, evaluation, and data handling, enabling a consistent pathway from research development to forecast product generation. Nested modelling approaches linking large-scale ocean conditions to high-resolution coastal processes have been implemented and tested within this framework. While still under active development, this pilot highlights the feasibility of bridging research and operations through shared workflows. It provides an initial foundation for enhancing collaboration, reducing duplication and supporting future expansion toward a coordinated national coastal forecasting capability.

Filling the gaps between coastal tide gauges – extending it to sea level

projections

Dr Oceane Richet[1], Dr Ebru Kirezci[1], Dr Ryan Holmes[1], Dr Vanessa Hernaman[2], Dr Claire Spillman[1]
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Tide gauges provide essential observations of sea level along many coastlines, yet their spatial distribution remains uneven – particularly in remote, low-population, or geomorphologically complex coastal regions. In addition to this limitation, tide gauge records vary significantly in temporal coverage, ranging from multi-decadal time series to short, intermittent observations. These limitations constrain robust, long-term assessments of sea level and coastal hazards. We address these gaps using a coupled barotropic hydrodynamic model (CCHaPS), to generate a high-resolution network of coastal virtual tide gauges around Australia. This network provides a set of multidecadal (1982–2020) hourly total water level time series—comprising tidal reconstructions, nontidal residuals, and tidal constituent amplitude and phase—at a spatial resolution of 2–4 km. The modelled tidal signal is further validated against observations and shows high skill (≥ 0.6), outperforming existing regional and global tide models along the northwest, south, and east coasts. This enhanced dataset is further applied to CCHaPS Climate Projections (2081-2100) to assess the response of tides to sea level rise along the Australian coastline.

Drivers of non-uniform warming inshore of the East Australian Current

Dr Fernando Sobral[1,2], Prof. Moninya Roughan[1,2], Dr Neil Malan[2,3], Dr Claudio Cardoso[1,2]
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Western Boundary Currents (WBC) are important features in the upper ocean to redistribute heat. Under climate change, WBC extensions are warming at an accelerated rate, often linked to increased mesoscale eddy activity. In the East Australian Current (EAC) system, shelf waters exhibit non-uniform warming, with steeper trends observed in eddy-dominated regions. However, the mechanisms driving shelf-offshore heat exchange, and their interactions, remain poorly understood. Using a high-resolution 26-year ocean model alongside observational data, we investigate the drivers of heat transport to the shelf, while also identifying features contributing to extreme shelf warming events. Distinct heat transport mechanisms underpin the observed non-uniform warming of the adjacent shelves. A poleward shift in the separation of the EAC enhances jet-driven heat transport, whereas the strengthening of anticyclones in the southern extension, together with their increasing interaction with the shelf, drives the accelerated warming along the coast of southeastern Australia, with a discontinuity in between. Connecting offshore processes with shelf temperature variability and trends enhances our ability to predict extreme warming events and long-term trends. This understanding not only advances knowledge of the EAC system but also provides insights applicable to other WBCs globally.

Integrating Observations, Physics-Based Modelling and Deep Learning Remote Sensing to Assess Water Quality in the NSW Marine Estate

Mr Jake Stanaway-dowse[1], Dr Nagur Cherukuru, Dr Eric Lehmann, Dr S L Kesav Unnithan, Dr Timothy Ingleton, Miss Gemma Kerrisk, Mr Neil Doszpot
[1]NSW Department of Climate Change, Energy, the Environment and Water, [2]Commonwealth Scientific and Industrial Research Organisation

Global remote sensing algorithms often perform poorly in Australian coastal waters, biasing retrievals of key water quality variables such as chlorophyll-a. To address this, NSW DCCEEW and CSIRO developed a regional deep learning remote sensing model calibrated for NSW estuarine and coastal waters. The model is underpinned by a 2022–2025 field campaign spanning more than 180 sites across nine major NSW estuaries, combining in situ optical observations along river-to-ocean gradients with physics-based forward modelling. Applied to 30 m Landsat 8 imagery, the approach produced a decadal (2013–2024) time series of key biogeochemical variables, including TSS, DOC, total chlorophyll-a, CDOM and Kd490. This integrated observation–modelling framework enables new applications for marine estate management, including quantification of estuarine TSS and DOC export to coastal waters, mapping of sediment plume extent and severity following major rainfall and flood events, and identification of Kd490 light-limitation hotspots affecting vulnerable benthic habitats. The study demonstrates how regionally calibrated AI/ML methods, combined with marine observations and physical modelling, can deliver scalable, management-ready water quality information for coastal systems.

Escalating future coral bleaching risk at Ningaloo Reef revealed by high-resolution climate projections using deep learning

Dr Chaojiao Sun[1], Dr Ajitha Cyriac[1], Madeline Copcutt[2]
[1]CSIRO Environment, [2]Department of State Growth Tasmania

The 2025 Ningaloo coral bleaching event demonstrated that even recognised climate refugia are vulnerable to severe thermal stress, and events of this magnitude are projected to become increasingly frequent. To quantify future bleaching risk, we produced high-resolution sea surface temperature (SST) projections for the Ningaloo Coast by applying a deep learning downscaling model to the seven best-performing CMIP6 models for Australian climate across multiple emission scenarios. Raw climate model SSTs were first bias-corrected against satellite daily observations to remove a systematic ~1°C warm bias, then downscaled to 10 km resolution using a super resolution deconvolution network (SRDN). By end-of-century, Ningaloo Coast SSTs are projected to warm by up to 1.7°C under the low emission scenario (SSP1-2.6), ~2.5°C under the intermediate scenario (SSP2-4.5), and up to 3.7°C under the high emission scenario (SSP3-7.0). This sustained warming drives a substantial increase in Degree Heating Weeks (DHW), directly translating to a higher frequency of mass bleaching events comparable to or exceeding 2025 under the intermediate and high emission scenarios. These findings underscore the urgency of ambitious climate action to safeguard the future of this World Heritage Area.

Optimal policies for responding to marine heatwave impacts on fisheries

Mr Richard Takyi
IMAS, University of Tasmania

Accurate stock assessment is essential for sustainable fisheries management, as marine heatwaves are projected to increase in intensity under climate change. Reliable models are therefore needed to guide management responses to heatwave impacts. This study assessed the effects of alternative management policies during marine heatwave events on fish biomass and catch in Tasmanian coastal waters. Moderate and extreme marine heatwave scenarios were developed from historical sea surface temperature data (1995–2023) and applied to an Ecopath with Ecosim model representing key functional groups, including phytoplankton, macroalgae, seagrass, zooplankton, abalone, rock lobster, squid and jack mackerel. Simulations incorporated single and multiple heatwave events under five fishing management scenarios, parameterised using historical fishing effort and catch per unit effort time series, ranging from maintaining effort (0% reduction) to temporary fishery closures (100% reduction). Results show management responses were most effective when implemented in the same year as heatwave events. Temporary fishery closures led to higher biomass and catch one year later, particularly for small pelagic species. Overall, species exhibited increased biomass responses to both moderate and extreme heatwaves and associated management measures, while abalone showed little sensitivity. These findings emphasise the importance of timely and adaptive management to mitigate marine heatwave impacts.

Adaptive Real Time Data Visualisation to Enhance Marine Operations

Dr Geoffrey Wake, Dr Peter McComb, Mr Gabriel Valente, Dr David Johnson
Oceancomm

Over the past 25 years, substantial advances have been achieved in the accuracy of weather forecasting across a range of spatial and temporal scales, alongside significant improvements in marine observation systems. Despite these step-change developments, the manner in which observational and forecast information is communicated to end users remains limited, often constraining its effective interpretation and operational utility. Here, we present a novel marine data visualisation platform that enables end users to interactively interrogate observational and forecast datasets in an integrated, real-time environment. By improving the accessibility and interpretability of complex marine datasets, the platform supports enhanced situational awareness and more informed operational decision-making.

Seasonal redistribution of riverine freshwater over the Western Java Sea–Sunda Shelf from high-resolution regional NEMO experiments

Dr Xingkun Xu[1], Dr Pavel Tkalich[2]
[1]National University Of Singapore, [2]Technology Centre for Offshore and Marine

River runoff is an important freshwater source to the western Java Sea–Sunda Shelf, but its role in shaping regional salinity variability and freshwater pathways remains poorly understood. Here, we use a high-resolution regional NEMO model forced by JRA55 to investigate the seasonal redistribution of riverine freshwater. Two experiments are compared, with and without river runoff, to isolate the runoff-induced signal. Model performance is evaluated against satellite sea surface salinity products, with SMAP used as the primary reference for coastal and shelf-scale freshening patterns and OISSS providing an additional benchmark for broader-scale, temporally smoothed variability. Including runoff improves the simulation of coastal and shelf salinity, especially in regions affected by strong discharge and low-salinity plume development. Results show that riverine freshwater is not confined to river mouths but is seasonally redistributed across the western Java Sea–Sunda Shelf under monsoon-driven circulation. The freshwater signal exhibits both nearshore retention and offshore spreading, with some regions showing enhanced boundary export. Vertical analyses further indicate that runoff modifies upper-ocean salinity structure and strengthens near-surface stratification. These findings highlight river runoff as a key control on seasonal freshwater storage, spreading, and transport in this dynamically complex tropical shelf sea.

SeaScope FVON: user-friendly access to ocean data from the global Fishing Vessel Observing Network

Remy Zynfogel[1], Dr Peter McComb[2], Mr Sebastien Delaux[2], Mr Simon Weppe[1]
[1]Calypso Science, [2]Oceanum

SeaScope FVON is an open-access web platform designed to integrate, visualise, and distribute ocean observations at global scale. The system brings together temperature-depth observations from programmes within the Fishery and Vessel Observing Network (FVON) and aggregates these near-real-time measurements with the colocated regional and global model nowcasts. The combination of measured and modelled parameters on a single plot provides an enhanced environmental context, and allows deeper interpretation of the numerical predictions at relevant spatial and temporal scales. A key objective is to provide user-friendly and seamless access to both recent and historical data. Users can explore the latest sampling locations and download harmonised datasets in multiple formats using user-defined filters such as time range and spatial search radius, with access to the last three months of observations. Built on the OCEANUM.IO Datamesh architecture, the platform enables automated data ingestion and processing while supporting rapid integration of new FVON programmes. The platform is intended for a broad audience, including researchers, fishers, industry stakeholders, and the general public. It is designed to improve accessibility and practical use of globally distributed ocean observations and to support collaborative engagement across the marine data community.

Posters

Ocean Jets

Mr Chris Aiken
University Of Tasmania

We take a new look at the evolving structure of ocean jets (and eddies).

Model-ready data products: Taking discrete zooplankton observations from the local to the global scale

Dr Jason Everett[1,2,3], Ms Claire Davies[3], Professor Anthony Richardson[3]
[1]Everdat Solutions, [2]The University of Queensland, [3]CSIRO, Environment

Zooplankton biomass observations have been collected globally for well over 100 years, yet most datasets have been unavailable or difficult to use by the research community. Many of these are small-scale datasets, but when combined, they provide zooplankton observations over a large spatial and temporal scale. We have collated >200,000 records of marine zooplankton biomass into a single database, from which we developed statistical models based on a suite of environmental variables including sea surface temperature, chlorophyll-a and depth, and adjusted for biases associated with different sampling methods. These statistical models were used to produce spatial maps as model-ready data products. These model-ready data products are publicly available at any spatial extent or resolution the user requires via an R-Shiny Application. The zooplankton database and associated model-ready products will be invaluable for global change studies, research assessing trophic level linkages, and for initialising and assessing biogeochemical and ecosystem models of lower trophic levels.

Modelling salmon aquaculture production in offshore environments

Dr Scott Hadley[1,2,3], Professor Chris Carter[1,2], Dr Maxi Canepa[1,2], Dr Jenny Skerratt[3]
[1]University Of Tasmania, [2]Blue Economy Cooperative Research Centre, [3]CSIRO

Offshore relocation of salmon aquaculture exposes farms to higher temperatures and stronger currents that can reduce growth and increase metabolic costs. Funded by the Blue Economy CRC, we present a mechanistic growth model for Atlantic salmon that integrates temperature- and oxygen-dependent physiological processes and includes a module to quantify heat-related tissue damage during thermal stress. To improve transferability across sites, the mechanistic core is coupled with a physics-informed machine learning component that captures unexplained variability using data from multi-month growth trials on individual fish under elevated temperatures. The coupled model is embedded within a regional hydrodynamic–biogeochemical model for southeast Tasmania to simulate growth across a range of environmental scenarios (including episodic warming and high-flow sites). We compare model predictions with observed growth from farm sites to validate performance and identify environmental and management strategies for optimizing offshore deployments. Results demonstrate the framework's potential to inform site selection, stocking strategies, and operational planning under future ocean conditions.

Australian regional atmospheric models display considerable differences in estimated cloud cover over the Australian Great Barrier Reef with implications for ocean-atmosphere heat budget calculations

Mr Luke Harrison[1], Professor Charles Lemckert[1], Dr Clothilde Langlais[2], Dr Songyan Yu[1], Dr Daniel Harrison[1]
[1]Southern Cross University, Reefs and Oceans Cluster, [2]Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Low level marine clouds play a significant role in modulating shortwave radiative forcing, limiting positive heat flux into the ocean and affecting marine heatwave formation. Over large shallow lagoons with limited water transport such as the Great Barrier Reef in Queensland this can have a pronounced effect on water temperatures. Despite the importance of cloud cover, current operational forecast models and reanalysis datasets exhibit significant differences in the amount of low cloud predicted over the oceans. Here we compare the amount of cloud predicted from the current Bureau of Meteorology operational atmospheric forecast model ACCESS-R and reanalysis data products BARRA-R2 and BARRA-C2 to satellite retrievals and continuous ground based observations by lidar and optical cloud camera located at One Tree Island. These multiple data sources create a clear picture of the discrepancies in atmospheric data available for the forcing of regional coastal hydrodynamic modelling. Our analysis indicates that BARRA-R2 and ACCESS-R likely underpredicts the prevalence of low cloud whilst BARRA-C2 overpredicts low cloud cover with implications for ocean-atmosphere heat budget calculations. These impacts are explored for the eReefs implementation of the CSIRO EMS hydrodynamic and biogeochemical model.

The snakes and ladders of the ocean surface boundary layer: Observations of turbulent heat transport

Prof. Nicole Jones, Dr Matt Rayson, Emeritus Prof. Greg Ivey
University Of Western Australia

The atmosphere-ocean exchange of heat and gases is influenced by the turbulent layer that extends from the surface to the seasonal pycnocline 10s to 100s metres below, termed the ocean surface boundary layer (OSBL). Despite the importance of the OSBL in the Earth's response to weather and climate forcing, leading predictive models for both seasonal ocean forecasts and future climate projections do not reproduce the depth and strength of the pycnocline, in part due to inadequate representation of turbulent stirring in the OSBL. New turbulence observations, made possible by rapid profiling microstructure sensors, uncover the temporal and spatial variability of turbulent heat transport. In the tropical ocean location studied, the strength of the near-surface thermocline (~10 m) varied diurnally, but often did not get destroyed at nighttime. Here, patches of elevated turbulent stirring were often confined to the surface, but during periods of stronger convective nighttime cooling the turbulent stirring extended towards the seasonal pycnocline. The seasonal pycnocline (~70 m depth) continuously oscillated due to nonlinear internal waves, driving continuous with some notable higher peaks. These observations provide some of the first OSBL turbulence observations we require for ocean model development and evaluation.

Dedicated Climate Quality Ocean products for the Australian region

Dr Benoit Legresy[1,2,3], Dr Christopher Chapman[1], Dr Thomas Moore[1], Ms Rebecca Cowley[1], Dr Gabriela Semolini-Pilo[1]
[1]CSIRO, [2]IMOS, [3]AAPP

In this presentation we present a number of Products produced at CSIRO which are contributing to the climate record and reference for every day oceanographic work. The four products presented here are the CSIRO Atlas of Regional Seas (CARS), the global and regional Sea Level record, the Ocean heat content and the reference Sea Surface Temperatures Atlas of the Australian Regional Seas (SSTAARS). In this presentation we will introduce the four products, what's involved in their construction to make them climatically relevant and examples of their everyday use. The CARS is a reference climatology for ocean profiles constructed from a huge number of in situ measurements optimally put on a 3D gridded climatology. Among the many applications, it is used every day to quality control of the Argo floats data. The Regional Sea Level and Ocean heat content are built from the Refrence Satellite altimeters and Argo data with climate control and QC to produce monthly gridded sea level and ocean heat profiles. The SSTAARS is a Sea Surface Temperature climatology that is used to detect Marine Heat waves and produce maps of extreme sea surface temperatures.

Dynamics of the Capricorn Eddy dynamics in the southern Great Barrier Reef

Ms Ambre Leveque[,2], Dr Benoit Legresy[3,4], Dr Clothilde Langlais[1], Dr Severine Choukroun[2], Dr Helen Bostock[5]
[1]CSIRO, [2]James Cook University, [3]AAPP, [4]IMOS, [5]University of Queensland

In this study, we investigate the ocean circulation in the southern Great Barrier Reef using novel SWOT satellite observations and high resolution 3D ocean modelling from the eReef project. Previous work using oceanographic campaigns from the 1980s and 90s and remote sensing show the East Australian Current (EAC) flowing around the Swain reefs and forming the Capricorn Eddy providing nutrients to the reefs. We adapted the processing of the SWOT high resolution data to the specific region and assess the occurrence and variability of the Capricorn eddy. SWOT allows us to validate the high-resolution model. In turn the eReef model offers a 3D extension of the circulation understanding.We will describe the variability and activity of the eddy (occurrence, extent at depth, seasonality, and interactions with the EAC) and discuss the implications on transfers between the open ocean and the continental shelf and reefs. This study will support the dedicated RV Investigator voyage to the Darumbal and Woppaburra Sea Country aiming at supporting the management of the region.

Long-term climate-quality data time series of coastal seawater temperature for the Fiji Islands

Dr Antoine De Ramon N'Yeurt[1], Dr Jacobo Martin Nascimento[1], Dr Christophe Menkes[2], Dr Maxime Duphil[2], Romain Le Gendre[3]
[1]Centre for Sustainable Futures. The University Of The South Pacific, [2]Institut de Recherche pour le Développement, [3]IFREMER

With the ever-growing threat of climate change for small island developing states in the Pacific region, an accurate assessment of the impacts of global warming relies critically on long-term precise data for seawater properties such as temperature, salinity, dissolved organic carbon (DOC) and pH. The correct use of satellite remote sensing data also requires accurate calibration and validation with direct field observations. However, currently there is a noticeable gap in the availability of such quality in situ climate data for those islands. Here we report on a first step towards addressing this dilemma for the Fiji Islands, through the implementation, since November 2012, of a network of seawater temperature monitoring platforms at 13 sites around Fiji. The network produces continuous, climate-quality time series with data products made freely available to researchers and the public on a dedicated web server (https://www.reeftemps.science/en/data/). With now well-over a decadal time-series of data for the Fiji Islands, we present some preliminary analyses showing trends supporting the impact of global warming on coastal waters, with direct consequences for coral bleaching and loss of marine biodiversity.

Bridging the Gap: The indispensable synergy of physical and numerical modelling in complex nearshore environments

Mr Nick Naderi, Mr Kane Nielsen
Queensland Government Department Of Environment, Tourism, Science And Innovation

Numerical models have become highly advanced and efficient for simulating regional wave transformation from offshore to nearshore environments. However, as wave energy converges on complex coastal features—such as variable dredge deposition mounds, artificial reefs, or porous rock armouring—hydrodynamic interactions become non-linear. In these shallow, structurally complex zones, purely numerical approaches can become computationally expensive and struggle with accuracy without empirical validation. This poster highlights the synergy between physical and numerical modelling, utilising the Bilinga dredge placement study as a primary case study. To assess the surf amenity benefits of an artificial sand mound, a non-hydrostatic wave-flow model (SWASH) was developed. Initially, the model's default breaking parameters failed to accurately capture the U-shaped wave focusing and breakpoint trajectories over the mound's rapidly changing bathymetry High-fidelity physical modelling conducted in the QGHL wave basin provided the benchmark data necessary to tune the numerical breaking parameters. This calibration successfully aligned the numerical outputs with observed wave mechanics. Field observations further support these findings, with video footage of the placed sand mound at Bilinga showing similar wave energy focusing and induced wave breaking over the mound. Ultimately, this highlights the importance of integrating physical and numerical modelling for reliable simulation of complex wave–structure interactions.

Modelling range extensions of Eastern Rock Lobster

Dr Christopher Roach[1], Prof. Andrew Jeffs[2], Prof. Helen Phillips[1], Dr Hannah Dawson[1], Prof Paul Spence[1]
[1]University Of Tasmania, [2]University of Auckland

Eastern Rock Lobster (ERL, *Sagmariasus verreauxi*) is a species of lobster found in 50-100m deep waters around eastern Australia and northern New Zealand. ERL spawn in summer around northern NSW and northern New Zealand. The last decade has seen range extensions of ERL, with individuals being recorded in South Australia (Linnae et al. 2023) and an increase in settlement in Tasmania (Robinson et al. 2015). In this paper we employ the Parcels lagrangian particle tracking package using data from the ACCESS-OM2-01 10km global ocean model to explore settlement of S. verreauxi in South Australia between 1988 and 2018 and under future climate scenarios. We find that between 1988 and 2018 no larvae settled in South Australia. However, we see a shift in settlement in western Victoria from irregular single year pulses prior to 2010 to a more consistent rate of settlement subsequently. We speculate the increased settlement in Victoria may drive an increase in migration of juvenile and mature ERL against the prevailing current (Booth 1986; Booth 1997; Montgomery 1992). Under future climate emissions scenarios we see larval settlement expanding westward, implying that by late century settlement of ERL larvae in South Australian waters is highly likely.

Enabling Long-Term Ocean Observation in Antarctica: Insights from ADCP Measurements in the Weddell Sea

Mr Rowan Tesch
Nortek Australia

Understanding how ocean heat reaches Antarctic ice shelves is critical for improving projections of ice melt and global sea level rise. This presentation highlights findings from a multi-year observational study in the Weddell Sea by researchers at the University of Bergen, where ocean currents were continuously measured over a three-year period using a Nortek Signature 55. The dataset shared by the researchers revealed how variability in shelf currents and ocean fronts influences the transport of relatively warm deep water toward ice shelves. These processes play a key role in modulating basal melt, yet remain challenging to capture due to the harsh and remote Antarctic environment. Sustained, high-resolution observations provide valuable insight into seasonal variability in ocean circulation and heat delivery. This work demonstrates the importance of robust, long-duration instrumentation in enabling such measurements. Acoustic Doppler Current Profilers deployed beneath sea ice can operate for years, collecting detailed velocity profiles across the water column with minimal intervention. These capabilities are essential for expanding observational coverage in high-latitude regions, were data scarcity limits model validation. This highlights a proof of concept for how technology contributes to a better understanding of ocean processes and their role in the global climate system.

Horizontal resolution is not enough: SWOT assesses submesoscale-resolving ocean models in the Antarctic Circumpolar Current

Mr Yann-Treden Tranchant[1,2,3], Benoit Legresy[1,3], Darren Engwirda[3], Clothilde Langlais[3], Paul Sandery[3], Mike Herzfeld[3], Annie Foppert[1,2]
[1]Australian Antarctic Program Partnership, [2]Institute for Marine and Antarctic Studies, University of Tasmania, [3]CSIRO Environment

Submesoscale motions (1–10 km) play a central role in the redistribution of heat, carbon and nutrients in the ocean. Yet their realistic representation in ocean models remains challenging and is often assumed rather than directly evaluated. The recently launched Surface Water and Ocean Topography (SWOT) satellite now provides global sea surface height (SSH) observations down to scales of order 10 km, offering a new observational reference for high-resolution ocean models. Here, we use SWOT to evaluate a hierarchy of models, from 5 km to 1.5 km grid spacing, in an energetic meander of the Antarctic Circumpolar Current (ACC). We show that kilometre-scale resolution is required not only to represent SSH variability down to SWOT scales, but also to capture the upscale energy transfers that sustain realistic variability at larger scales. However, horizontal refinement alone is insufficient. Adequate vertical discretization is also required to avoid grid-scale noise and artificial mixing. To mitigate this issue, we introduce and validate a wave-dissipation closure that suppresses non-physical instabilities while preserving physical submesoscale motions. By identifying existing biases in ocean models and providing practical solutions to improve it, this work provides a pathway toward more reliable estimates of submesoscale tracer fluxes in the Southern Ocean.

Augmenting Argo Quality Control Using Machine Learning

Dr Robin Wederick
Bureau Of Meteorology

The 4000+ Argo floats currently active in the global oceans are an essential source of sub-surface ocean observations. The data provided by the floats are subject to both real-time (RT) and delayed-mode (DM) quality control (QC): the latter being the gold-standard validation. The DMQC is not available in time for operational forecasting, and the efficacy gap between the RTQQ and the DMQC is a source of systematic error for operational ocean analyses. This can detrimentally affect the accuracy of downstream forecasts. Previous efforts to replace the standard RTQC methodology using machine learning (ML) techniques have yielded mixed results. In contrast, this work describes a method to augment- rather than replace- the Bureau of Meteorology's existing RTQC using a gradient-boosted decision tree ML algorithm. The results indicate that the proportion of erroneous Argo profiles correctly identified can be significantly increased without substantially reducing the number of accurate profiles. These enhancements have the potential to improve the reliability of both dynamic and ML-based ocean and coupled model forecasts.

Coastal Ningaloo's response to TC Narelle: fusing in-situ and remote sensed observations with IMOS HF radar

Andrew Zulberti[1], Matt Rayson[1], Nicole Jones[1], William Edge[1], Paul Branson[1], Simone Cosoli[3], Jeff Hansen[1]
[1]School of Earth and Oceans, The University of Western Australia, [2]CSIRO Environment, [3]School of Engineering, The University of Western Australia

We present high resolution surface current maps of the Ningaloo coast's response to TC Narelle in March 2026. The current maps resolve a large sediment-laden eddy that formed over the UNESCO World Heritage listed reef, highlighting a mechanism for cross-shelf exchange in response to extreme forcing. We derived these maps by fusing a suite of data sources including the IMOS HF radar at point Billie, surface drifters, surface current moorings, Sentinel 2 optical imagery, Himawari-9 SST, as well as vessel-mounted ADCP transects from the R.V. Investigator. This new data provides a more comprehensive validation set for Sentinel 2 surface currents than we have seen in the literature – and the timing with a category 4 TC at Ningaloo is highly fortuitous. The processing here extends remote sensing techniques being developed for Sentinel 2 and Himawari-9, and highlights some systematic errors with remote sensed observations at this site. We provide insight into improved experimental design to quantify and eliminate these errors in the future.

Posters & Lightning Talk

Regional ocean dynamics regulate the efficiency of Ocean Alkalinity Enhancement

Dr Harris Anderson, Dr Mathieu Mongin, Dr Clothilde Langlais, Dr Mark Baird, Dr Elizabeth Shadwick, Dr Andrew Lenton
CSIRO

Ocean Alkalinity Enhancement (OAE) is a promising marine carbon dioxide removal (mCDR) method. While global ocean and Earth system models are necessary to track air-sea CO_2 equilibration and far-field alkalinity transport on extended timescales, OAE efficiency is affected by local processes. Using a regional 3-D hydrodynamic-biogeochemical model (2 km), we assess the effects of deployment location and interannual climate on OAE in Bass Strait, southeast Australia. We add 113.21 Gmol of alkalinity (theoretical uptake of ~4.2 Mt CO_2) over one month via four infrastructure-constrained pathways: desalination outfalls, shipping lanes, ferry tracks, and coastal outfalls. Simulations are repeated across three Southern Annular Mode (SAM) winter conditions: 2017 (positive SAM, low winds), 2021 (neutral SAM, moderate winds), and 2023 (negative SAM, strong winds). CO_2 uptake efficiency (mol CO_2/mol TA) is mainly controlled by delivery method and location (95.2 %), with minimal influence from SAM phase (3.9 %). At the shelf-break, 70.7 ± 10.5 % of added alkalinity subducts below the mixed layer before equilibrating with the atmosphere, reducing realised CO_2 uptake and producing lower efficiencies (0.11–0.27) than global model estimates (0.31). To resolve scale-dependent mismatches, we recommend integrated monitoring, reporting, and verification frameworks of observational networks, regional models, and global models.

A multi-metric framework for calibrating XBeach against laboratory observations of barrier overwash

Elysia Andrews
Queensland Government Department Of Environment, Tourism, Science And Innovation

Process-based morphodynamic models such as XBeach are widely used to predict storm-driven overwash and breaching, but most calibrations optimise against a single scalar metric. It remains unclear whether a model that performs well on bulk wave statistics performs equally well on bed evolution and on discrete event-scale processes. To address this, XBeach (2DH surfbeat) was calibrated against a laboratory physical model of a sandy barrier. Calibration proceeded through four sequential one-factor-at-a-time and joint sensitivity stages, with model performance ranked using a composite scoring framework aggregating nine independent hydrodynamic, morphodynamic, and event-scale skill metrics. The calibrated model reproduced post-storm morphology with a profile Brier skill score of 0.994 and a 7 mm crest-elevation error, but systematically underpredicted observed overwash event counts. This gap between bulk and event-scale skill is quantified, and calibration protocols for overwash applications are recommended to include explicit event-scale metrics rather than relying on bulk hydrodynamic and morphodynamic skill alone.

The Biological Ocean Observer: An online visualisation portal for IMOS Biological data

Ms Claire Davies[1], Dr Jason Everett[1,2,3]
[1]CSIRO, [2]The University of Queensland, [3]Everdat

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. Not everyone has the necessary skills to make use of the data resources available. Here we demonstrate a solution to simplify these processes for all users: the Biological Ocean Observer (BOO). BOO is an online Shiny application that

Integrates, Analyses and Visualises IMOS data so that everyone can better understand, query and interpret it. BOO increases our ability to deliver impact by expanding the analysis and visualisation of biological data to a broad audience and accelerating the generation of scientific insights. BOO uses internationally recognised programming frameworks (R and Shiny), and all code are freely available, facilitating further development and collaboration with the community. The Shiny application is underpinned by an R-package (planktonr) that allows power-users to replicate the data and visualisations they access from BOO, but also to modify the analysis and visualisation for their use case. This tool is designed to be used by a wide range of national stakeholders including science researchers, natural resource managers, policy makers, educators and the general public – including you!

Introducing the Coastal Hazard Index (CHI)

Dr Isabela De Souza Cabral[1], Paul Bierman[1], James Taylor[1], Claire Spillman[1]
[1]The Bureau Of Meteorology

This study introduces the Coastal Hazard Index (CHI) – a single composite parameter that combines the influence of three key drivers of storm-driven coastal erosion together into a single dimension-less value representing coastal erosion "potential". The CHI consists of three terms to represent metocean ingredients to the hazard: wave energy flux, wave direction, and water level. In the development of CHI, we utilised hindcast data from the recently developed Coupled Coastal Hazard Prediction System (CCHaPS). CHI values were calculated at virtual wave buoys positioned approximately 10 km offshore along the Australian coastline, and evaluated against documented historical coastal erosion events, as well as shoreline change metrics derived from satellite imagery. The analysis demonstrates strong potential for CHI as an indicator of coastal erosion risk, showing notable improvement relative to the existing thresholds currently applied in the Bureau of Meteorology's Coastal Hazard Warnings. This nationally consistent, model-based assessment provides critical insights to support coastal hazard risk evaluations and to inform policy development and coastal management strategies at both regional and national scales.

GPU acceleration of MOM6 using a directive driven approach

Dr Jorge Galvez[1], Edward Yang[2], Micael Oliveria[2], Utheri Wagura[3], Marshall Ward[3]
[1]NCI, [2]ACCESS-NRI, [3]NOAA-GFDL

The Modular Ocean Model version 6 (MOM6) is a well established ocean model used worldwide for climate and ocean research, as well as informing policy about climate change and the evolving oceans. MOM6 was designed as a CPU only code and given the high computational demands for high resolution ocean modelling and the ever increasing availability of GPUs for traditional compute, it is paramount that MOM6 is able to harness the power of GPUs. This work presents the advanced of a collaboration between the NCI, NOAA, and ACCESS-NRI on the GPU acceleration of MOM6 using a directive driven approach. The algorithmic redesign decisions and porting methodology are discussed herein. So far, the dynamical core has been ported to GPUs showcasing promising speedups against CPU architectures at the NCI and NOAA supercomputers.

Accelerating coastal simulations using GPUs: Flooding hazards from tidal and mean-sea level changes at Lakes Entrance

Dr Jorge Galvez
NCI

This work presents Rakali, a GPU-accelerated 2D/3D coastal simulator. While GPU acceleration can offer large speedups over traditional CPU codes, most GPU-accelerated hydrodynamic models for coastal simulation have been ported from CPU-optimized programs, imposing a natural ceiling on how effectively they exploit massively parallel GPU architectures. Rakali was designed from the ground up for GPU acceleration with multinode capability, while also retaining CPU support. A single GPU run in Rakali provides up to 5–7× speedup over 104 CPU cores and up to 100× over serial implementations. Rakali supports both structured and unstructured meshes, with the ability to nest them for maximum flexibility. It can simulate river plumes, salinity mixing, wetting and drying, tides, and sea-surface height, and accounts for wind forcing, atmospheric pressure, and rainfall. Including non-hydrostatic effects is a work in progress Rakali's capabilities are demonstrated by analyzing tide- and mean-sea-level-rise-driven flooding hazards at Lakes Entrance, Victoria.

Uplifting the Bureau of Meteorology's National Storm Surge prediction system

Dr Ryan Holmes, Dr Frank Colberg, Dr Diana Greenslade
Bureau Of Meteorology

This study presents an assessment and roadmap for improving the Bureau of Meteorology's operational National Storm Surge (NSS) forecasting system. The NSS provides high-resolution (~2 km), short-range (3-day lead) forecasts of coastal water levels around Australia using a barotropic ROMS configuration forced by ACCESS-G. Tidal and wave setup components are added in post-processing. Given the growing importance of coastal hazard warning services, there is a need for more comprehensive end-to-end verification, particularly of total water levels used by forecasters. We conduct a detailed case study–based verification, extending previous work by evaluating forecast skill out to 10-day lead times and assessing total water levels rather than non-tidal residuals alone. Results show forecast errors remain relatively stable out to at least 6 days, suggesting lead times could be extended beyond the current 3-day limit to provide additional value. However, systematic limitations are identified in the representation of mean sea level, the seasonal cycle, and tidal amplitudes in some key locations. . We propose practical, easy-to implement modifications to the post-processing system to address these issues, leading to improved forecast performance, particularly along the southern Australian coastline. We conclude by outlining remaining limitations and future development pathways to meet evolving operational needs.

Ocean temperature forecasts for coastal decision making

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Global seasonal and climate ensemble forecasts provide valuable large-scale ocean information, but their coarse resolution is insufficient for coastal decision-making. Critical processes such as marine heatwaves (MHWs) and the associated ecosystem impacts occur at spatial scales of order 1 km. Running high-resolution regional ocean models to resolve these features is computationally expensive, energy-intensive, and often infeasible for ensemble forecasting or for longer time periods. Here we present a statistical downscaling framework that efficiently reconstructs high-resolution (2 km) coastal sea surface temperature from coarse-resolution forecasts. The approach is designed specifically for Marine heatwave detection and early warning, Ensemble-based seasonal forecasting and Long-term climate risk analysis. A case study of the 2011 WA marine heatwave demonstrates that the framework successfully resolves fine-scale coastal anomalies that are absent in coarse models. The method improves detection of extreme temperature events while reducing computational cost by orders of magnitude compared to dynamical downscaling. By operating in a compressed reduced-order representation, the framework enables storage-efficient ensemble generation and uncertainty quantification without requiring large high-resolution simulation archives, making it suitable for operational deployment. This UN Ocean Decade endorsed project contributes to scalable ocean forecasting tools that supports climate resilience, ecosystem protection, and sustainable coastal management.

Update on VICIMOS autonomous ship-borne monitoring operations and applications

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In 2024, Deakin Marine and IMOS reactivated an upgraded autonomous water quality monitoring system on Spirit of Tasmania 1 after Covid-related downtime. The system now collects water quality data every 200m along a 440-kilometre route across Port Phillip Bay and Bass Strait, capturing interannual and seasonal cycles, tidal exchanges, and catchment inflows, for environmental assessment, and assisting local model development. It also delivers in-situ measurements from Bass Strait, supplementing satellite and large-scale model data. The real-time data have monitored dredging operations, and tracked flooding impacts and bloom events. In 2026, Deakin Marine established a similar system aboard the Bar-ba-ka, operated by Gippsland TAFE, building on earlier systems that mapped floods and blooms and aided model validation. The latest installation quickly identified toxic blooms of *Nodularia* and *Pseudo-nitzschia*, prompting enhanced monitoring and timely health advisories during bloom and recovery phases.

Validation of river discharge estimates from the Surface Water and Ocean Topography mission for use in coastal ocean modelling

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Remote sensing-based evaluation of river flows is emerging as a potential technique for the inclusion of freshwater forcing in coastal ocean models. In this study, we evaluate the potential of altimetry from the Surface Water and Ocean Topography satellite mission to provide river discharge estimates suitable for inclusion in a coastal ocean model off southeastern Australia. Through comparison with collocated river-gauges calibrated to the same datum, we show that SWOT altimetry frequently achieved good or excellent matches to gauge-estimated river height. Discharge algorithms applied to SWOT river height measurements captured baseline flow well. However, the same algorithms mostly missed extremes of outflow. We further show through analysis of observational data from the coastal ocean that it is precisely these extremes of flow that exert a major influence on ocean dynamics in the region. Whilst SWOT Level 4 discharge estimates currently appear unsuitable for forcing coastal ocean models in southeastern Australia, alternatives exist, potentially including the development of bespoke pipelines for converting SWOT river height estimates into validated discharge estimates. These methods could prove useful in other regions with sparse gauge data, but with sporadic yet significant discharge events.

Advancements in the recent release of 12 years of Biogeochemical properties in eReefs

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The update to the eReefs modelling framework, released publicly in June 2025, significantly improves the ability to investigate biogeochemical (BGC) processes across the Great Barrier Reef from coast to offshore by extending the temporal coverage of hindcast simulations from 4 to 12 years. This expanded dataset allows analysis of marine environmental variability, including the impacts of significant events such as catchment, floods, coral bleaching, and tropical cyclones. While the core representation of chlorophyll a remains consistent with previous versions, the extended time series enables a more comprehensive understanding of long-term patterns in phytoplankton biomass and primary productivity. Researchers can now examine interannual variability in chlorophyll concentrations in relation to climatic drivers (e.g., El Niño), land-based runoff, and oceanic nutrient intrusions with greater statistical confidence and ecological context. Additional model improvements include enhanced catchment representation for more representative coastal dispersal of nutrient and sediment loads, with expansion from 35 to 101 rivers, as well as refined simulation of shelf break dynamics. The updated datasets will continue to inform the Reef Water Quality Report Card and ongoing model extensions every one to two years will continue to strengthen the utility of eReefs for monitoring and managing reef health under changing environmental conditions.

Advancing Coastal Management through Monitoring and Numerical Modelling: Insights from investing in Tweed Sand Bypassing

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The Tweed Sand Bypassing (TSB) program is a critical coastal management initiative designed to maintain navigability at the Tweed River Entrance and ensure sediment transport to the southern Gold Coast beaches. To address the challenges of managing complex coastal processes, the Department of Environment, Tourism, Science and Innovation (DETSI) has embarked on a comprehensive numerical modelling capability uplift, leveraging modern tools and technologies to refine TSB operations. A key component of this investment is the collaborative research activity under the UQ-DETSI Alliance for Environmental Science. This partnership between The University of Queensland (UQ) and DETSI focuses on developing and testing state-of-the-art coastal morphology models and machine learning/artificial intelligence (ML/AI) tools. These models aim to optimise sand bypassing operations by forecasting sand accumulation, navigability, and sediment dynamics. The project also involves curating and analysing historical TSB data to identify trends, gaps, and opportunities for improved coastal management. Complementing this Alliance activity, DETSI has made additional investments in TSB, including expanding the local metocean monitoring network; development of Phase 1 models for sediment supply areas; and the evaluation of data capture techniques to maximise multi-purpose value.

Connectivity patterns of *Centrostephanus rodgersii* along the eastern Australian coast in recent decades

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The longspined sea urchin *Centrostephanus rodgersii* is a key herbivore whose intense grazing can transform temperate rocky reefs into urchin barrens. Historically endemic to eastern Australia, this species has recently expanded its range, with adult populations detected near Port Davey on the west coast of Tasmania (~42°S, ~145°E), approximately 900 km from its native distribution. While enhanced southward transport associated with the East Australian Current has been linked to range expansion towards eastern Tasmania, the oceanographic pathways supporting connectivity towards western Tasmania remain poorly constrained. Here, we assess larval connectivity from 1994 to 2018 to identify potential source regions along the eastern Australian coast contributing to adult C. rodgersii observed in western Tasmania. We employ Lagrangian particle-tracking simulations using OceanParcels, driven by the interannually forced ACCESS-OM2-01 ocean model at 0.1° horizontal resolution. This modelling framework resolves realistic circulation variability and provides a process-based assessment of spatiotemporal connectivity patterns, enabling the identification of dominant dispersal pathways and the relative contribution of eastern source populations to westward and southward range expansion.

Hi-res relocatable modelling in the GBR

Mr Farhan Rizwi
CSIRO

While the spatial fidelity of regional models are ever increasing, due to many practical challenges, they'll never adequately be able to resolve the complex bathymetry as well as fine scale processes at a local level needed to resolve individual bays/estuaries or reef clusters. The high computation burden, specialised parameterisation, initialisation of the in-water, benthic and sediment tracers make them quite prohibitive for large domains. Here we introduce the concept of relocatable hires (100's of metres) modelling in the context of eReefs. Expert researchers can very quickly spin-up a model configuration for their own area of interest, adding local knowledge and customising processes for their particular use case. We have designed the system such that the child model uses the same EMS (Environmental Modelling Suite) package as that of the regional models being nested into, such that there is much greater dynamic consistency within the heirarchy of models to more accurately charaterstise the domain of interest. We describe the system, known as RECOM (RElocatable COastal Model) and provide case studies within the GBR.

Using the IMOS-OceanCurrent website to support model validation and data exploration through integrated ocean observations

Dr Gabriela S. Pilo, Dr David Griffin
CSIRO

Australia hosts an extensive ocean observing network, with data made openly accessible through the efforts of IMOS and partner organisations. While these observations support model validation, data assimilation, and process studies, identifying the best observations for a given application remains challenging. Finding what (and when) observations are available, what can be compared to model results and to other observations, and how representative the data is of broader ocean conditions can be complicated. A good tool to help us understand the available physical oceanography observations in IMOS OceanCurrent, where up-to-date and past observations of the ocean around the country are visualised. In this presentation, we'll provide an overview of what's available on the website that can help us to a) characterise an ocean region, b) assess the representativeness and comparability of different observing platforms for model evaluation, and c) have a more holistic view of an ocean event, from the surface to the sub-surface. We'll show an example of the different types of 'ocean currents' we show on the website, to help you assess what observation is the best for answering your research question.

Exploring Australia's Coasts - Interactive visualisation of large scale 4D data with the Model Visual Explorer (MoVE)

Mr David Secretan-Hallett, Mr Tim Heap
CSIRO

Responsive and interactive visualisation of large geospatial datasets has always been a challenge. With more and more models outputting their data in irregular or unstructured grid formats, some tools have started to fall behind. One of the largest hurdles for tools, is large scale 4D model result datasets that use an unstructured grid. These datasets have file sizes exceeding 100GB with more than 1.4 million polygons, which presents major challenges when trying to load, manipulate and render the data for interactive visualisation. With open-source libraries and industry standard tooling, I'll show you how we achieve responsive interactivity with large scale models using just a laptop. No HPC nodes required!

From hooks to heat: novel fishing vessel observations reveal subsurface temperature variability and extremes around Pacific countries

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Climate change and ocean warming significantly impact millions of people in Pacific Countries (PCs), rendering them among the most vulnerable regions to extreme weather and natural hazards. The economies of many PCs are heavily dependent on the fishing industry and are affected by tropical cyclones, droughts, and marine heatwaves. Subsurface temperature observations are crucial for improving models that accurately predict these extreme events. The Pacific Islands Fishing Vessel Ocean Observation Network (PI-FVON), in collaboration with IMOS, has been instrumenting fishing vessels in the Western Central Pacific (WCP). Sensors collect temperature, pressure, time, and location data, providing a reliable source of near real-time subsurface observations.
Since early 2025, thousands of temperature profiles have been collected across the WCP alongside fishing activities, particularly in regions where observations are sparse or absent. This study examines the spatio-temporal variability of mixed layer depth, isothermal depth, temperature anomalies, and extremes. The PI-FVON dataset provides valuable information for remote areas of the WCP that are difficult to access with traditional instrumentation and where subsurface observations are limited. These results highlight the value of widespread, low-cost ocean observing in typically understudied regions, representing a successful example of co-designed systems in areas of global economic importance.

Drivers of circulation near a headland: observations and modelling in a tropical gulf

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Interactions between tides and coastal morphology can strongly influence transport pathways, ecological connectivity, and contaminant dispersal in coastal systems. In this study, we analysed water level and current velocity records from ADCP deployments near the Puntarenas headland in the Gulf of Nicoya (Costa Rica), using harmonic and Empirical Orthogonal Function (EOF) analyses. A hydrodynamic model forced by astronomical tides was used to examine the spatial structure of residual flow. Observations showed that tidal forcing governs both instantaneous and long-period (>30 h) circulation. Residual currents near Puntarenas were directed toward the headland tip, consistent with theoretical expectations for tide-topography interactions. Model simulations reproduced the same structure and indicated a counterclockwise residual eddy on the left side of the headland (looking offshore). These results indicate that the interaction between tidal forcing and gulf geometry can dominate circulation in the study area, suggesting that the transport of particles, including larvae, may be strongly controlled by tides. These findings are relevant to estuarine and embayment systems with strong tides and complex coastlines, where circulation influences larval dispersal, contaminant pathways, and ecosystem connectivity.

Modelling Pacific oyster growth in a warming coastal environment

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This project aims to develop a process-based numerical model of filter-feeder aquaculture systems in a Tasmanian coastal environment. Growth, filtration, and survival of Pacific oysters (*Magallana gigas*) are strongly influenced by water temperature, phytoplankton availability and water quality, the dynamics of which are influenced by ocean warming to the south-east of Australia. The proposed model will represent biotic and abiotic factors governing oyster performance and will be embedded within CSIRO's existing coupled hydrodynamic–biogeochemical model of Storm Bay, capturing spatial and temporal environmental variability. Empirical data will be used to calibrate and validate the model. The framework will enable simulation of oyster growth responses to changing environmental conditions, supporting assessment of site suitability and aquaculture productivity. There is scope to extend the model using a hybrid approach that integrates empirical observations with mechanistic understanding to better account for uncertainty in complex coastal ecosystems. Additionally, the three-dimensional coastal model may be used to downscale broad-scale marine heatwave forecasts, providing insight into local water temperature variability and biogeochemical dynamics. Expected outcomes for my PhD include improved understanding of the environmental drivers of filter-feeder growth and survival, and enhanced predictive capability for local marine heatwave dynamics, supporting adaptive aquaculture management under climate variability.