

# From the Ocean to the Cloud Now and the Future

## Using the Australian Ocean Data Network

Mark Rehbein  
Director, Australian Ocean Data Network

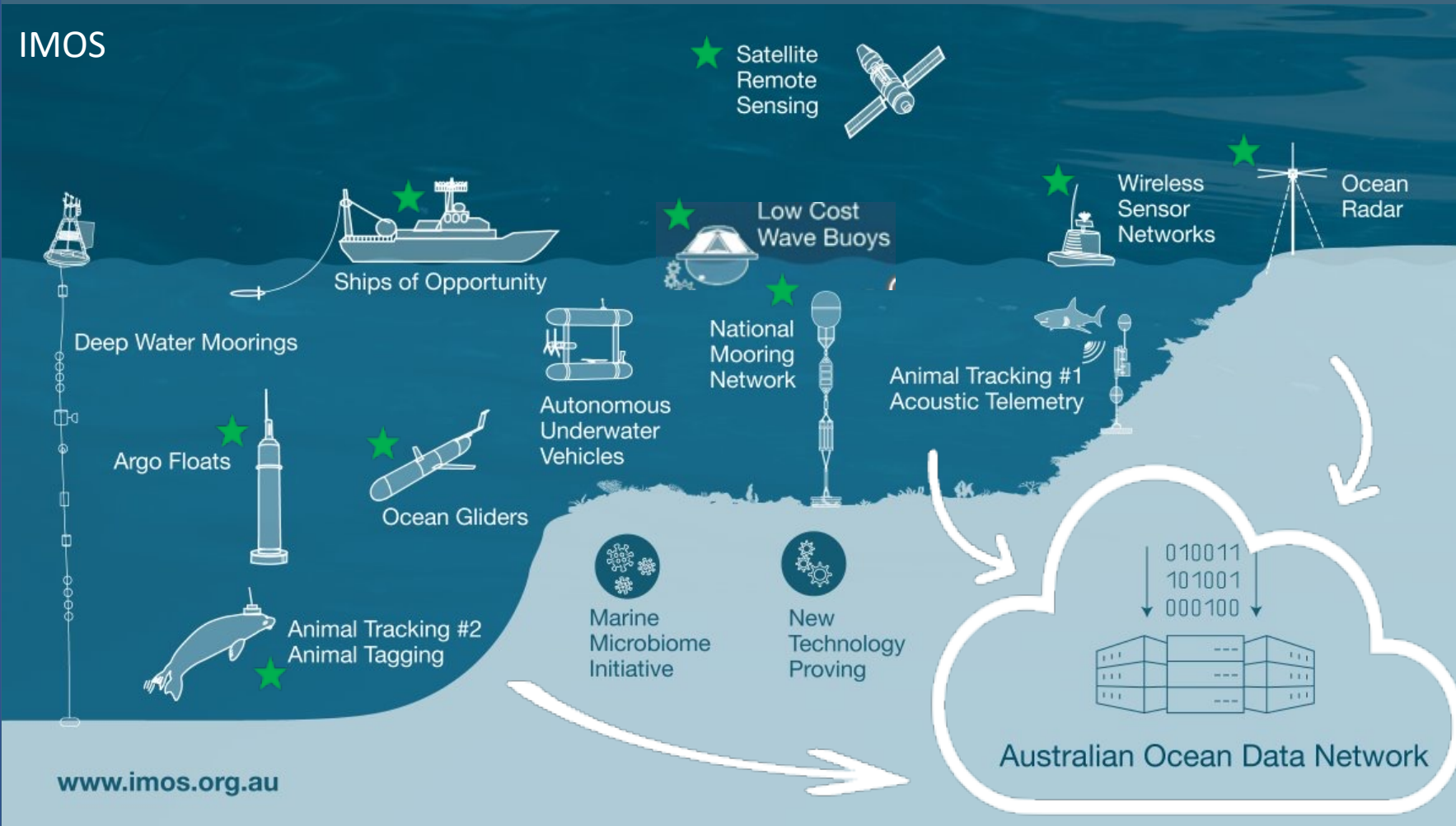


*IMOS acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe and recognise their unique connection to land and sea. We pay our respects to Aboriginal and Torres Strait Islander peoples past and present.*

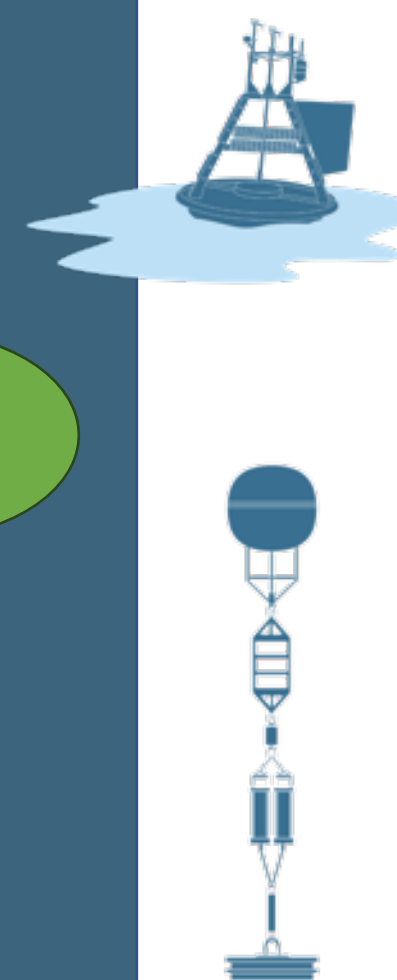


# From the Ocean to the Cloud!

Access to freely and openly accessible data



★ = near real time component



# A Diverse Range of Data

Depth Profiles	Acoustic Tag Detections	Larval Fish Species	Oceanic Sound
Plankton Biomass	Zooplankton Backscatter	Larval Fish Abundance	eDNA
Phytoplankton	Zooplankton	Phytoplankton Colour Index	Bioinformatics
Phytoplankton Pigments	Chlorophyll	Surface Phytoplankton	Bio-Acoustic Backscatter

**Biological**

Turbidity	PIM Particulate Inorganic Matter	CO <sub>2</sub> Partial Pressure
Alk Surface Total Alkalinity	DIC Dissolved Inorganic Carbon	pH Seawater pH
Mole Fraction CO <sub>2</sub>	Mole Fraction CO <sub>2</sub> in Air	Mole Fraction CO <sub>2</sub> in Seawater
Dissolved Oxygen	Nutrients	POM Particulate Organic Matter
Bulk Fluxes		

**Chemical**

Sea Surface Temperature	Sub-Surface Temperature	Maximum Wave Height
Sub-Surface Salinity	Current	Swell Period and Duration
Wave Direction	Wave height	Wave-Number Spectra
Sinking Particle Flux	Radiation	Rain
Surface Air Temperature	Humidity	Directional Waves

**Physical**



★ = near real time component

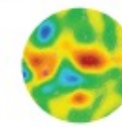
# Bluewater & Climate

## Spatial coverage

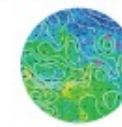
All IMOS data is openly and freely available on the IMOS Australian Ocean Data Network (AODN):

[portal.aodn.org.au](http://portal.aodn.org.au)

SATELLITE REMOTE SENSING PRODUCTS



SEA LEVEL ANOMALY



OCEAN COLOUR



SEA SURFACE TEMPERATURE

### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE



#### ANIMAL TAGGING

Seals are fitted with satellite data loggers that collect valuable oceanographic measurements in regions inaccessible to researchers, that validate oceanographic models and provide information on seal behaviour.



#### ARGO FLOATS

IMOS manages Australia's contribution to the global Argo Array. Deploying regular, ice and biogeochemical Argo floats, Argo Australis is the second largest contributor to this international program.



#### SATELLITE CALIBRATION

The Lucinda Jetty in QLD collects optical measurements to support satellite ocean colour calibration. Buoys located in the Bass Strait TAS measure sea surface height, providing the only Southern Hemisphere calibration site.



#### DEEP WATER MOORING

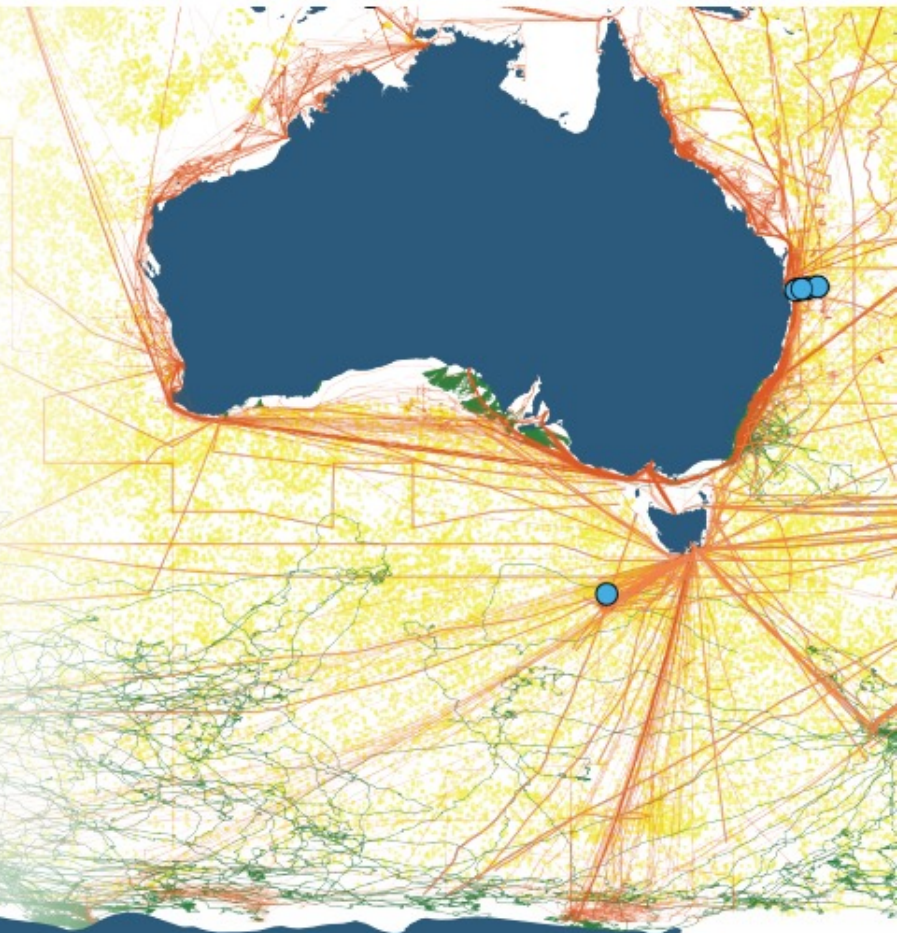
The IMOS Southern Ocean Time Series Observatory monitors long term trends in weather and climate in the Southern Ocean.



#### SHIPS OF OPPORTUNITY

Australia benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements including;

- Biogeochemical Sensors
- Sea Surface Temperature
- Expendable Bathythermographs
- Continuous Plankton Recorders
- Air-Sea Fluxes



### IMOS DATA STREAMS CONTRIBUTE TO



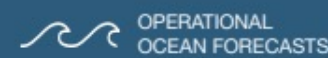
REGIONAL OCEAN MODELS



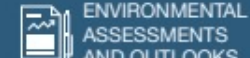
WEATHER FORECASTING



CLIMATOLOGIES



OPERATIONAL OCEAN FORECASTS



ENVIRONMENTAL ASSESSMENTS AND OUTLOOKS



# Northern Territory

## Spatial coverage



### SHIPS OF OPPORTUNITY

The Northern Territory benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements.

'\_\_\_\_\_' indicates Ships Of Opportunity observations.



### MARINE MICROPLASTICS

Monitoring of Marine Microplastics as part of our New Technology Proving Facility identifies potential sources, fate and impacts of microplastics in the marine environment.



### NATIONAL MOORING NETWORK

A national network of moorings that monitor environmental conditions in Australia's coastal waters.



### WAVE BUOY

A wave buoy deployed north of the Tiwi Islands provide valuable real-time information on wave data used to validate wave, weather and climate models.



### LOW-COST WAVE BUOYS

Low-Cost Wave Buoys deployed as part of our New Technology Proving Facility, are being trialled to lower the cost of collecting wave observations.

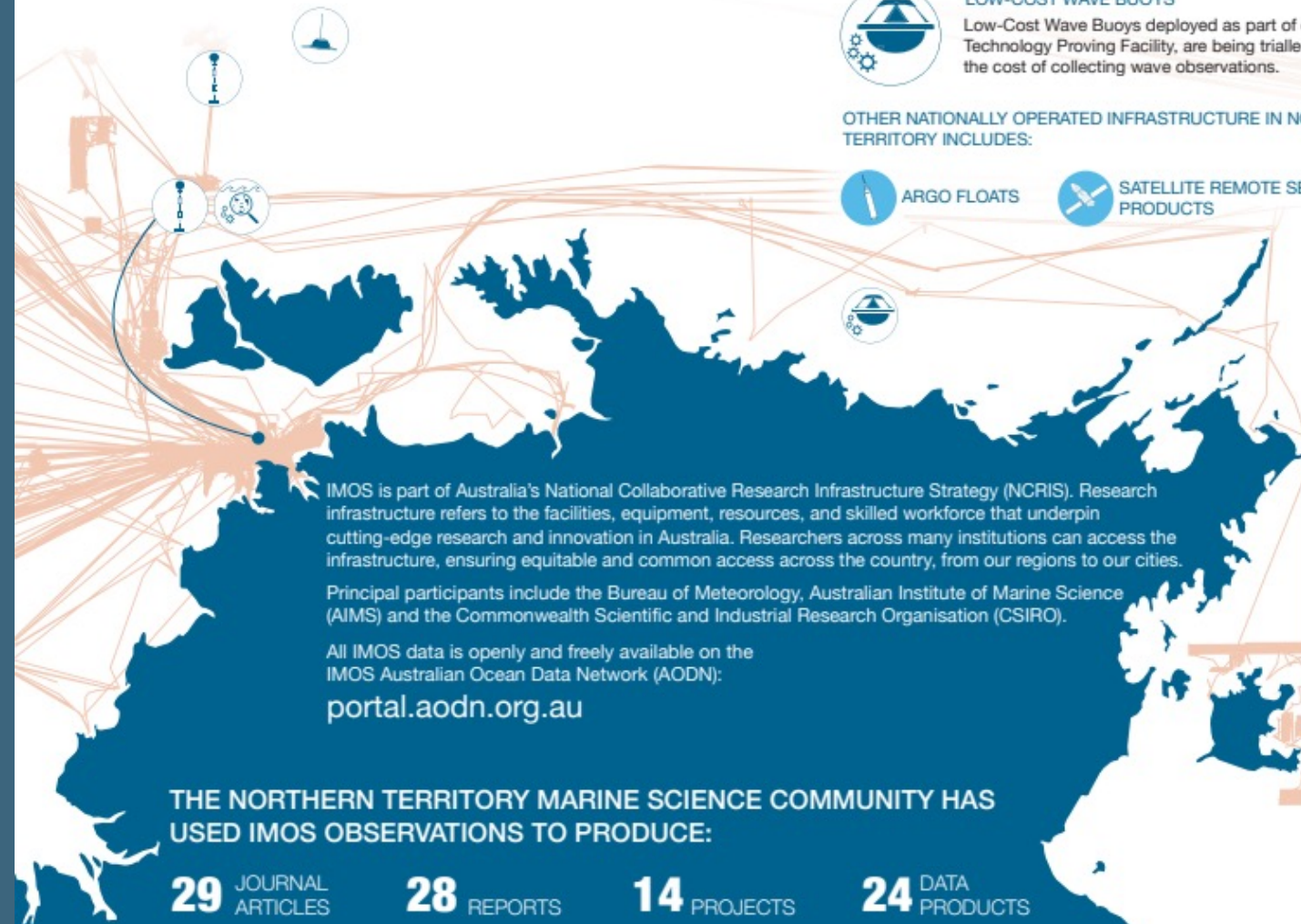
OTHER NATIONALLY OPERATED INFRASTRUCTURE IN NORTHERN TERRITORY INCLUDES:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



# Tasmania

## Spatial coverage

### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN TASMANIA



**NATIONAL MOORING NETWORK**  
A national network of moorings that monitor environmental conditions in Australia's coastal waters.



**SATELLITE REMOTE SENSING**  
Located in the Bass Strait, the Southern Hemisphere's only calibration site for international satellite altimetry missions which measure sea level.



**ACIDIFICATION MOORINGS**  
Acidification Moorings measure CO<sub>2</sub> of surface waters to monitor ocean acidification.



**WAVE BUOY**  
A wave buoy deployed off Maria Island provide valuable real-time information on wave data used to validate wave, weather and climate models.



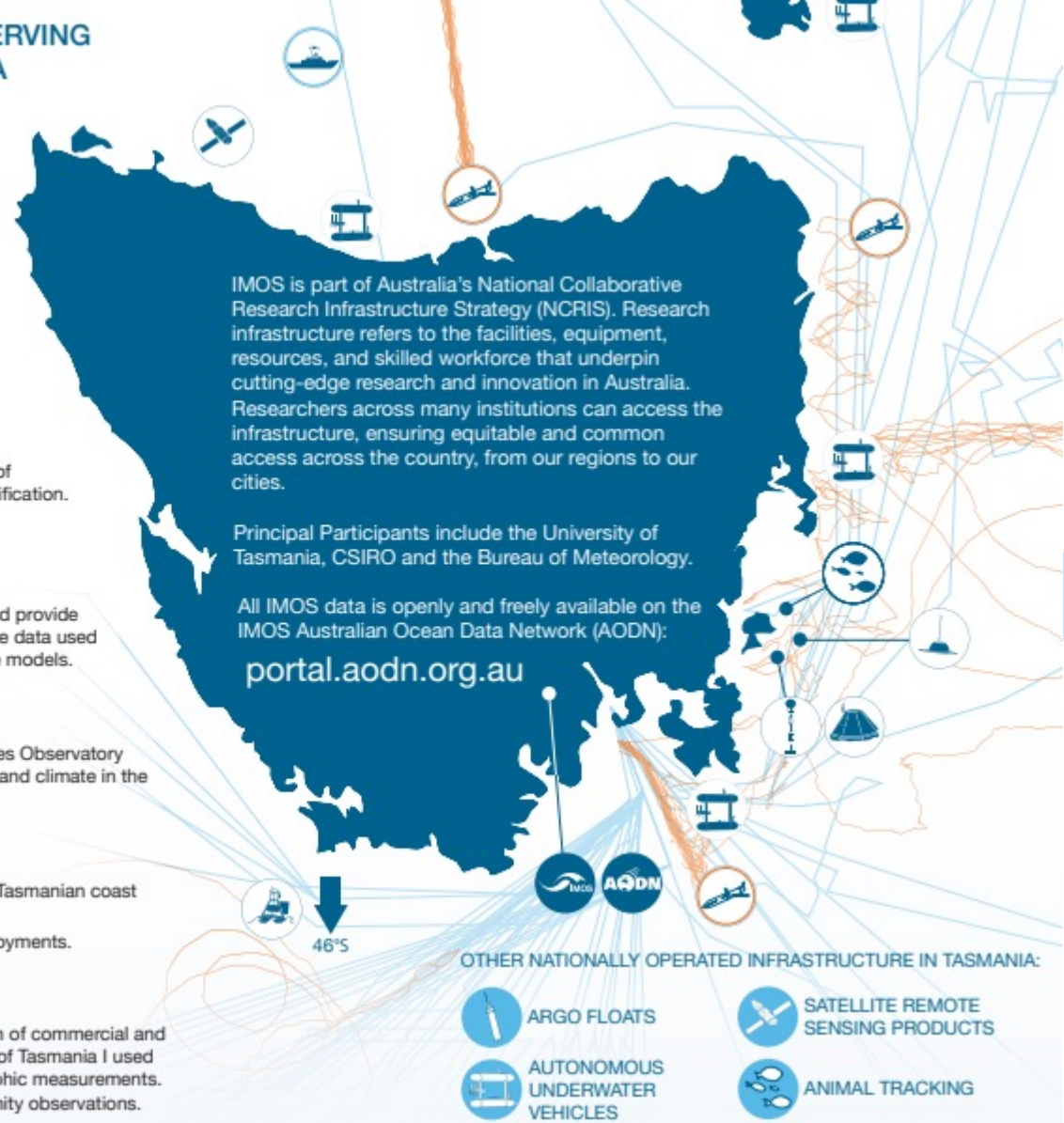
**DEEP WATER MOORING**  
The IMOS Southern Ocean Time Series Observatory monitors long term trends in weather and climate in the Southern Ocean.



**OCEAN GLIDERS**  
Ocean Glider deployments along the Tasmanian coast monitor shelf and boundary currents.  
'—' indicates Ocean Glider deployments.



**SHIPS OF OPPORTUNITY**  
Tasmania benefits from a combination of commercial and research vessels, including the Spirit of Tasmania I used to collect a wide range of oceanographic measurements.  
'—' indicates Ships Of Opportunity observations.



IMOS is part of Australia's National Collaborative Research Infrastructure Strategy (NCRIS). Research infrastructure refers to the facilities, equipment, resources, and skilled workforce that underpin cutting-edge research and innovation in Australia. Researchers across many institutions can access the infrastructure, ensuring equitable and common access across the country, from our regions to our cities.

Principal Participants include the University of Tasmania, CSIRO and the Bureau of Meteorology.

All IMOS data is openly and freely available on the IMOS Australian Ocean Data Network (AODN):

[portal.aodn.org.au](http://portal.aodn.org.au)

#### OTHER NATIONALLY OPERATED INFRASTRUCTURE IN TASMANIA:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



AUTONOMOUS UNDERWATER VEHICLES



ANIMAL TRACKING

<https://imos.org.au/nodes/nodes/tasmania>




# Victoria

## Spatial coverage

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### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN VICTORIA



**SHIPS OF OPPORTUNITY (SOOP)**  
Victoria benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements.  indicates SOOP voyage observations.



**NATIONAL MOORING NETWORK**  
A national network of moorings that monitor environmental conditions in Australia's coastal waters.



**COASTAL WAVE BUOYS**  
Coastal Wave Buoys are collecting wave observations in near real-time in Victoria, Western Australia and the Northern Territory.



**MARINE MICROPLASTICS**  
Monitoring of Marine Microplastics as part of our New Technology Proving Facility identifies potential sources, fate and impacts of microplastics in the marine environment.



**MARINE MICROBIOME**  
Providing a central database of marine microbial DNA and bioinformatics in association with Bioplatforms Australia to help understand ocean health and productivity.

#### OTHER NATIONALLY OPERATED INFRASTRUCTURE IN VICTORIA INCLUDES:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



ANIMAL TRACKING



AUTONOMOUS UNDERWATER VEHICLES



OCEAN GLIDERS

 indicates Ocean Glider deployments.



<https://imos.org.au/nodes/nodes/vicimos>



# South Australia

## Spatial coverage

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[portal.aodn.org.au](http://portal.aodn.org.au)

### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN SOUTH AUSTRALIA



#### SHIPS OF OPPORTUNITY

South Australia benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements.

'—' indicates Ships Of Opportunity observations.



#### NATIONAL MOORING NETWORK

A national network of moorings that monitor environmental conditions in Australia's coastal waters.



#### ACIDIFICATION MOORINGS

Acidification Moorings measure CO<sub>2</sub> of surface waters to monitor ocean acidification.



#### OCEAN RADAR

South Australia benefits from Ocean Radar which contributes to biological systems research, ocean modelling and ocean circulation and industry operations.



#### OCEAN GLIDERS

Ocean Glider deployments along the South Australian coast monitor shelf and boundary currents.

'—' indicates Ocean Glider deployments.

#### OTHER NATIONALLY OPERATED INFRASTRUCTURE IN SOUTH AUSTRALIA INCLUDES:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



AUTONOMOUS UNDERWATER VEHICLES



ANIMAL TRACKING VEHICLES

<https://imos.org.au/nodes/nodes/saimos>





# New South Wales

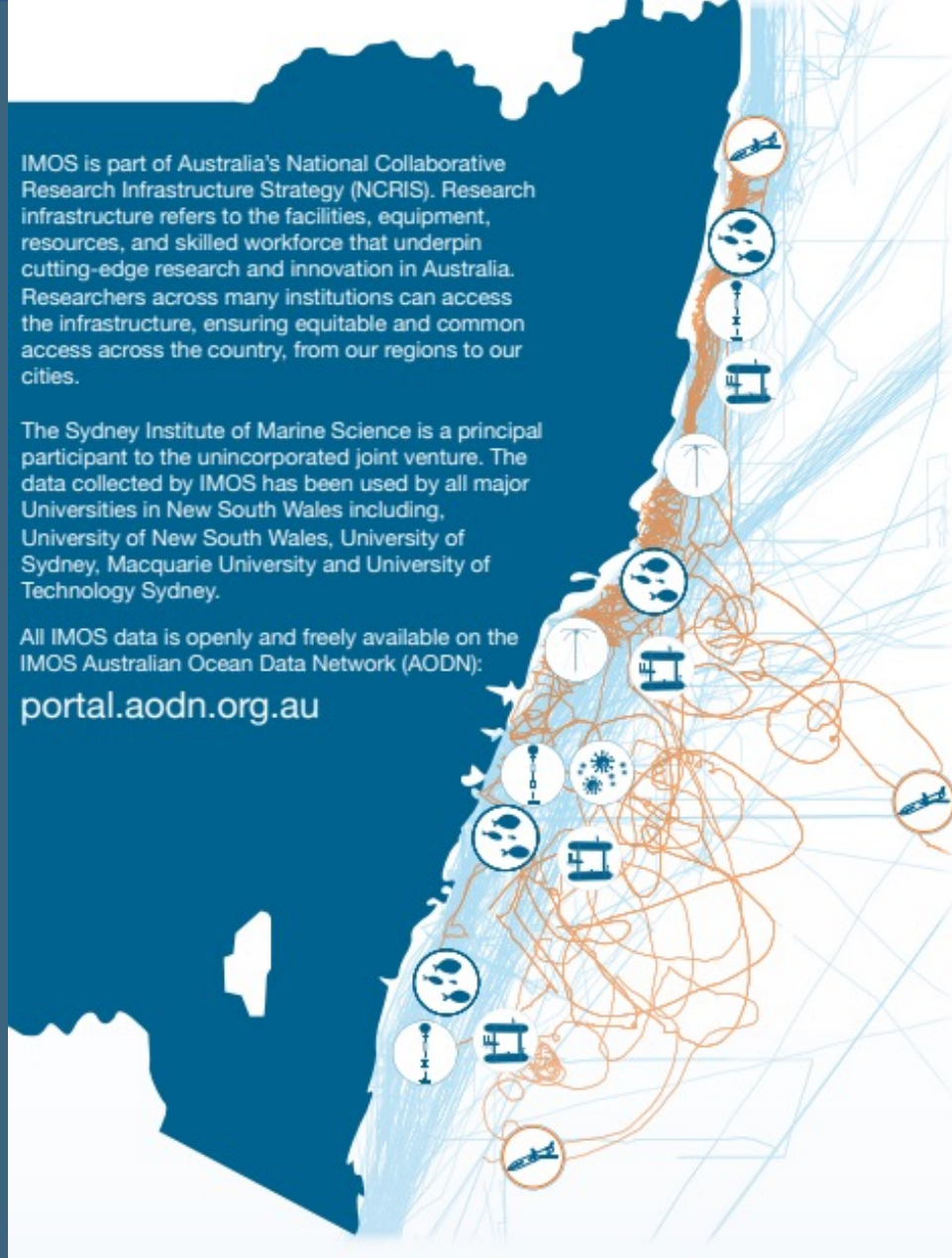
## Spatial coverage

IMOS is part of Australia's National Collaborative Research Infrastructure Strategy (NCRIS). Research infrastructure refers to the facilities, equipment, resources, and skilled workforce that underpin cutting-edge research and innovation in Australia. Researchers across many institutions can access the infrastructure, ensuring equitable and common access across the country, from our regions to our cities.

The Sydney Institute of Marine Science is a principal participant to the unincorporated joint venture. The data collected by IMOS has been used by all major Universities in New South Wales including, University of New South Wales, University of Sydney, Macquarie University and University of Technology Sydney.

All IMOS data is openly and freely available on the IMOS Australian Ocean Data Network (AODN):

[portal.aodn.org.au](http://portal.aodn.org.au)



## IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN NEW SOUTH WALES



### SHIPS OF OPPORTUNITY (SOOP)

New South Wales benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements.

'—' indicates of SOOP voyage observations.



### NATIONAL MOORING NETWORK

A national network of moorings that monitor environmental conditions in Australia's coastal waters.



### OCEAN RADAR

New South Wales benefits from Ocean Radar which contributes to biological systems research, ocean modelling and ocean circulation.



### ANIMAL TRACKING

New South Wales benefits from a national acoustic animal tracking network which can track priority species along the coast.



### OCEAN GLIDERS

Ocean Glider deployments along the New South Wales coast monitor shelf and boundary currents.

'—' indicates Ocean Glider deployments.



### AUTONOMOUS UNDERWATER VEHICLES

AUVs collect precisely navigated time series of benthic imagery.

### OTHER NATIONALLY OPERATED INFRASTRUCTURE IN NEW SOUTH WALES INCLUDES:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



MARINE MICROBIOME

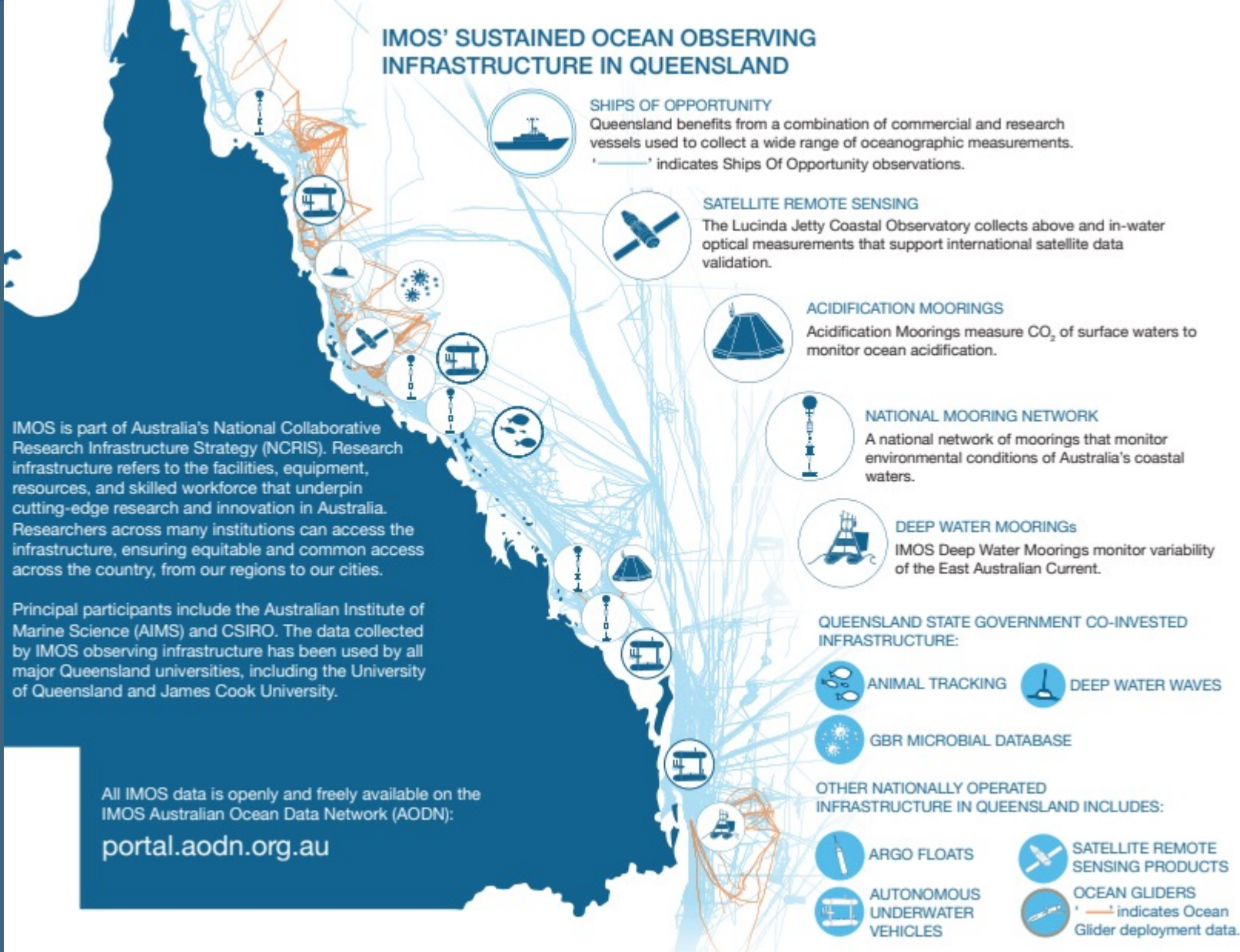


<https://imos.org.au/nodes/nodes/nswimos>

# Queensland

## Spatial coverage

### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN QUEENSLAND



IMOS is part of Australia's National Collaborative Research Infrastructure Strategy (NCRIS). Research infrastructure refers to the facilities, equipment, resources, and skilled workforce that underpin cutting-edge research and innovation in Australia. Researchers across many institutions can access the infrastructure, ensuring equitable and common access across the country, from our regions to our cities.

Principal participants include the Australian Institute of Marine Science (AIMS) and CSIRO. The data collected by IMOS observing infrastructure has been used by all major Queensland universities, including the University of Queensland and James Cook University.

All IMOS data is openly and freely available on the IMOS Australian Ocean Data Network (AODN):  
[portal.aodn.org.au](http://portal.aodn.org.au)

<https://imos.org.au/nodes/nodes/qimos>



# Western Australia

## Spatial coverage

### IMOS' SUSTAINED OCEAN OBSERVING INFRASTRUCTURE IN WESTERN AUSTRALIA



#### SHIPS OF OPPORTUNITY

WA benefits from a combination of commercial and research vessels used to collect a wide range of oceanographic measurements.

'—' indicates of Ships Of Opportunity voyage data.



#### NATIONAL MOORING NETWORK

A national network of moorings that monitor environmental conditions in Australia's coastal waters.



#### OCEAN RADAR

WA benefits from Ocean Radar which contributes to biological systems research, ocean modelling and ocean circulation.



#### OCEAN GLIDERS

Ocean Glider deployments along the WA coast monitor shelf and boundary currents.

'—' indicates Ocean Glider deployment data.



#### NEW TECHNOLOGY PROVING

WA is the home of our Low-Cost Wave Buoy New Technology Proving Facility at the UWA Great Southern Marine Research Facility, being trialled to lower the cost of collecting wave observations.

#### WESTERN AUSTRALIA STATE GOVERNMENT CO-INVESTED INFRASTRUCTURE:



NINGALOO MOORING



ONSLOW GLIDERS

#### OTHER NATIONALLY OPERATED INFRASTRUCTURE IN WESTERN AUSTRALIA INCLUDES:



ARGO FLOATS



SATELLITE REMOTE SENSING PRODUCTS



AUTONOMOUS UNDERWATER VEHICLES



ANIMAL TRACKING

IMOS is part of Australia's National Collaborative Research Infrastructure Strategy (NCRIS). Research infrastructure refers to the facilities, equipment, resources, and skilled workforce that underpin cutting-edge research and innovation in Australia. Researchers across many institutions can access the infrastructure, ensuring equitable and common access across the country, from our regions to our cities.

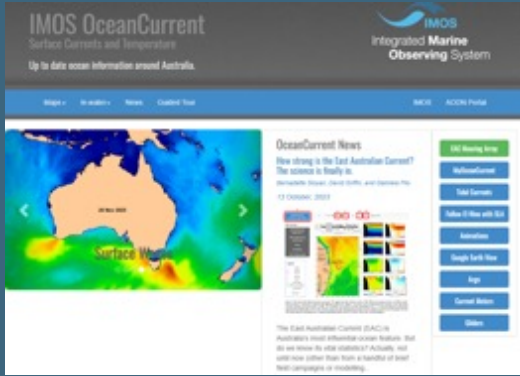
Principal participants include the University of Western Australia, the Australian Institute of Marine Science (AIMS) and CSIRO, with data collected by IMOS observing infrastructure used by all major Western Australian Universities, including the University of Western Australia and Curtin University.

All IMOS data is openly and freely available on the IMOS Australian Ocean Data Network (AODN): [portal.aodn.org.au](http://portal.aodn.org.au)

<https://imos.org.au/nodes/nodes/waimos>



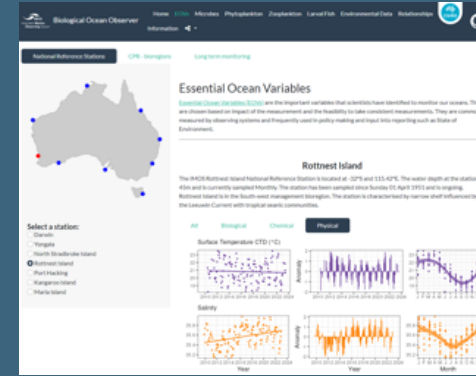
# Visualising & Downloading IMOS Data



IMOS Ocean Current



<https://portal.aodn.org.au/>



IMOS Biological Ocean Observer



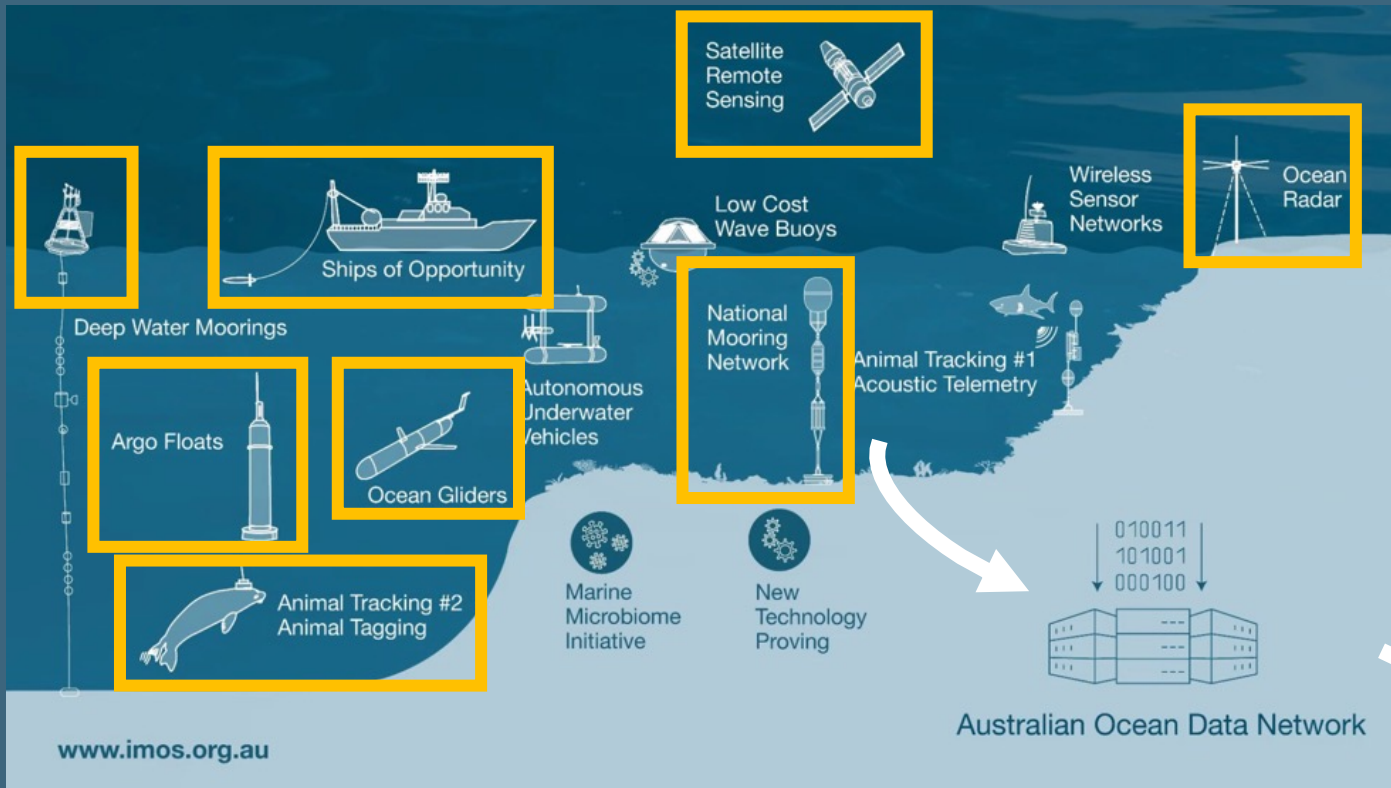
GIS Users



Data Science Users



# IMOS OceanCurrent - Data Streams



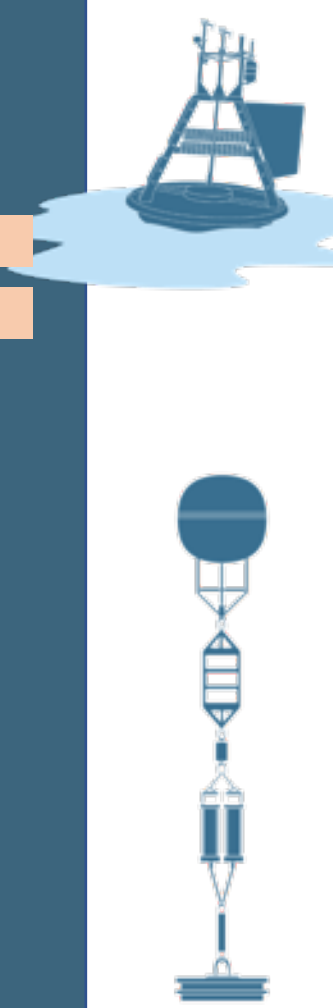
Tide gauge data

Tide gauge data

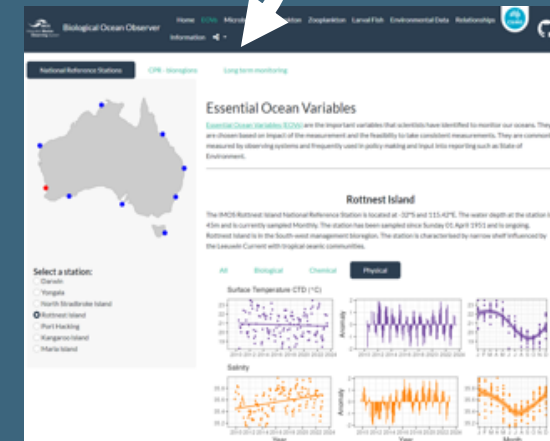
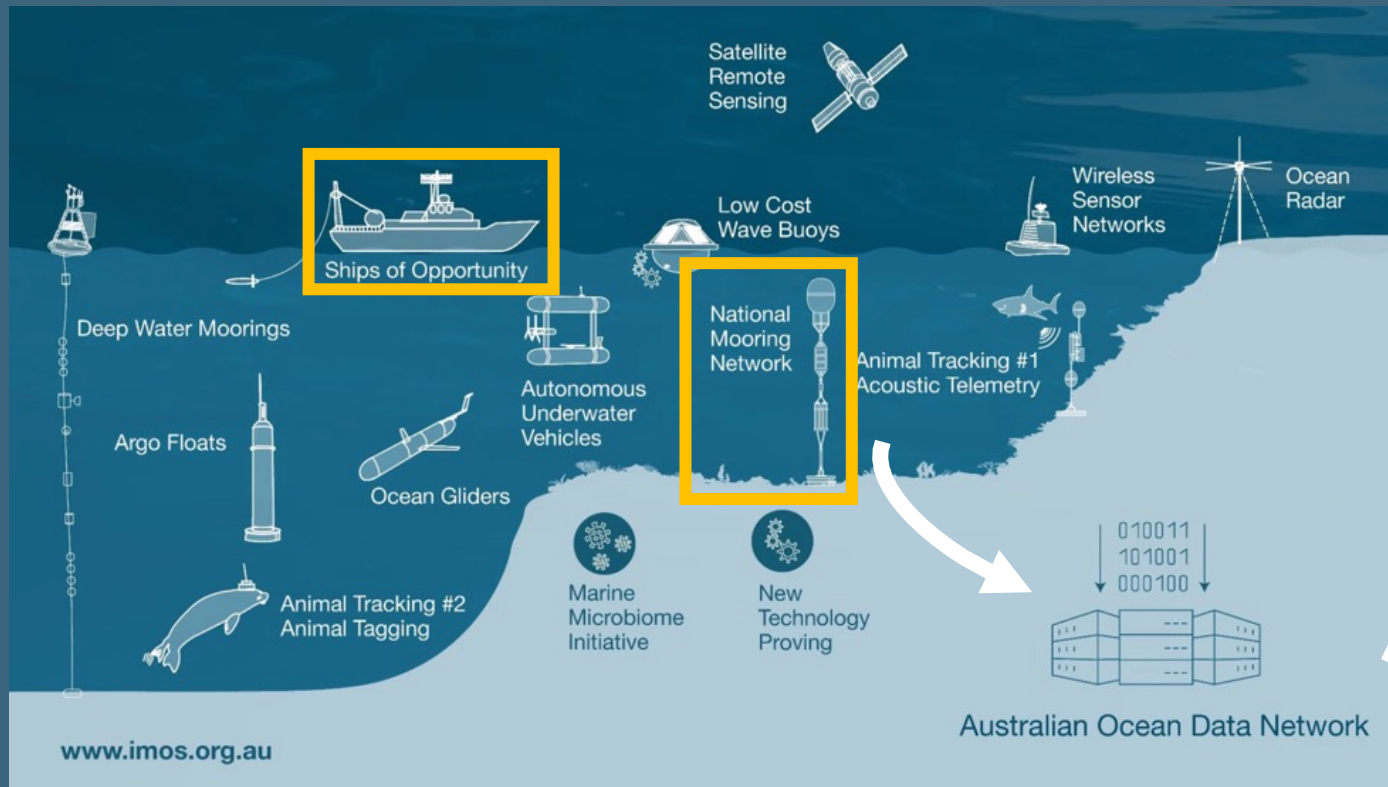


IMOS OceanCurrent  
Download Visualisations

<https://oceancurrent.aodn.org.au/>



# IMOS Biological Ocean Observer - Data Streams



IMOS Biological Ocean Observer

<https://shiny.csiro.au/BioOceanObserver/>



# AODN Portal – Now and the Future

Existing portal is 9 years old

1. Select



2. Subset



3. Download



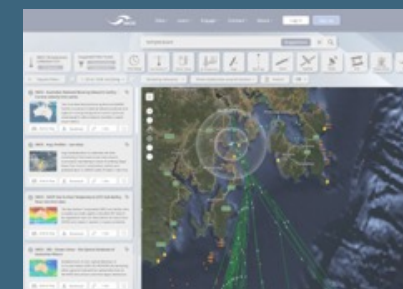
Now  
~300 datasets

Future  
~14,000 datasets

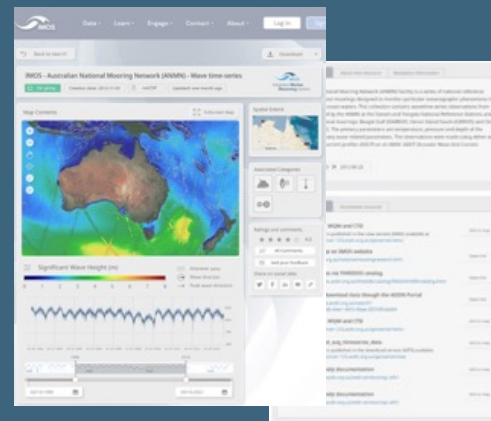
1. Search



2. Explore



3. Assess and Download



# AODN Portal Future

## Key concepts

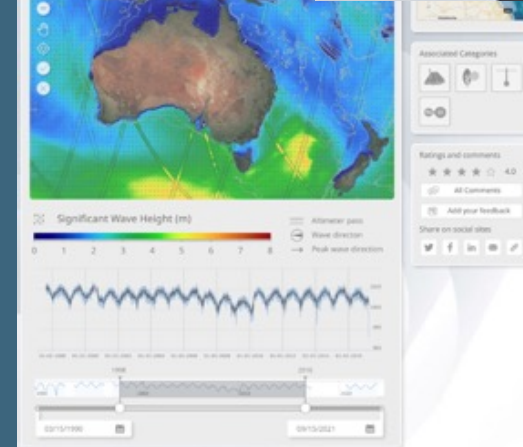
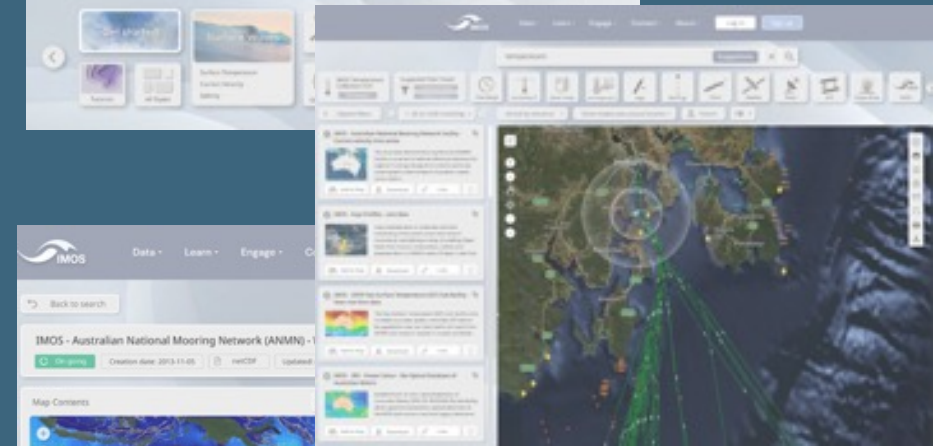
A focus on usability, discoverability & data uptake

Easier to Find Data – not just IMOS data

- Search + interactive map-based exploration
- Inclusion of non-IMOS datasets

Easier to Use IMOS Hosted Data

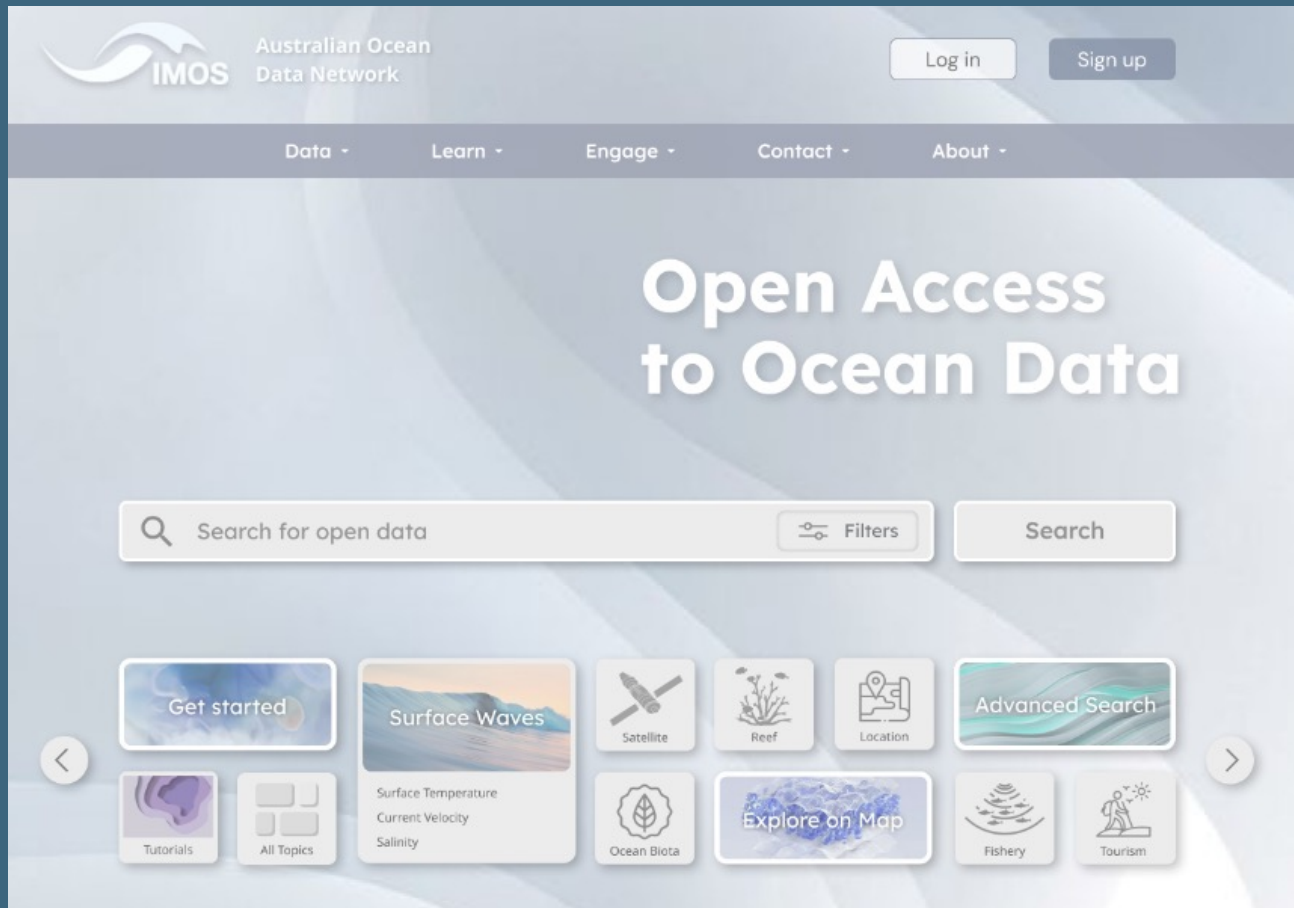
- Basic data previews (gridded, timeseries, profiles)
- Data science ready - kick start guides/coding samples
- Ready to use data (pre integrated and in desired formats)
- Data subset extraction performance improvements





# AODN Portal Future – Initial Concepts

## A better, simple search

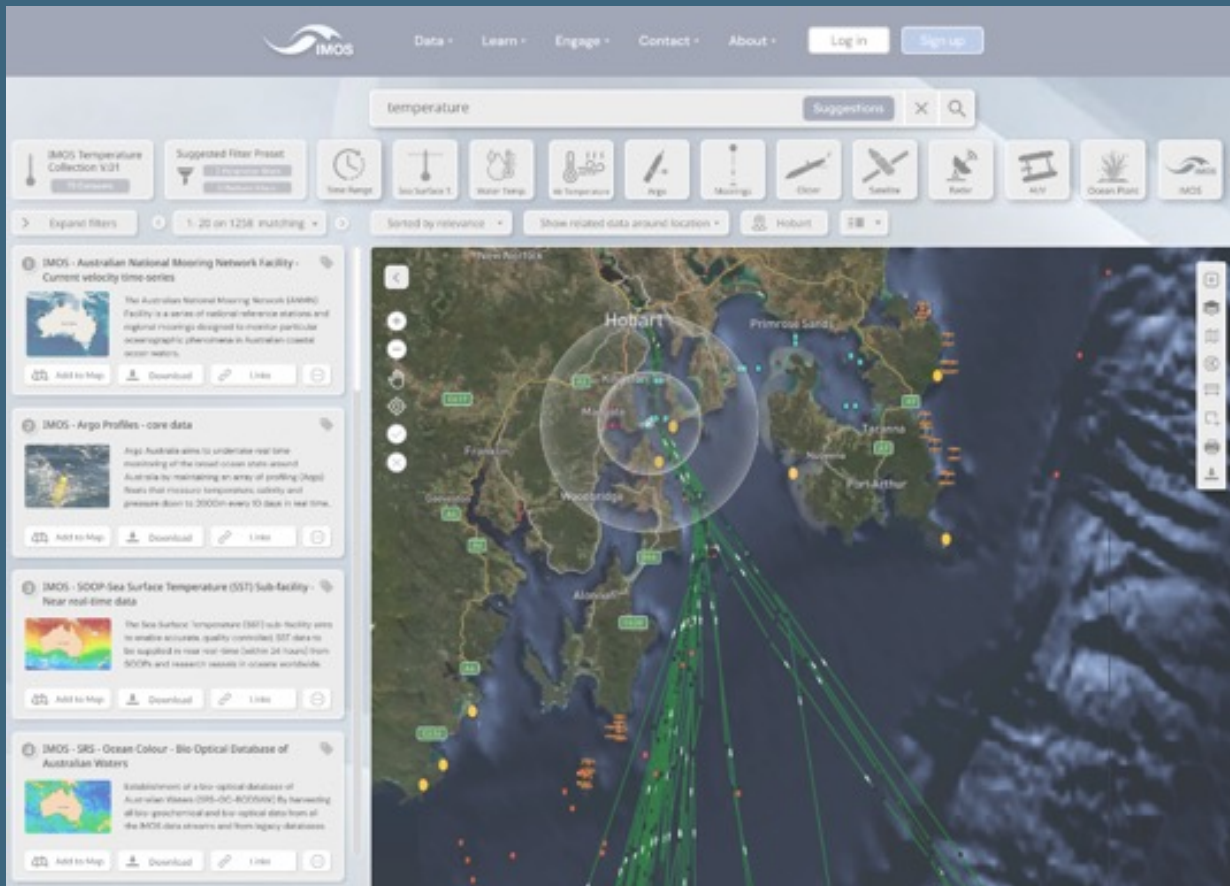


- Free text 'google like' search
- Search suggestion autocomplete
- Topic search
- Popular filters including:
  - Time period
  - Parameter



# AODN Portal Future – Initial Concepts

## Interactive map-based exploration

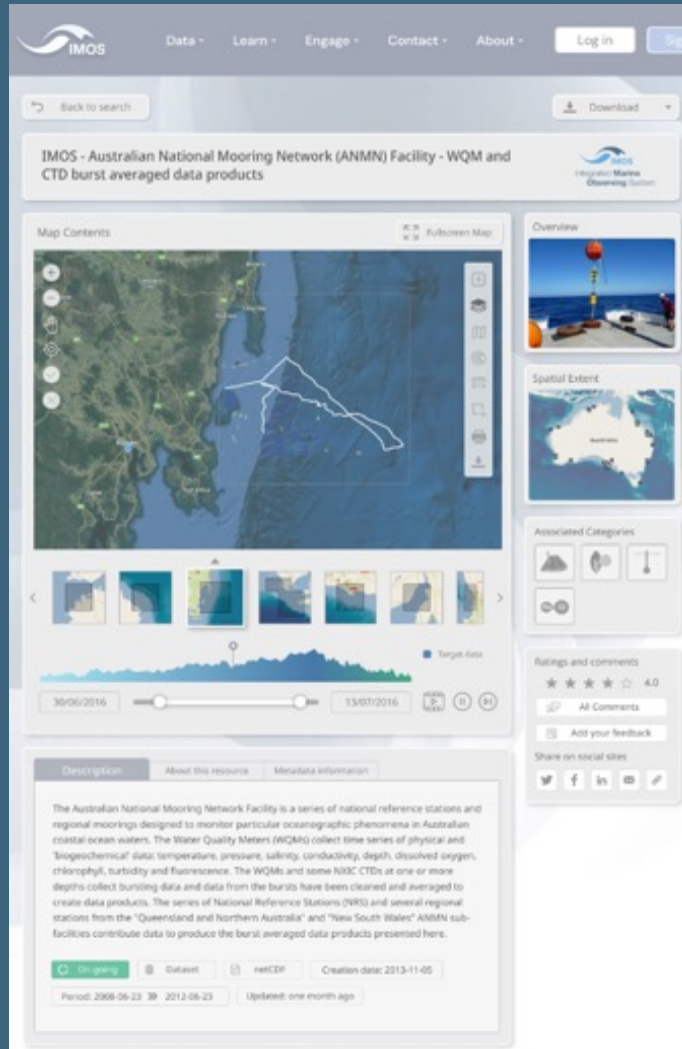


- Visualise the location of datasets
  - What is in my area of interest?
- Inclusion of non-IMOS datasets
- Dataset filter search options



# AODN Portal Future – Initial Concepts

## Dataset information – transect / profile / timeseries example



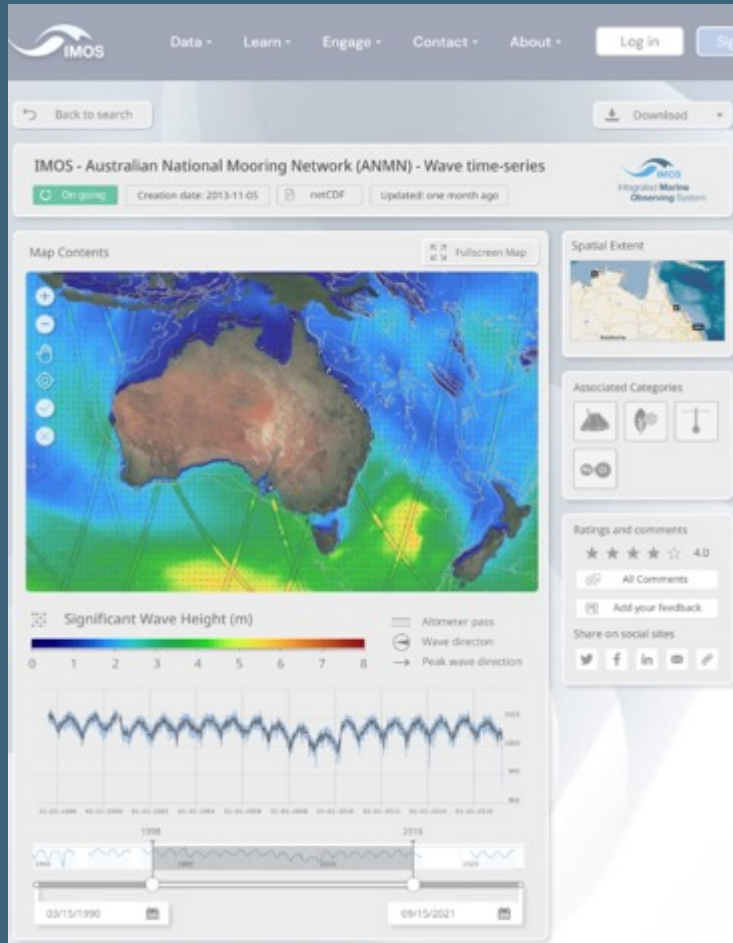
With 'compatible' datasets:

- Dataset details
- Data chart preview
- Subset & download
- Data services & links
- Data science kick-starter & coding samples



# AODN Portal Future – Initial Concepts

## Dataset information – gridded example



**Description** | About this resource | Metadata information

The Australian National Mooring Network (ANMN) Facility is a series of national reference stations and regional moorings designed to monitor particular oceanographic phenomena in Australian coastal ocean waters. This collection contains wavetime-series observations from moorings deployed by the ANMN at the Darwin and Yongala National Reference Stations and the following regional moorings: Beagle Gulf (DARBGF), Heron Island South (GBRHES) and One Tree East (GBROTE). The primary parameters are temperature, pressure and depth of the instrument, and many wave related parameters. The observations were made using either an acoustic Doppler current profiler (ADCP) or an AWAC ADCP (Acoustic Wave And Current Profiler).

Period: 2008-06-23 to 2012-06-23

**Links** | Associated resource

- Moorings - WQM and CTD**  
This dataset is published in the view service (WMS) available at <http://geoserver-123.aodn.org.au/geoserver/wms> Add to map
- ANMN page on IMOS website**  
<http://imos.org.au/nationalmooringnetwork.html> Open link
- NetCDF files via THREDDS catalog**  
<http://thredds.aodn.org.au/thredds/catalog/IMOS/ANMN/catalog.html> Open link
- View and download data through the AODN Portal**  
<https://portal.aodn.org.au/search?uuid=8964658c-6ee1-4015-9bae-2937dfc5ab9> Open link
- Moorings - WQM and CTD**  
<http://geoserver-123.aodn.org.au/geoserver/wms> Add to map
- anmn\_burst\_avg\_timeseries\_data**  
This dataset is published in the download service (WFS) available at <http://geoserver-123.aodn.org.au/geoserver/wfs> Add to map
- OGC WFS help documentation**  
<https://help.aodn.org.au/web-services/ogc-wfs/> Add to map
- OGC WFS help documentation**  
<https://help.aodn.org.au/web-services/ogc-wfs/> Add to map

With 'compatible' datasets:

- Visualise gridded data
- Timeseries at a point
- Subset & download
- Data services & links
- Data science kick-starter & coding samples



# Mark Rehbein

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Integrated Marine Observing System (IMOS)

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IMOS node info-graphics: <https://imos.org.au/nodes>

Biological Ocean Observer: <https://shiny.csiro.au/BioOceanObserver/>

Ocean Current: <https://oceancurrent.aodn.org.au/>

AODN Portal: <https://portal.aodn.org.au/>



Australia's Integrated Marine Observing System (IMOS) is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent. [www.imos.org.au](http://www.imos.org.au)

## PRINCIPAL PARTICIPANTS



SIMS is a partnership involving four universities.

## ASSOCIATE PARTICIPANTS



IMOS thanks the many other organisations who partner with us, providing co-investment, funding and operational support, including investment from the Tasmanian, Western Australian and Queensland State Governments.

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

