The role of Australia's Integrated Marine Observing System in understanding our future oceans

Michelle Heupel

IMOS Integrated **Marine Observing** System

What is IMOS?

A **national, collaborative, research infrastructure**, funded by the Australian Government

1. National

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

2. Collaborative

PRINCIPAL PARTICIPANTS

University of Tasmania (Lead Agent) · Australian Government · Australian Institute of Marine Science · Australian Government Bureau of Meteorology · CSIRO

Government of South Australia · SARDI · The University of Western Australia · SIMS sydney institute of marine science · UTS · The University of Sydney · Macquarie University · UNSW

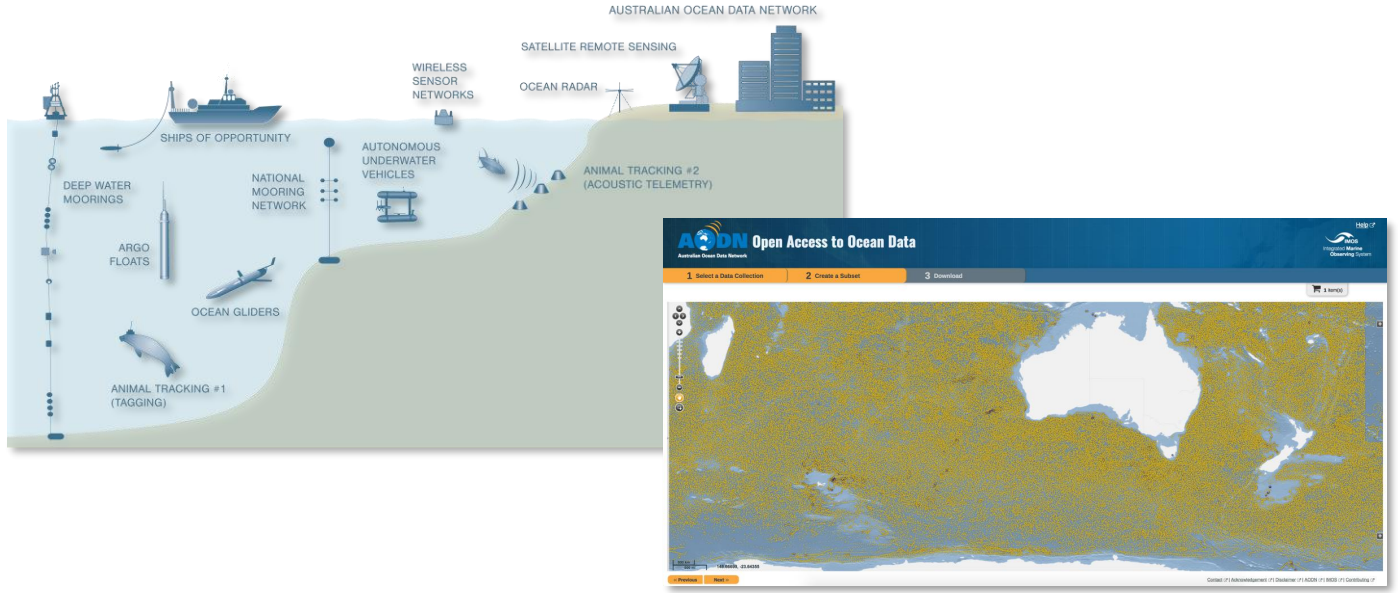
SIMS is a partnership involving four Universities.

ASSOCIATE PARTICIPANTS

Curtin University · Australian Government Department of the Environment and Energy Australian Antarctic Division

3. Research Infrastructure

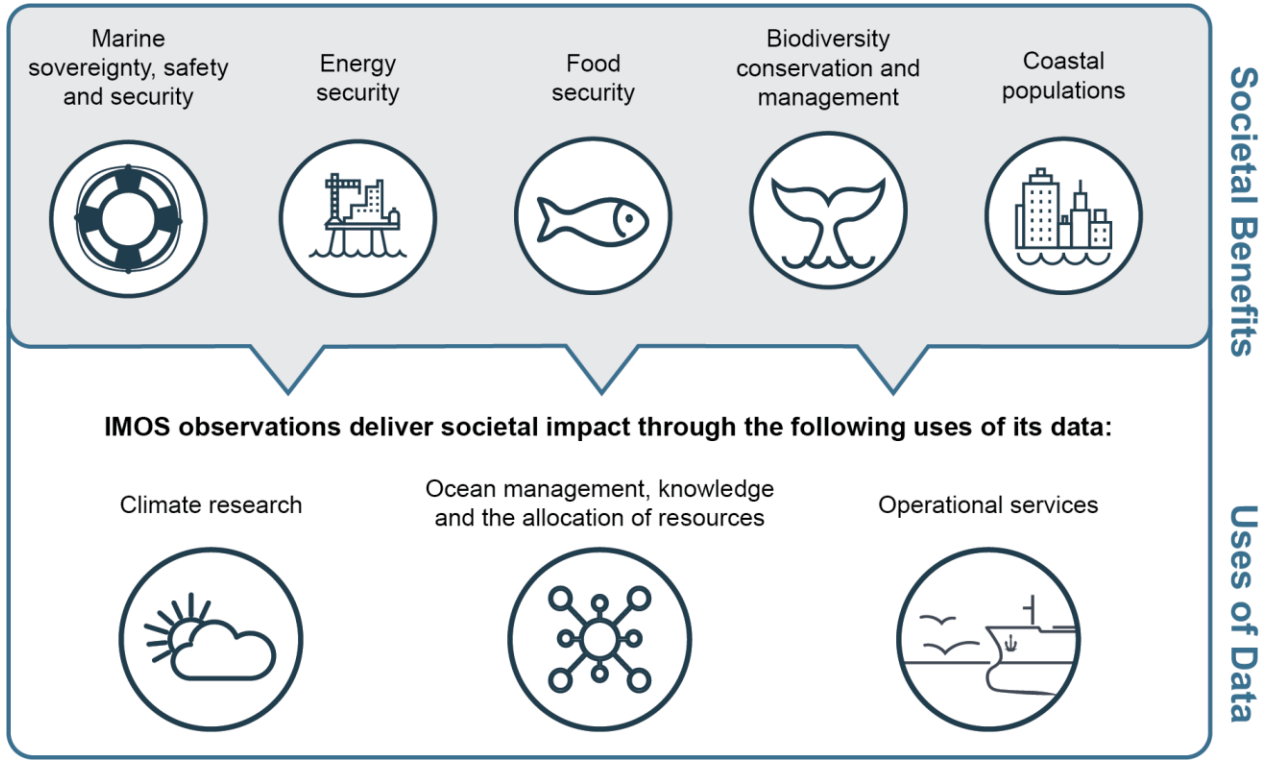
- systematic and sustained observing of the marine environment
- **open data** access for scientific research and other purposes



Ensuring relevance and impact

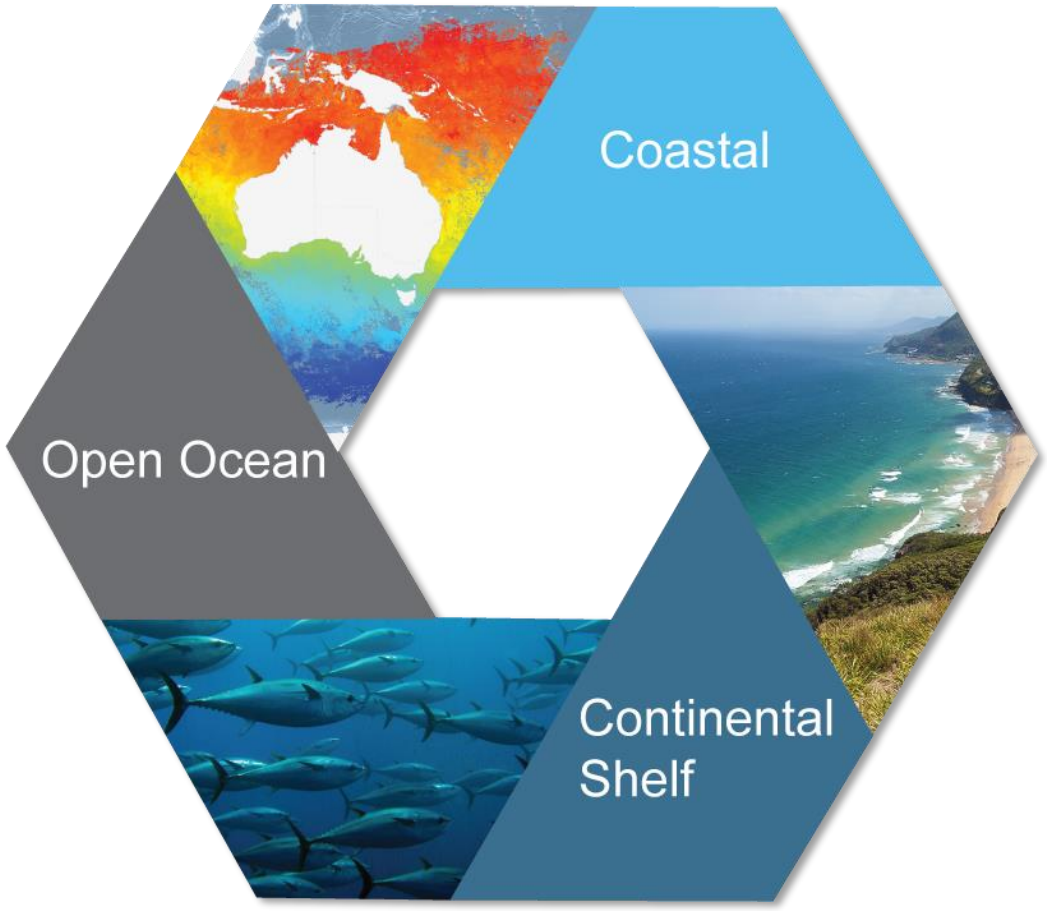
- Contributing to socio-economic, environmental, legal and policy needs in Australia
  - Delivering outputs (observations, data, products, services) needed in decision-making
  - Enabling outcomes (uptake and use via publications, projects, presentations, products) based on sustained observing
  - Partnering with industry and stakeholders to meet their data needs

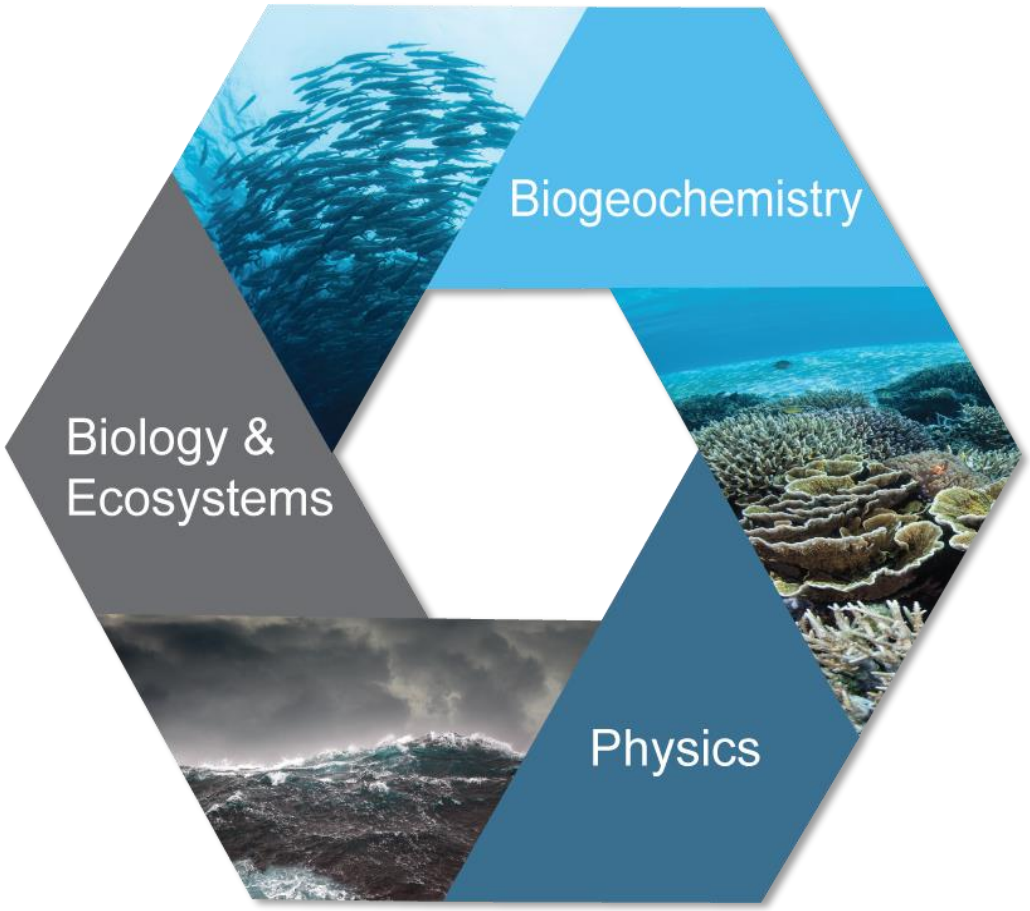
Forum for Operational Oceanography



IMOS Scales and Disciplines

The Facility portfolio is integrated across **scales** and **disciplines**

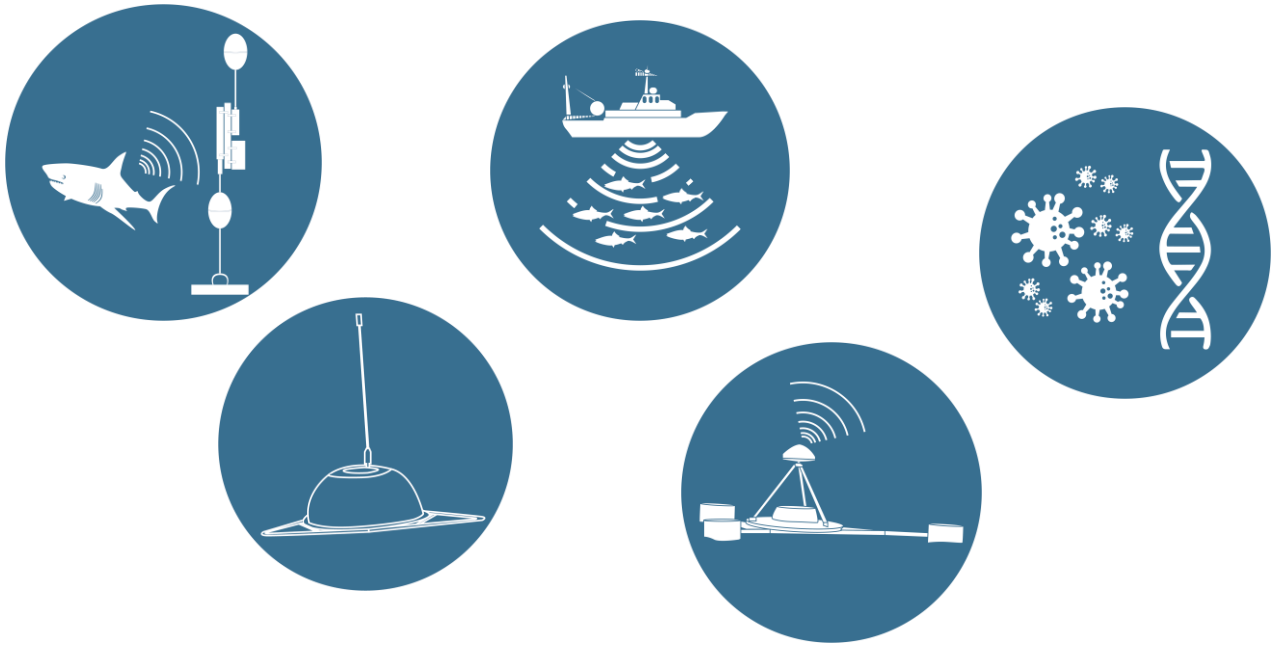


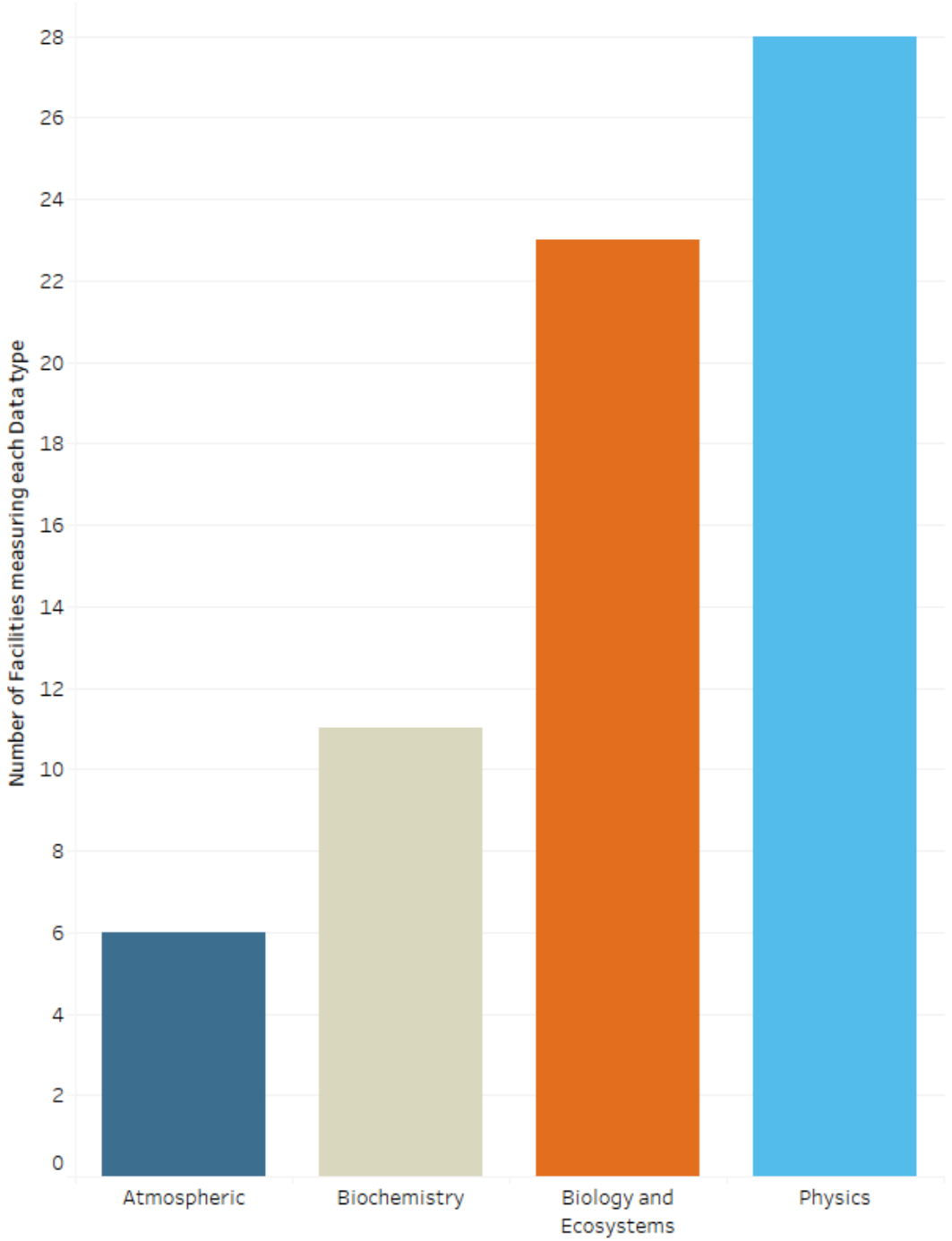


IMOS data types

Facilities/ sub-Facilities:

- 77% measure Physical variables
- 63% measure Biological variables
- 30% measure Biochemical variables
- 16% measure Atmospheric variables





IMOS Facilities

SATELLITE REMOTE SENSING

DEEP WATER MOORINGS

SHIPS OF OPPORTUNITY

NATIONAL MOORING NETWORK

WIRELESS SENSOR NETWORKS

OCEAN RADAR

MARINE MICROBIOME INITIATIVE

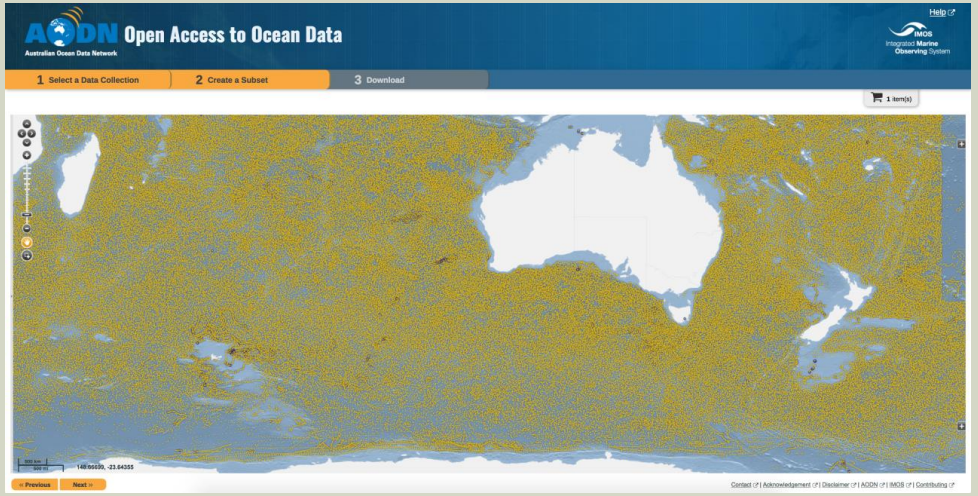
AUTONOMOUS UNDERWATER VEHICLES

OCEAN GLIDERS

ARGO FLOATS

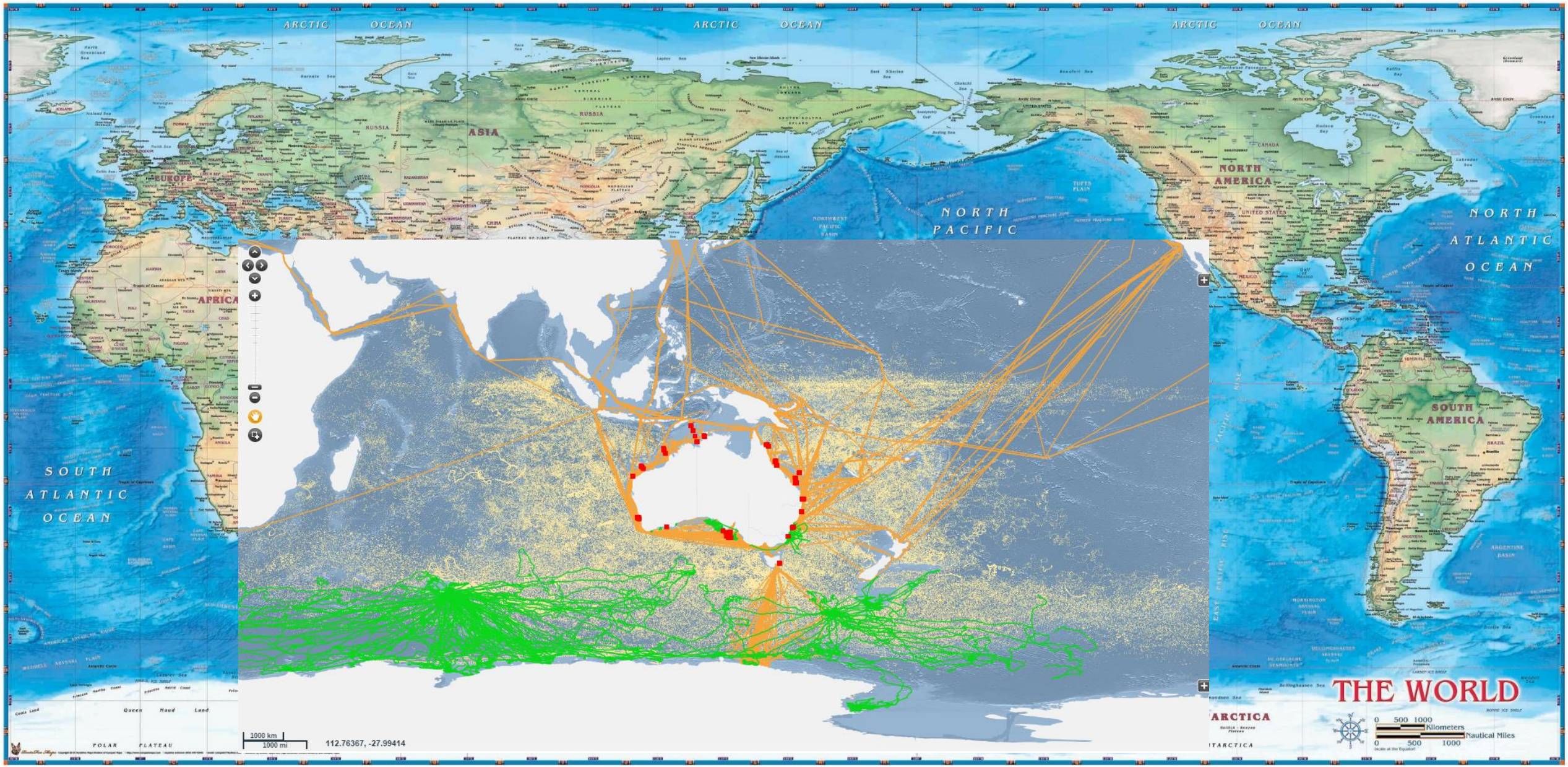
ANIMAL TRACKING #2 (Acoustic Telemetry)

ANIMAL TRACKING #1 (Animal Tagging)



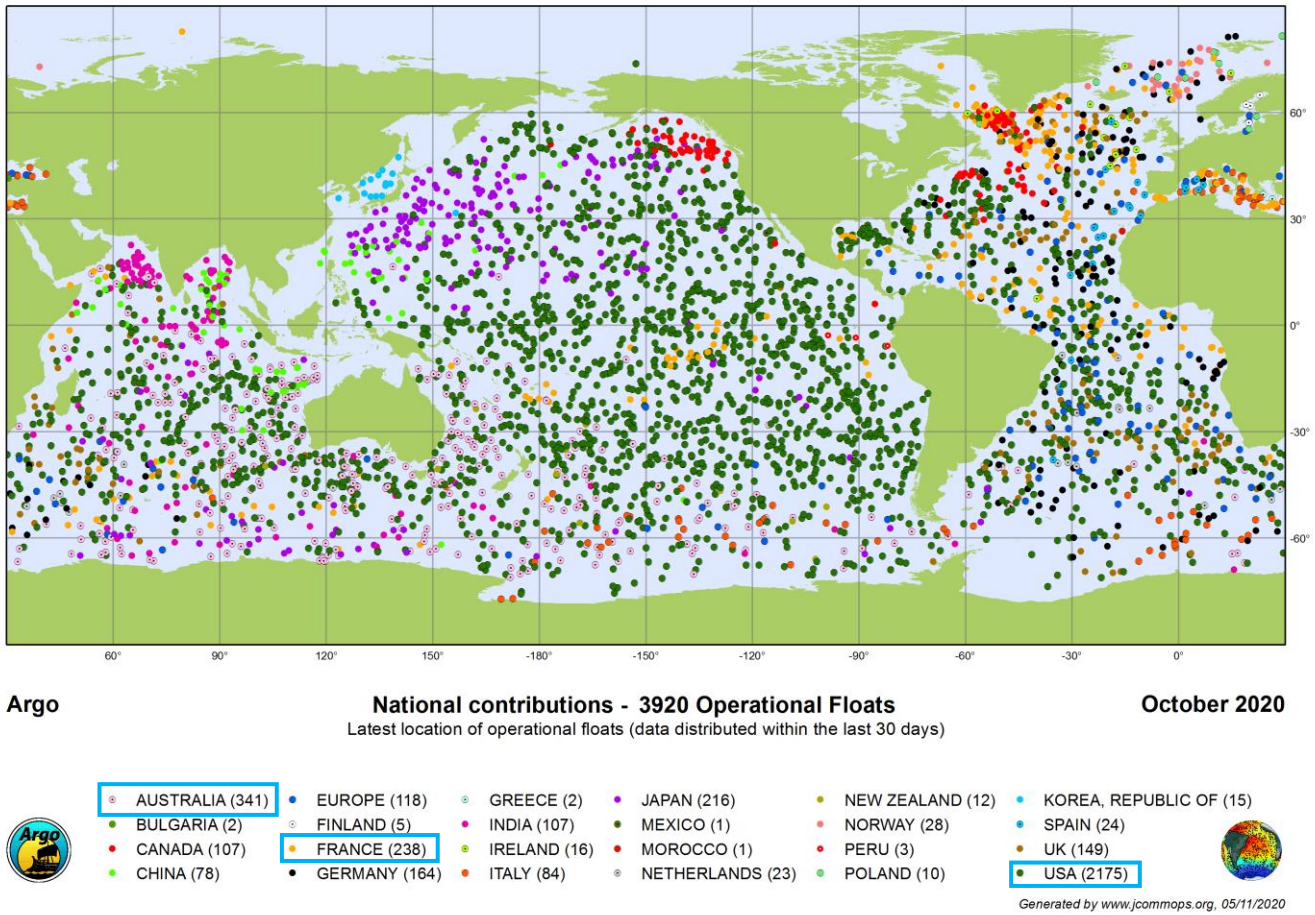
portal.aodn.org.au

Ocean Observing – Australia's context



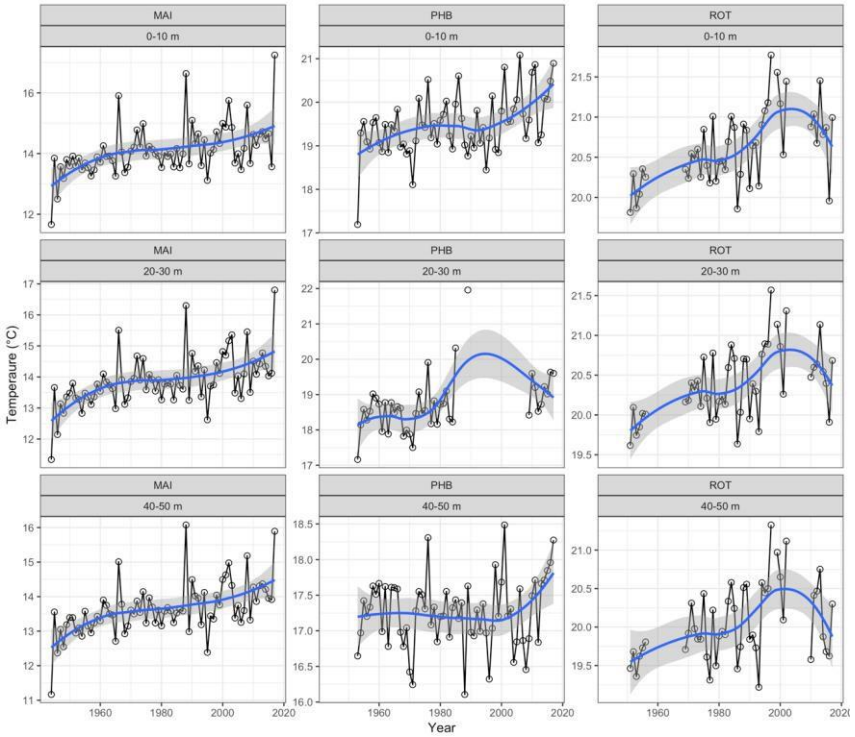
Argo

- Measure the broadscale structure of the ocean via measurement of salinity and temperature every 10 days
- Due to the ocean's ability to store heat, it plays a large role in seasonal and long-term climate
- Improved understanding of ocean conditions from Argo and other in situ observing helps enable climate and ocean modelling and forecasting
- Australia is a major contributor to the global Argo program



Moorings and reference stations

- Baseline information to understand how large-scale, long-term change and variability in the global ocean is affecting ecosystems in the Australian region



East Australian Current (EAC) transport array

Southern Ocean Time Series (SOTS)

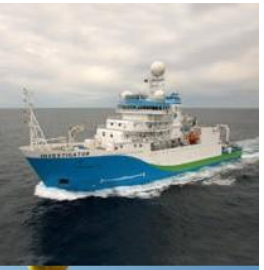
National Reference Station Network

- Continuous sampling via moored sensor packages
- Monthly/quasi-monthly vessel-based sampling
- With 10+ years of data from all sites (70+ from three), emphasis is being placed on analysing time series and extracting information and state and trends

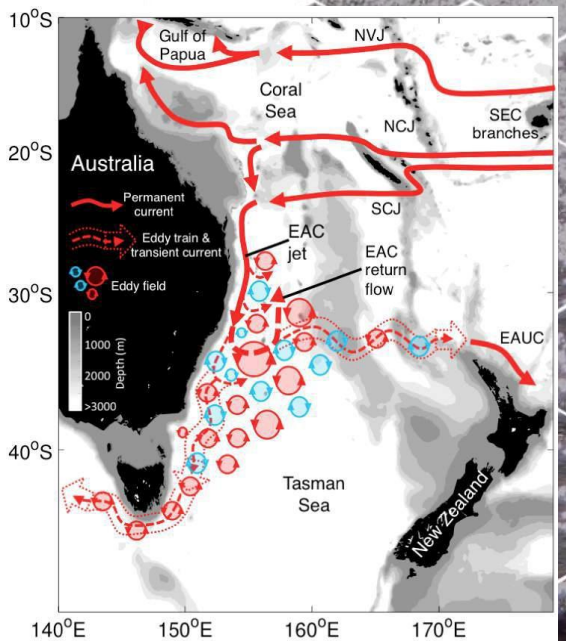
NRS location	Established	Lat/Long	Depth	Bioregion
Port Hacking	1942	34S 151E	100m	East
Maria Island	1944	42S 148E	90m	Southeast
Rottnest Island	1951	32S 115E	50m	Southwest
Yongala	2007	19S 147E	27m	GBR/East
Kangaroo Island	2008	36S 136E	110m	Southwest
Stradbroke Island	2008	27E 154S	67m	East
Darwin	2009	12S 130E	20m	North

- These time series data, built on robust and sustained sampling with rich environmental context, are attracting the attention of new science communities e.g. marine microbial ecologists

Deep Water Moorings



- Southern Ocean Time Series provides high temporal resolution observations in sub-Antarctic waters
- Includes a surface air-sea flux mooring, a sub-surface biogeochemistry mooring, and a deep ocean sediment trap mooring
- East Australian Current (EAC) transport array measuring full depth transport of the EAC off Brisbane



Shelf Moorings

- IMOS Shelf Moorings are designed to characterise and monitor regional processes on the continental shelf
- Measuring a range of parameters including: water temperature, salinity, current, dissolved oxygen and chlorophyll to serve as baseline data and identify changes and trends
- Acidification moorings measure CO_2, pH and atmospheric pressure
- Wave buoys measure sea state, directional waves and currents
- Mooring data are integral to modelling ocean systems and processes

Low Cost Wave Buoy Technology

Project objectives

1. Performance comparison between conventional wave buoys and new, low-cost ‘Spotter’ wave buoys
    - ~10x less expensive and 40x lighter
2. Performance across a range of oceanic conditions in moored (primary) and drifting (secondary) applications
3. Durability and longevity for operational networks

Highlights

- Moored buoys deployed in WA and Vic adjacent to established buoys
- Equivalent performance between Spotter and established buoys
- 2 drifting buoys deployed off Albany recorded waves in excess of 20m

Wind Speed and Direction Extension

Project objectives

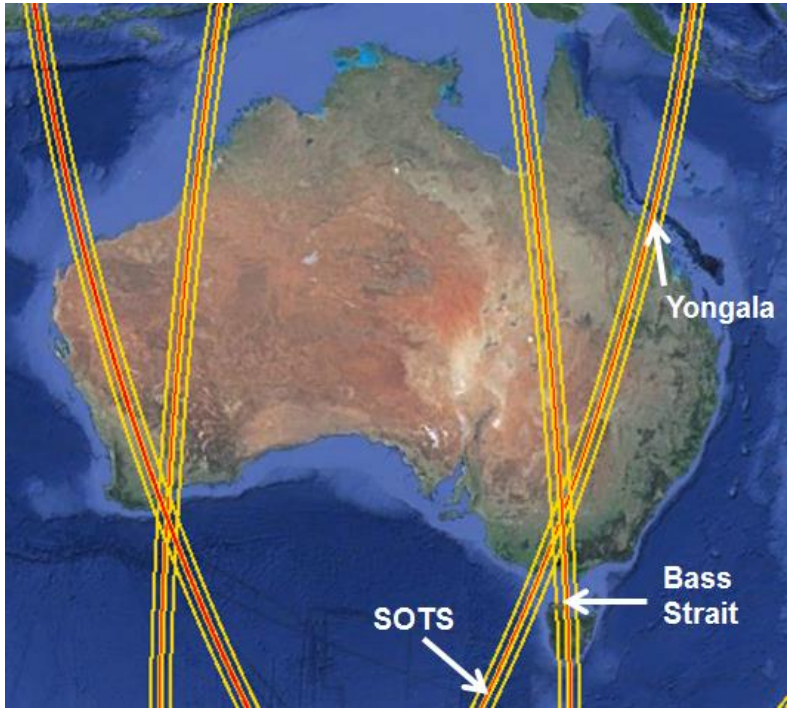
1. Produce the first global database of calibrated and validated wind speed and direction
2. Acquire global records of scatterometer data from 1992-present and calibrate data against buoy data to form a continuous record
3. Include higher-resolution nearshore winds for Australia and its surrounds by augmenting the database with synthetic aperture radar (SAR) satellite data.

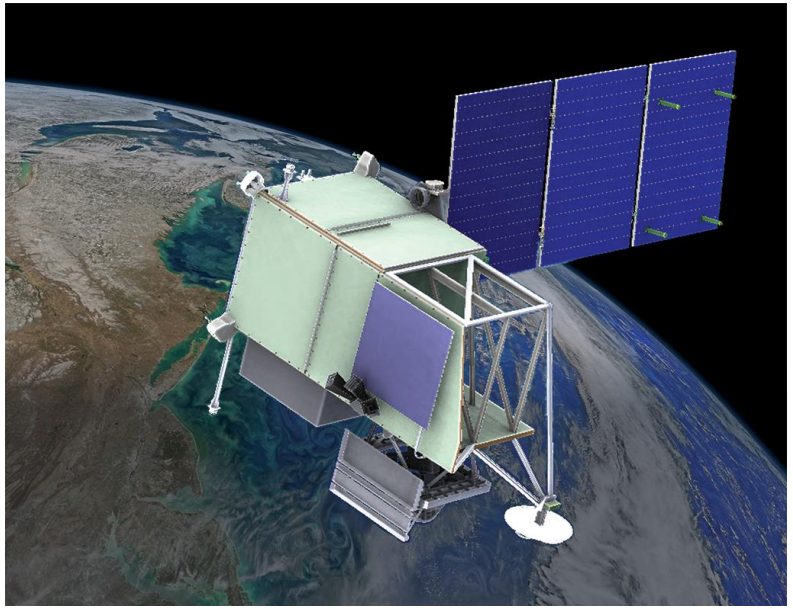
Highlights

- All scatterometer data has been sourced and calibrated
- Initial data product of scatterometer data is now available on the AODN
- Data is already being used in research

Satellite Remote Sensing

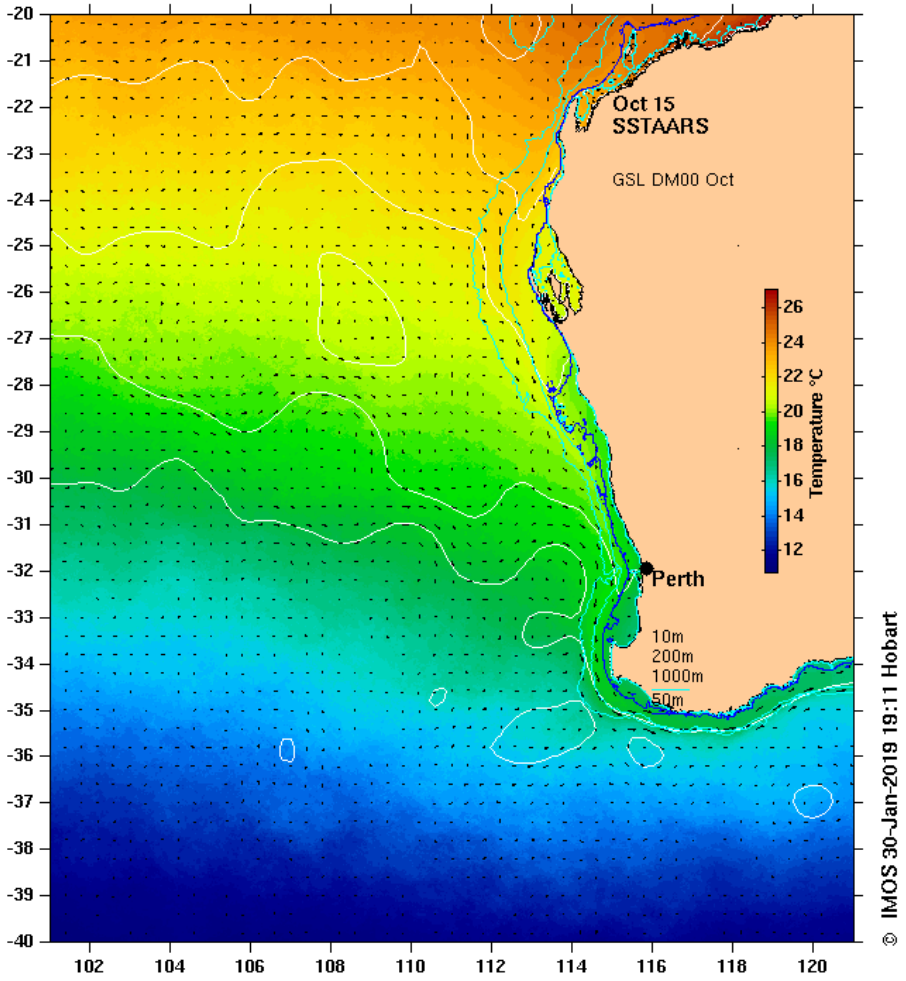
- IMOS applies satellite remote sensing data to help measure sea surface temperature, ocean colour, surface waves and conduct calibration and validation
- SWOT satellite mission
  - Surface Water Ocean Topography (NASA/CNES)
  - Game changer for meso-scale features and coastal altimetry
- PACE satellite mission
  - Plankton, Aerosol, Cloud, ocean Ecosystem (NASA)
  - Potential for Rottnest Island to serve as a site for ground-truthing off Perth

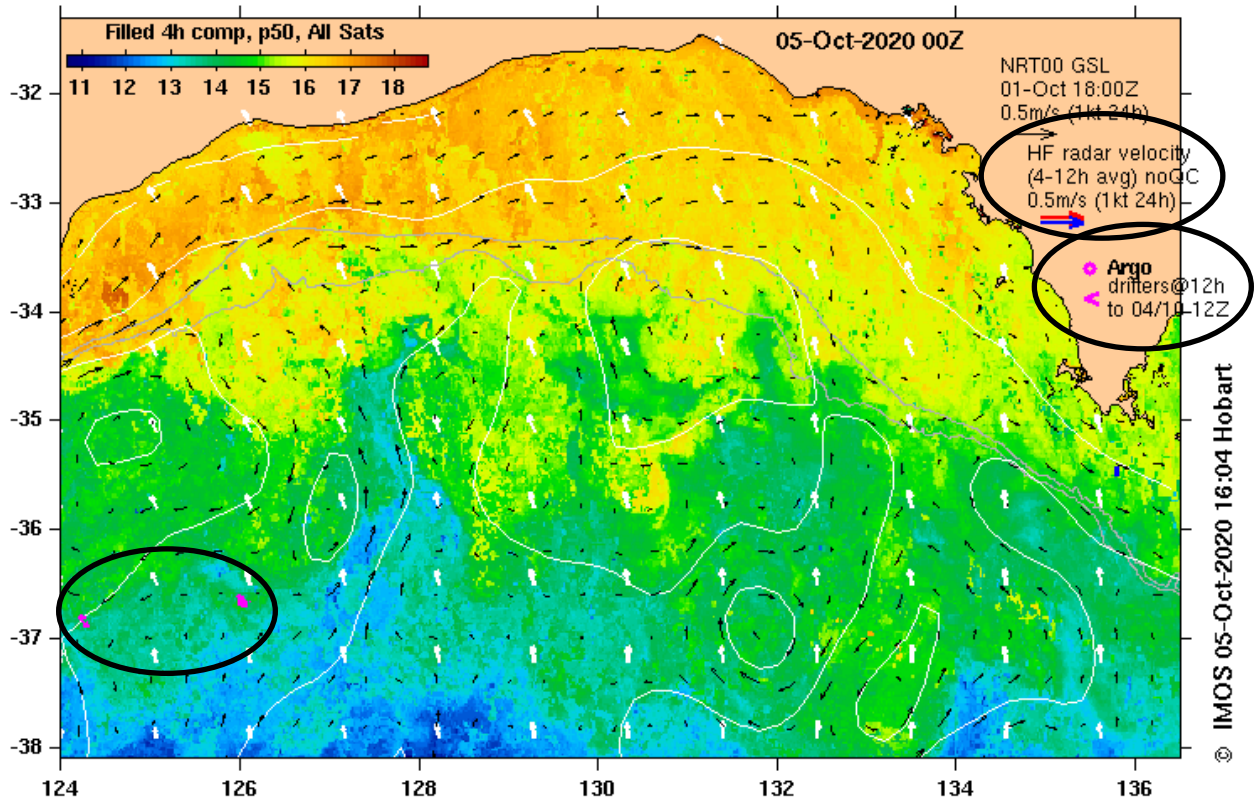




IMOS OceanCurrent

SST Atlas of Australian Regional Seas has a spatial resolution of ~2km. These products reveal regional oceanographic phenomena, including tidally-driven entrainment cooling over, wind-driven upwelling, shelf winter water fronts, cold river plumes, the footprint of the seasonal boundary current flows and features in the major offshore currents.



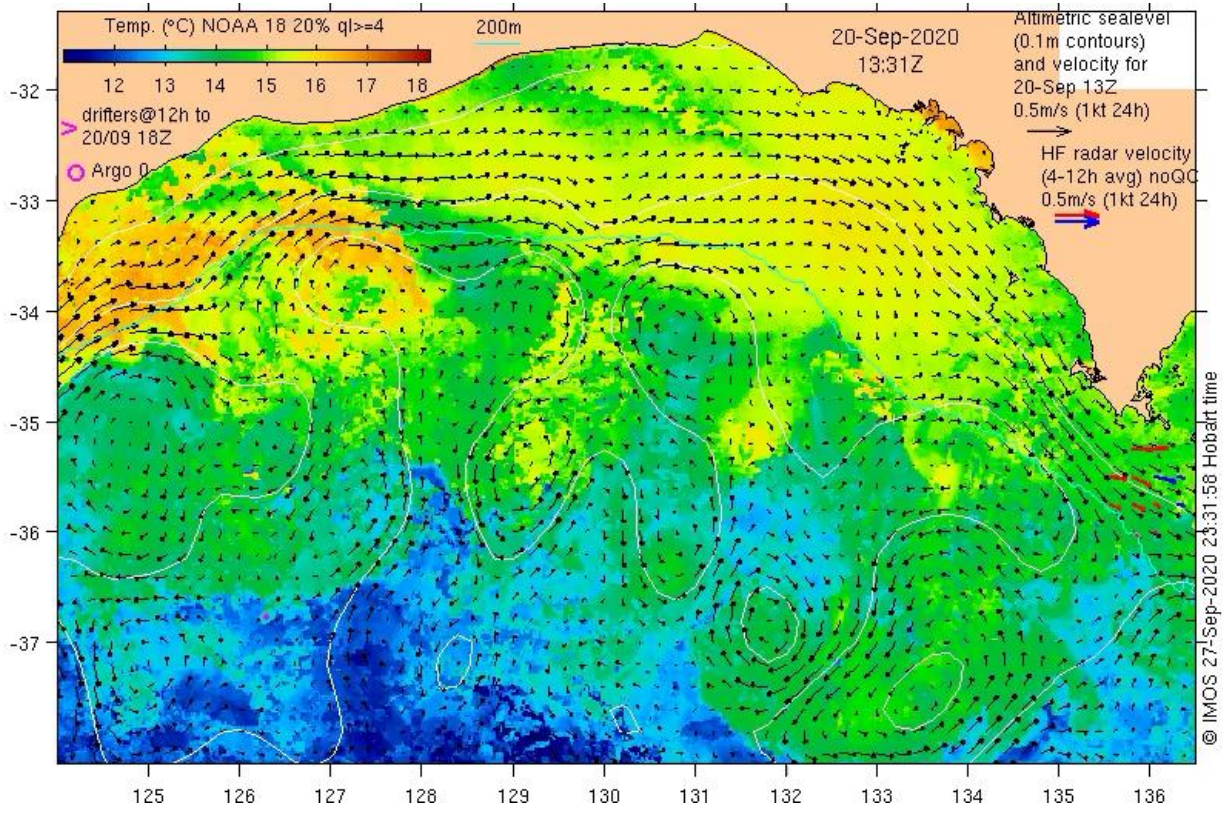


Four hour SST

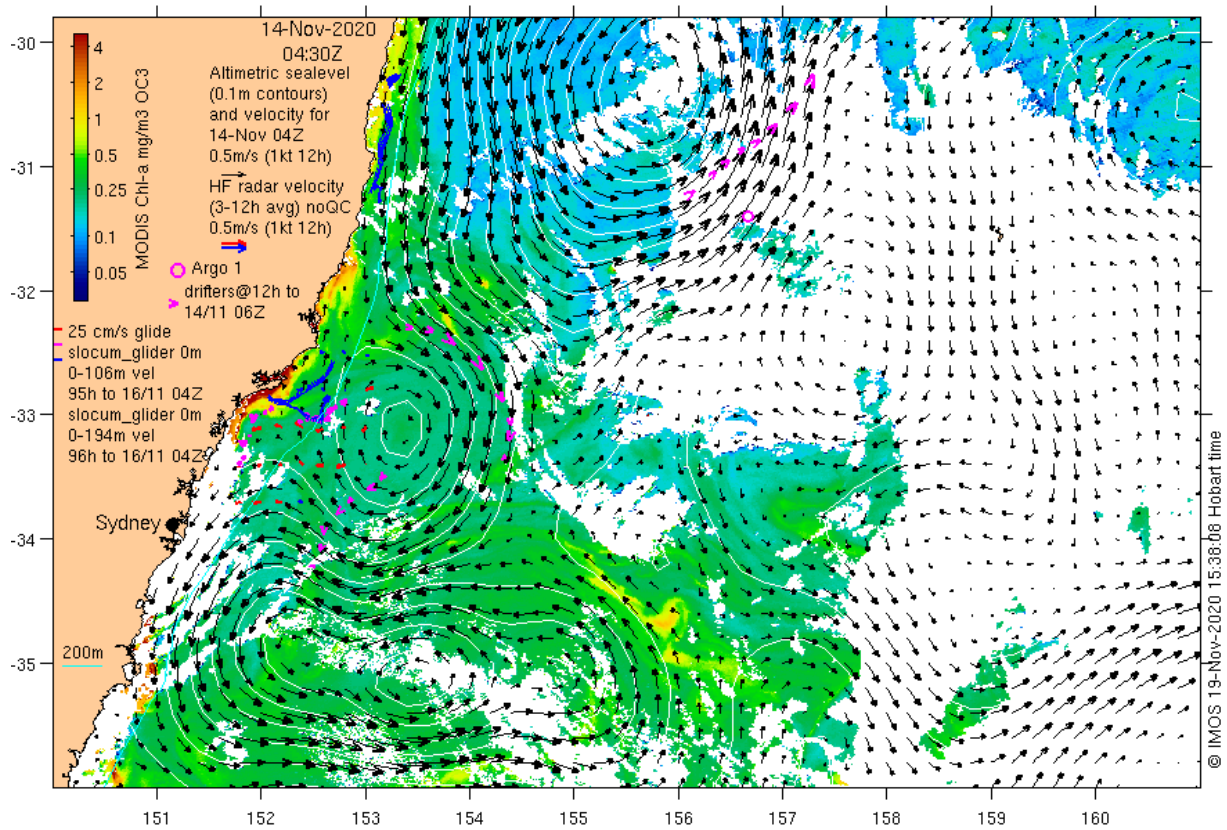
SSTAARS Product
Sea Surface Temperature (SST) Atlas of Australian Regional Seas

http://oceancurrent.imos.org.au

IMOS OceanCurrent



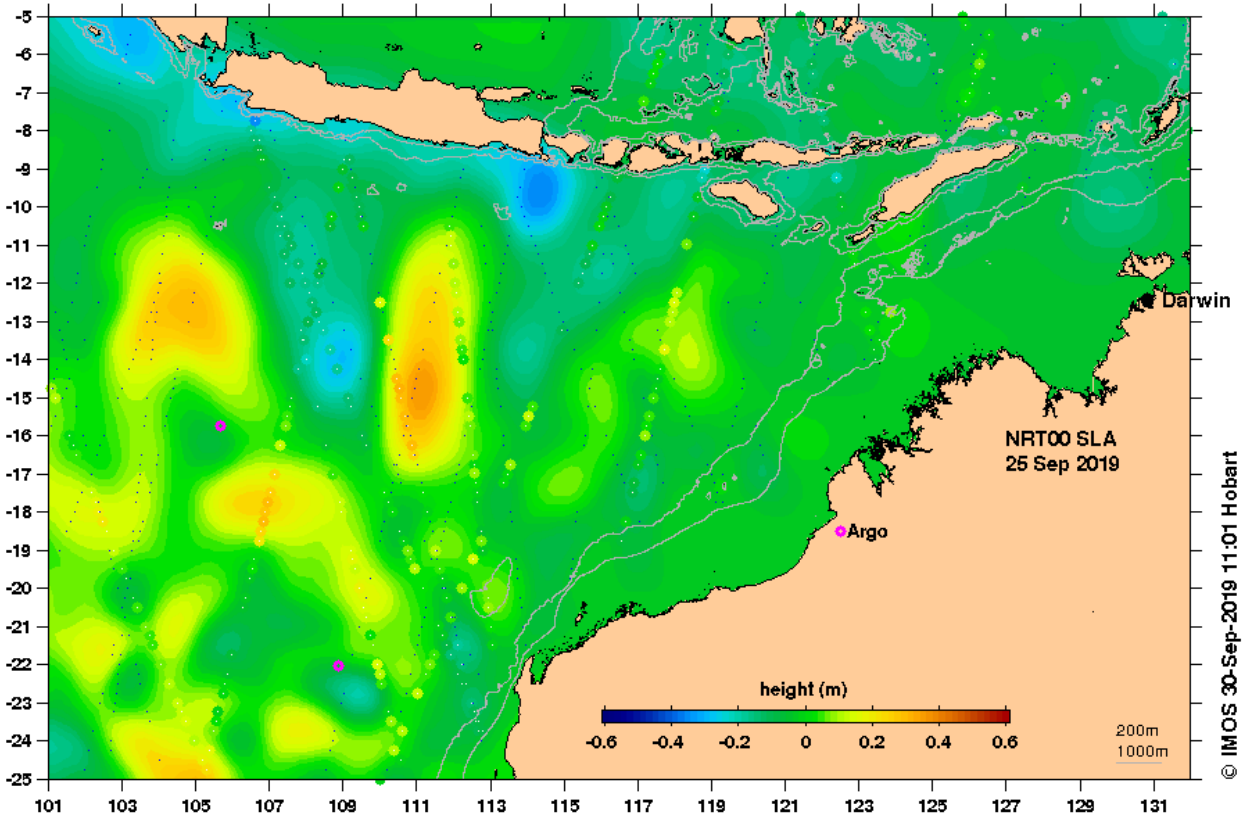
Snapshot SST Product



Snapshot Chl-a

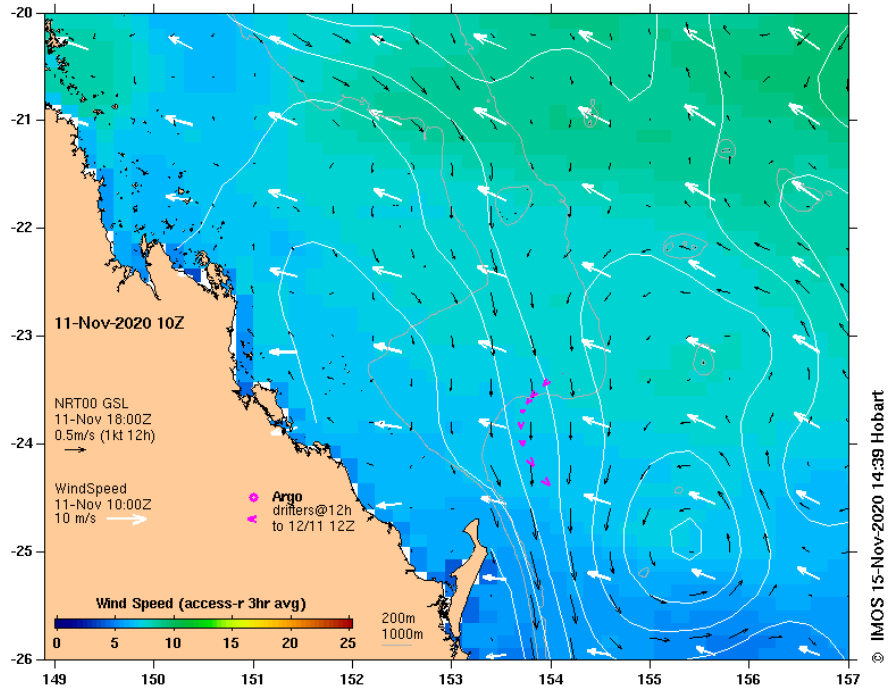
http://oceancurrent.imos.org.au

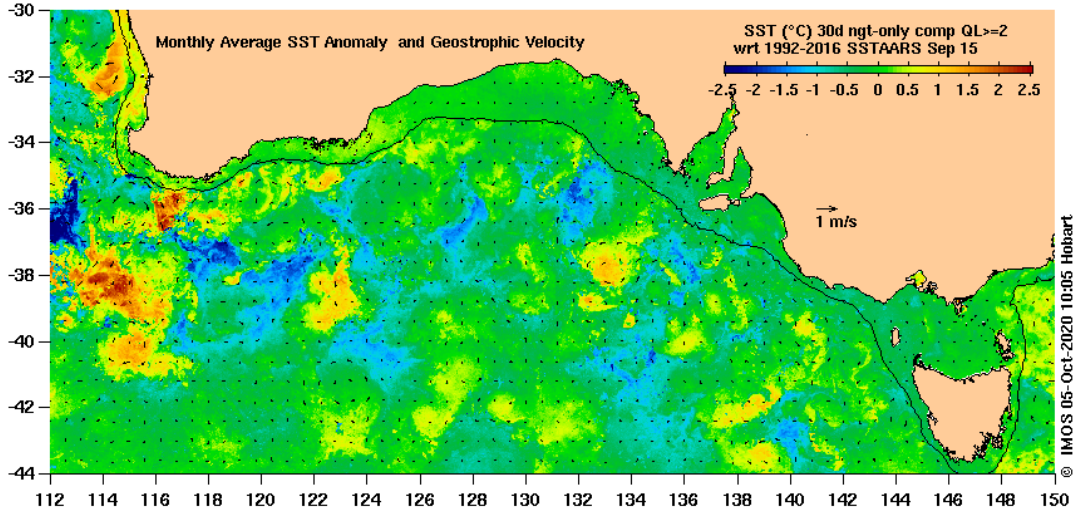
IMOS OceanCurrent



Monthly mean sea level anomaly

Wind speed





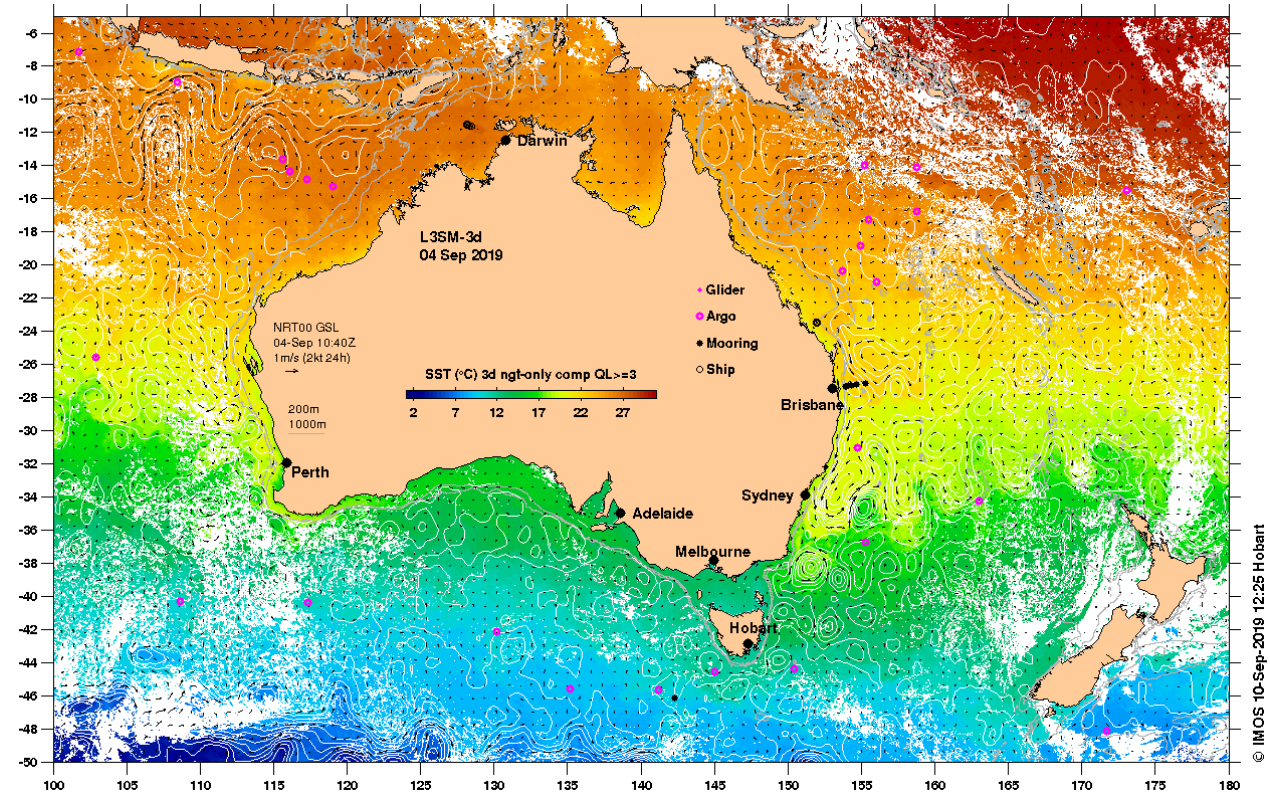
Monthly average SST anomaly

http://oceancurrent.imos.org.au

Application of IMOS data

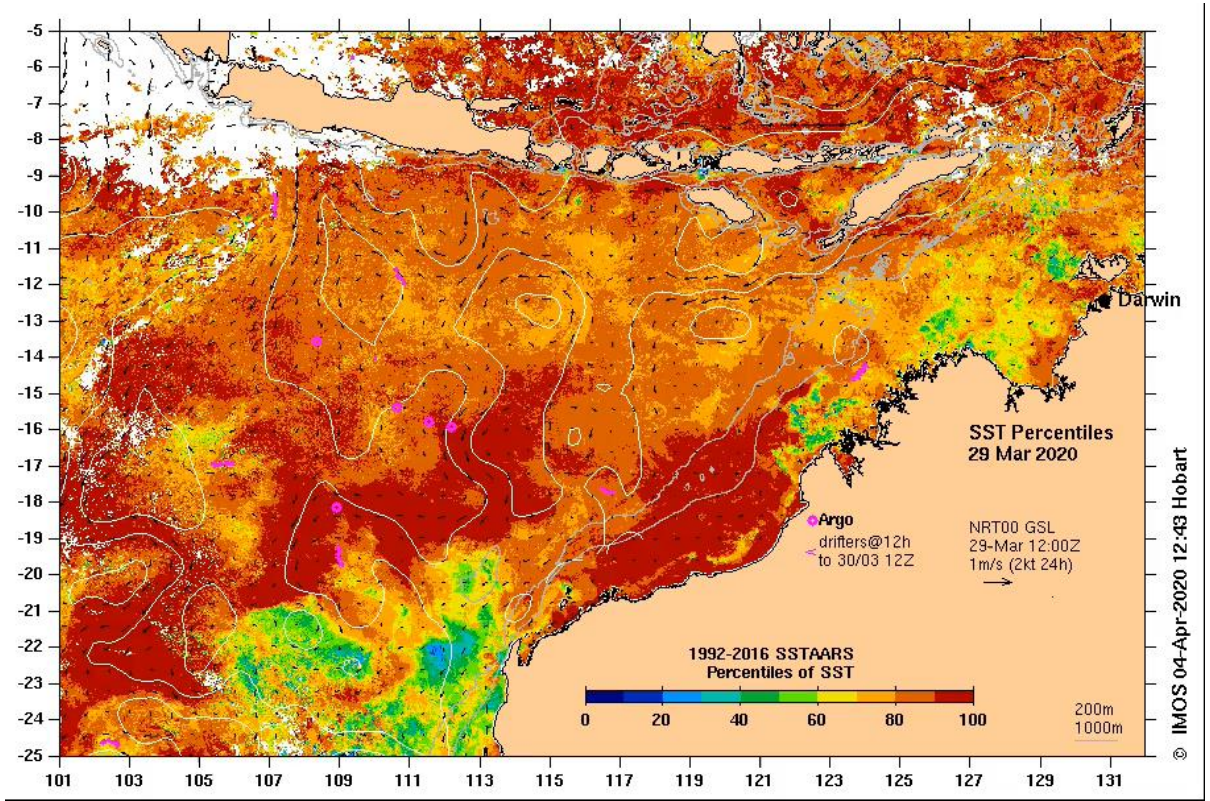
IMOS contributes data to a range of programs and products at national and international scales including:

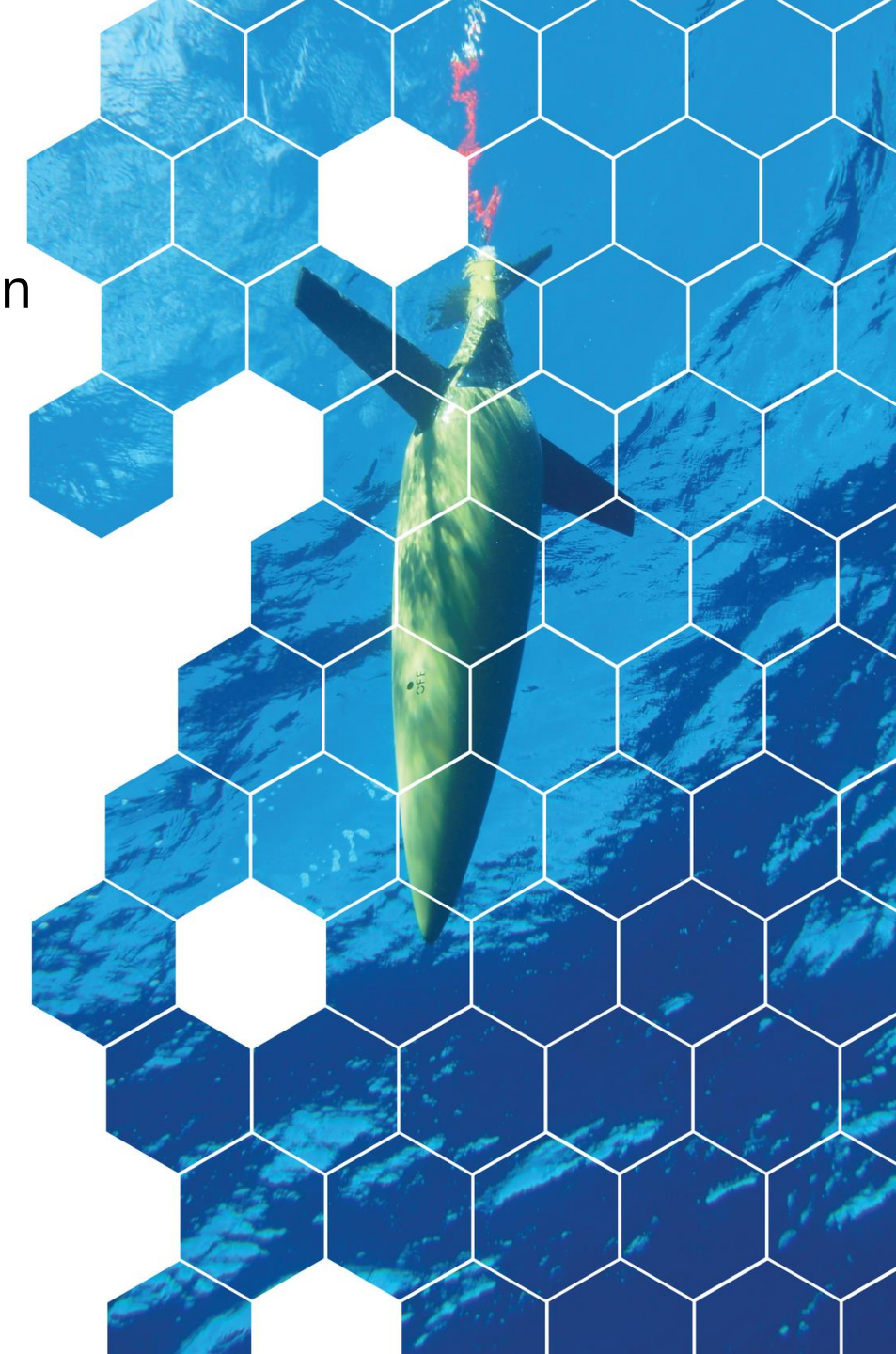
- Oceanographic modelling
- Weather forecasting
- Climate projections
- Extreme events (marine heat waves)



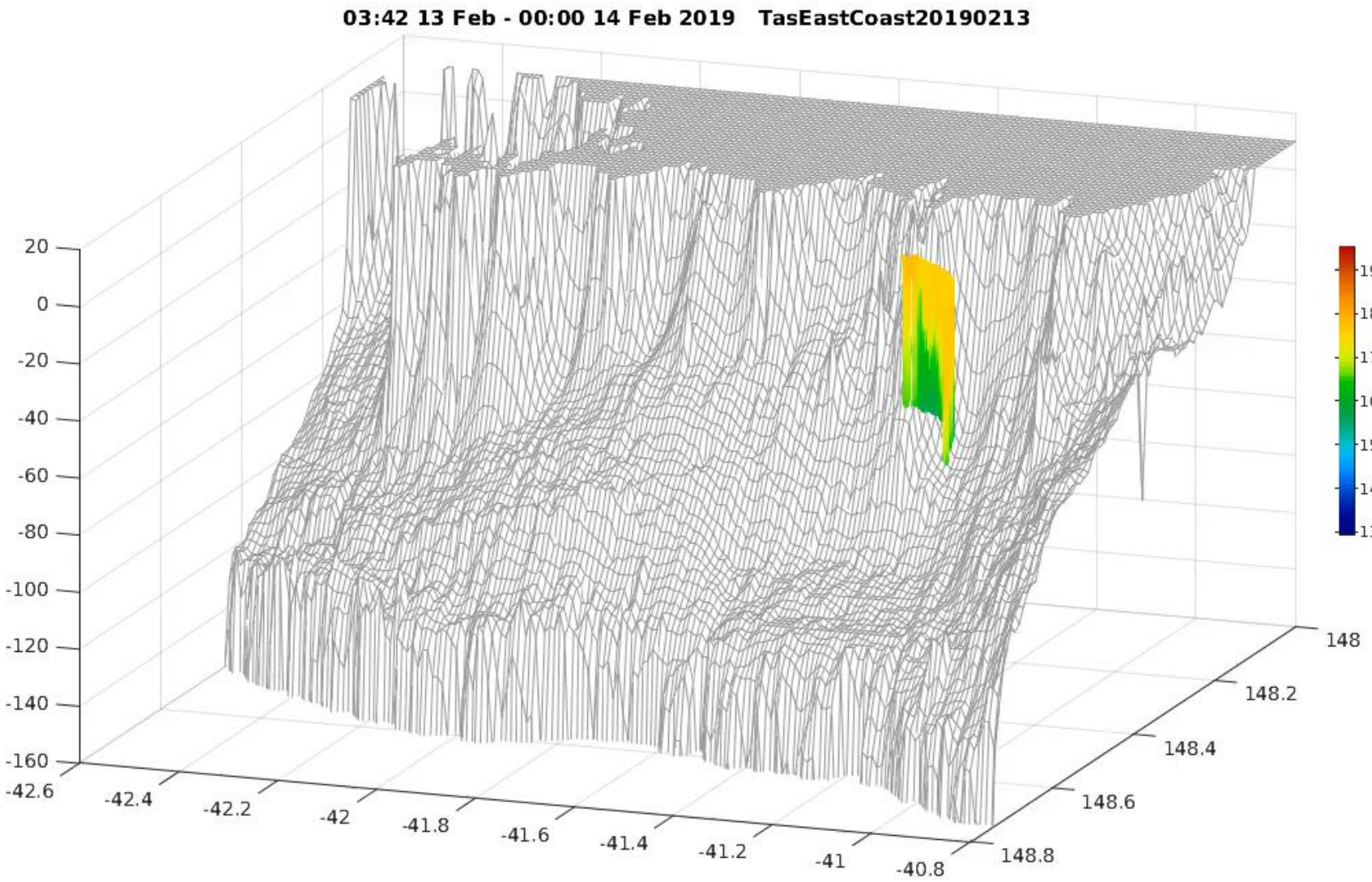
IMOS event-based sampling

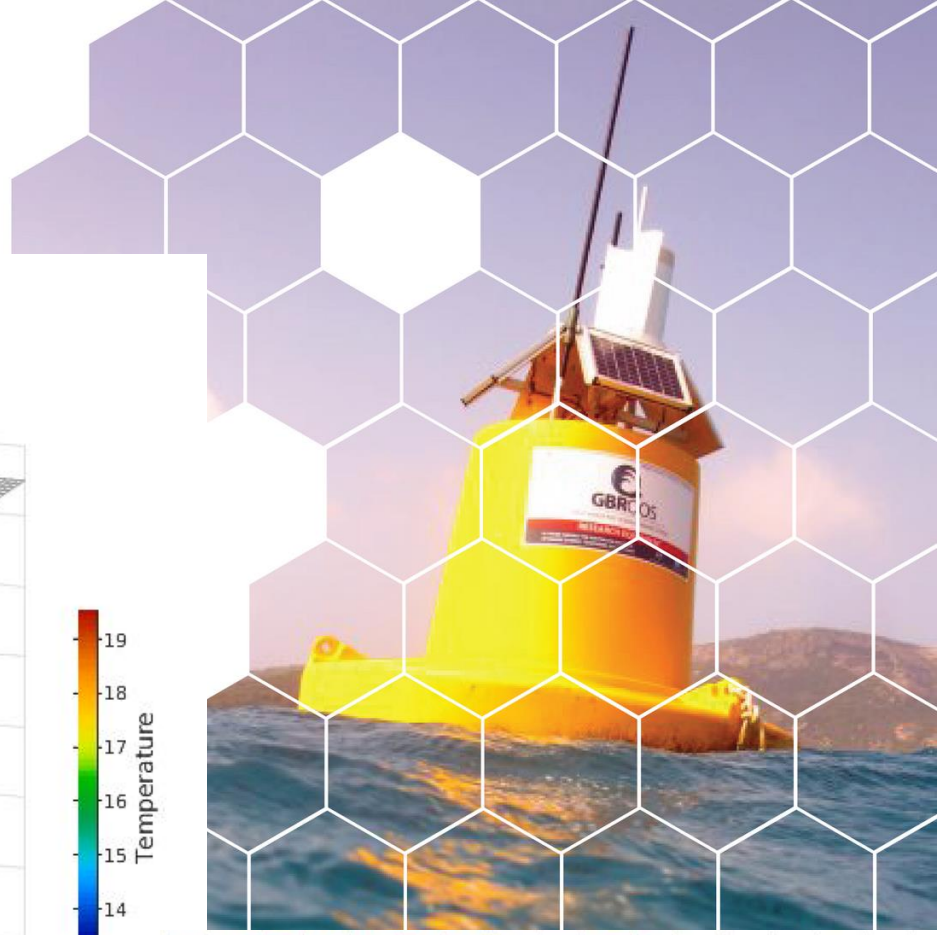
- IMOS uses ocean gliders to monitor marine heatwaves in coastal waters
- These measurements are crucial to understanding the implications of these episodic events including habitat loss, coral bleaching and other associated impacts

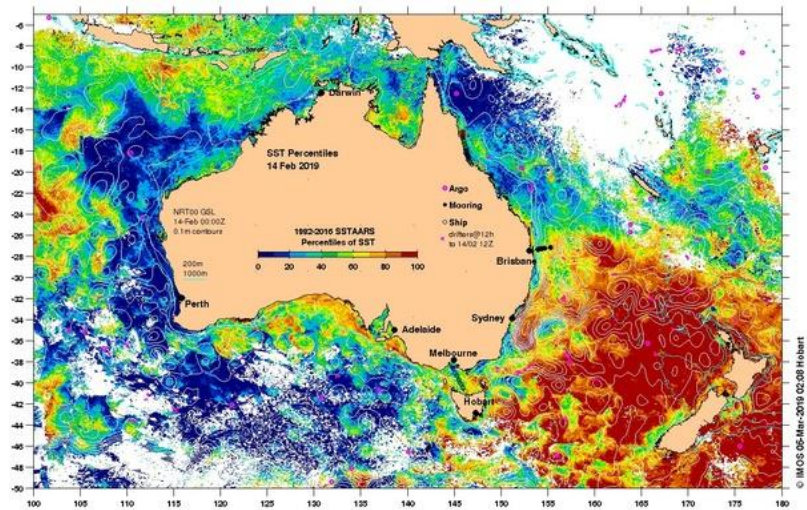




Measuring marine heatwaves





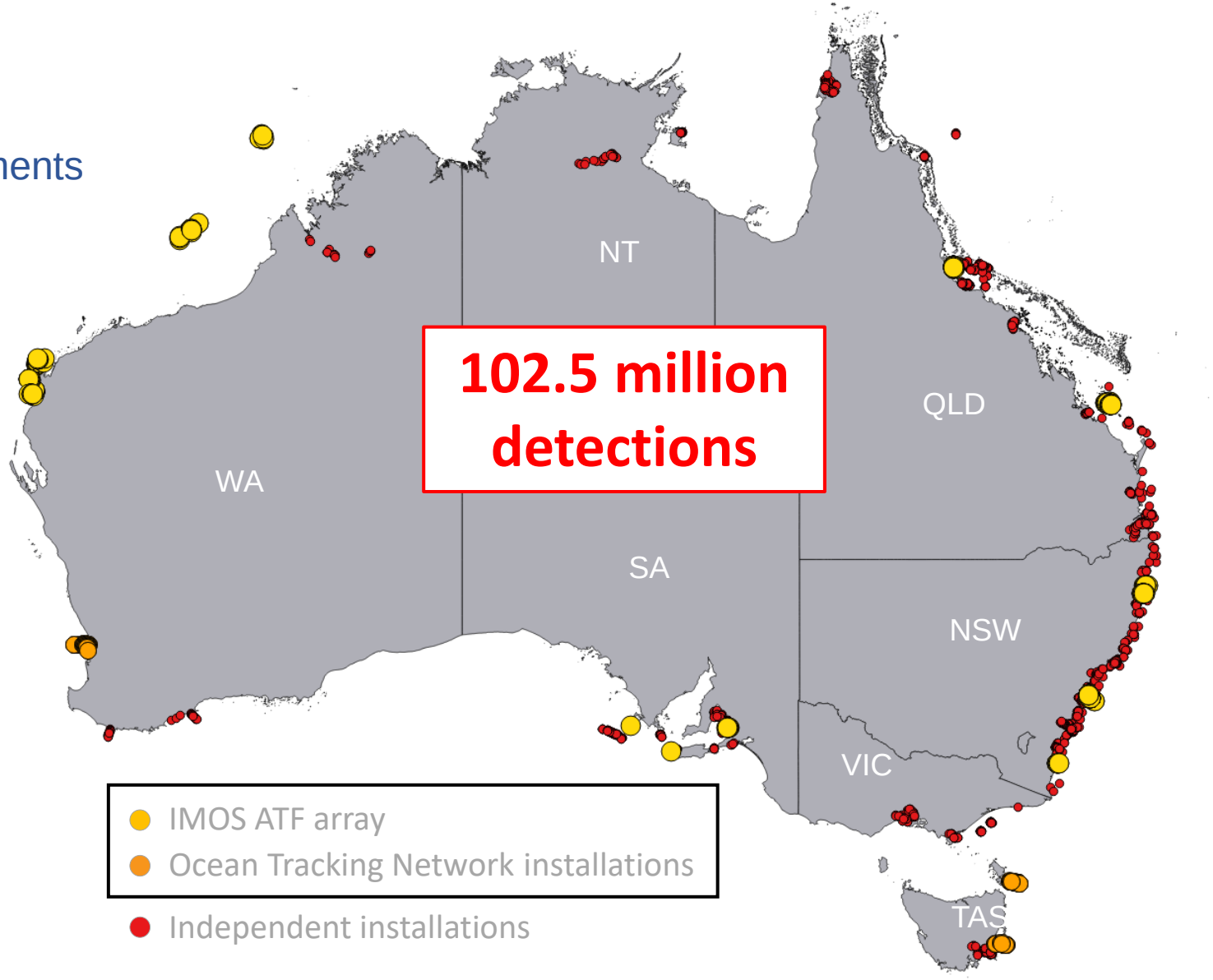


Investing in biological observations: Animal Tracking

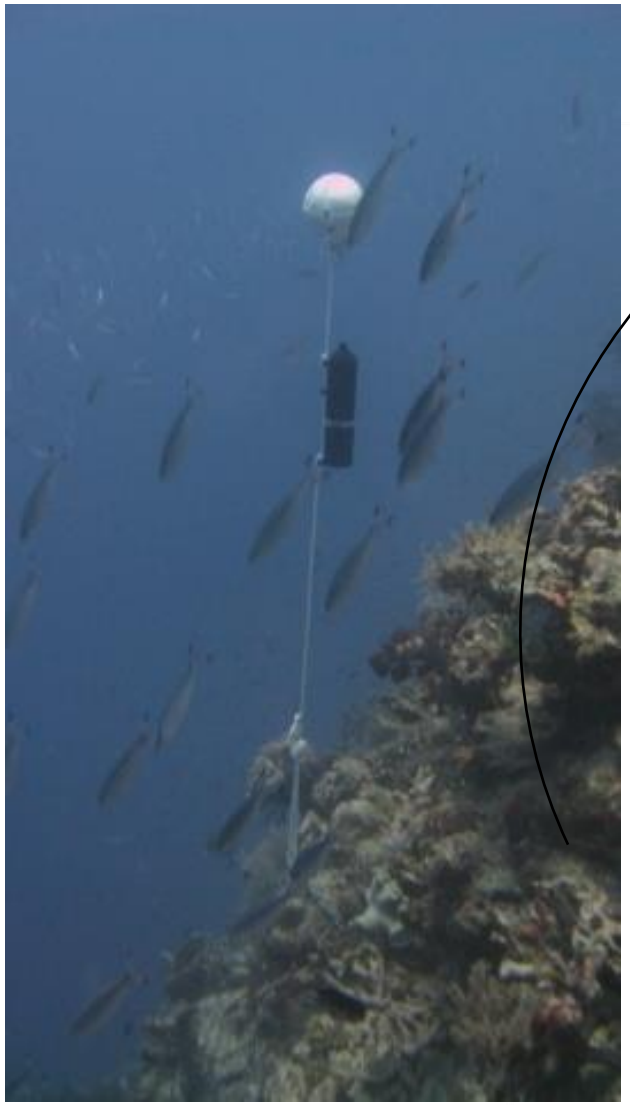
>8,000 receiver deployments

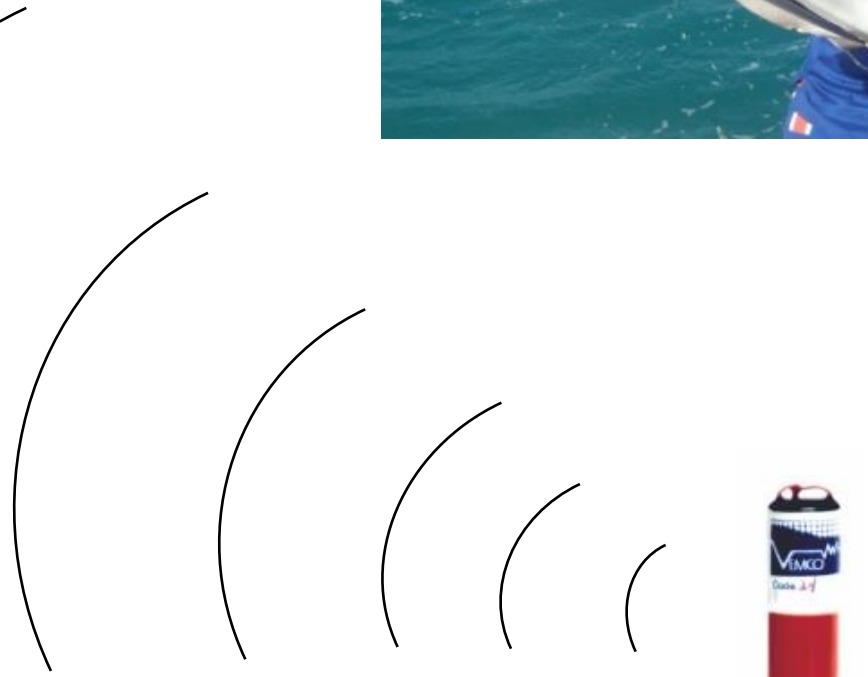
>9,000 animals tagged

139 species

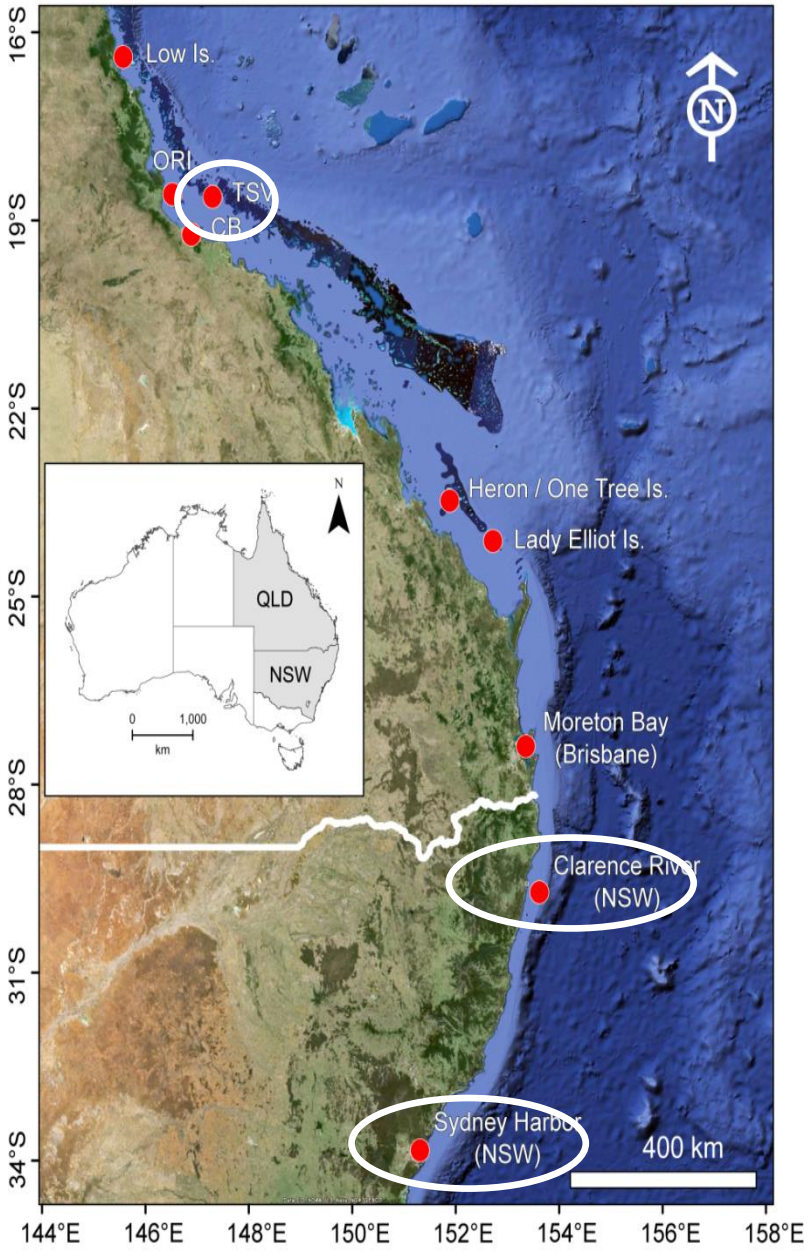


How does it work?



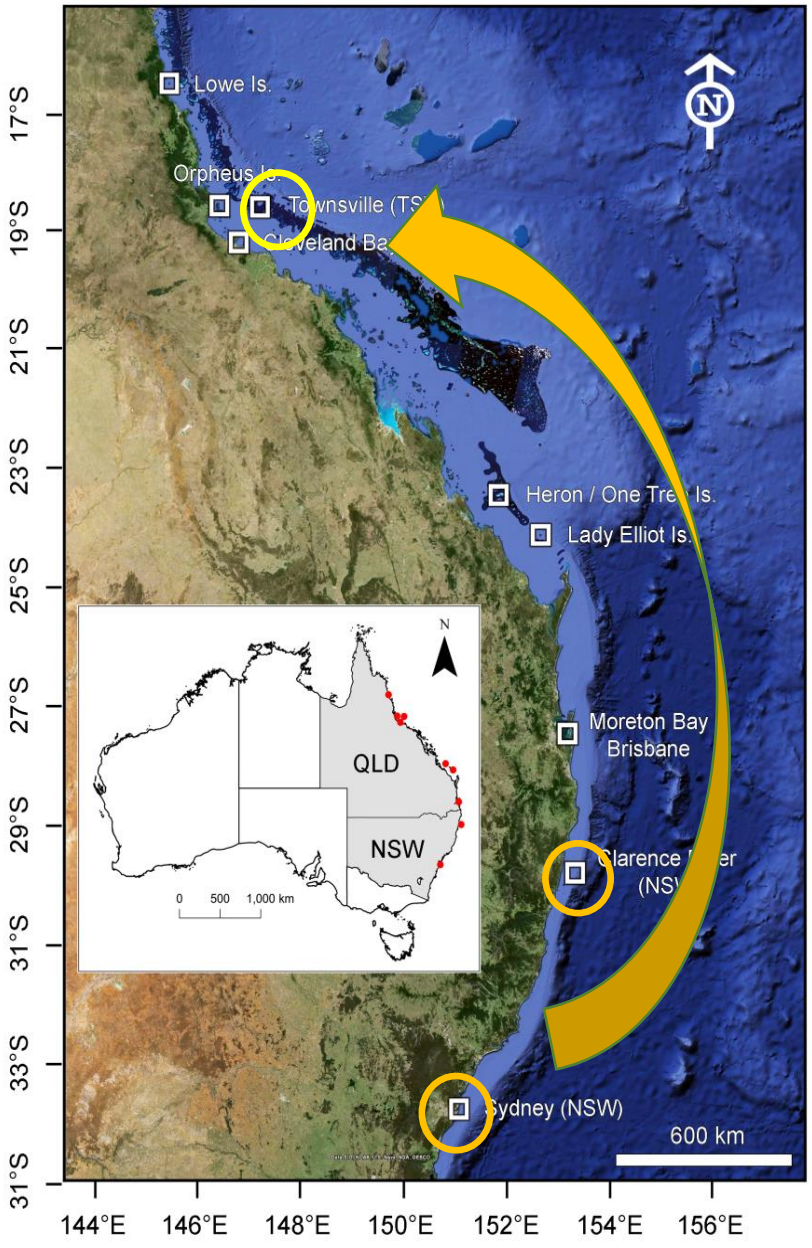


Bull shark movement example

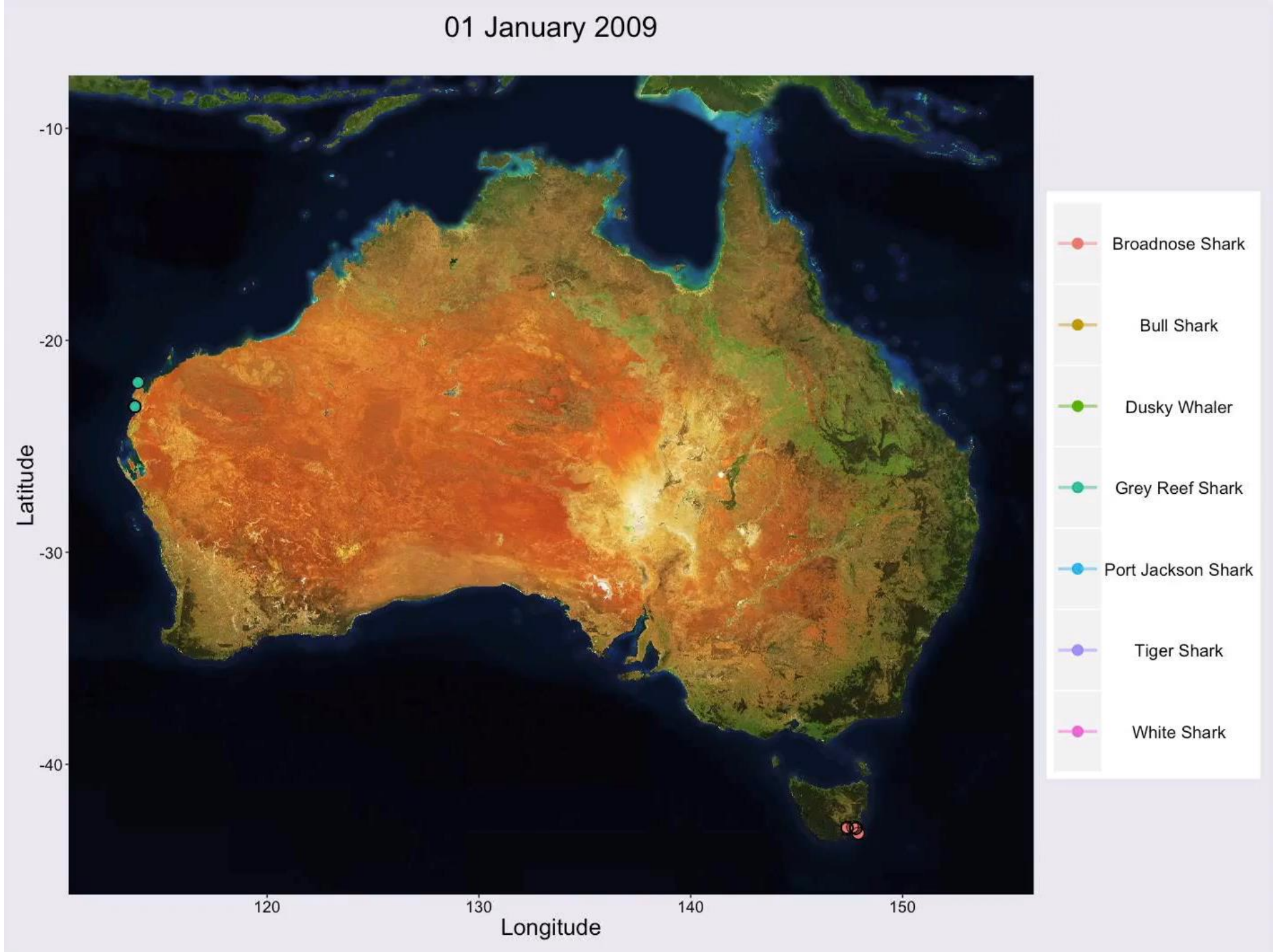


- 114 bull sharks were fitted with acoustic transmitters
  - QLD – 39 (30 female, 9 male)
    - Size range: 176 - 296 cm TL
  - NSW – 75 (33 female, 42 male)
    - Size range: 82 - 322 cm TL
- Movements were tracked by acoustic receivers along the QLD and NSW coastlines

Shark moves

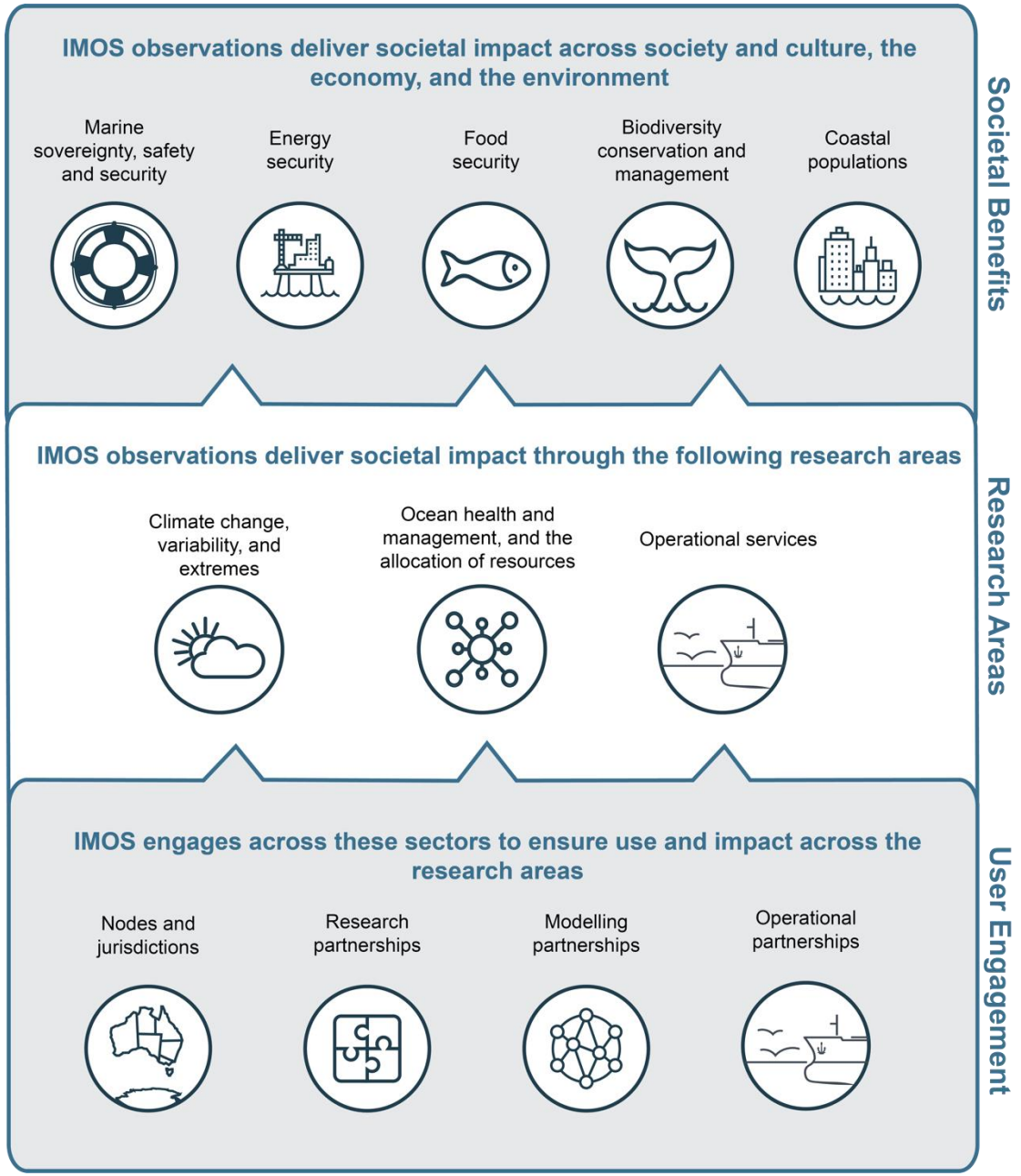


- 36 sharks from NSW (16 female, 20 male) moved to QLD
- Straight line distances moved ranged from 60-1770 km (mean: 1194 km)
- Individuals moved between NSW and QLD up to five times (predominantly females)
- Size was a factor in movement with larger individuals more likely to move between states
- Only 1 QLD shark moved to NSW (and returned)


01 January 2009
-10
-20
-30
-40
Latitude
120
130
140
150
Longitude
Broadnose Shark
Bull Shark
Dusky Whaler
Grey Reef Shark
Port Jackson Shark
Tiger Shark
White Shark

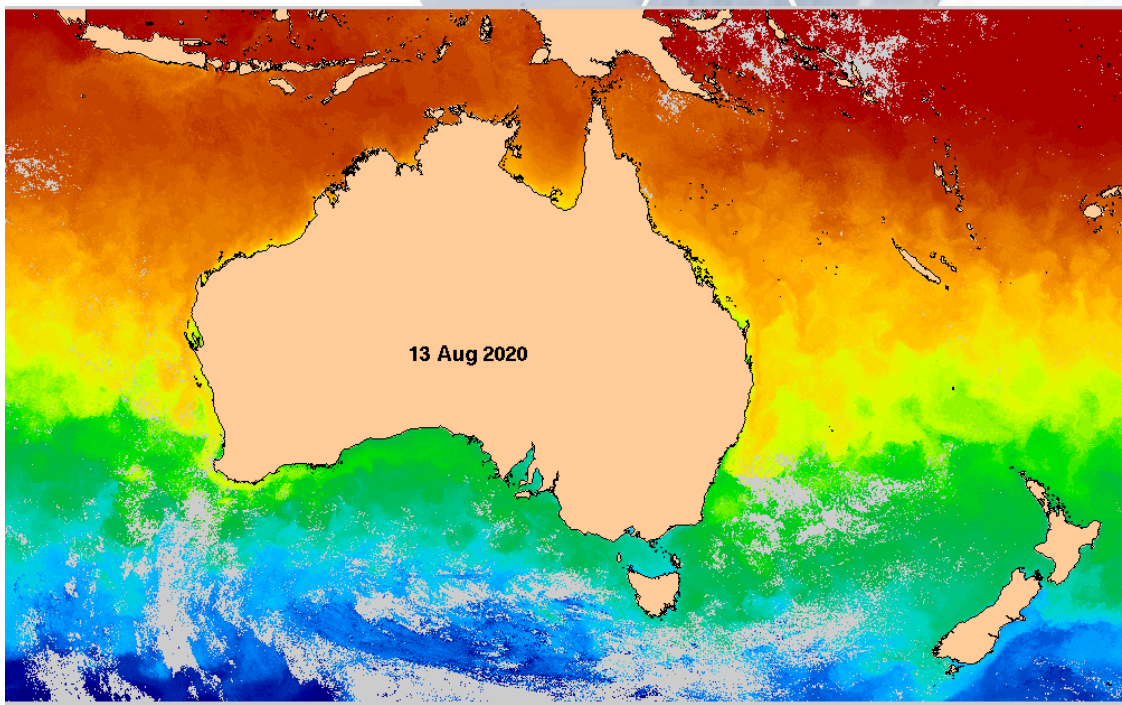
Working end-to-end

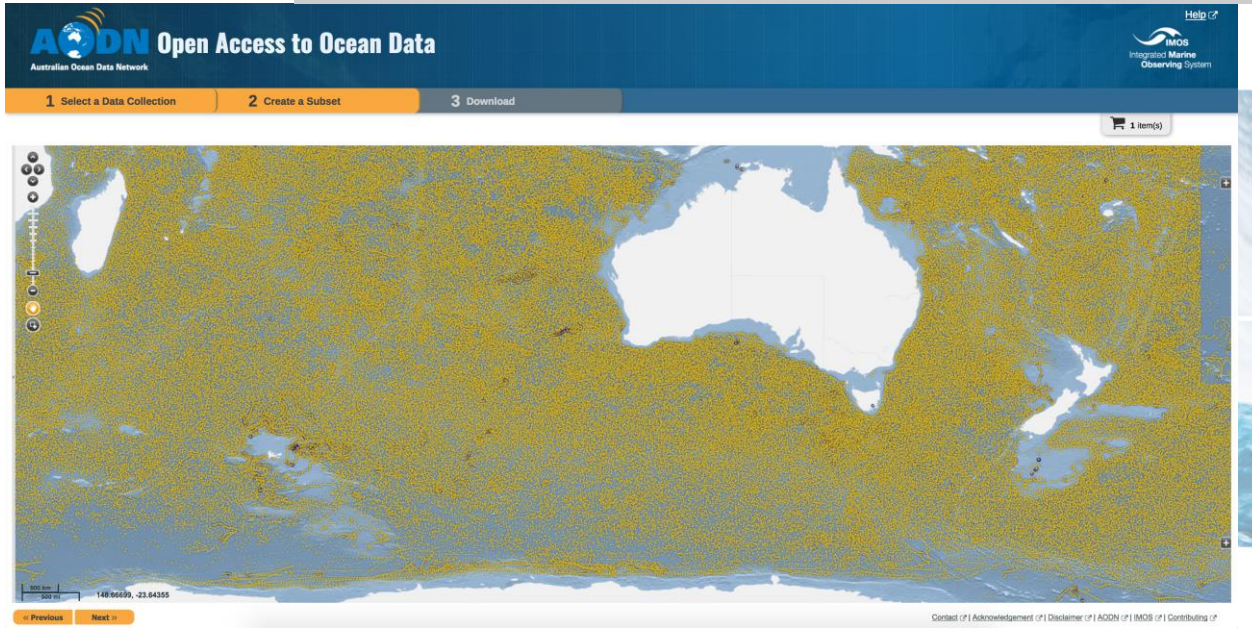
- IMOS works to engage across sectors to ensure relevance of our observations
- In conjunction with the research community we identify areas of overarching importance where IMOS observations can contribute
- Deliver outputs and research outcomes for real-world applications to create benefits for Australia
- Ocean modelling and prediction plays a key role in this process



How can you engage with IMOS?

- Visit the IMOS website (www.imos.org.au)
- Access our freely available resources via the Australian Ocean Data Network (portal.aodn.org.au)
- Check out data streams such as OceanCurrent (http://oceancurrent.imos.org.au/)





Thanks

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An Australian Government Initiative

IMOS is a national collaborative research infrastructure, supported by Australian Government. 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**

PRINCIPAL PARTICIPANTS

University of Tasmania (Lead Agent)

Australian Government

Australian Institute of Marine Science

Australian Government Bureau of Meteorology

CSIRO

Government of South Australia

SARDI South Australian Research and Development Institute

The University of Western Australia

sims sydney institute of marine science

UTS

The University of Sydney

Macquarie University

UNSW Sydney

SIMS is a partnership involving four Universities.

ASSOCIATE PARTICIPANTS

Curtin University

Australian Government
Department of the Environment and Energy
Australian Antarctic Division