



## Bringing ocean observations to the classroom: student access to open data

**Roger Proctor**<sup>1</sup>, Jason Everett<sup>2</sup>, Moninya Roughen<sup>3</sup>, Amandine Schaeffer<sup>3</sup>, Xavier Hoenner<sup>1</sup>, Iain Suthers<sup>3</sup>, Peter Steinberg<sup>2</sup>, Martina Doblin<sup>4</sup>, Stefan Williams<sup>5</sup>, Mitch Bryson<sup>5</sup>, Stef Brodie<sup>6</sup>, Kerrie Swadling<sup>7</sup>

<sup>1</sup>IMOS, <sup>2</sup>SIMS

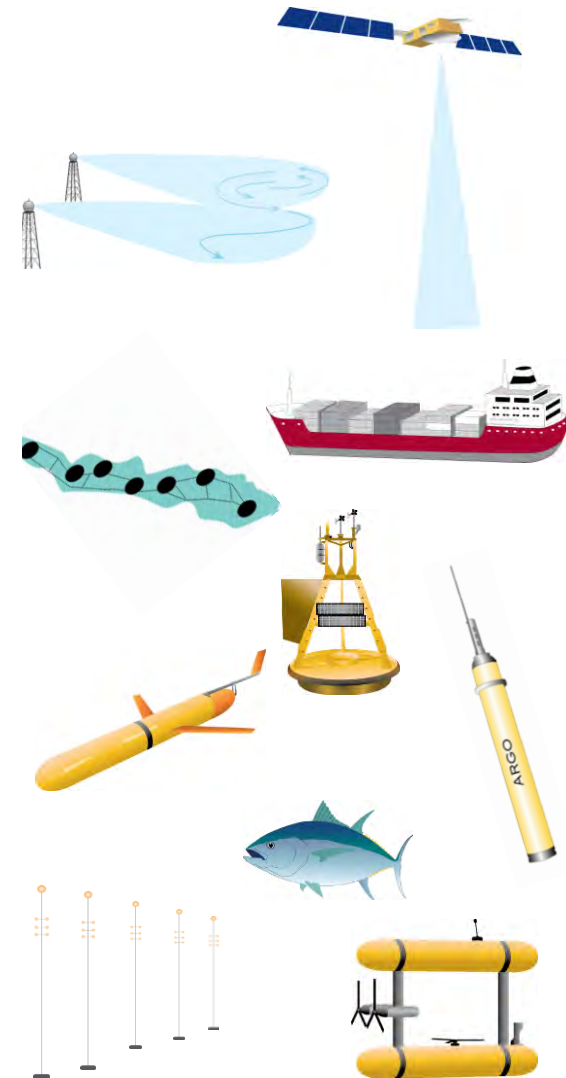
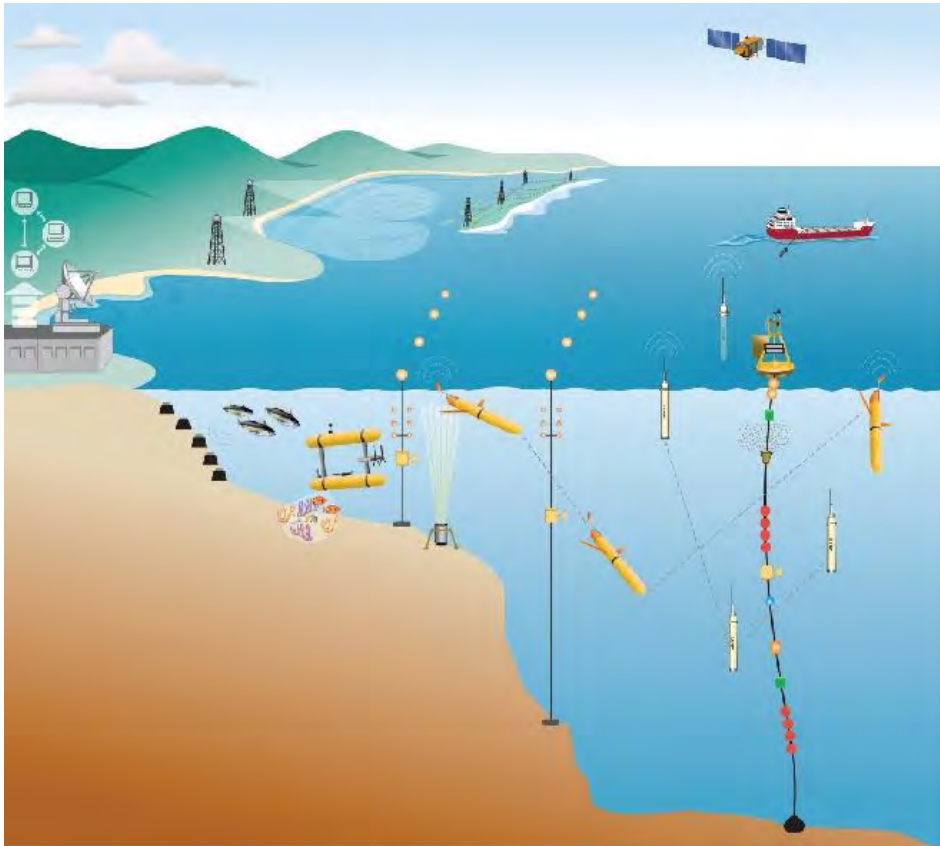
<sup>3</sup>UNSW, <sup>4</sup>UTS

<sup>5</sup>USydney, <sup>6</sup>Macquarie U

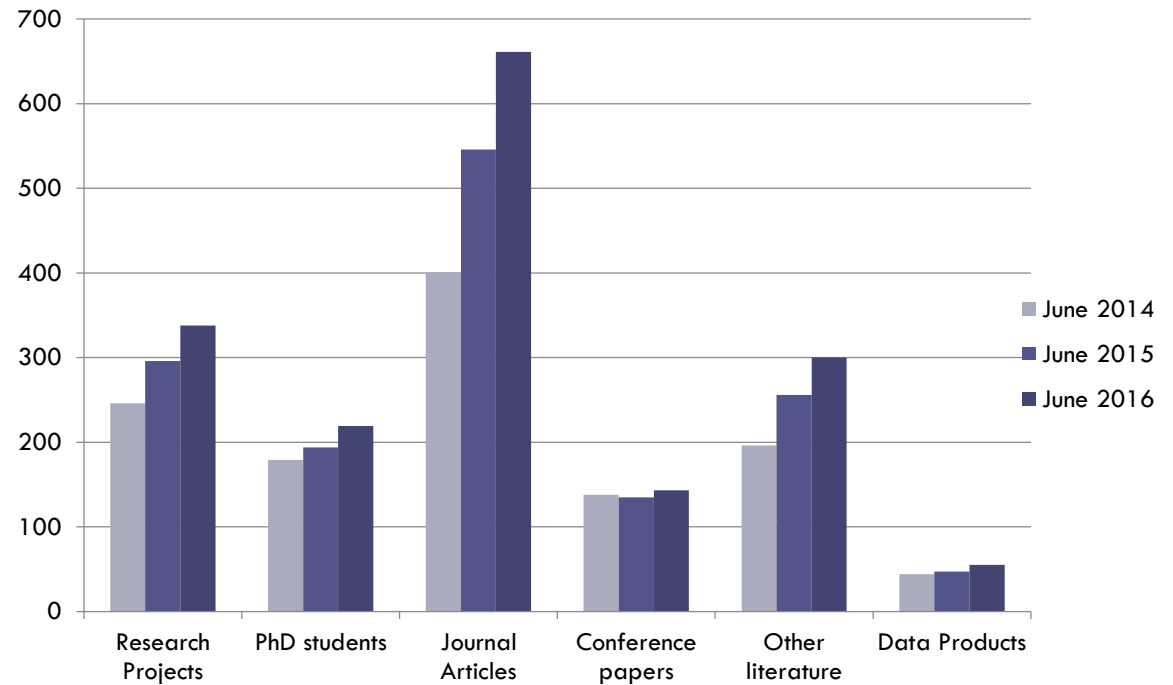
<sup>7</sup>UTAS

# What is IMOS?

**Free and open** biological, physical and chemical data for coastal and open waters around Australia



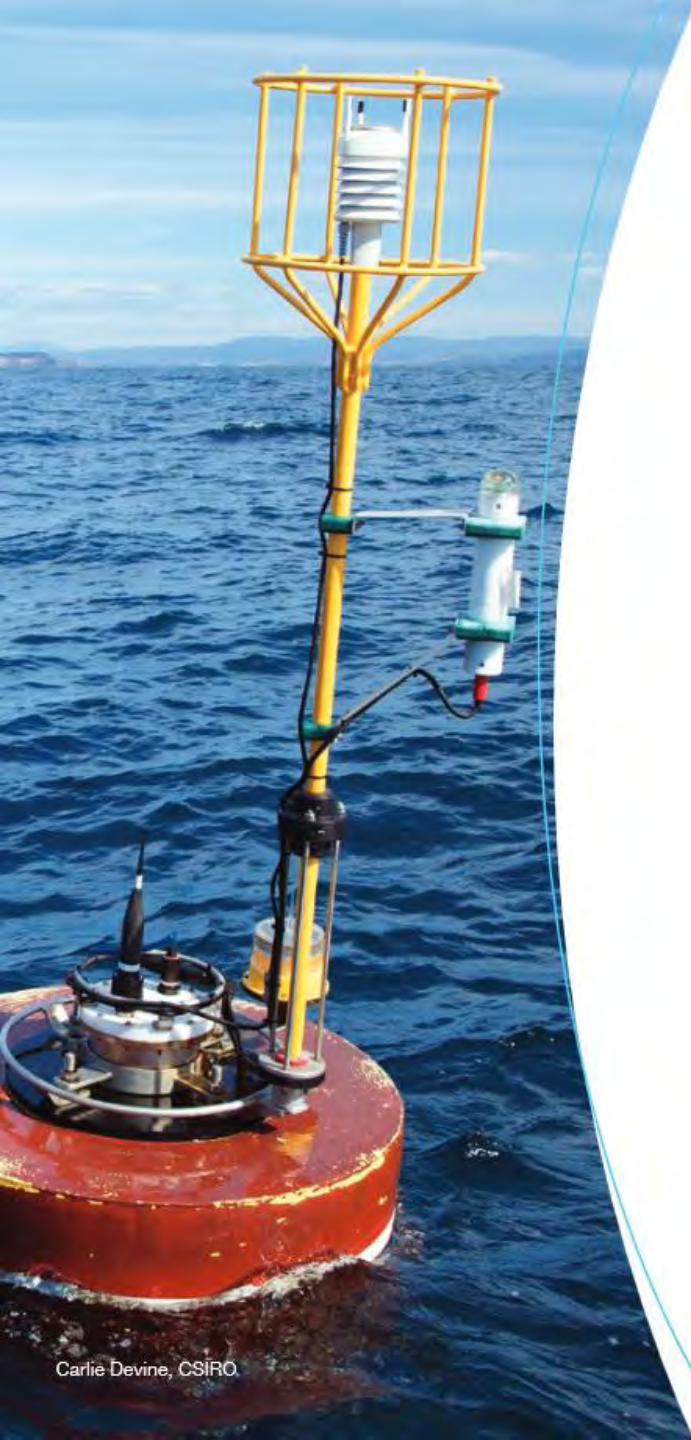
# What is IMOS?





# Topics in Australian Marine Science (TAMS)

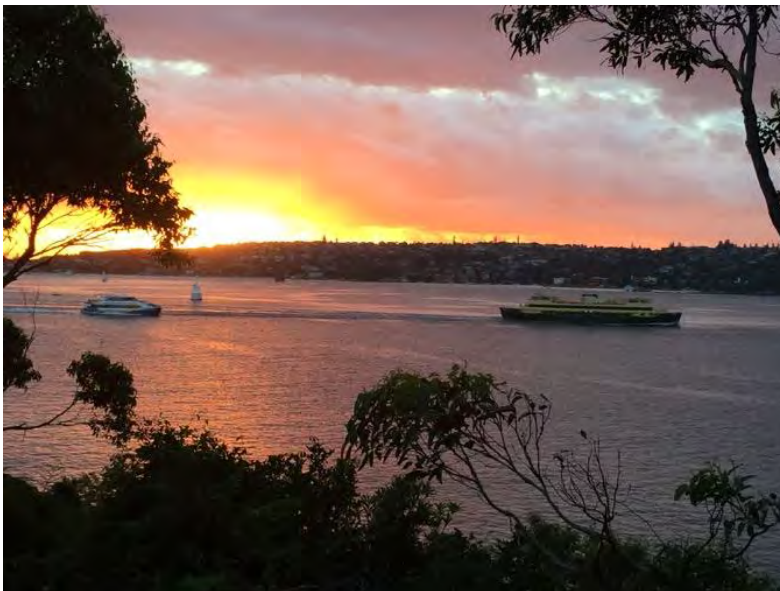
- IMOS has been integral to a combined university graduate program at the Sydney Institute of Marine Science
- Partnership between SIMS, Macquarie University, UNSW, UTS and the University of Sydney
- IMOS focused lectures, tutorials and fieldwork
- Started in 2013



Carlie Devine, CSIRO



# The location 😊 Sydney Institute of Marine Science, Chowder Bay, Sydney



# 2016 Program

## 2016 Topics in Australian Marine Science (TAMS) Course Schedule

	Tutorials/Practical (9:30am - 12:30pm)	Seminars (1:15 - 2:15pm)
Week 1 (3 Mar)	PRAC 1: 1. Welcome (Peter); 2. Course Overview/Expectations/Computing (Jason); 3. Introduction to the IMOS Ocean Portal (Xavier Hoenner, AODN)	Iain Suthers (UNSW)
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Week 14 (9 Jun)	EXAM	BBQ at IMS

The program is broadly broken into 6x 2-week modules on different parts of IMOS  
Expanded in 2016 with inclusion of fisheries management

# 2016 Seminars – introductory topics

Week	Topic
1 (3 March)	Iain Suthers (UNSW) - Fisheries Oceanography
2 (10 March)	David Booth (UTS) - Coastal Fish Communities
3 (17 March)	Moninya Roughan (UNSW) - Physical Oceanography
4 (24 March)	Vic Peddemors (NSW-DPI) - Shark Ecology - Research and Management
5 (7 April)	Martina Doblin (UTS) - Phytoplankton Ecology in the ocean
6 (14 April)	Bill Gladstone (UTS) - Marine Biodiversity Conservation
7 (21 April)	Aldo Steffe (Fish. Surv. Soln.) - Recreational Fishing
8 (28 April)	David Raftos (Macquarie) - Environmental stress and disease
9 (5 May)	Rob Harcourt (Macquarie) - Marine Mammals
10 (12 May)	Paulina Heredia-Cetina (UNSW) - Modelling Connectivity and Dispersal
11 (19 May)	Ezequiel Marzinelli (UNSW) - Macroalgae ecology - Human impacts and solutions
12 (26 May)	John Stewart and Doug Ferrell (NSW-DPI) - Research and management of over-fished mulloway
13 (2 June)	Ana Vila Conjevo (USyd) - Morphology of coral reef systems



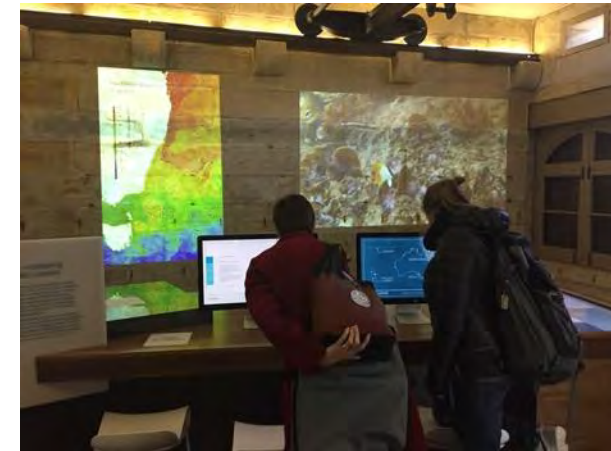
## Lunchtime Program

A program to get the students exposed to as much as possible at SIMS outside of the core-IMOS topics they are covering.

It includes age and growth of fish demonstrations, SIMS facility tour, Discovery Centre tour, AUV demonstration.

It is voluntary but most students attend and rate it very highly in the final reviews.

<http://sims.org.au/community/sims-discovery-centre/>



# Lunchtime Program

## Age and Growth of Mulloway Demonstration

This demonstration was paired with a seminar on 26 May 2016 from John Stewart & Doug Ferrell (DPI) on Mulloway research and management.



# TAMS Enrolments

	2013	2014	2015	2016
TOTAL	26	41**	26	26

\*\* USyd closed their M. Env. Mgt and merged students into MMSM hence inflated numbers for 2014

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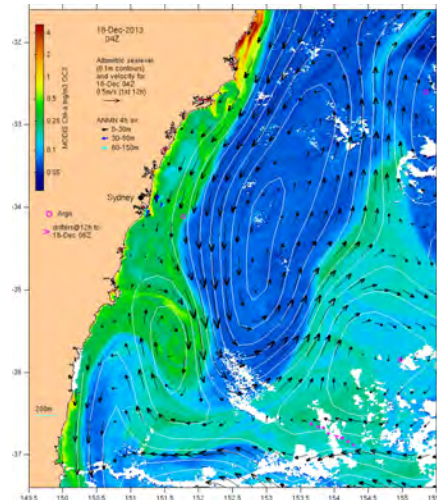
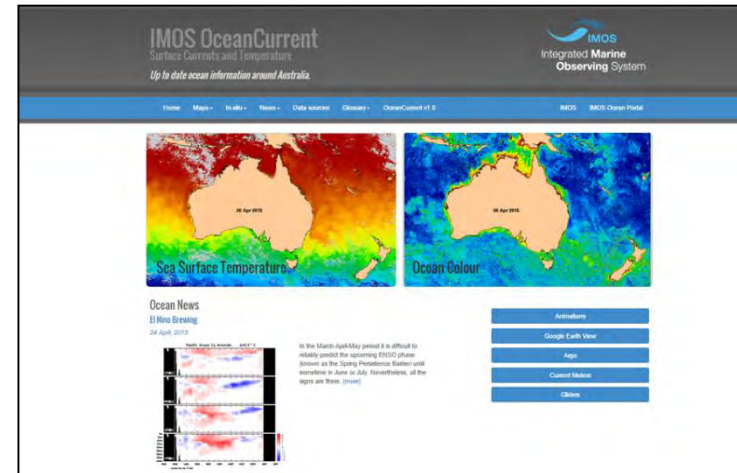
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# How does IMOS work? – Add value to Data

## *OceanCurrent*

<http://oceancurrent.imos.org.au/>

- Daily maps
  - ▣ Surface currents
  - ▣ Temperature
  - ▣ Ocean Colour
  - ▣ + HF radar, Argo, surface drifters
- ‘Super user’ of the IMOS data streams
- Making ocean data available to a wider audience



# How do you get the data?

All data discoverable, accessible, downloadable and reusable  
Access: the Australian Ocean Data Network

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

The image displays the AODN Open Access to Ocean Data portal interface, which is designed for users to discover, create subsets, and download ocean data. The interface is organized into three main steps:

- Step 1: Select a Data Collection**: This step involves choosing a specific data collection from a list. The current selection is "JRMOS - SRS Satellite - SST L3S - 01 day composite - night time".
- Step 2: Create a Subset**: This step allows users to define the spatial and temporal extent of the data. The current subset is defined by a bounding box (129°E to 129°W, 35°S to 35°N) and a temporal extent from 2016/08/01 15:20 UTC to 2016/09/21 15:20 UTC.
- Step 3: Download**: This step provides options for downloading the data in various formats, including NetCDF, CSV, and NetCDF (sub-netCDF). The current download options are NetCDF and NetCDF (sub-netCDF).

The interface also includes a sidebar with filters for Parameter, Organisation, Platform, Date (UTC), Geographic Boundary, and Keyword. The current filters are: Parameter: SST; Organisation: JRMOS; Platform: Satellite; Date (UTC): 2016/08/01 15:20 UTC to 2016/09/21 15:20 UTC; Geographic Boundary: 129°E to 129°W, 35°S to 35°N; Keyword: SST.

# TAMS Prac 1, 3rd March 2016

## Introduction to the AODN Ocean Portal

### Example query

#### □ **Step 1: Select a Data Collection**

- 1. How many data collections in the **AODN Ocean Portal** include the parameter “Temperature” and of these, how many were collected from profiling platforms?

#### □ **Step 2: Create a Subset**

- How many profiles off the coast of NSW are available for Argo float number 5901625 for the month of January 2008?

#### □ **Step 3: Download**

- Choose one of the Argo floats off the coast of NSW and download the associated profile as a CSV file. What is the salinity recorded by the float at the top of the profile? What are the units for salinity?

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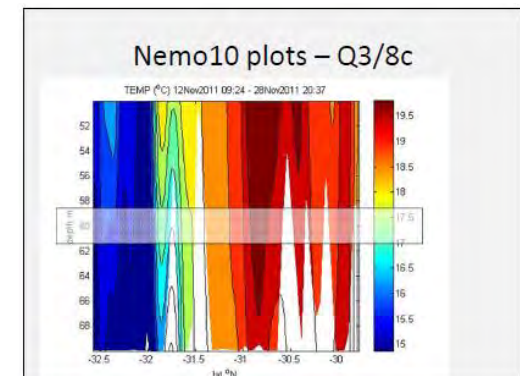
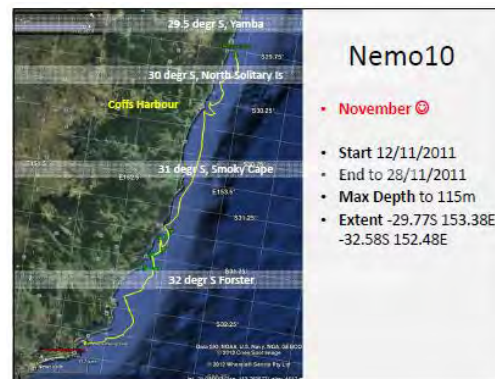
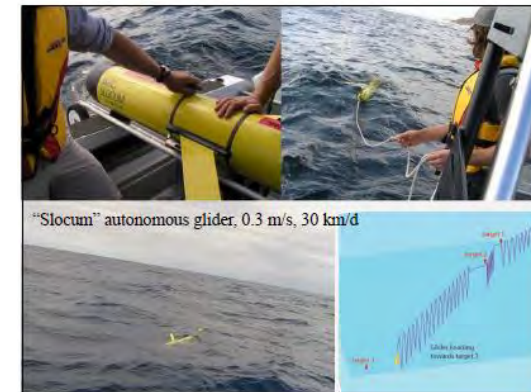
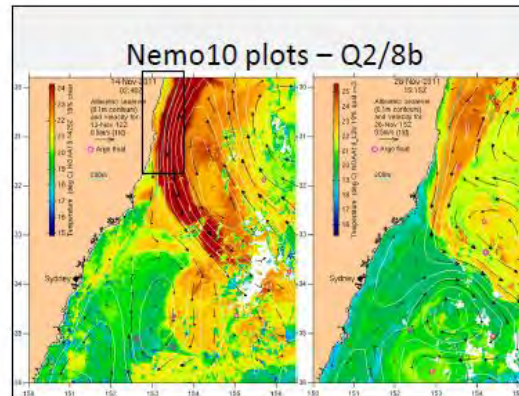
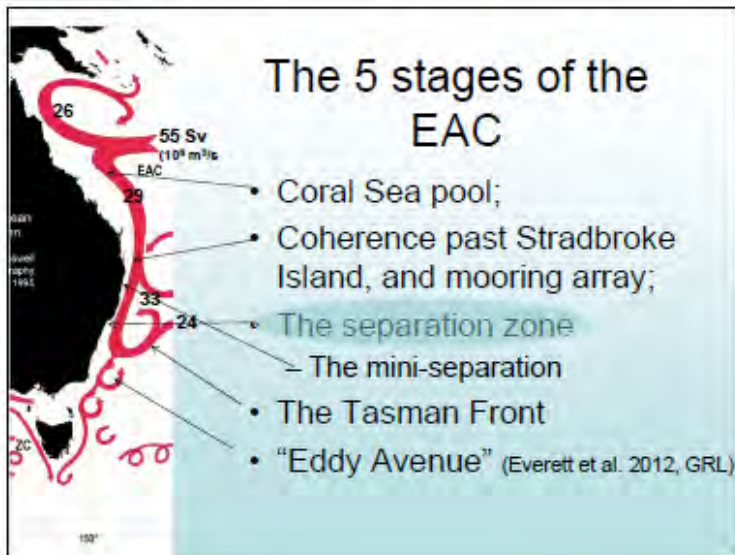
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# Setting the scene – summary science

The East Australian Current – a western boundary current

Described in terms of IMOS data



# Specific example from 2015 course

Practical 8: the 3<sup>rd</sup> dimension –  
Discover the EAC separation using  
ocean glider data and remote sensing



Iain Suthers

7 May 2015

[I.Suthers@unsw.edu.au](mailto:I.Suthers@unsw.edu.au)

Builds on work of the previous weeks

## Past few weeks

- Martina – SST and Ocean colour (spatial)
  - <http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html>
- Moninya – Ocean currents, temperature (temporal)
  - Matlab toolbox
- Argo floats – vertical structure
  - Altimetry and eddies
  - Vertical structure from the Argo program
  - <http://oceancurrent.imos.org.au/>
- Also Lagrangian drifters
- Today – the separation zone
  - Similar to that of the Agulhas, Kuroshio, Gulf Stream
  - Even Eastern Boundary currents the same

# The practical

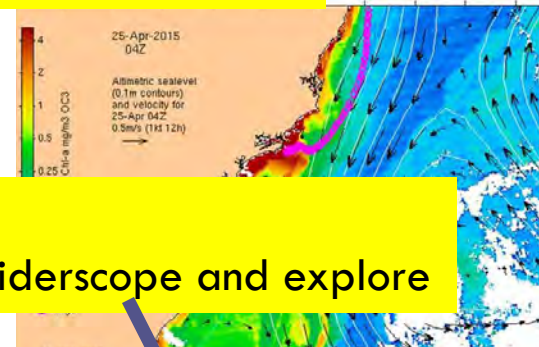
Today:

- 1) Investigate coastal upwelling across the shelf and separation zone, using “Gliderscope v 5.1”
  - Nemo14 (spring) and Nemo10 (spring)
  - Vertical section plots (a vertical profile or slice)
    - Depth by latitude
    - Temp, Sal, Fluor, CDOM
  - Property-property plots of particular ends of transects
    - T-S diagrams
- 2) Compare with winter missions (take home)
- 3) Investigate Nemo23 via the portal
  - [http://oceancurrent.imos.org.au/gliders/4day.php?link=Yamba20150416\\_4d/latest.html](http://oceancurrent.imos.org.au/gliders/4day.php?link=Yamba20150416_4d/latest.html)

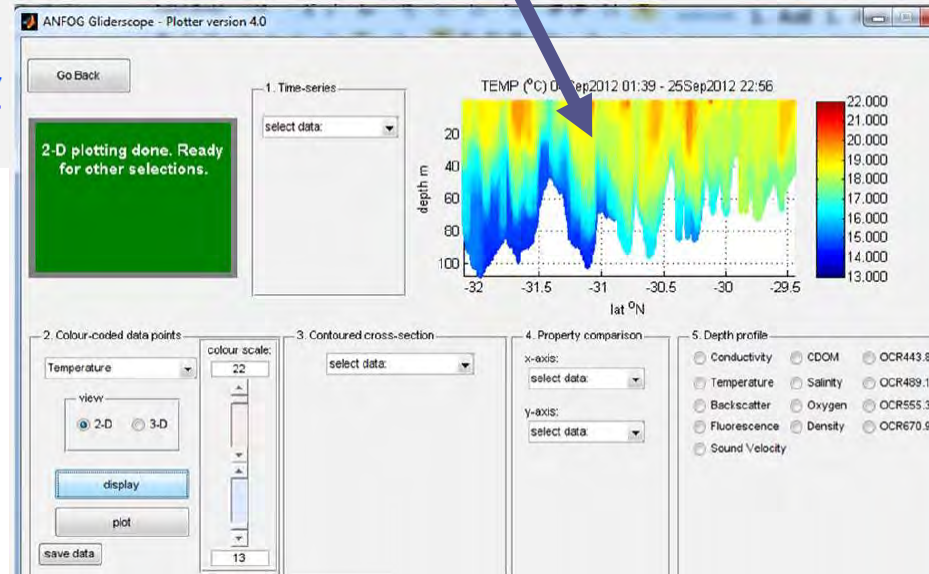
Download Glider file from here

Latest mission Nemo23 ...  
happening during the course

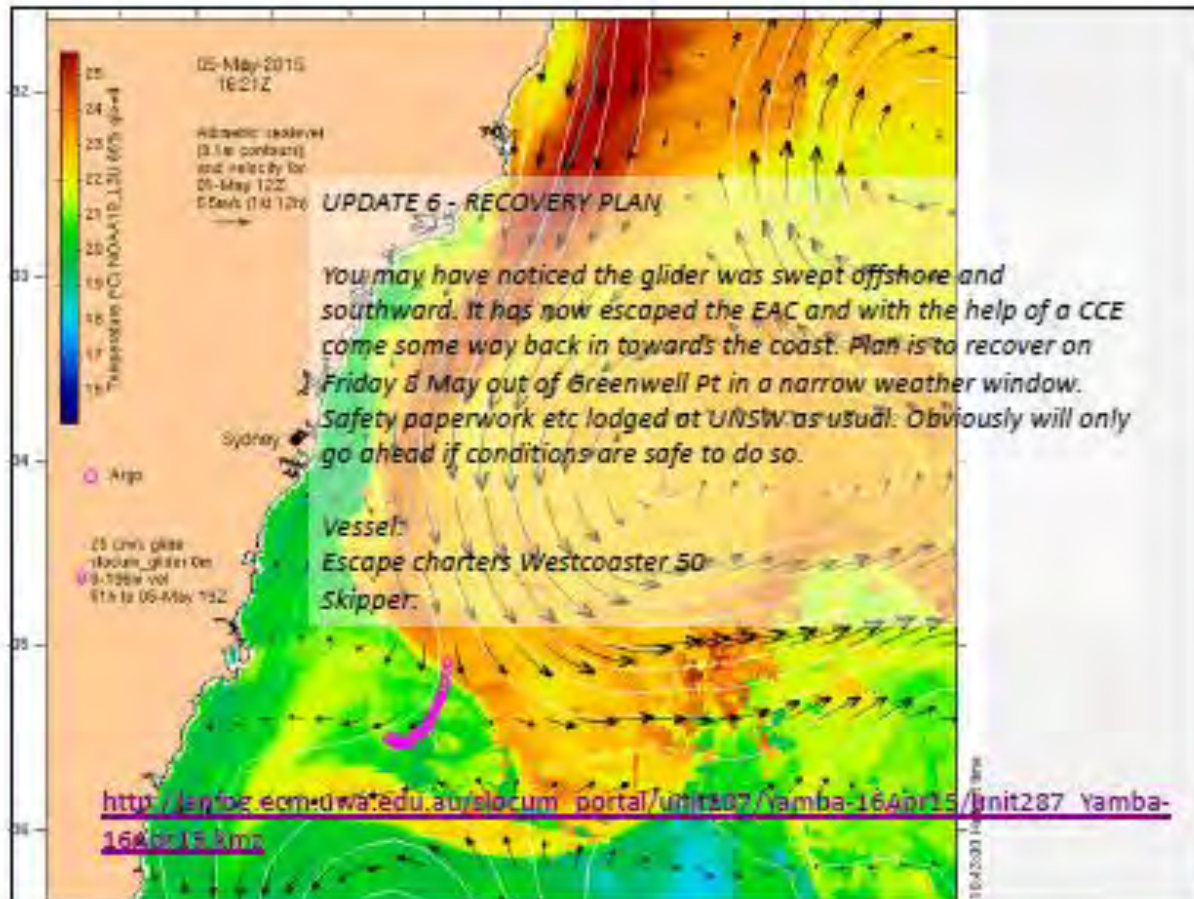
Examine historical glider tracks and profiles for eddies and separation zone



Open file in Gliderscope and explore



# Sometimes things don't go according to plan ...



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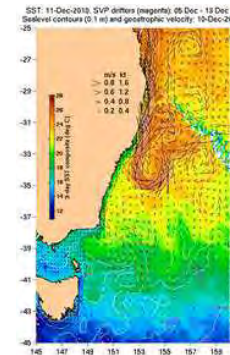
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# Mooring Module: shelf dynamics and processes

The IMOS observational dataset used includes moored temperature and current measurements, and CTD casts (NetCDF format). Students can extend this dataset to longer periods and different moorings by downloading the files from the IMOS server

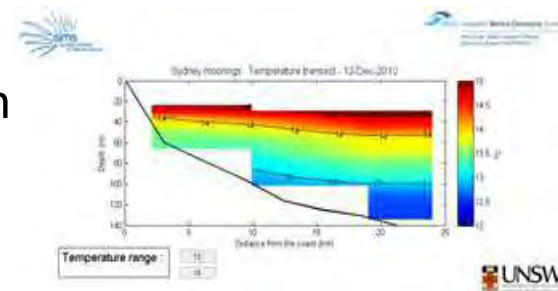
## East Australian Current

Students investigate the variability of the water temperature and velocity from different mooring measurements and complementary remote sensing observations ([www.oceancurrent.imos.org.au/](http://www.oceancurrent.imos.org.au/)) to identify and characterise different events of EAC intrusions onto the shelf.



## Wind-driven upwelling

Students focus on a specific upwelling event that occurred off Sydney in December 2010. They identify the event from temperature observations, investigate the geographic extension and analyse the possible cause of this event (wind stress) and its biological consequences.



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# Animal Tracking Network

- Covers a range of remote monitoring techniques in lectures
- Practicals focus on data exploration & biological interpretation rather than statistical analysis
- Case studies used as worked examples

Case study 1: spatial movement of grey reef sharks



Case study 2: body movement of yellowtail kingfish





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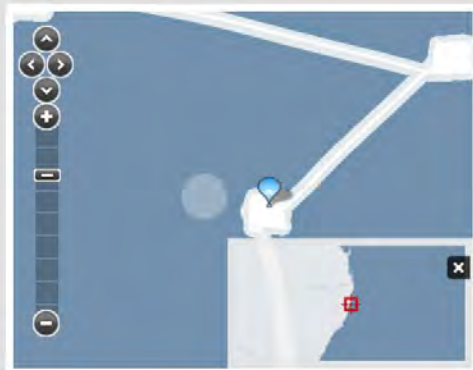
# Exploring biodiversity using the AUV



System  
Vehicle (AUV)

[Help](#) [AODN Home](#) [IMOS Home](#)

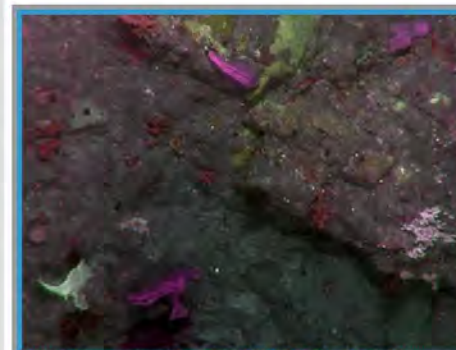
## Autonomous Underwater Vehicle Images Viewer



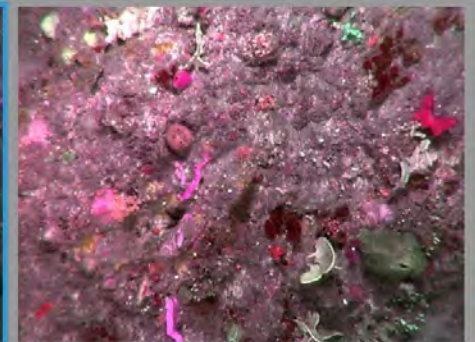
**NCRIS**  
National Research  
Infrastructure for Australia  
An Australian Government Initiative

  
**UNIVERSITY of  
TASMANIA**

Legend  
Lon: 153.20482  
Lat: -30.24533



Si 02 SplitBommyDense Aug 26, 2012 5:19:52 PM Depth:31.0m  
Temperature:18.159°C Salinity:35.544989 Chlorophyll:0.775



Si 02 SplitBommyDense Aug 26, 2012 5:20:47 PM Depth:31.1m  
Temperature:18.229°C Salinity:35.569358 Chlorophyll:0.813



Si 02 SplitBommy  
Temperature:18.2

Si 02 SplitBommyDense

RESET

Click on the AUV track to see the nearest images and data links  
(Zoom in to get better results)

# AUV Demonstration in 2014

(doesn't happen every year due to the availability of the AUV and staff away on IMOS work)



# Feedback

- Feedback from the students have been very encouraging. Some comments from students include:
  - *“Excellent lecturers, great variety of topics, interesting (but taxing) tutorial ..... Exhausting but fun.”*
  - *“you and the SIMS team are getting the best feedback from me as I've really enjoyed this module, it was my favourite and the most useful by far so thanks for your help”.*
  - *“Learning practical skills applicable to my field”*
  - *“the enthusiasm of the lecturers; and the seminars”*
  - *”Meeting people from other universities and finding out the variety of things I can do with my degree.”*
  - *“Having different facilitators with a interdisciplinary approach.”*
  - *“The teachers has different kind of expertise so that we can learn a lot of different things every week”*
  - *All of the practical work was challenging and had clear aims and I had good understanding of the final result.*

# TAMS Course Satisfaction

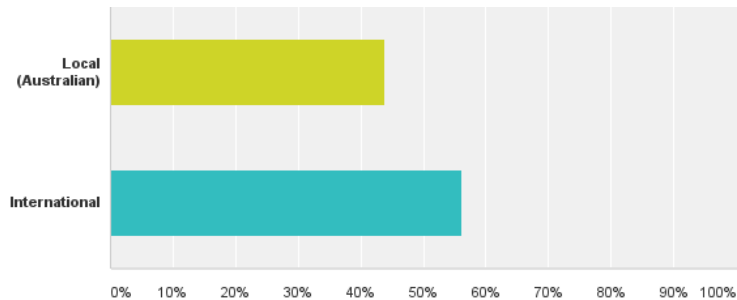
Since 2014, Overall satisfaction with the quality of the course ('Agree' or 'Strongly Agree') has increased from

86 % in 2014, to 90.5% in 2015 and 94% in 2016.

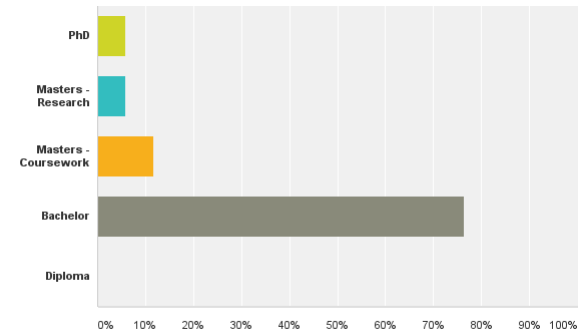
In addition, 'Strongly Agree' has increased from 20 % in 2014, to 43 % in 2015 and 59% in 2016.

# Student Background

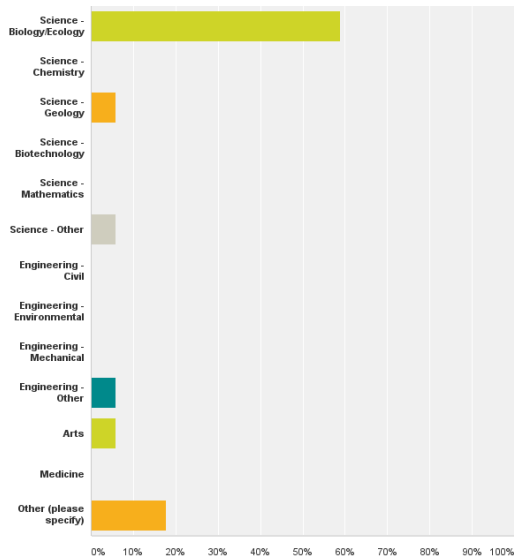
Q1: Are you enrolled as a local (Australian) or international student?



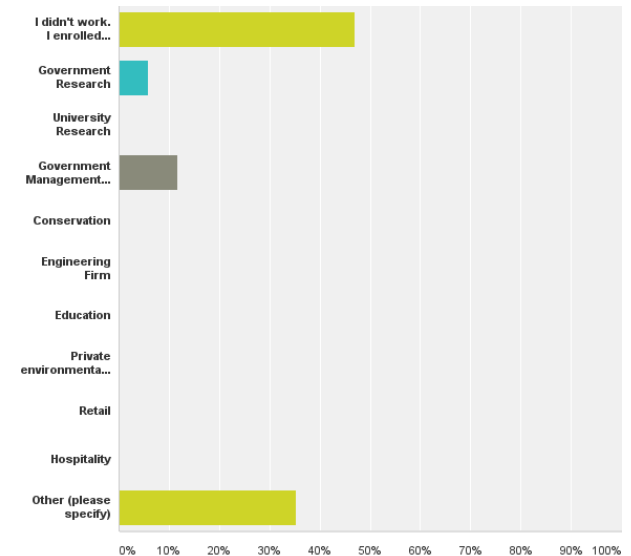
Q2: What is your highest previous qualification?



Q3: In which field of study did you achieve this qualification?



Q4: Prior to enrolling in this Masters Program, in what field did you work?



# TAMS - Looking to 2017

- We are expanding the modules to include a zooplankton component using the IMOS NRS and CPR data (Everett, Suthers and Richardson)
  
- We are streamlining the teaching of the physical oceanography (Moorings, Drifters, Argo, Gliders)
  - Will now be taught by Amandine Schaeffer and Moninya Roughen
  - Use Ocean Data View across all 4 weeks (previously we had used a combination of web resources, Gliderscope, Mooring Software and MS Excel).

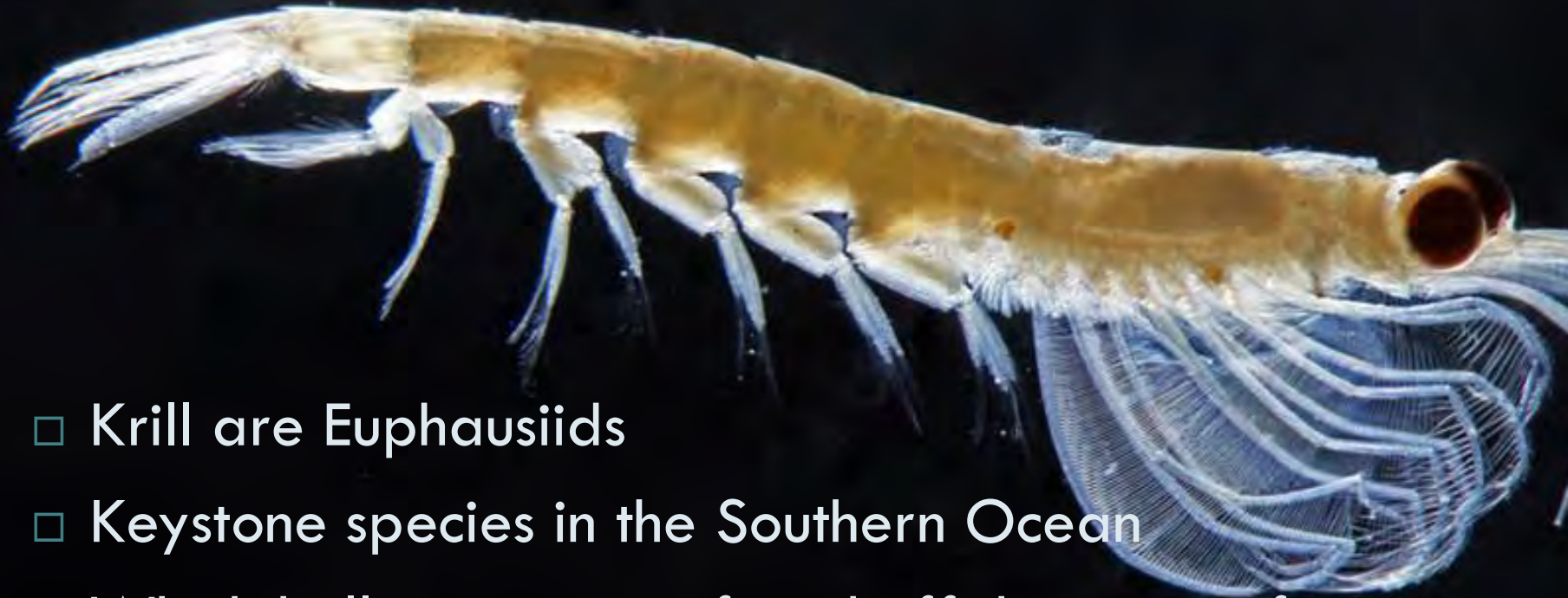
# Teaching with the Data Portal



- A tool for face-to-face and self-paced learning
- **University of Tasmania Antarctic Ecology course**
- **Blend:**
  - ▣ theoretical understanding of Zooplankton ecology
  - ▣ practical application to answer scientific questions using real data
- **Live demonstration**



# Krill in Tasmanian waters



- Krill are Euphausiids
- Keystone species in the Southern Ocean
- Which krill species are found off the coast of Tasmania?

5 mm

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# Antarctic zooplankton collection



- Access Portal to download data



# Finding Krill data off Tasmania

IMOS\_-\_AusCPR#\_Zooplankton\_Abundance.csv - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Clipboard Font Alignment Number Styles Cells Editing

Document Recovery

Excel has recovered the following files. Save the ones you wish to keep.

Available Files

- waveob\_parm.xlsx [Original]  
Version created last time the user ...  
16/02/2016 10:16 AM
- waveob\_55026\_sample (version 1...)  
Version created from the last Auto...  
16/02/2016 10:38 AM
- waveob\_55026\_sample.csv [Original]  
Version created last time the user ...  
16/02/2016 10:17 AM

Which file do I want to save?

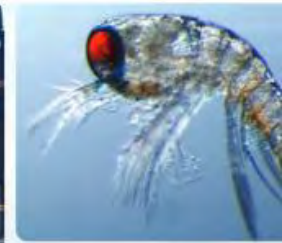
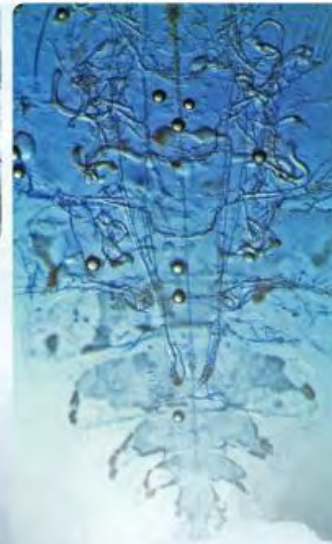
	J	K	L	M	N	O	P	Q	R	S	T	U	V	Z
1	TIME	geom	taxon_name	family	genus	species	sex	life_stage	taxon_group	taxon_eco_group	caab_code	taxon_start_date	taxon_per_z	
2	2010-03-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702047	29/09/2008		
3	2010-03-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	ADULT	NON-COPI	Euphausiid	28702047	29/09/2008		
4	2010-03-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702047	29/09/2008	2.6667	
5	2010-03-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702047	29/09/2008	0.6667	
6	2010-03-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702047	29/09/2008	0.6667	
7	2012-07-1	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	
8	2012-07-1	POINT (14	Euphausi	Euphausiidae			UNDETERI	ADULT	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	
9	2012-07-2	POINT (14	Nematos	Euphausiidae	Nematoscelis	spp.	UNDETERI	ADULT	NON-COPI	Euphausiid	28702015	29/09/2008	0.6667	
10	2012-07-2	POINT (14	Euphausi	Euphausiidae			UNDETERI	ADULT	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	
11	2012-07-2	POINT (14	Euphausi	Euphausiidae	Euphausia	vallentini	UNDETERI	ADULT	NON-COPI	Euphausiid	28702044	29/09/2008	1.3333	
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13	2010-11-0	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	5.3333	
14	2010-11-0	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	4	
15	2010-11-0	POINT (14	Euphausi	Euphausiidae			UNDETERI	ADULT	NON-COPI	Euphausiid	28702000	29/09/2008	16.6667	
16	2010-11-0	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	4.6667	
17	2010-11-0	POINT (14	Euphausi	Euphausiidae			UNDETERI	ADULT	NON-COPI	Euphausiid	28702000	29/09/2008	4.6667	
18	2015-06-2	POINT (14	Nyctiphan	Euphausiidae	Nyctiphanes	australis	UNDETERI	ADULT	NON-COPI	Euphausiid	28702047	29/09/2008	0.6667	
19	2015-06-2	POINT (14	Euphausi	Euphausiidae			UNDETERI	NAUPLII	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	
20	2015-06-2	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	
21	2015-06-2	POINT (14	Euphausi	Euphausiidae			UNDETERI	JUVENILE	NON-COPI	Euphausiid	28702000	29/09/2008	0.6667	

IMOS\_-\_AusCPR#\_Zooplankton\_Abun

# Coming developments

- Integration of Marine Virtual Laboratory (<http://www.marvl.org.au>)
- Marine Sciences Cloud
  - ▣ Underwater imagery cloud + tools (viz, annotation, analysis)
  - ▣ Marine climate science analysis tools (e.g. R-Studio, Julia, Jupyter ... ClipC??)

# Questions? Feedback? Thanks!



<https://portal.aodn.org.au>  
[roger.proctor@utas.edu.au](mailto:roger.proctor@utas.edu.au)

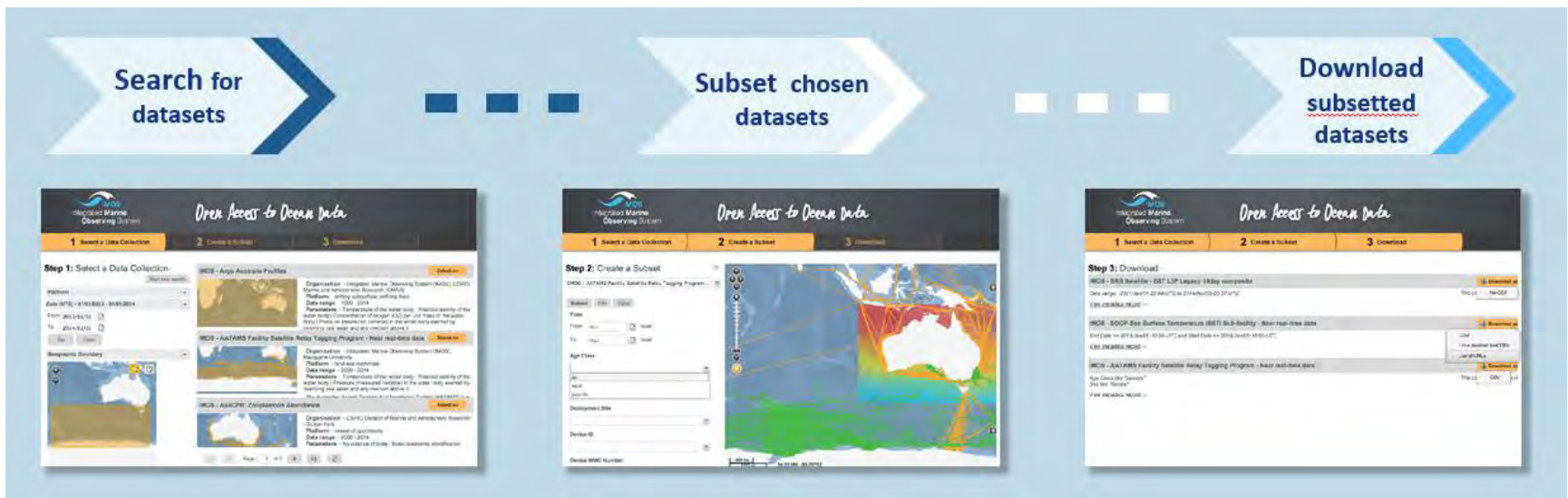
The Operators of the IMOS infrastructure are:



# Additional teaching: Data User Workshops



- Run “Data User Workshops” to introduce scientists, managers and students to a wealth of observations
- Intuitive three-step process for online data access
- Blended-learning tool that gives students direct online access to ongoing high quality observational datasets



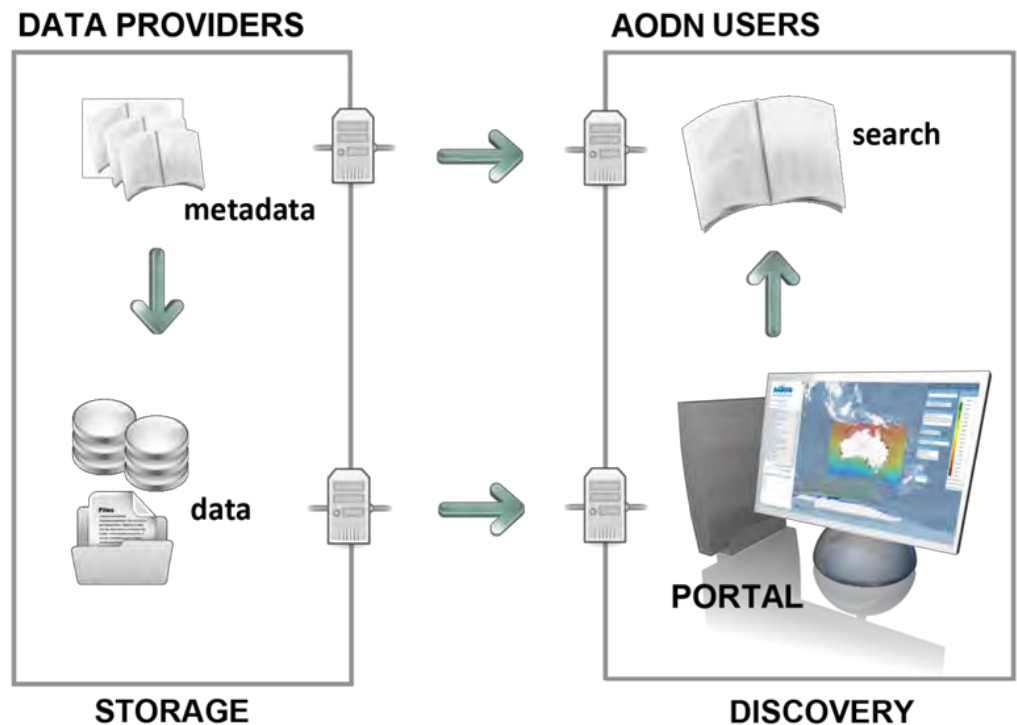
# Data Policy

- IMOS delivers data that are:
  - ▣ unencumbered – free, no charge to the end user
  - ▣ with metadata that is ISO19115 MCP compliant
  - ▣ well curated
  - ▣ licensed appropriately
- IMOS expects provider facilities to be responsible for:
  - ▣ data curation
  - ▣ data accuracy
  - ▣ creating metadata records for datasets on behalf of individuals
- Creative Commons BY ATTRIBUTION licence:
  - ▣ **Share** = to copy, distribute and transmit the work
  - ▣ **Remix** = to adapt the work
  - ▣ *Under the condition:* **Attribution** = You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse your or your use of the work).



# IMOS Data Standards

- Metadata standards
  - ▣ ISO compliant
- Metadata exchange
  - ▣ Catalog services for the web (CWS)
- Controlled vocabularies
  
- Data format
  - ▣ NetCDF convention
  - ▣ Database guidelines
- Data visualisation
  - ▣ Web map service (WMS)
- Data download
  - ▣ Web feature service (WFS)
  - ▣ OPeNDAP
  
- Legal standards
  - ▣ Creative Commons





**Time and date:** 1:15 - 2:15 pm; Thursday 17<sup>th</sup> March 2016

**Speaker:** A/Prof Moninya Roughan

**Location:** Lecture Theatre Building 21 | Sydney Institute of Marine Science

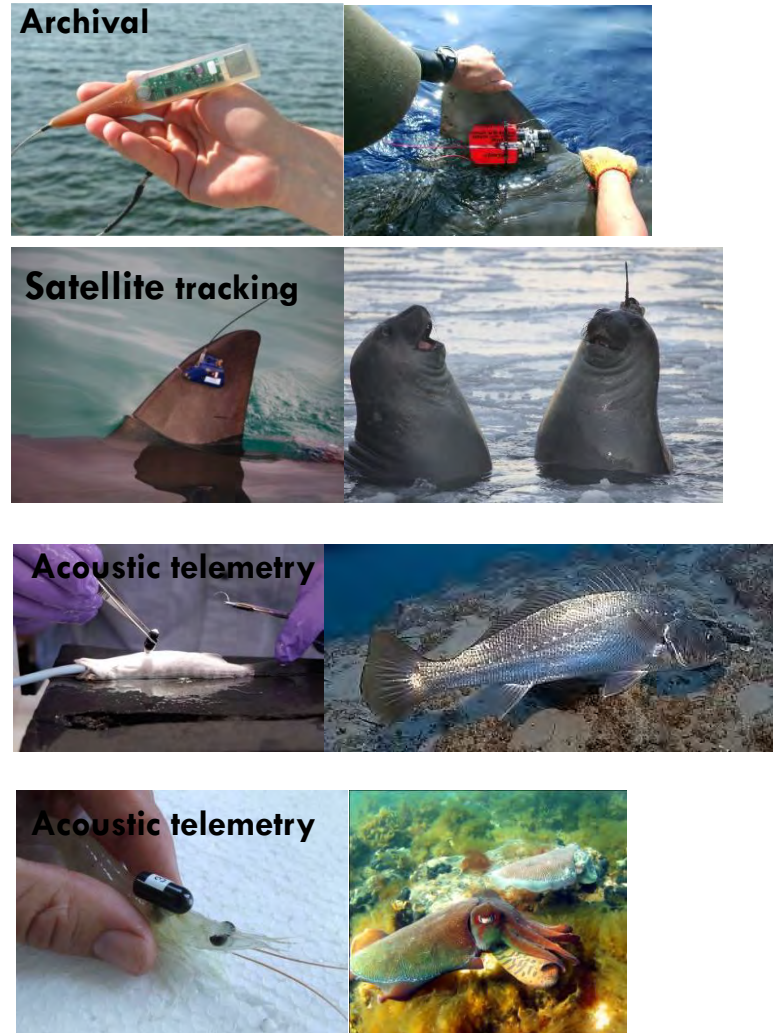
## **Cross Shelf Processes and the East Australian Current**

The East Australian Current flows poleward along the coast of south eastern Australia, generally separating at about 31S before heading eastward to form the Tasman Front. The current has the potential to dominate the physical structure of continental shelf waters as it encroaches upon the continental shelf and drive upwelling in what is typically an oligotrophic region. Before the commencement of the IMOS programme observational process studies were limited in both time and space. Since 2008, the deployment of significant oceanographic infrastructure in NSW shelf waters has allowed for an in depth investigation into significant cross shelf processes. In particular we have new understanding of the: Temporal and spatial variability of EAC intrusions and shelf circulation, the impact of EAC eddy encroachments (both cyclonic and anticyclonic) on shelf waters, the frequency of upwelling events, their forcing mechanisms and impacts , the prevalence of submesoscale features and their impact on the shelf and the Biological response to EAC forcing. These processes will be discussed in the context of the IMOS observations and new results presented.

# Animal Tracking Network

Case studies also used in lectures to illustrate the variety of remote monitoring techniques and their research applications

## Example case studies



# What else can IMOS provide?

- **Expertise** in data publishing
- Interoperable **data and metadata standards** for Australian marine data
  - ▣ Vocabularies and parameter mapping
  - ▣ Data formats
  - ▣ Versioning
- Working with Universities to publish their data

