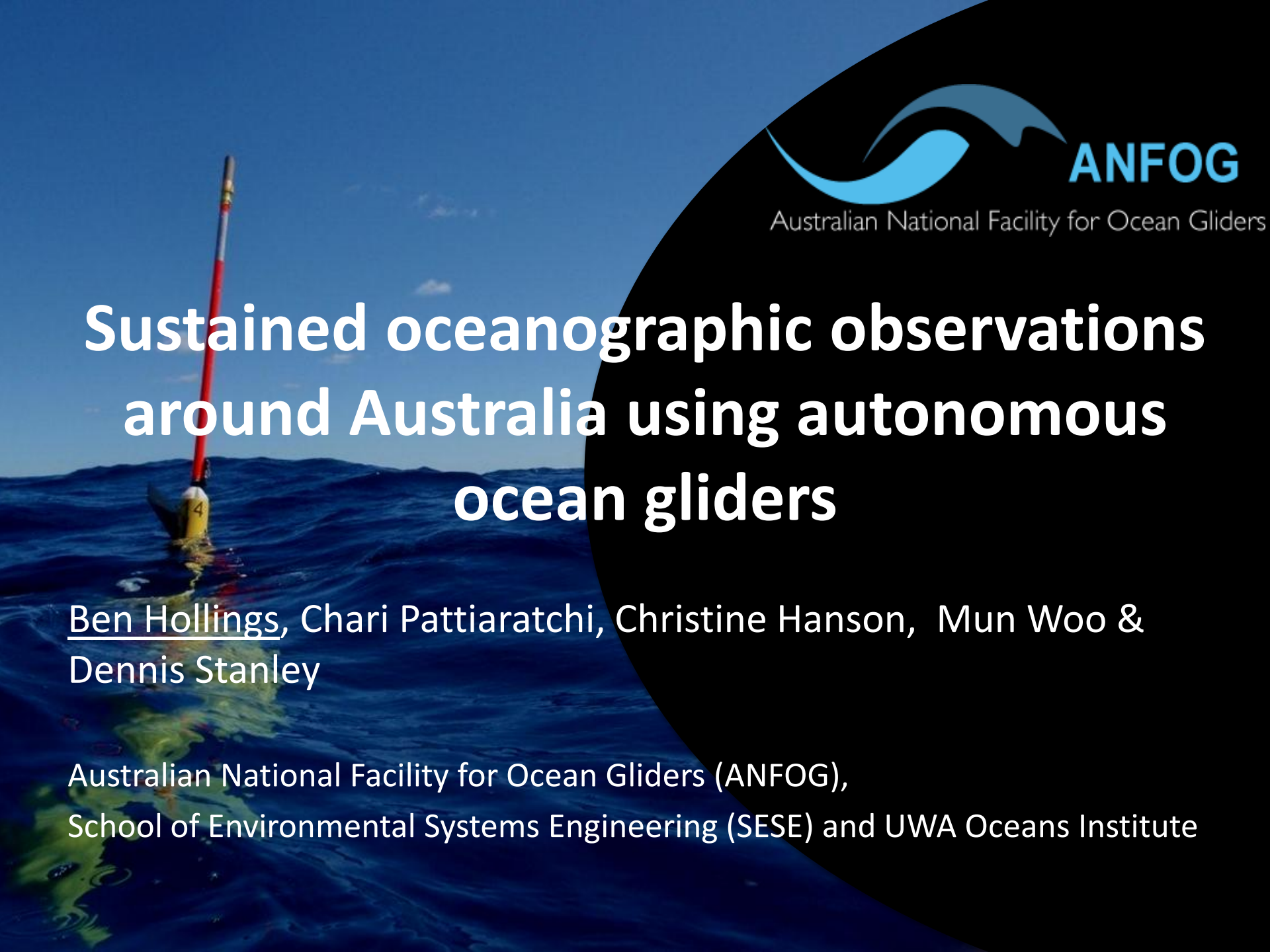

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Sustained oceanographic observations around Australia using autonomous ocean gliders

Ben Hollings, Chari Pattiaratchi, Christine Hanson, Mun Woo & Dennis Stanley

Australian National Facility for Ocean Gliders (ANFOG),
School of Environmental Systems Engineering (SESE) and UWA Oceans Institute

Outline

The developing use of gliders to autonomously conduct oceanographic surveys on unprecedented temporal and spatial scales has the potential to revolutionise our understanding of ocean dynamics.

- Introduction to IMOS
- Introduction to ANFOG
- GE Monitoring Console
- Deployments summary & sample data
- Closer look at WAIMOS data

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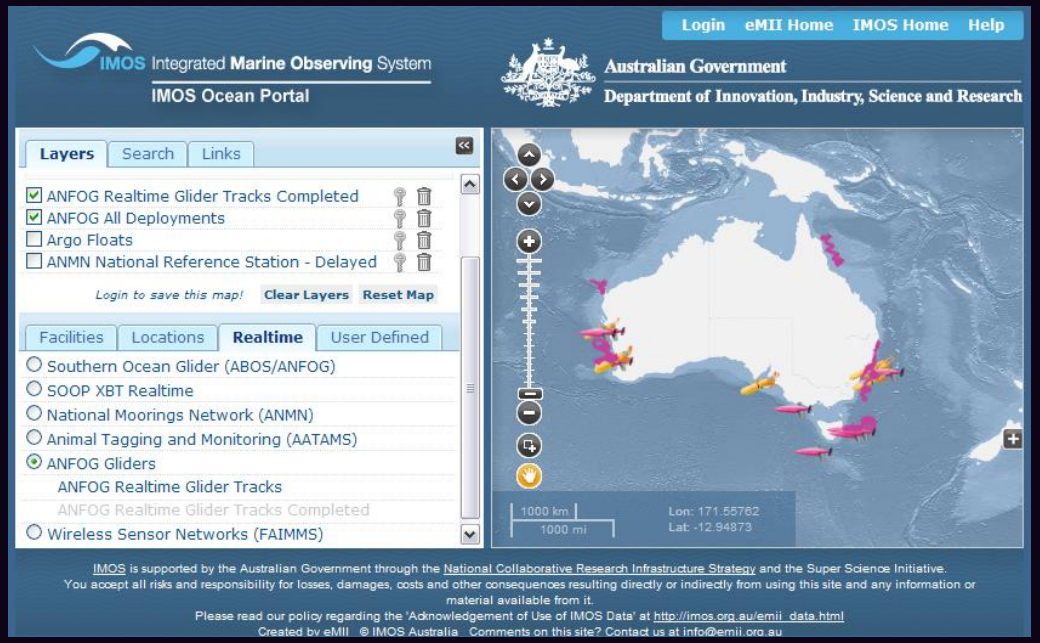
IMOS Integrated Marine Observing System

Australian Government
Department of Innovation Industry, Science and Research

- Established in 2007 with $50m funding over 3 years
- Additional funding in 2009 of $52m to enhance and extend the program through to 2013

- Funding to deploy and operate ocean observing equipment
- Focus on sustained observation
- Bring together Australian Universities and Publicly-Funded Research Agencies working in marine and climate science
- All data freely available to the whole community



Data freely available online:

http://imos.aodn.org.au/webportal/

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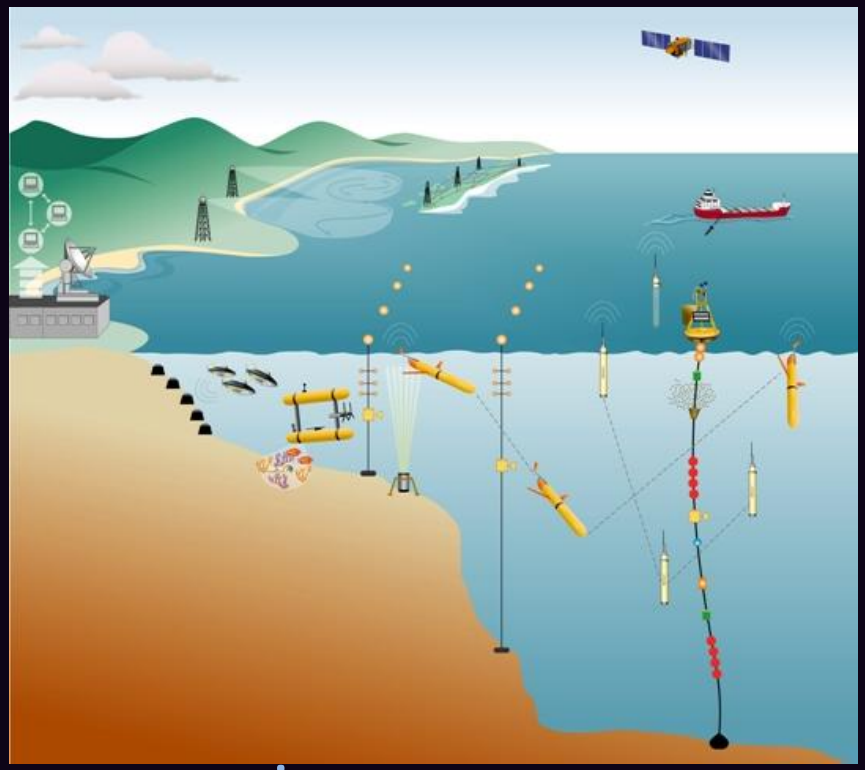
IMOS Integrated **Marine Observing** System

Australian Government
Department of Innovation Industry, Science and Research

Facilities (currently 11) own and operate the designated equipment and make the quality controlled data streams available to the whole community

- ARGO Floats
- Ships of Opportunity
- Deep Water Moorings
- Ocean Gliders (ANFOG)
- Autonomous Underwater Vehicle
- National Mooring Network
- Ocean Radar
- Animal Tagging and Monitoring
- Wireless Sensor Networks
- Satellite Remote Sensing (SRS)
- Marine Information (eMII)



imos.org.au

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IMOS Integrated Marine Observing System

Australian Government
Department of Innovation Industry, Science and Research

Nodes (currently 6) represent the scientific opinion of the research community, provide the scientific rationale, develop research goals, and identify the need to obtain specific data streams

- BLUEWATER & CLIMATE
- QLDIMOS
- NSWIMOS
- TASIMOS
- SAIMOS
- WAIMOS

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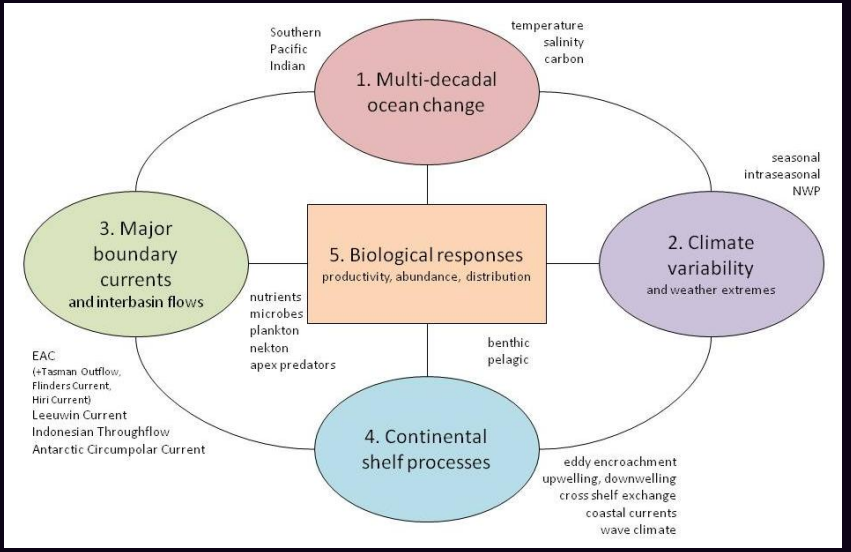
IMOS Integrated Marine Observing System

Australian Government
Department of Innovation
Industry, Science and Research

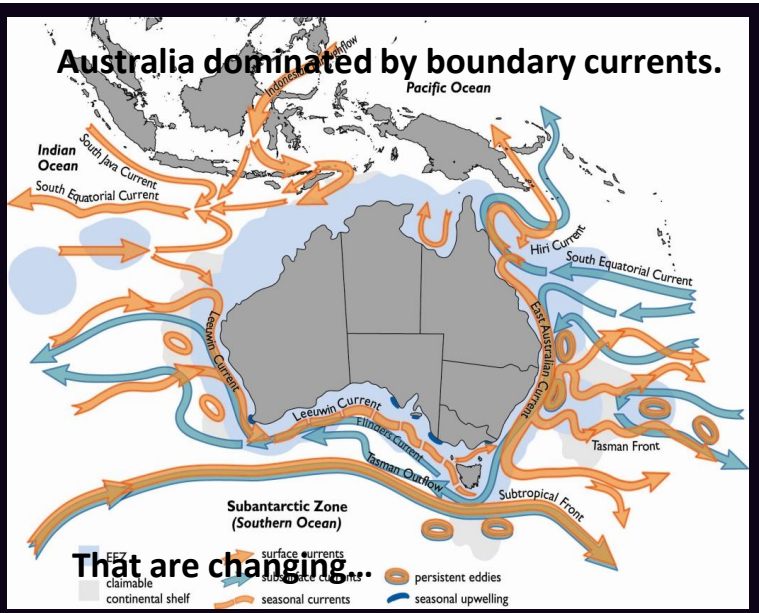
Primary goals are to research:

- the role of the ocean in the climate system
- the impact of major boundary currents on continental shelf environments, ecosystems and biodiversity



Gliders are effective in monitoring boundary currents (particularly in Australia):

- vast coastline
- small population
- comparatively recent history of oceanographic exploration



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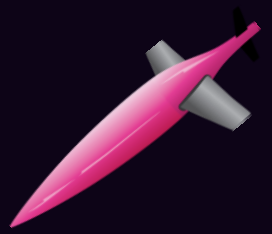
Australian National Facility for Ocean Gliders (ANFOG)

- ANFOG operating since mid-2008
- Sustained observations off the western, southern and eastern coasts of Australia
- Example of a “Centralised national glider facility”
  - Glider operation, maintenance and piloting
  - Data retrieval, archiving, processing & QC
  - All testing, maintenance, communication and computing infrastructure based at UWA in Perth, Western Australia
  - Established ‘Glider Ports’ to deploy and recover

- Glider fleet consists of 4 x TWR Slocum gliders and 11 Seagliders (5 x UW & 6 x iRobot)
  - 6 x iRobot Seagliders received in early 2010
  - 2 x G2 TWR Slocum gliders received in 2011



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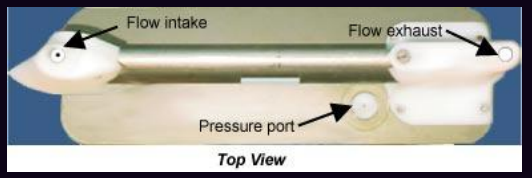
What data / variables are we measuring?

- Seabird CTD
  - Conductivity (Salinity)
  - Temperature
  - Depth



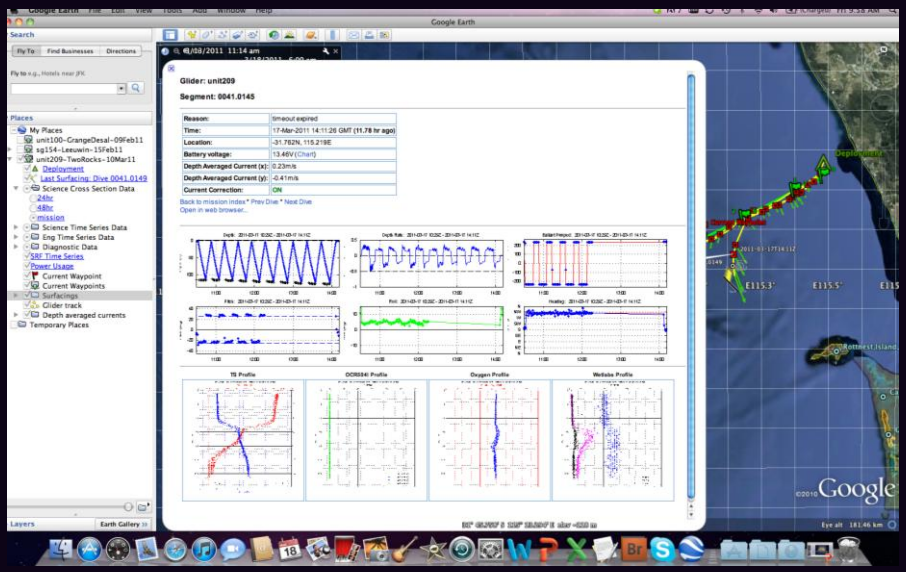
- Dissolved oxygen sensor (Aanderraa, SBE)

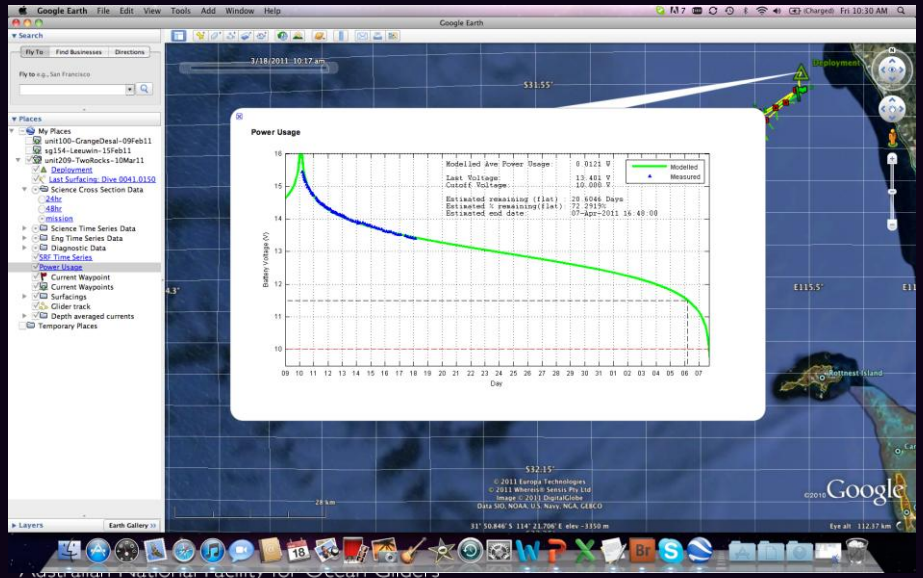
- WETLABS BBFL2 Sensor:
  - Optical backscatter (650 nm)
  - Chlorophyll *a* fluorescence
  - CDOM (coloured dissolved organic matter) fluorescence

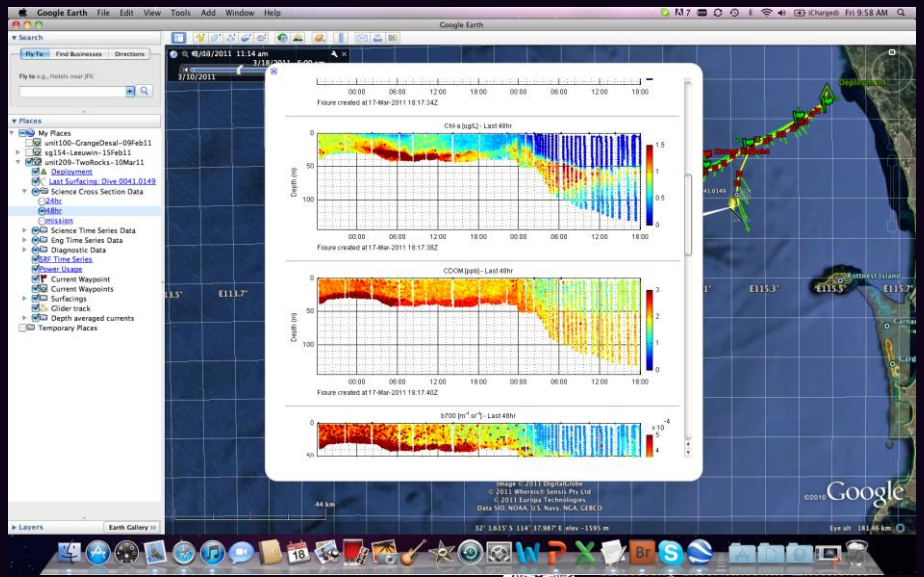
- Satlantic Four channel downwelling irradiance (on 2 new Slocums)

- Estimates of Depth Averaged and Surface currents

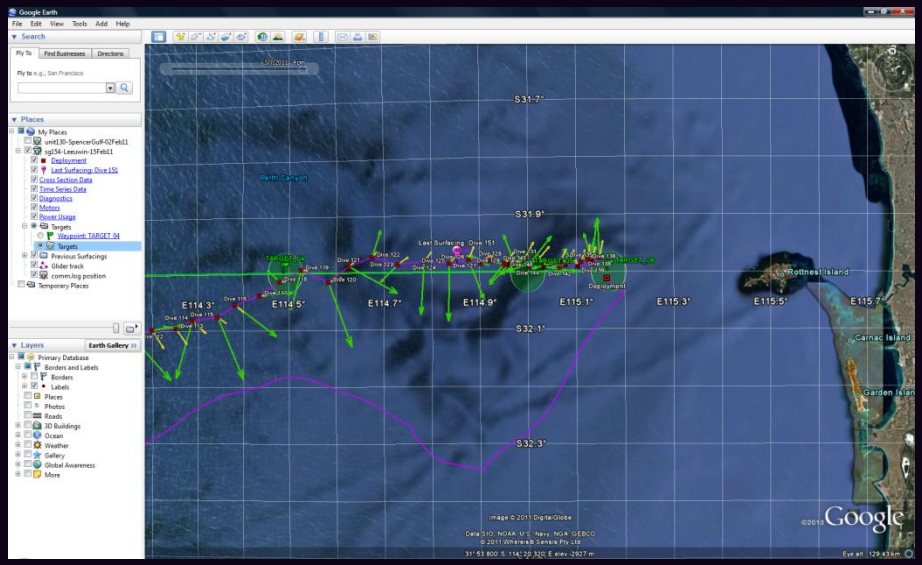
Google Earth Monitoring Console (Slocum)

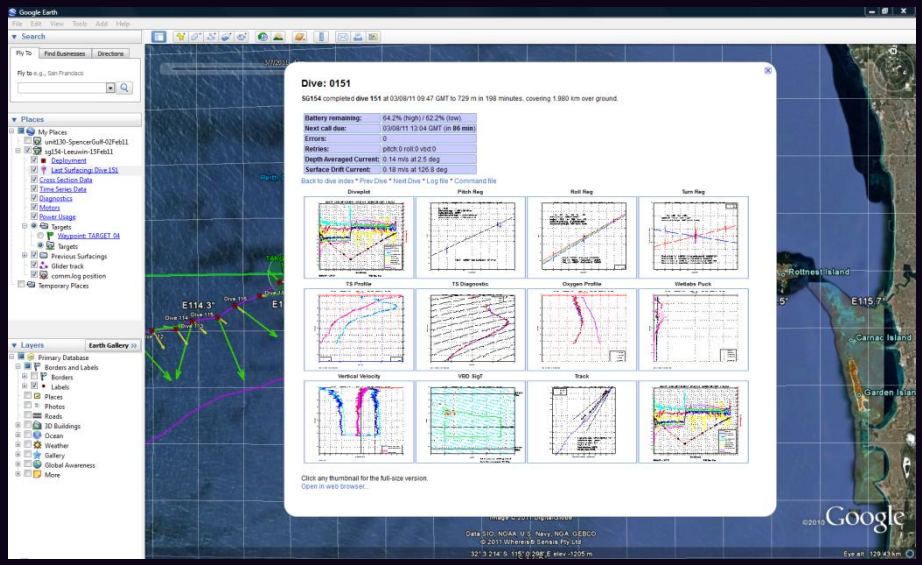


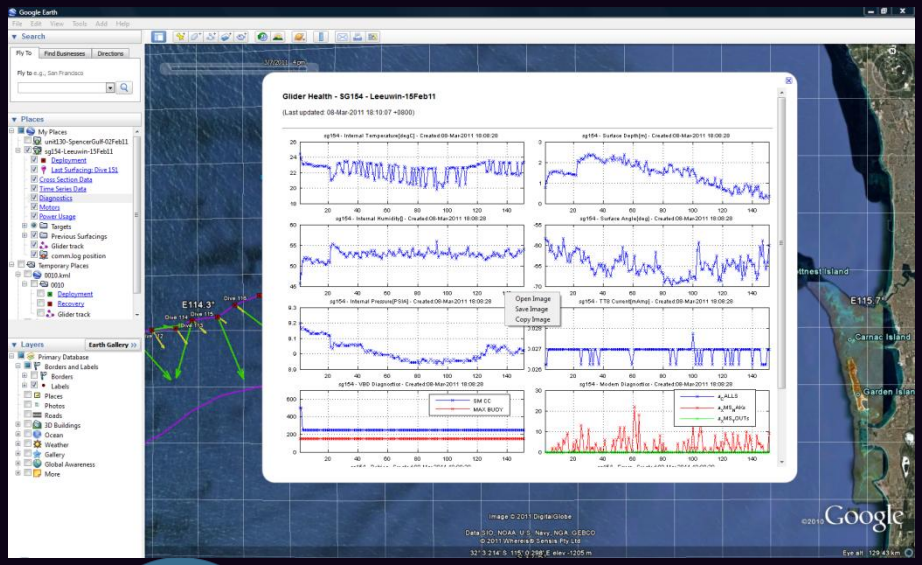


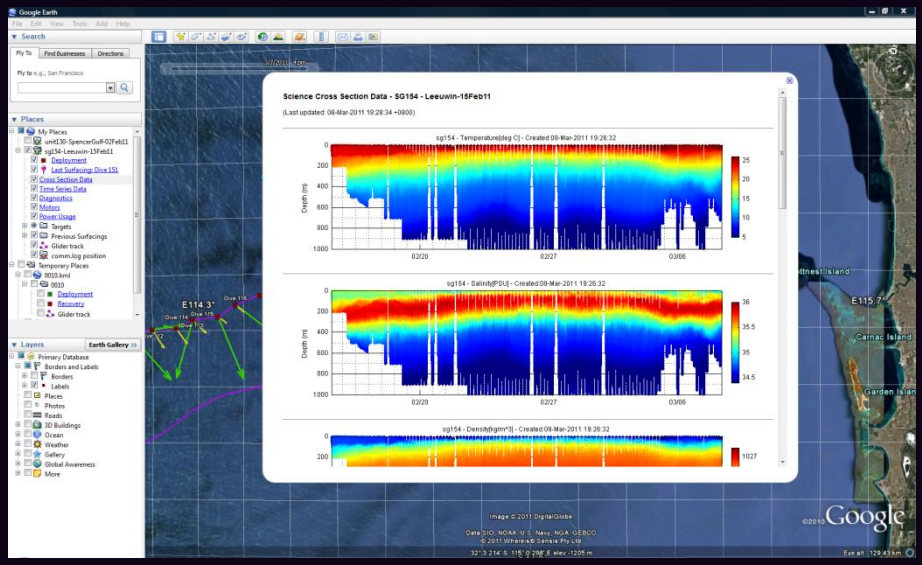


Google Earth Monitoring Console (Seaglider)









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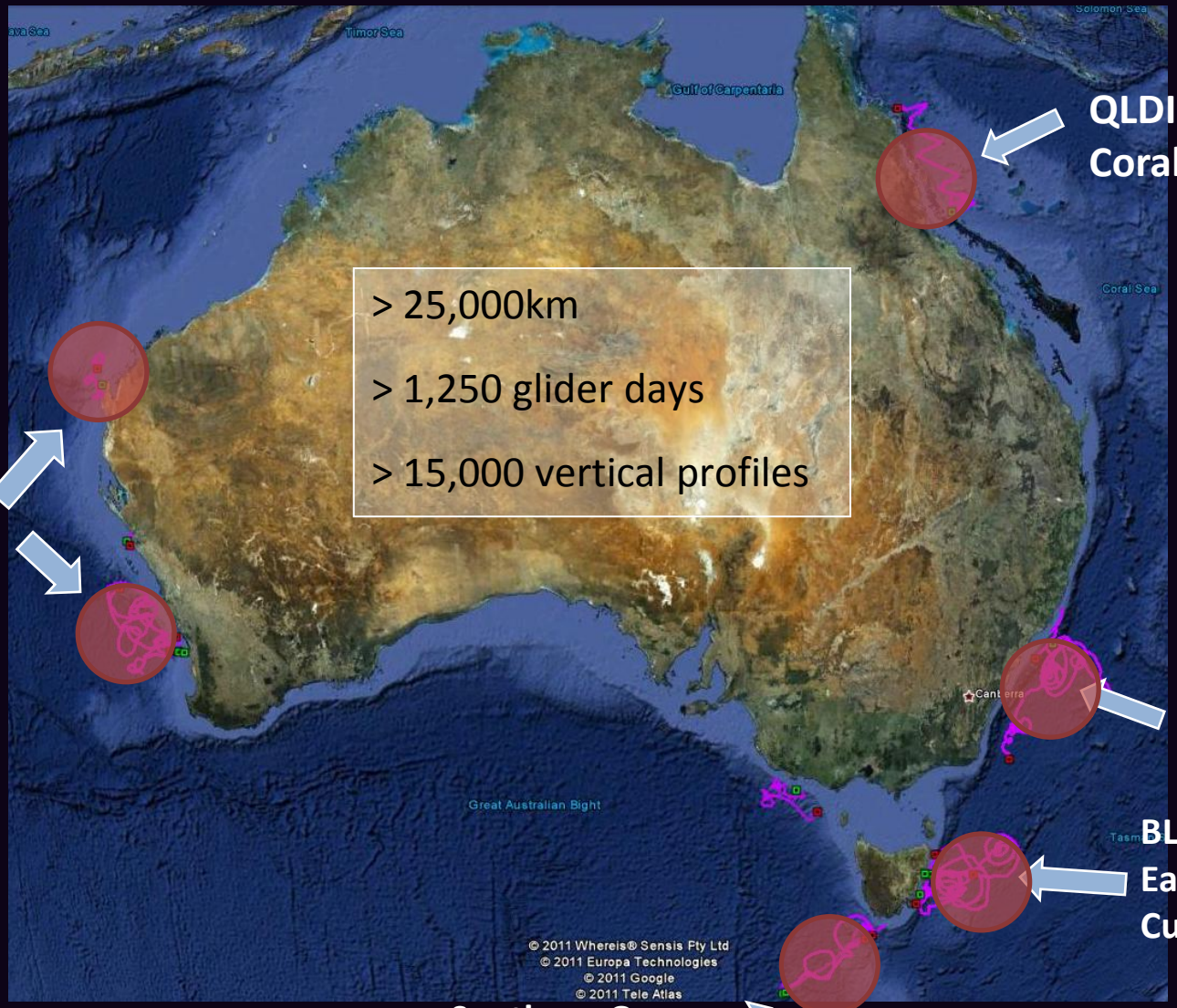
ANFOG Seaglider Deployments



QLDIMOS
Coral Sea

WAIMOS
Leeuwin
Current

NSWIMOS
East Australian
Current

BLUEWATER
East Australian
Current

Southern Ocean
Time Series

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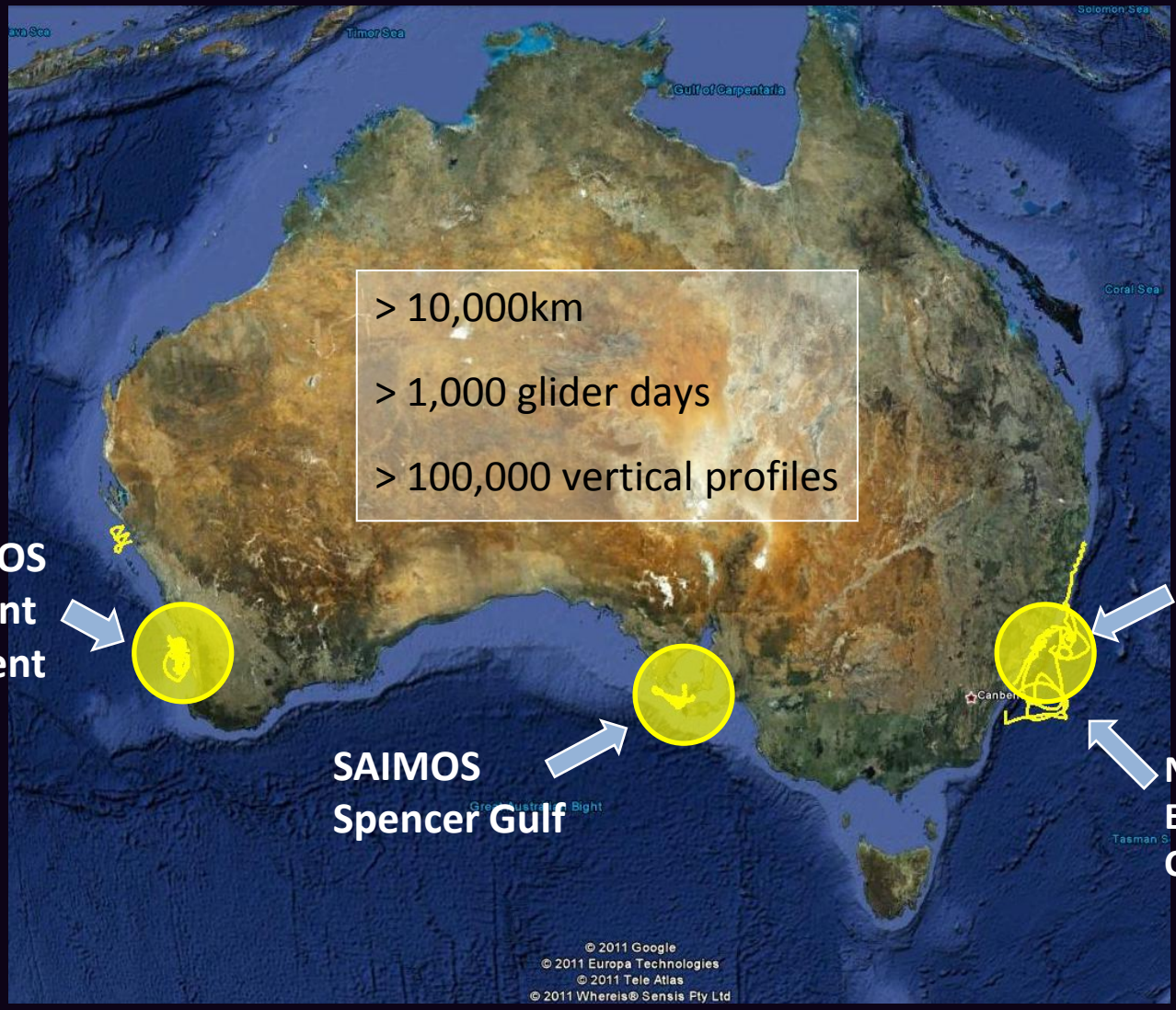
ANFOG Slocum Deployments



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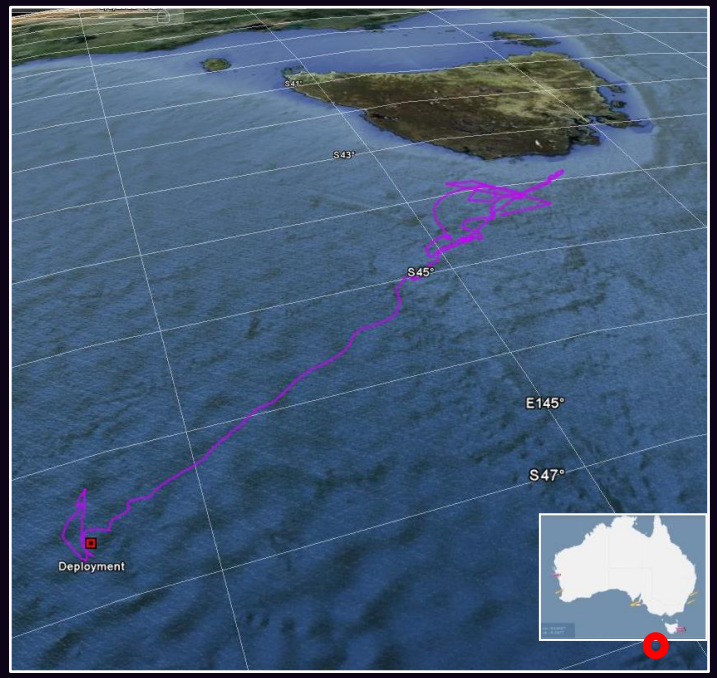
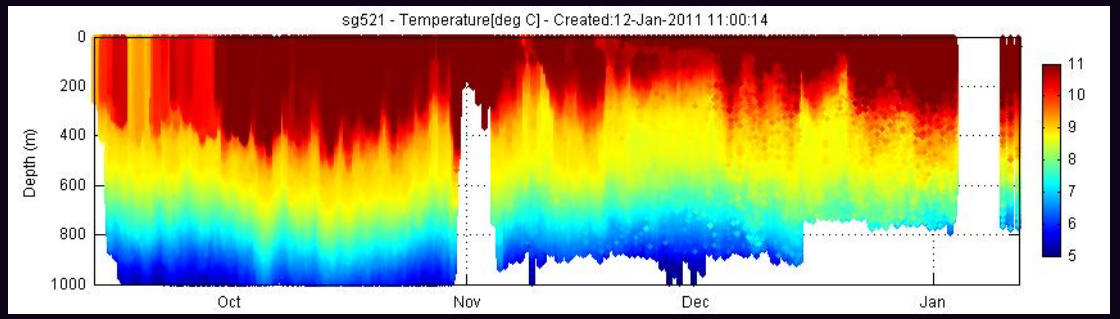
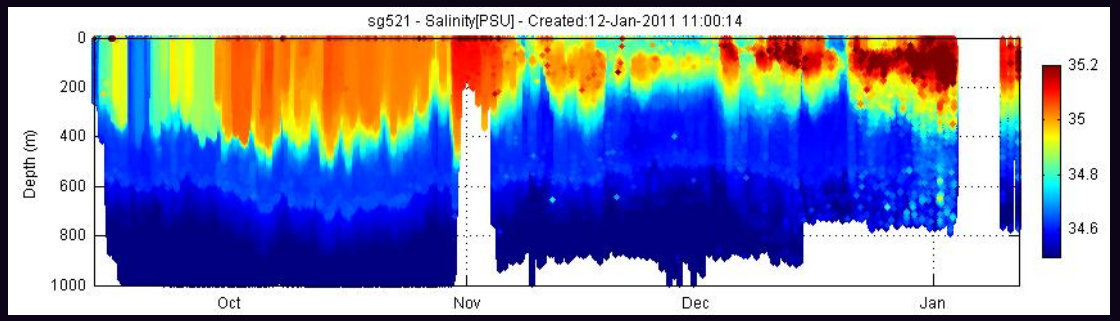
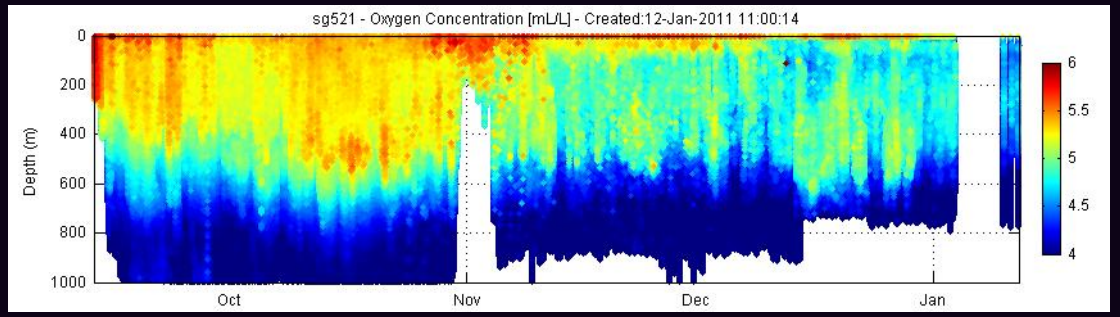
BLUEWATER - SOTS Seaglider Deployments

- Impact of Southern Ocean on Australian Climate
- Deployed ~600km SW of Tasmania at SOTS mooring site
- 2 Successful deployments and recoveries to date









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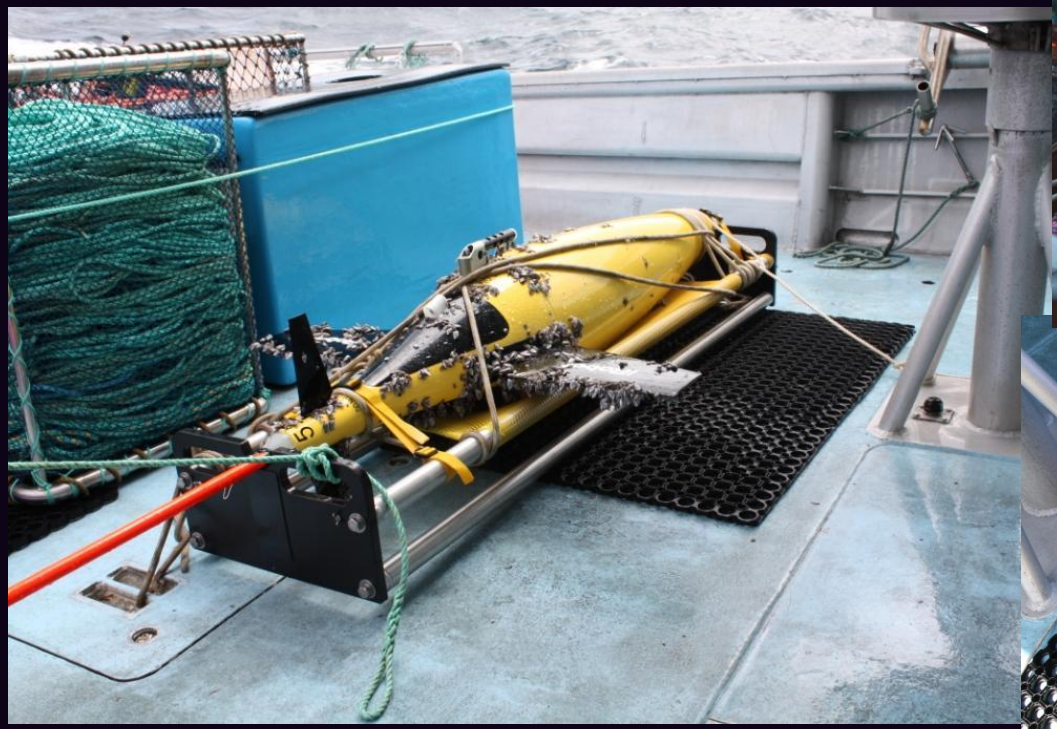
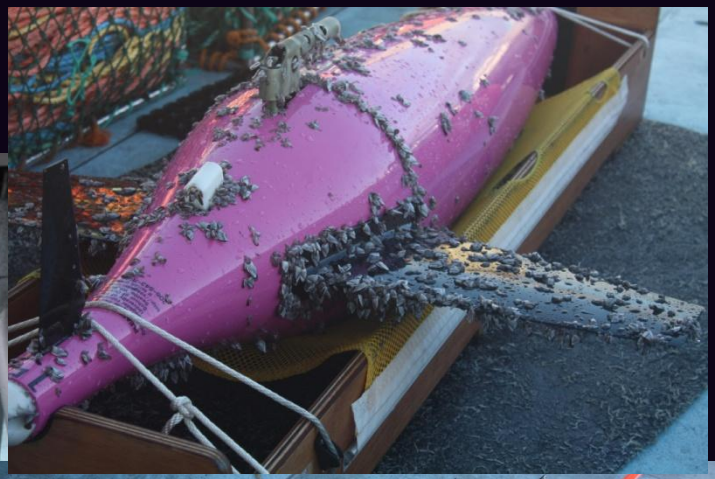
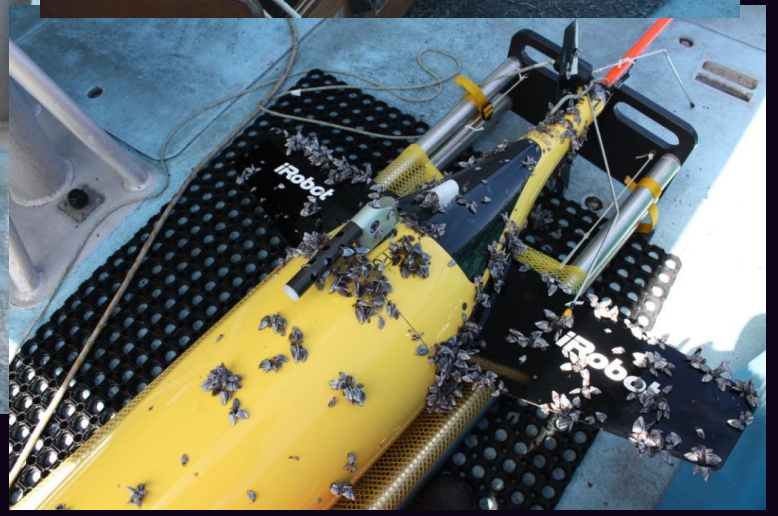
BLUEWATER - SOTS Seaglider Deployments







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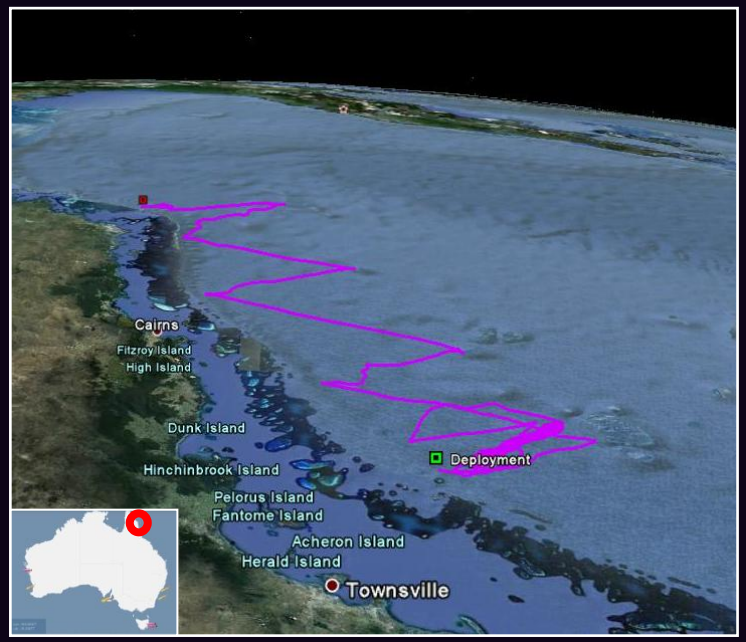
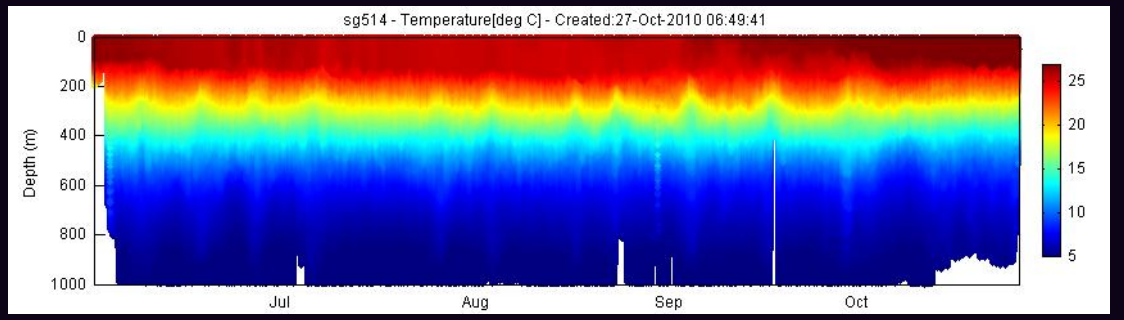
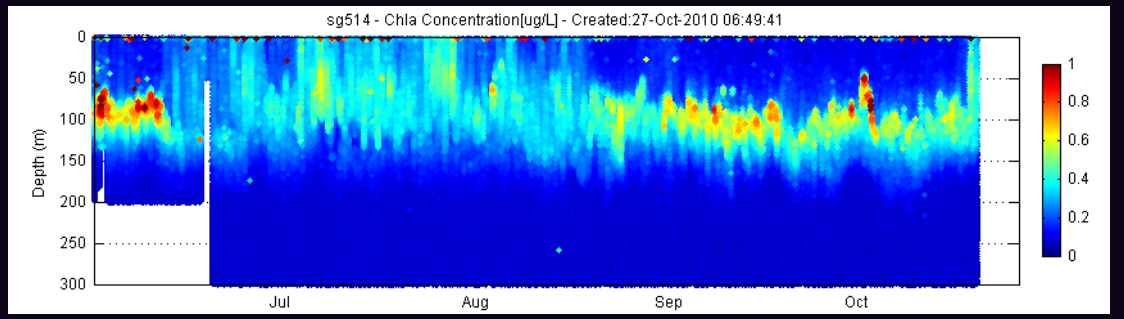
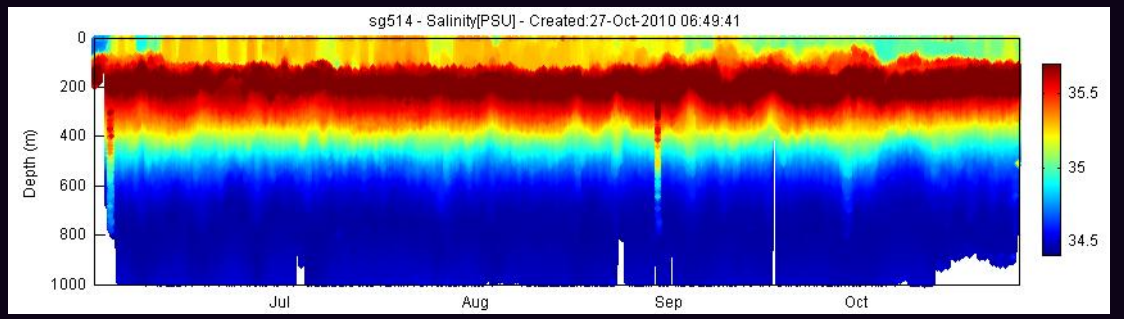
QLDIMOS - Coral Sea

- Hiri current & East Australian Current
- 149 days, 768 dives, 2977 km
- 1st deployment > sum of all historical shipboard survey data









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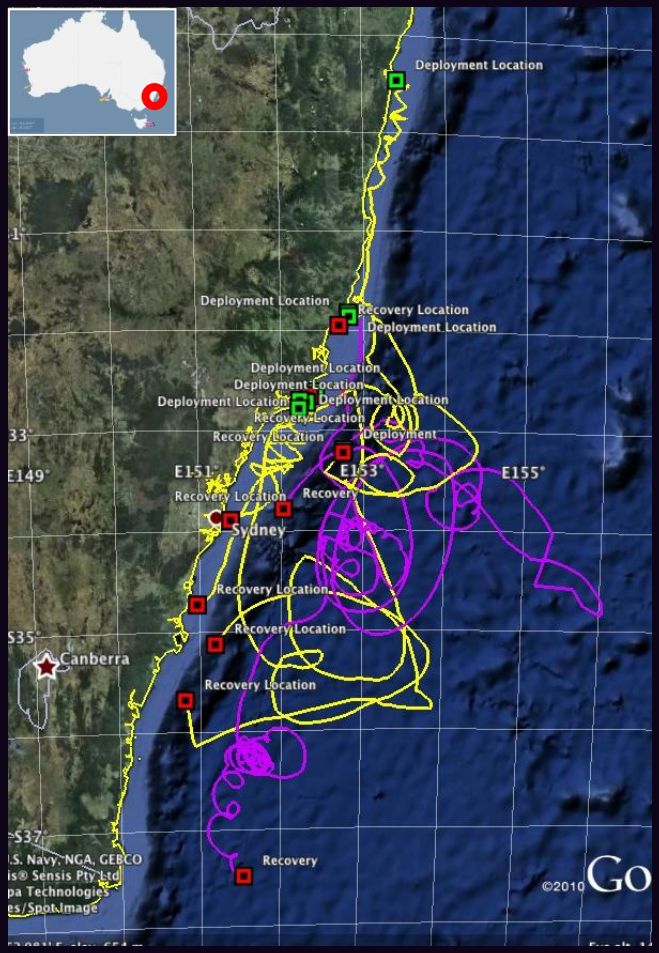
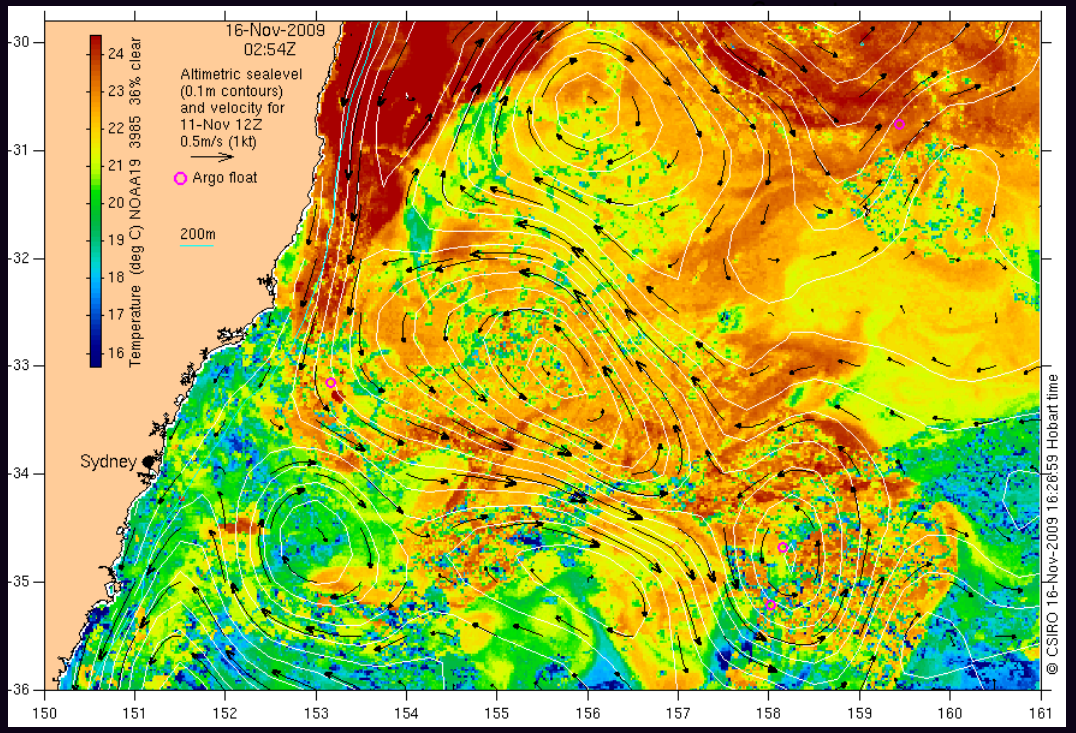
NSWIMOS - East Australian Current & Eddy Field



- Investigating interactions of the East Australian Current (EAC) with the shelf waters
- Examine vertical structure of EAC eddies



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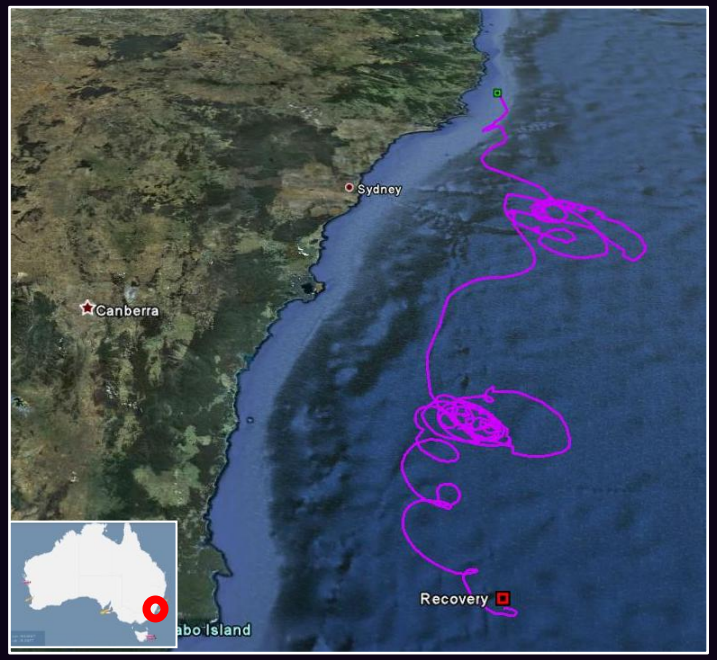
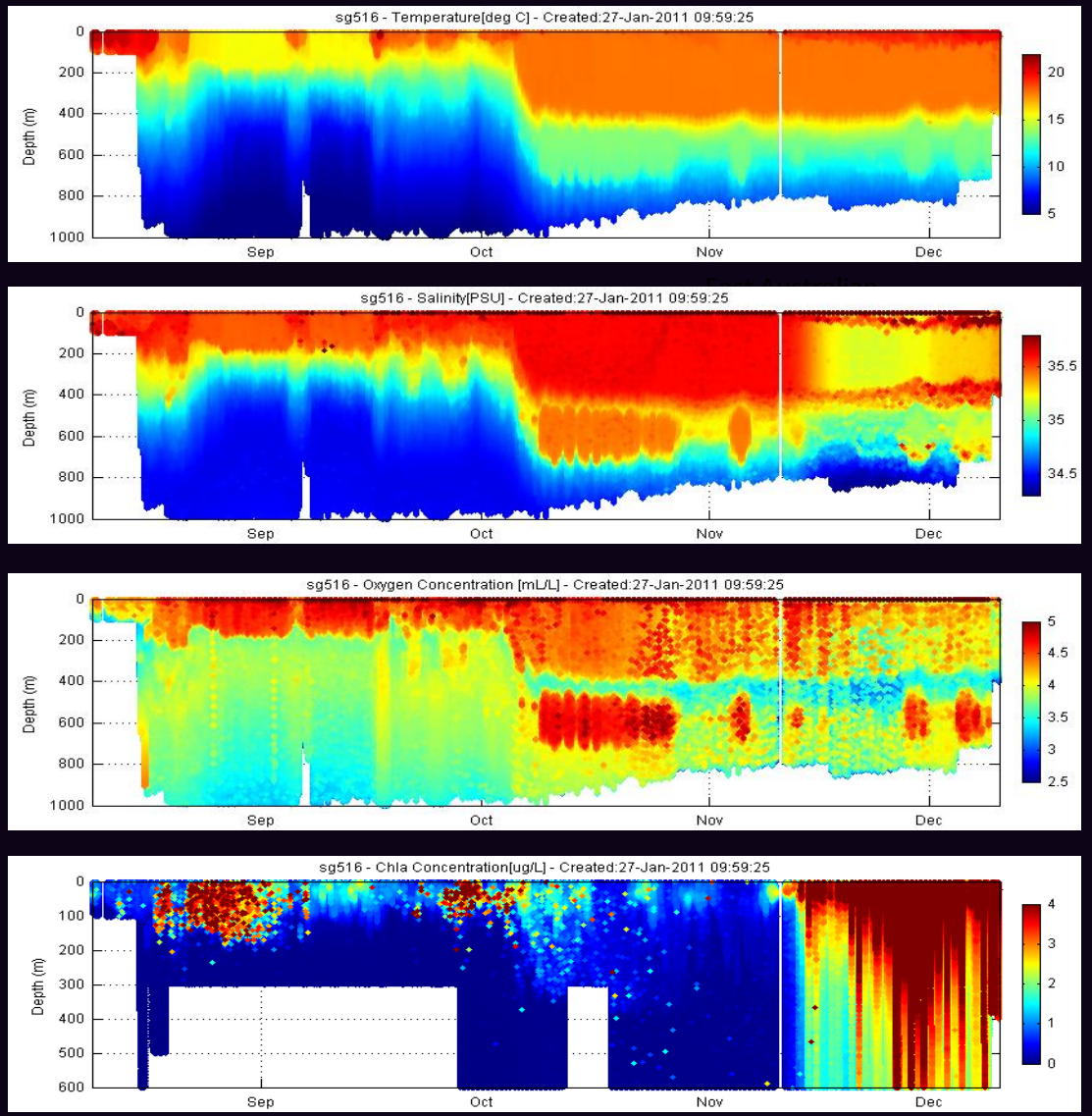
NSWIMOS - East Australian Current & Eddy Field





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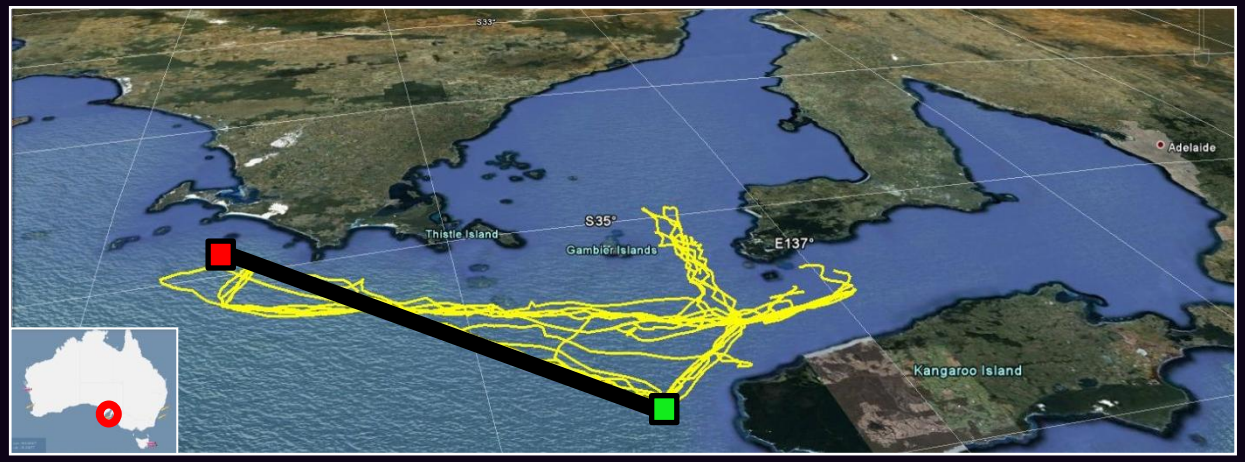
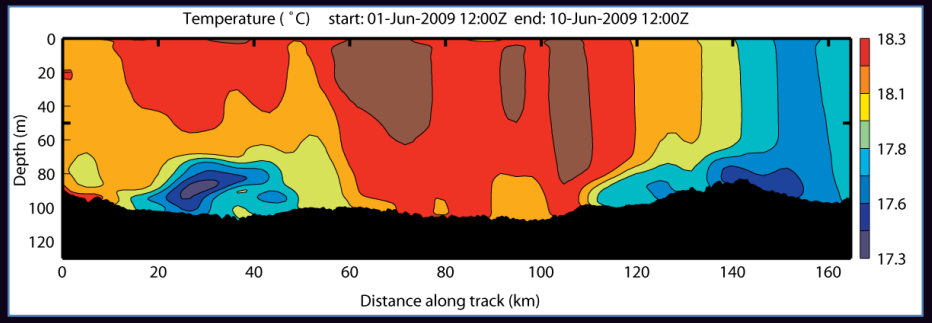
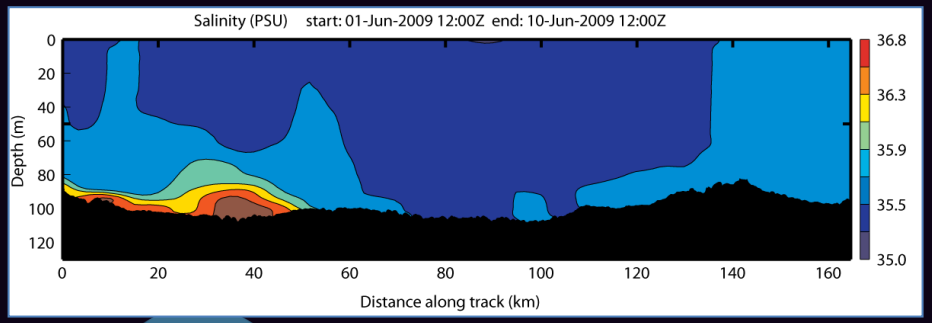
SAIMOS - Spencer Gulf



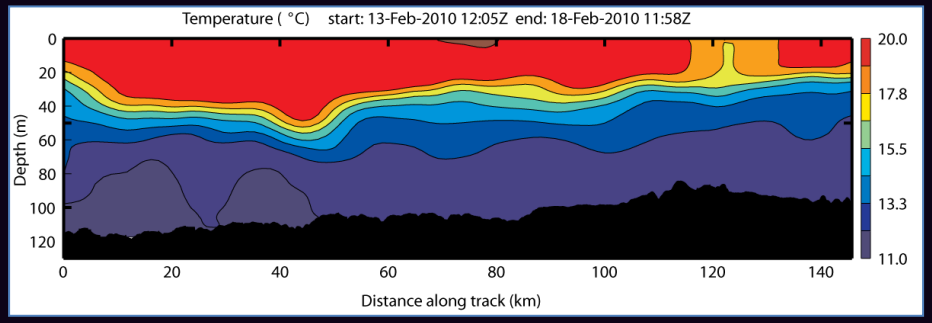
- Spencer gulf – continental shelf exchange
- 5 Deployments (2 x Winter, 3 x Summer)

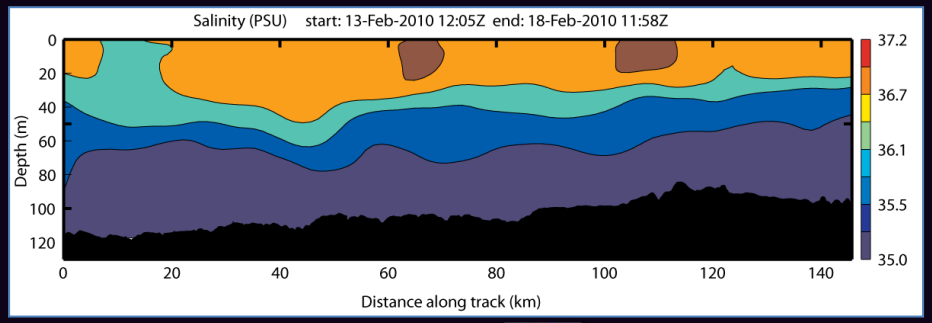
Jun 2009





Feb 2010





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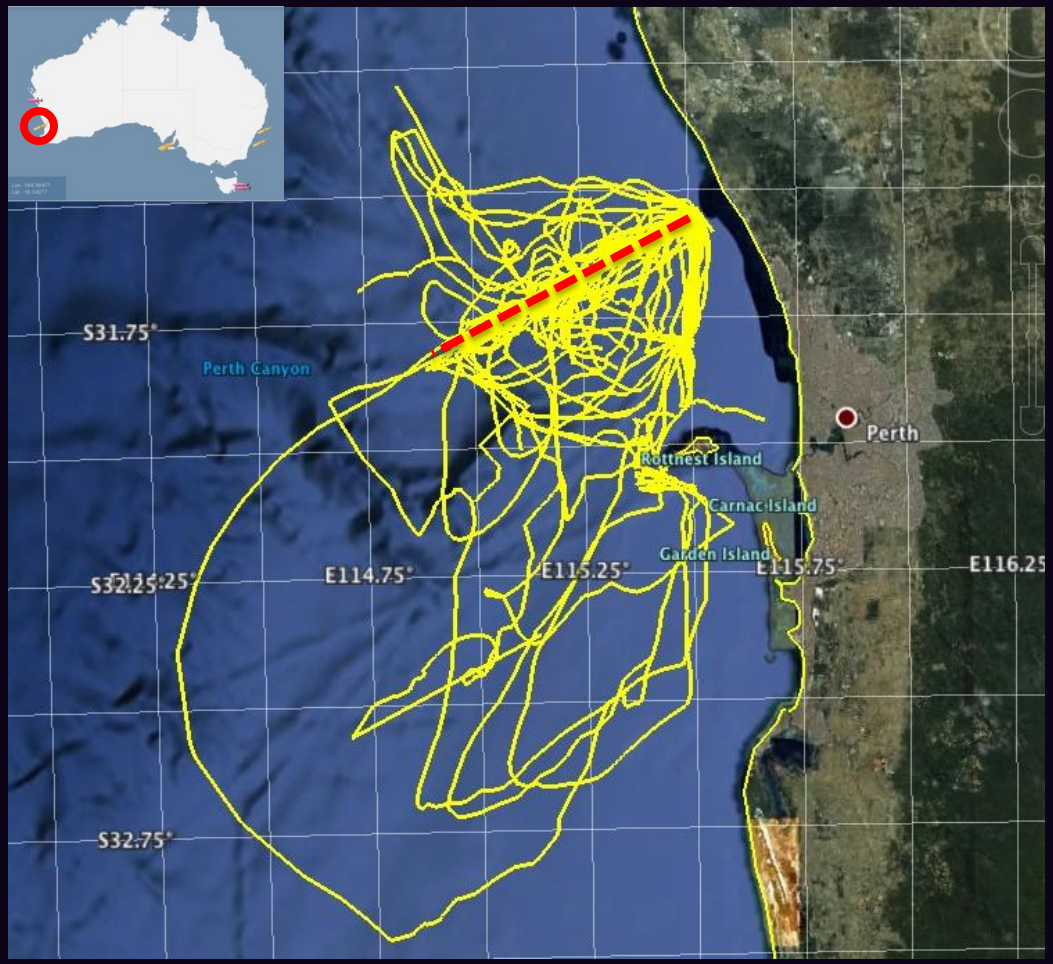
WAIMOS – Two Rocks Transect



- Monthly Slocum deployments since Jan 2009
- Observe the seasonal evolution of the Leeuwin Current system, and associated bio-optical properties

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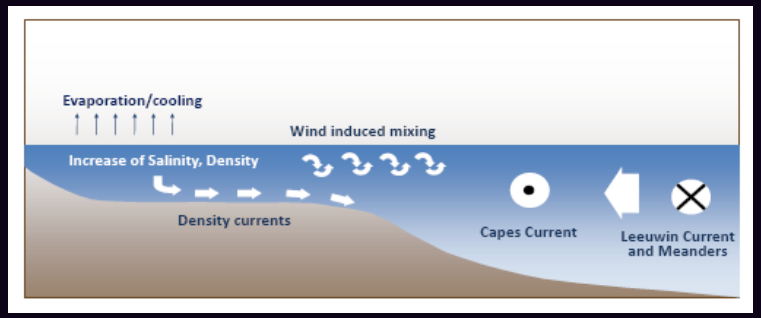
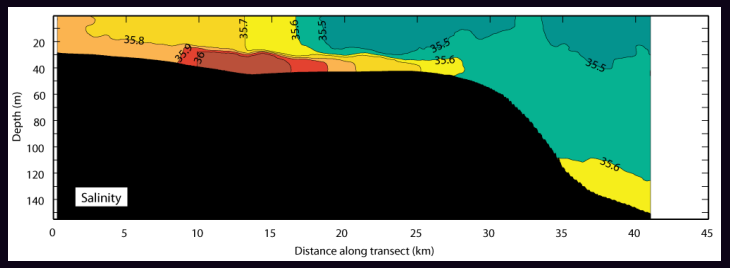
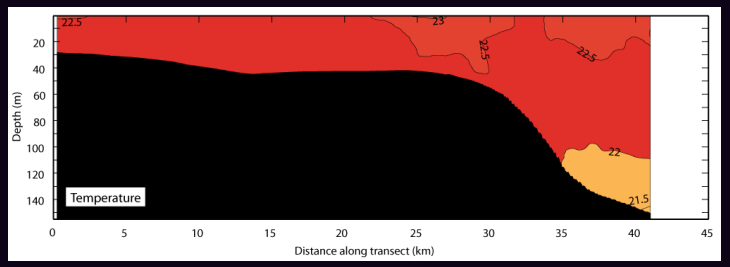
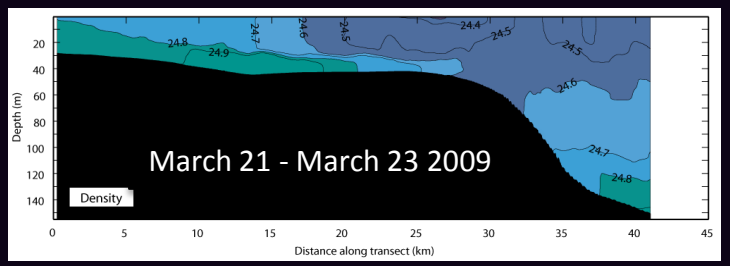
WAIMOS – Two Rocks Transect

- Sustained high resolution sampling with gliders has allowed observation of DSWC
- DSWC important feature off southwestern WA during both autumn and winter
- Driven by:
  - high evaporation in summer
  - seasonal cooling in winter
- Chlorophyll fluorescence peaks in:
  - frontal region
  - within DSWC









Recent publication - Pattiaratchi, Hollings, Woo & Welhena. Dense shelf water formation along the south-west Australian inner shelf. *Geophysical Research Letters, in press*.

Student projects using Two Rocks glider data:

- Thisara Welhena (PhD)
- Anton Kuret (Hons)
- Noel Pelland (visiting PhD student, University of Washington)

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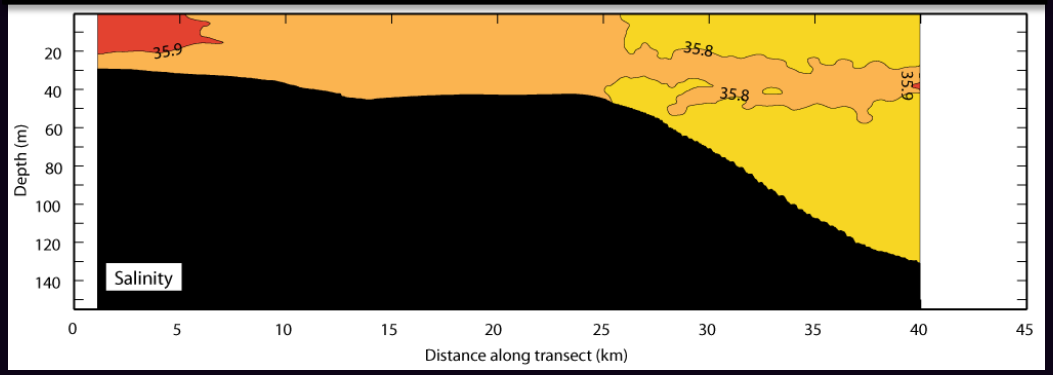
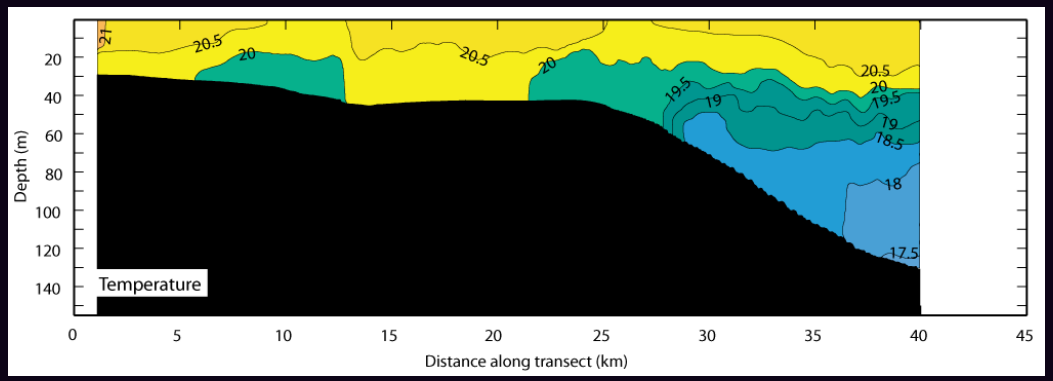
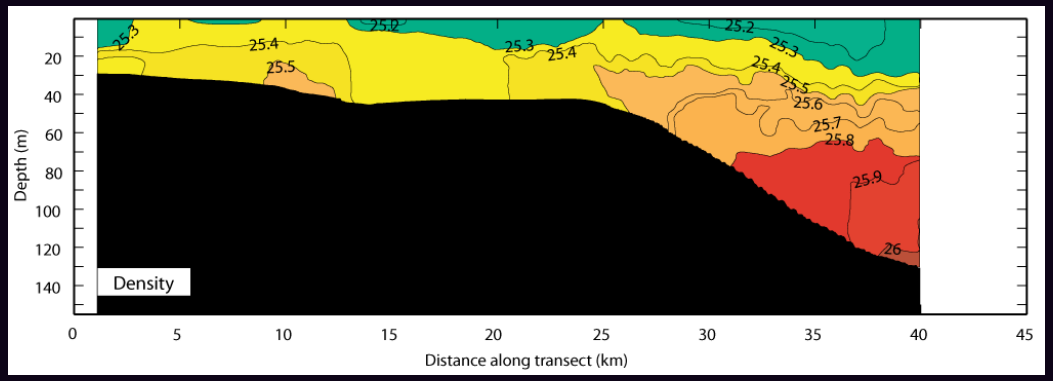
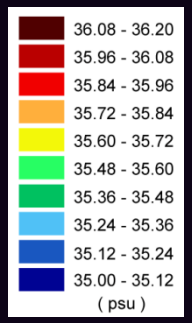
WAIMOS – Two Rocks Transect

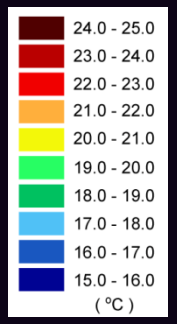
January 28 – January 30 2010 Upwelling

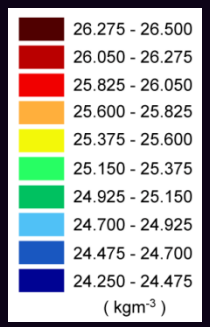












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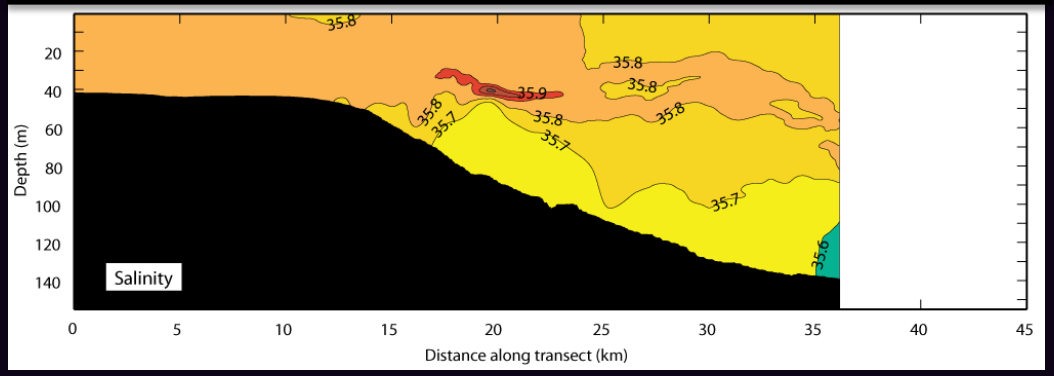
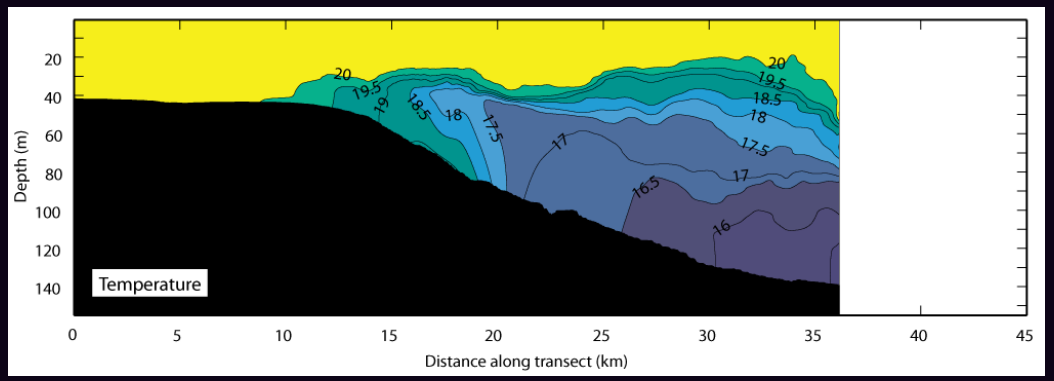
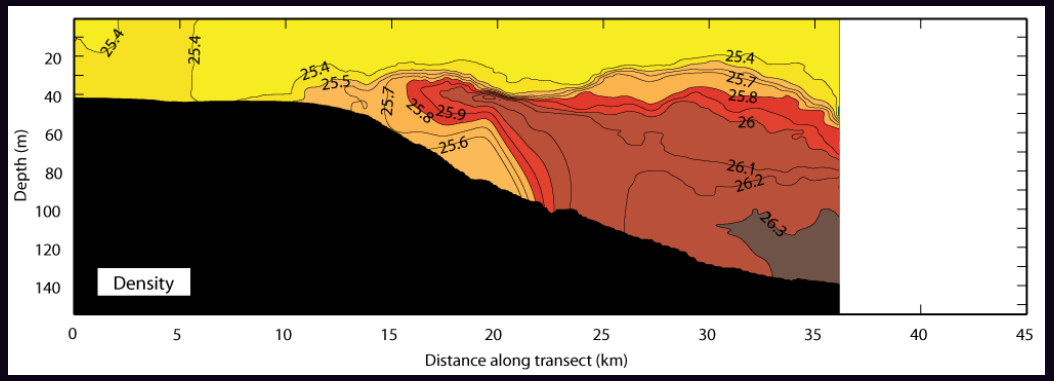
WAIMOS – Two Rocks Transect

February 02 - February 05 2010 Upwelling







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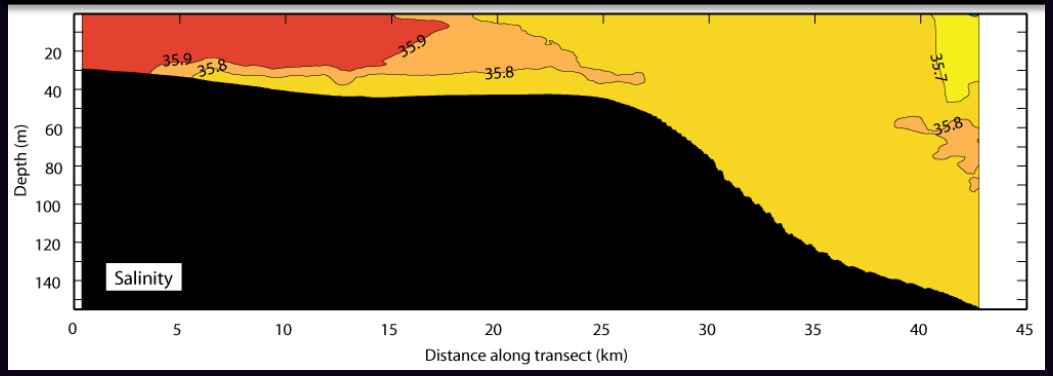
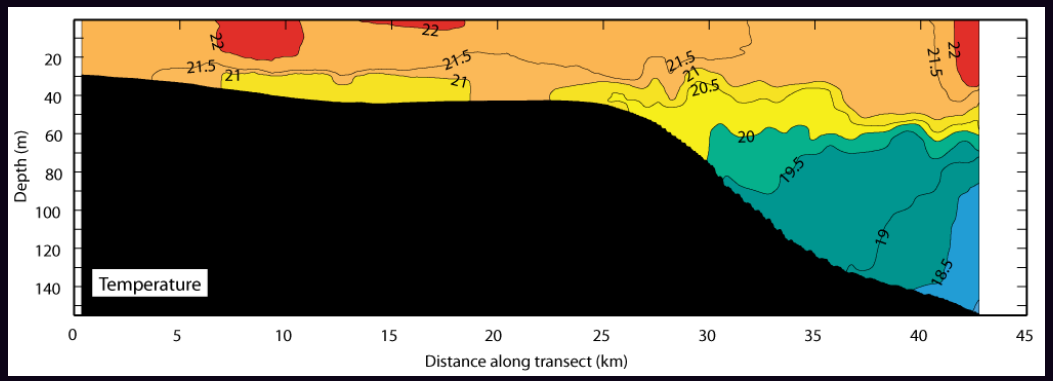
WAIMOS – Two Rocks Transect

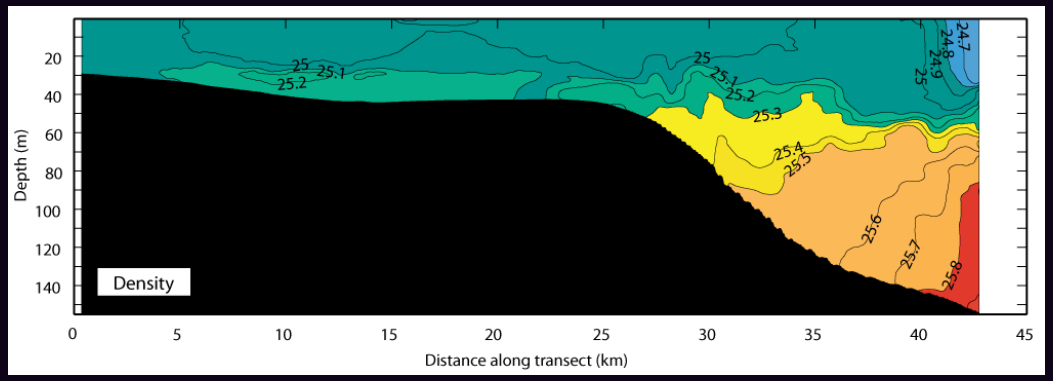
February 05 - February 08 2010 Relaxation



36.08 - 36.20
35.96 - 36.08
35.84 - 35.96
35.72 - 35.84
35.60 - 35.72
35.48 - 35.60
35.36 - 35.48
35.24 - 35.36
35.12 - 35.24
35.00 - 35.12
(psu)



24.0 - 25.0
23.0 - 24.0
22.0 - 23.0
21.0 - 22.0
20.0 - 21.0
19.0 - 20.0
18.0 - 19.0
17.0 - 18.0
16.0 - 17.0
15.0 - 16.0
(°C)



26.275 - 26.500
26.050 - 26.275
25.825 - 26.050
25.600 - 25.825
25.375 - 25.600
25.150 - 25.375
24.925 - 25.150
24.700 - 24.925
24.475 - 24.700
24.250 - 24.475
(kgm^{-3})

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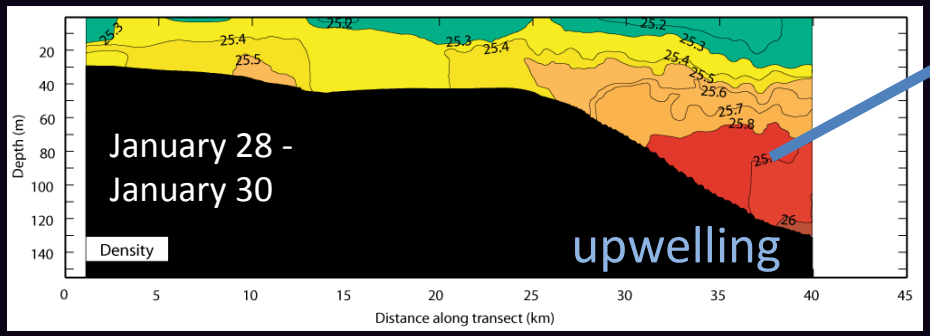
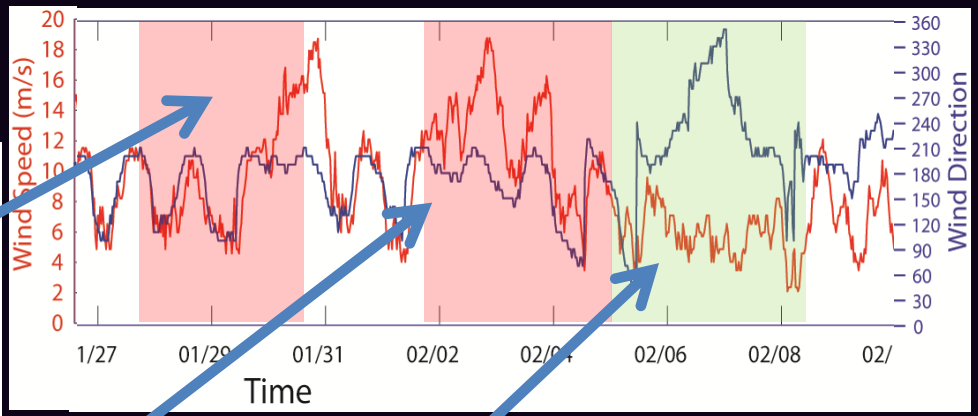
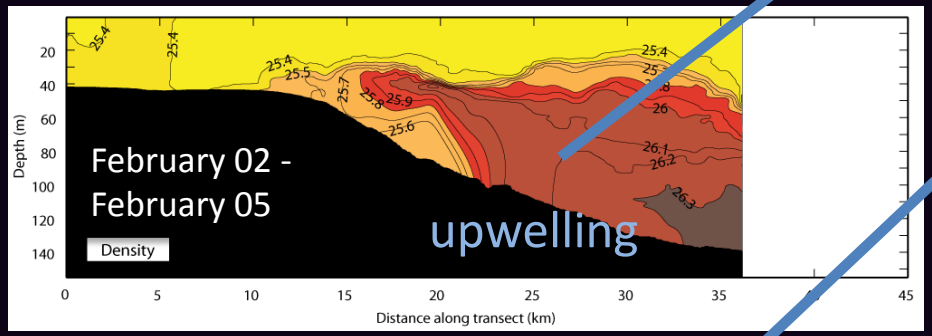
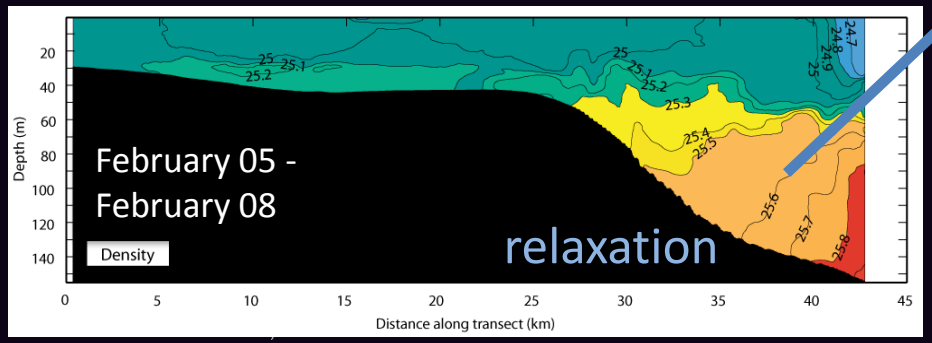
WAIMOS – Two Rocks Transect

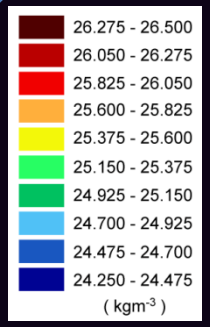


Wind data









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2010 Achievements

- In house Seaglider refurbishment & maintenance
- Trained personnel in science nodes to deploy and recover gliders (‘Glider Ports’)
- 7 Gliders deployed at one time
- Addition of new sustained observation sites:
  - Deployment 2 Southern Ocean Seagliders
  - Seaglider deployment in the Coral Sea
  - Seaglider deployment in NW Australia
- Development of Google Earth based monitoring console
- Development of GliderScope data visualisation software

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Summary

- ANFOG glider data provides new, high-resolution view of oceanographic processes off WA and around Australia
- Unprecedented temporal and spatial coverage

Moving forward…

- Maintain current sustained monitoring
- Establish additional ‘Glider Ports’
- Increase student involvement
- Encourage data uptake

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Thank you!

GLIDERSCOPE is available for download at:

http://imos.org.au/anfog.html

ANFOG data files are available from:

http://imos.aodn.org.au

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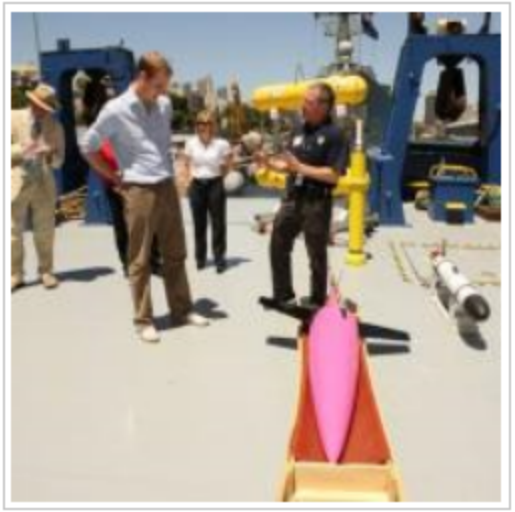
Australia Network News
Provided by the ABC Asia Pacific News Centre

University News

UWA's ocean glider fit for a prince

Friday, 12 February 2010



His Royal Highness Prince William of Wales KG took a keen interest in a high-tech marine ocean glider owned by The University of Western Australia when he visited CSIRO aboard the Marine National Facility Research Vessel *Southern Surveyor* in Sydney last month.

Winthrop Professor Chari Pattiaratchi said the glider had helped revolutionise ocean observations and climate science, playing a vital role in understanding climate change, rising sea levels and ocean acidification.

The glider was on show while CSIRO scientist Dr Steve Rintoul provided Prince William with a five-minute overview of CSIRO's climate and ocean-climate research, which relies heavily on observations made using gliders and other ocean robots from the Integrated Marine Observing System (IMOS). The glider is one of the high-tech submersibles in IMOS's Australian National Facility for Ocean Gliders, which is based at UWA and led by Professor Pattiaratchi.

During the ship visit, Prince William was also able to view samples of marine life such as coral, deep-sea fish, crustaceans and sea stars from the Australian Museum and CSIRO.

Professor Pattiaratchi's research on how the oceans are changing, and the effects of those changes on coastal populations, is part of the UWA-based Western Australian Marine Science Institution's research into the real effects of climate change.

Pic caption: Prince William views an ocean glider owned and operated by UWA to monitor oceans around Australia. Photo by: Belinda Mason, Courtesy of: CSIRO