Australian Argo National Data Management Report
ADMT13
Hyderabad, India – 12-16 November 2012
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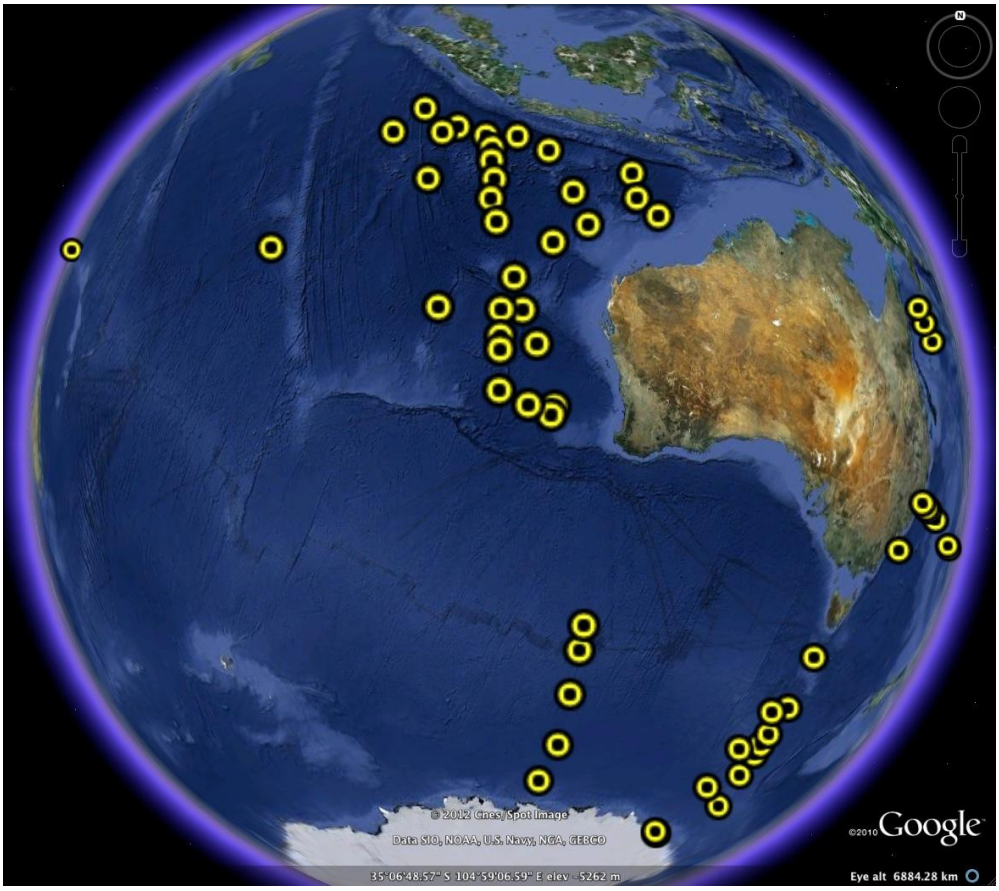
Status of Array

Australian deployments in 2011-2012:



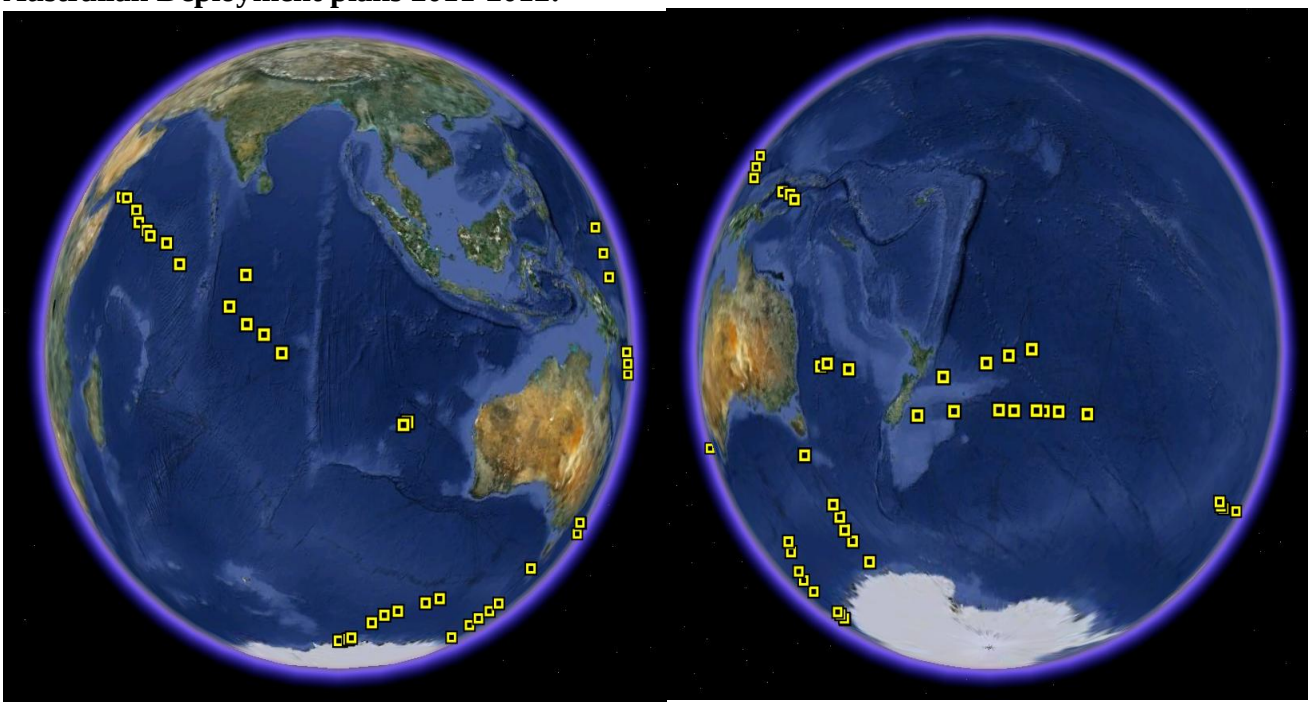
Australian Argo deployments between November 2011 and October.Yellow dots are new deployments,

Australiahas deployed 61 Argo floats since the last meeting, which is average for us.We currently have 383floats giving us good data (an increase of 48 from last year) from a total of 533 deployments. We also have 58 floats in the lab or on ships about to be deployed with another 40 on order. These purchases will help us to maintain float density in our region.

One major development this year was the requirement that we go to tender for our new floats. In the past, we have been allowed to purchase floats from a single supplier. With the advent of new float models and manufacturers, we were required to establish a tender process for float procurement. We designed this in two parts – proven technology for our day-to-day purchases and Proof of Concept (POC) for new technology. As a result of the tender process, we acquired 16 floats from 3 manufacturers. Most of these are on Kaharoa being deployed now. The remaining floats will shortly be deployed during a Southern Ocean cruise. The POC process is intended to run for approximately one year. The floats will be fully tested both in the lab before deployment and in the field, running a 5 day cycle initially to exercise the mechanics and batteries and then reprogramming them remotely to test this feature. We expect to finish our assessment before the next meeting and will report on the results to the Argo community.

Deployment plans for the floats we either have on (or about to go on) ships or on orderare shown below. We will continue to reseed the Indian Ocean and attempt to get floats into the northwestIndian Ocean when we can by working more with our Naval contacts. The Australian Navy has been very helpful, though the planning takes a long time.

Australian Deployment plans 2011-2012:



We have continued with our decision to deploy only iridium-equipped floats. The increased data density and speed of communications make this system preferable for most of our deployments and maintaining an array with uniform configurations makes testing easier. Communication costs are reasonable given the data return and they are decreasing as we move the array to RUDICS.

During the year, a float was picked up by a fisherman in PNG. Our technician is retrieving it this month. It is an older APF8 Argos version of the Teledyne Webb Apex float. We intend to reconfigure this float with an APF9 board and iridium communications before redeployment. There is another float that might be on shore in PNG as well and, if so, we will try to retrieve it if possible.

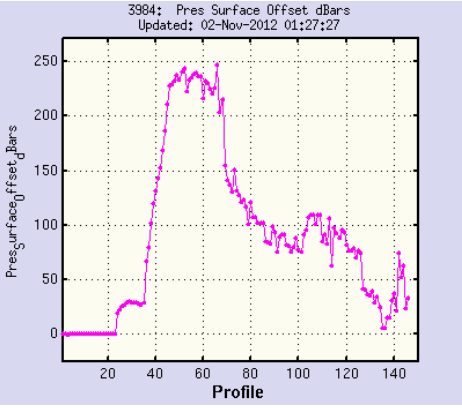
Technical Problems Encountered and Solved:
As for last year, our biggest problem this year was the apparent leaking of floats. In particular, some batches of Iridium floats seem prone to leaks, often progressing quite quickly after a period of no leaks. The Iridium array consists primarily of Webb APF9 Apex floats but we have recently acquired, as part of the POC process, 4 MRV SOLO-2 floats and 8 Seabird Navis floats (4 are equipped with the new optical dissolved oxygen sensor SBE-63). As mentioned above, these are being deployed now by Kaharoa.

Currently of the 144 iridium floats deployed, 112 are live, 18 are overdue, and 14 have been declared dead. Between 7 and 11 of the overdue floats are under ice. The cause of 'death' for these floats varied – 7 have been attributed to antenna leaks, 3 disappeared because of faulty air solenoid valves, 3 failed on deployment (unknown or possibly failed pressure activation) and 1 Iridium transmitter apparently failed.

Last year we were fortunate to recover a leaking iridium float. Upon investigation (by Teledyne Webb), it was discovered that the leak was due to weak bonding between the potting compound and the inside aluminium tubing of the antenna. The new iridium antenna design has since resolved this problem.

The added benefits of using iridium, including two way communications and real-time data delivery have been crucial in improving float survivability, mission changes and float recovery.

We have had very few issues with our Argos floats this year but one exhibited strange behavior. It shows a steadily increasing positive pressure offset so it is not a microleaker. Further, after reaching an offset of over 200db, it started to decrease again. This float is reaching the surface but reporting very strange pressure readings. We have notified the manufacturer of this issue and the float is now grey listed.



Software development:
Software development continues with the addition of new features, programming in new float formats, reprogramming of some functions and simplification of the routines.

KORDI has implemented the Australian ArgoRT software package we use and is now delivering data from its Apex floats automatically. The next step will be to give them our DMQC software and train Moon-Sik in its use. This has been a major accomplishment, second only to the implementation of this software at Incios.

If anyone else is interested in our Argo Real-time software, it is a Matlab program that works from the raw Argos hex data and iridium RUDICS delivered files (SBD is being added to the capability as well) to decode the profiles and create all required netcdf files for delivery to the GDACs. We are happy to help with getting it set up elsewhere.

Oxygen floats received an upgrade recently with the Optode calibrations now using the Uchida equation and fewer calibration coefficients. We don't intend to reprocess our older oxygen floats in real-time but all new deployments and delayed mode oxygen data will use the improved process whenever possible. We are also deploying some of the new Seabird optical oxygen sensors as part of the POC testing.

Data Acquisition and delivery to the GDACs and GTS:
Data processing has basically not changed. Raw data is processed within a maximum of 18 hours of delivery from either Argos or to us via Iridium. Argos data is processed twice – once as soon as practical, then again in 2-3 days to ensure we have the maximum number of reports and the best possible message. After passing through the real-time QC, all netcdf files are generated and the data is then sent via FTP to both GDACs. Our processing is mirrored at BOM so each file is delivered 4 times in total, ensuring that the GDACs have the data if either CSIRO or BOM are offline for some reason.Problems this year appear to have been minimal. We have, however, seen some large delays at the GDACS – this occurred particularly in August and September when we deployed 5 floats with oxygen sensors but did not yet have the calibration coefficients. The lack of these coefficients delayed processing for over 3 weeks. Further biasing the delay statistics, two of these floats are bounce-profiling up to seven (!) times a day. When you deliver 700 profiles in a month with a mean delay of over 400 hours, and don't start processing immediately, the delays add up quickly.

The data is also issued to the GTS via TESAC messages immediately.BUFR messages are now being generated and delivered to the GTS. We have confirmed that this data is being seen at the US GODAE.

InAugust 2012, the data from approximately 98% of our floats were delivered to the GTS within 24 hours of the float surface time. This is calculated from our file creation times and our float surface times so should be accurate. Yet we still see larger delays reported by the AIC. This will be investigated but we suspect it is the method of calculation, not the delays though there might still be unidentified delays at the GDAC.

Data is available for delayed mode QC as soon as the real-time data is processed but only considered valid for DMQC after 6 months. The Delayed Mode report is appended below.

Additional Data Distribution:
As noted last year, the National Collaborative Research Infrastructure Strategy (NCRIS) funds the Integrated Marine Observing System (IMOS) which is a major source of Argo funding for Australia. As part of this initiative, it is required that we have a local data delivery pathway. IMOS is now serving Argo data as a mirror to the US GDAC through its data portal which can be accessed at:

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

All IMOS data, from all nodes, can be accessed through this web site.

Float Performance:
Float performance has been excellent this year with two floats exceeding 10 years of operation. This year, only one died on deployment. And two floats we thought gone for good have returned, one after 2 years stuck on the bottom north of Papua New Guinea. Three floats have now been confirmed with the Druck microleak fault and another 10are suspected of having microleaking pressure sensors but they are in the early stages. Nine of the suspect microleakers are APF9 floats so we can monitor the progress of these – we also have one TNDP float (APF8s) that is suspect and may eventually be classed as a microleaker.

Of the 533 floats we have deployed, 131 have now been declared 'dead', an increase of 30 since last meeting. There are another 40 on the missing list but most of these are under ice. Of the dead floats, 21% ceased to operate due to natural causes when they ran down their battery packs. A further 17% died due to unknown reasons. The remainder of floats ceased to operate prematurely mainly due to environmental reasons such as grounding (20%) and loss or damage under sea ice (6%). Other contributing factors were hardware failures such as communications problems, CTD/pressure sensor damage or faults (7%); leakage (10%); software issues such as firmware bugs (5%); premature battery failure (6%) or human error (e.g. turning on the float too early resulting in buoyancy problems and subsequent loss, picked up by fisherman or deployed in the plastic bag (8%).

Web Pages:
The Australian Argo web pages are updated with the most recent data during the processing of the reports from the floats. They are therefore up to date as soon as float data is received.We have added web pages that contain details of the technical data from our floats, aiding in the diagnosis of problems. This is now done as a float is processed making them up-to-date and easy to find.

Home page for Argo Australia (IMOS)
http://imos.org.au/argo.html

The Australian data portal can be found at:
http://www.imos.org.au/facilities/argo-australia.html;

Information on individual floats can be found at:
http://www.marine.csiro.au/~gronell/ArgoRT/;

There are links to the technical pages for a float from each profile page.

Information on our DMQC process and floats can be found at:
http://www.marine.csiro.au/argo/dmqc/

Home page for DMQC documentation of floats:
http://www.cmar.csiro.au/argo/dmqc/html/Argo_DM.html
and
http://www.cmar.csiro.au/argo/dmqc/index.html

Example DMQC documentation page for a float:
http://www.cmar.csiro.au/argo/dmqc/html/DMQCnotes_5901618.html

Statistics of Argo data usage:
Argo data is downloaded to a local mirror once a week. It is then converted to a Matlab format with an index table to help local users find the data they need.

Argo usage is a difficult list to compile, as Argo data are now being used routinely by many researchers nationally and globally. Not much has changed in the past year. In addition to the information below, there are numerous publications from Australian researchers which have used Argo data and have appeared in the last year.

The data is being used with other data on the GTS to inform the Bureau of Meteorology's Seasonal Climate Outlook and is used in a dynamical climate forecast system (POAMA). As part of this the data are ingested into the BMRC Ocean Analysis (http://www.bom.gov.au/bmrc/ocean/results/climocan.htm)

- Argo data is also being used in the BLUElink ocean forecasting system.
  http://www.bom.gov.au/oceanography/forecasts/index.shtml

- We are also incorporating it as a high quality background data field for our upper ocean temperature QC programs (QuOTA archives, SOOP XBT QC).

Please see Appendix A for a list of research projects using Argo data in Australia.

Delayed Mode QC (DMQC):

Australian DM Statistics (to 21 Oct 2012)

D files submitted to GDAC	35007
Total R files	29346
R files eligible for DMQC	7205
Total eligible files for DMQC	42212

Total files at GDAC 64353

Table 1. Delayed Mode processing statistics for the Australian array.

The Australian Argo array continues to grow rapidly with 74 floats deployed over the past year (21 Oct 2011 to 21 Oct 2102). A total of 539 floats have been deployed since the beginning of the Argo program and of these, 129 floats have died and a further 22 are giving suspect data. As at 21/10/2012, 84% of eligible profiles (those that are greater than 6 months old) have been processed in delayed mode quality control.

The DMQC processing software is complete and we are now operating in maintenance mode with new floats assessed after 6 months and older floats being revisited between 1-2 times per year. Over the next 12 months we will be working on incorporating new float data formats from new float models into the data stream, new trajectory and metafile formats, incorporating multi-profile files into the DM process. We will also start to put significant effort into trajectory and oxygen data and delivery of novel Argo products. A challenge for our program is the significant increase in data volumes of our standard data in the Delayed Mode data stream as well as new QC of trajectory data and other parameters such as oxygen.

The Delayed Mode data stream is in good shape with 83% of eligible profiles (data record longer than 6 months) QC'd and available at the GDAC's. There are now more than 64,000 R and D profiles from Australian floats available at the global DACs.

A total of 437 floats have been assessed through the DMQC process for drift of the salinity sensor. Of these, 9 floats (2 %) returned no data from deployment and 9floats (2 %) returned bad data for the entire record due to pressure sensor issues or other hardware problems. Of the remaining 419 assessable floats, 377 (90 %) show no salinity drift for the life of the float. A further 34 or 8 % of floats show a positive salinity drift. A small number of floats (8) or 2 % are affected by a fresh offset or biofouling. Of the floats that are either salt or fresh offset, most were corrected using the OW salinity drift correction. 18 floats (4 %) suffered from TBTO fouling at the start of the record, generally only the first or second profiles but in some cases up to 7 profiles.

From a total of 190 APEX floats with APF 8 controller boards and Druck pressure sensors, 58 (26%) were truncated negative pressure drifting (TNPD). Three floats have been confirmed as Druckmicroleakers (5901649, 5901689, 5901660); two of these were APF9's and one TNPD APF8. Float 5901704 identifed as a DML last year has now been confirmed as a non DML (this float is thought to have had data issues caused by grounding). The Druck pressure sensor serial numbers on all 3 confirmed DML floats are greater than 2324175. Two of these floats showed rapid gross pressure drift (-10 db within 18 and 23 cycles for the two APF9 floats respectively) and severely anomalous TS data within 20 to 30 cycles. The third float is an APF8 float that truncates negative pressure drift and hence the only indication is anomalous TS data from profile 65 onwards. A further 10 floats are suspected microleakers (9 of these are APF9 so we can track the pressure drift) and are exhibiting negative pressure drifts of between 3 and 6 db after around 100-150 cycles. The APF8 float has been greylisted from pf 74 onwards for showing anomalous TS data.

The Argo Australia web pages are continuously updated and are available at the following website: http://imos.org.au/argo.html
There is a Delayed Mode webpage for every float that has undergone DMQC (including detailed plots and diagnostic information), these are available at:
http://www.cmar.csiro.au/argo/dmqc/html/Argo_DM.html

Appendix A.

The following table shows some of the uses to which Argo data is put within Australia.

Project Title	Institution	Principal Investigators
Australian Climate Change Science Program: Ocean Processes and Change	Department of Climate Change and Energy Efficiency, Commonwealth Scientific Industrial Research Organisation	Steve Rintoul, Susan Wijffels, Bernadette Sloyan
Australian Climate Change Science Program: Sea Level Rise	Department of Climate Change and Energy Efficiency, Commonwealth Scientific Industrial Research Organisation	John Church, Susan Wijffels
Climate Variability and Change Program	Centre for Australian Weather and Climate Research , Antarctic Climate and Ecosystems Cooperative Research Centre	Steve Rintoul
Sea Level Rise Program	Centre for Australian Weather and Climate Research , Antarctic Climate and Ecosystems Cooperative Research Centre	John Church
Ocean Control of Carbon Dioxide Oceans Change Program	Antarctic Climate and Ecosystems Cooperative Research Centre	Tom Trull
Pacific Climate Change Science Program; Oceans Component - Ocean change, variability and sea level rise	Department of Climate Change and Energy Efficiency, Commonwealth Scientific Industrial Research Organisation, Centre for Australian Weather and Climate Research , University of New South Wales	John Church, Susan Wijffels, Jaci Brown, Alexander Gupta, Partner Institution(s): Pacific Island Countries
POAMA development: improving seasonal climate forecasting for Australia	Bureau of Meteorology	Oscar Alves, Harry Hendon
WAMSI Node 1: Southwest Australia marine ecosystem	Commonwealth Scientific Industrial Research Organisation, University of Western Australia	John Keesing, Ming Feng, D Slawinski
WAMSI Node 2: Leeuwin Current dynamics and variability	Commonwealth Scientific Industrial Research Organisation, University of Western Australia	Ming Feng, Dirk Slawinski, LiejunZhong,
Modeling of source-sink relation of western rock lobster recruitment	Fisheries Research & Development Corporation	N Caputi, Ming Feng, E Weller
BlueLink II/III - ocean forecasting for Australia - Bluelink Global Program (OFAM, BRAN,	Centre for Australian Weather and Climate Research , Bureau of Meteorology	Helen Beggs, G Brassington, D Griffin, P Oke, Eric Schulz, 2003-2013, Partner Institution(s): Royal Australian

OceanMaps) - Bluelink Regional Program (ROAM, CLAM) - Bluelink Littoral Zone Program The global and regional components use Argo explicitly. These components of Bluelink use IMOS data in different ways.		Navy
Research program: Mechanisms and attribution of past and future ocean circulation change	ARC Centre of Excellence for Climate System Science	Professor Nathaniel Bindoff (University of Tasmania);Dr Andrew Hogg (ANU);Professor Matthew England (UNSW);Dr DietmarDommenget (Monash University);Professor David Karoly (University of Melbourne);Dr Peter Strutton (University of Tasmania);Dr Richard Matear (CAWCR-CSIRO);Dr Anthony Hirst (CAWCR-CSIRO);Dr Scott Power (CAWCR-BoM);Dr Stephen Griffies (Geophysical Fluid Dynamics Laboratory, USA)
ARC Future Fellowship: Southern Ocean productivity and CO2 exchange under current and future climate regimes.	University of Tasmania	Peter Strutton
Environmental factors affecting the low puerulus settlements	FRDC	Caputi and Feng,
Mixing parameters in the Southern Ocean determined by inverse methods	Commonwealth Scientific Industrial Research	Andrew Meijers OCE Postdoc, co-supervised by Trevor McDougall and Bernadette Sloyan
Quantifying the role of salps in marine food webs and organic carbon export	University of New South Wales, Funding: ARC Discovery Project	,IainSuthers
Coastal cold core eddies of the East Australian Current and their fisheries potential	University of New South Wales, Funding: ARC Discovery Project	Iain Suthers
Eddies and Upwelling: using satellite datasets to examine patterns in chlorophyll a adjacent to the East Australian Current	University of Technology Sydney	Jason Everett

Postgraduate research projects using Argo data

Degree Type	Degree Title	Student	Institution
Doctor of Philosophy (Phd)	Ocean Salinities and Changes to the Hydrological Cycle	D Abecasis	University of Tasmania, Commonwealth Scientific Industrial Research Organisation
Doctor of Philosophy (Phd)	Decadal Variability in the Indo-Pacific	Mauro Vargas	University of Tasmania, Commonwealth Scientific Industrial Research Organisation
Doctor of Philosophy (Phd)	Southern Ocean Overturning	Amelie Meyer	University of Tasmania, Commonwealth Scientific Industrial Research Organisation
Doctor of Philosophy (Phd)	Intraseasonal Variability in the Indian Ocean	K Drushka	Scripps Institution of Oceanography, Commonwealth Scientific Industrial Research Organisation
PhD	Phytoplankton Variability in the Southern Ocean South of Australia	Robert Johnson	UTas
Doctor of Philosophy (Phd)	An Operational Circulation Forecast System for Jervis Bay, NSW	Donghui Jiang	ADFA
Doctor of Philosophy (Phd)	Evaluating the Potential Economic Benefits from Regional Ocean Observing System to the Australian East Coastal Areas	Fan Zhang	ADFA
Doctor of Philosophy (PhD)	Predicting the Ocean Mesoscale Dynamics in the Australian Region	R. Woodham	UNSW at ADFA
Doctor of Philosophy (PhD)	Modelling Dynamics of the East Australian Current and The Subtropical Mode Water off East Coast of Australia	Vihang Bhatt	UNSW at ADFA
Doctor of Philosophy (Phd)	Numerical modelling of Tasman Sea eddy field	Helen Macdonald	UNSW
Doctor of Philosophy (Phd)	Argo data in the Coral Sea...	Jasmine Jaffres	JCU
Doctor of Philosophy (Phd)	The Kinematics of Ocean Salinity Changes	Veronique Lago	QMS at UTas
Doctor of Philosophy (Phd)	Ocean circulation and mixing from inverse	SjoerdGroeskamp	UTas, CSIRO

	methods		
Doctor of Philosophy (Phd)	Variability of Sub-Antarctic Mode Water and Antarctic Intermediate Water in the Australian sector of the Southern Ocean	Laura Herraiz-Borreguero	UTas
Doctor of Philosophy (Phd)	Quantifying ocean mixing from hydrographic data	Jan Zika	UNSW, CSIRO
Doctor of Philosophy (Phd)	Decadal ocean water mass changes: Global observations and interpretation	Kieran Helm	UTas
Doctor of Philosophy (Phd)	Global Ocean Salinity: A climate change diagnostic?	Paul Durack	UTas