

# Physical Oceanography



Looking back from the bridge of Research Vessel Ice Breaker (RVIB) Nathaniel B. Palmer as it travels through the Straits of Magellan.

## Members

### Academic Staff:

**Dr Andrew Kiss** (a.kiss@adfa.edu.au) BSc (Hons), PhD ANU

**Dr Robin Robertson** (r.robertson@adfa.edu.au) PhD *Oregon State University*. Adjunct Assoc. Research Scientist: Lamont-Doherty Earth Obs. Columbia Univ. & Adjunct Scientist: UNSW Climate Change Research Centre.

**Dr Xiao Hua Wang** (h.wang@adfa.edu.au) BSc *Shandong*, PhD *James Cook*

### Research Students:

**Vihang Bhatt** - Research Topic - Modelling dynamics of the East Australian Current and the Subtropical Mode Water off the East Coast of Australia.

**Donghui Jiang** - Research Topic - An operational circulation and ecology forecast system for Jervis Bay, NSW.

**Li Li** - Research Topic - Coastal mud dynamics and their ecological-socio-economic impact.

**Zhaosu Meng** - Research Topic - The effects of climate change in the East Asia Monsoon Region.

**Dehai Song** - Research Topic - Modelling of the Yellow Sea circulation and sediment transport dynamics.

**Darrell Terry** - Research Topic - Effects of ice shelf melting on Southern Ocean water formation.

**Robert Woodham** - Research Topic - Ensemble methods in oceanic modelling.

**Wen Wu** - Research Topic - Application of the ISO 14031 Environmental Performance Evaluation to the Australian Defence Force Environmental Management System.

**Fan Zhang** - Research Topic - Estimate the social economic benefits of ocean observing system.

### Current Honours Students:

**Scott Baxter**

**Danica Ellicott**

### Research Collaborators:

#### Coastal oceanography and environment management

**Prof. X. Bao** (Ocean University of China, Qingdao)

**Dr D-S. Byun** (National Oceanographic Research Institute, Korea)

**Dr L. Oey** (Princeton University, USA)

**Prof. N. Pinardi** (Bologna University, Italy)

**Prof. D. Wu** (Ocean University of China, Qingdao)

**Prof. L. Zhao** (Ocean University of China, Qingdao)

#### Internal tides and tidal effects on ice shelves and sea ice

**Prof. N. Bindoff** (Univ. of Tasmania)

**Dr A. Field** (Earth and Space Research, Grandview, NY, USA)

**Prof. A. Gordon** (Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA)

**Dr Petra Heil** (Australian Antarctic Division, Hobart, Australia)

**Dr H. Hellmer** (Alfred Wegener Institute fuer Polar und Meeresforschung, Bremerhaven, Germany)

# Physical Oceanography

**Dr S. Jacobs** (Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA)

**Dr Jason Middleton** (SIMS-Univ. of New South Wales, Sydney, Australia)

**Dr F. Nitsche** (Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA)

**Dr M. Roughan** (SIMS-Univ. of New South Wales, Sydney, Australia)

**Dr A. Schiller** (CSIRO, Marine Research, Hobart, Australia)

**Dr J. Sprintall** (Scripps Institute of Oceanography, La Jolla, CA, USA)

**Prof. B. Tremblay** (McGill University, Montreal, Canada)

**Dr S. Wijffels** (CSIRO, Marine Research, Hobart, Australia)

**Dr X. Yuan** (Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA)

## Ocean modelling

**Dr O. Alves** (CSIRO Marine and Atmospheric Research, CAWCR)

**Dr M. Baird** (UNSW)

**Dr G. Brassington** (CSIRO Marine and Atmospheric Research, CAWCR)

**Dr D. Griffin** (CSIRO Marine and Atmospheric Research, CMAR)

**Dr A. Hogg** (ANU)

**Dr A. Maharaj** (Macquarie University)

**Prof. D. Marshall** (Oxford)

**Prof. J. Middleton** (SIMS-UNSW)

**Dr P. Oke** (CSIRO Marine and Atmospheric Research, CMAR)

**Dr M. Roughan** (SIMS-UNSW)

**Assoc. Prof. I. Suthers** (SIMS-UNSW)

**Dr S. Williams** (USIMS-U.Syd)

## Current Research

### Dr Andrew Kiss

#### Nonlinear dynamics of ocean currents

##### Dr Andrew Kiss

Computer models of ocean circulation typically feature western boundary currents (WBCs, such as the Gulf Stream and East Australian Current) which separate much further downstream than in reality, producing large errors in ocean/atmosphere heat fluxes and therefore in water properties. Attempts to rectify this problem have been hampered by a lack of theoretical understanding of the dynamics responsible for separation. I am using high-resolution ocean models to investigate whether the separation mechanism I discovered in idealised models (Kiss, 2002) also applies in a more realistic setting. A related aspect of this work also involves collaboration with Dr M. Roughan and H. McDonald (UNSW). The insights gained from this research may lead to improved accuracy in ocean and climate models.

I am also studying the extent to which variability in realistic WBCs is determined by wind forcing, internal instabilities, or nonlinear interactions between the two, following on from previous work with idealised models (Kiss, 2007). This may provide insights into the origins of the pronounced variability seen in the East Australian Current.

## Ensemble methods in ocean modeling

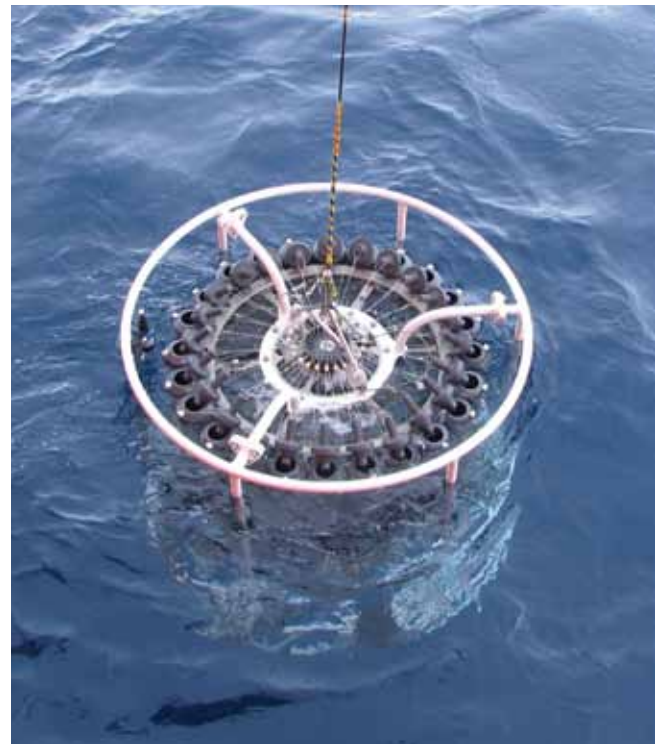
**Dr Andrew Kiss** collaborative project with PhD student **Robert Woodham**, Dr Gary Brassington and Dr Oscar Alves

The BlueLink ocean forecasting system has recently become operational, providing three-dimensional forecasts of ocean currents and temperature analogous to those produced by numerical weather forecasting. Robert's PhD project is an investigation of the growth of forecast errors in the SHOC and OFAM components of the BlueLink system. Model sensitivity is being characterized by constructing ensembles of runs whose initial conditions are perturbed by simulated errors consistent with observational uncertainties, and using the divergent evolution of these runs to better understand the processes that limit the accuracy of long-term ocean forecasts. Error growth in OFAM has also been investigated and compared with persistence forecasts and climatology.

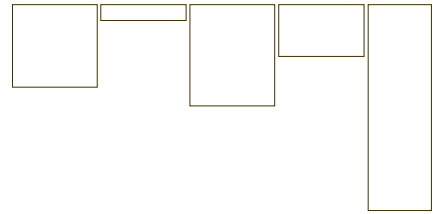
## Exploring hydrography and fluorescence in the EAC, its eddy field and in the Tasman Front

### Dr Andrew Kiss

I am an investigator in an Integrated Marine Observing System autonomous gliders project "Exploring hydrography and fluorescence in the EAC, its eddy field and in the Tasman Front" for deployments of the Slocum Glider and Sea Glider in the Tasman Sea. Other investigators include: I. Suthers (SIMS-UNSW); M. Baird (UNSW); D. Griffin (CMAR); M. Roughan (SIMS-UNSW); A. Maharaj (Macquarie U); R. Robertson (ADFA-UNSW); P. Oke (CMAR); J. Middleton (SIMS-UNSW); S. Williams (SIMS-U.Syd). This project has a budget of about \$1.3 million over 18 months (mostly ship time and in-kind salary).



A CTD being lowered into the water. A rosette of gray Niskin bottles is visible inside white frame.



# Physical Oceanography



Dr Robin Robertson standing on sea ice near the Thwaites Ice Tongue with RVIB Nathaniel B. Palmer in the background.

## Dr Robin Robertson

In general, Dr Robin Robertson investigates tides and their effects on circulation and mixing. She is particularly interested in internal tides and waves, which are tides or waves occurring below the surface of the ocean at density layers within the ocean. Most of her research involves numerical modeling using the Regional Ocean Model System (ROMS). However, she tries to participate in at least one research cruise every other year in order to stay in touch with the real world and to gain access to observational data for realistic simulations and model performance evaluation.

### Internal Tides and Mixing in the Antarctic Seas

#### Dr Robin Robertson

Internal tides and the mixing they generate play a major role in climate in the Antarctic Seas, influencing sea ice, melting of the ice shelves, the heat flux from the ocean to the atmosphere, bottom water formation, etc. These factors affect the global thermohaline circulation and global climate. Dr Robin Robertson has been investigating tides, tidal currents, and tidal impacts for several Antarctic Seas: the Weddell, Ross, and Amundsen Seas. She is collaborating with Drs Craig Stevens and Mike Williams of National Institute for Water and Atmospheric Research in New Zealand for the Ross Sea and McMurdo Sound and they have recently received a Marsden Grant for this work. She went to the Pine Island Glacier, Amundsen Sea in Antarctica in 2009 with Stan Jacobs of Lamont-

Doherty Earth Observatory of Columbia University to observe the changes in the Amundsen Sea associated with the rapid melting of the Pine Island Glacier. She is modeling the tidal circulation under the Pine Island Glacier and in the Amundsen Sea with honours student Scott Baxter and this work is being continued by PhD student Darrell Terry. The effects of tides on sea ice are being investigated with Dr Petra Heil of the Australian Antarctic Division.

### Internal Tides and Mixing in the Indonesian Seas

#### Dr Robin Robertson

The Indonesian Seas are the only low-latitude connection between the Pacific and Indian Oceans and the surface return flow of the global thermohaline circulation. As Pacific waters pass through the Indonesian Seas, they are mixed by the "Indonesian Mixmaster". Tides have been observed to be one of the primary mixing mechanisms. Dr Robin Robertson has simulated the internal tides for the Indonesian Seas. The model results replicated the sparse observations in the region and filled in the picture of tidal fields between the observations. This work is continuing in collaboration with Drs Susan Wijffels and Andreas Schiller of CSIRO and Dr Janet Sprintall of Scripps Institute of Oceanography with the goal of including the mean currents in the simulations with the tides and determining an algorithm to include tidal mixing into larger scale models such as Bluelink or the global climate models.

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## Internal Tides and Mixing off Eastern Australia

### Dr Robin Robertson

The Eastern Australian Current (EAC) interacts with the chain of seamounts, including Taupo, causing upwelling and mixing. Prof. Jason Middleton and Dr Moniya Roughan of UNSW and Dr John Wilkins of Rutgers are investigating the interactions of the EAC with the seamounts. Dr Robin Robertson is simulating the interactions of the internal tides with the seamounts, focusing on tidal effects. She is also participating in research cruise with Drs Middleton and Roughan to investigate mixing around the seamounts on Lord Howe Rise off Eastern Australia.

## Vertical Mixing in Ocean Models

### Dr Robin Robertson

Before accepting the model results for mixing, Dr Robin Robertson has investigated the performance of nine different vertical mixing parameterizations in the Regional Ocean Model System (ROMS). The goal was to identify differences in performance and select the best performer for subsequent model simulations. As part of his PhD work, Darrell Terry expanded this work as his introduction to modelling with ROMS.

### Dr Hua Wang

## Oceanic nepheloid layers and their role in coastal oceanography

### Dr Hua Wang

Nepheloid layers in the oceans, formed through sediment resuspension events by waves and currents on the continental shelf, 'shut down' the bottom boundary layer processes and reduce mixing and hence transport of sediments and other materials. This project will develop and implement new numerical models to investigate the dynamic features of such layers including their highly nonlinear behaviours of resuspension hysteresis. The impact of such layers in determining coastal ocean and ecosystem dynamics and in transporting sediments from the rivers into the outer shelves of the marginal seas will be investigated. This project covers the coastal oceans such as Jervis Bay, NSW, the Adriatic Sea, Italy, the southwestern coast of Korea and East China and Yellow Seas. The outcome of the project will result in new knowledge on the roles that resuspended sediments played in flow dynamics and the primary biomass production in the turbid coastal ecosystem environments.

## IMOS (Integrated Marine Observing System) NSW node – Jervis Bay mooring

### Dr Hua Wang

UNSW@ADFA researchers have investigated the oceanography of Jervis Bay and its adjacent shelf since 1988 spurred by the interest of Defence. In this proposal, we aim to construct and deploy a pair of moorings at a site off Jervis Bay to extend this data set. The primary purposes of the moorings are to provide real-time observational capability and obtain longer records to be used for on-going oceanographic and climate studies at UNSW@ADFA. All observations will be incorporated into IMOS (Integrated Marine Observing System) and BlueNet. Our mooring complements NSW-IMOS' planned observational infrastructure.

## Coastal environment management - Comparative study of marine protected areas in Australian and China

### Dr Hua Wang

The project aims to compare the legislative frameworks, management characteristics and impact of the ecosystems of the marine protected areas in Australia and in China. It is widely known that China has a growing interest in developing marine protected areas and management plans in its coastal zones whilst Australia has a well developed integrated coastal management system. This study will be a comparative analysis of the advantages and disadvantages of coastal environmental management systems in two countries. It is hoped that the present work can assist and enhance management of the marine protected areas both in Australia and in China.

## Managing Australian Defence Force activities in marine protected areas - The environmental management of Jervis Bay and Shoalwater Bay Training Areas

### Dr Hua Wang

This project aims to study coastal management issues of Australia Defence Force (ADF) activities in Australian Marine Protected Areas, by analysing the Environmental Management Systems of Jervis Bay and Shoalwater Bay training areas. The research has important significance to the sustainable development of ADF training activities, ecology, environment, economy and society. At the completion of this project, we hope to provide experiences and lessons learnt from managing these two training areas in an environmentally sustainable manner; and to assist management of ADF training activities in other regions.

## Student Research

### An operational circulation and ecology forecast system for Jervis Bay, NSW

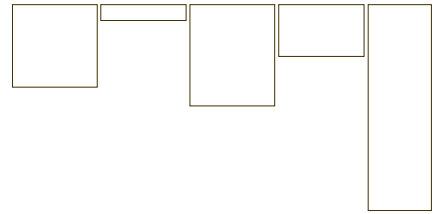
**Donghui Jiang** (d.jiang@student.adfa.edu.au) PhD

#### Field of Study: Oceanography

In recent years, Jervis Bay, NSW, has increasingly been used by the RAN and DSTO as a trials area for equipment testing (e.g. Unmanned Autonomous Underwater Vehicles with US Navy). In evaluation of the results of these trials, it became apparent that supporting environmental data for the bay was not available, or was insufficient for the trials. Furthermore, there exists very few 3-dimensional circulation modelling studies for the region. An exception is the study by Wang and Symonds (1999) that has a specific research interest of winter surface cooling.

This project aims:

- To develop a Jervis Bay ecosystem database of relevant environmental parameters encompassing the planned measurements and historical data.
- To develop a high resolution 3-dimensional hydrodynamic Jervis Bay circulation model coupled with a sediment and an ecosystem model.
- To calibrate/validate Jervis Bay circulation and ecosystem model with in-situ measurements.



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Development of an environmental database together with operational circulation and ecology forecast models for Jervis Bay will enable more robust estimations of performance of technically complex developmental and Commercial Off The Shelf (COTS) systems.



From 27-29 July 2009, Donghui Jiang and Colin Symons conducted a field trip to Jervis Bay for deploying the PEMS new ADCP (Acoustic Doppler Current Profiler) and SBE 39 (Sea-Bird Electronics) Temperature Recorder at the site (S 35 04.600' E 150 50.868') in 70 m water depth off Jervis Bay. This is the UNSW@ADFA Ocean Reference Station in Jervis Bay and IMOS (Integrated Marine Observing System) NSW node-Jervis Bay mooring which has been maintained by Hua Wang (UNSW@ADFA).

## Application of the ISO 14031 Environmental Performance Evaluation to the Australian Defence Force Environmental Management System

Wen Wu (w.wu@student.adfa.edu.au) PhD

Field of Study: Oceanography

Environmental management of military activities is of growing global concern by defence forces. As one of the largest landholders in Australia, the Australian Defence Force (ADF) is increasingly concerned with sustainable environmental management. Environmental management tools are employed to manage environmental performance, and the Environmental Management System (EMS) is used widely by the ADF. This project focuses on the Shoalwater Bay Training Area (SWBTA) as a research example to examine environmental management activities by the ADF. SWBTA is one of the most significant military training areas in Australia. With its maritime part within the Great Barrier Reef Marine Park (GBRMP) and the Great Barrier Reef World Heritage Area (GBRWHA), and abutting Queensland's State Marine Parks, it is an important region with high environmental, ecological and heritage values. Therefore, it is difficult and complex to manage Defence activities in such an environmentally sensitive Marine Protected Area.

On the basis of reviewing the Environmental Management System (EMS), this project will focus on how the ADF EMS operates during military training, and how effective the Defence EMS is in minimizing environmental impacts and improving environmental performance in SWBTA. To sufficiently measure the Defence EMS effectiveness, the study will use the ISO 14031 Environmental Performance Evaluation (EPE) to develop a systematic environmental performance indicator framework by selecting a suite of environmental performance indicators (EPIs) specific to SWBTA. This framework will combine the EMS and the EPE through the EPIs. It can be used for identifying gaps between the ISO 14001 requirements and the Defence EMS steps, evaluating the ADF environmental performance, and examining whether the EMS is effective. This study will further the knowledge of Defence environmental management practice, especially in a marine environment. It is expected to form systematic evaluation outcomes on SWBTA and provide stakeholders and environmental managers with references on day- to-day environmental management activities in this area, and other military sites in the future.

## Coastal mud dynamics and their ecological-socio-economic impact

Li Li (li.li@student.adfa.edu.au) PhD

Field of Study: Oceanography

Over the past 50 years both the large river catchments and coasts have been greatly modified by extensive human activities including dams and irrigation, land reclamation, and port construction. These rapid developments have altered both the flux of terrestrial materials to the sea, and their transport processes in the coastal ocean, resulting in distinct physical, chemical, and biological responses in the marine environment in the coastal oceans. Huanghe (Yellow River), Changjiang (Yangtze River) in China and Burdekin and Fitzroy Rivers in Queensland have been illustrative examples of such modifications, and the environmental issues have presented challenges to the social and economical development. This project aims: (1) to model sediment dynamics of muddy coasts and estuaries; (2) to examine the role of estuarine and coastal mud in preventing toxic/non-toxic algae blooms and sequestering nutrients and pollutants in turbid estuaries and coastal waters; and (3) to evaluate its socio-economic impact.

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Sea ice in the Amundsen Sea.

## Effects of ice shelf melting on Southern Ocean water formation

**Darrell Terry** (d.terry@student.adfa.edu.au) PhD (started Session 2 2009)

### Field of Study: Oceanography

One of the big unknowns in climate change is Antarctic ice shelf stability. The latest International Panel on Climate Change (IPCC) report projects a ~0.5 m sea level rise by 2099. However contributions of melting Antarctic ice were excluded, since they are poorly understood. Collapse of the ice shelves could increase sea level by 1-7 m, with the Amundsen Sea ice shelves alone contributing 1.5 m. Consequently, there is a growing contingent of scientists who believe that the IPCC report underestimates sea level rise by a factor of 2 or more. Due to the large quantity of freshwater tied up in Antarctic ice, rapid deglaciation resulting from ice shelf collapse not only increases sea level, but also freshens the waters of the Antarctic seas and Southern Ocean. This freshening impacts the thermohaline circulation, which in turn affects global climate and influences weather patterns. The Amundsen Sea ice shelves are melting rapidly, roughly 100 times faster than others in the Antarctic. Their rapid melting is believed to be driven by the ocean, with tides a primary mechanism for injecting warm water into the cavity under the ice shelves and inducing turbulent mixing through internal waves. Turbulent mixing influences both the melt rate and the spread of the resultant fresher water. The Circumpolar Deep Water (CDW), which supplies the heat for this process, has been observed

to be warming in recent decades. As the CDW warms, melting and mixing will accelerate.

This project will simulate the dynamics of ocean circulation in the Amundsen Sea using ROMS (Regional Ocean Model System), a well-developed ocean model. The primary goal is to determine amount of heat transferred from the ocean into the ice shelf and the associated melting both for present conditions and for warming CDW. The resulting changes in the salinity and temperature over the continental shelf will also be evaluated. The Amundsen Sea has been chosen as a study site, not only due to its rapid melting, but also due to the observational data available from a recent research expedition that Dr Robertson participated in. This data along with Quikscat satellite data will be used for model verification. The work in the Amundsen Sea extends a present honours student's project. It is applicable to other Antarctic Seas, such as the Ross Sea, which is being investigated in collaboration with Mike Williams of NIWA (National Institute for Water and Atmospheric Research) in New Zealand. Dr Robertson is currently collaborating with NIWA providing modeling expertise and results and they provide observational data in return. The outcomes of this project will not only provide estimates of the heat fluxes into the ice shelves in the Amundsen Seas, but also a systematic way of evaluating the ocean's contribution to ice shelf melting. This is a key step in addressing the "poorly understood" ice shelf processes for future IPCC evaluations of climate change.

## Ensemble methods in oceanic modelling

**Robert Woodham** (Robert.Woodham@defence.gov.au) PhD

### Field of Study: Ocean modelling

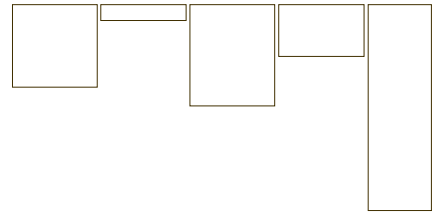
This research project seeks to investigate the predictability of oceanic models, using a limited area model of the ocean, as well as ocean observational and forecast data from the BLUElink ocean forecasting system. The limited area model has been used to investigate a domain in the vicinity of Perth, and error growth in this domain has been studied by perturbing sea surface temperatures (SST), using Empirical Orthogonal Functions (EOFs). This enables the Jacobian matrix to be approximated with a relatively small number of model runs, and the most significant error patterns to be identified. More recently, data from the BLUElink system has been used to compute the average error growths, for a domain in the Tasman Sea, of three forecasting strategies: persistence, climatology and deterministic forecasts. This study indicates that SST is less predictable than Sea Surface Height (SSH), but surprisingly, the BLUElink system seems better able to predict SST than SSH. The latency of assimilated observations is identified as a major source of error in the deterministic forecasts. Furthermore, predictability is found to be highly flow-dependent, making the a priori selection of forecasting strategy problematic.

## Estimate the social economic benefits of ocean observing system

**Fan Zhang** (f.zhang@student.adfa.edu.au) PhD

### Field of Study: Oceanography

The aim of my research are first to explore the relationship between NSW ocean observing system and potential benefit related sectors, then evaluate the social economic benefits that different users and public agencies could get from the information provided by NSW ocean observing system, and finally conduct the cost benefit analysis of NSW ocean observing system. For the beneficiaries analysis, I will focus on three related sectors: commercial fishery, tourism and natural hazard prediction.



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## Modelling dynamics of the East Australian Current and the subtropical mode water off the east coast of Australia

**Vihang Bhatt** (v.bhatt@student.adfa.edu.au) PhD

**Field of Study: Oceanography**

The East Australian Current (EAC) is the weakest and one of the most complex western boundary current. The complexity of the EAC not only generates special interest in numerical investigation of its seasonal variability under the influence of the atmospheric and oceanic forcing but also its influence on the water mass of the oceanic basin. Recent advances in the high performance computing (HPC) using parallel cluster computers have enabled oceanographers to resolve this problem up to a certain degree. Working in this direction, Commonwealth Scientific and Industrial Research Organization (CSIRO), Bureau of Meteorology (BoM) and Royal Australian Navy (RAN) setup global ocean general circulation model with special emphasis on Australian region on a parallel cluster computer under the Bluelink Reanalysis (BRAN) program. As a cross verification of BRAN data, high resolution ocean reanalysis from the OFES model (The Earth Simulator) has also been used. In this project, the high resolution data obtained from the BRAN and OFES has been used to meet the following objectives

- Investigate seasonal circulation on the East Australian Coast and the role of topographic and baroclinic forcing (JEBAR)
- Study the role of the East Australian current in heat balance in the region
- Examine the mode water formation in the East Australian coast and its seasonal and inter-annual variability
- Study model initialization errors using diagnostic and prognostic ocean model
- Investigate the role of thermohaline source and sinks in the diagnostic ocean circulation.

## Modelling of the Yellow Sea circulation and sediment transport dynamics

**Dehai Song** (dehai.song@student.adfa.edu.au) PhD

**Field of Study: Oceanography**

This project aims to develop and implement nested high-resolution models to study the inter-annual variability of the circulation and sediment transport dynamics in the Yellow and East China Sea (YECS). The circulation models will be coupled with waves and tides, and incorporate data assimilation techniques. We will explore the major processes of the Yellow and East China Sea inter-annual variability in temperature, salinity and the circulation patterns, using the state-of-the-art data analysis methods including the EOF analysis. Additionally, the remote sensing and the in-situ data will be used to calibrate/validate the numerical model results. The sediment transport model will be based on Wang (2002) and Wang and Pinardi (2002) and be coupled to the Yellow Sea Circulation Model to simulate the sediment transport dynamics of the region. A particular focus of the sediment dynamics will be on the fate of the particulate matter discharged from the major rivers such as Yellow and Yangtze Rivers and their cross-shelf transport mechanisms.

## The effects of climate change in the East Asia Monsoon Region

**Zhaosu Meng** (z.meng@student.adfa.edu.au) PhD

**Field of Study: Climate/Economics**

## PhD Opportunities and Scholarships

Potential PhD students are invited to discuss possible projects involving large-scale ocean dynamics or internal tides/waves.

All Australian 1st class Honours BSc graduates are eligible for a scholarship from ADFA.

**Contact:**

**Dr Andrew Kiss** (a.kiss@adfa.edu.au)

**Dr Robin Robertson** (r.robertson@adfa.edu.au)

**Dr Hua Wang** (h.wang@adfa.edu.au)



Pine Island Glacier (PIG). This glacier is melting the fastest in the Antarctic, 10 x faster than the others.

## Major Facilities

The school supports field based oceanographic research with a range of instruments for in-situ measurements and access to small research vessels for inshore work. There is access to the Australian National University Supercomputer Facility.

## Publications

### In Press

#### Journal - Refereed

**Ellicott, D.J. & Robertson, R.**, in press, Antarctic bathymetry compilations: Which is the most accurate?, resubmitted to *Geochemistry, Geophysics, and Geosystems (G3)*, September 2009.

Jacobs, G.A., **Woodham, R.**, Jourdan, D. & Braithwaite, J., in press, GODAE applications useful to navies throughout the world, to be published in the September 2009 issue of *Oceanography* magazine.

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**Robertson, R.**, in press, Interactions between tides and other frequencies in the Indonesian Seas, submitted to *Journal of Physical Oceanography*, July 2009.

**Robertson, R.** & Ffield, A., in press, Tidal currents and mixing at the INSTANT mooring locations, invited submission to a special issue (Indonesian throughflow and instant program), *Dynamics of Atmospheres and Oceans*, Sept 2009.

**Wen, W., Wang, X.H., Paull, P. & Kesby, J.**, in press, Defence force activities in marine protected areas: Environmental management of the Shoalwater Bay Training Area, Queensland, Australia, submitted to *Chinese Journal of Oceanography and Limnology* (in English, SCI-E), accepted subject to revision.

**Woodham, R., Kiss, A., Alves, O. & Brassington, G.**, submitted, Selecting forecast strategies for the East Australian Current, in preparation for *Deep Sea Research* Vol 2 – special edition on the East Australian Current.



Looking aft of the 2nd deck on the RVIB Nathaniel B. Palmer (also called the Natty B) at icebergs and brash ice.

## Book - Chapter

**Robertson, R.**, in press, Are the deep waters of the Weddell Sea still warming?, accepted April 2009 for Chapter 13 in *Climate Alert: Climate Change Monitoring and Strategy*, Y. You & A. Henderson-Sellers (eds), Sydney University Press, forthcoming December 2009.

You, Y., Rossby, T., Zenk, W., Gordon, A., Ilahude, A.G., Suginoara, N., Davis, R., Hu, D., Susanto, D., Richardson, P.L., Villanoy, C., Liu, C.-T., Kim, K., Molcard, R., Fukasawa, M., Pandoe, W.W., Baker, D.J., Koga, M., Qu, T., Fine, R., Gabric, A., **Robertson, R.**, Masumoto, Y. & Riser, S., in press, PACSWIN: A new international ocean climate program in the Indonesian seas and adjacent regions, accepted April 2009 for Chapter 15 in *Climate Alert: Climate Change Monitoring and Strategy*, Y. You & A. Henderson-Sellers (eds), Sydney University Press, forthcoming December 2009.

## 2009 publications

### Journal - Refereed

**Wang, X.H.**, Li, L., Bao, X. & Zhao, L., 2009, Economic cost of an algae bloom cleanup in China's 2008 Olympic sailing venue, *Eos Trans. AGU*, 90(28), 238–239, doi:10.1029/2009EO280002.

**Simmonds, F., Wang, X.H. & Lees, B.G.**, 2009, Comment on 'Marine GIS: Identification of mesoscale oceanic thermal fronts', *International Journal of Geographic Information Science*, 23(3), 369–373, doi: 10.1080/13658810701851404.

Song, D., Bao, X., **Wang, X.H.** & **Wu, W.**, 2009, The optimization algorithm for the pathfinder sea surface temperature in the East China Seas, *Ocean Science Journal*, 44(1), 11–19, doi: 10.1007/s12601-009-0002-7.

### Conference paper

**Robertson, R.**, 2009, Tidal effects on circulation and mixing in the Ombai Strait region, *9th International Conference on Southern Hemisphere Meteorology and Oceanography*, 9–13 February 2009, Melbourne, Australia. Available at: [http://www.bom.gov.au/events/9icshmo/manuscripts/M1530\\_Robertson.pdf](http://www.bom.gov.au/events/9icshmo/manuscripts/M1530_Robertson.pdf)

### Conference - Abstract

**Robertson, R.**, 2009, Tidal effects on circulation and mixing in the Ombai Strait region, *World Ocean Conference*, 12–14 May 2009, Manado, Indonesia.

**Robertson, R.**, 2009, Vertical mixing in ROMS, *ROMS/TOMS Asia-Pacific Workshop*, 31 March–2 April 2009, Sydney Institute of Marine Science, Sydney, Australia.

**Robertson, R.**, 2009, Yo-Yo and the PIG, *New Zealand Physical Oceanography Workshop*, March 2009, Wellington, New Zealand.

**Robertson, R.**, 2009, Tidal effects on circulation and mixing in the Ombai Strait region, *9th International Conference on Southern Hemisphere Meteorology and Oceanography*, 9–13 February 2009, Melbourne, Australia.

**Wen, W., Wang, X. H., Kesby J. & Paull, D.**, 2009, Australian Defence Force activities in marine protected areas: Environmental management of Shoalwater Bay Training Area, *Australian Marine Sciences Association 46th Annual Conference*, Adelaide, 5–9 July 2009, *AMSA 2009: Program and Abstract Handbook*, p. 247, Australian Marine Sciences Association, Kilkivan, Qld. ISBN: 9780958718530.

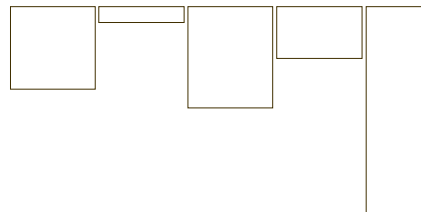
## 2008 publications

### Journal - Refereed

Ffield, A. & **Robertson, R.A.**, 2008, Temperature finestructure in the Indonesian Seas, *Journal of Geophysical Research*, 113, C09009–1–C09009–19, doi: 10.1029/2006JC003864.

Qiao, L., Bao, X., Wu, DL. & **Wang, X.H.**, 2008, Numerical study of generation of the tidal shear front off the Yellow River mouth, *Continental Shelf Research*, 28(14), 1782–1790, doi:10.1016/j.csr.2008.04.007.

**Robertson, R.A.** & Ffield, A., 2008, Baroclinic tides in the Indonesian Seas: Tidal fields and comparisons to observations, *Journal of Geophysical Research: Oceans*, 113(C7), 7031, doi:10.1029/2007JC004677.



# Physical Oceanography

Zhao, L., Zhang, Y., **Wang, X.H.** & **Lees, B.G.**, 2008, Lesson from Australian marine parks for promoting the income of our fisher folk, *Fisheries Economy Research*, 2, 51-55, in Chinese.

Zhao, L., **Wang, X.H.** & **Lees, B.G.**, 2008, Managing Australian defence force activities in marine protected areas: Using Jervis Bay as a case study, *Ocean Economics Review of China*, 2(1), 45-58.

## Journal - Non refereed

You, Y., Rossby, T., Zenk, W., Gordon, A., Ilahude, A.G., Suginojara, N., Davis, R., Hu, D., Susanto, D. Richardson, P.L., Villanoy, C., Liu, C.-T., Kim, K., Molcard, R., Fukasawa, M., Pandoe, W.W., Baker, D.J., Koga, M., Qu, T., Fine, R., Gabric, A., **Robertson, R.**, Masumoto, Y. & Riser, S., 2008, PACSWIN: A new international ocean climate program in the Indonesian seas and adjacent regions, *CLIVAR Exchanges*, 13(2), 30-31.

## Conference – Abstract

**Robertson, R.**, 2008, The Indonesian “Mixmaster”, tides, and climate, *Climate Change Monitoring and Strategy Workshop*, 12 December 2008, Sydney University, Sydney Australia.

**Robertson, R.**, 2008, Are the deep waters of the Weddell Sea still warming?, *Climate Change Monitoring and Strategy Workshop*, 12 December 2008, Sydney University, Sydney Australia.

**Robertson, R.**, 2008, Baroclinic tides in the Indonesian Seas, *INSTANT Meeting*, 28-30 May 2008, Palisades, NY, USA.

## Grants

### External Grants

**A. E. Kiss** (principal investigator), Nonlinear dynamics of ocean currents, Australian Partnership for Advanced Computing Merit Allocation Scheme competitive grant n68, allocated 20,000 supercomputer CPU hours for 2008 (nominal value \$10,000) and 13,000 CPU hours for 2009 (nominal value \$6,500).

**R. Robertson**, Tidal effects on the ice concentration and lead fraction over the continental shelf and slope off Wilkes Land, Australian Antarctic Division, 2007-2009: \$4,800.

**H. Wang**, Thermistor string mooring in Jervis Bay, CSIRO/IMOS, 2009: \$44,561.

**H. Wang**, Enhancement of an Ocean Reference Station off Jervis Bay, NSW, Sydney Institute of Marine Science, 2008-2010: \$29,340.

**H. Wang**, Jervis Bay ocean forecast and management system, DSTO, 2008: \$36,000.

**H. Wang**, Scientific visit to Korea, Australian Academy of Science, 2008: \$3,000.

### UNSW Grant

**R. Robertson** & H. Sidhu, Melting of Antarctic ice shelves by ocean processes: Will tides and warming deep waters cause sea level rise to double?, UNSW@ADFA RTS Scholarship, 2009.

**H. Wang**, UNSW@ADFA DSARC Scholarship, 2008-2010: \$21,207 p.a.

## Conference/Seminar/Workshop Participation

### Dr Andrew Kiss

- EAC Separation, short presentation at NSW-IMOS Community Meeting, 5th August 2008, Sydney Institute for Marine Science.
- Western boundary current dynamics, short seminar for ACT-AMOS, 15 September 2008, ANU.
- Western boundary current separation dynamics, *9th International Conference on Southern Hemisphere Meteorology and Oceanography*, February 2009, Melbourne.
- The role of the cyclonic sublayer in western boundary current separation, 9 June 2009, seminar at RSES, ANU.

### Dr Robin Robertson

- Tidal effects on circulation and mixing in the Ombai Strait region, *World Ocean Conference*, 12-14 May 2009, Manado, Indonesia.
- Amundsen Ice Shelf collapse: Is it likely to affect Australia?, Faculty Research Seminar, UNSW@ADFA, 8 April 2008.
- Vertical mixing from ROMS, *ROMS/TOMS Asia-Pacific Workshop*, 31 March-2 April 2009, Sydney, Australia.
- Tidal effects on circulation and mixing in the Ombai Strait region, *9th International Conference on Southern Hemisphere Meteorology and Oceanography*, 9-13 February 2009, Melbourne, Australia.
- The Indonesian “Mixmaster”, tides, and climate, *Climate Change Monitoring and Strategy Workshop*, 12 December 2008, Sydney University, Sydney, Australia.
- Are the deep waters of the Weddell Sea still warming?, *Climate Change Monitoring and Strategy Workshop*, 12 December 2008, Sydney University, Sydney, Australia.
- Baroclinic tides in the Indonesian Seas, *INSTANT Meeting*, 28-30 May 2008, Palisades, NY, USA.
- Local and surface intensification of tidal currents and mixing in the Indonesian Seas, *AGU Ocean Sciences Meeting*, 24-29 February 2008, Orlando, FL, USA.
- Tides in the Amundsen Sea and under its ice shelf, *Australian Meteorological and Oceanographic Society (AMOS) Meeting*, 28 January-1 February 2008, Geelong, Victoria, Australia.

### Dr Hua Wang

- **Wang, X.H.** (Invited paper), Sediment transport modeling, Session Chair, *3rd Italy-China DESTINY Workshop*, 27 February-1 March 2009, Beijing, China.
- **Wang, X.H.** (Invited paper), A three-dimensional, wave-current coupled, sediment transport model for POM, *International Workshop on Modeling the Ocean: Dynamics, Syntheses and Predictions*, 23-26 February 2009, Taipei, Taiwan.

# Physical Oceanography

- Qiao, L., Wu, D.X., Bao X.W. & **Wang, X.H.**, Circulation and sediment transport due to winter storms in the Bohai Sea and Yellow Sea, *International Workshop on Modeling the Ocean: Dynamics, Syntheses and Predictions*, 23-26 February 2009, Taipei, Taiwan.
- Song, D.H., Bao, X.W. **Wang, X.H.** & Wu, W., A study on the tides in Qingzhou Bay based on FVCOM, *International Workshop on Modeling the Ocean: Dynamics, Syntheses and Predictions*, 23-26 February 2009, Taipei, Taiwan.
- Bhatt, V., **Wang X.H.** & Morrison, J. Seasonal variability of the East Australian Current: The role of JEBAR. *International Workshop on Modeling the Ocean: Dynamics, Syntheses and Predictions*, 23-26 February 2009, Taipei, Taiwan.

**Robert Woodham** attended a workshop on ensemble prediction and data assimilation, at the Bureau of Meteorology, in February 2009.

**Fan Zhang** attended the *NSW-IMOS Community Meeting* on both 10 November 2008 and on 30 April 2009.

## Service

### Dr Andrew Kiss

- Australian Meteorological and Oceanographic Society (ACT committee member since 2005).
- Member of Organising Committee for the 2010 Australian Meteorological and Oceanographic Society National Conference.

### Dr Robin Robertson

- National Treasurer for Australian Meteorological and Oceanographic Society (AMOS).
- ACT Council member for AMOS since 2007.

### Dr Hua Wang

- Member of Executive Committee of the Academic Board 2008-present.
- Coordinator for Ocean University of China CSC Scholarship students.

## Visitors

**Associate Professor Adam Sobel** of Columbia University in the City of New York, visited **Robin Robertson** of PEMS in June 2008 and presented a seminar on the Indian Ocean Dipole.

**Dr Houije Wang**, Associate Professor in Marine Geosciences, Ocean University of China, Qingdao visited PEMS as a Rector Funded Visiting Fellow from 20 July 2008-21 October 2008. During this time he collaborated with **Hua Wang** on intertidal variability in sediment transport in the Huanghe River (Yellow River) estuary.

**Qun Liang** an engineer from Guangxi Oceanic Administration, Nanning, China, specializing in marine protected area and integrated coastal management systems visited PEMS as a Visiting Fellow from 9 March 2008-8 March 2009. He worked with **Hua Wang** on a project entitled 'A comparative study of the marine protected areas in Australia and China'. Qun Liang has participated and organized several marine environment management protection projects funded by various funding agencies in China. Qun Liang was supported by the China Guangxi Province Overseas Visiting Fellowship Scheme.

[Emperor Penguins, Antarctica, January 2009.](#)

