annual report

2005-06

Antarctic Climate & Ecosystems
COOPERATIVE RESEARCH CENTRE

Established and supported under the Australian Government's Cooperative Research Centre Programme

The Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC) provides a focus for Australia's national effort to understand the variability of Antarctica and the Southern Ocean and their role in Australia's future. The ACE CRC is a partnership dedicated to sustainable management of Antarctic marine ecosystems and the study of atmospheric and oceanic processes of the Southern Ocean and their role in global and regional climate change.

vision

The ACE CRC will serve as the keystone of the national effort to deliver environmental, economic and social value from Australian engagement in the Southern Ocean and Antarctic region. The ACE CRC will:

- Advance Australia's aspirations for its Antarctic territory and Southern Ocean exclusive economic zones.
- Increase international engagement in Southern Ocean and Antarctic research relevant to Australia's interests.
- Deliver strategic science for climate adaptation, ecosystem management, carbon budgeting, and marine and ice operations.
- Deliver the knowledge and information needed by our diverse research users and ensure that policy and commercial opportunities are realised.
- Produce expertly-trained scientists with international experience, skills in research, its broad application, and its role in enterprise.

mission

ACE CRC research will:

- Provide a factual base for the sustainable management of Antarctic and Southern Ocean fisheries and ecosystems in line with Australia's obligations under the Convention on the Conservation of Antarctic Marine Living Resources (CAMLR).
- Provide estimates of the ability of the Southern Ocean to act as a carbon sink, including the efficacy and risks of iron fertilization to enhance CO_2 uptake, thereby increasing Australia's influence in international climate negotiations.
- Deliver systems for operational prediction of Southern Ocean currents and sea ice conditions for use in Antarctic operations, ranging from shipping to fisheries management to tourism.
- Contribute key observations and insights on the role of the Southern Ocean and Antarctica in climate in order to produce more reliable projections of variability and change, allowing Australia to benefit from opportunities and minimise risks.
- Increase the reliability of projections of sea level rise for Australia and neighbouring nations for use in coastal zone management and other risk assessments.

Antarctic Climate & Ecosystems
COOPERATIVE RESEARCH CENTRE

annual report 2005-06

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executive summary

Research by the ACE CRC and its partners in 2005-06 continued to produce some surprising and exciting results that are altering our understanding of global climate systems and the mechanisms by which they are likely to change. Oceanographic surveys of the Southern Ocean revealed widespread and rapid changes in bottom water properties to the south of Australia and in the Indian Ocean. These changes are larger and have occurred more quickly than expected and indicate that global ocean circulation can change more rapidly than thought previously.

Researchers in the ACE CRC **Sea-level Rise Program** discovered two particularly important features of sea-level dynamics that are changing the way we consider the implications of climate change for sea levels and coastal impacts. First, our researchers found that the rate at which sea level has been rising over the last 150 years or so, after a long period of stasis, is accelerating. This discovery will significantly change projections of future sea level. Second, we were able to demonstrate that volcanic eruptions have significant 'damping' effects on sea-level rise and we need to take those effects into account when estimating sea-level rise to avoid under-estimating the likely changes over medium to long term timescales.

The global carbon cycle is central to the discussion of climate change because much of the anthropogenic impact on climate is via carbon emissions and their inputs to the atmospheric component of the global carbon budget. The Southern Ocean plays a particularly important role in buffering the accumulation of carbon in the atmosphere through uptake of carbon dioxide into the global oceans. Work in our **Ocean Control of Carbon Dioxide Program** in the last year made significant inroads into resolving some of the key limitations on that buffering capacity and understanding how natural variations in some limiting factors, such as the availability of dissolved iron to oceanic plants, alter the ocean draw-down of carbon from the atmosphere.

Linking physical environmental research and biological or ecological research explicitly often proves difficult because of significant disciplinary differences in the methods of research. One of our important internal achievements in 2005

was the realisation of explicit links among our biological, physical and chemical research from field operations right through to analyses and publication. In particular, we completed one of our major research voyages in which we related a range of biological observations, covering plants and animals from microscopic plankton to krill and right up to seabirds and whales, to data on physical oceanography over more than 50 degrees of longitude from around the Antarctic margin and up in to the Southern Ocean. This work will provide major insights into the factors that regulate krill populations and the animals that depend on them off East Antarctica, as well as providing important oceanographic information from a part of the world that is key to the world's ocean circulation.

The ACE CRC **Policy Program** hosted another successful forum in Canberra that brought together researchers from our science programs and staff from 17 government departments and agencies to discuss the latest results of our research and how to make best use of them in the formulation of national policies on a wide range of climate and ocean related issues. This forum was focused on linking the work we do in and around Antarctica and the Southern Ocean with our understanding of modern climate change and its impacts around the Australian coast and in the tropical Pacific. Many people don't realise that our knowledge of climate change and its impacts is built on research done in the far South. Part of our purpose in the ACE CRC research and policy fora is to clarify those links and improve understanding of their importance to Australia and globally.

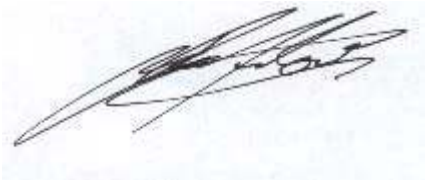
Delivering national benefit from research is a key platform of the CRC Programme. The ACE CRC's Commercialisation & Utilisation Plan (C&UP), that detailed just how this CRC would do so, received formal approval from DEST at

executive summary

the end of August 2005 – without revision and with commendation. This was a particularly pleasing result given that our approach to the commercialisation objectives of the CRC Programme was couched explicitly in the context of this CRC's prominent obligations to deliver research outputs to the public domain, both nationally and internationally. We see commercialisation as an important supplement to our public domain activities through which important innovations arising from our research activities can be given exposure to commercial development as and when appropriate. To this end, we have embarked on specific strategies to identify such innovations within the centre, assess them for commercial potential, reconcile clearly partner and centre intellectual property issues and effect formal decisions to deliver maximum benefit from our innovations, whether through delivery to our partners, disclosure in the public domain or development for market. We continued our commercialisation education and training throughout 2005-06 to ensure that our graduate students and staff are commercially aware and well equipped to mange the nexus between their primary research skills and their obligations to facilitate appropriate commercialisation opportunities.

We have also used the development of our C&UP as a catalyst to resolve better strategies for delivery of our research outputs to end users beyond the research community. In coming years, we will be implementing a series of formal delivery projects that will be run as formal projects dealing with specific research products, focused on understanding the needs and expectations of users for those products and working with those users and our researchers to effect specific paths to adoption that will provide effective delivery. In the first instance, we will be targeting delivery of information about the impacts of sea-level rise and extreme events on coastal communities, a sea ice forecasting system to improve shipping safety around Antarctica, and analyses of the economic value of reduced uncertainty about climate change through the provision of better informed planning and development options. We are, of course, also delivering our research outputs through established processes, with our staff producing over 80 refereed publications and delivering more than 175 conference presentations in 2005-06 and several of our staff having significant input to the Intergovernmental Panel on Climate Change 4th Assessment Report, due for release early in 2007.

The 2005-06 year has been another very productive one for the ACE CRC. The achievements noted above are just a few of those to be found in the following pages that signal the importance of the research done through this centre and its partners. As our centre patron, Professor Sir Guy Green, noted at the 2006 CRC Association Conference in Brisbane: 'While the research done by environment CRCs such as the ACE CRC may take longer to come to fruition and its outcomes may be less easy to predict than that of some other CRCs, it is also the sort of research which is likely to create a great deal of genuinely new knowledge which will eventually lead to substantial and enduring economic benefits both for particular industries and for the entire community.'



Bruce Mapstone

Chief Executive Officer
ACE CRC

The ACE CRC was successful in its bid as a new from existing CRC in the 2002 round of CRC funding, its predecessor being the Antarctic and Southern Ocean CRC. The ACE CRC began its seven-year life on July 1, 2003 and is an unincorporated joint venture.

The University of Tasmania has been appointed as the ACE CRC agent, and contributes services for finance, human resources and asset management.

Core Partners	Supporting Partners
Australian Antarctic Division (AAD)	Alfred Wegener Institute (AWI, Germany)
Australian Bureau of Meteorology (BoM)	Australian Greenhouse Office (AGO)
CSIRO Division of Marine and Atmospheric Research (CMAR)	The Australian National University (ANU)
University of Tasmania (UTAS)	National Institute of Water and Atmospheric Research (NIWA, New Zealand)
	Silicon Graphics Inc (SGI)
	Tasmanian Department of Economic Development (DED)

Governing Board

The ACE CRC Governing Board has an independent Chair and members from the core partners and key research users. The Australian Antarctic Division holds an additional ex-officio seat in recognition of the magnitude of its contributions. The Board meets quarterly and considers ACE CRC matters out of session as required.

Board Member	Organisation	Position in Partner Organisation
Dr Katherine Woodthorpe, *Chair*	People & Innovation Corporate Advisers Pty Ltd	Director
Dr Tony Press	AAD	Director
Prof Andrew Glenn*	UTAS	Pro Vice-Chancellor (Research)
Dr Bill Downey	BoM	Deputy Director Corporate Activities
Dr Tony Haymet*	CSIRO	Director Science and Policy (Chief-on-secondment CMAR)
Mr Greg Johannes	DED	Deputy Secretary
Mr Bill Trestrail	SGI	Managing Director, Asia Pacific Region
Mr Howard Bamsey	AGO	Deputy Secretary, Department of the Environment and Heritage
Prof Michael Stoddart, *ex-officio*	AAD	Chief Scientist
Prof Bruce Mapstone, *ex-officio*	ACE CRC	Chief Executive Officer

Board Meetings 2005-06

2005: 30 August, 1 December
2006: 22 March, 30 May

**Retired from Board August 2006*

organisational structure

Executive

Governing Board Chair: Dr Katherine Woodthorpe
Chief Executive Officer: Prof Bruce Mapstone,
Deputy CEO: Assoc Prof Tom Trull (CMAR/UTAS)

Administration

Business Manager: Vicki Randell
Administration Manager: Kerrie Bidwell
Commercial Development Manager:
Christie le Goy
Communications Manager: Dr Sandra Zicus
Computer Support Officer: Ben Joseph

Research

Climate Variability and Change (CVC)

Program Leader: Dr Steve Rintoul (CMAR)
Deputy Leader: Dr Nathan Bindoff (CMAR/UTAS)

Antarctic Marine Ecosystems (AME)

Program Leader: Dr Andrew Constable (AAD)
Deputy Leader: Dr Steve Nicol (AAD)

Ocean Control of Carbon Dioxide (CO2)

Program Leader: Assoc Prof Tom Trull (CMAR/UTAS)
Deputy Leader: Dr Bronte Tilbrook (CMAR)

Sea-level Rise (SLR)

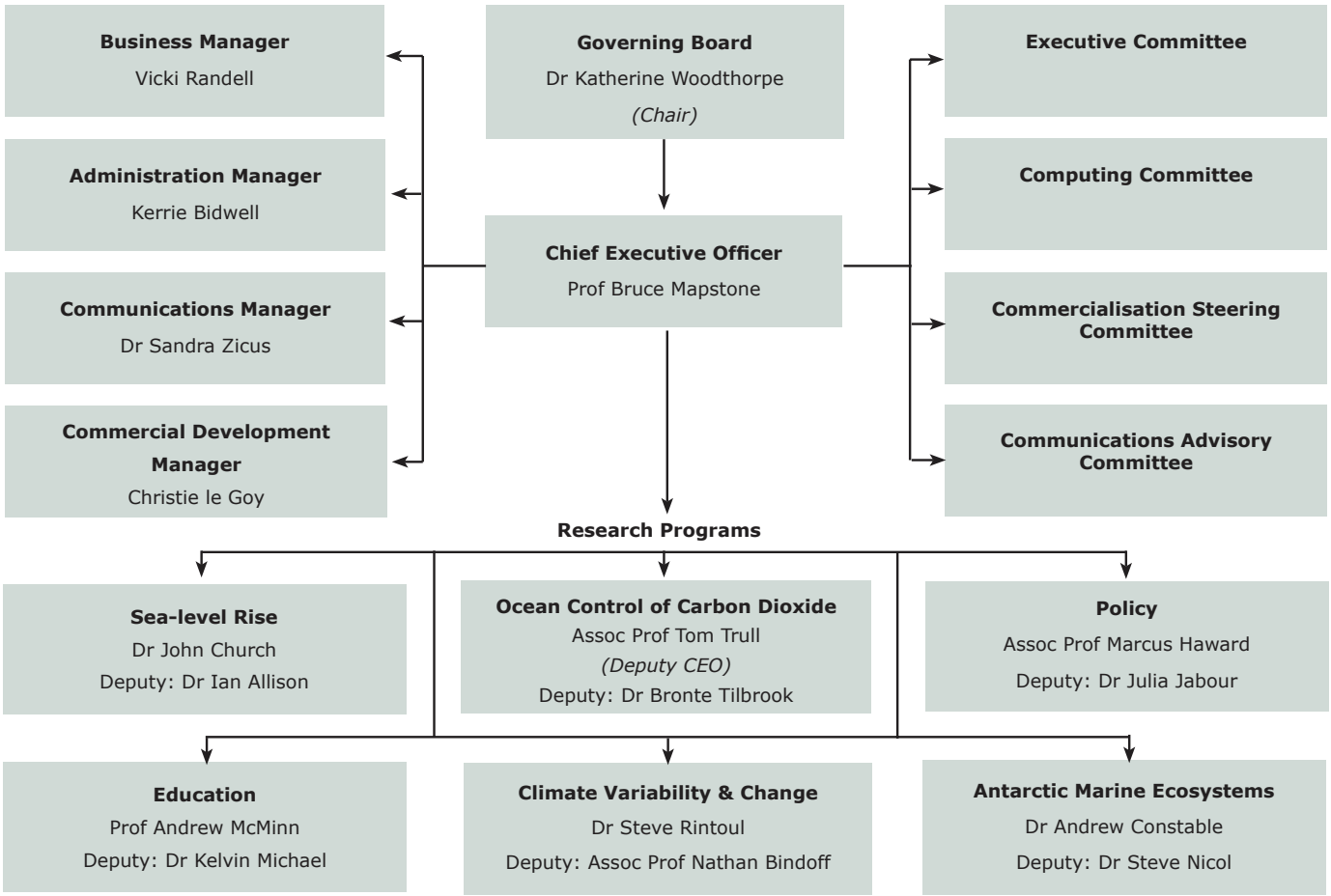
Program Leader: Dr John Church (CMAR)
Deputy Leader: Dr Ian Allison (AAD)

Policy (POL)

Program Leader: Assoc Prof Marcus Haward (UTAS)
Deputy Leader: Dr Julia Jabour (UTAS)

Education: Looking South Together (EDU)

Program Leader: Prof Andrew McMinn (UTAS)
Deputy Leader: Dr Kelvin Michael (UTAS)



The Governing Board has approved the following management committees:

Executive Committee

The ACE CRC Executive Committee advises the CEO and Board of the ACE CRC on a wide range of matters relating to the management of resources, including human resources, and coordination of research across the ACE CRC portfolio. It comprises all Program Leaders, selected deputies and ACE CRC administration, together with representatives from the Tasmanian Partnership of Advanced Computing (TPAC), the Australian Bureau of Meteorology and research student body.

Member	ACE CRC Position
Prof Bruce Mapstone (ACE CRC) *Chair*	Chief Executive Officer
Dr Ian Allison (AAD)	SLR Program Deputy Leader
Dr John Church (CMAR)	SLR Program Leader
Assoc Prof Marcus Haward (UTAS)	Policy Program Leader
Ms Christie le Goy (DED)	Commercial Development Manager
Prof Andrew McMinn (UTAS)	Education Program Leader
Dr Kelvin Michael (UTAS)	Education Program Deputy Leader
Dr Sandra Zicus (ACE CRC)	Communications Manager
Dr Andrew Constable (AAD)	AME Program Leader
Mr Michael Grose (UTAS)	PhD student
Ms Vicki Randell (ACE CRC)	Business Manager
Dr Stephen Rintoul (CMAR)	CVC Program Leader
Dr Jason Roberts (TPAC)	Chair Computing Committee
Assoc Prof Thomas Trull (CMAR/UTAS)	CO2 Program Leader/Deputy CEO
Ms Kerrie Bidwell, Secretary (ACE CRC)	Administration Manager

Executive Committee Meetings

2005: 11 August, 3 November 2006: 2 March, 30 May

Commercialisation Steering Committee

The ACE CRC Commercialisation Steering Committee provides advice on commercialisation opportunities arising from ACE CRC activities. The ACE CRC Commercialisation Steering Committee advises the CEO, Executive Committee and Board of the ACE CRC.

Member	Position
Prof Bruce Mapstone (ACE CRC) *Chair*	Chief Executive Officer
Mr Rod Allen (AAD)	General Manager, Corporate
Dr Steve Pendlebury (BoM)	Regional Director, Tasmania
Ms Jackie Zanetti (CMAR)	Business Development Manager
Ms Christie le Goy (DED)	Commercial Development Manager
Ms Wendy Spencer (DED)	Director – Innovation, Science & Technology Unit
TBA (UTAS)	No permanent appointment to date

Commercialisation Steering Committee Meetings

Throughout the year the committee members maintained contact via a number of out-of-session communications.

management

Computing Committee

The ACE CRC Computing Committee supports the science, education and policy programs of the ACE CRC through advice on information technology infrastructure and management. This support is focused primarily on those components of the ACE CRC based at the University of Tasmania's Hobart Campus. The ACE CRC Computing Committee advises the ACE CRC Executive Committee and CEO.

Member	Position
Dr Jason Roberts (TPAC) *Chair*	Researcher
Prof Bruce Mapstone (ACE CRC)	Chief Executive Officer
Assoc Prof Marcus Haward (UTAS)	Leader Policy Program
Dr Kelvin Michael (UTAS)	Deputy Leader Education Program
Mr Glenn Hyland (AAD)	Researcher
Dr Simon Marsland (ACE CRC)	Researcher
Dr Richard Matear (CMAR)	Researcher
Dr Benedicte Pasquer (ACE CRC)	Researcher
Dr Roland Warner (AAD)	Researcher
Dr Steven Phipps (TPAC)	Researcher
Mr Michael Sumner (UTAS)	PhD student
Mr John Dalton (UTAS)	Information Technology Resources
Mr Nick Grundy (UTAS) *ex-officio*	Information Technology Resources
Mr Ben Joseph (ACE CRC)	Computer Support Officer
Ms Vicki Randell (ACE CRC)	Business Manager
Ms Kerrie Bidwell (ACE CRC) *Secretary*	Administration Manager

Computing Committee Meeting

5 April 2006

Communications Coordinating Committee

The ACE CRC Communication Coordinating Committee is a network of communicators within the ACE CRC and its partner organisations. It was formed to support the implementation of the ACE CRC through the coordination of public communication and reporting strategies. Informal gatherings of a number of the Partner communications staff were held throughout the year as opportunities arose.

context & major developments

The work of the Antarctic Climate and Ecosystems CRC is centred on advancing the following National Research Priorities under the category 'An Environmentally Sustainable Australia':

Sustainable use of Australia's biodiversity

Managing and protecting Australia's terrestrial and marine biodiversity both for its own value and to develop long term use of ecosystem goods and services ranging from fisheries to ecotourism.

Responding to climate change and variability

Increasing our understanding of the impact of climate change and variability at the regional level across Australia, and addressing the consequences of these factors on the environment and on communities

The reality of climate change, its impacts and the need for action have come to the forefront of public consciousness over the past three years. End users of the ACE CRC's research in this field include decision-makers in various local, state and national government agencies, as well as the partner organisations and international scientific community.

We anticipate a continuing increase in demand for the ACE CRC's research, especially in the area of climate change impacts on sea-level rise and extreme events, to provide accurate predictions to support Australia's adaptation and mitigation strategies. We have appointed a new Policy research fellow, Dr Rosemary Sandford, to help address the question of effective delivery of research outcomes.

In addition to continuing with our core research, we have begun two new projects this year with additional support from one of our supporting partners, the Australian Greenhouse Office through its Climate Change Science Program (CCSP). Dr Tas van Ommen (CVC Program) will analyse existing ice cores to shed light on *Abrupt Climate Change and North-South Climate Connection*s. Dr Will Howard (CO2 Program) will lead analyses of existing seabed cores to investigate *Potential Effects of Increasing Anthropogenic CO_2 on Marine Plankton in the Southern Ocean* and derive inferences about prospects for ocean acidification as a result of anthropogenic greenhouse gas emissions. Both projects involve collaborations with European researchers from France and Germany (AWI).

Key Staff Appointments

The following cash funded appointments were made during the year:

Member	ACE CRC Position	ACE CRC Program
Dr Andrew Bowie	Trace Metal Marine Biogeochemist	CO2
Dr Mathieu Mongin	Biogeochemical Marine Modeller	CO2
Dr Andrew Moy	Research Fellow	CO2
Dr Benedicte Pasquer	Sea Ice Ecosystems Modeller	AME
Dr Rosemary Sandford	Policy Research Fellow	Policy
Dr Sandra Zicus	Communications Manager	Communications

Major Equipment Purchases

The following major equipment purchases were made during the year:

Equipment	ACE CRC Program
Fluorometer ($21,547.10)	AME
Sediment trap ($28,229.09)	CO2
Glass balls ($21,616.74)	CO2
Floats ($308,000.00)	CVC
Times series moorings ($100,000)	CO2
Astrolab ($20,000)	CO2

commercialisation

Program Leader

Christie le Goy, Tasmanian Department of Economic Development

Overview

The ACE CRC's Commercialisation & Utilisation Plan (C&UP) received formal approval from DEST at the end of August 2005. Our approach to the commercialisation objectives of the CRC Programme took into account the specific context of this CRC's research program:

- The development of technology is not a strategic goal of this CRC, nor of our research users. However, innovative technology is developed as part of the operational activity that underpins the CRC's research.
- The Antarctic Treaty has established a spirit of cooperation between treaty partners, who readily collaborate on research and technology. The Australian Antarctic Science program places a high value on open access to the technology of other treaty partners, and offers Australian technology in return. Successful candidates for commercial exploitation of ACE CRC technologies are likely to be those for which a broader market can be identified outside that of polar operations.
- The market for ACE CRC's research is not industry based: it is primarily our core partners, supporting partners and sectors of the Australian Government and the international community. The focus of the ACE CRC will be on promoting effective utilisation of our research in these markets.

Two distinct strategies developed from this context; the commercialisation of technology, and the utilisation of research.

Program Strategies

Technology Commercialisation

This strategy established disclosure, assessment and formal decision making processes for the ACE CRC. Because Antarctic, climate and ecosystems research generally offers low exposure to a commercial culture, the ACE CRC has given a high priority to education as a necessary pre-requisite.

Education

The Commercialisation Program delivers formal generic commercialisation training and specific ACE CRC briefings to staff and students, to meet CRC Programme objectives and to provide the necessary background and common understanding to support implementation of the C&UP. In 2005-06, the ACE CRC undertook the following activities:

Workshops

With the support of the Tasmanian Department of Economic Development, we commissioned a second commercialisation workshop for PhD students from the Australian Institute for Commercialisation in October 05. The ACE CRC has now delivered these workshops to:

- 22 PhD students
- 31 staff associated with the ACE CRC
- 5 partner staff not closely associated with the ACE CRC

Staff Briefings

We developed a 'User Guide to the ACE CRC' with distinct versions tailored for each core partner. Staff briefings were convened in conjunction with each partner to launch the guide and to demonstrate the relationship between the partner's own commercialisation policies and those of the ACE CRC. The guide has been incorporated into staff induction procedures.

Disclosure and Assessment

Disclosure of innovative technology within the ACE CRC was formally introduced during 2005-06. An initial Technology Survey was rolled out with staff briefings at all partner sites. A Technology Report form is now available from the participants' area of the ACE CRC website, for use by individuals, project and program leaders.

Responsibility for assessing the technologies lies initially with a working group comprising the CEO, the Commercial Development Manager, and other members of the Executive Committee as required. Technologies may then be passed to the Commercialisation Steering Committee for further assessment that takes into account partner interests. The Committee may recommend that a commercial feasibility report may be commissioned before a formal recommendation is made to the ACE CRC board.

Spin-offs and patents

To date the ACE CRC has not applied for any patents, nor created any spin-off companies. We are actively seeking closer links with a local SME, and a Memorandum of Understanding with that organisation is under negotiation.

Research Utilisation

The ACE CRC has embarked on a two-fold strategy to improve our capability for delivering economic, environmental or social value from our research.

Know our users

We recognise the need to bring a better understanding of our research users' interests into our research community. We invited external speakers to address our annual symposium on what they need from ACE CRC research, and later followed up with each speaker to identify means of better meeting the needs. As a direct result of this, we co-hosted with one user – the Tasmanian Department of Primary Industries and Water – a workshop on Coastal Extreme Events for Tasmanian organisations responsible for built coastal infrastructure which delivered specifically targeted and useful information to 22 organisations. Further joint work is planned for the forthcoming year.

Our Policy Program hosted its second Research Users' Forum in Canberra, and followed up with detailed discussions with government agencies to identify their 'top 20' questions regarding climate issues. Regular follow up with these users has continued through the year.

We consulted with Tasmanian organisations to better understand the climate parameters that drive their strategic decisions. We have uncovered a widespread recognition of the importance of climate to economic decision making in a variety of industries. The scale of the issue of climate change is such that no single local organisation or industry could fund the research necessary to answer questions specific to Tasmania's climate future. But the evident interest from this Tasmanian community offers a promising delivery mechanism for future research.

Relate our research to user needs

During this year each project was reviewed to identify its potential for delivery to the range of end users identified in the C&UP. From this work we have identified a short list of delivery projects that will require commitment from both the ACE CRC and its end users to ensure that value is both delivered and taken up. These projects will be refined and prioritised to focus our attention on those activities most likely to deliver the highest value.

In recognition of our role in developing the capacity of our postgraduate students to deliver value in their future research careers, we are undertaking a review of our student projects to identify those which could benefit from closer association with external research users.

Commercialisation Milestone

Milestone	2005-06 Milestones &/or outputs	Achieved	Progress during 05-06
Commonwealth Agreement	Commonwealth approval of Commercialisation & Utilisation Plan	Yes	Notification of Commonwealth approval given on 26 August 2005

commercialisation

IP management

During the period under review, the ACE CRC has not sold, transferred or licensed its IP for commercialisation.

In terms of IP management, the ACE CRC has successfully gained the commitment of its core partners to improve two fundamental aspects of its IP Management, in line with the National Principles of IP Management:

- Alignment of institutional policies: Consultation with key staff in partners' Human Resources, Legal and Commercial areas has ensured that the relationship between partner IP policies and those of the ACE CRC are well understood. Agreement was reached across all partners on a 'User Guide to the ACE CRC' that explicitly spells out the expectations of partner agencies on their staff assigned to the ACE CRC.
- Management of Contributed IP: The ACE CRC commenced operation without a register of background IP supplied by its partners. During the year under review, core partners were asked to agree to a pragmatic approach to redressing the situation, with a focus on identifying major contributed items by project. The proposal was accepted and implementation is underway.

The role of the ACE CRC's IP arrangements in accruing maximum national benefits for our research is not as critical as it would be in a highly commercial organisation. Nevertheless, our success in working closely with our partners to secure a common understanding in these matters adds further strength to the collaboration necessary to achieve our research goals.

End-user involvement

Much of our end-user involvement occurs through collaborative projects and committee work. These are detailed later in this report under Research Collaboration. The following table supplements that information. Through our commercial development program, we continue to work with our end-users to determine the benefit received from involvement with ACE CRC activities.

Industry or other research users and basis of interaction	Type and location of activity	Nature and scale of benefits to end-users	Actual or expected benefit to user
ABARE (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Australian Fisheries Management Authority (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Australian Local Government Association (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Australian Marine Safety Authority (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Bureau of Rural Sciences (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Cradle Coast Water (Non-participant)	Consultation on impact of climate change to their business	Increased sensitivity to projected risks	
CSIRO/UTAS/BoM (Core partners)	Development of core modules for ACCESS – Aus Community Ocean Model and TPAC/AAD sea ice model	A state of the art system science model for predicting or simulating future climate scenarios and for sea ice forecasts underpinning all Australian Weather Forecasts by BoM	
Department of Agriculture and Fisheries and Forestry (Non-participant)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Department of Education Science and Training (Non-participant)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Department of Environment and Heritage, Australian Antarctic Division (Core partner)	Participation in Research users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Department of Environment and Heritage, Australian Antarctic Division (Core partner)	Calculation of krill biomass figures for delivery to CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) that will enable CCAMLR to revise the catch limits for the krill fishery in the South West Indian Ocean sector.	Increased productivity of krill fishing industry	

commercialisation

Industry or other research users and basis of interaction	Type and location of activity	Nature and scale of benefits to end-users	Actual or expected benefit to user
Department of Environment and Heritage, Australian Greenhouse Office (Supporting partner)	Working group to formulate Australian Government response to IPCC 4AR, hosted at BOM, Melbourne	Well-founded scientific basis for response	
Department of Environment and Heritage, Australian Greenhouse Office (Supporting partner)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	Contribution towards the objectives of the Australian Climate Change Science Program
Department of Environment and Heritage, Australian Greenhouse Office (Supporting partner)	Staff briefing on Hockey Stick curve (Tas van Ommen)	Increased understanding of the science behind the public debate	Contribution towards the objectives of the Australian Climate Change Science Program
Department of Environment and Heritage, Australian Greenhouse Office (Supporting partner)	Commissioned project on Ocean Acidification ($109,608 ex GST). Hobart.	Increased readiness to adapt to projected risks	Contribution towards the objectives of the Australian Climate Change Science Program
Department of Environment and Heritage, Australian Greenhouse Office (Supporting partner)	Commissioned project on high-precision timing on past climate events ($40,500 ex GST). Hobart.	Increased readiness to adapt to projected risks	
Department of Foreign Affairs and Trade (Non-participant)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Department of Foreign Affairs and Trade – AusAid (Non-participant)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Esk Water (Non-participant)	Consultation on impact of climate change to their business	Increased sensitivity to projected risks	
Geoscience Australia (Non-participant)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Gippsland Coastal Board (Non-participant)	Gippsland Coastal Study	Understanding coastal vulnerability at a detailed local level.	'The Board sees this work as invaluable ... A number of other stakeholders are particularly interested and bodies at the State and National level are extremely interested in the results ...'
Hobart Water (Non-participant)	Consultation on impact of climate change to their business	Increased sensitivity to projected risks	
Insurance Australia Group (Non-participant)	Participation in Environmental CRC's forum; provided speakers to ACE CRC symposium; received presentation to senior risk executives.	Awareness of the contribution of the Antarctic to understanding of the risk of insured weather events	

Industry or other research users and basis of interaction	Type and location of activity	Nature and scale of benefits to end-users	Actual or expected benefit to user
Local Government Association of Tasmania (Non-participant)	Consultation on impact of climate change on Local Government in Tasmania	Increased sensitivity to projected risks	
Royal Australian Navy (Non-participant)	Participation in Research Users' Forum, Canberra	Increased awareness of projected risks associated with climate change	
Tasmanian Department of Primary Industries and Water (Non-participant)	Joint hosting of day long workshop on Sea Level Rise and Extreme Events, Hobart	Increased awareness of risks and adaptation issues	'I look forward to continuing our strong relationship through joint work such as [this workshop]. I believe that through such collaboration, the business needs of our organisations and our clients will be greatly enhanced.'
Tasmanian Department of Primary Industries and Water (Non-participant)	Coordination of Sea Level Rise Reference Group, Hobart	Access to expert and current advice on emerging developments in understanding of sea-level rise	
Tasmanian Farmers and Graziers Association (Non-participant)	Consultation on impact of climate change to their business	Increased sensitivity to projected risks	
Vineyards Association of Tasmania (Non-participant)	Consultation on impact of climate change to their business	Increased sensitivity to projected risks	

research programs

climate variability & change

ocean control of carbon dioxide

antarctic marine ecosystems

sea-level rise

policy

climate variability & change

The Southern Ocean provides a critical link in the global ocean circulation that distributes heat around the Earth, stores heat and carbon in the ocean, provides nutrients to fuel Antarctic ecosystems, and supplies oxygen to the deep ocean. Present climate models indicate that this circulation is sensitive to climate change. A change in Southern Ocean currents would likely have profound impacts on climate, ocean uptake of carbon dioxide and marine ecosystems both in the Southern Ocean and globally.

By advancing our understanding of variability and change in the Southern Ocean, the CVC Program is improving our ability to simulate and predict the impact of Southern Ocean processes on climate, sea-level rise, marine ecosystems and the marine carbon cycle. More reliable projections of climate variability and change and their impacts will allow Australia to plan for the future and minimise the risks of a variable and evolving climate. Specific applications of CVC Program research will include improved predictions of the status of Southern Ocean ecosystems, improved marine resource management, marine impact studies, public good services such as search and rescue, guidance for safe Antarctic shipping operations, and research into global ocean and climate dynamics.

Program Leader

Dr Steve Rintoul

CSIRO Marine & Atmospheric Research

Program Objectives

- ***To characterise the variability of Southern Ocean currents, sea ice and climate and to understand their causes***. Variability of the physical environment of the Southern Ocean influences regional and global climate, distributions and productivity of marine organisms, ocean uptake and storage of CO_2, and the rate and pattern of sea-level rise. Knowledge of the variability of the coupled ocean-atmosphere-ice system, including understanding of the physical processes driving the variability, is a prerequisite for the other ACE CRC Programs.
- ***To determine the likelihood and impact of significant changes in the Southern Ocean physical environment***. Changes such as a slow-down in the Southern Ocean overturning circulation, a decrease in sea-ice extent, or an alteration in circulation patterns in the atmosphere and ocean would have substantial impacts on Antarctic ecosystems and Australian and global climate. We need to determine the risk of such changes in order to develop robust management strategies for Southern Ocean marine living resources and to guide planning for future changes in climate and their impacts.
- ***To combine state-of-the-art ocean observations and numerical models to provide simulations and forecasts of ocean currents and sea ice for Southern Ocean applications.*** The applications include ecosystem prediction, marine resource management, marine impact studies, initial state estimates for climate models, public good services such as search and rescue, guidance for safe Antarctic shipping operations, and research into ocean dynamics.

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Overview

Variability of the physical environment of the Southern Ocean influences regional and global climate, the distribution and productivity of marine organisms, the ocean uptake and storage of carbon dioxide, and the rate and pattern of sea-level rise. Understanding the variability of the coupled ocean-atmosphere-ice system is therefore a prerequisite for all of the ACE CRC research programs. Knowledge of ocean variability can also provide opportunities for prediction and is required to assess the skill of model simulations and to combine models and data in sensible ways. Our present understanding of Southern Ocean variability is limited, primarily due to the lack of observations. New tools (including autonomous floats, highly accurate satellites and improved numerical models) and measurements collected over the last decade make it now possible to investigate the variability of the Australian sector of the Southern Ocean.

The CVC program is tackling the issue of Southern Ocean variability and change in a number of ways: collecting new observations of the ocean and sea ice; comparing historical data with more recent measurements to document change, often by developing new analysis approaches; developing a hierarchy of numerical models targeted at specific problems; and using climate proxies from ice and sediment cores to place recent variability in a longer-term context. The integration of the research effort across disciplines (ocean, ice and atmosphere; physics, biology and chemistry; present, future and past climate; observations and modelling) is a particular strength.

In the first two years of the ACE CRC, we carried out a number of major field programs. We deployed the first Australian Argo floats in the Southern Ocean. These autonomous floats measure temperature and salinity profiles every ten days and relay the data by satellite, providing real-time observations of Southern Ocean circulation. Several multi-disciplinary expeditions involving the CVC, AME and CO2 programs of ACE have been carried out between Australia and Antarctica. New, very high resolution ice cores have been obtained from Law Dome, providing a record of past climate with unprecedented temporal resolution. Sea ice experiments have provided essential ground-truth for the next generation of satellite sensors and tested innovative electro-magnetic approaches for determining ice thickness. The field work is complemented and integrated with a variety of numerical simulations. Models developed by CVC staff and collaborators include full coupled climate models used for greenhouse warming simulations and high resolution ocean and ocean-sea ice models for process studies. Both the field work and modelling studies are generally carried out in the framework of national and international collaborations. These collaborations have leveraged substantial overseas investment in projects of relevance to Australia over the last three years.

Key achievements 2005-06

- *BROKE-West:* A major multi-disciplinary voyage surveyed the waters off the Antarctic continental margin between 30°E and 80°E, in a joint CVC-AME-CO2 experiment. A major goal of the program is to relate the distribution of krill to ocean circulation.
- *Antarctic Bottom Water change:* Comparison of new measurements with historical data confirms that the bottom water south of Australia is undergoing rapid and widespread change. Between 1970 and 2005, the bottom water has become fresher and less dense. Together with results from the Northern Hemisphere, the research suggests both the northern and southern limbs of the global overturning circulation are responding to changes in high latitude climate.
- *Intergovernmental Panel on Climate Change (IPCC):* CVC scientists have played a leading role in drafting the upcoming 4th Assessment Report and ACE research features prominently in the report.
- *Publications based on results from Law Dome ice cores:* Ferretti et al. (*Science*) demonstrate large unexpected changes in global methane sources in the pre-industrial period. Landais et al. (*Quaternary Science Reviews*) present evidence for large changes in snow accumulation during the Holocene at Law Dome.
- *Publication of two major books on polar remote sensing:* These were co-authored by CVC scientist Rob Massom.

Plans for 2006-07

- CVC scientists will participate in the SAZ-SENSE voyage, led by the ACE CO2 program. The field program will provide new insights into the relative roles of physical and biological factors in driving carbon export in the Subantarctic Zone and improve our understanding of the formation of Subantarctic Mode Water.
- In a joint experiment with NIWA in New Zealand, we will deploy current meter moorings along the Macquarie Ridge to measure the flow of the Antarctic Circumpolar Current.
- Several CVC scientists will be involved in completing the IPCC 4th Assessment Report, including the Technical Summary and the Summary for Policy Makers.
- Preparations will continue for a heavy field season in 2007-08 as part of the International Polar Year (IPY). The planned fieldwork includes a winter sea ice voyage and a joint CVC-AME-CO2 expedition from Australia to Antarctica along 140°E. CVC scientists will also be involved in international coordination and organisation of IPY activities.
- Analysis of results from major field programs in 2004-05 and 2005-06 and model studies will continue.
- Activities by the ice core group will include analysis and production of finalised Law Dome records of accumulation and temperature proxy; investigation of the provenance of sea-salts and implications for their interpretation in ice cores; analysis of the GD17 ice core; and a study of rapid climate change using methane measurements from the deep ice core.

Project reports

CVC-01: Variability of Southern Ocean currents and air-sea interaction

Project leader

Steve Rintoul, CMAR

Project staff

S Sokolov, J Church, CMAR; D Greenslade, J Kepert, BMRC; N Bindoff, ACE/CSIRO/TPAC; C Curran, M Rosenberg, ACE; E Fahrbach, AWI; M Williams, H Neil, NIWA; R Coleman, UTAS

Project aim

We aim to characterise and understand the variability of the Southern Ocean and to use this knowledge to test and improve climate models. The outcomes of the research will include advances in understanding of Southern Ocean dynamics, improved projections of climate variability and change from models that better represent Southern Ocean processes, an enhanced ability to manage and assess the status of marine ecosystems, and ocean circulation estimates for use in operations such as search and rescue and transport.

Key achievements in 2005-06

- BROKE-West: A major multi-disciplinary voyage surveyed the waters off the Antarctic continental margin between 30°E and 80°E, in a joint CVC-AME-CO2 experiment. A major goal of the program is to relate the distribution of krill to ocean circulation.
- CVC scientists made a significant contribution to the 4th IPCC Assessment Report, including as Convening Lead Author of Chapter 5 – Observations: Oceanic Climate Change and Sea Level (Bindoff). ACE CRC research on sea-level and ocean changes features prominently in the report.
- Studies of changes in water mass properties have been extended, demonstrating that the warming of Circumpolar Deep Water is circumpolar in extent and Antarctic Bottom Water (AABW) in the Australian-Antarctic Basin is now significantly fresher and lighter than observed in the 1970s.

- A combination of satellite altimeter data and temperature profiles from king penguins were used to map oceanographic fronts east of New Zealand. The results demonstrate that the penguins forage almost exclusively between the northern and southern branches of the Polar Front.

CVC-02: Ocean-atmosphere-cryosphere interactions at the Antarctic margin

Project leader

Anthony Worby, AAD

Project staff

I Allison, P Heil, B Giles, R Massom, AAD

Project aim

Sea ice is critically important in both the physical and biological processes of the Southern Ocean, affecting many other processes that are essential to driving and maintaining the global climate system. Our goal is to characterise and understand the variability of Southern Ocean sea ice and the interaction between the ocean, atmosphere and cryosphere at the Antarctic margin.

Despite the importance and sensitivity of sea ice processes around the Antarctic margin, the sea ice zone remains one of the most data sparse regions of the Earth. Our research will enable more reliable predictions of variability and change in the sea ice zone and of the effects of such variability on climate and ecosystems.

Key achievements in 2005-06

- A large international program involving CVC scientists examined the impact of anomalous atmospheric circulation on sea ice and associated biota in the West Antarctic Peninsula region. This showed the importance of extreme events on ice conditions and ice dynamics, and the devastating impact such conditions may have on local breeding success. Anomalous conditions, in the form of persistent strong northerly winds and low ice concentration on the eastern side of the Antarctic Peninsula are also attributed, at least in part, to the break-up of the Larsen B ice shelf.
- First results of the summer Weddell Sea experiment have been published and show that concentrations of the major sulphur compounds increased by more than an order of magnitude during periods with smooth surface water conditions. This increase coincided with a profound stratification of the water column, caused by a decrease in salinity of near surface water. We estimate that the dimethylsulphide (DMS) emission from leads and open water in Antarctic sea ice could contribute significantly to the yearly DMS flux from the Southern Ocean.
- The ASPeCt sea ice data archive was added to the TPAC Digital Data Library and derived data products have been made available to the scientific community. The archive has been used in a study of sea ice albedo in the Southern Ocean, to produce seasonally averaged albedo values in the appropriate wavelength bands for general circulation models.
- An ongoing program of fast ice monitoring at Davis and Mawson stations is being undertaken by Petra Heil. During 2005-06, 4 sites were monitored at Mawson station and 7 at Davis station, with extremely high quality data collected. These fast-ice records provide information on temporal changes in the coastal Antarctic environment and, together with external forcing data collected at those locations, will be analysed to identify links between the different components (ice, atmosphere, ocean) of the global climate system.

CVC-03: Climate history project

Project leader

Tas van Ommen, AAD

Project staff

V Morgan, M Curran, B Smith, R Brand, AAD; W Howard, ACE

Project Aim

The climate history project provides records of past climate from ice cores and ocean sediment cores, from which we aim to improve understanding of underlying climate mechanisms, and factors that drive climate and natural climate variability. Our research will provide new data-sets and interpretations that put current climate conditions in the context of long-term patterns in past climate. These will provide improved capability for detection and attribution of contemporary climate change, better understanding of uncertainties in climate assessment and greater capacity for verification of climate models.

Key achievements in 2005-06

- We received AGO funding for a study of rapid climate change using small sample methane measurements in collaboration with LGGE Grenoble (France). The first tranche of measurements are complete and interpretation is underway; 8.2ky 'event' detected.
- Ferretti et al. (*Science*) demonstrated large unexpected changes in global methane sources in the pre-industrial period; Landais et al. (*Quaternary Science Reviews*) found supporting evidence for large changes in Holocene snow accumulation at Law Dome.
- The benthic carbon isotopic record from a sediment core at the South Tasman Rise suggests that Circumpolar Deep Water had a composition similar to the Pacific during the late Pleistocene, rather than being a 'mix' of North Atlantic and Pacific Deep Water as found in the Holocene. This implies that the 'conveyor belt' ran continuously through the Late Pleistocene, rather than 'shutting off' during glacial stages, but that the dominant influence on Southern Ocean deep waters was the Pacific.
- Field drilling by collaborators at Law Dome for a separate study has provided core material to develop a new project exploring solar-climate connections using beryllium-10.
- An ice core automatic melter system was developed that will enable improved sampling throughput; a new ion chromatograph was acquired by AAD and a new mass-spectrometer was acquired that will give additional proxy data from water isotopes.
- Expert reviews (individual and government) were provided to the IPCC.

CVC-04: Simulation of ice-ocean-atmosphere interaction and climate

Project leader

Nathan Bindoff, UTAS/CMAR

Project staff

S Marsland, R Murray, ACE; T Hirst, S O'Farrell, CMAR; J Roberts, TPAC; P Heil, G Hyland, R Warner, AAD; N Adams, S Pendlebury, P Reid, BoM; O Alves, N Smith, F Tseitkin, BMRC; P Petrelli, University of Sienna (Italy)

Project Aim

Seasonal and decadal variations and long term trends in Southern Ocean water masses (e.g., in temperature, salinity, currents, etc.) are poorly understood at present. We are researching the processes that are central to understanding climate variability near Australia and Antarctica, and are also involved in activities related to the forecasting of sea ice motion.

We are using numerical simulations of the Southern Ocean and its components, which are tested and validated against observational data from the other ACE CRC research programs. This allows us to diagnose the important processes acting in the Southern Ocean that both influence and respond to global and regional climate. The enhanced climate models resulting from this research will deliver more reliable projections of climate variability and change and their impacts.

Key achievements in 2005-06

- Assessment of sensitivity of Adélie Land Bottom Water Formation in response to changed atmospheric conditions in the climate system has been completed and is undergoing revision.
- The variations in the Indian Ocean at 32°S have now been explained in terms of the processes of ocean advection and sea surface temperature changes. These processes in this region agree with the mechanisms of Bindoff and McDougall (2001).
- New model analyses show that the mean ocean flow is highly correlated to eddy generation. Most significant heat transport by eddies is north of the Sub-Antarctic Front associated with the Agulhas retroflection.
- A new set of climate scenarios have been run with the CSIRO Mk3.5, which has an improved ACC and stratification in Southern Ocean. Analyses of these results are underway.
- The variability of the sea ice in the Mk3.0 and Mk3.5 models has been analysed with strengths of links with El Niño Southern Oscillation (ENSO), Southern Annular Mode (SAM) and Southern Ocean overturning in each sector calculated.
- The digital library on the national APAC grid has been released. The library has been augmented with key ACE CRC data, including Argo data, new altimetry products, Modis colour simulations, IPCC model simulations, ACE high resolution model simulations, and enhanced search and browse facilities. Most of these data are central to ACE CRC deliverables, and being used across the ACE CRC programs. We have completed a robust web crawler for OpenDAP sites that scales to data sets that includes millions of files. Twenty-five Terabytes are now under management across Australia.
- Technical improvements have been made in grid design for numerical models and in particular for the AusCOM model.
- New results are emerging on the changes of water mass distributions, ocean ventilation and subduction rates and ocean stratification from IPCC class models. These model results have a high degree of correspondence to the results from the observational program.

Progress against contractual milestones

Outcome: Estimates of sea level change resulting from anthropogenic climate change used as one of the bases for intergovernmental climate change negotiations.

Output / Milestone	Date	Progress
Complete circumpolar oceanographic transect at 30°S, with Japan	2004	Completed.
Establishment of initial data assimilation experiments in ocean-only model	2005	In partnership with CSIRO Bluelink project, initial data assimilation runs completed for Australian sector of the Southern Ocean. Companion high resolution model studies have also been completed.
Creation of historical and real-time ocean database system	2005	Digital data libraries established. This library has continued to be developed and includes a unique 'crawler' for OpenDAP sites.
Complete oceanographic transects at 115°E (WOCE I9) and across Kerguelen boundary current (joint with CO2), collaboration with Japan. Complementary observations at 0°E by AWI (Germany)	2005	Completed.
Complete oceanographic survey of shelf/ slope waters between 30°E and 80°E (joint with AME; collaboration with Germany)	2006	Completed (refer comments elsewhere on BROKE-West survey).
Assessment of the variability of Southern Ocean currents and sea ice	2006, 2010	Analysis of variability and change of southern ocean water masses and sea ice has been completed and published in several papers.
Quantify transport and variability of bottom waters in Australian sector (with Japan) and compare to Atlantic sector (with Germany)	2007	In progress. Quality control or mooring data underway.
Deploy array of Argo profiling floats (collaboration with Germany, USA and other nations).	2007	Continuing. 45 floats deployed between July 2003 and April 2006.
Assess influence of projected changes in Southern Ocean climate on basal melting of ice shelves and assess impact on the Southern Ocean of resulting changes on freshwater inputs and / or changes in iceberg discharge	2007	Underway. Recent changes in Antarctic Bottom Water have been attributed to enhanced basal melting of ice shelves. An ocean – ice shelf model has been developed and is being used to conduct sensitivity studies.
Estimation of overturning strength from WOCE data using inverse models	2008	Inverse model under construction.
Estimation of sensitivity of overturning strength to changes driven from different forcing scenarios	2008	Global coupled model under development. Sensitivity studies have been completed with a high resolution ocean-ice model.
Census of water mass changes from recent and historical data	2008	Work is underway. Work on changes in several Southern Ocean water masses has been published.
Production of ocean analyses for the Australian sector by data assimilation model	2008	Preliminary ocean analyses completed, in partnership with Bluelink project.

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Output / Milestone	Date	Progress
Assessment of variability and change of the sea ice mass budget in the Indian Ocean sector of the Southern Ocean	2008	Work is underway. New approaches are being developed to combine ship-based and remote sensing data to derive maps of sea ice thickness.
Identification and quantification of physical mechanisms driving variability in the ocean-ice system in the Australian Antarctic sector	2009	Study of mechanisms has begun, including use of records of past climate derived from ice core proxies.
Past changes of annual-to-centennial scale climate variability in the Southern Ocean, its sea ice cover and the southern atmosphere inferred from ice core proxy records	2009	Underway. Ice core proxies have so far been used to derive a record of a decline in sea ice extent and an index of the southern annular mode circulation in the atmosphere, among others.
Production of scenarios of changes in Southern Ocean circulation and sea ice and their impact on ecosystems, carbon uptake and sea level rise	2009	Climate change runs completed and submitted to IPCC (in partnership with CSIRO). Improvements to the climate models are underway. Impacts not yet assessed.
Operational, fully-coupled ocean-sea ice analysis and forecast system	2010	Coupled model under development. Sea ice analysis based on remote sensing is in progress.

ocean control of carbon dioxide

The ocean currently absorbs about one-third of the carbon dioxide (CO_2) emitted by human activities. This reduces the build-up of greenhouse gases in the atmosphere, but makes the ocean more acidic and may have a major impact on marine ecosystems.

Determining CO_2 uptake and its effect on the ocean, and relating this to the larger goal of predicting human-induced global change, requires consideration of natural climate processes and their interaction with the global carbon cycle. New knowledge arising from the ACE CRC Ocean Control of Carbon Dioxide Program will help Australia plan effectively for mitigation and adaptation in response to a changing climate.

Program Leader

Assoc Prof Tom Trull

University of Tasmania and CSIRO Marine & Atmospheric Research

Program Objectives

- ***To determine the current magnitude of uptake of anthropogenic atmospheric CO_2 by the Southern Ocean south of Australia.*** To predict future atmospheric concentrations of greenhouse gases, we need to know how much CO_2 is currently absorbed by the ocean. Work by the ACE CRC is contributing to an assessment of global ocean uptake and helping quantify relationships among ocean circulation and CO_2 transfers between the atmosphere and the ocean.
- ***To determine the role of upper ocean dynamics in the control of phytoplankton production and biological carbon export to the deep ocean.*** ACE CRC researchers are collecting and analysing suspended and sinking marine particles and documenting the ecological processes that form and destroy them. These particles redistribute carbon, nutrients and other elements within the ocean. Understanding the transfer rates of the particles between the surface and the deep ocean is important for understanding the contributions of the Southern Ocean to the control of atmospheric CO_2.
- ***To determine the influence of iron availability on Southern Ocean plankton community structure and the associated ecosystem control of carbon transfer to the deep ocean.*** ACE CRC scientists are examining the availability of iron and other micro-nutrients in the Southern Ocean through extensive field mapping, sampling and laboratory analyses. Documenting the distribution of iron in surface and deep waters, and understanding the processes that supply iron and remove it from the Southern Ocean will help us assess the benefits and risks of proposals to increase biological sequestration of carbon through controlled iron fertilisation.
- ***To determine the impact of increasing CO_2 concentrations on phytoplankton and on the relative growth rates of different classes of Southern Ocean phytoplankton.*** In order to predict the future capacity for biological uptake of CO_2 into the ocean, we need to understand how phytoplankton communities and associated ecosystems will respond to increased concentrations of CO_2. ACE CRC scientists from this program and the

Antarctic Marine Ecosystems Program are exploring these processes through laboratory experiments and field studies. The results will be incorporated into computer models that will allow us to assess the impact of global change on marine ecosystems in the Southern Ocean.

- ***To develop simulations of future scenarios of global and regional ocean carbon cycle dynamics.*** We will provide tools to incorporate data from ACE CRC field programs and other international research efforts into regional and global assessments of potential changes in the ocean carbon cycle. These assessments can assist Australian and other governments in devising effective short- and long-term mitigation and adaptation strategies to future climate change.

Overview

The ACE CRC CO2 Program is providing information to address two aspects of societal concern about the impacts of rising emissions of CO_2:

- *To what degree can uptake of CO_2 by the ocean help keep atmospheric levels of CO_2 low?*
- *How will the accumulation of our CO_2 emissions in the ocean affect marine ecosystems?*

These questions are global in scope, and cannot be answered by any single research program, institution, or nation on its own. We have been both participants and leaders of long-term international programs (World Ocean Circulation Experiment [WOCE], Climate Variability & Predictability Study [CLIVAR], Joint Global Ocean Flux Study [JGOFS], Surface Ocean – Lower Atmosphere Study [SOLAS], GEOTRACES and Global Ocean Observing System [GOOS]) and multi-national regional investigations (KEOPS, VERTIGO, SAFE, AMT, *l'ASTROLABE*). Our work has received external funding from agencies in Europe, the United States and Asia.

ACE CRC research in the CO2 Program has made major advances in the understanding and quantification of the role of the Southern Ocean in the control of atmospheric CO_2 over the past three years. We have educated 9 PhD and 3 Honours students in integrated, solution-focused collaborative research of international quality. Our program has published more than 30 refereed publications and book chapters, and provided many more presentations to research and public fora.

Our research results are useful both in international assessment processes, such as the Intergovernmental Panel on Climate Change for the assembly of global outlooks, and for Australian agencies addressing emission management and policy and planning for climate change.

Key achievements 2005-06

- *Natural iron input studies:* Quantification of the natural iron input from deep waters and sediments that fuels elevated phytoplankton production over the Kerguelen plateau in the Southern Ocean demonstrated that this input leads to much greater transfer of carbon to the ocean interior than has been observed in short-term artificial iron fertilisation experiments (in collaboration with European researchers, Blain et al., *Nature*, in review).
- *Impact of sea ice on atmospheric CO_2 exchange:* We demonstrated that the long-held assumption that there is negligible exchange of atmospheric CO_2 exchange with sea ice covered oceans is incorrect, indicating that climate models must include both physical and biological aspects of sea ice gas dynamics to correctly simulate atmospheric carbon budgets (in collaboration with European researchers; Delille et al., *Nature*, in review).
- *Simulation of future ocean acidification as a result of continued uptake of anthropogenic CO_2:* This suggests there will be major impacts on carbonate-shell forming organisms, and that the greatest effects are likely to occur in Antarctic waters (in collaboration with US, European, and Japanese researchers, Orr et al., *Nature*, 2005).
- *Ocean acidification monitoring:* A program to monitor the response of marine organisms to ocean acidification has been initiated.

Plans for 2006-07

We will lead 3 major field programs in the coming year:

- Development of our 'PULSE' automated biogeochemical measurement surface mooring in the Sub-Antarctic Zone (SAZ) to augment our deep moored sediment traps, with the addition of additional sensors in early spring and subsequent service visits in mid-summer and late autumn.
- Underway observations from the French resupply vessel *l'Astrolabe* on upper ocean carbon cycling and continued examination of phytoplankton responses to ocean acidification.
- A month-long study onboard *Aurora Australis* of the controls on SAZ productivity and carbon cycling and their sensitivity to climate change (SAZ-SENSE). This project will compare low productivity waters west of Tasmania with higher productivity waters to the east. It will also expose phytoplankton communities to elevated CO_2 levels to determine their responses, and examine foraminifera (carbonate-shell forming zooplankton) compositions for comparison to sedimentary records of past ocean pH (with funding from the Australian Greenhouse Office).

We will advance the simulation of Southern Ocean biogeochemical cycles, phytoplankton production, and microbial ecosystem structure, with emphasis on:

- Controls on elevated phytoplankton accumulation over the naturally iron-fertilised Kerguelen plateau.
- Interactions between climate warming and anthropogenic CO_2 uptake in terms of their affect on ocean acidity.

Ongoing synthesis and delivery of our research will include six presentations at the international Scientific Committee on Antarctic Research (SCAR) meeting in Hobart in July 2006, and publication in peer-reviewed journals. Some of the contributions currently in review are detailed in the Project reports.

Project reports

CO2-01: Carbon uptake in the Southern Ocean

Project leader

Bronte Tilbrook, CMAR

Project staff

M Pretty, K Paterson, CMAR

Project Aim

This project will describe the variability and large-scale biological and physical drivers of the air-sea exchange of carbon dioxide (CO_2) in the Southern Ocean, south of Australia. The results will better define the critical role of the Southern Ocean in controlling atmospheric CO_2 concentrations, and allow more robust predictions of how the Southern Ocean uptake may be altered in future under changed climatic conditions. The research will contribute to a major new initiative to determine regional and global scale carbon budgets, which are required to develop useful strategies to manage future CO_2 emissions and their environmental impacts.

Key achievements in 2005-06

- Analysis of the full hydrographic section completed in 2005 from Australia to Antarctica along the WOCE-CLIVAR I9S line south of Fremantle revealed increases in CO_2 and decreases in dissolved O_2 concentrations for mode and intermediate waters, compared to 1995 results from the same section obtained by the USA. These results are consistent with continued CO_2 uptake and storage in sub-Antarctic waters leading to a pH decrease in the region. The oxygen changes are consistent with previous work from the Biogeochemical Simulation Project suggesting that the overturning circulation that carries CO_2 and O_2 into the ocean interior is slowing in response to climate warming, but could also represent shorter term climate and ocean variability.

- Demonstration that the long held assumption that there is negligible exchange of atmospheric CO_2 exchange with sea-ice covered oceans is incorrect suggests that climate models must include both physical and biological aspects of sea ice gas dynamics to correctly simulate atmospheric carbon budgets (in collaboration with European researchers; Delille et al., *Nature*, in review).
- Advances in observational strategies for ocean biogeochemical characteristics included i) expansion of the underway observation program to measure estimate of gross and net phytoplankton production from dissolved O_2/Ar ratios (in collaboration with Princeton University) and ii) initial deployments of autonomous profiling Argo floats equipped with oxygen sensors to monitor oxygen changes remotely at low cost and in real time.

CO2-02: Carbon Export Processes

Project leader

Tom Trull, UTAS/CMAR

Project staff

L Armand, S Bray, D Davies, W Howard, C Moy, T Remenyi, L Robertson, M Rosenberg, ACE; B Griffiths, D McLaughlin, L Pender, C Rathbone, CMAR; L Forbes, UTAS; P Boyd, S Nodder, NIWA

Project Aim

We are estimating rates of transfer of particulate carbon between the ocean surface and the deep sea, identifying the major processes that control these rates, and developing conceptual models of the sensitivity of these processes to climate variability and change. A clearer view of the role of the 'biological pump' (the transfer of carbon to the deep sea in particulate form) in the Southern Ocean in regulating atmospheric CO_2 is a necessary step towards the development and verification of reliable carbon cycle models for the simulation of future atmospheric CO_2 levels and thus future climate change. Understanding of the modern biological pump is also a useful aid in the interpretation of past changes in the Southern Ocean environment, and thus their application to estimating future changes.

Key achievements in 2005-06

- Demonstration that carbon export to the ocean interior from the naturally iron-fertilised, high phytoplankton biomass waters over the Kerguelen plateau in the Indian sector of the Southern Ocean is large per unit of iron supplied. This contrasts strongly with the results of short-term artificial iron fertilisation experiments which found low carbon export efficiencies. This work was undertaken in collaboration with the CO2-03: Iron Biogeochemistry project and European researchers as part of the French KEOPS program (Blain et al., *Nature*, in review).
- Demonstration that the carbon isotopic composition of Southern Ocean deep water masses has closely tracked that of the Pacific over most of the past 160,000 years (Moy, Howard, and Gagan, in press, *Journal of Quaternary Science*). These new data from South Tasman Rise challenge the traditional view that the North Atlantic component of the 'conveyor belt' circulation usually modulates the composition of Southern Ocean deep water masses. Similarly, these results suggest that the conveyor belt circulation has been active throughout the late Pleistocene and not, as thought previously, 'shut off' during glacial stages.
- Advances in observational strategies for the measurement of biogeochemical properties, including i) development of viscous polyacrylamide gels for the *in situ* deceleration and isolation of fragile marine aggregates for photo-micrometric characterisation (Ebersbach and Trull, *Limnology and Oceanography*, in review); ii) deployment of an *in situ* settling column to

separate particles by sinking rates – a key control on carbon export (in collaboration with American researchers in the 'VERTIGO' Vertical Flux in the Global Ocean program); iii) deployment of the PULSE mooring – the first surface-mooring in the open Southern Ocean based on an innovative shock-dampening design, with the goal of obtaining continuous observations of mixed layer depth, light levels, and in later years phytoplankton and nutrient concentrations to address the role of surface dynamics in the control of ecosystem structure and carbon export; iv) development of analytical methods for particulate carbonate and particulate silicate concentrations; and v) critical reviews of sediment trap techniques (Buesseler et al., *Journal of Marine Research*, in review) and the application of ^{234}Th disequilibria to the estimation of carbon export (Buesseler et al., *Marine Chemistry*, 2006).

CO2-03: Iron biogeochemistry

Project leader

Andrew Bowie, ACE CRC

Project staff

S Bray, T Remenyi, L Robertson, ACE; E Butler, CMAR; P Boyd, NIWA

Project Aim

We are evaluating the importance of iron and other trace micronutrient elements in driving Southern Ocean biogeochemical cycles. The research team will map the distribution of dissolved iron in waters south of Australia, fingerprint supply and removal mechanisms, and quantify trace element limitation of phytoplankton growth and community structure in sub-Antarctic ecosystems. This project will feed vital information on the prevalence and flux of trace elements into biogeochemical and ecosystem models of the region, thus allowing a prediction of the role of Southern Ocean biology in past and future regulation of atmospheric CO_2 through ecosystem control of carbon transfer to the deep ocean. The research will assess the risk and efficacy of proposals to increase carbon sequestration through intentional iron fertilisation of the Southern Ocean.

Key achievements in 2005-06

- Demonstration that elevated phytoplankton biomass over the Kerguelen plateau in the Indian sector of the Southern Ocean as seen in satellite remote sensing images is fuelled by iron inputs from deep waters, and thus this region represents an area of natural persistent iron fertilisation that can inform debate about the role of iron in the control of atmospheric CO_2. This work was undertaken in collaboration with the Carbon Export Processes project and European researchers as part of the French KEOPS program (Blain et al., *Nature*, in review).
- Demonstration that dissolved iron concentrations are low in surface waters along the WOCE/Clivar transect from Tasmania to Australia with early spring depletion in polar waters, but evidence of continued inputs into summer in sub-Antarctic waters from sources to the north (Sedwick et al., *Deep-Sea Research*, in review).
- Advances in observational strategies for the measurement of biogeochemical properties, including i) international intercomparison of iron analytical techniques (Bowie et al., 2006) and ii) trace-metal clean size-fractionation filtration techniques.

ocean control of carbon dioxide

CO2-04: Effect of elevated CO_2 on phytoplankton

Project leader

Simon Wright, AAD

Project staff

A Davidson, F Scott, P Thomson, R van den Enden, K Westwood, AAD; W Howard, A Moy, ACE; B Griffiths, B Tilbrook, CMAR; G Hallegraeff, UTAS; T Trull, CMAR/UTAS

Project Aim

This project will describe how Southern Ocean phytoplankton and microbial communities will change as atmospheric CO_2 concentrations increase. The research team will study the likely changes in phytoplankton species and size distribution, in rates of uptake of carbon dioxide through photosynthesis, and the extent to which CO_2 is recycled through the microbial loop or sedimented to the deep ocean. This knowledge is vital to predictions of the role of the Southern Ocean in absorbing and storing CO_2 produced through human activity and so its role in influencing global carbon budgets. The results will also be important for developing ecosystem models that allow assessment of impacts of climate change on Antarctic marine ecosystems and provide advice for ecosystem based management of Southern Ocean fisheries, particularly those regulated through CCAMLR.

Key achievements in 2005-06

- The distribution and carbonate shell characteristics of the globally important phytoplankton *Emiliania huxleyi* were determined from samples collected by the underway observation program onboard the French Antarctic resupply ship *l'Astrolabe*. In comparison to results from the 1980s, *E. huxleyi* populations showed expansion southward all the way to the Antarctic sea ice, but with lower calcification in southern samples. This poleward expansion parallels results from the Northern Hemisphere and may be a response to ocean warming. The reduced calcification is consistent with expectations from laboratory experiments on the response to ocean acidification by anthropogenic CO_2. This complexity of response to global change typifies the difficulty of ecosystem predictions and also the occurrence of transient states as the system evolves.
- Initiation of a study of the genetic diversity of *E. huxleyi* phytoplankton as the next step in understanding their response to ocean acidification.
- Award of research funds from the Australian Greenhouse Office to initiate a study into the links between ocean acidity and the carbonate shell compositions of Southern Ocean foraminifera (a globally important type of amoebic zooplankton).
- This project has growing collaborations with our partner agencies, including S Blackburn and P Thompson (CMAR) and U Bjima (AWI).

CO2-05: Biogeochemical simulations

Project leader

Richard Matear – CMAR

Project staff

M Mongin, T Roy, ACE; M Nuñez, L Forbes, UTAS; C Rathbone, T Moore, CMAR; T Trull CMAR/UTAS

Project Aim

Through the development and application of ocean carbon models, we are quantifying the Southern Ocean uptake of atmospheric CO_2 and exploring potential feedbacks of projected global warming on this uptake. The results of this research will be vital to predicting the role the Southern Ocean will play in absorbing and storing anthropogenic CO_2 in the future and, therefore, how future atmospheric CO_2 levels will evolve.

Key achievements in 2005-06

- Simulation of ocean acidification through the end of this century suggests major impacts on carbonate-shell forming organisms, and that the greatest effects are likely to occur in Antarctic waters (in collaboration with US, European, and Japanese researchers, Orr et al., *Nature*, 2005). This work emphasises the *direct* effect of anthropogenic CO_2 on marine ecosystem, which is not dependent on climate warming.
- Assessment of spatial and temporal variability of air-sea CO_2 exchange in the Southern Ocean from a global ocean circulation and biogeochemical model suggests that measuring uptake with sufficient precision to capture interannual variability in the net flux over the whole Southern Ocean will require an approximate two-fold improvement spatial coverage by observational networks (Lenton et al., *Global Biogeochemical Cycles*, in review). Further investigation suggests that large scale atmospheric dynamics (the Southern Annular Mode) are important drivers of internannual variability (Lenton and Matear, *Global Biogeochemical Cycles*, in review).
- Investigation of possible microbial ecosystem responses to elevated iron inputs and ocean stratification using a model tuned to reproduce seasonal cycles at the Kerfix Polar Frontal Zone time series site suggests that 10-fold increases in aerosol iron delivery are insufficient to induce significant change, but that 100-fold and, especially, 1000-fold increases lead to significant increases in production and changes in ecosystem structure. Increased stratification of the upper water column in response to approximately 3-fold decreases in wind stresses can induce similar increases in production, emphasising that light limitation is also a key factor in Southern Ocean productivity (Mongin et al., *Global Biogeochemical Cycles*, in review).

ocean control of carbon dioxide

Progress against contractual milestones

Output / Milestone	Date	Progress
An estimate of the current inventory of anthropogenic CO_2 in the Southern Ocean south of Australia	1st estimate 2005; 2nd estimate 2009	First milestone achieved ahead of time in 2004: Publication of Southern Ocean inventory as part of global compilation (Sabine et al., *Science*, 2004). On track for second milestone in 2009.
Measurement of anthropogenic CO_2 contents along the WOCE/CLIVAR I9 section from Western Australia to Antarctica	2005	Milestone delayed but now completed. Field sampling completed in 2005, but analysis delayed until 2006 because of staff medical issues preventing at-sea analysis. Analysis now complete.
Measurement of anthropogenic CO_2 contents on a transect along the Antarctic shelf	2006	Milestone achieved, although lack of CFC measurements as a result of unavailability of international collaborators will restrict the quality of anthropogenic CO_2 estimates. Development of CFC analytical capability in Australia is needed but beyond the scope of the ACE CRC. Field program completed in 2006 in concert with the ACE AME Program Broke-West project, data synthesis initiated, project on-track for publication in 2007.
Measurement of anthropogenic CO_2 contents along the WOCE/CLIVAR SR3 section from Tasmania to Antarctica	2008	This work is planned for a voyage in 2008 jointly with the CVC Program, as part of the International Polar Year and in conjunction with the Census of Antarctic Marine Life.
Determination of the role of stratification in biological carbon export to the deep sea, to inform estimates of future carbon export in an increasingly stratified ocean	2005-07	Delayed more than 1 year by initial mooring equipment failures. Automated measurement 'PULSE' mooring successfully deployed in March 2006. 2006-07 will be crucial for this project.
Development of a model with explicit ecosystem structure linking stratification and export over seasonal timescales	2006	Milestone achieved: 1-D model developed and first application to seasonal simulations completed (Mongin et al., in review).
Comparison of the model to observations of stratification and surface export in the Southern Ocean south of Australia	2008	On track: Tuning of the model scheduled for 2007, and comparison to data in 2008. Observations from PULSE mooring pending. Successful proposal to Australian Antarctic Science program for major field program in 2007 (SAZ-SENSE) will provide additional observations. Participation in US NSF-funded VERTIGO program provides additional perspectives.

Output / Milestone	Date	Progress
Comparison of the model to observations of export to deep sediment traps in the Southern Ocean south of Australia	2010	Progress towards milestone slowed by two maternity leaves in 2006-07, but alternate staffing plans under development and milestone should be achieved on time. Deep sediment trap samples successfully obtained and currently being analysed using newly developed methods for particulate carbonates and silicates.
Determination of the role of iron limitation in biological carbon export to the deep sea		Field study in 2005 of the naturally iron fertilised waters over the Kerguelen plateau by ACE CO2 program researchers during the French-led KEOPS program suggested that the additional iron supply in these waters produces a very efficient carbon export to depth – at least 10 times higher than that observed in artificial iron fertilisation experiments. Currently in review for publication in *Nature*.
Examination of the links between iron supply and export in an area of natural iron inputs	2003-05	Program delayed 1.5 years by international partner shipping schedule change. KEOPS field program completed in 2005. Analyses ongoing in 2006, first papers in review (Blain et al., Ebersbach and Trull), additional publications expected in 2007.
Quantification of the response of Southern Ocean ecosystems to persistent natural iron fertilisation	2006-07 and 2009; efficacy & risk assessed 2006 & 2010	Strong but delayed progress (see above milestone) with completion of KEOPS field program in 2005, first research papers in review in 2006, and additional papers expected in 2007. Assessment of efficacy expected in 2007, but evaluation of risk requires further conceptual and experimental advances.
Determination of the role of elevated CO_2 levels on phytoplankton communities	2007	Initial results achieved ahead of time with publication of paper on expected changes in ocean acidification (Orr et al., 2005). Major field program SAZ-SENSE to address phytoplankton community responses scheduled for early 2007 but analysis and publication likely to be delayed until 2008. Additional study of this problem scheduled for 2007 with supplementary funding from AGO.
Laboratory experiments under elevated CO_2	2007	Large tanks are currently being modified to allow work under elevated CO_2 levels, with the first experiments to be carried out in January 2007 during the SAZ-SENSE field program.

antarctic marine ecosystems

The Southern Ocean, in particular the coastal region around Antarctica, hosts a vast and complex marine ecosystem that supports the fisheries of Australia and several other nations. This important region is internationally acknowledged as region of great ecological importance, but it remains relatively under-sampled and poorly understood.

The ACE CRC Antarctic Marine Ecosystems Program is exploring relationships among the biological patterns and processes of the marine ecosystem around East Antarctica and relating them to physical oceanographic processes. This knowledge will help guide Australian government and industry decision-makers in the formulation of policy and management strategies in response to harvest of some resources and to future climate change.

Program Leader

Dr Andrew Constable

Australian Antarctic Division

Program Objectives

- ***To identify how biological productivity is affected by sea ice extent and properties, and by ocean circulation.*** Productivity in the Southern Ocean has been linked to the winter sea ice cover and to large-scale ocean circulation patterns, both of which are sensitive to climate change. ACE CRC researchers are combining oceanographic data, satellite data and ship-based observations with historical data from ice and sediment cores, penguin rookeries and operational records. They will use this data to test the hypothesis that reduced sea ice extent due to climate warming or other factors will lead to a smaller sea ice algal community and to explore what impacts such changes would have further up the food chain.
- ***To quantify and describe processes that link sea ice, and primary and secondary productivity.*** The linkage between the physical environment and the Antarctic marine food web is poorly understood at present. ACE CRC research will result in models of the small scale processes linking the physical and biological components of the system. The models will be used as the basis for predicting the impacts of physical or biological changes on the overall function of the Antarctic marine ecosystem.
- ***To project the effects of long-term change on Antarctic ecosystems.*** The Antarctic environment is highly variable in space and time. We need to account for this variation in ecosystem processes in order to develop accurate predictive models for the Southern Ocean. We also need improved models to predict how local changes caused by climate change and fisheries might impact the greater ecosystem. ACE CRC scientists are using remote sensing of ocean colour and water movements, as well as field-based oceanographic and biological measurements, to improve our abilities to accurately model the effects of ocean circulation and sea ice on biological productivity.
- ***To translate predictions of the effects of climate change on Southern Ocean ecosystems into sustainable management models.*** A combination

of field data and models will be used to predict the effects of ecosystem changes on harvested species and the food web. This work will also be used in combination with credible models of fishery dynamics to promote more effective management of marine living resources.

Overview

Most marine life is found in the surface mixed layer of the ocean, typically to about 200 metres deep, where light from above and nutrients from below provide the foundations of productivity. Many of the vertebrate species (e.g., whales, seals and penguins) of the Antarctic region are of high conservation value and depend primarily on Antarctic krill for food. The current inability to predict the effects of environmental changes on their populations makes it difficult for bodies such as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the International Whaling Commission (IWC) to establish sound long-term management strategies.

Australian research has already highlighted the structure and dynamics of the krill-based Southern Ocean ecosystem. Much of this research has led to the adoption by CCAMLR, to which Australia is a signatory, of many precautionary proposals for management of biological resources around Antarctica. CCAMLR manages the krill harvest, which is the Antarctic's largest fishery and the one with the greatest potential to impact widely on the food web in the region. The krill fishery is projected to expand into one of the world's largest fisheries, yet the effects of climate change on krill stocks, and on the species dependent on krill (seabirds, penguins, seals and whales), are unknown.

The ACE CRC is examining the predicted environmental changes and their implications for sustainable management of Southern Ocean fisheries and the marine life protected through CCAMLR. During the first two years, we developed a framework for elaborating ecosystem models of the Southern Ocean and created conceptual ecological models for key taxa, including krill, in the Antarctic marine food web. We also analysed large-scale datasets of ice and ocean colour to elaborate an empirical model of primary production in the sea ice zone of eastern Antarctica and made substantial progress in developing under-ice sensing capability to measure *in situ* chlorophyll abundance in the sea ice zone.

Key achievements 2005-06

- *Completion of BROKE-West Survey:* The BROKE-West expedition surveyed more than 1 million square kilometres of the Southern Ocean, gathering data on krill populations and physical oceanographic properties.
- *Proposal for multidisciplinary sea ice study in 2007:* A 30-day early season cruise was approved by both the Physical Sciences and the Life Sciences Antarctic Research Assessment Committee (ARAC).
- *Sea ice algal distribution:* A conceptual model for large-scale sea ice algal distribution was developed.
- *Krill population model:* A spatially-structured krill population model based on empirical measurements was developed for the southwest Atlantic.
- *Physical regionalisation of the Southern Ocean:* Methods have been developed to assist in compartmentalising the ecosystem models as well as for providing a foundation for reviewing the biological diversity in the Southern Ocean.

Plans for 2006-07

- Testing of optical sensor (hyperspectral radiometer) for remote and non-invasive determination of ice algae distribution (*Polarstern* cruise).
- Coordination of multidisciplinary sea ice cruise (September 2007).
- Scoping out the development of the fully-coupled biophysical model.
- Completion of the physical regionalisation of the Southern Ocean.
- Further development of components of a Southern Ocean ecosystem model, particularly model linkages between the physical environment and krill productivity.
- Analysis and publication of BROKE-West results.

Project reports

AME-01: Dynamic modelling of the Antarctic marine ecosystem

Project leader

Andrew Constable, AAD

Project staff

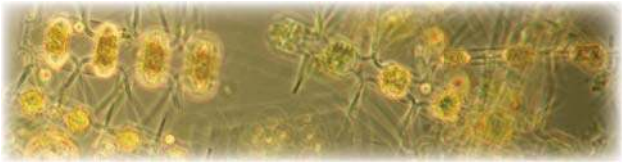
B Pasquer, K Meiners, G Williams, M Mongin, S Marsland, T Roy, ACE; P Heil, R Leaper, L Emmerson, I Ball, S Candy, S Frydman, R Warner, AAD; J Roberts, TPAC

Project Aim

We are developing a framework for marine ecosystem modelling, including a coupled biophysical model of the Southern Ocean, in order to explore and assess the consequences of historical exploitation of biota in the Southern Ocean, the ecological sustainability of exploitation and conservation strategies in the Southern Ocean, and the impacts of climate change on the ecology of the Southern Ocean. A key outcome will be to provide flexible software that can be used by researchers to simulate the Southern Ocean ecosystem at any scale.

Key achievements in 2005-06

- Development of a spatially-structured krill population model for the southwest Atlantic based on empirical measurements of the relationship of growth, reproduction and recruitment to sea surface temperature, chlorophyll and sea ice concentration and extent.
- Development of a prototype interface for the ecosystem modelling framework to assist users in managing computer simulation code, input parameters as well as output data, graphics and analytical routines.
- Development of an algorithm to divide the Southern Ocean into bio-physical regions using satellite data on sea surface height, temperature, chlorophyll, sea ice concentration and bathymetry. These bio-physical regions will be used to assist in compartmentalising the ecosystem models, as well as to provide a foundation for reviewing the biological diversity in the Southern Ocean.
- Initial development of a one-dimensional model linking physical parameters, primary production and secondary production (krill).



AME-02: Processes linking physical and biological elements in the sea ice zone

Project leader

Klaus Meiners, ACE CRC

Project staff

S Nicol, A Constable, T Jarvis, B Raymond, A Davidson, S Wright, S Kawaguchi, V Lytle, A Worby, R Massom, AAD; A McMinn, UTAS; G Williams, S Marsland, ACE

Project Aim

Our aim is to identify and quantify the relative importance of processes that link physical and biological elements of Antarctic marine ecosystems in the sea ice zone. In particular, we are evaluating the effect of sea ice on the productivity of these ecosystems.

The results will provide information for the development and validation of an ecosystem modelling framework that will enable assessments of the impact of historical and potential future changes on Antarctic marine ecosystems. The findings of the project will help improve the science-based development of sustainable management and conservation plans by CCAMLR and the International Whaling Commission (IWC).

Key achievements in 2005-06

- Development of conceptual model for the large scale-distribution of sea ice algae off East Antarctica.
- Proposal for multidisciplinary sea ice study in 2007 (early season cruise, 30 days ship time) approved by both the Physical Sciences and the Life Sciences Antarctic Research Assessment Committee (ARAC).

AME-03: Factors influencing large-scale regional dynamics

Project leader

Steve Nicol, AAD

Project staff

G Williams, K Meiners, R Massom, ACE; B Raymond, AAD; M Hindell, UTAS

Project Aim

Our goal is to describe the large-scale relationships between the biological patterns and oceanographic processes of marine ecosystem of the Southern Ocean around East Antarctica and to use this knowledge to assess the impact of climate change. This research will provide information that can help guide Australian government and industry decision-makers in the formulation of policy and management strategies in response to future climate change.

Key achievements in 2005-06

- Workshop on East Antarctic change.
- Review paper in *Nature* on the polar ocean ecosystems and climate change (August 2005).
- Presentation of a number of interdisciplinary talks and posters at the international Dynamic Planet meeting in Cairns in August.
- Publication of conceptual model of krill life history in relation to physical environment (February 2006).
- Submission of 2 manuscripts analysing 2003 KAOS data to SO-GLOBEC special Issue (December 2005).

AME-04: BROKE-West – an integrated survey of the waters between 30° and 80° East (CCAMLR Division 58.4.2)

Project leader

Steve Nicol, AAD

Project staff

G Williams, K Meiners, ACE; J Gedamke, G Hosie, T Jarvis, S Kawaguchi, G Roberston, B Raymond, S Wright, AAD; D Thiele, Deakin University; T Trull, N Bindoff, UTAS/CMAR; F Volckaert, Universiteit Leuven

Project Aim

Our aim is to survey the krill biomass in the southwest Indian Ocean between 30° and 80°E in January-March 2006 and to obtain a full suite of ecological measurements in order to estimate the relationships in this region between key physical ocean parameters, primary productivity and important biota, including krill and krill predators. The estimate of krill biomass will be used by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to update the out-of-date precautionary catch limit in the CCAMLR Division 58.4.2. The results of this project will be used as foundation material for the other projects in the program.

Key achievements in 2005-06

- Completion of BROKE-West Survey.
- Holding of the first BROKE-West workshop to plan publication for results (May 2006).

antarctic marine ecosystems

Progress against contractual milestones

Outcome: Estimates of sea level change resulting from anthropogenic climate change used as one of the bases for intergovernmental climate change negotiations.

Output / Milestone	Date	Progress
Incorporation of physical and biological information into Antarctic ecosystems model	2005-09	A spatially-structured krill population model for the southwest Atlantic has incorporated satellite data (sea surface temperature, sea ice and chlorophyll) as primary drivers of the dynamics of krill populations. ACE CRC staff are centrally involved in coordinating the compilation and review by CCAMLR and the IWC of food web parameters for use in Antarctic food web models. Physical data have been compiled for use in delineating physical subdivisions of the Southern Ocean for the purposes of modelling.
Development of under-ice remote sensing instrumentation for AUV	2004	Project submitted through the AAD's assessment process and was highly rated and received approval (Nicol). Joint proposal with UK colleagues to the UK NERC to use *Autosub* failed on technical grounds. Research plan being modified to proceed with other technology (Nicol). Optical sensor package has been purchased and will be tested in under-ice conditions during upcoming fieldwork (*Polarstern* cruise, Aug-Oct 2006) (Meiners). Contact with AUV developing team from CSIRO Marine Research established. AUV will be available for early season cruise in September 2007. Sensor will be coupled to AUV platform in early 2007 (Meiners).
Testing of the hypothesis that there has been a major change in sea-ice extent in the 1950s and 1960s using data from ice cores, sediment cores, penguin rookeries and operational data	2005	Available data has been assembled and a workshop held in September 2005 (the East Antarctic Workshop) to begin the analyses (Hindell). Biological data for eastern Antarctica was more sparse than anticipated. A review is currently underway to determine what can be achieved with the limited data available. Analyses will be supplemented by statistical and dynamic modelling.

Output / Milestone	Date	Progress
Submission to CCAMLR of an estimate of the biomass of krill in Division 58.4.2	2006	BROKE-West collected the data on which the biomass estimate will be based. Data currently being analysed and will be submitted to the intersessional meeting of CCAMLR's WG-EMM in July 2006 (Nicol).
Autumn/winter/spring process study voyages	2007-09	Discussions on this voyage are occurring and it has been included in the AAD's forward plans (Nicol). BROKE-West study (Jan-Mar 2006) completed, late winter/ spring cruise with AWI in Aug-Oct 2006 in preparation, proposal for spring study in 2007 approved by ARAC (see above) (Meiners).
Development of an observation-based model that links physical variables (sea ice, oceanography, meteorology) with biological productivity at the primary and secondary levels	2008	Progress has been made on this model and a poster has been presented at the ACE CRC Symposium and at the Dynamic Planet meeting in Cairns in August 2005 (Nicol). Conceptual sea ice algae distribution model developed (Meiners).
Development of a region-based predictive model that integrates existing climate models with higher trophic level ecosystem models	2010	Spatially structured models have been successfully developed (Constable). All work is feeding into this process (Nicol).

sea-level rise

Sea-level rise as a result of climate change may affect millions of people worldwide in coming years. A combination of higher sea level, possibly combined with stronger winds, could also cause more frequent flooding in coastal lowlands and put billions of dollars of coastal development at risk.

Scientists in the ACE CRC Sea-level Rise Program are helping Australia prepare for these possibilities by improving our ability to project and respond to future changes based on better understanding of historical sea-level change and the factors that contributed to it.

Program Leader

Dr John Church

CSIRO Marine & Atmospheric Research

Program Objectives

- ***To narrow estimates of the range of 20th century global-averaged and regional sea level rise.*** Through analyses of historical and new data, including tide-gauge records and satellite-altimeter measurements, ACE CRC researchers are significantly enhancing our knowledge of sea-level rise over the past century. This knowledge is improving our ability to test models that project future sea levels and increasing our confidence in those projections.
- ***To improve estimates of the different contributions to 20th century sea-level rise.*** ACE CRC scientists are using *in situ* and satellite observations and measurements, combined with computer modelling, to improve our understanding of how different processes interacted to affect sea-level rise and its regional distribution during the 20th century. This will help reduce uncertainties in future projections, especially at regional and local scales.
- ***To significantly reduce the range of 21st century projections of sea-level rise.*** ACE CRC research results are helping increase the precision of projections for global average and regional sea levels in the 21st century to enable society to develop appropriate responses to projected changes.
- ***To forecast change in extreme events during the 21st century for strategic locations.*** ACE CRC researchers are assessing how climate change will affect the frequency and intensity of natural extreme events around Australia and selected South Pacific locations. This will help coastal planners assess the vulnerability of different parts of the coastline and provide guidance for adaptation and mitigation strategies to protect coastal communities and assets.
- ***To address key uncertainties in the longer-term projections of sea level rise.*** Sea level will continue to rise after 2100, potentially by several metres, because of ongoing warming and resultant expansion of the ocean, as well as changes in the Antarctic and Greenland Ice Sheets. The rate and amount of rise are uncertain, however, and reducing that uncertainty is another focus for ACE CRC research.

Overview

Current uncertainties in projections of sea-level rise are dominated by uncertainties in models (e.g., from differences between models of ocean thermal expansion) rather than uncertainties in projected greenhouse gas emissions. By advancing our understanding of historical sea-level rise and the factors contributing to it, the Sea-level Rise Program aims to reduce uncertainties related to estimates of 20th century sea-level rise and projections for the 21st century and beyond. More reliable projections of sea-level rise and estimates of potential changes in sea-level variability (particularly related to extreme events, such as severe storms and tidal surges) will allow better planning of coastal land use and development of infrastructure to minimise the impacts of sea-level rise and any changes in the intensity/frequency of extreme events. The results will contribute directly to the IPCC Assessment Reports. Decreased uncertainties are also important in successful intergovernmental negotiations under the United Nations Framework Convention on Climate Change.

In the past two years, the Sea-level Rise Program has made significant progress towards its objectives. Among other accomplishments, we have reduced the uncertainty range for estimates of global averaged sea-level rise by about a factor of two and produced estimates of ocean thermal expansion that will appear in the IPCC 4th Assessment Report.

In collaboration with Tasmanian Government and local councils, we established a community monitoring program (Tasmarc) to measure beach movements. Three of our researchers also served on the Tasmanian Sea-level Rise Reference Group (convened by DPIW), which released a sea-level rise information sheet and a Tasmanian Vulnerability Study.

Key achievements 2005-06

- *Impact of volcanic eruptions:* Showed that volcanic eruptions have a significant impact on ocean heat content and steric sea level. Post-1960 volcanic eruptions masked part of the acceleration that would otherwise have been present (*Nature*, 2006).
- *Rate of sea-level rise:* Showed that the rate of sea-level rise has increased during the 20th century and provided the first comprehensive estimate of the rate of sea-level rise during the latter half of the 20th century for Pacific and Indian Ocean islands.
- *International involvement and recognition:* ACE CRC scientists convened and participated in the World Climate Research Programme (WCRP) Sea-level Rise workshop in June 2006. SLR Program leader John Church was elected as chair of the Joint Scientific Committee of the WCRP and SLR scientist Kurt Lambeck was elected as President of the Australian Academy of Sciences.
- Detected a small positive mass budget over the upper part of Law Dome using a 40-year record from gravity surveys. This surface rise is consistent with a snow accumulation rate increase since the 1960s.
- Detected episodic rift propagation from analysis of passive seismic observations and GPS measurements, and assessed rift propagation on the Amery Ice Shelf by satellite image analysis.
- Showed a decrease in extent of the Shackleton and West Ice Shelves from a century of historical records.
- Applied our ice shelf model to the Mertz Glacier tongue and explored changes in flow and ice thickness arising from projected increased basal melting expected under projected climate change.
- Advanced our reassessment of East Antarctic mass budget using ANARE historical field data, and presented results at WCRP Sea-level workshop.
- Used satellite imagery to undertake the first survey of iceberg numbers and size characteristics around the entire Antarctic coastal seas.
- A number of refinements to the methodological approach for estimating event probabilities for storm surge from grided model output have been made and incorporated in a study on the effects of climate change on storm surges along the east Victorian coast.
- The east Victorian study results have been downscaled to high spatial scale over Corner Inlet and the Gippsland Lakes and the effect of various climate change scenarios on inundation extent have been modelled.

sea-level rise

Plans for 2006-07

- An estimate of the rate of sea-level rise from the presently un-analysed Hobart record and addition of this data set to the PSMSL data set.
- Estimates on the frequency of extreme events for selected location in Australia and the South Pacific.
- Publish paper on historical rates of sea level rise around Australia.
- New estimates of ocean thermal expansion using reduced space optimal interpolation techniques for historical data and the ongoing international *Argo* Program.
- Use new Radio-Echo-Sounding data on the ice thickness around the coastal sector of the Antarctic ice sheet between longitude 130°E and 80°E (obtained in collaboration with Italy) to improve estimates of the discharge of grounded ice in this sector.
- Incorporate a new parameterization of the growth of frazil ice (developed in collaboration with NIWA) in a sub-ice shelf ocean circulation model to advance understanding of marine ice accretion beneath ice shelves.
- Interpret new Radio-Echo-Sounding data of ice thickness for the Amery Ice Shelf to determine the distribution of melt – freeze regions under the central part of the ice shelf (in collaboration with Italy).
- Couple our time-evolving ice shelf model to a sub-ice ocean circulation model and validate the performance with new field results from the Amery Ice Shelf. Use this coupled model to investigate the consequence to grounded ice discharge of ice shelf change.
- Extend ice shelf model to include the ice stream to ice shelf transition, exploring the response of the grounded ice sheet and hence of sea-level to ice shelf changes.
- The effects of climate change on storm surges along the west Victorian coast and the northern Tasmanian coast will be undertaken.
- Scenarios of future changes to wind and extreme storm events along the NSW coast will be undertaken as a first step towards assessing the likely effects of climate change on storm surges along this coastline.
- A journal paper on the work completed to date for Bass Strait will be prepared and submitted to a suitable journal.

Project reports

SLR-01: Observations of sea-level rise

Project leader

John Church, CSIRO

Project staff

N White, CMAR; J Hunter, ACE; R Coleman, UTAS; K Lambeck, T Purcell, ANU; H Brolsma, R Handsworth, AAD

Project Aim

The project will produce new estimates of historical sea-level change and changes in the observed frequency of extreme events. These estimates are an essential element in the Intergovernmental Panel on Climate Change Assessment Reports.

Key achievements in 2005-06

- Showed that the rate of sea-level rise has increased during the 20th century.
- Provided the first comprehensive estimate of the rate of sea-level rise during the latter half of the 20th century for Pacific and Indian Ocean islands.
- ACE CRC scientists convened and participated in the WCRP Sea-level Rise workshop in June 2006.

SLR-02: Estimates of ocean thermal expansion

Project leader

John Church, CSIRO

Project staff

N White, S O'Farrell, CSIRO; N Bindoff, UTAS/ CMAR

Project Aim

Increased confidence in our understanding of changes in sea level during the 20th century is dependent on more accurate estimates of observed 20th century thermal expansion and the confirmation that climate models are realistically simulating observations. This confirmation will result in reduced uncertainty of future projections of thermal expansion.

Key achievements in 2005-06

- Showed that volcanic eruptions have a significant impact on ocean heat content and steric sea level (*Nature* 2005). Post-1960 volcanic eruptions masked part of the acceleration that would otherwise have been present.
- Nearing completion of a new observational estimate of ocean thermal expansion for the 1990s and the period 1960 to 2000.
- Demonstrated that modelled and observed sea level display similar signatures of atmospheric, oceanic and coupled variability in both control and transient simulations. The longest modes of variability are driven by the ocean thermohaline circulation, with periods of 20-70 years.

SLR-03: Ice sheet and glacier contributions to sea-level rise

Project leader

Ian Allison, Australian Antarctic Division (AAD)

Project staff

N Young, R Warner, AAD; J Hunter, ACE; N Adams, BOM; S O'Farrell, CMAR

Project Aim

The balance between accumulation of ice and snow on ice sheets and the discharge of water to the sea from them determines the influence of the ice sheets on global sea level. This project will deliver more robust estimates of snow and ice accumulation on the Antarctic and Greenland continents during the 20th and 21st centuries. Modelling of these ice sheets will also deliver estimates of longer-term contributions to changes in sea level from ice discharge or melt water from Greenland and Antarctic Ice Sheets. We will draw on international efforts to estimate contributions to changes in sea level from glacier melting as well as from ice sheets. These improved projections will, in turn, guide Australian decision-makers in the formulation of policy and management strategies to respond to sea level change induced by climate change.

Key achievements in 2005-06

- Detected a small positive mass budget over the upper part of Law Dome using a 40-year record from gravity surveys. This surface rise is consistent with a snow accumulation rate increase since the 1960s.
- Detected episodic rift propagation from analysis of passive seismic observations and GPS measurements, and assessed rift propagation on the Amery Ice Shelf by satellite image analysis.
- Showed a decrease in extent of the Shackleton and West Ice Shelves from a century of historical records.
- Applied our ice shelf model to the Mertz Glacier tongue and explored changes in flow and ice thickness arising from projected increased basal melting expected under projected climate change.
- Advanced our reassessment of East Antarctic mass budget using ANARE historical field data, and presented results at WCRP Sea-level workshop.
- Undertook the first survey of iceberg numbers and size characteristics round the entire Antarctic coastal seas using satellite imagery.

sea-level rise

SLR-04: Modelling extreme events

Project leader

Kathleen McInnes, CSIRO

Project staff

I Macadam, CSIRO

Project Aim

A primary goal of this research is to develop Australia-wide guidance about the impact of climate change on extreme sea level hazard due to the combined effect of rising sea levels and changed behaviour of severe storm events under future climate conditions. The goal, therefore, is to determine how climate change may affect the frequency and intensity of extreme sea-level events around Australia and selected South Pacific locations due to future changes in severe weather systems and increases in mean sea level.

Key achievements in 2005-06

- A study into the effect of model resolution on tropical storm intensity has been completed and a manuscript submitted to the *Journal of Climate* is now being revised.
- A study into the effect of climate change on mid-latitude storm tracks is being finalised for submission to the *Journal of Climate*.
- A number of refinements to the methodological approach for estimating event probabilities for storm surge from gridded model output have been made and incorporated in a study on the effects of climate change on storm surges along the east Victorian coast.
- The east Victorian study results were downscaled to high spatial scale (50-100 m) over Corner Inlet and the Gippsland Lakes and the effect of various climate change scenarios on inundation extent have been modelled.

Progress against contractual milestones

Outcomes:

- Estimates of sea level change resulting from anthropogenic climate change used as one of the bases for intergovernmental climate change negotiations.
- Estimates of sea level change as an essential input to coastal zone management and other planning considerations in Australia and in neighbouring nations in the South Pacific

Output / Milestone	Date	Progress
Revised estimates of historical (20th century and early 21st century) sea-level change	2004-09	2005: Published revised estimates for 1950-2000. 2005: Showed that coastal sea level is rising at about the same rate as global averaged sea level over the period 1950 to 2000. 2006: Narrowed the uncertainty of estimates of the 20th century rate of sea level rise and showed that the rate of sea level rise has increased during the 20th century. 2006: Provided the first comprehensive estimate of the rate of sea-level rise during the latter half of the 20th century for Pacific and Indian Ocean islands and for Australia since 1920.
Revised estimates of ocean thermal expansion from observations and models (both the CSIRO and AWI models)	2005-09	2005: Produced estimates of 20th century ocean thermal expansion from the CSIRO Mark 3 model that will appear in the IPCC 4th Assessment Report. 2005: Showed (*Nature* 2005) that volcanic eruptions have a significant impact on ocean heat content and steric sea level. Post 1960 volcanic eruptions masked part of the acceleration that would otherwise have been present.
Revised estimate of the 20th century Antarctic ice sheet contribution to sea-level change derived from a comparison of measured ice discharge (field observations and remote sensing) with results from a balance flux model forced with improved estimates of accumulation distribution and temporal variability (from field observations, meteorological models and ice cores)	2005-09	2005-2006: Comparison of historical field data with satellite data has detected significant ice mass loss on the Totten Glacier and a small mass gain over the Law Dome. Historical ANARE field data have been compiled for a reassessment of the East Antarctic mass budget, and some earlier regional balance estimates have been revised. These have been compared with a test run of the balance flux model using a reference accumulation compilation. Alternative descriptions of ice accumulation are being sought to explore the uncertainties in the input to the mass budget.

sea-level rise

Output / Milestone	Date	Progress
Revised projections for future sea-level change during the 21st century and on longer time-scales	2006, 2010	Showed that over the last 15 years sea levels have been tracking near the upper bound of the IPCC TAR projections (Submitted to *Nature*, 2006). Revised estimates for a number of the contribution to the rate of sea-level rise have been completed (see below) and these have been incorporated in revised projections to be published under IPCC banner early 2007.
Revised estimates of future ocean thermal expansion	2005, 2009	2005: Produced estimates of 21st century ocean thermal expansion from the CSIRO Mark 3 model that will appear in the IPCC 4th Assessment Report.
Estimate of the future contribution of the Antarctic and Greenland ice sheets to sea-level change using an improved high-resolution ice sheet-system model (including ice stream-ice shelf interaction, full thermodynamics and flow anisotropy) and changes in meteorological forcing	2010	An ice shelf ice stream transition model is under test (see next milestone). Ice deformation experiments have collected data on flow of anisotropic samples of Antarctic ice (2004-06) and theoretical models of anisotropic ice flow will be tested in 2006-07.
Estimates of the response of ice shelves to global warming from improved models of ice shelf-ocean interaction (validated against field observations and remote sensing data from the Amery Ice Shelf); prediction, from improved models of ice stream-ice shelf boundaries, of the consequence of ice shelf collapse on the discharge of grounded ice	2006-09	The ACE CRC ice shelf model has been used to explore the dynamics of the Mertz Glacier tongue and its response to global warming (2006). The model will also be applied to the larger Amery ice shelf (2006-07). The ice shelf model has also been extended (testing in progress in 2006) to study the ice stream-ice shelf transition by adding a basal friction term, to enable studies of influences on grounded ice. A model of frazil ice growth has been developed (2004-06) as a step towards understanding marine ice accretion beneath the Amery ice shelf.
Estimates of the historical impacts of sea-level change at key locations	2005	Changes in the frequency of extreme events at a number of locations have been determined. There is significant interest in these results and we are being requested to do further studies.
Estimates of the historical frequency of extreme events from observational (and proxy) records	2004	2004 and 2006: Showed that the frequency of extreme sea-level events of a given magnitude at Fremantle and Sydney has increased by about a factor of 2-3 during the 20th century.
Estimates of the expected impacts of sea-level change at key locations	2010	A study for the Victorian coast has been completed, following a pre-ACE CRC study of the Cairns area.
Selection of key locations for more detailed studies	2004	Completed 2004: South coast of Australia chosen as first study site.
Estimates of the changes in frequency of extreme events from numerical modelling studies	2009	Study completed for eastern Victorian coastline, extension to other parts of coastline is ongoing.

The Australian government is responsible for management of the world's fourth largest Exclusive Economic Zone, which includes about 16 million square kilometres of the Southern Ocean. In addition, Australia was an original signatory to the Antarctic Treaty and claims stewardship of a territory covering 42% of the Antarctic continent.

ACE CRC Policy researchers address issues that will help Australia formulate its input to Antarctic and Southern Ocean affairs and manage its interests in the region. Policy Program staff and students provide analyses of probable policy implications arising from the science programs and also provide advice to ACE CRC scientists about the major policy issues relevant to their research.

Program Leader

Assoc Prof Marcus Haward

University of Tasmania

Program Objectives

- ***To translate research outputs into forms useful to research users in the spheres of law, public policy and regulation.*** Improving integration of Australian government goals, objectives and interests into the work of the science programs increases the policy relevance of the ACE CRC's research and provides the greatest opportunity for use of relevant research in policy formulation.
- ***To identify emergent issues influencing the developments in legal and political regimes in the Southern Ocean and Antarctica.*** Scientific research on Antarctic and Southern Ocean climate and ecosystems has direct impacts on the management of the region and raises a number of policy issues. For example, improved understanding of the impacts of climate variability, and resultant changes in marine ecosystems, will affect decisions about resource use in the Southern Ocean and related ecosystems. Proposals for adaptation and mitigation strategies such as iron fertilisation or deep ocean storage of carbon dioxide need to be considered from the legal and policy perspectives as well as in terms of scientific or logistic feasibility. As climate knowledge and projections of sea-level rise improve, the definition of extremes in natural events and the degree to which they represent 'acts of God' will evolve, with ramifications for public and private relief and insurance industries. Linking ACE CRC science research on these issues to potential policy implications is a core business of the Policy Program.
- ***To contribute to improved effectiveness of public policy management arrangements and regimes governing the Southern Ocean and Antarctica.*** There are a large number of international regimes and legal instruments that affect the Southern Ocean. The ACE CRC Policy Program is exploring issues related to the effectiveness of these regimes, such as levels of compliance and enforcement, and looking at the interconnections among them. One result of this research will be advice about options for refining and improving regulatory processes underpinning such instruments to make the instruments more robust and effective.

policy

Overview

Australia will face a range of challenges over the next decade in managing its Southern Ocean and regional interests. We aim to contribute to national benefit by providing greater understanding of the nature of international marine resources and environmental regulation, the policy implications of climate change research, the patterns of interaction amongst stakeholders, and the types of institutional forms that support and/or inhibit the effectiveness of these regimes.

The Policy Program also ensures that scientific outputs from the other ACE CRC research program are able to contribute to policy development and outcomes for partner agencies and research users within Australian, State and Local Government Agencies.

A major strand of the Program's research has centred on science-policy integration over climate science and related areas and the means by which this can be improved. Members of the policy program have engaged in regular discourse with partner agencies and research users through processes such as the development of the Research Users' Forum and through project level linkages. The ACE CRC held its first annual Research Users' Forum in Canberra in late November 2004, and the second in February 2006 enabling communication of ACE CRC research to users and identification of users' interests and needs. These activities have been supported by other end-user presentations and participation in seminars.

Research on emergent issues has focused on areas such as Antarctic marine biological prospecting, examining issues and challenges in developing regulatory responses to biological prospecting. Work on human impacts in Antarctica and the Southern Ocean has identified challenges in existing management of Antarctic tourism. Research on Southern Ocean whaling has highlighted issues related to Australia's domestic legal regimes and its linkage with international instruments.

The third, related focus of the program has been linking improved understanding of the region to appropriate international regimes and to Australian policy objectives. Achievements here have included development of inventories of international regimes and Australian legislative and regulatory responsibilities, with this research providing greater understanding of the nature of international marine resources and environmental regulation, the patterns of interaction amongst stakeholders, and the types of institutional forms that may support and/or inhibit the effectiveness of the regimes.

Key achievements 2005-06

- Development and presentation of Second Research Users' Forum
- Second workshop on Australia's Antarctic Agenda in collaboration with Sydney Centre for International and Global Law
- Identification of Australian legislative and regulatory responsibilities implementing Australia's international instruments that link to ACE CRC science outputs.
- Development of new research projects on integrating climate science research and Australian public policy and managing science-intensive public policy.
- Development of internal arrangements to integrate science and policy research within the ACE CRC through establishment of ad hoc science-policy working group(s) to synthesise ACE science and policy knowledge relevant to specific tasks/outputs. The working groups will provide a mechanism for interdisciplinary discussion and for the production of specific outputs of policy-relevance to government.

Plans for 2006-07

- Development of collaborative research initiatives between the Policy Program and the Massachusetts Institute of Technology (MIT), USA including a study of the management of science-intensive public policy.
- Completion of Stage 1 of new project on institutional structures and knowledge management systems for integrating climate science research and Australian public policy.
- Continuing development of international collaboration in analysis of polar regimes.
- Completion of *Australia's Antarctic Agenda* with book publication.

Project reports

POL-01: Improving the effectiveness of Southern Ocean regimes

Project leader

Marcus Haward, UTAS

Project staff

J Jabour, R Hall, A Kellow, L Kriwoken, G Lugten, UTAS

Project Aim

We are assessing the effectiveness of relevant international and regional instruments and regimes, given domestic effect in Australia through national legislation and policy, and identifying gaps, strengths and weaknesses in these regimes. A key question is the relationship between the Law of the Sea Convention (LOSC) and the Antarctic Treaty System. While much has been written on this nexus, the question of the relationship between these instruments is not yet fully explored, nor how this relationship affects other regimes that cover the Southern Ocean.

Key achievements in 2005-06

- Refinement of inventory of regimes.
- First stage analysis linking key legislative responsibilities and international commitments with ACE CRC science outputs.

POL-02: Whaling and the management of cetaceans in the Southern Ocean

Project leader

Julia Jabour, UTAS

Project staff

E Molenaar, UTAS/NILOS

Project Aim

This research addresses the pro-whaling/conservation deadlock in the IWC over whaling in the global oceans, and the Southern Ocean in particular, from the Australian strategic policy perspective. The Southern Ocean is a whale sanctuary under the International Convention for the Regulation of Whaling, with limited prescribed scientific research by lethal means (scientific 'whaling'). Australia is fundamentally opposed to the use of lethal techniques in research on cetaceans and recently transferred responsibility for cetacean conservation to the Australian Antarctic Division.

Key achievements in 2005-06

- Project was competed in August 2005 and copies of the report were circulated to four key Australian Government stakeholders.
- The project determined that Australia's current policy position raises consistency issues under international law related to the principal of 'good faith'.
- The report is being converted into a 7,000 word book chapter for publication in another ACE CRC Policy Program output – a proposed book entitled *Australia's Antarctic Agenda* that also involves research outcomes from POL-01 and POL-05.

POL-03: The challenges for demersal and pelagic fisheries management in the Southern Ocean

Project leader

Marcus Haward, UTAS

Project staff

G Lugten, UTAS; E Molenaar, UTAS/NILOS

Project Aim

This research centres on the problems of illegal, unreported and unregulated (IUU) fishing in the Southern Ocean and within the Exclusive Economic Zones (EEZs) of states, including the Australian EEZ off Heard and Macdonald Island and Macquarie Island. It addresses the efficacy of existing instruments, institutions and practice, including the science-policy interface, to combat this problem.

Key achievements in 2005-06

- Publications on enforcement and compliance in Southern Ocean fisheries.
- Completion of survey on the extent of the science-policy gap in marine resource management.

POL-04: The management of 'associated and dependent species'

Project leader

Marcus Haward, UTAS

Project staff

R Hall, J Jabour, G Lugten, L Kriwoken, UTAS

Project Aim

This project is focused on the development of legal and political responses to the problem of managing impacts on associated and dependent species (ecosystem-based management). Our research is addressing the development and implementation of marine protected areas (MPAs), and examining tools and approaches that can be used to facilitate the implementation of the Agreement for the Conservation of Albatross and Petrel species. Improved understanding of the impact of climate change on the environment through ACE CRC research in other programs, and the integration of this research into management of areas and species is an expected outcome.

Key achievements in 2005-06

- Completion of research using sea bird at sea data as surrogates for identification of potential marine protected areas.
- Presentation on institutional arrangements for deep sea high seas marine protected areas outside national jurisdiction at International Marine Protected Area Conference (IMPAC).
- Presentations of use of sea bird at sea data and on management options for deep sea high seas marine protected areas at IMPAC.
- Contribution of paper, Review of criteria for the identification of internationally important breeding sites critical for species listed in Annex 1 of the Agreement on the Conservation of Albatrosses and Petrels, to the Advisory Committee for the Agreement for the Conservation of Albatrosses and Petrels.

POL-05: The nexus between the Law of the Sea Convention and the Antarctic Treaty System in marine areas south of 60°S

Project leader

Marcus Haward, UTAS

Project staff

J Jabour, R Hall, A Kellow, G Lugten, L Kriwoken, UTAS

Project Aim

The intersection of the Law of the Sea Convention (LOSC) and the Antarctic Treaty System (ATS) has helped focus attention on sovereignty. The declaration of maritime zones off the Australian Antarctic Territory (AAT) has been controversial, but resolved by not enforcing territorial sea rights. The question of delimitation of the continental shelf of the AAT posed important political and legal challenges to Australia, but also a dilemma in relation to its interests. Asserting rights under the LOSC may directly challenge the primary objective of maintaining the ATS and enhancing Australia's influence within the system. This project is analysing the extent to which these regimes are converging or diverging, and examining the implications for Australia's interests in the management of the Southern Ocean.

Key achievements in 2005-06

- Holding of second phase workshop on Australia's Antarctic Agenda, with focus on possible and actual tensions between Australian sovereignty and management of AAT – particularly in relation to maritime zones off the AAT.
- Completion of research on legal issues surrounding whaling in the Southern Ocean and links to questions surrounding Australian territorial sea and EEZ off the AAT.
- Identification of current limitations on management and regulation of marine biological prospecting in the Southern Ocean, linking marine scientific research under LOSC with relevant principles within the ATS.

POL-06: Impacts of potential sea-level rise for current and future coastal zone management, including policy implications of climate variability and change

Project leader

Marcus Haward, UTAS

Project staff

A Kellow, UTAS

Project Aim

The Australian coastline borders a number of biogeographical regions, each containing a diversity of marine habitats. Australian coastal policy is shaped by the political, legislative and administrative overlap in interests and responsibilities among the Commonwealth, State and local governments. This project focuses on the extent to which current legal, administrative and institutional arrangements can manage the impacts of climate variability and change, including sea-level rise, in the coastal zone.

Key achievements in 2005-06

- Publication of ACE CRC Technical Report No 2, Sea-level Rise and Coastal Settlements: An Analysis of Adaptive Decision Making Within Integrated Coastal Zone Management (Rigby 2005). This report focused on risk assessment and institutional arrangements affecting potential sea level rise within coastal zone management.
- Presentation of project results to Tasmanian government through briefing to state government officials and submission of report.

POL-07: The ocean's role in the carbon cycle: Legal and political implication of large-scale ocean sequestration through iron fertilisation in the Southern Ocean

Project leader

Marcus Haward, UTAS

Project staff

A Kellow, J Jabour, UTAS

Project Aim

A number of political and legal issues have arisen as a result of increased research into the ocean's role in the carbon cycle. The theoretical potential for enhancement of natural sequestration of CO_2 by the ocean is yet to be proven, but experiments in 'iron fertilisation' are already raising concern over its potential impact on ecosystems. We are analysing the legal regimes and policy development governing iron fertilisation with a focus on the differences in regulation of marine scientific research and commercial activities, both inside EEZs and in the high seas.

Key achievements in 2005-06

- Analysis of debates over application of London Dumping Convention (the international Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter) affecting potential 'iron fertilisation' and/or oceanic CO_2 sequestration within Exclusive Economic Zones and in the high seas.
- Identification of emerging legal issues surrounding oceanic CO_2 sequestration.
- First stage analysis of extent to which London Dumping convention can regulate oceanic CO_2 sequestration.

Progress against contractual milestones

Outcomes:

- Delivery of science outputs to research users.
- Improved Australian influence in and effectiveness of Southern Ocean management regimes.

Output / Milestone	Date	Progress
Organise & host Annual research users' forum	2003-10	Development and delivery of successful Research Users' Forum (November 2005 and February 2006) and targeted follow-up (March-April 2006)
Improve responses to emergent issues	2003-10	Development of internal ACE CRC science policy working groups
Identify and, with science programs, provide policy users with details on emergent issues and likely impacts on Southern Ocean management regimes	2003-10	Presentations at Research Users' Forum November 2005 and February 2006
Identify emergent issues e.g. bio-prospecting, iron fertilisation	Ongoing	Completion of project on regulatory issues surrounding marine biological prospecting in the Southern Ocean (June 2006)
Complete an inventory of Southern Ocean management regimes	2004	2004: Inventory completed
Critical review and assessment of regimes	2006	Review underway, leading to first stage analysis linking key legislative responsibilities and international commitments with ACE CRC science outputs
Identify gaps in regimes	2008	Research ongoing, milestone expected to be reached on schedule
Establish criteria for assessment of Australian influence in, and the effectiveness of, Southern Ocean management regimes	2004	2004: Draft criteria developed
Establish assessment criteria to measure influence and effectiveness	2006	Work on criteria continuing, milestone to be completed December 2006
Assess Southern Ocean management regimes against criteria	2008	Research ongoing, milestone expected to be reached on schedule
Completion of project; recommendations to government	2010	Milestone expected to be reached on schedule

The nature of Antarctic and global climate research is such that collaboration is essential. The study of global climate is multidisciplinary by nature, and relies on a wide range of research conducted by multiple organisations in many countries. For Antarctic research, distances are vast, conditions are harsh and costs are enormous.

The ACE CRC's collaborative efforts result in increased logistical and scientific support – such as ship time, satellite data, and access to computer facilities, data bases and models – that is necessary to maintain Australia's leadership position in this field of research.

In addition to ongoing the collaborations among the different research programs within the ACE CRC, our researchers are involved in 43 national collaborative projects and 82 international collaborative projects involving 17 different countries. They also served on 23 national and 51 international committees.

Collaborative projects, committee memberships, staff exchanges, international visitors, research consultancies and grants are detailed in the following tables.

National collaborative projects

Project	ACE Researcher(s)	Collaborator(s), Affiliation
Response of Southern Ocean circulation to scenarios of protracted elevated greenhouse gas concentrations	Bi D, Hirst A	Budd B, *UTAS* (Retired)
The ARC Earth System Science Network (ARC Network)	Bindoff N, Coleman R	Pitman A, *Macquarie University*
Australian Community Ocean Model	Bindoff N, Roberts J, Heil P	Alves O, *BMRC*
Targeting organically-complexed iron species in seawater using selective solid-phase adsorbent resins	Bowie A	Haddad P, School of Chemistry, *UTAS*
Exopolysaccharides from Antarctic bacteria	Bowie A	Mancuso-Nichols C, *School of Agricultural Science, UTAS*
Iron content of Southern Ocean phytoplankton: implications for carbon transfer to the deep sea	Bowie A	Townsend A, *Central Science Laboratory, UTAS*
Selenium as a key micronutrient in primary productivity in the Southern Ocean	Bowie A	Butler E, *CSIRO Marine and Atmospheric Research*
Looking back to see the future: Change in the Lambert Glacier and the East Antarctic Ice Sheet (ARC Discovery)	Coleman R	Lambeck K, Fabel D, Tregoning P, *ANU*; Fink D, *ANSTO*
Winter temperature and salinity measurements in the Southern Ocean using elephant seals as ocean observing platforms (ARC Discovery)	Coleman R, Rintoul S	Hindell M, *UTAS*; Michael K, *IASOS*

research collaboration

Project	ACE Researcher(s)	Collaborator(s), Affiliation
Reassessing the mass balance of Law Dome and the adjacent main plateau basin (AAS grant)	Coleman R, Young N	Morgan P, *University of Canberra*; Lackie M, *Macquarie University*
Tasmanian Shoreline Monitoring Project in Northern Tasmania (IRGS grant)	Coleman R, Hunter J	Hennecke W, *UTAS*
The role of Antarctic marine protists in trophodynamics and global change and the impact of UV-B on these organisms	Davidson A	Jones G, *Southern Cross University* (NSW)
UV climate over the Southern Ocean south of Australia, and its biological impact	Davidson A	Michael K, *IASOS*; Nuñez M, *UTAS*; Jones G, *Southern Cross University* (NSW)
Broke-West investigation of western Antarctica oceanography	Griffiths B	Westwood K, *AAD*
Australia's Antarctic Agenda	Haward M	Rothwell D, *Sydney Centre for International and Global Law*, *University of Sydney*; Rayfuse R, *University of New South Wales*
Australia Canada Ocean Research Network	Haward M	Rothwell D, *Sydney Centre for International and Global Law, University of Sydney*
AUSCOM	Heil P	Bindoff N, Roberts J, *TPAC*
Modelling Oceanic DMS Emissions	Hirst A	Gabric A, *Griffith University*
Circumpolar Deep Water behaviour in CSIRO Mk2 coupled model	Hirst A, O'Farrell S	England M, Santoso A, *University of New South Wales*
Antarctic Bottom Water and Intermediate Water variability in CSIRO Mk 3 model	Hirst A, O'Farrell S	England M, *University of New South Wales*
Subantarctic Mode Water variability and change in CSIRO Mk 3 model	Hirst A, O'Farrell S	Ribbe J, *University of Southern Queensland*
ARC Network for Earth System Science	Howard W	Pitman A and other members of ARCNESS, *Macquarie University*
OZ-INTIMATE (INTegration of Ice-core, Marine and TErrestrial records – a core programme of INQUA (International Union for Quaternary Research)	Howard W, van Ommen T	Turney C and other INTIMATE Members, *University of Wollongong*
Tasmanian Shoreline Monitoring and Archiving Project	Hunter J	Sharples C, *Consultant*
Australia's Antarctic Agenda	Jabour J, Lugten G	Rothwell D, *Sydney Centre for International and Global Law*
Impact of patterns of anomalous atmospheric circulation on sea ice and biota	Massom R	Pook M, *CMAR*
Impact of patterns of anomalous atmospheric circulation on the break-up of the Larsen B Ice Shelf	Massom R	Simmonds I, *University of Melbourne*
Effect of climate change and coastal primary productivity	McMinn A	Ralph P, *UTAS*
Sea ice primary production off eastern Antarctica	Meiners K	McMinn A, *UTAS*
Isotopic and elemental tracers in ice and snow	Morgan V	Rosman K, *Curtin University of Technology*
Signature Lipids in Food Webs	Nichols P	Danaher K, *James Cook University*; Virtue P, *IASOS*; Hindel M and students, *UTAS*
BROKE-West survey of the waters off East Antarctica (30-80°E)	Nicol S	Gedamke J, Hosie G, Gales N, Jarvis T , Kawaguchi S, Robertson G, Wright S, *AAD*; Thiele D, *Deakin University*; Jones G, *Southern Cross University*; Mitchell J, *Flinders University*

Project	ACE Researcher(s)	Collaborator(s), Affiliation
10Be in Antarctic ice and Radiomethane in Antarctic ice	Pedro J, Morgan V, Curran M, van Ommen T, Smith B	Smith A, *ANSTO*
The CSIRO Mk3L climate system model	Phipps S, Roberts J, Bindoff N, Hyland G	England M, *ARC Research Network for Earth System Science*
Climate Change Science Program	Rintoul S	*Australian Greenhouse Office*
Biogeochemical modelling; ocean climate change modelling; marine climate impacts	Rintoul S	*Wealth from Oceans National Research Flagship*
Southern Ocean Climate Dynamics	Rintoul S	England M, *University of New South Wales*
Managing science-intensive public policy conflicts	Sandford R	Ross H, Baldwin C, *School of Natural & Rural Systems Management, University of Queensland*; Tan P-L, Griffith Law School, *Griffith University*
Changes in the water balance over the ice sheets	Smith I	Watson C, *University of Melbourne*
East Antarctic and circum-Antarctic climate history from ITASE coring in Eastern Wilkes Land	van Ommen T, Curran M, Morgan V, Smith B	Goodwin I, *University of Newcastle*
Air sampling from Antarctic firn and ice	van Ommen T, Morgan V	Etheridge D, MacFarling-Meure C; *CMAR*
Ship-based electromagnetic measurements of sea ice thickness	Worby A	Reid J, *UTAS*
The role of Antarctic marine protists in trophodynamics and global change and the impact of UV-B on these organisms	Wright S, Davidson A, Marchant H	Jones G, *Southern Cross University*

International Collaborative Projects

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
Prediction of the future mass balance of the polar ice sheets under a range of possible climate conditions	Allison I	Gogineni P, *SF Science and Technology Center for Remote Sensing of Ice Sheets, University of Kansas* (USA)
Surface meteorological measurements in East Antarctic using automatic weather stations	Allison I	Bian L-G, Qin D-H, Xiao C, *Chinese Meteorological Administration* (CHINA)
Amery Ice Shelf – ocean interaction and marine ice properties	Allison I, Craven M	Li Y-S, Cai M, *Polar Research Institute of China* (CHINA)
Australia-UK collaboration for the Exploitation of Grid and Geospatial Standards?	Bindoff N, Roberts J, Hyland G	Woolf A, *CCLRC Rutherford Appleton Laboratory* (UK)
Iron atmospheric inputs to the Sargasso Sea: temporal variability and impact on iron distribution in the upper ocean	Bowie A	Sedwick P, *Bermuda Biological Station for Research* (BERMUDA); Church T, *University of Delaware* (USA)
Targeting organically-complexed iron species in seawater using selective solid-phase adsorbent resins	Bowie A	Worsfold P, *University of Plymouth* (UK)
Sampling and analysis of iron in seawater (SAFE), an international community-wide intercomparison exercise for the certification of iron in seawater	Bowie A	Johnson K, *Monterey Bay Aquarium Research Institute*; Boyle E, *Massachusetts Institute of Technology*; Moffett J, *Woods Hole Oceanographic Institution*; Bruland K, *University of California, Santa Cruz*; Measures C, *University of Hawaii*; Coale K, *Moss Landing Marine Laboratories* (USA)

research collaboration

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
Kerguelen: compared study of ocean and plateau in surface waters (KEOPS), program examining the effects of natural iron fertilization on Southern Ocean ecosystems and carbon sequestration	Bowie A, Trull T, Griffiths B, Remenyi T, Armand L, Ebersbach F	Blain S, Quéguiner B, Jeandel C, *Centre d'Oceanologie de Marseille Observatoire Midi-Pyrénées* (FRANCE)
Trace element (Al and Fe) distributions in upper ocean waters during the CLIVAR repeat hydrography program	Bowie A	Measures C, *University of Hawaii*; Landing W, *Florida State University* (USA)
Interactive effects of light, CO_2 and iron on phytoplankton community dynamics in the Ross, Sea, Antarctica	Bowie A	DiTullio G, *Grice Marine Laboratory*; Hutchins D, *University of Delaware*; Smith W, *Virginia Institute of Marine Science*; Dunbar R, *Stanford University* (USA); Sedwick P, *Bermuda Biological Station for Research* (BERMUDA); Tortell P, *University of British Colombia* (CANADA)
Redox and colloidal iron biogeochemistry in surface Atlantic waters and its role in ocean productivity	Bowie A	Worsfold P, *University of Plymouth*; Ussher S, Achterberg E, Gledhill M, *National Oceanography Centre Southampton* (UK)
The importance of iron cycle complexity when predicting C cycle response to Fe fertilisation	Bowie A	Tagliabue A, *Stanford University* (USA)
Dissolved iron in the Australian sector of the Southern Ocean (SR3 line)	Bowie A	Sohrin Y, *Kyoto University* (JAPAN)
Altimetry for Real Time Applications and Climate Studies relevant to Australia	Church J, White N, Coleman R	The Ocean Surface Topography Science Team – *NASA* (USA); *CNES* (FRANCE)
Fracturing and deformation along the Amery Ice Shelf (AAS grant)	Coleman R, Young N	Fricker H, *Scripps Institution of Oceanography* (USA); Lackie M, *Macquarie University* (AUSTRALIA)
Iceberg Calving from active ice-shelf rift systems on the Amery Ice Shelf (AAS grant)	Coleman R, Young N	Fricker H, *Scripps Institution of Oceanography* (USA)
NASA/CNES Jason-1 altimeter mission	Coleman R, Church J, White N	French, US team
ESA Envisat mission	Coleman R, Church J, White N	European team, many EU countries, USA
Borehole ice camera probe	Craven M, Allison I	Behar A, *CalTech – Jet Propulsion Laboratory* (USA)
Deglacial ice core chemistry	Curran M, Morgan V, van Ommen T, Smith B	Steffense J-P, Dahl-Jensen D, *University of Copenhagen* (DENMARK)
Broke-West: Biooptical properties of the atmosphere and water column	Griffiths B	Schwarz J, *AWI* (GERMANY)
Australia Canada Ocean Research Network	Haward M	VanderZwaag D, *Dalhousie University* (CANADA)
ISPOL deformation array	Heil P	Hutchings J, *IARC, University of Alaska*; McPhee M, *McPhee Research Company* (USA); Launiainen J, Johansson M, *Finnish Institute of Marine Research* FINLAND; Haas C, AWI (GERMANY)
Arctic ice-ocean modelling	Heil P	Hibler W, Roberts A, *IARC, University of Alaska*; Fowler C, *University of Colorado* (USA)

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
AFIN – IPY project	Heil P	Langhorne P, *University of Otago*; Haskell T, *Industrial Research Ltd*; Trodahl J, Victoria University of Wellington (NZ); Gerland S, *Nordsk Polar Institute* (NORWAY); Haas C, *AWI* GERMANY); Uto S, *National Maritime Research Institute* (JAPAN); Melnikov I, *Moscow State University* (RUSSIA); Li Z, *Dalian University of Technology* (CHINA); Gobin C, *Laboratoire Arago* (FRANCE); Eicken H, *Geophysical Institute, UAF* (USA)
Improved ocean modelling	Hirst A	Griffies S, *Geophysical Fluid Dynamics Laboratory* (USA)
Australian Canadian Oceans Research Network III (ACORN III)	Jabour J	McConnell M, VanderZwaag D, *Marine and Environmental Law Institute, Dalhousie University* (CANADA)
At Risk Marine Species	Jabour J	Hoel A, Hersoug B, *University of Tromsø* (NORWAY); VanderZwaag D, *Marine and Environmental Law Institute, Dalhousie University* (CANADA)
Experiments on krill growth and physiology	Kawaguchi S, Nicol S, King R	Meyer B, Teschke M, *AWI* (GERMANY)
Constraints on ocean volume change during the present interglacial: Evidence from the Baltic and Mediterranean	Lambeck K	Anzidei M, *INGV Rome;* Antoniolli F, ENEA Rome (ITALY); Svensson N, *Lund University* (SWEDEN)
Constraints on changes in Greenland ice volumes	Lambeck K	Sparrenbom C, Bjorck S, *Lund University* (SWEDEN); Bennike O, *Geological Survey* (DENMARK)
Maximum sustainable yield domestic fisheries law of developing states	Lugten G	Andrew N, Hall S, *World Fish Centre* MALAYSIA
POLYANNA: A comparative analysis of Antarctic polynyas by modelling and in situ validation	Marsland S, Massom R	Zambianchi E, *Università degli Studi di Napoli 'Parthenope'* (ITALY); Ackley S, *Clarkson University* (USA); Brandon M, *The Open University*; Flocco D, *Centre for Polar Observations and Modelling*; Willmott A, *Proudman Oceanographic Laboratory* (UK)
Impact of patterns of anomalous atmospheric circulation and sea ice on the break-up of the Larsen B Ice Shelf	Massom R	Scambos T, *NSIDC, University of Colorado*; Stammerjohn S, *NASA Goddard Institute for Space Studies*; Fahnestock M, *University of New Hampshire*; MacAyeal D, University of Chicago (USA); Turner J, *British Antarctic Survey* (UK); Squire V, Williams T, *University of Otago* (NEW ZEALAND)
Review of bi-polar polynya processes	Massom R	Barber D, *University of Manitoba* (CANADA)
Polar remote sensing (books)	Massom R	Lubin D, *Scripps Institution of Oceanography* (USA)
Behaviour of, and rift development on, the Mertz Glacier tongue	Massom R	Fricker H, *Scripps Institution of Oceanography* (USA); Legresy B, *CNRS* (FRANCE)
ARISE remote sensing validation experiment	Massom R	Markus T, Comiso J, *NASA Goddard Space Flight Center*; Scambos T, Haran T, *NSIDC, University of Colorado*; Key E, *University of Miami* (USA); Enomoto H, Tateyama K, *Kitami Institute of Technology*; Tamura T, *University of Hokkaido* (JAPAN); Pfaffling A, *AWI* (GERMANY)

research collaboration

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
Impact of patterns of anomalous atmospheric circulation on sea ice and biota	Massom R	Stammerjohn S, Smith R, Quetin L, *Goddard Institute of Space Studies*; Ross R, Martinson D, *University of California Santa Barbara*; Iannuzzi R, *Lamont Doherty Earth Observatory*; Vernet M, *Scripps Institution of Oceanography*; Fraser W, *Polar Oceans Research Group* (USA); Krouse H, University of Calgary (CANADA)
Sea ice primary production	McMinn A	Ralph P, *University of Technology, Sydney* (AUSTRALIA); Ryan K, *Victoria University* (NZ); Hegseth E, *Tromsø University* (NORWAY)
Effect of Climate Change on the Saroma Ko, Hokkaido ecosystem	McMinn A	Hattari H, *Hokkaido Tokei University*; Fukuchi M, *National Institute for Polar Research* (JAPAN)
Interdisciplinary sea ice studies in the northwestern Weddell Sea	Meiners K	Dieckmann G, *AWI* (GERMANY); Thomas D, *University of Wales* (UK)
Water isotopes in Antarctic ice cores	Morgan V, van Ommen T	Masson-Delmotte V, Jouzel J, *Laboratoire des Sciences du Climat et l'Environnement* (FRANCE)
Isotopic studies of atmospheric methane from ice and firn	Morgan V, van Ommen T	Etheridge D, *CMAR* (AUSTRALIA); Ferretti D, *NIWA* (NZ); White J, *University of Colorado* (USA)
Holocene chemistry of the Law Dome DSS ice core	Morgan V, van Ommen T, Curran M, Smith B	Mayewski P, *University of Maine* (USA)
Effects of decadal changes in Southern Ocean carbonate chemistry on marine ecosystems	Moy A, Howard W	Bijma J, Nehrke G, *AWI* (GERMANY); Reichart G, *Utrecht University* and *AWI* (NETHERLANDS); Palmer M, *University of Southampton* (UK); Bassinot F, *Laboratoire des Sciences du Climat et l'Environnement* (FRANCE)
Signature lipids in food webs	Nichols P	Hagen W, *University of Bremen* (GERMANY)
BROKE-West survey of the waters off East Antarctica (30-80°E)	Nicol S	van de Putte A, *University of Leuven* (BELGUIM); Widdoo A, Arif D, *Ministry of Fisheries* (INDONESIA); Yoshiki T, *Soka University* (JAPAN); Xavier D, *University of Nottingham* (UK)
Using tracers to describe processes governing heat uptake in the ocean	O'Farrell S	Gregory J, *University of Reading*; Lowe J, *Hadley Centre* (UK)
Analysis of Antarctic climate processes in IPCC models	O'Farrell S	Turner J, *British Antarctic Survey* (UK); Bromwich D, *Byrd Polar Research Center* (US)
Water mass variability in the Southern Ocean	Rintoul S	Aoki S, *Hokkaido University* (JAPAN)
Tracer measurements in the Southern Ocean	Rintoul S	Watanabe S, *JAMSTEC* (JAPAN)
Transport of the Kerguelen deep western boundary current	Rintoul S, Church J, Sokolov S	Watkatsuchi M, Fukamachi Y, *Hokkaido University* (JAPAN)
CLIMA project	Rintoul S	Spezie G, *University of Naples* (ITALY)
Southern Ocean mixing	Rintoul S	Speer K, *Florida State University* (USA)
SURVOSTRAL	Rintoul S	Morrow R, *LEGOS* (FRANCE)
Earth Systems Science OPeNDAP compute server framework	Roberts J, Bindoff N, Hyland G, Phipps S	Woolf A, *CCLRC Rutherford Appleton Laboratory* (UK)

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
Microparticle measurements in ice cores	Smith B, van Ommen T, Morgan V, Curran M	Petit J-R, *Laboratoire de Glaciologie et Géophysique de l'Environnement* (FRANCE)
Southern Ocean biogeochemical cycle monitoring from *Astrolabe*	Tilbrook B, Griffiths B, Wright S	Poisson A, *Université Pierre et Marie Curie*; Goyet C, *Université Perpignan* (FRANCE)
CO_2 storage along CLIVAR I9S	Tilbrook B	Watanabe S, Sasaki K, *JAMSTEC* (JAPAN)
Using oxygen measurements to constrain primary production estimates in the Southern Ocean	Tilbrook B	Bender M, Cassar N, *Princeton University* (USA)
CO_2 storage in the Southern Ocean	Tilbrook B	Sabine C, *NOAA*; Warner M, *University of Washington* (USA)
CO_2 exchange in the sea-ice zone	Tilbrook B	deLille B, *University of Liège* (BELGIUM)
Vertical Flux in the Global Ocean (VERTIGO) program measuring carbon transport in sinking particles to the ocean interior	Trull T, Bray S, Moy C, Robertson L. Ebersbach F	Buesseler K, *Woods Hole Oceanographic Institution* (USA)
Kerguelen compared study of Ocean and Plateau in surface waters (KEOPS) program examining the effects of natural iron fertilisation on Southern Ocean ecosystems and carbon sequestration	Trull T, Bowie A, Griffiths B, Remenyi T, Armand L, Ebersbach F	Blain S, *Université de Marseille*; Quéguiner B, Jeandel C, *Observatoire Midi-Pyrénées* (FRANCE)
Belgian Carbon in the Antarctic (BELCANTO) program measuring controls on carbon export and remineralisation in the Southern Ocean	Trull T, Bray S	Dehairs F, Cardinal D, *Vrije Universiteit Brussel* (BELGIUM)
Studies of sub-Antarctic nitrogen utilization	Trull T, Karsh K	Sigman D, *Princeton University* (USA)
Atmospheric methane records from the Law Dome DSS ice core (as part of AGO CCSP project 'Abrupt Climate Change and North-South Climate Connections')	van Ommen T, Morgan V	Chappellaz J, *Laboratoire de Glaciologie et Géophysique de l'Environnement* (FRANCE)
Isotopic studies of atmospheric methane from ice and firn	van Ommen T, Morgan V	Ferretti D, *NIWA* (NZ)
Isotope reconstructions of Antarctic temperature and climate	van Ommen T	Steig E, Schneider D, *University of Washington* (USA)
Trace ion and metal analysis techniques and applications	van Ommen T, Curran M, Morgan V	McConnell J, Edwards R, *Desert Research Institute* (USA)
Water isotopes and solar climate signals	van Ommen T	Solanki S, *Max-Planck-Institut für Sonnensystemforschung* (GERMANY)
Water isotopes and solar climate signals	van Ommen T	Usoskin I, *University of Oulu* (FINLAND)
Antarctica's subglacial waters – is frazil ice a vital factor?	Warner R	Williams M, *NIWA* (NZ)
Validation of satellite-derived snow thickness over Antarctic sea ice	Worby A, Massom R	Markus T, *NASA – Goddard Space Flight Centre* (USA)
Surface albedo of the Antarctic sea ice zone	Worby A	Brandt R, Warren S, Grenfell T, *University of Washington* (USA)
Regional and seasonal climatology of Antarctic sea ice thickness	Worby A	Geiger C, *Cold Regions Research and Engineering Laboratory*; DeLiberty T, *University of Delaware*; Ackley S, *University of Texas San Antonio*; Van Woert, *National Science Foundation* (USA)
Thermodynamic evolution of summer sea ice properties in the Western Weddell Sea	Worby A	Tison J-L, Delille B, Lannuzel D, *University of Brussels* (BELGIUM)

research collaboration

Project	ACE Researcher(s)	Collaborators, Affiliation & Country
Helicopter-based EM for measuring Antarctic sea ice thickness	Worby A	Haas C, Pfaffling A, *AWI* (GERMANY)
Emission of dimethylsulphide through Antarctic sea ice leads	Worby A	Zemmelink H, Liss P, *University of East Anglia* (UK); Dacey J, Houghton L, *Woods Hole Oceanographic Institution* (USA)
Diatom induced Silicon isotopic fractionation in Antarctic sea ice	Worby A	Fripiat F, *Laboratoire de Glaciologie Polaire*; Tison J-L, *University of Brussels* (BELGIUM)
SOLAS-SAGE	Wright S, van den Enden R	Harvey M, *NIWA* (NZ); Jones G, *Southern Cross University* (AUSTRALIA)

National Committees

Staff Name	Name of Committee
Allison I	National Committee for Earth System Science (AAS)
	Antarctic Research Assessment Committee, Physical Sciences
	Local Organizing Committee, SCAR Open Science Conference 2006, Hobart *(Chair)*
Bindoff N	APAC Program Coordination Committee, 2000 to present
	ANARE (Astronomical Society of Australia and Science Program Managers Committee), 2003 to present *(Oceanography Coordinator)*
	BlueNET steering Committee, 2005 to present
Butler E	Environmental Chemistry Division Standing Committee, Royal Australian Chemical Institute
Church J	Tasmanian Sea Level Reference Group
	Greenhouse 2005, Program Committee
	National Collaborative Research Infrastructure Strategy, Expert Advisory Committee
Constable A	Australian Fisheries Management Authority – Subantarctic Resource Assessment Group
Haward M	CCAMLR Consultative Forum
Heil P	TPAC Education, Outreach and Training, 2002 to present *(Project Leader)*
Hirst A	Physical Sciences Antarctic Research Assessment Committee
	Australian Association of Science (AAS) CLIVAR Sub-committee of the National Committee for Climate and Global Change
Howard W	National Committee for Earth Sciences
Hunter J	Tasmanian Sea Level Reference Group
Lambeck K	Australian Academy of Science, 2006-10 *(President)*
Mc Minn A	National Committee for Antarctic Research (AAS)
	Australian Institute of Nuclear Science and Engineering – Environment *(Chair)*
Nichols P	Australasian Section American Oil Chemists Society *(President)*
	Tasmanian Branch Committee, Australian Biotechnology
Nicol S	Antarctic Research Advisory Committee *(Program Leader)*
van Ommen T	Antarctic Research Assessment Committee Physical Sciences *(Ice, Oceans, Atmosphere and Climate Program Leader)*
Wright S	CSIRO Marine National Facility Underway Measurement of Fluorescence sub-committee

International Committees

Staff Name	Name of Committee
Allison I	ICSU/WMO Joint Committee for International Polar Year 2007-08 *(Co-chair)*
	International Glaciological Society Committee *(Vice President)*
	International Commission for Polar Meteorology (ICPM), International Association of Meteorology and Atmospheric Sciences
	Working Group I, IPCC Fourth Assessment Report *(Lead Author, Chapter 4 'Observations: Changes in Snow, Ice and Frozen Ground')*
	Editorial Advisory Board, *Antarctic Science*
	Editorial Advisory Board, *Terra Antarctica*
	Scientific Committee on Antarctic Research IPY Committee
Bindoff N	IPY Data Management Committee, 2005-present
	Working Group, IPCC Fourth Assessment Report *(Coordinating Lead Author [with J Willebrand] Chapter 5 'Observations: Oceanic climate change and sea level')*
	CLIVAR Expert Team on Climate Change Detection, Monitoring and Indices, 2002-present
Church J	Joint Scientific Committee for the World Climate Research Programme *(Chair)* Vice chair to March 2006, Chair from April 2006
	International Organising Committee of the Earth System Science Partnership
	Organising Committee for the WCRP Workshop on Sea-level Rise *(Co-chair)*
	International Oceanographic Commission, Scientific Advisory Committee
Constable A	CCAMLR Working Group on Ecosystem Monitoring and Management, July 2005
	CCAMLR Working Group on Fish Stock Assessment, October 2005
	CCAMLR Scientific Committee, October 2005
	CCAMLR Steering Committee on bioregionalisation for the CCAMLR Convention Area, October 2005-ongoing
	CCAMLR Subgroup on the Development of Operating Models, July 2005-ongoing
Haward M	Editorial Board, *Ocean and Coastal Management*
Heil P	International Programme for Antarctic Buoys, Dec 2005-present *(Co-chair)*
Hirst A	CLIVAR/WCRP Working Group on Coupled Modelling
Hirst A	Editorial Board, *Ocean Dynamics: Theoretical, Computational and Observational Oceanography*
Howard W	Editorial Board, *Paleoceanography,* December 2004 – December 2007
Kawaguchi S	CCAMLR Working Group – Ecosystem Monitoring and Management
	CCAMLR Scientific Committee
Massom R	Science Steering Group, US National Science Foundation Palmer Long-Term Ecological Research Program
	NASA Aqua AMSR-E Science and Software Team
	International Programme for Antarctic Buoys
Morgan V	IPICS Steering Committee
	IGS Council
Nicol S	Southern Ocean GLOBEC Steering Committee
	Joint SCAR/SCOR co-ordinating Group on Interdisciplinary Southern Ocean Science
	Integrated analyses of Circumpolar Climate interactions and Ecosystem Dynamics Steering Group
	Australian CCAMLR Delegation
O'Farrell S	International Commission for Polar Meteorology and Climatology

research collaboration

Staff Name	Name of Committee
Reid P	WMO Commission for Climatology Expert Team on El Niño/La Niña definitions
	WMO Commission for Climatology Expert Team on Climate Watches
Rintoul S	SCAR/SCOR Expert Group on Oceanography
	CLIVAR/Clic/SCAR Southern Ocean Panel
	Southern Hemisphere Meteorology and Oceanography Working Group, American Meteorological Society
Tilbrook B	International Ocean Carbon Coordination Project, 2004-present *(Steering Committee Member)*
	CLIVAR Indian Ocean Panel, 2004-06*(Biogeochemist)*
Trull T	Scientific Committee on Oceanographic Research Experts Group 116 on Upper Ocean Export, 2003-06
	Global Ocean Observing System (GOOS) Steering Committee, 2003-06
	OceanSITES committee for time-series stations, 2006-present
van Ommen T	SCAR Physical Sciences Standing Scientific Group
	SCAR-ITASE Synthesis Group on Climate Variability *(Leader)*
	Editorial panel, *Climate of the Past*
Williams G	International Antarctic Zone, 2005-07 *(Australian & New Zealand Representative)*
Worby A	World Climate Research Program (WCRP) Climate and Cryosphere (CliC) Scientific Steering Group, 7-11 November 2005 *(Vice Chair)*
	Antarctic Sea Ice Processes and Climate (ASPeCt) committee *(Co-chair)* Start December 2005
	Scientific Committee on Antarctic Research (SCAR) program on Antarctica and the Global Climate System (AGCS)
	Climate and Cryosphere (CliC) Data Management and Information Panel (DMIP)
	International workshop on Antarctic sea ice thickness *(Convener & Chair of Scientific Committee)*
Zicus S	International Polar Year Education and Outreach Committee Steering Group

Staff Exchanges

Staff Name	Institution Visited & Country	Purpose of exchange
Bowie A	*University of Plymouth* (UK)	Preparation of publication reporting iron distributions and speciation along the Atlantic Meridional Transect (AMT)
Butler E	*NIWA* (NZ)	Discuss upcoming collaboration on Southern Ocean cruises.
Coleman R	*Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS)* (FRANCE)	Projects on Amery Ice Shelf
	Scripps Institution of Oceanography (USA)	Collaborative projects on ice shelf calving
Curran M	*University of Copenhagen* (DENMARK)	Collaborative data processing
	AWI (GERMANY)	Scientific discussion
	British Antarctic Survey (UK)	Scientific discussion
Haward M	*Dalhousie University* (CANADA)	Research on Canadian oceans governance
	St Mary's University (CANADA)	Research on fisheries policy
Hirst A	*Hadley Centre* (UK)	CLIVAR/WCRP Working Group on Coupled Modelling meeting
Lugten G	*World Fish Centre* (MALAYSIA)	Research on fisheries

Staff Name	Institution Visited & Country	Purpose of exchange
Marsland S	*AWI* (GERMANY)	Visit H Hellmer to collaborate on ocean-sea ice-0ice shelf interaction
	Max Planck Institute for Meteorology (GERMANY)	Visit H Haak and J Jungclaus to update modelling skills with Max Planck Institute Ocean Model
McMinn	*University of Hokkaido* (JAPAN)	IAI Discussions, field work
	Universitie Sains Malaysia (MALAYSIA)	IAI Discussions, field work
Meiners K	*AWI* (GERMANY)	Planning of fieldwork
	Institute for Polar Ecology (GERMANY)	Planning of fieldwork
Moy A	*AWI* (GERMANY)	Effects of decadal changes in Southern Ocean carbonate chemistry on marine ecosystems
Nichols P	*University of Bremen* (GERMANY)	Member of specialist group looking at future global zooplankton research
Nicol S	*Antarctica New Zealand* (NZ)	To review NZ Antarctic Program
Phipps S	*CCLRC Rutherford Appleton Laboratory* (UK)	International collaboration on the development of a web processing service
Sandford R	*Harvard University* (USA)	Research on climate science and public policy
	Massachusetts Institute of Technology (MIT) (USA)	Research on climate science, public policy and managing science-intensive public policy issues
	Tufts University (USA)	Research on climate science, public policy and managing science-intensive public policy issues
	Department of Resource Economics and Development, University of New Hampshire (USA)	Opportunities for collaboration on climate and marine-related public policy, including the management of science-intensive issues
	Massachusetts Fishermen's Partnership (USA)	Managing science-intensive issues
Smith B	*Laboratoroire de Glaciologie et Géophysique de l'Environnment* (FRANCE)	To receive training in the laboratory techniques of microparticle analysis in ice cores
Trull T	*University of Hawaii* (USA)	Discuss new techniques for individual compound ^{15}N analyses
Warner R	*NIWA* (NZ)	Developing a computer model of frazil ice growth and transport
	WCRP Workshop: Understanding sea-level rise and variability (FRANCE)	Participate in workshop discussions, present poster
	LEGOS (FRANCE)	Explore collaborative research into ice shelf dynamics
Wright S	*British Antarctic Survey* (UK)	Pigment analytical techniques / discuss genomics analysis

International Visitors

Visitor's Name	Institution/Affiliation & Country	Purpose of visit
Abram N	*British Antarctic Survey* (UK)	Scientific discussion
Bjørnland T	*Norwegian University of Life Sciences* (NORWAY)	Sabbatical visit. Characterise marker pigments in dinoflagellates and euglenophytes
Blain S	*Centre d'Océanologie de Marseille* (FRANCE)	Prepare paper from collaborative KEOPS project on the effects of natural iron fertilisation of the Southern Ocean

research collaboration

Visitor's Name	Institution/Affiliation & Country	Purpose of visit
Brigham L	*US Arctic Research Commission* (USA)	Seminar and discussions on Arctic Climate Impact Assessment and the Arctic Marine Shipping Assessment (2005-2008) of the Arctic Council
Cassar N	*Princeton University* (USA)	Set up of instrumentation used for collaborative work on O_2/Ar measurements
De'Ath R	*Bristol Glaciology Centre, University of Bristol* (UK)	Participate in Antarctic accumulation workshop at ACE CRC, present seminar on contribution of glaciers to future sea-level rise, and discuss iceberg trajectory modelling research.
Fricker H	*Scripps Institution of Oceanography* (USA)	Collaborative projects on Antarctic research
Hagen W	*University of Bremen* (GERMANY)	Food web studies, including laboratory feeding trials and manuscript preparation
Hegseth E	*University of Tromsø* (NORWAY)	Collaboration on sea ice primary productivity studies
Hibler W	*IARC, University of Alaska* (USA)	Collaboration on ice-ocean model
Granskog M	*University of Manitoba* (CANADA)	Planning of fieldwork
Legrésy B	*LEGOS/CNRS* (FRANCE)	Participate in Antarctic summer field season and project work on Amery Ice Shelf
Lenser T	*University of York* (UK)	Masters professional placement
Poisson A	*Université Pierre et Marie Curie* (FRANCE)	Joint work on *Astrolabe*
Schneider D	*University of Washington* (USA)	SCAR Fellowship
Schwarz J	*AWI* (GERMANY)	Post-cruise analysis of bio-optical samples from the Broke-West voyage.
Szeto A	*York University* (CANADA)	Sabbatical leave, working with Roland Warner and Richard Coleman on ice shelf flexure
Teschke M	*AWI* (GERMANY)	Collaborative experiment on krill growth and physiology using Kingston facility
Woolf A	*CCLRC Rutherford Appleton Laboratory* (UK)	Establish Web Services at UTAS, and shape TPAC grid vision

Research Consultancies & Contracts

Name	Consultancy or contract	Period	Total (A$)	2005-06 ($)
Bindoff N	Strategies and Recommendations Report for Future Best Practice Science Computing in Department of Natural Resources, Mines and Water	May 2005 to March 2006	Pro bono	Pro bono
	Hydro Tasmania Contract	2003 to May 2006	*$340,000 cash plus in-kind ~$340,000	*$150,000 cash
Hunter J Coleman R	Sea-level Reference Group (Tasmanian Government)	2003-06	$800	$200
Lugten G	Sustainable yield as a fisheries conservation objective in developing states	Jan – June 2006	Pro bono	Pro bono
McInnes K	Gippsland Coastal Board	1 October 2005 – 30 June 2006	*$45,000	*$45,000

Name	Consultancy or contract	Period	Total (A$)	2005-06 ($)
Trull T	Ocean Nourishment, Inc.: Advice on formulating and presenting quantification of carbon sequestration achieved by ocean nutrient additions for submission to United Nations Sustainable Development Mechanism process	July 2006	*$3,000 (estimated value – pro bono)	$3,000 (estimated value – pro bono)

*Funds not administered by the ACE CRC.

Grants

Project & granting body	Researchers	Grant period	Cash and/or In-Kind	
			Total	2005-06
Ice sheet-atmosphere interaction and surface climatology of interior Antarctica *(Australian Antarctic Research Program)*	Allison I	2003-08	Logistical support	
Sea ice thickness distribution in the Indian Ocean sector of the Southern Ocean. *Australian Antarctic Research Program*	Allison I	2003-08	Logistical support	
The drift of Antarctic sea ice *Australian Antarctic Research Program*	Allison I	2003-08	Logistical support	
Ice shelf - ocean interaction in the cavity beneath the Amery Ice Shelf *Australian Antarctic Research Program*	Allison I, Bindoff N, Craven M	2003-07	Logistical support	
Simulating the Southern Ocean With an Active Sea ice Model *APAC Merit Allocation Scheme*	Bindoff N	2005	Computer time 460800 Service Units, $200,000	$200,000
IPCC, Chapter 5 Observations: Oceanic Climate Change and Sea Level *Aust. Greenhouse Office*	Bindoff N	July 2004-July 2007	$58,000	$29,000
TPAC National Facility, Grid and EOT program 2004-2006 *APAC*	Bindoff N	2004-06 inclusive	$1,440,000	$480,000
The oceanography of the region between 30° and 80° East (CCAMLR Division 58.4.2) *ASAC*	Bindoff N, Trull T, Tilbrook B, Nicol S	2005-06	Ship time for $1,792,000	Ship time for $1,792,000
Targeting organically-complexed iron species in seawater using selective solid-phase adsorbent resins *ARC Discovery*	Bowie A	2003-06	$275,035	$82,345
Origin of elevated Southern Ocean productivity and its influence on atmospheric carbon dioxide (KEOPS) *DEST International Science Linkages (FAST program)*	Bowie A, Trull T	2004-06	$52,680 cash; $3,456,584 in-kind	$34,180 cash
Selenium as a key micronutrient in primary productivity in the Southern Ocean *Australian Antarctic Science grant*	Butler E, Wake B, Bowie A	2004-07	$122,000 in kind	

research collaboration

Project & granting body	Researchers	Grant period	Cash and/or In-Kind	
			Total	2005-06
Active Ice-Shelf Rift Systems on the Amery Ice Shelf, East Antarctica *ARC Discovery*	Coleman R	2006-08	$290,000	$55,500
Tasmanian Shoreline Monitoring Project in Northern Tasmania *UTAS Institutional Research Grant Scheme*	Coleman R	2005	$22,500	$11,250
Fracturing and deformation along the Amery Ice Shelf *AAS*	Coleman R, Fricker A, Lackie M, Young N	2005-06	$18,055 Logistical $850,000	$18,055
Iceberg Calving from active ice-shelf rift systems on the Amery Ice Shelf *AAS*	Coleman R, Fricker H, Young N	2005-06	$27,277 Logistical $1.2M	$27,277
Interactive effects of light, CO_2 and iron on phytoplankton community dynamics in the Ross Sea, Antarctica *National Science Foundation, Office of Polar Programs (USA)*	DiTullio G, Hutchins D, Smith W, Sedwick P, Dunbar R, Tortell P, Bowie A	2005-07	$495,428	$15,000
Supporting or Sabotaging Sustainable Development: State Responses to Environmental Certification Schemes' *ARC Discovery*	Gale F, Haward M	2004-06	$150,000	$50,000
Hyphenated Capillary Electrophoresis - Mass Spectrometry Facility *ARC Linkage-Infrastructure, Equipment and Facilities*	Haddad P, Clark M, Reid J, Bowie A, Macka M, McMeekin T, Bowman J, Ross J, Breadmore M, Hilder E, Guijt R, Shellie R, Jacobson G	2006	$263,000	$263,000
Long term investigation of the southern ocean with high resolution simulations of a coupled ice-ocean model *AAS*	Heil P, Allison I	2004-10	Logistical support	Logistical support
Implementation of a sea ice model *AAS*	Heil P, Bindoff N	2004-08	Logistical support	Logistical support
Investigation of Antarctic sea ice with a high-resolution coupled ice-ocean model *APAC Merit Allocation Scheme*	Heil P, Bindoff N and others	2005	$230,000 service units, $100,000 logistical	$100,000
Studying high-frequency Arctic and Antarctic sea ice dynamics using drifting buoy data. *AAS*	Heil P	2006-09	Logistical support	Logistical support
Long term investigation of the Southern Ocean with high resolution simulations of a coupled ice-ocean model *APAC Merit Grant Scheme*	Heil P and others	2005	$460,000	$207,000

Project & granting body	Researchers	Grant period	Cash and/or In-Kind	
			Total	2005-06
Long term investigation of the Southern Ocean with high resolution simulations of a coupled ice-ocean model *APAC Merit Grant Scheme*	Heil P and others	2006	$60,000	$20,000
Winter temperature and salinity measurements in the Southern Ocean using elephant seals as ocean observing platform *ARC Discovery*	Hindell M, Michael K, Coleman R, Rintoul R	2003-05	$250,000	$40,000
Variability and stability of Antarctic Bottom Water in Mk3 model *Australian Antarctic Program*	Hirst A, O'Farrell S, England M	July 2004-July 2007	$84 000	$28 000
Physical and biogeochemical dynamics of the Subantarctic Zone *AAS*	Howard W, Trull T, Bowie A, Tilbrook B, Griffiths B, Wright S	15/1/07 – 15/2/07	$3,000,000 logistical support	
Potential effects of increasing anthropogenic CO_2 on marine plankton in the Southern Ocean *Australian Greenhouse Office*	Howard W, Moy A	May 2006-May 2007	$108,000	$108,000
Federalism and international risk management *ARC Discovery*	Kellow A, Haward M	2002-05	$90,000	$32,000
Tourism to subantarctic Macquarie Island and East Antarctica from Hobart – A scoping study *Tasmanian Polar Network*	Jabour J	Nov 2005-Nov 2006	$38,500 (includes $27,500 in kind support for ship berths and survey production)	$32,466
Looking back to see the future: Change in the Lambert Glacier and the East Antarctic Ice Sheet – postglacial work of relevance to SLP *ARC Discovery*	Lambeck K, Fabel D, Tregoning P, Coleman R, Fink D	2003-06	$530,000	$140,000
The Southern Ocean and sea ice response to climate variability and change *APAC Merit Grant Scheme*	Marsland S, Heil P and others	2006	$190,000	$90,000
A study of fast-ice distribution and polynyas in East Antarctica using ALOS data *JAXA (Japanese Space Agency)*	Massom R, Worby A, Lytle V	2003-07	Satellite data	Satellite data
Validation of AMSR-E Antarctic sea ice products in East Antarctica *NASA*	Massom R, Lytle V, Worby A, Michael K, Young N	2002-06	Satellite data	Satellite data
Remote sensing validation experiment *ASAC*	Massom R, Allison I, Worby A, Lytle V, Michael K, Young N	2002-06	Logistical support for V1 2003-04	
The validation of Cryosat sea ice thickness measurements in Antarctica *European Space Agency*	Massom R, Allison I, Worby A, Michael K, Lytle V, Young N	2002-06	Satellite data	Satellite data

research collaboration

Project & granting body	Researchers	Grant period	Cash and/or In-Kind	
			Total	2005-06
Southern Ocean Primary Production *AAS*	McMinn A	2005-06	$20,000 + $200,000 logistical	
Effect of climate change on coastal primary production *AAS*	McMinn A	2005-06	$12,000 + $415,000 logistical support	
An integrated study of processes linking sea ice and biological ecosystem elements off East Antarctica during winter *Department of Environment and Heritage*	Meiners K, Allison I, Davidson A, Hosie G, Nicol S, Wright S, Constable A, Worby A, McMinn A, Trull T, Williams G, Kawaguchi S, Wadley V, Allen S, Brierley A	Sept 2007	Ship time (Approx. $2.5 M, 30 days @ $85,000)	
Simulating the climate of the last glacial cycle *APAC*	Phipps S, Roberts J, Budd W, van Ommen T	2005-06	Computer time $27,000.00 (approx.)	$27,000.00 (approx.)
Simulating the climate of the last glacial cycle *iVEC*	Phipps S, Roberts J, Budd W, van Ommen T	2005-06	Computer time $200,000.00 (approx.)	$200,000.00 (approx.)
The ARC Earth System Science Network *ARC Network*	Pitman A, Bindoff N, Coleman R	2005-07	$1,170,000	$400,000
Earth Systems Science OPeNDAP compute server framework *ARC*	Roberts J, Bindoff N, Hyland G	1 Jan-31 Dec 2006	$81,900	$40,950
Impact of atmospheric deposition on the distribution and speciation of trace elements in the upper ocean: Focus on iron in the Sargasso Sea *National Science Foundation, Chemical Oceanography (USA)*	Sedwick P, Bowie A, Church T, Sholkovitz E	2006-09	$568,205	
Southern Ocean carbon cycle (for BROKE cruise and underway sampling) *Australian Antarctic Science Program award #2592*	Tilbrook B	2005-06	Logistical support on *Aurora Australis,* Nov-April	Berths and ship time on *Aurora Australis*
PULSE: Role of rapid and seasonal mixed-layer dynamics in Southern Ocean plankton production and carbon transports including air-sea exchange of carbon dioxide and particulate carbon fluxes to the ocean interior *Australian Marine National Facility*	Trull T, Griffiths F, Tilbrook B, Butler E, Bowie A	2005-06	14 days ship time in 2005-06	14 days ship time on *Southern Surveyor*, March 2006
SAZ Project: Mooring based study of Subantarctic carbon export *Australian Antarctic Science Program award #1156*	Trull T, Bray S	2005-06	5 days ship time on *Aurora Australis*	5 days ship time on *Aurora Australis*
VERTIGO: Vertical Flux in the Global Ocean *US National Science Foundation*	Trull T, Buesseler K	2003-06	$ 3,800,000	$ 900,000

Project & granting body	Researchers	Grant period	Cash and/or In-Kind	
			Total	2005-06
Climate modulation of the 10Be solar activity proxy *AINSE (Australian Institute of Nuclear Science and Engineering)*	Trull T, Pedro J	Grant is currently unofficial Expected to be official before 30 June.	$17,220	
van Ommen T Morgan V	Abrupt climate change	Until December 2007	$40,500	$40,500
'Antarctica's subglacial waters – is frazil ice a vital factor?' Refining modelling of ice shelf ocean interactions, improving numerical modelling of the ocean circulation under ice shelves, and advancing understanding of the processes controlling freezing beneath the Amery ice shelf *Royal Society of New Zealand Marsden Fund*	Williams M, Warner R (Associate Investigator)	2004-06	$83,000	$27,600
Redox and colloidal iron biogeochemistry in surface Atlantic waters and its role in ocean productivity *National Environmental Research Council (UK)*	Worsfold P, Bowie A	2004-06	$515,120	$4,200
Application of new techniques for sea ice characterisation *AAS*	Worby A, Heil P, Massom R	2004-06	Logistical support	Logistical support

education & training

Looking South Together is an integrated research training and knowledge transfer program of the Antarctic Climate & Ecosystems CRC. The program uses ACE CRC expertise to produce well-trained scientists who have world class skills in research, an understanding of its broad application and its role in enterprise, and international experience. It is managed by the University of Tasmania's Institute of Antarctic and Southern Ocean Studies (IASOS), whose staff contribute 50 per cent of their time to the ACE CRC.

Program Objectives

- ***To develop higher education programs that meet the needs of ACE CRC stakeholders.***

  Developing higher education programs is a continuing process of refinement. The program is focused on postgraduate training through the PhD program. The program is large by both national and international standards and produces a steady flow though of finishing graduate students. These students are substantial contributors to each of the ACE CRC research programs.

- ***To address the long-term un-met national demand for highly-trained personnel with quantitative skills in oceanography and marine ecology.***

  By working with the Quantitative Marine Science (QMS) program we are providing, advanced, high level training courses to help meet the shortage of quantitative scientists. Ten of our PhD students are enrolled in this program, which is now in its second year of operation. All other ACE CRC students are enrolled in projects identified as research required by the ACE CRC.

- ***To facilitate the communication of our research outcomes to the community through interaction with the media, museums, schools and other community associations.***

  Communication of research outcomes to the community are coordinated through the ACE CRC Communications Program and progress toward this objective is detailed in that section.

Program Leader

Prof Andrew McMinn

University of Tasmania

Program Overview

Postgraduate Training

Development of highly-trained scientists is a priority of the ACE CRC. This training program builds on the significant contribution made by the previous Antarctic CRC to national training in strategic scientific areas. *Looking South Together* works with the Science and Policy Programs and all ACE CRC participants to identify high priority research for students and uses a mix of broadly-advertised, fully-funded and 'top-up' scholarships to attract first-rate students to these areas.

The ACE CRC Educational Program is one of the largest graduate programs at the University of Tasmania and among the top polar science graduate programs in the world. During the first two years of the ACE CRC, 14 postgraduate students received degrees and 16 new students were admitted. The program has a strong international focus with students from 11 different countries enrolled.

The Education Program is also genuinely multidisciplinary and interdisciplinary. Not only do our students work in areas as diverse as ocean policy, climate modelling, Appendicularians, sea-level change, krill physiology and phytoplankton ecology; there are also significant numbers of students who work across discipline areas and across two or more of the ACE CRC research programs. This level of cooperation is unusual in Australian higher education and is a tribute to the partners of the ACE CRC who are clearly able to think laterally and are committed to optimising research outcomes.

Knowledge Transfer

It is also important for the ACE CRC to communicate its research outputs and outcomes to the wider community. We are working with our core partners, museums and education organisations to raise awareness of Antarctic Science. We contribute to displays and exhibitions, provide speakers and generally seek to enhance awareness of the importance of Antarctic and Southern Ocean science. We also participate in national science and education promotions to ensure that our research results are communicated to the widest possible audience. This work is coordinated with, and supported by, the ACE CRC Communications Manager.

Key Achievements 2005-06

- Recruited 12 new graduate students into the Education Program, giving a current enrolment of 61 students.
- Currently have 7 students participating in the joint CSIRO/University of Tasmania Quantitative Marine Science (QMS) PhD Program. Six CRC staff members run or contribute to these courses. A further 3 CRC funded staff and 13 contributed staff lecture in other UTAS undergraduate courses.
- Held first student-based symposium.
- Supported 5 students to attend international conferences, 2 to participate in the AWI exchange program and 4 to attend national conferences.
- Conducted extension courses for students in commercialisation and poster-making.

Plans for 2006-07

The Education Program will continue the education and training of young scientists and policy makers. A strong recruitment drive in 2006-07 will endeavour to attract as large a cohort of new students as possible to maximise the use of scholarships prior to the completion of the CRC in 2010. Other programs will continue.

In addition, we will provide continued support for student conference travel. This will include a large group (12) to attend the SCAR Science Meeting in Hobart in July 2006.

The AWI exchange program will continue and another 2 students will travel to Germany to work with AWI. Take up of the reciprocal scholarships by German students coming to Hobart is less fully subscribed.

education & training

Progress against contractual milestones

Outcome: Increase awareness of the climate system and our role/influence in it.

Output: Train the climate specialists of tomorrow.

Milestone	Date	Progress
Attract an increasing number of top-quality students and deliver on-time completion of research theses.	2003-10	Intake of 12 new students in the past 12 months. 6 students were awarded their PhD and a further 10 are under examination.

Outcome: Raise public awareness of Antarctica and Southern Ocean science.

Output: Communication liaison with the general public.

Milestone	Date	Progress
Establish communications/liaison with community groups via ACE CRC contributions to *'Antarctic Adventure', museums and educational facilities.	2003-10	Second Research Users' Forum held in Canberra in February 2006. ACE CRC researchers contributed to the development of a major Antarctic exhibit at the Tasmanian Museum and Art Gallery. ACE CRC researchers did more than 50 presentations to non-specialist audiences, including school groups, teachers and community organisations. The ACE CRC participated in 3 different events during the Hobart Antarctic Midwinter Festival.

* Note: 'Antarctic Adventure' no longer exists.

Current student projects - PhD

Student name	Program	Thesis title	Supervisors & Affiliations
Andrews-Goff, Virginia	AME	Winter Foraging Ranges of Weddell Seals	Dr Mark Hindell (Zoology), Dr Jean-Benoit Charrassin (Paris)
Bombardieri, Daniel	EDU	Solar Proton Events: Their Origins and Effects on Polar NOx Levels	Dr Kelvin Michael (IASOS/ACE), Dr Marc Duldig (AAD), Dr John Humble (AAD)
Broweleit, Jane	POL	Can Market-Oriented Measures Dry up Enough of the Profits from IUU Fishing Operations in the Southern Ocean to Force a Wholesale or Incremental Abandonment of the Trade?	Dr Julia Jabour (IASOS/ACE), Dr Gail Lugten (Law), A/Prof Marcus Haward (Government/IASOS/ACE)
Brown, Matthew	AME	Growth and Reproduction of Antarctic Krill	Dr Patti Virtue (IASOS/IAI), Dr Steve Nicol (AAD/ACE), Dr So Kawaguchi (AAD/ACE)
Court, John	SLR / CVC	Computer Simulations of the Dynamics and Time Evolution of Ice Shelves and Ice Streams	Dr John Hunter (ACE), Prof Bill Budd (IASOS), Dr Roland Warner (AAD/ACE)
Donoghue, Shavawn	SLR	Heard Island Climate and Glacial Retreat	Dr Rob Massom (AAD/ACE), Dr Ian Allison (AAD/ACE), Dr Doug Thost (AAD/ACE)
Durack, Paul	CVC	Ocean Climate Change with Emphasis on the Southern Hemisphere	A/Prof Nathan Bindoff (IASOS/CSIRO/ACE), Dr Susan Wijffels (CSIRO)
Estermann, Gisella	SLR	Monitoring Recent Environmental Changes	Prof Kurt Lambeck (ANU)
Foster, Jacqui	POL	Development and Management of the Southern Ocean Krill Fishery	A/Prof Marcus Haward (Government/IASOS/ACE), Dr Julia Jabour (IASOS/ACE), Dr Steve Nicol (AAD/ACE)
Galton-Fenzi, Ben	SLR	Numerical Modelling of the Circulation and Melt/Freeze Pattern under Ice Shelves	Prof Richard Coleman (QMS/ACE), Dr John Hunter (ACE), Dr John Church (CSIRO/ACE)
Goldsworthy, Brett	CVC	Antarctic and Southern Ocean Processes in Global Climate Modelling	Dr Kelvin Michael (IASOS/ACE), Prof Bill Budd (IASOS)
Grose, Michael	AME	Biogenic Gas Production and Phytoplankton Ecology at Cape Grim	Prof Andrew McMinn (IASOS/ACE), Dr Jill Cainey (BoM)
Helm, Kieran	CVC	Dynamics of Global Ocean Circulation Variability	A/Prof Nathan Bindoff (IASOS/CSIRO/ACE), Dr John Church (CSIRO/ACE)
Herraiz Borreguero, Laura	CVC	Variability of SAMW and AAIW in the Australian Sector of the Southern Ocean	Prof Richard Coleman (QMS/ACE), Dr Steve Rintoul (CSIRO/ACE)
Higgins, Jane	AME	Maps of levels of UV radiation in the East Antarctic Sea ice zone to estimate potential damage to the marine biota of the region	Dr Kelvin Michael (IASOS/ACE), Dr Rob Massom (AAD/ACE)
Hill, Katrina	CVC	A Climatology of Polynyas in East Antarctica	Dr Kelvin Michael (IASOS/ACE), Dr Rob Massom (AAD/ACE), Dr Ray Williams (Computing)
Hill, Katy	EDU	Dynamics and Impacts of East Australian Current Variability off the Southeast Coast of Australia	A/Prof Nathan Bindoff (IASOS/CSIRO/ACE), Prof Richard Coleman (QMS/ACE), Dr Steve Rintoul (CSIRO/ACE)
Hislop, Cheryle	POL	Marine Protected Areas in High Seas: Past Problems and Fresh Discourses in Issues of Ocean Governance	A/Prof Marcus Haward (Government/IASOS/ACE), Dr Julia Jabour (IASOS/ACE), Dr Robert Hall (Government)

Student name	Program	Thesis title	Supervisors & Affiliations
Howe, Sarah	CVC	Detecting Climate Change in the Southern Ocean Using Historical and WOCE Temperature, Salinity and Nutrient Data	A/Prof Nathan Bindoff (IASOS/ CSIRO/ACE), Dr John Church (CSIRO/ACE)
Iliff, Mike	POL	The International Whaling Commission 2005-2008	Dr Julia Jabour (IASOS/ ACE), A/Prof Marcus Haward (Government/IASOS/ACE)
Ingleton, Tim	EDU	Effects of Thermal Pollution on Benthic Communities in Lake Macquarie, NSW	Prof Andrew McMinn (IASOS/ ACE), Prof Gustaaf Hallegraeff (Plant Science), Dr Henk Heijnis (ANSTO)
Jackson, Christine	AME	Determining Cetacean - Cephalopod Dietary Structure and Trophic Relationships in the Southern Ocean: A Qualitative and Quantitative Approach	Dr Patti Virtue (IASOS/IAI), Dr Peter Nichols (CSIRO), Dr Eric Grist (CSIRO), Dr Rosemary Gales (DPIWE)
Karsh, Kristen	CO2	Environmental Controls on Nitrogen Isotopic Fractionation by Subantarctic and Antarctic Phytoplankton	A/Prof Tom Trull (IASOS/ CSIRO/ACE), Dr Danny Sigman (Princeton)
Klocker, Andreas	CVC	Why is the Ocean so Skinny, and What are the Consequences of this Sparseness?	A/Prof Nathan Bindoff (IASOS/ CSIRO/ACE), Dr Trevor McDougall (CSIRO), Dr Stephen Griffies (NOAA/GFDL), Dr David Jackett (CSIRO)
Lake, Sam	AME	Population Ecology of Weddell Seals in the Vestfold Hills, Antarctica	Dr George Jackson (IASOS/ACE), Dr Mark Hindell (Zoology/ACE), Mr Harry Burton (AAD)
Lewis, Patrick	AME	An Investigation into Introduced Marine Species in the Sub-Antarctic	Prof Andrew McMinn (IASOS/ ACE), Dr Chad Hewitt (CSIRO), Dr Martin Riddle (AAD)
Lindsay, Margaret	AME / CO2	Biology of Southern Ocean Appendicularians, their Role in Carbon Cycles and Impacts on Marine Microbial Community	Prof Andrew McMinn (IASOS/ ACE), Dr Graham Hosie (AAD)
Meijers, Andrew	CVC	Southern Ocean Intermediate Water Dynamics and Variability Inferred from Satellite Altimetry	A/Prof Nathan Bindoff (IASOS/ CSIRO/ACE), Dr Steve Rintoul (CSIRO/ACE)
Mohammad, Mahadi	EDU	Antarctic Meiofauna from Casey Station, Antarctica	Prof Andrew McMinn (IASOS/ ACE), Dr Johnny Stark (AAD), Dr Martin Riddle (AAD)
Molina, Ernesto	CO2	Response of Photosynthetic Parameters to Varying Light Regimes in the Marine Environment	A/Prof Tom Trull (IASOS/CSIRO/ ACE), Dr Andy Bowie (ACE)
Murray, Carl	POL	"Scott of the Antarctic": The Conservation of a Story	Dr Julia Jabour (IASOS/ ACE), A/Prof Marcus Haward (Government/IASOS/ACE)
Nevill, Jon	POL	Australian Marine Biodiversity Conservation: Rhetoric and Reality	A/Prof Marcus Haward (Government/IASOS/ACE), Dr Karen Edyvane (Geog & Env Studies), Dr Ian Cresswell (NOO), Dr Trevor Ward (UWA)
Parkinson, Rachael	CVC	Determination of Palaeoprecipitation using High-Resolution Lake Sediment Cores from the Vestfold Hills	Prof Andrew McMinn (IASOS/ ACE), Dr John Gibson (IASOS), Dr Dom Hodgson (BAS)
Passmore, Abraham	AME	A DNA-based Study of the Diet of Antarctic Krill	Prof Andrew McMinn (IASOS/ ACE), Dr Simon Jarman (AAD), Dr Steve Nicol (AAD), Dr Kerrie Swaddling (Zoology)

Student name	Program	Thesis title	Supervisors & Affiliations
Pethybridge, Heidi	AME	Ecology of Pelagic Organisms and Foodweb Interactions	Dr George Jackson (IASOS/ACE), Dr Patti Virtue (IASOS/IAI), Dr Peter Nichols (CSIRO), Dr Ross Daley (CSIRO), Dr Ed Butler (CSIRO)
Pointing, David	EDU	Implementing Hydrogen Energy Technologies in Remote, Harsh and Sensitive Environments: Using Antarctica as a Case Study	Dr Kelvin Michael (IASOS/ACE), Dr Oystein Ulleberg (IFE Norway), A/Prof Jian Guo Zhu (UTS)
Salleh, Sazlina	EDU	Effects of Cultural Eutrophication on the Benthic Primary Production of Tropical, Temperate and Polar Ecosystems	Prof Andrew McMinn (IASOS/ACE), Prof Gustaaf Hallegraeff (Plant Science)
Saunders, Krystyna	EDU	Human Impacts on Southeast Australian Coastal Lagoons and Shallow Bays since European Settlement: Three Case Studies	Prof Andrew McMinn (IASOS/ACE), Dr Donna Roberts (IASOS)
Scherrer, Frances	POL	International Environmental Law	Prof Don Chalmers (Law), A/Prof Marcus Haward (Government/IASOS/ACE)
Smith, Rick	CVC	Dominating Physical Processes on the Australian Continental Shelf	Prof Richard Coleman (QMS/ACE), Dr Peter Harris (GA)
Stark, Camilla	CVC	Gravity Wave Interactions with Polar Stratospheric Clouds above Davis, Antarctica	Dr Kelvin Michael (IASOS/ACE), Dr Andrew Klekociuk (AAD)
Stark, Kate	AME	Ecology of Arrow Squid	Dr George Jackson (IASOS/ACE), Dr Jeremy Lyle (TAFI)
Sumby, Jon	POL	Science-Policy Gap in Marine Resource Management	A/Prof Marcus Haward (Government/IASOS/ACE), Prof Bruce Mapstone (ACE)
Sumner, Mike	AME	Mapping Marine Predator Foraging Behaviour	Dr Kelvin Michael (IASOS/ACE), A/Prof Mark Hindell (Zoology), Dr Simon Wotherspoon (Mathematics), Dr Corey Bradshaw (CDU)
Tierney, Megan	AME	Comparative Analysis of Existing and Novel, Non-invasive Methods for Determining Diet of Adelie Penguins	A/Prof Mark Hindell (Zoology), Dr Simon Jarman (AAD)
Treverrow, Adam	SLR / CVC	Laboratory Investigation of Ice Rheological Properties and Incorporation into Antarctic Ice Sheet Mass Balance Calculations	Dr Kelvin Michael (IASOS/ACE), Prof Bill Budd (IASOS), Dr Roland Warner (AAD), Dr Jo Jacka (AAD)
Tria, Juliette	CO2	Quantifying the Impact of Dust Deposition to the Southern Ocean using Dissolved Aluminium Concentrations	Dr Andy Bowie (ACE), Prof Paul Haddad (Chemistry), Dr Ed Butler (CSIRO/ACE)
Wake, Bronwyn	CO2	Speciation of Some Metalloid Elements in Open Ocean Waters	Prof Paul Haddad (Chemistry), Dr Andy Bowie (ACE), Dr Ed Butler (CSIRO/ACE)
Widolf, Elli	POL	Australian Antarctic Science: Consciousness and Behaviour	Dr Julia Jabour (IASOS/ACE), A/Prof Marcus Haward (Government/IASOS/ACE), Dr John Davidson (Psychology)
Yoshida, Toshihiro	AME	The Effect of Environmental Factors on the Early Development of Antarctic Krill	Dr George Jackson (IASOS/ACE), Dr Steve Nicol (AAD/ACE), Dr So Kawaguchi (AAD/ACE)

Current student projects - MSc or MA

Student name	Program	Thesis title	Supervisors & Affiliations
Downes, Stephanie	CVC	Assessing the Climatic Response of Changes in Ocean Currents and Atmospheric Conditions in the Southern Hemisphere	A/Prof Nathan Bindoff (IASOS/ CSIRO/ACE), Dr Steve Rintoul (CSIRO/ACE), Dr Jason Roberts (TPAC)
Evans, Sherrie-Lee	POL	Heritage at Risk: Cultural Heritage Management in the Antarctic and Sub-Antarctic	Dr Julia Jabour (IASOS/ACE), Mr Tom Maggs (AAD), Dr Michael Pearson (ACT)
Gan, Irina	POL	International Relations and the Human Factor - The History of Relations between Different Nations involved with Antarctica	Dr Julia Jabour (IASOS/ ACE), A/Prof Marcus Haward (Government/IASOS/ACE)
Jordan, Leonie	EDU	The Effect of Changing Light on the Quantum Yield of Migrating Benthic Diatoms	Prof Andrew McMinn (IASOS/ ACE), Dr Klaus Meiners (ACE)
Matthews, David	CVC	Southern Ocean Circulation from Iceberg Drift Patterns	A/Prof Nathan Bindoff (IASOS/ CSIRO/ACE), Mr Neal Young (AAD)
Turner, Jacquelyn	POL	Does the Use of Consensus Decision Making in CCAMLR make it more Difficult to Formulate Effective Conservation Measures	Dr Julia Jabour (IASOS/ACE), Prof Denzil Miller (CCAMLR)

Under exam - PhD

Student name	Program	Thesis title	Supervisors & Affiliations
Harris, Jane	POL	The Madrid Protocol and Beyond: Strategies for Marine Conservation and Sustainable Use in the Antarctic	A/Prof Marcus Haward (IASOS/ Government/ACE), Dr Julia Jabour (IASOS/ACE), Dr Eric Woehler (IASOS)
Lenton, Andrew	CO2	The Air-Sea Flux of CO2 in the Southern Ocean	A/Prof Tom Trull (IASOS/ACE), Dr Richard Matear (CSIRO/ACE), Dr Bronte Tilbrook (CSIRO/ACE)
Moore, Jason Kendall	POL	The Western Hemisphere and US-British Commonwealth Relations toward the Antarctic, 1939-1959	A/Prof Marcus Haward (IASOS/ Government/ACE), Dr Robert Hall (Government)
Moore, Thomas	CVC	Physical Oceanographic Controls on Phytoplankton Distribution in the Banda Sea and Western Australian Region	A/Prof Tom Trull (IASOS/ACE), Dr Richard Matear (CSIRO/ACE), Dr David Griffin (CSIRO/ACE)
Olivier, Frederique	AME	Nesting Habitat Preferences of Snow Petrels *(Pagodroma nivea)* and Wilson's Storm Petrels *(Oceanites oceanicus)* in East Antarctica: A Modelling Approach to Predict Species Distribution	Dr George Jackson (IASOS/ ACE), Dr Simon Wotherspoon (Mathematics)
Pankowski, Andrew	AME	Ferredoxin and Flavodoxin as Indicators of Iron Availability in Antarctic Sea Ice Microalgal Communities	Prof Andrew McMinn (IASOS/ ACE), Dr John Bowman (Agricultural Science)
Phipps, Steven	CVC	Long-term Climate Studies using a Coupled General Circulation Model	A/Prof Nathan Bindoff (IASOS/ ACE), Prof Bill Budd (IASOS), Dr Tas van Ommen (AAD/ACE), Dr Scott Power (BoM), Dr Jason Roberts (TPAC)
Roy, Tilla	CO2	Atmospheric and Oceanic Constraints on Global Biogeochemical Processes	A/Prof Tom Trull (IASOS/ACE), Dr Richard Matear (CSIRO/ACE), Dr Roger Francey (CSIRO), Prof Bill Budd (IASOS), Dr Peter Rayner (CSIRO)

Under exam - MSc or MA

Student name	Program	Thesis title	Supervisors & Affiliations
Catchpole, Ann-Maree	CVC	Variability and Climate Change Signals in the Southern Ocean in the CSIRO and Antarctic CRC Coupled Ocean-Atmosphere Model	A/Prof Nathan Bindoff (IASOS/CSIRO/ACE), Dr John Church (CSIRO/ACE)
Pike, Rhonda	AME	Diet and Distribution of Weddell Seals along the Mawson Coast, East Antarctica	Dr George Jackson (IASOS/ACE), Dr Mark Hindell (Zoology/ACE), Mr Harry Burton (AAD)

PhD Degrees awarded 1 July 2005 – 30 June 2006

Student name	Program	Thesis title	Supervisors & Affiliations
Hunt, Brian	AME	Distribution of Zooplankton in the Southern Ocean	Prof Andrew McMinn (IASOS/ACE), Dr Graham Hosie (AAD), A/Prof David Ritz (Zoology)
Lane, Alison	EDU	Ecotoxicological Studies of the Effects of Heavy Metals and Hydrocarbons on Antarctic and Temperate Echinoderms	Prof Andrew McMinn (IASOS/ACE), Dr Martin Riddle (AAD)
Lane, Chris	EDU	The Use of Diatoms as Biological Indicators of Water Quality, and for Environmental Reconstruction, in South-East Tasmania, Australia	Prof Andrew McMinn (IASOS/ACE)
McMorrow, Alison	CVC	Intercomparison of Snow Pit Parameters and Meteorological Observations	Dr Rob Massom (ACE), Dr Mark Curran (AAD/ACE), Dr Tas van Ommen (AAD/ACE), Mr Vin Morgan (AAD/ACE)
Moy, Andrew	CVC	Late Pleistocene Palaeoceanographic and Geochemical Evolution of the South Tasman Rise	Dr Will Howard (ACE), Dr Peter Harris (GA)
Roberts, Andrew	CVC	Medium-range Numerical Prediction of Antarctic Sea Ice	Prof Bill Budd (AntCRC), Dr Roger Hughes (CSIRO), Dr Petra Heil (TPAC)

MSc or MA degrees awarded 1 July 2005 - 30 June 2006

Student name	Program	Thesis title	Supervisors & Affiliations
Jackson, Christine	AME	Biology and Ecology of the Southern Ocean Ommastrephid Squid *Todarodes filippovae*	Prof Andrew McMinn (IASOS/ACE), Dr Simon Wotherspoon (Mathematics), Dr Patti Virtue (IASOS)

performance measures

Objective 1: Enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development

1.1 Advance Australia's aspirations for its Antarctic territory and Southern Ocean exclusive economic zones.

Performance Measures	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
International commitment to Australia's claims is augmented by wise stewardship. ACE CRC will provide scientific leadership necessary to this stewardship. Performance measures include: 1. Use of ACE CRC research by EA, AGO, and other Australian agencies in their international discussions, regulatory activities and management decisions. 2. Broad recognition by the international community that Australian Antarctic climate and ecosystem science is of the highest quality, and is targeting essential issues.	ACE CRC researchers sit on 11 national and 17 international committees relating to Antarctic and Southern Ocean research/ management and climate change prediction and analysis. ACE CRC researchers published 65 refereed papers, 44 conference papers, seven book chapters and 24 other papers.	ACE CRC researchers served on 24 national and 41 international committees, editorial boards or advisory boards related to Antarctic and Southern Ocean research/ management and climate change prediction and analysis. ACE CRC researchers published 47 refereed papers, 29 conference papers or abstracts, 2 book chapters, 9 technical reports, and 4 other papers. 7 ACE CRC researchers served as consultants to various industries or government agencies.	ACE CRC researchers served on 24 national and 56 international committees, editorial boards or advisory boards related to Antarctic and Southern Ocean research/ management and climate change prediction and analysis. ACE CRC researchers authored or co-authored 63 refereed papers, 3 books, 10 book chapters, 4 conference articles, 29 conference abstracts, 2 technical reports and 14 other papers. 8 ACE CRC researchers served as consultants to various industries or government agencies. 2 ACE CRC researchers served as lead author and convening lead author for chapters in the upcoming 4th IPCC Assessment Report.

1.2 Increase international engagement in Southern Ocean and Antarctic research relevant to Australia's interests.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Commitment by other nations to undertake scientific research in the Australian Antarctic territory and in the Southern Ocean south of Australia in collaboration with the ACE CRC.	ACE CRC has 37 international collaborations, involving 10 countries, relating to Antarctica, the Southern Ocean and/or climate change.	ACE CRC researchers took part in 69 international collaborations involving 13 countries. ACE CRC hosted 25 international visitors from 11 different countries.	ACE CRC researchers took part in 82 international collaborations involving 17 countries. ACE CRC hosted 19 international visitors from 6 different countries.

Objective 2: Enhance the transfer of research outputs into commercial or other outcomes of economic, environmental or social benefit to Australia

2.1 To develop new approaches to the forecasting of ocean and ice conditions, which can be implemented for operational use by partner and other agencies.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Uptake of these approaches by operational agencies.	Research projects initiated.	Demonstrated that ocean temperatures can be used to derive accurate transport estimates of the Antarctic Circumpolar Current in Drake Passage, allowing a cost-effective means of monitoring the current.	Meteorologist responsible for developing sea ice data assimilation from satellite images employed; work is ongoing in the development and delivery of a sea ice analysis system for Bureau of Meteorology forecasters in the Antarctic. Planning well advanced for July 2007 International Workshop on Antarctic sea ice thickness, to be held in Hobart. Variability of the sea ice in the Mk3.0 and Mk3.5 models has been analysed and strengths of links with ENSO, SAM and Southern Ocean overturning in each sector calculated.

2.2 To provide science for the assessment of sustainable ecosystem management.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Use of these outputs by management agencies.	Successful scientist recruitment program.	Review of available ecosystem models completed; conceptual models on key taxa in the Antarctic marine ecosystem developed. Framework for developing Antarctic marine ecosystem models established; submitted to SC-CAMLR to assist in development of ecologically sustainable krill management procedures.	BROKE-West expedition surveyed more than 1 million square kilometres of the Southern Ocean, gathering data on krill populations and physical oceanographic properties. Developed krill population model based on empirical measurements for the southwest Atlantic, and a conceptual model for large-scale sea ice algal distribution. A large international program involving ACE CRC scientists examined the impact of anomalous atmospheric circulation on sea ice and associated biota in the West Antarctic Peninsula region. This showed the importance of extreme events on ice conditions and ice dynamics, and the devastating impact such conditions may have on local breeding success.

performance measures

2.3 To ensure recognition of oceanic carbon sinks and their impacts, to contribute to the effective management of carbon dioxide emissions.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Consideration of ocean carbon sinks in carbon management plans and agreements.	Research projects initiated.	Co-authorship of global compilation of oceanic inventory of anthropogenic CO_2 published in *Science* (Sabine et al., 2004) raised profile of ocean's role in moderating atmospheric greenhouse gas build-up.	Demonstrated that climate models must include both physical and biological aspects of sea ice gas dynamics to correctly simulate atmospheric carbon budgets. Demonstrated that elevated phytoplankton biomass over Kerguelen plateau is fuelled by iron inputs from deep waters; thus this region represents an area of natural persistent iron fertilisation that can inform debate about the role of iron in the control of atmospheric CO_2. Simulation of ocean acidification through the end of this century suggests major impacts on carbonate-shell forming organisms, and that the greatest effects are likely to occur in Antarctic waters; emphasises direct effect of anthropogenic CO_2 on marine ecosystem.

2.4 To provide observations essential to the consideration of climate change and variability in economic and environmental planning.

Performance Measures	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
1. Improved assessments of climate variability and change, and 2. Increased reference to this information by economic and environmental research users.	Research projects initiated.	Published revised estimates of sea-level rise for 1950 to 2000 and new assessment of warming of the Southern Ocean and associated thermal expansion. Discovered new evidence of the connection between mid-latitude atmospheric circulation anomalies and physical and ecological impacts in Antarctica. Completed several simulations demonstrating importance of links between Southern Ocean and global circulation and potential responses of ocean circulation to climate change.	Showed that volcanic eruptions have a significant impact on ocean heat content and steric sea level and that 20th century eruptions masked sea-level rise that would otherwise have been present. Showed that the rate of sea-level rise has increased during the 20th century and provided the first comprehensive estimate of the rate of sea-level rise during the latter half of the 20th century for Pacific and Indian Ocean islands. Comparison of new measurements with historical data confirm that the bottom water south of Australia is undergoing rapid and widespread change, suggesting both the northern and southern limbs of the global overturning circulation are responding to changes in high latitude climate.

Objective 3: Enhance the value to Australia of graduate researchers

3.1 To become a major training centre for climate, marine, and ecosystem science.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Increased recognition of Hobart as a top educational centre in these areas.	First intake of ACE CRC postgraduate students and awarding of ACE CRC scholarships.	41 PhD and 9 Masters students associated with ACE CRC. 6 PhD students under examination; 4 students awarded PhDs; 2 received Masters.	59 PhD and 8 Masters students associated with ACE CRC. 8 PhD and 2 Masters students under examination; 6 students awarded PhDs; 1 received Masters.

3.2 To deliver students with interdisciplinary skills useful to the climate, marine, and ecosystem research and research user communities.

Performance Measure	Achievements 2003-04	Achievements 2004-05	Achievements 2005-06
Successful placement of students within these communities.	Seven of 11 (63%) completing postgraduate students took up employment with industry/research using groups.	3 completing postgraduate students took up employment with industry/research user groups.	4 students who completed their PhDs took up employment with industry/research user groups.

Objective 4: Enhance collaboration among researchers, between researchers and industry or other users, and to improve efficiency in the use of intellectual and other research resources

4.1 To undertake interdisciplinary research which is larger in scope than the interests of individual participants.

Performance Measures	Achievements 2003-04	Achievements 2004-05	Achievements 2004-05
Number of projects involving multiple participants. Degree to which participants view the research as larger than the sum of its parts.	15 of 22 (68%) research projects involved multiple participants across more than one discipline.	ACE CRC researchers were involved in 42 national and 69 international collaborative projects.	ACE CRC researchers were involved in 43 national and 82 international collaborative projects involving 17 countries.

4.2 To undertake research of direct value to research users.

Performance Measures	Achievements 2003-04	Achievements 2004-05	Achievements 2004-05
Number and success of projects involving research users in their design and completion.	Development of Research Users' Forum proposal.	Conducted Research Users' Forum for government agencies. Involved research users in commercialisation plan development.	Conducted 2nd Research Users' Forum for government agencies. Involved research users in ACE CRC Annual Symposium. Conducted stakeholders' workshop on extreme sea levels to help in research design.

communication strategy

The ACE CRC Communication Strategy was developed early in 2004 to provide a framework for both internal and external communication activities. The first year of communications activity established the foundation, including the necessary processes and frameworks, for effective communication. The second year continued to build on this foundation to achieve the stated goals and resulted in an increased commitment and support for communications initiatives from program leaders and other research staff.

Communication Goals

The major goals as outlined in the Communication Strategy are:

1. To promote a sense of community and common purpose among researchers involved in the ACE CRC, strengthening staff and student commitment to the organisation and fostering collaborative work among participants.
2. To develop and maintain effective multidirectional communication among all staff and students within the ACE CRC, enabling the flow of knowledge about research and other activities between and across programs and people.
3. To promote awareness of the work of the ACE CRC among partner organisations and help partners gain value from their involvement with ACE CRC and benefit from ACE CRC research.
4. To promote awareness among key stakeholders of the ACE CRC and its role, achievements and value to Australia.
5. To attract high quality students to the ACE CRC postgraduate education program.
6. To strengthen links between the ACE CRC and other relevant national and international research and development initiatives, including those in the private sector.
7. To ensure that ACE CRC research contributes to evidence-based decision-making by local, state and federal government in the realms of Antarctica, the Southern Ocean, global and regional climate changes and their impacts.
8. To encourage private industry in Australia to use ACE CRC research in planning for the impacts of climate change.
9. To increase awareness and understanding among the Australian community about Antarctica, the Southern Ocean and climate change.
10. To promote the CRC Programme and its objectives.

Approaches to Communication

To address the above goals, the following approaches were identified in the Communication Strategy:

- The web site will be a core means of communication with staff, students and other key stakeholders.
- Communication tools and frameworks will be available to help staff and students communicate their work effectively.
- Personal contact will be used wherever possible, especially when interacting with senior decision-makers, and strong personal relationships with key stakeholders will be established and maintained by senior members of the ACE CRC.
- Multidirectional knowledge flow within the ACE CRC will be encouraged through use of e-mail lists, newsletters, web pages, workshops, forums and meetings.
- Publications will be developed on current and emerging research/issues that are tailored to the specific needs of the target audience.
- The ACE CRC will work collaboratively with other Partner organisations via the Communications Advisory Committee to maximise communication opportunities.
- ACE CRC will monitor the environment (via media scanning, personal contact, networks and so on) and respond to emerging issues as appropriate.
- Redundancy will be used in all communication tactics to reach stakeholders (that is, reach stakeholders using a variety of mediums, repeating messages as often as possible).
- The media will be used to reach a broad range of stakeholders and raise awareness of the CRC and its work.

Communication Activities in 2005-06

During the past year, we expanded our focus on liaison with end-users of our research. In addition to conducting the second Research Users' Forum for government agencies in Canberra, we held a local stakeholders' workshop on sea-level rise and extreme events in Hobart. This workshop provided interested parties from state and local government with information on climate change, sea-level rise and sea-level extremes relevant to the Australian coastline, and gathered information from stakeholders about the way they would like to get statistical information about sea-level extremes. The workshop was supported by the Tasmanian Department of Primary Industries and Water.

We also involved research users in our annual ACE CRC Symposium. The first day of the symposium centred on the question 'Climate change: What will happen to the ocean and what will be the impacts?' ACE CRC researchers shared their latest research findings, and representatives from the Australian Greenhouse Office, the Bureau of Meteorology, DPIW, ACIL Tasman and the Insurance Australia Group (IAG) informed us about their particular research needs.

More emphasis was put on public outreach efforts in 2005-06. ACE CRC researchers gave more than 50 talks to general or non-scientist audiences. Audiences included the general public, politicians, teachers, and primary and secondary school students. These talks are detailed in Appendix B.

Among the public outreach programs, we collaborated with the CSIRO Discovery Centre in Canberra in a thematic program on 'The Southern Ocean: Linking Antarctica and Australia'. ACE CRC scientist Will Howard gave a public lecture on global climate change that was attended by more than 75 people. The following day, we conducted a related hands-on professional development workshop for an additional 21 teachers.

Five ACE CRC people gave presentations during the Antarctic Midwinter Festival in Hobart in mid-June. Tony Worby and Guy Williams spoke about sea ice during a public luncheon at Hadley's Hotel, Vin Morgan and Shavawn Donoghue talked about their perspectives of Antarctica at the 'Ice Cold Words' literary event and Julia Jabour participated in a panel discussion, also at 'Ice Cold Words'.

The website continued to attract an increasing number of visitors. The website use statistics showed an average of 1,633 unique visitors per month during 2005-06, compared to an average of 806 per month in 2004-05. The website has been improved by the addition of more detailed information about the ACE CRC research, as well as links to national and international collaborative projects.

Media coverage was maintained and included the participation of a John Hunter from the Sea-level Rise Program in a television special on global climate change co-produced by the BBC and the Discovery Channel in the United States. A list of media contacts is included in Appendix C.

ACE CRC publications included 63 articles in refereed journals, 3 books, 10 book chapters, 4 conference articles, 29 published conference abstracts, 2 technical reports and 14 other papers. (Appendix E)

ACE CRC researchers also gave 82 national and 94 international presentations at scientific conferences, seminars or workshops. (Appendix A)

specified personnel

Specified personnel as of 30 June 2006

Title and Name	Role in CRC	Contributing Organisation	Time CRC (0.0 - 1.00)
Prof Bruce Mapstone	Chief Executive Officer	ACE CRC	1.00
Dr Stephen Rintoul	CVC Program Leader	CMAR	0.36
Dr Andrew Constable	AME Program Leader	AAD	0.80
Dr Thomas Trull	CO2 Program Leader / Deputy CEO	CMAR/UTAS	1.00
Dr John Church	SLR Program Leader	CMAR	0.64
Assoc Prof Marcus Haward	Policy Program Leader	UTAS	0.50
Prof Andrew McMinn	Education Program Leader	UTAS	0.50
Ms Christie Le Goy	Manager - Commercial Development	DED	1.00
Ms Vicki Randell	Business Manager	ACE CRC	1.00
Dr Sandra Zicus (see below)	Communications Manager	ACE CRC	0.92

Changes during 2005-06

Appointments

Dr Sandra Zicus, Communications Manager – Commenced appointment 1 August 2005

appendix a: scientific presentations

National scientific presentations

Staff name	Title or topic	Type	Event	Location
Allison I	An emerging vision of the International Polar Year 2007-2008	Oral	Royal Society of Tasmania	Hobart, TAS
Allison I	Research initiatives developing within the International Polar Year 2007-2008	Oral	Australian Antarctic Division seminar	Hobart, TAS
Bindoff N	Observational evidence for the changing state of the oceans	Oral	ACE CRC Symposium	Hobart, TAS
Bindoff N	Modelling the Southern Ocean	Oral	CLIVAR Working Group Ocean Model Development, Modelling the Southern Ocean	Hobart, TAS
Church J	Volcanic eruptions: Their impacts on sea level and oceanic heat content	Oral and poster	ACE CRC Symposium	Hobart, TAS
Church J	The changing ocean: Implications for the future	Oral	Indian Ocean Climate Initiative Symposium	Perth, WA
Church J White N Arblaster J	20th century sea-level rise	Oral	Greenhouse 2005 Conference	Melbourne, VIC
Constable A	Bioregionalisation of the Southern Ocean	Oral	ACE CRC Workshop on bioregionalisation of the Southern Ocean (AAD)	Hobart, TAS
Court J Warner R	Computer simulation of the Mertz Glacier tongue	Poster	ACE CRC Symposium	Hobart, TAS
Curran M	Ice core records from Amery Ice Shelf	Workshop	Amery Workshop	Hobart, TAS
Curran M	Sea ice proxy records in ice cores	Workshop	East Antarctic	Hobart, TAS
Griffiths B	Primary production in the Southern Ocean: Comparison between estimates from the Behrenfeld-Falkowski VGPM model and measurements	Oral	Informal CSIRO presentation	Hobart, TAS
Haward M Hall R	Australia's influence in the ATS	Workshop	Australia's Antarctic Agenda Workshop	Hobart, TAS
Haward M	Australian Antarctic science	Workshop	Australia's Antarctic Agenda Workshop	Hobart, TAS
Haward M Hall R Kellow A	Australian Antarctic policy	Workshop	Australia's Antarctic Agenda Workshop	Hobart, TAS
Haward M	Policy Program update	Oral	ACE CRC Symposium	Hobart, TAS
Haward M Sandford R	Cracks in thin ice: The science policy gap	Oral	ACE CRC Research Users Forum	Canberra ACT
Heil P	Sea-ice drift & floe-size distribution during Ice Station POLarstern [ISPOL]	Oral	ACE CRC Symposium	Hobart, TAS
Hirst A	CSIRO MK3.5 model: simulations and evaluation	Oral	CSIRO CLIMATE Annual Meeting	Sydney, NSW
Hirst A	CSIRO MK3.5 model: simulations and evaluation	Oral	Departmental Seminar, Monash University	Melbourne, VIC
Howard W	History and future of the carbon cycle	Oral	ACE CRC Symposium	Hobart, TAS
Howard W	History and future of the carbon cycle	Oral	ACE CRC Research Users' Forum	Canberra, ACT

appendix a: scientific presentations

Staff name	Title or topic	Type	Event	Location
Howard W Moy A	Geological insights into carbon cycling	Poster	Greenhouse 2005	Melbourne, VIC
Jabour J	Cold fusion: Teaching in Malaysia	Oral	Teaching Matters, UTAS	Hobart, TAS
Lugten G	Fishing (book chapter under preparation)	Workshop	Australia's Antarctic Agenda Workshop	Hobart, TAS
Marsland S	Antarctic coastal polynya response to climate change	Oral	ACE CRC Symposium	Hobart, TAS
Massom R	Bioregionalisation of the Southern Ocean: Sea ice	Oral	Bioregionalisation of the Southern Ocean	AAD, Kingston, TAS
Massom R	Recent sea ice results	Workshop	Ecological change in East Antarctica workshop	AAD, Kingston, TAS
Massom R	Positive and negative impacts of extreme sea ice conditions on the ecology of the West Antarctic Peninsula region, 2001/2	Poster	ACE CRC workshop	Hobart, TAS
McInnes K	Storm surges and climate change along the Victorian coast	Oral	Australian Meteorological and Oceanographical Society Conference	Newcastle, NSW
McInnes K	The effect of climate change on storm surges along the eastern Victorian coastline	Oral	Coast to Coast, 2006 Conference	Melbourne, Victoria
McInnes K	Extreme event impacts from warmer oceans	Oral	ACE CRC Research Users' Forum	Canberra, ACT
McInnes K	Storm surges and climate change	Seminar	Geoscience Australia	Canberra, ACT
McGregor J	Antarctic simulations using CCAM	Oral	ACE CRC workshop on Antarctic Accumulation	Hobart, TAS
McGregor J	Recent CCAM simulations and pan evaporation	Oral	CSIRO CLIMATE Annual Meeting	Sydney, NSW
Mongin M	Impact of elevated Fe dust input in the Southern Ocean	Poster	ACE CRC Symposium	Hobart, TAS
Mongin M	What's behind a complex biogeochemical model	Oral	CSIRO Oceanographic seminar	Hobart, TAS
Mongin M	Particulate organic matter distribution during the BROKE- West survey	Oral	BROKE-West Workshop	Kingston TAS
Moy A Howard W Gagan M Samson C	The effects of surface and deep-water carbonate chemistry on planktonic foraminiferal isotopic composition at the South Tasman Rise	Poster	ACE CRC Symposium	Hobart, TAS
Moy A	Late Pleistocene palaeoceanographic and geochemical evolution of the South Tasman Rise	Seminar	IASOS seminar	Hobart, TAS
Nicol S	BROKE-West	Oral	AAD seminar	Kingston, TAS
Nicol S	BROKE-West	Oral	ACE CRC seminar	Hobart, TAS
O'Farrell, S	Comparison of ocean warming at 900m in models and observations	Oral	ACE CRC Symposium	Hobart, TAS

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Staff name	Title or topic	Type	Event	Location
Phipps S	An efficient and portable climate system model for studying past, present and future climate	Oral	Workshop On Earth System Models Of Intermediate Complexity	Melbourne, VIC
Phipps S	An efficient and portable climate system model for studying past, present and future climate	Seminar	iVEC seminar	Perth, WA
Phipps S	The CSIRO Mk3L climate system model	Seminar	CSIRO seminar	Melbourne, VIC
Phipps S	The CSIRO Mk3L climate system model	Workshop	ARC Research Network for Earth System Science workshop	Sydney, NSW
Phipps S	A climate system model for studying past, present and future climate	Seminar	ACE CRC seminar	Hobart, TAS
Phipps S Roberts J Bindoff N	A coupled climate system model for long-term climate studies	Poster	ACE CRC Symposium	Hobart, TAS
Phipps S Roberts J Bindoff N	A coupled climate system model for long-term climate studies	Poster	APAC '05	Gold Coast, QLD
Raymond B	A bioregionalisation of the Southern Ocean: Why, how, and with what?	Seminar	AAD seminar	Kingston, TAS
Raymond B Hindell M Worby A Williams G Meiners K Hosie G Adams N Woehler E	Ecological change in East Antarctica	Poster	Ecological change in East Antarctica workshop	Kingston, TAS
Raymond B Meiners K Williams G Massom R Nicol S	A conceptual model of the large-scale distribution of sea ice algae off East Antarctica during the autumn-winter transition	Poster	ACE CRC Symposium	Hobart, TAS
Reid P	Antarctic snow accumulation	Oral	ACE SLR Antarctic Ice Accumulation workshop	Hobart, TAS
Reid P	Sea ice analysis	Oral	Weather Research Meeting	Melbourne, VIC
Reid P	A view of my early research career	Oral	IASOS Seminar Series	Hobart, TAS
Reid P	Nurturing young scientists	Oral	CRCA Annual Conference	Brisbane, QLD
Rintoul S	Overview of CVC achievements	Oral	ACE CRC Symposium	Hobart, TAS
Rintoul S	Ocean climate change	Oral	ACE CRC Symposium	Hobart, TAS
Rintoul S	Marine climate impacts	Oral	Wealth from Oceans Marine Impacts workshop	Hobart, TAS
Rintoul S	Changes in the Southern Ocean: Nature or Nurture?	Oral	ACE CRC Research Users' Forum	Hobart, TAS
Rintoul S	Climate change and the Southern Ocean	Plenary talk	Australian Earth Sciences Convention	Melbourne, VIC

appendix a: scientific presentations

Staff name	Title or topic	Type	Event	Location
Roberts J Heil P Bindoff N Matear R Hirst T Hunter J Marsland S	Australian Community Climate Model	Oral	APAC '05	Gold Coast, QLD
Roberts J	OASIS coupler	Oral	APAC Coupled Modelling Workshop	Canberra, ACT
Thost D Allison I	Automatic weather station burial as a proxy for mass balance, from sites in East Antarctica	Poster	ACE CRC Symposium	Hobart, TAS
Tilbrook B	Ocean biogeochemical cycling	Oral	Wealth from Oceans Workshop	Melbourne, VIC
Trull T	Ocean control of CO_2	Oral	ACE CRC Symposium	Hobart, TAS
Trull T	Effects of natural iron Fertilisation on the Southern Ocean	Oral	CMAR Informal Oceanography Seminar Series	Hobart, TAS
van Ommen T	Climate past, present & future: An introduction to ACE-CRC climate history research	Oral	ACE CRC Symposium	Hobart, TAS
van Ommen T	Antarctic Ice: Why should we care?	Oral	ACE Research Users' Forum	Canberra, ACT
Wake B Bowie A Butler E Haddad P	Selenium species distribution on a meridional transect of the Southern Ocean	Poster	13th Annual RACI Research & Development Topics Conference	Mount Eliza, VIC
Warner R	20th Century Antarctic Accumulation	Oral	ACE CRC SLR Workshop on Antarctic accumulation	Hobart, TAS
Warner R Williams M	Antarctica's subglacial waters – is frazil ice a vital factor?	Oral	ACE CRC Symposium	Hobart, TAS
White N Church J	A 20th century increase in the rate of sea-level rise: A challenge for coastal managers	Oral	Coast to Coast 2006	Melbourne, VIC
Williams G	Autosub-Under-Greenland fast ice	Poster/ Oral	ACE CRC Symposium	Hobart, TAS
Williams G	Heard Island oceanography	Poster	ACE CRC Symposium	Hobart, TAS
Williams G	ISW production from Mertz Glacier	Poster	ACE CRC Symposium	Hobart, TAS
Williams G	Summertime mixed layer development in East Antarctica	Poster	ACE CRC Symposium	Hobart, TAS
Williams G	Southern Ocean climate change	Oral	Ecosystem Regime Shift Workshop	Hobart, TAS
Williams G	Preliminary mixed layer results from BROKE-West	Oral	1st BROKE-West Workshop	Hobart, TAS
Wright S Jeffrey S	Current knowledge of pigments as biomarkers	Oral	Tasmanian phytoplankton group	Hobart, TAS
Wright S van den Enden R	Phytoplankton biomass measurements using pigment markers	Oral	BROKE-West workshop	Hobart, TAS

appendix a: scientific presentations

International scientific presentations

Staff name	Title or topic	Type	Event	Location
Adams N	Continued developments in numerical weather prediction and weather forecasting in support of the Australian Antarctic program.	Oral	The Antarctic Meteorological Observation, Modeling, and Forecasting Workshop	Boulder, Colorado USA
Adams N	The Casey Automatic Weather Station (AWS) Network.	Oral	The Antarctic Meteorological Observation, Modeling, and Forecasting Workshop.	Boulder, Colorado USA,
Allison I	The International Polar year 2007-08	Oral	ICSU General Assembly	Suzhou CHINA
Allison I	Ice on Earth: the cryosphere and climate	Oral	International Summer School on the Climate System and Climate Change	Beijing CHINA
Allison I	Sea ice processes and their role in the global climate system	Oral	as above	Beijing CHINA
Allison I	Climate variability and change in sub-polar and polar regions	Oral	as above	Beijing CHINA
Allison I	Meteorological and climate studies in the International Polar Year 2007-08	Oral	as above	Beijing CHINA
Church J White N Arblaster J	A 20th century increase in the rate of sea-level rise and the impact of volcanic eruptions on sea level	Oral	15 years of Progress in Radar Altimetry Symposium	Venice ITALY
Domingues C Church J White N Wijffels S Willis J	Estimating ocean steric sea-level rise (and ocean heat content) from sparse ocean data sets	Oral	Second Argo Science Workshop	Venice ITALY
Church J	Climate variability and change: Implications for sustainable development	Oral	United Nations Convention on Sustainable Development 14; Side Event on The Science of Climate Change and its Impact	New York USA
Church J	Potentially dangerous sea-level rise: A research needs example	Oral	UNFCC SBSTA-24 Side event on Climate change research achievements and challenges	Bonn GERMANY
Church J	Key climate change research gaps	Oral	UNFCC SBSTA-24 Side event on Climate change research achievements and challenges	Bonn GERMANY
Church J	World Climate Research Programme	Oral	SBSTA 24 UNFCCC Special Side Event on Research Needs of the Convention	Bonn GERMANY
Constable A	Implementing plausible ecosystem models for the Southern Ocean: An ecosystem, productivity, ocean, climate (EPOC) model	Oral/ workshop	CCAMLR Working Group on Ecosystem Monitoring and Management	Yokohama JAPAN
Constable A	International implementation of the ecosystem approach to achieve the conservation of Antarctic marine living resources	Oral/paper	United Nations Informal Consultative Process on Law of the Sea	New York USA
Curran M	Sea ice proxy records in ice cores	Seminar	Uni of Copenhagen	Copenhagen DENMARK

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Staff name	Title or topic	Type	Event	Location
Curran M	Sea ice proxy records in ice cores	Seminar	AWI	Bremerhaven GERMANY
Curran M	Sea ice proxy records in ice cores	Seminar	BAS	Cambridge UK
Curran M	Ice cores and climate	Seminar	Uni College Dublin	Dublin, IRELAND
Etheridge D MacFarling Meure C Langenfelds R Trudinger C Steele P Allison C Ferretti D Smith A Lassey K Lowe D van Ommen T Francey R Fraser P	Changes in concentrations of CO_2, CH_4 and N2O over the past 2000 years and their causes	Poster	Greenhouse 2005	Melbourne, VIC AUSTRALIA
Griffiths B	Photosynthetic parameters, size-fractionated chlorophyll and primary production during the KEOPS Expedition	Poster	AGU-ALSO-TOS Ocean Sciences meeting	Honolulu, HI USA
Harris J Haward M Jabour J Woehler E	Selecting high seas marine protected areas in the Southern Ocean	Poster	SCAR Biology Symposium	Curitiba BRAZIL
Heil P	Australian contributions to IPAB	Workshop	IPAB workshop	Dunedin NZ
Heil P	AFINL Australian Fast-Ice Network	Workshop	IPY2007 workshop	Dunedin NZ
Heil P	Sea-ice drift and deformation during ARISE 2003.	Oral	IGS conference	Dunedin NZ
Heil P	Antarctic sea-ice velocity as evidenced by passive-microwave data.	Oral	IGS conference	Dunedin, NZ
Hill K Rintoul S	East Australian Current changes and impacts	Oral	International Association for the Physical Sciences of the Ocean (IAPSO)	Cairns, QLD AUSTRALIA
Hirst A	Coupled modelling at CSIRO and BMRC	Oral	CLIVAR/WCRP Working Group on Coupled Modelling meeting	Exeter UK
Howard W	Effects of climate change on biodiversity in the Southern Ocean	Oral	Australia-Germany Workshop on Biodiversity	Canberra, ACT AUSTRALIA
Hunter J	Changes of extreme sea levels in Australia associated with sea-level rise	Oral	Coastal and Self Seas conference	Bangor, North Wales UK
Hunter J	Tides and tidal observations	Training lecture	GLOSS Training Course	Tokyo JAPAN
Hunter J	Climate change and sea-level rise	Training lecture	GLOSS Training Course	Tokyo JAPAN
Hunter J	International Oceanographic and Climate Programmes	Training lecture	GLOSS Training Course	Tokyo JAPAN
Hunter J	The effect of climate change on the frequency of extreme sea-level events	Poster	Understanding Sea-Level Rise and Variability (WCRP workshop)	Paris FRANCE

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Staff name	Title or topic	Type	Event	Location
Hunter J Church J White N	Communicating key indicators for sea level	Poster	Understanding Sea-Level Rise and Variability (WCRP workshop)	Paris FRANCE
Kawaguchi S	Learning about Antarctic krill from the fishery	Keynote	SCAR International Biology Symposium	Curitiba BRAZIL
Lambeck K	Palaeo- and 20th century sea-level variations	Workshop	Understanding Sea-Level Rise and Variability (WCRP workshop)	Paris FRANCE
Marsland S Church J Bindoff N Williams G	Antarctic coastal polynya response to climate change	Oral/poster	3rd International Conference on the Oceanography of the Ross Sea	Venice ITALY
Marsland S	Antarctic coastal polynya response to climate change	Seminar	Visiting Scientist Seminar, Max Planck Institute for Meteorology	Hamburg GERMANY
Marsland S	Ocean and sea ice studies at the Antarctic Climate & Ecosystems Cooperative Research Centre	Seminar	Seminar des Fachbereichs Klimawissenschen	Bremerhaven GERMANY
Marsland S Church J Bindoff N Williams G	Antarctic coastal polynyas in a changing climate	Oral	Dynamic Planet Meeting 2005	Cairns, QLD AUSTRALIA
Massom R	ARISE (Antarctic Remote Sensing Ice Experiment) in the East: Validation of satellite sea-ice data products	Poster	IGS International Symposium on Sea Ice	Dunedin NZ
Massom R	Validation of sea ice thickness calculated from AVHRR data in an Antarctic coastal polynya	Oral	IGS International Symposium on Sea Ice	Dunedin NZ
Massom R	Extreme sea ice conditions in the Antarctic Peninsula region, their impact and possible links with the disintegration of the Larsen B Ice Shelf	Oral	International Workshop on Antarctic Peninsula Climate Variability: Observations, Models, and Plans for the International Polar Year	Boulder, CO USA
Massom R Worby A Young N Hyland G	ARISE (Antarctic Remote Ice Sensing Experiment) in the East: 2003: Validation of satellite sea-ice data products	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
McInnes K Macadam I Hubbert G Abbs D Bathols J	Storm surges and climate change in eastern Victoria, Australia	Poster	World Climate Research Program workshop on sea level rise	Paris FRANCE
McMinn A	Effect of climate change on polar primary production	Oral	SCAR Biology	Curitiba BRAZIL
Meiners K	A conceptual model of the large-scale distribution of sea ice algae off East Antarctica during the autumn-winter transition	Poster	Dynamic Planet Meeting 2005	Cairns, QLD AUSTRALIA
Morgan V	Australian Ice core drilling	Workshop	IPICS II	Brussels BELGIUM
Nichols P	Signature lipids and fatty acids in trophic studies	Oral	Southern Ocean Squid Workshop	Hobart, TAS AUSTRALIA
Nicol S	Linkages between krill, ice, circulation and productivity in the Southern Ocean	Oral	Dynamic Planet Meeting 2005	Cairns, QLD AUSTRALIA

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Staff name	Title or topic	Type	Event	Location
O'Farrell S	Comparison of ocean warming at 900m in models and observations	Informal poster	CLIVAR SO panel meeting on climate variability	Cambridge UK
O'Farrell S	Sea ice changes in ice cores: What does it say for Southern Ocean and Australian climate?	Informal poster	CLIVAR SO panel meeting on climate variability	Cambridge UK
O'Farrell S	Climate variability of sea ice in the Australian Southern Ocean sector	Oral	IGS Symposium on Sea ice	Dunedin NZ
O'Farrell S	Sea level variability in control and transient simulations with the CSIRO Mk3.5 model.	Poster	WCRP workshop on understanding sea level rise and variability	Paris FRANCE
Phipps S Roberts J Bindoff N	Multi-millennial simulations of the climate of the late Holocene	Oral	EGU General Assembly 2006	Vienna AUSTRIA
Phipps S Roberts J Bindoff N	Multi-millennial simulations of the climate of the late Holocene	Poster	HOLIVAR 2006 Open Science Meeting	London UK
Rintoul S	Freshening of Antarctic Bottom Water	Oral	IAPSO	Cairns, QLD AUSTRALIA
Rintoul S	The Antarctic Circumpolar Current, Climate and Marine Life	Oral (invited)	IAPSO	Cairns, QLD AUSTRALIA
Rintoul S	The role of the Ross Sea in the global ocean circulation and climate	Oral (invited)	3rd International Ross Sea Conference	Venice ITALY
Rintoul S	The global influence of the Southern Ocean overturning circulation	Oral (invited)	Georg Wüst lecture, Max Planck Institut	Hamburg GERMANY
Rintoul S	What can inadequate observations tell us about incomplete models?	Oral (invited)	Southern Ocean Dynamics Workshop, Working Group on Ocean Model Development	Hobart, TAS AUSTRALIA
Rintoul S	Climate of Antarctica and the Southern Ocean (CASO)	Oral	SCAR/SCOR Expert Group on Oceanography	Venice ITALY
Rintoul S	The global influence of the Southern Ocean circulation	Oral (invited)	8th International Conference on Southern Hemisphere Meteorology and Oceanography	Foz do Iguaçu BRAZIL
Sandford R	Australia, Antarctica and the Southern Ocean: Aspects of the Science and Politics of Climate Change	Seminar	Joint Program on the Science and Policy of Global Change, Massachusetts Institute of Technology (MIT)	Cambridge MA USA
Sandford R	Opportunities for collaboration with ACE CRC, Policy Program, in the integration of climate science and public policy	Seminar	School of Engineering, Tufts University	Cambridge, MA USA
Sandford R	Opportunities for collaboration with ACE CRC Policy Program in the integration of climate science and public policy	Seminar	University of New Hampshire	Durham, NH USA
Smith B	The Australian Ice Core Program	Oral	Laboratoroire de Glaciologie et Géophysique de l'Environnment (LGGE),	Grenoble FRANCE

appendix a: scientific presentations

Staff name	Title or topic	Type	Event	Location
Sohrin Y Lai X Norisuye K Mikata M Minami T Bowie A	Spatial and temporal distribution of Fe, Ni, Cu and Pb along 140E in the Southern Ocean in 2001/2002 austral summer	Poster	13th AGU/ASLO/ERF/TOS Ocean Sciences Meeting	Honolulu, HI USA
Sokolov S Rintoul S	Southern Ocean Fronts	Oral (invited)	IAPSO	Cairns, QLD AUSTRALIA
Tilbrook B	Australian Carbon Cycle research	Oral	IOCCP Meeting	Boulder, CO USA
Tilbrook B	Underway ocean carbon measurements	Oral	IOCCP Meeting	Boulder, CO USA
Trull T	Particle sinking rates determined in-situ	Oral	VERTIGO workshop	Honolulu, HI USA
Trull T	Novel sediment trap designs	Oral	SCOR Working Group 116	Honolulu, HI
Trull T	Sediment trap hydrodynamics	Oral	SCOR Working Group 116	Woods Hole, MA USA
Trull T	*In situ* particle settling rates	Oral	AGU/ASLO/ERF/TOS Ocean Sciences meeting	Honolulu, HI USA
Ussher S Bowie A Achterberg E Worsfold P	Iron distributions and speciation along the Atlantic Meridional Transect (AMT)	Poster	13th AGU/ASLO/ERF/TOS Ocean Sciences Meeting	Honolulu, HI USA
Ussher S Bowie A Achterberg E Worsfold P	Evidence for natural iron fertilization in the Atlantic Ocean	Oral	SET For Britain: Presentations on Bioscience by Britain's Top Younger Researchers at the House of Commons	London, UK
Wake B Bowie A Butler E Haddad P	Selenium speciation in the Southern Ocean south of Australia	Poster	13th AGU/ASLO/ERF/TOS Ocean Sciences Meeting	Honolulu, HI USA
Williams G Marsland S Jacobs S Hunter J Bindoff N	Mertz Glacier ice shelf water production	Oral/ poster	3rd International Conference on the Oceanography of the Ross Sea	Venice ITALY
Warner R	Reassessing the input-output mass budget of East Antarctica between 50°E and 140°E	Poster	WCRP Workshop: Understanding sea-level rise and variability	Paris FRANCE
Warner R	Antarctic ice shelf processes: rifts, broad scale flow and basal melting	Seminar	LEGOS	Toulouse, FRANCE
Williams M Warner R	A frazil ice model for embedding within three-dimensional ocean circulation models	Oral	Dynamic Planet Meeting 2005	Cairns, QLD, AUSTALIA
Williams M Warner R	A frazil ice model for embedding within three-dimensional ocean circulation models	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	Surface albedo of the Antarctic sea ice zone	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	Regional and seasonal variability in Antarctic sea ice thickness	Poster	International Glaciological Society Symposium on Sea Ice	Dunedin NZ

appendix a: scientific presentations

Staff name	Title or topic	Type	Event	Location
Worby A Heil P	Changes in floe size distribution observed during early summer in the western Weddell Sea	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	Evolution of the ice thickness distribution downstream of the Mertz Glacier polynya as determined from EM measurements	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	*In situ* measurements of the direct current conductivity of Antarctic sea ice: Implications for airborne electromagnetic sounding of sea ice thickness	Poster	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	Thermodynamic evolution of summer first year sea ice properties in the Western Weddell Sea and implications for biological activity and air-ice-sea gas exchanges	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	A four year data set of sea ice thickness and mass balance for the Southern Ocean	Oral	International Glaciological Society Symposium on Sea Ice	Dunedin NZ
Worby A	Sea ice thickness data sets available for cetacean research in the Southern Ocean	Oral	Workshop on cetacean abundance and distribution in the Southern Ocean	Norfolk, VA USA
Worby A	Climate change in the polar regions	Invited keynote	Fulbright Academy of Science and Technology Symposium	Berlin GERMANY
Worby A	Changes in floe size distribution observed during the ISPOL drifting ice station	Oral	Ice Station POLarstern (ISPOL) Workshop	Tvärminne FINLAND
Worby A	On the use of operational ice products for research applications	Oral	International Ice Charting Working Group	Ottawa, Ontario CANADA
Wright S Higgins H Boucher C	Chemtax analysis of pigment data: New developments	Oral	SCOR/UNESCO pigment workshop	MONACO

appendix b: public presentations

Public (non-scientist audience) presentations

Staff name	Title or topic	Type	Event or Audience	Location
Allison I	The Antarctic ice sheet and sea ice	Oral	QANTAS Antarctic sight-seeing flight	Antarctica
Bindoff N	BROKE-West	Oral, school visit	Sandy Bay Infant School	Sandy Bay, TAS
Craven M	Antarctic glaciology	Seminar	University of 3rd Age	Kingston, TAS
	AMISOR – double dipping	Seminar	ANARE Expeditioners 2005-06	*Aurora Australis*
Curran M	Ice cores and climate	Seminar	Midwinter Festival	Hobart, TAS
	Ice cores and climate	Seminar	Unimutual (ACE CRC)	Hobart, TAS
Heil P	Science & life in Antarctica	School visit	Kingston Primary	Kingston, TAS
	Physical sciences in Antarctica	Oral	Public event	Margate, TAS
Howard W	Climate history: Lessons from the mud	Oral	Antarctic Midwinter Festival	Hobart, TAS
	Climate history: Lessons from the mud	Oral	Sandy Bay Rotary Club	Sandy Bay, TAS
	Global climate: past & future	Public lecture	CSIRO Discovery Centre	Canberra, ACT
	Climate science at ACE CRC	Tour	Hutchins School, Year 8	Hobart, TAS
Hunter J	Ocean waves and the diver	Oral	Tasmanian Sub Aqua Club	Hobart, TAS
	Science in society: Climate change - a scientist's personal journey	Oral	Year 10 environmental science and physics high school students	University of Tasmania, Hobart, TAS
	Sea-level change and impacts on the coastal zone	Oral	Public	Lauderdale Public Hall, TAS
	Sea-level change and impacts on the coastal zone	Oral	Coastal, Estuarine and Marine Stakeholders' Forum	Launceston, Tasmania
	Why is Antarctica cold, dry and icy?	Oral	Tourist voyage to the Ross Sea (Quark Expeditions)	Icebreaker *Kapitan Khlebnikov*
	Lights in the sky	Oral	Tourist voyage to the Ross Sea (Quark Expeditions)	Icebreaker *Kapitan Khlebnikov*
	The sea on which we sail (I)	Oral	Tourist voyage to the Ross Sea (Quark Expeditions)	Icebreaker *Kapitan Khlebnikov*
	The sea on which we sail (II)	Oral	Tourist voyage to the Ross Sea (Quark Expeditions)	Icebreaker *Kapitan Khlebnikov*
	B15A and the Drygalski Ice Tongue	Oral	Tourist voyage to the Ross Sea (Quark Expeditions)	Icebreaker *Kapitan Khlebnikov*
	Monitoring for sea-level change	Oral	Coastal & Marine Community Forum	Woodbridge Marine Discovery Centre, TAS
	Climate change and sea-level rise	Oral	West Tamar Schools Project Research Forum	Exeter High School, TAS
	Climate change and sea-level rise	Oral	Kingston Rotary Club	Margate, TAS
	Workshop on sea-level extremes: Setting the scene	Oral	ACE CRC Stakeholder Consultation Workshop	Hobart, TAS

appendix b: public presentations

Staff name	Title or topic	Type	Event or Audience	Location
Jabour J	Teaching in Malaysia	Oral	IASOS Seminar Series	Hobart, TAS
	Antarctic tourism	Oral	Glenorchy School for Seniors	Glenorchy, TAS
	Translating climate change information	Oral	Primary Industry Consultative Committee	Hobart, TAS
	An Antarctic researcher	Oral	University Foundation	Hobart, TAS
	Tourism to subantarctic Macquarie Island and East Antarctica from Hobart – A scoping study	Oral	Tasmanian Polar Network	Hobart, TAS
	The truth about whaling	Oral	Orion Expedition Cruises	MV *Orion*, Southern Ocean
	Illegal fishing in the Southern Ocean	Oral	Orion Expedition Cruises	MV *Orion*, Southern Ocean
	The Antarctic Treaty System	Oral	Orion Expedition Cruises	MV *Orion*, Southern Ocean
	Lake Vostok drilling program	Oral	Orion Expedition Cruises	MV *Orion*, Southern Ocean
	Orion Expedition Cruises	Oral	International Association of Antarctica Tour Operators	Washington DC, USA
	Antarctic research	Oral	Claremont Probus	Claremont, TAS
	Antarctic impressions	Panel participation	Antarctic Midwinter Festival 'Ice Cold Words'	Hobart, TAS
Lugten G	Southern Ocean sustainability	Public lecture	KDU College	Kuala Lumpur, MALAYSIA
Mapstone B	Climate change: roles of physics in addressing the issues	Oral	Australian Institute of Physics – media breakfast	Canberra, ACT
McInnes K	Climate change: evidence, projections & responses	Oral	General Meeting of Association of Bayside Municipalities	Melbourne, VIC
	Climate change and the coast: evidence, projections & responses	Oral	Public presentation hosted by Kingston City Council	Melbourne, VIC
Morgan V	Antarctic impressions	Oral	Antarctic Midwinter Festival 'Ice Cold Words'	Hobart, TAS
Pedro J	AMISOR project work	School visit	Back to School Day	Walpole Primary School, WA
Rintoul S	The oceans and climate change	School visit		Friends School year 4 class
	Careers in oceanography and climate science	School visit	Careers Day	Friends School
	Contribute to Southern Ocean display	Museum		Tasmanian Museum and Art Gallery
Smith B	Why we study ice cores	Oral	Year 8 Hutchins science class visit to ACE CRC	Hobart, TAS

appendix b: public presentations

Staff name	Title or topic	Type	Event or Audience	Location
van Ommen T	It's not cricket: Understanding the debate over the 'hockey stick' climate reconstruction	Oral	Australian Greenhouse Office	Canberra, ACT
	A climate of concern: The view from the past	Oral	University of the Third Age	Hobart, TAS
Williams G	Climate change, Antarctic science and different career paths to working in Antarctica	School visit	Primary School Careers Day	Mt Faulkner (North Chigwell) Primary School, TAS
	Sub-sea-ice oceanography with AUVs	Oral	Antarctic Midwinter Festival	Hobart, TAS
Worby A	Antarctic sea ice in the climate system	Oral	Antarctic Midwinter Festival	Hobart, TAS
Zicus S Howard W	Climate change and ocean circulation	Teacher workshop	Primary & secondary teachers	CSIRO Discovery Ctr, Canberra, ACT

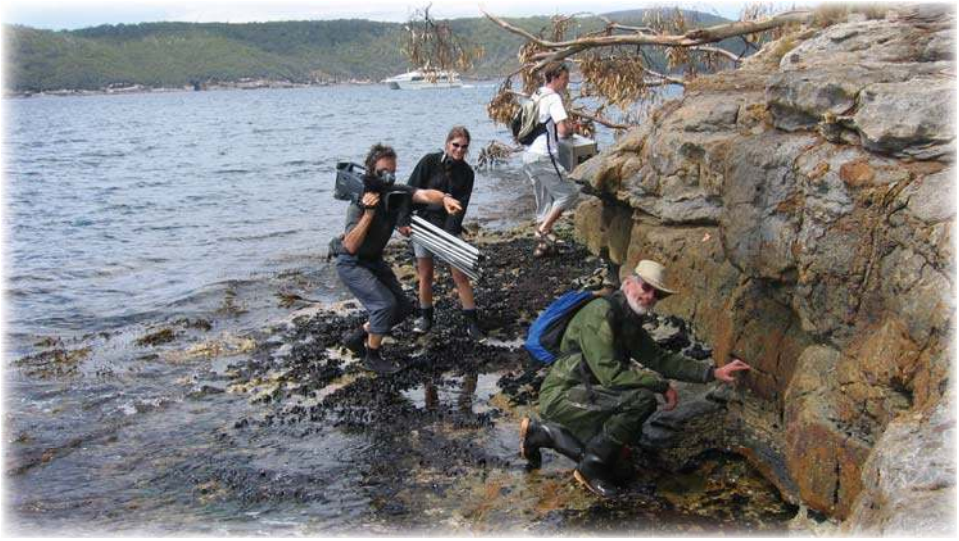
appendix c: media interviews

Media interviews

Name	Media Outlet(s)	Subject	Date
Allison I	ABC TV (Hobart & National), *Sydney Morning Herald*	Ice thickness changes in Antarctic	Oct 2005
	ABC Radio National, 'Australia Talks Back'	Arctic sea ice decline	Oct 2005
	International Council of Science (ICSU) press conference, CHINA	ICSU-wide issues, including the International Polar Year	Oct 2005
	Sydney Daily Telegraph	Iceberg calving and ice sheet mass balance	April 2006
Armand L	*The Mercury*	Marie Curie fellowship	Oct 2005
Bindoff N	ABC TV Evening News	Tracking devices on seals to collect oceanographic data	Sept 2005
	ABC Science On-line	Antarctic Circumpolar Current	Sept 2005
	ABC TV	BROKE-West departure and voyage	Jan 2006
	The Mercury, The Age	Return of BROKE-West	Mar 2006
Craven M	ABC TV, *The Australian*, *The Mercury,* Southern Cross TV, WIN	Departure of *Aurora Australis*; hot water ice drilling project	Sept 2005
Haward M	*The Age*	Commentary on increasing interest in Antarctic research from countries such as China	April 2006
	ABC local radio (Queensland), ABC drive radio (Canberra)	Mining in Antarctica	May 2006
	SBS radio	Antarctic Treaty and mining in Antarctica	May 2006
Hindell M	ABC TV Hobart	Tracking devices on seals to collect oceanographic data	Sept 2005
Howard W	Edge Radio	Climate change	Sept 2005
Hunter J	*Listener – The Things that Matter* (New Zealand magazine)	Climate change and sea-level rise in Tuvalu	Aug 2005
	BBC Natural History Unit, Radio 4 (UK)	Port Arthur sea-level measurements	
	BBC TV – Program on climate change	Port Arthur and sea-level rise	Feb 2006
	Inner City Courier (Sydney)	Sea level change in Sydney	April 2006
	BBC Radio News	Sea level rise in the Carteret Islands	April 2006
	Nature	Sea-level rise at Tuvalu	April 2006
	Super Interessante (Brazilian science magazine)	Sea-level rise at Tuvalu	May 2006
	BBC Television	Shoreline erosion	May 2006
Jabour J	EMBO Reports (USA)	Bioprospecting	July 2005
	NPR (National Public Radio, Washington) 'Science Friday'	Bioprospecting: live 15 minute radio interview	July 2005
King R	Asia Pacific TV	Live krill in Antarctica	Mar 2006
Matear R	ABC TV Hobart	Changes in methane over geologic time	Oct 2005

appendix c: media interviews

Name	Media Outlet(s)	Subject	Date
McInnes K	ABC Radio Gippsland	Climate change and extreme sea levels along the Gippsland report	Sept 2005
	Channel 10	1 hour documentary 'The Heat is On'	Nov 2005
	ABC Radio Gippsland	Climate change and its relevance to farmers and fishermen along the Gippsland coast	April 2006
	The Sunday *Age*	Article by Peter Weekes: 'Is this our gift to future generations? A drowned city? It could well be unless we all take immediate action.'	May 2006
McMinn A	ABC Bush Telegraph	Antarctica as cold desert	Mar 2006
Meiners K	Edge Radio	Life in ice	Oct 2005
Mongin M	Radio France	BROKE-West voyage	Jan 2006
Nicol S	6PR Radio Breakfast Show (Perth)	BROKE-West voyage	Feb 2006
	The Mercury, The Age, ABC Online	Return of BROKE-West	Mar 2006
	Canberra Times	Comparison of climate change in Antarctic region to Arctic	April 2006
Pedro J	WA Dept of Education media release	AMISOR work and school visit	Mar 2006
	ABC Great Southern Morning Program (WA)	AMISOR work and school visit	Mar 2006
	Edge Radio (UTAS)	Working in Antarctica & Antarctic climate	June 2006
Rintoul S	*Yachting World*	Southern Ocean currents	Jan 2006
	Sydney Daily Telegraph	Iceberg calving and ice sheet mass balance	April 2006
	New Scientist	Southern Ocean's role in global ocean circulation	April 2006
Tilbrook B	ABC TV (National)	*Southern Surveyor* voyage & carbon cycling in the ocean	Mar 2006
Trull T	ABC TV (Hobart & National), *Sydney Morning Herald*	Ocean acidification by anthropogenic CO_2	Oct 2005
	ABC TV (National), ABC Radio (Hobart)	*Southern Surveyor* voyage & carbon uptake in the ocean	Mar 2006
van Ommen T	ABC Bush Telegraph	Antarctica as cold desert	Mar 2006



appendix d: honours & awards

Honours & awards

Staff name	Honour or award	Reason for receiving	Date received
Bowie A	University of Tasmania, Faculty of Science, Engineering and Technology: Research Excellence Award (2006)	Award presented to the ACROSS (Chemistry) New Generation Research Group as recognition of their outstanding research achievements as early-career scientists	March 2006
Lambeck K	Election to French Academy of Science		June 2005
McMinn A	DSc – University of Tasmania	Outstanding contribution to science	December 2005
Phipps S	ACE CRC Earth Systems Modelling Travel Fellowship	Awarded to an ACE CRC student to attend an overseas conference of international standing	March 2006
Rintoul S	Elected to Australian Academy of Science		May 2006
Roberts J, Heil P and others	APAC award	Best technical paper	September 2006

Publications

Refereed journals

Adams N (2005) Identifying the characteristics of strong southerly wind events at Casey Station in East Antarctica using a numerical weather prediction system. *Monthly Weather Review* 131: 3548-3561.

Alonzo F, Virtue P, Nicol S and Nichols P (2005) Lipids as trophic markers in Antarctic krill, II. Lipid composition of *Euphausia superba* Dana in relation to phytoplankton abundance, and transfer of dietary signatures through secondary trophic levels. *Marine Ecology Progress Series* 296: 62-79.

Alonzo F, Virtue P, Nicol S and Nichols P (2005) Lipids as trophic markers in Antarctic krill, III. Lipid composition of *Euphausia superba* Dana in relation to diet changes: effect of incubation time and phytoplankton abundance. *Marine Ecology Progress Series* 296: 81-91.

Aoki S, Rintoul S, Ushio S, Watanabe S and Bindoff N (2005) Freshening of the Adélie Land Bottom Water near 140°E. *Geophysical Research Letters* 32, L23601, doi: 10.1029/2005GL024246.

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Buma A, Wright S, van den Enden R, van de Poll W, Davidson A (2006) PAR acclimation and UVBR induced DNA damage in Antarctic marine microalgae. *Marine Ecology Progress Series*, 315: 33-42

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appendix e: publications

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Corno G, McMinn A, Sturrock G, Parr R, Tindale N, Porter L, Gillett R, Fraser P, Derek N, Reeves C and Penkett S (2005) A preliminary investigation of the phytoplankton ecology and marine biogenic gas production near Cape Grim, Tasmania. *Baseline* 2001-2002, 8-14.

Craven M, Carsey F, Behar A, Matthews J, Brand R, Elcheikh A, Hall S, and Treverrow A (2006) Borehole imagery of meteoric and marine ice layers in the Amery Ice Shelf, East Antarctica. *Journal of Glaciology* 51 (172): 75-84.

Craven M, Carsey F and Nicol S (2006) Short Note: Ice krill under the Amery Ice Shelf, East Antarctica. *Antarctic Science* 18 (1): 81-82, doi:10.1017/S0954102006000071.

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List of Acronyms

AAD	Australian Antarctic Division
AAS	Australian Academy of Science
AAT	Australian Antarctic Territory
ACAP	Agreement for the Conservation of Albatross and Petrel Species
ACE CRC	Antarctic Climate & Ecosystems Cooperative Research Centre
AGCS	Antarctica and the Global Climate System
AGO	Australian Greenhouse Office
AGU	American Geophysical Union
AME	Antarctic Marine Ecosystems Program (ACE CRC)
AINSE	Australian Institute of Nuclear Science and Engineering
AMSA	Australian Marine Sciences Association
AMT	Atlantic Meridional Transect
ANARE	Australian National Antarctic Research Expeditions
ANCAR	Australian National Committee for Antarctic Research
ANSTO	Australian Nuclear Science and Technology Organisation
Antarctic CRC	CRC for Antarctica and the Southern Ocean
ANU	The Australian National University
APAC	Australian Partnership for Advanced Computing
ARAC	Antarctic Research Assessment Committee
ASAC	Antarctic Science Advisory Committee
ASLO	American Society of Limnology and Oceanography
ASPeCt	Antarctic Sea Ice Processes and Climate
ATS	Antarctic Treaty System
AusCOM	Australian Climate Ocean Model
AUV	Automated Underwater Vehicle
AWI	Alfred Wegener Institute (Germany)
BAS	British Antarctic Survey
BMRC	Australian Bureau of Meteorology Research Centre
BOM	Australian Bureau of Meteorology
CAR	CSIRO Atmospheric Research
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCLR	Council for the Central Laboratory of the Research Councils (UK)
CERES	Clouds and the Earth's Radiant Energy System
CIGL	Centre for International & Global Law (U. Sydney)
CliC	Climate & Cryosphere Program
CLIM-OSS	Climate - Sezione Analisi Sperimentali ed Osservazioni (Italy)

appendix f: acronyms

CLIVAR	Climate Variability & Predictability Program
CMAR	CSIRO Marine & Atmospheric Research
CNES	Centre National d'Etudes Spatiales
CO_2	Carbon dioxide
CO2	Ocean Control of Carbon Dioxide Program (ACE CRC)
CRC	Cooperative Research Centre
CVC	Climate Variability and Change Program (ACE CRC)
DED	Tasmanian Department of Economic Development
DMIP	Data Management and Information Panel (of CliC)
DPIWE	Tasmanian Department of Primary Industries, Water and Environment
DSTO	Defence Science and Technology Organisation
EEZ	Exclusive Economic Zones
EGU	European Geosciences Union
ENEA	Ente per le Nuove Technologie, l'Energia e l'Ambiente (Italy)
ENSO	El Niño Southern Oscillation
ERF	Estuarine Research Foundation (USA)
FAO	Food and Agriculture Organisation (United Nations)
FRISP	Forum for Research into Ice Shelf Processes
GFDL	Geophysical Fluid Dynamics Laboratory
GOOS	Global Ocean Observing System
IASOS	Institute for Antarctic and Southern Ocean Studies (UTAS)
ICCED	Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean
ICRW	International Convention for the Regulation of Whaling
ICSU	International Council of Science
IGS	International Glaciological Society
IOCCP	International Ocean Carbon Program
IPCC	Intergovernmental Panel on Climate Change
IPICS	International Partnerships in Ice Core Science
IPY	International Polar Year 2007-2008
ISPOL	Ice Station Polarstern (Germany)
IUU	Illegal, Unreported and Unregulated (fishing)
iVEC	Interactive Virtual Environments Centre (Perth, WA)
IWC	International Whaling Commission
JAMSTEC	Japan Marine Science and Technology Center
JGOFS	Joint Global Ocean Flux Study
JPL	Jet Propulsion Laboratory (USA)

appendix f: acronyms

KEOPS	Kerguelen compared study of Ocean and Plateau in surface waters
LEGOS	Laboratoire d'Etudes en Geophysique et Oceanographie Spatiales (France)
LOSC	Law of the Sea Convention
MPA	Marine Protected Area
NASA	National Aeronautics and Space Administration (USA)
NILOS	Netherlands Institute for Law of the Sea
NIPR	National Institute of Polar Research (Japan)
NIWA	National Institute for Water and Atmospheric Research (NZ)
NOAA	National Oceanic and Atmospheric Administration (USA)
NSF	National Science Foundation (USA)
OASIS	Ocean Acquisition System for Interdisciplinary Science
POOZ	Permanent Open Ocean Zone
PRNA	Programma Nazionale de Recerche Antartide (Italy)
QMS	Quantitative Marine Science (UTAS)
SAM	Southern Annular Mode
SAZ	Subantarctic Zone
SC-CCAMLR	Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanographic Research
SGI	Silicon Graphics International
SIO	Scripps Institution of Oceanography (USA)
SLR	Sea Level Rise Program (ACE CRC)
SO	Southern Ocean
SOLAS	Surface Ocean Lower Atmosphere Study
SMRU	Sea Mammal Research Unit (UK)
SSG	Scientific Steering Group
TOS	The Oceanographic Society
TPAC	Tasmanian Partnership for Advanced Computing
UNCLOS	United Nations Convention on the Law Of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
UTAS	University of Tasmania
VERTIGO	Vertical flux in the Global Ocean
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment

appendix g: staff resources

Staff Name	Total % Time	AME	CO2	CVC	POL	SLR	Rsch Total	Educ'n	Commerc	Admin
Australian Antarctic Division - In-Kind										
I Allison	65%	5%		25%		30%	60%		5%	
J Anderson	85%					80%	80%		5%	
I Ball	20%	20%					20%			
R Brand	85%			40%		40%	80%		5%	
A Constable	70%	65%					65%		5%	
M Craven	85%			40%		40%	80%		5%	
M Curran	85%	10%		70%			80%		5%	
A Davidson	50%	25%	25%				50%			
S Donoghue	45%			23%		22%	45%			
A Drinkell	50%			25%		23%	48%		2%	
A Elcheikh	40%			20%		20%	40%			
L Emmerson	1%	1%					1%			
S Frydman	13%	13%					13%			
J Gedamke	30%	30%					30%			
J Gibson	85%			10%		70%	80%		5%	
P Heil	85%	20%		60%			80%		5%	
G Hosie	25%	25%					25%			
G Hyland	85%			40%		40%	80%		5%	
T Jarvis	15%	15%					15%			
S Kawaguchi	70%	70%					70%			
R Leaper	60%	60%					60%			
V Lytle	9%	2%		7%			9%			
R Massom	27%	5%		20%			25%		2%	
V Morgan	85%			70%		10%	80%		5%	
S Nicol	80%	75%					75%		5%	
J Pedro	85%			80%			80%		5%	
D Rasch	55%			25%		25%	50%		5%	
B Raymond	45%	45%					45%			
M Richardson	85%			40%		40%	80%		5%	
G Robertson	3%	3%					3%			
T Robertson	2%	2%					2%			
B Smith	85%			40%		40%	80%		5%	
C Southwell	3%	3%					3%			
A Steer	25%	7%		18%			25%			
D Thost	85%			40%		40%	80%		5%	
T Van Ommen	80%			50%		25%	75%		5%	
R Warner	85%			20%		60%	80%		5%	
S Whiteside	50%			50%			50%			
A Worby	85%	25%		55%			80%		5%	
S Wright	45%	45%					45%			
N Young	85%			10%		70%	80%		5%	
Total	**2253%**	**571%**	**25%**	**878%**	**0%**	**675%**	**2149%**	**0%**	**104%**	**0%**

appendix g: staff resources

Staff Name	Total % Time	AME	CO2	CVC	POL	SLR	Rsch Total	Educ'n	Commerc	Admin
Australian Bureau of Meteorology - In-Kind										
N Adams	50%			48%			48%		2%	
O Alves	10%			10%			10%			
G Brassington	10%			10%			10%			
D Greenslade	10%			10%			10%			
P Reid	100%			95%			95%		5%	
E Schulz	10%			10%			10%			
N Smith	5%			5%			5%			
F Tseitkin	60%			60%			60%			
Total	**255%**	**0%**	**0%**	**248%**	**0%**	**0%**	**248%**	**0%**	**7%**	**0%**
CSIRO Division of Atmospheric Research - In-Kind										
T Hirst	13%			13%			13%			
I Macadam	13%					13%	13%			
K McInnes	12%					12%	12%			
Total	**38%**	**0%**	**0%**	**13%**	**0%**	**25%**	**38%**	**0%**	**0%**	**0%**
CSIRO Division of Marine Research - In-Kind										
N Bindoff	50%			50%			50%			
E Butler	50%		50%				50%			
J Church	64%			17%		45%	62%		2%	
R Coleman	20%					20%	20%			
B Griffiths	40%		40%				40%			
R Matear	40%		40%				40%			
P Nichols	10%	10%					10%			
J O'Sullivan	5%		5%				5%			
S Rintoul	36%			35%			35%		1%	
B Tilbrook	56%		56%				56%			
T Trull	50%		50%				50%			
N White	22%					22%	22%			
Total	**443%**	**10%**	**241%**	**102%**	**0%**	**87%**	**440%**	**0%**	**3%**	**0%**
University of Tasmania - In-Kind										
N Bindoff	50%			32%		10%	42%	3%	5%	
R Coleman	5%						0%	5%		
L Forbes	10%		5%				5%	5%		
R Hall	10%				10%		10%			
M Haward	50%				25%		25%	15%	10%	
M Hazlewood	30%						0%	5%		25%
M Hindell	6%	1%					1%	5%		
J Jabour	50%				30%		30%	20%		
G Jackson	50%	25%					25%	25%		
A Kellow	10%				10%		10%			
L Kriwoken	10%				10%		10%			
G Lugten	15%				15%		15%			
A McMinn	50%	25%					25%	20%	5%	

appendix g: staff resources

Staff Name	Total % Time	AME	CO2	CVC	POL	SLR	Rsch Total	Educ'n	Commerc	Admin
University of Tasmania - In-Kind (continued)										
K Michael	50%			25%			25%	25%		
S Phipps	31%			31%			31%			
J Roberts	50%	15%		30%		5%	50%			
T Trull	50%	10%	20%				30%	5%	5%	10%
Total	**527%**	**76%**	**25%**	**118%**	**100%**	**15%**	**334%**	**133%**	**25%**	**35%**
Alfred Wegener Institute - In-Kind										
U Bathmann	10%	10%					10%			
E Fahrbach	25%			25%			25%			
C Haas	25%			25%			25%			
R Hermann	8%	8%					8%			
B Meyer	5%	5%					5%			
I Runez	16%	16%					16%			
J Schroter	15%					15%	15%			
E Schutt / O Strothmann	45%			45%			45%			
M Teschke	25%	25%					25%			
M Wenzel	70%					70%	70%			
Total	**244%**	**64%**	**0%**	**95%**	**0%**	**85%**	**244%**	**0%**	**0%**	**0%**
Australian National University - In-Kind										
K Lambeck	15%					15%	15%			
J Zhao	15%					15%	15%			
P Tregoning	5%					5%	5%			
Total	**35%**	**0%**	**0%**	**0%**	**0%**	**35%**	**35%**	**0%**	**0**	**0**
National Institute for Water & Atmospheric Research - In-Kind										
P Boyd	10%	10%					10%			
H Neil	10%			10%			10%			
S Nodder	10%		10%				10%			
M Williams	25%			10%		15%	25%			
Total	**55%**	**10%**	**10%**	**20%**	**0%**	**15%**	**55%**	**0%**	**0%**	**0%**
Tasmanian Department of Economic Development - In-Kind										
C le Goy	100%								100%	
Total	**100%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**100%**	**0%**
TOTAL IN-KIND	**3950%**	**731%**	**301%**	**1474%**	**100%**	**937%**	**3543%**	**133%**	**239%**	**35%**

appendix g: staff resources

Staff Name	Total % Time	AME	CO2	CVC	POL	SLR	Rsch Total	Educ'n	Commerc	Admin
University of Tasmania - ACE CRC Cash Funded Staff										
K Bidwell	85%						0%			85%
A Bowie	33%		30%				30%		3%	
S Bray	100%		95%				95%		5%	
D Davies	63%		60%				60%		3%	
W Howard	100%	10%	35%	50%			95%		5%	
J Hunter	100%					95%	95%		5%	
B Mapstone	100%	10%	10%	10%	10%	10%	50%	10%	20%	20%
S Marsland	100%			95%			95%		5%	
R Massom	58%	5%		50%			55%		3%	
K Meiners	100%	82%				13%	95%		5%	
M Mongin	100%		95%				95%		5%	
A Moy	10%		10%				10%			
C Moy	54%		18%	30%			48%		2%	4%
B Pasquer	100%	75%	20%				95%		5%	
V Randell	100%						0%		10%	90%
T Remenyi	42%		40%				40%		2%	
L Robertson	8%		8%				8%			
M Rosenberg	100%		25%	70%			95%		5%	
T Roy	58%		56%				56%		2%	
R Sandford	71%				68%		68%		3%	
G Williams	100%	95%					95%		5%	
S Zicus	92%						0%	5%	2%	85%
Total	**1674%**	**277%**	**502%**	**305%**	**78%**	**118%**	**1280%**	**15%**	**95%**	**284%**
CSIRO Division of Atmospheric Research - ACE CRC Cash Funded Staff										
I Macadam	13%					13%	13%			
K McInnes	15%					15%	15%			
S O'Farrell	60%			30%		30%	60%			
Total	**88%**	**0%**	**0%**	**30%**	**0%**	**58%**	**88%**	**0%**	**0%**	**0%**
CSIRO Division of Marine Research - ACE CRC Cash Funded Staff										
P Nichols	10%	10%					10%			
M Pretty	55%		55%				55%			
C Rathbone	15%		15%				15%			
S Sokolov	72%			72%			72%			
Total	**152%**	**10%**	**70%**	**72%**	**0%**	**0%**	**152%**	**0%**	**0%**	**0%**
Australian National University - ACE CRC Cash Funded Staff										
J Zhao	33%					33%	33%			
G Estermann	50%					50%	50%			
Total	**83%**	**0%**	**0%**	**0%**	**0%**	**83%**	**83%**	**0%**	**0%**	**0%**
TOTAL CASH	**1997%**	**287%**	**572%**	**407%**	**78%**	**259%**	**1603%**	**15%**	**95%**	**284%**
TOTAL IN-KIND & CASH	**5947%**	**1018%**	**873%**	**1881%**	**178%**	**1196%**	**5146%**	**148%**	**334%**	**319%**

ANTARCTIC CLIMATE & ECOSYSTEMS
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Australian Bureau of Meteorology
CSIRO Marine and Atmospheric Research
University of Tasmania

Supporting Participants

Alfred Wegener Institute for Polar and Marine Research (Germany)
Australian Greenhouse Office
Australian National University
National Institute of Water and Atmospheric Research (New Zealand)
Silicon Graphics International
Tasmanian Department of Economic Development

CRC AUSTRALIA

Australian Government
Department of the Environment and Heritage
Australian Antarctic Division

UTAS

CSIRO

Australian Government
Bureau of Meteorology