



# ANTARCTIC CLIMATE & ECOSYSTEMS COOPERATIVE RESEARCH CENTRE

2011-2012 Annual Report



Established and supported under the Australian Government's Cooperative Research Centres Program

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Annual Report 2011-2012

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## 1 Executive Summary

The Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC) had a productive year in 2011-2012 culminating in a very positive mid-term Performance Review in May 2011. Good progress was made against all of the ACE CRC's milestones and contingencies were put in place to deal with emerging risks. Researchers in the ACE CRC published strongly in the scientific literature, and there were many activities involving end-users and the general public.

### 1.1 Achievements

The major fieldwork for the Oceans Program in 2011-2012 was the completion of the World Ocean Circulation Experiment, Indian Ocean 9 transect (WOCE I9) between Antarctica and Western Australia. Observations of temperature, salinity, oxygen, nutrients, carbon, and ocean currents were collected every 10-30 nautical miles, from the sea surface to the ocean floor to track changes in the physical and chemical properties of the Southern Ocean. A significant preliminary finding is that the Antarctic Bottom Water continues to become less salty, less dense and to contract in volume. The 2011-2012 voyage of the *RSV Aurora Australis* to the Mertz Polynya region also provided an opportunity to get scientific information from this region following the calving of the Mertz Glacier Tongue in February 2010. Scientists from the Oceans Program have continued to make a significant contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). Prof Nathan Bindoff and Dr Steve Rintoul are co-ordinating lead authors of the "Detection and Attribution" and "Observations of Ocean Change" chapters of the report, respectively. Dr Catia Domingues has made valuable contributions to several chapters and is recognised as a contributing author in the "Detection and Attribution" and "Oceans and Sea Level" chapters.

The Position Analysis "Climate Change and the Southern Ocean" was published in late 2011. This "plain-language" update on the latest Southern Ocean climate science report was well received by a variety of stakeholders and attracted substantial media interest in Australia and overseas.

The Sea-level Rise Impacts team made significant inroads towards achieving their major milestones in 2011 to 2012. A completely revamped version of the web-based sea-level rise decision support tool was released, now renamed 'Canute'. Canute now provides estimates of the present statistics of stormtides and tropical cyclones for the whole coastline – a first for Australia, and possibly a first for a whole continent globally. Dr John Hunter was also a Contributing Author to Chapter 13 of the IPCC AR5 Working Group 1 report, and was also a reviewer of Chapter 13 of the Working Group 1 First Order Draft.

Scientists from the Carbon Program participated in the 56-day international *Kerguelen compared study of Ocean and Plateau in Surface waters (KEOPS-2)* research voyage to the Kerguelen Plateau to study natural iron fertilisation of the

ocean. They also participated in the *WOCE 19* voyage. Data from these voyages, the Southern Ocean Time Series (SOTS) mooring, and the French resupply vessel *L'Astrolabe* is providing valuable information about the uptake of carbon in the Southern Ocean – an important component of the global climate budget.

Twenty-one papers from research in the Carbon Program were published in a special volume of *Deep-Sea Research Part II: Topical Studies in Oceanography 'Biogeochemistry of the Australian Sector of the Southern Ocean'*.

The ACE CRC Cryosphere Program made a significant contribution to the project 'Investigating the Cryospheric Evolution of the Central Antarctic Plate' (ICECAP) airborne survey of the bedrock of east Antarctica. Twenty-three flights in the 2011/12 season covered over 40,000 line kilometres over the continent. The results from this international collaboration show for the first time that a significant portion of the east Antarctic ice sheet is grounded below sea level – an important factor in understanding how the Antarctic ice sheet will respond to warming ocean waters. Models developed in the ACE CRC of ice-ocean interactions are now providing realistic simulations of ocean processes along the Antarctic continental shelf. These models will provide a significant contribution to understanding the impacts of climate change in the region.

Analyses of ice cores have revealed an important connection between the El-Niño Southern Oscillation (ENSO) and summertime wind speeds in the Southern Ocean, thus providing a proxy allowing for reconstruction of rainfall records in eastern Australia. Another important finding from ice core analyses at the ACE CRC is that the link between carbon dioxide (CO<sub>2</sub>) and temperature changes through the end of the last ice age, 18,000 to 12,000 years ago, is much shorter than previously thought. That is, ocean CO<sub>2</sub> response to warming took between 0 and 400 years to occur - considerably shorter than previous estimates of around 800 years. Cryosphere staff were involved in IPCC AR5 in both author and reviewer roles.

The ACE CRC's Ecosystems Program made significant progress in developing a coupled ocean-ecosystem model. An ocean model for the Indian Sector of the Southern Ocean has been developed using the Regional Ocean Modeling System (ROMS) and a sea-ice emulator developed as an approximation for sea-ice dynamics. A method for coupling the two modelling systems (ROMS and Atlantis) has also been developed. Testing of the coupled model is expected to begin later in 2012 and the first experiments to begin early in 2013. The circum-Antarctic database of biomass associated with sea-ice has been completed and results are in the process of being published. This database includes data sets on sea-ice biological properties from 32 German, United States of America (USA) and Australian voyages (1983 – 2008) and has been included in the Antarctic Sea-ice Processes & Climate (ASPeCt) database held at the Australian Antarctic Division (AAD). A second international workshop of the Southern Ocean Sentinel Program (Sentinel-2) was held in May 2012 as part of the international program, Integrating Climate and

Ecosystem Dynamics (ICED) of the Southern Ocean, including further discussions on developing the Sentinel.

During the reporting period, the Ecosystems Program contributed to the Working Group 2 of the IPCC AR5. The Ecosystems Program research on impacts of climate change in Polar Regions will contribute to chapter 28 of the report.

The ACE CRC published 1 book, 19 book chapters, 84 articles in scholarly refereed journals, and 4 full written conference papers in refereed proceedings during the reporting period (Appendix 1). These include publications from the Climate for Tasmania, National Environmental Research Program (NERP) and Natural Disaster Resilience Program (NDRP) projects (see section 4.4).

### **Honours and awards**

ACE staff members and Honorary Fellows have been presented with Honours and Awards during the reporting period. Prof Ian Allison was awarded the Scientific Committee for Antarctic Research (SCAR) medal for International Science Coordination for his 30-year leading role in international collaboration in glaciology and climate science, most notably as co-chair of the International Council for Science (ICSU)/World Meteorological Organisation (WMO) Joint Committee for the International Polar Year 2007-2008.

Dr Elizabeth Shadwick was awarded the Land-Ocean Interactions in the Coastal Zone (LOICZ) Young Scientists Forum prize for her outstanding performance at the forum and LOICZ Open Science Conference in September 2011.

Dr Donna Roberts was appointed, through competitive national nomination and appointment process, as Australia's expert to the United Nations Convention on Biological Diversity Committee of Ocean Acidification Experts in October 2011.

Dr Steve Rintoul has been awarded the prestigious 2012 Martha T. Muse Prize for Science and Policy in Antarctica for his outstanding research on the Southern Ocean. The Muse Prize is awarded to an individual in the fields of Antarctic science or policy who has demonstrated potential for sustained and significant contributions that will enhance the understanding and/or preservation of Antarctica. Dr Rintoul delivered the Muse Prize Lecture at the SCAR Open Science Conference in Portland, Oregon, in July 2012.

ACE CRC honorary research fellow Dr Delphine Lannuzel received the Vice Chancellor's award for Research Excellence from the University of Tasmania (UTAS) on 22 September 2011.

### **Staff appointments**

During the reporting period, the ACE CRC successfully recruited the following people:

Name	Position	Start Date	Program
Dr Rebecca Harris	Climate Research Fellow	19 December 2011	Climate Futures
Dr Greg Lee	Climate Modeller	1 December 2011	Climate Futures

### Major purchases for the year

Major capital costs for this reporting period were:

Item	Amount	Program
Remotely Operated Vehicle (ROV)	\$173,164	Ecosystems
McLane pump	\$62,987	Carbon
Mooring replacement	\$23,021	Oceans
BW mooring	\$20,882	Oceans
Ice profiling floats	\$257,627	Oceans
<b>TOTAL</b>	<b>\$537,681</b>	

### External reviews

The ACE CRC had its performance review from 23 May 2012 until 25 May 2012. The panel found that:

*"The CRC is recognised as a public good research centre which is delivering high quality research outputs for policy and industry end-users, including; federal, state and local government agencies, as well as service sector entities (engineering, scientific and management services; planning consultants; risk and natural resources managers).*

*The CRC's work directly contributes to the needs of national and international bodies, such as the Intergovernmental Panel on Climate Change (IPCC), the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Australian Antarctic Division whose responsibilities include the Australian Antarctic Territory. The CRC's expertise has been clearly recognised by the IPCC engaging researchers of the CRC to author key documents.*

*The CRC is nearing the completion of its CRC program funding and is at a critical decision point for its future funding and organisational arrangements. The panel were of the view that the CRC must continue to urgently address these future arrangements so that (i) the scientific capacity and capability that has developed in the CRC over the past 21 years can be maintained and enhanced and (ii) the*

*recent breakthroughs in science that have emerged under the current research programs can be capitalised upon for national and international benefit.*

*The panel specifically identified that:*

- 1. The CRC undertakes scientific research of high quality and the products are valued by end-users; and that these are also directly relevant to national and international interests;*
- 2. The CRC is achieving program delivery objectives, in particular the collaboration between researchers and end-users;*
- 3. The CRC demonstrates good governance and is well managed, with an appropriate and effective separation of roles between the Board and the executive;*
- 4. The CRC provides an environment that is highly supportive of cooperative and collaborative research;*
- 5. The CRC, in addition to the core activities, has stretched its horizons to generate important scientific capability in Australia;*
- 6. The CRC is characterised by its capacity to generate knowledge (scientific push), to advise on policy and generate service sector value, that in turn stimulates new knowledge questions (end-user pull);*
- 7. The CRC has managed effectively the end-user / researcher relationship that leads to better programs, outputs and impact. All of this activity is occurring in a changing natural and political environment; and*
- 8. The CRC operates successful post-graduate and community outreach programs."*

The following recommendations were made by the panel:

- 1. As the CRC moves into transition, the CRC should increase the frequency of executive committee meetings to review its research programs and utilisation activities, and to communicate the outcomes to staff.*
- 2. As the CRC moves into transition the CRC should ensure its business processes are well documented.*
- 3. The CRC should articulate with greater clarity and focus the intended outcomes of the ecosystems program and how they contribute to the strategic value and direction of the CRC and for end-users.*
- 4. The CRC should continue to examine quantitative metrics of research impact and methods for capturing end-user use and uptake of research outputs.*
- 5. The CRC should promote opportunities for post-graduate students supervision by, and placements with, end-users where appropriate.*
- 6. The CRC should improve their ability to identify users and usage of web-based tools, social media, and other outputs, as a measure of research impacts;*

*while also providing for future business opportunities and building community knowledge and support.*

7. *The CRC participants should pursue a unified approach to planning for the future.*
8. *The CRC transition strategy should be urgently developed as a whole-of government approach in the context of the Australian Antarctic Science Strategic Plan (AASSP) and the National Framework for Climate Change Science (NFCCS).*

The following actions have been taken as a result of this performance review:

1. Bi-monthly Executive Committee meetings have been scheduled. The utilisation team has met with the program leaders to plan for the outcome of the utilisation milestones. This will continue throughout the life of the ACE CRC. Regular staff meetings have been held and will be scheduled to the wind-up of the ACE CRC in June 2014. The ACE CRC will establish formal review processes with each of the private sector end-user partners.
2. Business processes have been reviewed and well documented with particular attention to:
  - a. Finances
  - b. Purchasing and asset management
  - c. Recruitment and retention of staff
  - d. Education, scholarships and bursaries
  - e. Management of staff leave
  - f. External grants, grant applications and consultancies
  - g. Insurance
  - h. Resource management (including data management and storage; and scientific sample management including quarantine)
3. The Ecosystems Program is in the process of producing a Position Analysis on Southern Ocean ecosystems, which will involve end-users directly through briefings and a workshop. The Ecosystems Program will be working closely with international initiatives to develop whole-of-ecosystem models and to design and implement field programs. The Ecosystems Program leader has been recently invited to become a lead author for Working Group 2 of the IPCC AR5.
4. Capturing end-user use and uptake of ACE CRC research outputs will be tracked through ERA impacts; e-newsletter distribution; case-study outcomes from ValueMetrics Australia; attendance at ACE CRC briefings, short courses, meetings, symposia, conferences and launches; website and media metrics; and using an online survey tool to conduct regular surveys of those attending ACE CRC conference and symposia and using ACE CRC publications.
5. Profiling post-graduate students on the ACE CRC website and scoping end-user opportunities for placements have begun.
6. Tracking and measurement of users through the sea-level rise website, *Canute*, and ACE CRC Twitter followers have begun. The ACE CRC will establish formal review processes with each of the private sector end-user

partners. The Climate Conversation community forums will continue to encourage conversations between researchers and the public about climate change. ACE CRC researchers will continue to present seminars at public and private schools. A show-and-tell tour occurred at the ACE CRC for the Calvin Christian School year 9 and year 10 students on 28 August 2012.

7. The core Hobart-based partners are actively engaged in developing options for transition from the ACE CRC. The outcome of these discussions is reported regularly to the ACE CRC Board.
8. The core Hobart-based partners are actively engaged in developing options for transition from the ACE CRC. The Board of the ACE CRC will ensure that transition initiatives are developed which will contribute to and are consistent with the AASSP and the NFCCS.

For a complete update on the progress of implementation of recommendations, see section 4.5.1.

## 1.2 Risks and Impediments

The risk register, established at the beginning of this funding period, was updated and discussed at Board meetings during the reporting period. The purpose of the register is to ensure careful management of risks throughout the life of the ACE CRC.

Financial risk is identified as a 'medium' risk. This risk rating resulted from the actual funding received from the CRC program being 20% less than requested in the ACE CRC application. The risk that, despite the Board's best intentions, the ACE CRC will not be able to successfully deliver *all* the contracted outputs with this diminished funding is mitigated by a suite of actions. These include seeking complementary funding and careful management of costs. The result of these management actions is that the projected cash position for the end of the ACE CRC's current funding period has improved from last year's forecasted surplus of \$41K to a forecasted surplus of \$379K.

Logistic risk continues to be identified as 'medium'. This is because conducting fieldwork in Antarctica and the Southern Ocean is inherently risky due to ocean, ice and weather conditions. The environment is very hard on equipment, and aircraft and shipping delays and rescheduling are not uncommon. The second Sea-Ice Physics & Ecosystem Experiment (SIPEX-II) voyage foreshadowed for 2011-2012 was rescheduled for 2012-2013. This has resulted in some delays in fieldwork for the Cryosphere and the Ecosystems Programs. These delays are not anticipated to be material over the life of the ACE CRC. Fixed-wing aircraft capability continues to be problematic due to operational difficulties. As an alternative, the aerial sea-ice work during the year was completed using helicopter-based observations. While the AAD assesses its future fixed-wing aircraft capability, helicopter-based sea-ice operations will continue.

Collaboration and usage are all identified as 'low' risk. Staffing has been revised to a high risk in the performance review. The budget of the ACE CRC is being carefully managed to provide the maximum opportunity to retain key staff. The potential loss of staff towards the end of the life of the ACE CRC needs to be carefully managed.

The new collaboration with Woods Hole Oceanographic Institution (WHOI) to provide an Autonomous Underwater Vehicle (AUV) for the SIPEX-II field campaign in 2012 was signed in August 2012. The AUV has a different mapping range to the proposed original AUV, and the sea-ice research project within the Cryosphere Program had to be adjusted accordingly.

An emerging risk to the ability of the ACE CRC to meet its milestones are funding pressures on ACE CRC's core partners. Budget cuts to Government agencies have reduced their ability to carry out some functions. The ACE CRC has identified this as a risk and has taken steps, such as rescheduling payments for logistics, to minimise the impact of this risk on ACE CRC activities.

### 1.3 End-user Environment

During the reporting period, the Clean Energy Futures legislation, including the Carbon Price, passed through Parliament with a start date of 1 July 2012. The implementation of this legislation will focus Australia on reducing human-induced carbon emissions. The activities of the ACE CRC aim to provide guidance to government, industry and the community on the level and timing of emissions reduction by delivering more accurate projections of future climate change. This provides a more concrete framework to cost the economic impacts of the ACE CRC's research and is quantified in the ACE CRC Impact Template.

The ACE CRC actively contributed to the IPCC AR5, to be released in 2013 with updated projections of future climate change. The IPCC projections are a major source of information for policymakers.

Changes in state government in Queensland, New South Wales and Victoria placed greater uncertainty on their positions on climate change adaptation and mitigation.

The fiscal environment remained tight with the impacts of the Global Financial Crisis still being felt across most sectors of the economy. This has presented a challenging environment for engaging end-users in long term planning for climate change.

The uncertainty of ACE CRC's transition creates some ambiguity for end-user participants and their ongoing engagement in ACE CRC research. The ACE CRC will remain vigilant in actively engaging with its end-users (both government and commercial). A proactive stakeholder plan will be developed.

The revamp of the sea-level rise calculator 'Canute' ([www.sealevelrise.info](http://www.sealevelrise.info)), with enhanced features, presents an opportunity to re-engage with potential new and existing end-users.

The ACE CRC board includes end-user representatives from its core research end-users, key government end-users and Small and Medium Enterprise (SME) representatives (as well as independent members). The representation of these end-users on the ACE CRC board ensures that our strategic direction is in alignment with its existing end-users. The ACE CRC is working with its core end-users to develop a transition plan, which will aim to meet their needs. The ACE CRC is conscious of the need to engage with other potential new end-users as it further develops its transition.

## 1.5 Impacts

The ACE CRC Impact Template was updated for 30 June 2012.

Benefit: Cost ratios have increased for each program. Overall, the benefit cost ratio has increased from 1.91 to 2.74. The major drivers of this change include:

- Reduction of inputs (cash/in-kind) by 12.72%
- Increase in forward projection of gross domestic product (GDP) growth
- Increased confidence in delivery of outputs and usage of outputs
- Demonstrable uptake by IPCC and policymakers
- Some adjustment to reflect operational changes but unlikely to impact delivery over life of project
- Probability of dollar impact occurring reduced due to delayed action on climate change

## 2 Governance and Management

The ACE CRC is an unincorporated joint venture comprising 6 essential and 15 other participants. The UTAS continues to provide Centre Agent services such as human resource and financial services as in-kind contributions. UTAS signed the Commonwealth Agreement on behalf of all participants. The six Essential Participants are bound by the Participants Agreement, and the Other Participants Agreements set out the duties and commitments of the remaining 15 parties.

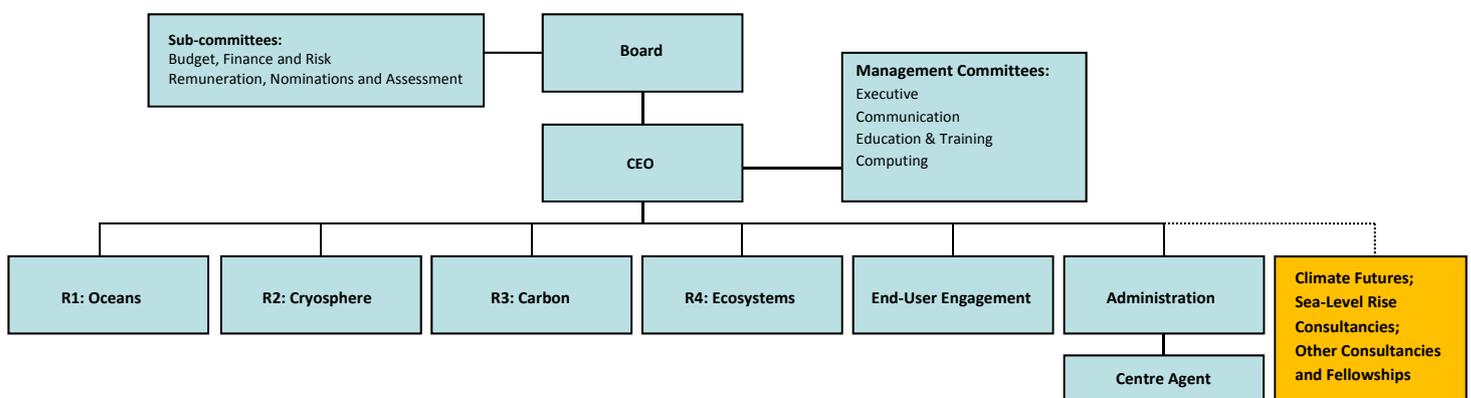
During the reporting period, both GHD Pty Ltd and MUN, Canada, officially withdrew. Participant GHD Pty Ltd terminated their participation in the ACE CRC on 31 January 2012 due to changes in GHD staff and other global economic factors.

The ACE CRC is registered for GST purposes and classified as a government partnership for taxation purposes.

The Impact Tool (IT) forms the basis of the risk register against which ACE CRC manages its risks. The IT is also used to manage ACE CRC activities and track performances against contracted milestones.

The ACE CRC’s transition plan has been developed to consider the ACE CRC’s future beyond the life of current CRC program funding. At this juncture, there are no obvious direct funding vehicles that will assist ACE CRC to transition in its current form. Other options are being explored which may support components of the existing ACE CRC. Regular updates to the IT and transition plan will ensure rigorous management going forward.

The governance and management structure of ACE CRC has been established as follows:



## 2.1 Governance – Board, Committees and Key Staff

### The Board

The Board is constituted with a balance of skills, experience and independence and operates in accordance with the provisions of the Participants' Agreement. It comprises an independent chairperson, representatives of ACE CRC six Essential Participants, two representatives from Other Participants (including one commercial participant), two independent members and two ex-officio members (without voting rights). During the reporting period, the vacant independent Board position was filled by Mr Howard Bamsey. An ACE CRC Code of Conduct for Board members has been developed and approved by the Board.

Board meetings are held every quarter. During this reporting period Board meetings were held on 18 July 2011 (Board and Stakeholder’s meeting), 2 September 2011, 5 December 2011 and 9 March 2012. The 15 June 2012 Board meeting was postponed due to lack of a quorum. The item for discussion in this Board meeting was the annual budget for the ACE CRC, which was provided to the members of the ACE CRC Board Budget, Finance and Risk Sub-Committee for consideration and recommendation to the Board. The annual budget was approved by the Board out-of-session on 29 June 2012.

End-user organisations, pitt&sherry Pty Ltd and the Department of Climate Change and Energy Efficiency (DCCEE), were represented on the Board by Mr John Pitt and Ms Harinder Sidhu respectively. Prof Ulrich Bathmann (Alfred Wegener Institute for Polar Research (AWI)) resigned during the reporting period and was replaced by Dr Bettina Meyer. Mr John Gunn (AAD) resigned and was replaced by Dr Nick Gales. Dr Lyn Maddock (AAD) resigned and was replaced by Dr Tony Fleming.

## Board Members

Name	Role	Key Skills	Independent/ Organisation	Number of meetings	% as Board member
<b>Prof Ulrich Bathmann</b>	Board Member	<ul style="list-style-type: none"> <li>- Leadership in international scientific programs</li> <li>- High level administrative experience</li> <li>- Strong international standing as a scientist</li> </ul>	Alfred Wegener Institute (Essential Participant)	0/2 (resigned after 38 <sup>th</sup> meeting)	0% Granted leave of absence by Board
<b>Mr Tony Coleman</b>	Board Member	<ul style="list-style-type: none"> <li>- High level executive management experience in private enterprise</li> <li>- Financial audit, actuarial and risk management expertise</li> <li>- Commercial objectivity and independence from CRC participants</li> </ul>	Independent	3/4	75%
<b>Dr Tony Fleming</b>	Board Member	<ul style="list-style-type: none"> <li>- Broad and extensive experience in development of environmental policy and program delivery</li> <li>- Extensive Federal and State public service experience</li> <li>- Experience with not-for-profit sector</li> <li>- High level policy experience</li> </ul>	Australian Antarctic Division (Essential Participant)	3/3 (appointed 1 Sep 2011)	100%
<b>Dr Nick Gales</b>	Ex-Officio	<ul style="list-style-type: none"> <li>- High level national and international experience in science and policy</li> <li>- High level science expertise in applied marine mammal conservation science</li> <li>- Australian Marine Mammal Centre leadership</li> </ul>	Australian Antarctic Division (Essential Participant)	2/2 (appointed 4 Dec 2011)	100%

Name	Role	Key Skills	Independent/ Organisation	Number of meetings	% as Board member
<b>Mr John Gunn</b>	Ex-Officio	<ul style="list-style-type: none"> <li>- High level executive management experience in research agencies and government</li> <li>- Strategic planning of national and international research programs</li> <li>- Marine and climate science leadership</li> </ul>	Australian Antarctic Division (Essential Participant)	1/2 (resigned after 38 <sup>th</sup> meeting)	50%
<b>Mr Greg Johannes</b>	Board Member	<ul style="list-style-type: none"> <li>- High level executive management experience in both policy and operational roles in the public and private sector</li> <li>- Substantial and wide ranging Board experience in both the research and community sector</li> <li>- Lead State Government representative in national negotiations under Council of Australian Governments (COAG) on climate change policy, legislation and regulation</li> </ul>	Tasmanian Government (Other Participant)	3/4	75%
<b>Dr Bruce Mapstone</b>	Board Member	<ul style="list-style-type: none"> <li>- Extensive experience in research leadership and management at senior &amp; institutional levels</li> <li>- Experience with CRC establishment, leadership, and governance, including the previous ACE CRC</li> <li>- Broad relevant domain expertise in climate and marine science</li> </ul>	Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Essential Participant)	4/4	100%

Name	Role	Key Skills	Independent/ Organisation	Number of meetings	% as Board member
<b>Dr Bettina Meyer</b>	Board Member	<ul style="list-style-type: none"> <li>- High level Antarctic science expertise</li> <li>- Strong international standing as a scientist</li> <li>- High level administrative experience</li> </ul>	Alfred Wegener Institute (Essential Participant)	0/2 (appoint ed 6 Sep 2011)	0% Granted leave of absence by Board
<b>Dr Rob Murdoch</b>	Board Member	<ul style="list-style-type: none"> <li>- High level executive management experience</li> <li>- Broad experience in the operation of research vessels</li> <li>- Extensive Board experience</li> <li>- High level science expertise in biological oceanography and marine ecology</li> </ul>	National Institute for Water and Atmospheric Research, New Zealand (NIWA) (Essential Participant)	1/4	25% Granted leave of absence by Board
<b>Prof Paddy Nixon</b>	Board Member	<ul style="list-style-type: none"> <li>- Extensive experience in research leadership and management at senior &amp; institutional levels</li> <li>- High level industrial and commercial executive management experience</li> <li>- Broad and extensive expertise in computer science and technology</li> </ul>	University of Tasmania (Essential Participant)	3/4	75%

Name	Role	Key Skills	Independent/ Organisation	Number of meetings	% as Board member
<b>Mr John Pitt</b>	Board Member	<ul style="list-style-type: none"> <li>- Experienced company director including broad network across private and public sectors</li> <li>- High level private sector executive management (including technology commercialization) experience</li> <li>- Strategic planning expertise in relation to the adaptation of infrastructure assets to climate change</li> </ul>	pitt&sherry (Other Participant)	4/4	100%
<b>Dr Tony Press</b>	Ex-Officio	<ul style="list-style-type: none"> <li>- High level leadership and administrative experience</li> <li>- Extensive experience in government and public policy</li> <li>- High level international experience in science and policy</li> </ul>	ACE CRC	4/4	100%
<b>Ms Harinder Sidhu</b>	Board Member	<ul style="list-style-type: none"> <li>- High level executive experience in government</li> <li>- Broad and extensive experience in policy, communications and public affairs activities</li> </ul>	Department of Climate Change & Energy Efficiency (Essential Participant)	1/4	25%

Name	Role	Key Skills	Independent/ Organisation	Number of meetings	% as Board member
<b>Dr Katherine Woodthorpe</b>	Chair	<ul style="list-style-type: none"> <li>- High level management skills – Chief Executive Officer (CEO) of Australian Private Equity &amp; Venture Capital Association Ltd (AVCAL)</li> <li>- High level Board skills</li> <li>- Broad experience on audit committees - Ventracor, Agenix and chaired the Audit Committee of Australian Cancer Technologies Ltd and Insearch</li> </ul>	Independent	4/4	100%

The Board has two sub-committees. The Budget, Finance and Risk sub-committee includes Dr Bruce Mapstone (CSIRO), Prof Paddy Nixon (UTAS) and Mr Tony Coleman as members. The Budget, Finance and Risk sub-committee provided two 'out of session' recommendations to the Board. On 28 October 2011, this sub-committee recommended the acceptance of the audited financial statements and on 8 June 2012, this sub-committee recommended the approval of the ACE CRC annual budget. The annual budget was approved by the Board 'out of session' on 29 June 2012.

The Remuneration, Nominations and Assessment sub-committee consists of Dr Katherine Woodthorpe, Dr Tony Fleming (replacing Ms Lynn Maddock) and Mr Greg Johannes. They met on 20 December 2011.

### The Executive Committee

The ACE CRC Executive Committee advises the CEO and Board on a range of matters relating to management of resources, research coordination and research utilisation across the ACE CRC portfolio. The ACE CRC Executive Committee convenes quarterly. These meetings occurred on 23 August 2011, 13 December 2011, 21 February 2012 and 15 May 2012.

Name	Role	Key Skills	Organisation
<b>Prof Nathan Bindoff</b>	Leader, Climate Futures; Director Tasmanian Partnership for Advanced Computing (TPAC)	Computing/research	ACE CRC/TPAC
<b>Ms Wenneke ten Hout</b>	Administration Manager	Administration	ACE CRC
<b>Dr Andrew Constable</b>	Leader, Ecosystems Program	Research	ACE CRC/AAD
<b>Ms Miranda Harman</b>	Communications Manager	Communications/Media	ACE CRC
<b>Assoc Prof Marcus Haward</b>	School of Government, UTAS	Research/policy/end-user engagement	ACE CRC/UTAS
<b>Ms Tessa Jakszewicz</b>	Deputy CEO, Business Development	Business Development/end-user engagement	ACE CRC

<b>Name</b>	<b>Role</b>	<b>Key Skills</b>	<b>Organisation</b>
<b>Ms Kate Maloney</b>	Business Management	Finance, administration, governance	ACE CRC
<b>Prof Andrew McMinn</b>	IMAS Representative	Education	IMAS
<b>Dr Kelvin Michael</b>	IMAS Representative	Education	IMAS
<b>Dr Tas van Ommen</b>	Program Leader, Cryosphere Program	Research	ACE CRC/AAD
<b>Dr Tony Press</b>	CEO	Management, governance	ACE CRC
<b>Ms Sarah Ugalde</b>	Student representative	Education	IMAS/ACE CRC
<b>Dr Stephen Rintoul</b>	Program Leader, Oceans Program	Researcher	ACE CRC/CSIRO
<b>Dr Jason Roberts</b>	Researcher, Chair ACE CRC Computing Committee	Research/computing	ACE CRC/AAD
<b>Prof Thomas Trull</b>	Program Leader, Carbon Program	Researcher	ACE CRC/UTAS/CSIRO

### **Communications Coordination Committee**

The communications coordinating committee met once during the reporting period on 15 July 2011. There has been regular liaison between the ACE CRC Communications and Media Manager and partner Communications Managers during the reporting period.

<b>Name</b>	<b>Role</b>	<b>Organisation</b>
<b>Ms Sally Chambers</b>	General Manager, Corporate Communications	AAD
<b>Mr Peter Cochrane</b>	Media Manager, Communications and Media Office	UTAS
<b>Ms Miranda Harman</b>	Communications and Media Manager	ACE CRC
<b>Mr Craig Macaulay</b>	Communications Officer	CSIRO

<b>Name</b>	<b>Role</b>	<b>Organisation</b>
<b>Ms Sam East</b>	Communications, Outreach and Marketing Officer	IMAS

### **Education and Training Committee**

An Education and Training committee has been formed between the Institute for Marine and Antarctic Studies (IMAS, based at UTAS) and the ACE CRC to discuss a range of matters relating to education and training. Discussions during this reporting period have centred on recruitment of PhD students and improving the visibility of ACE CRC and IMAS research projects. The Education and Training committee met informally throughout the reporting period.

<b>Name</b>	<b>Role</b>	<b>Organisation</b>
<b>Prof Mike Coffin</b>	Executive Director IMAS	IMAS
<b>Dr Julia Jabour</b>	IMAS Representative	IMAS
<b>Prof Gustaaf Hallegraeff</b>	IMAS Representative	IMAS
<b>Dr Kelvin Michael</b>	IMAS Representative	IMAS
<b>Dr Tony Press</b>	CEO	ACE CRC

### **Computing Committee**

The ACE CRC Computing Committee supports the science, education and policy programs of the ACE CRC by providing advice on information technology, infrastructure and management. The ACE CRC Computing Committee advises the ACE CRC Executive Committee and CEO. The ACE CRC Computing Committee did not formally meet during the reporting period, however, Dr Jason Roberts (Chair) and Ms Kate Maloney met with Information Technology Resources (ITR, UTAS) to finalise the service level agreement on 2 November 2011, 5 May 2012, and 4 June 2012. In addition, Dr Tony Press and Ms Kate Maloney met with Mr John Parry (ITR UTAS) and Mr Colin Broadbent (ITR UTAS) on 1 December 2011.

<b>Member</b>	<b>Role</b>	<b>Organisation</b>
<b>Ms Wenneke ten Hout</b>	Administration Manager	ACE CRC
<b>Mr Colin Broadbent</b>	Information Technology Resources	UTAS
<b>Mr Brian Kelty</b>	Information Technology Resources	UTAS

<b>Member</b>	<b>Role</b>	<b>Organisation</b>
Mr James Harrison	Information Technology Resources	UTAS
Mr Iain Sheppard	Information Technology Resources	UTAS
Dr Jan Lieser	Researcher	ACE CRC
Ms Kate Maloney	Business Manager	ACE CRC
Dr Tony Press	Chief Executive Officer	ACE CRC
Dr Jason Roberts (Chair)	Researcher	AAD
Dr Roland Warner	Researcher	AAD

### Key Staff

<b>Staff Member</b>	<b>Role</b>	<b>% Time</b>
Dr Tony Press	CEO	100%
Dr Stephen Rintoul	Program Leader - Oceans	50%
Dr Tas van Ommen	Program Leader - Cryosphere	80%
Prof Tom Trull	Program Leader - Carbon	75%
Dr Andrew Constable	Program Leader - Ecosystems	60%
Prof Nathan Bindoff	IPCC AR5 – coordinating lead author and Deputy Program Leader – Oceans	50%
Prof Ian Allison*	IPCC AR5 – lead author	50%
Ms Tessa Jakszewicz	Deputy CEO	100%
Ms Kate Maloney	Business Manager	100%
Ms Miranda Harman	Communications Manager	60%
Ms Wenneke ten Hout	Administration Manager	100%

\*Prof Ian Allison is an ACE CRC Honorary Fellow

## 2.2 Participants

### CRC participants during the reporting period

Participant's name	Participant type	ABN or ACN	Organisation type
Alfred Wegener Institute of Polar and Marine Research (AWI), Germany	Essential	NA	Government research institute
Australian Antarctic Division (AAD)	Essential	56 428 630 676	Government
CSIRO Division of Marine and Atmospheric Research (CMAR)	Essential	41 687 119 230	Government
Department of Climate Change and Energy Efficiency (DCCEE)	Essential	50 182 626 845	Government
National Institute of Water and Atmospheric Research Ltd (NIWA), New Zealand	Essential	NA	Government research institute
University of Tasmania (UTAS)	Essential	30 764 374 782	University
Centre for Polar Oceanography and Modelling (CPOM), University College London, UK	Other	NA	Research institute

<b>Participant's name</b>	<b>Participant type</b>	<b>ABN or ACN</b>	<b>Organisation type</b>
<b>Chinese Academy of Meteorological Science (CAMS)</b>	Other	NA	Government research institute
<b>Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)</b>	Other	34 190 894 983	Government
<b>First Institute of Oceanography (FIO), China</b>	Other	NA	Government research institute
<b>Institute of Low Temperature Science (ILTS), Hokkaido University, Japan</b>	Other	NA	Research institute
<b>Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), France</b>	Other	NA	Research institute
<b>Myriax Software Pty Ltd</b>	Other	95 009 587 848	Industry
<b>National Institute of Polar Research (NIPR), Japan</b>	Other	NA	Government research institute
<b>pitt&amp;sherry</b>	Other	88 234 540 094	Industry
<b>RPS MetOcean Pty Ltd</b>	Other	42 107 962 872	Industry

<b>Participant's name</b>	<b>Participant type</b>	<b>ABN or ACN</b>	<b>Organisation type</b>
<b>SGS Economics and Planning Pty Ltd</b>	Other	25 007 437 729	Industry
<b>Tasmanian Government</b>	Other	84 531 577 304	Government
<b>University of Texas at Austin, USA</b>	Other	NA	University
<b>University of Texas at San Antonio, USA</b>	Other	NA	University
<b>Vrije Universiteit Brussel, Belgium</b>	Other	NA	University

## Changes to participants

The following Other Participants withdrew:

Participant's name	Participant type	Retiring, withdrawing or new	Department approval yes/no
<b>Memorial University of Newfoundland</b>	Other	Withdrew - the planned collaboration with MUN in Canada, which was to provide an AUV for the SIPEX-II field campaign in 2012, ceased after discovering that this specific vehicle would be difficult to operate from Aurora Australis given limited deck space and the acoustically noisy operating environment. The ACE CRC has commenced a new collaboration with the WHOI, which owns and operates a smaller AUV. The new vehicle has a different mapping range to the proposed original AUV, and the sea-ice research project within the Cryosphere Program had to be adjusted accordingly.	NA
<b>GHD Pty Ltd</b>	Other	Withdrew – terminated their participation in the ACE CRC on 31 January due to changes in GHD staff and other global economic factors	NA

## 2.3 Financial Management

The ACE CRC made considerable efforts to ensure that its budget would be balanced following the shortfall in funding from the CRC Program. The result of these management efforts over the reporting period has seen that the projected cash position for end of the ACE CRC's current funding period improve from a forecasted surplus of \$41K (June 2011 approved budget) to a forecasted surplus of \$379K (June 2012 approved budget).

Staff appointments were made based on three-year contracts with most appointments due to expire at the end of 2013. This was done to manage costs and to reduce the projected end of contract deficit. The concerted cost management over the first two years of the ACE CRC has result in 2014 forecasted surplus funds. With this surplus the ACE CRC is prioritising staff contracts extensions to ensure the delivery of the milestones and outputs.

Other factors that assisted in producing the surplus in the budget included:

- Two participants deferred logistics payments into the 2012/13 year thereby improving the cashflow position and the interest earned. Interest of \$206,325 was earned on the ACE CRC account during this reporting period (shown as 'Other Firm Cash' in the ACE CRC financial tables).
- One participant provided additional cash contributions to cover the development cost of the sea-level rise tool, and ocean acidification research costs. The additional cash contributions of \$450K from DCCEE were received during the reporting period.

In terms of in-kind contributions, there was an unfavourable difference of 24% to the agreement budget in the current reporting year. This resulted from a number of factors:

- The AAD's contribution for the current year was 23% lower than budgeted. Therefore, to date the AAD contribution is 15% under budget. The remainder of this difference is due to the SIPEX-II rescheduling. It is expected over the life of the ACE CRC that this contribution from the AAD will run to budget.
- The other major factor to the lower than expected in-kind contributions was NIWA 99.9% unfavourable deviation from the agreement due to the rescheduling of the Tangaroa voyage. It is expected that this contribution from NIWA will correct next year with the voyage departing in January 2013.

The online 'Expenses' table for the ACE CRC over the year shows major variances to the agreement.

**Table 1** Excerpt from the online 'Expenses' table 3, 2011/12

	<b>Actual</b>	<b>Agr'mt</b>	<b>Diff</b>	<b>%Diff</b>
Employee Expenses	3,447	3,365	82	2
Supplier Expenses	1,145	1,552	-407	-26
Capital	538	280	258	92
Other Expenses	-	-	-	-
<b>TOTAL EXPENSES</b>	<b>5,130</b>	<b>5,197</b>	<b>-67</b>	<b>-1</b>

As expected with the full recruitment in the prior year the employee expense variance is now negligible at 2%.

The difference in supplier expenses arose due to a number of factors:

- The change of the timing of the SIPEX-II cruise (departed September 2012), meant that some of the final preparation costs for this cruise will be expended in the next financial year, resulting in an underspend in this reporting year. The major contributor is the contract with WHOI for the AUV for \$270K. Negotiations were completed in the reporting year but payments were scheduled for 2012/13 although previously budgeted in 2011/12.
- Savings on voyage and analysis costs for KEOPS-2 cruise with VUB (other participant) taking up additional costs.

The current year variance in capital is correcting for prior year underspends.

As reported in previous annual reports the calculation of variances needs to be amended in the agreement column for the carried forward cash when evaluating the totals to date and the forecasted position to the end of the ACE CRC. The expected use of these additional funds and the years in which the expenditure was budgeted was advised to the CRC Program in June 2010. In this year's table 3, the unadjusted totals show the following variances:

**Table 2** Excerpt from the online 'Expenses' table 3 Totals

	Totals to 2011-12				Totals for 5 years			
	Actual	Agr'mt	Diff	%Diff	Actual/Proj	Agr'mt	Diff	%Diff
Employee Expenses	7,420	6,620	800	12	13,874	12,273	1,601	13
Supplier Expenses	2,849	3,804	955	-25	7,959	5,798	2,161	37
Capital	1,262	807	455	56	1,262	807	455	56
Other Expenses	0	0	0	0	225	612	-387	-63
<b>TOTAL EXPENSES</b>	<b>11,531</b>	<b>11,231</b>	<b>300</b>	<b>3</b>	<b>23,320</b>	<b>19,490</b>	<b>3,830</b>	<b>20</b>

These variances change with the inclusion of the carried forward cash as per the below:

**Table 3** Adjusted online 'Expense' table 3 Totals for carried forward cash

	Totals to 2011-12				Totals for 5 years			
	Actual	Agr'mt	Diff	%Diff	Actual/Proj	Agr'mt	Diff	%Diff
Employee Expenses	7,420	7,441	-21	0	13,874	13,094	780	6
Supplier Expenses	2,849	4,891	-2,042	-42	7,959	6,885	1,074	16
Capital	1,262	1,696	-434	-26	1,262	1,696	-434	-26
Other Expenses	0	0	0	0	225	612	-387	-63
<b>TOTAL EXPENSES</b>	<b>11,531</b>	<b>14,028</b>	<b>-2,497</b>	<b>-18</b>	<b>23,320</b>	<b>22,287</b>	<b>1,033</b>	<b>5</b>

From the comparison of these tables (2 and 3) the 20% reduction in funding, as seen in the unadjusted table for five years, has been managed to a 5% overrun when the cash carried forward is included in the agreement figures. The overrun represents

additional expenses due to additional DCCEE sea-level rise contributions and interest earned, neither of which are included in the agreement figures, while the totals to date clearly show the deferral of logistics costs rather than the overspend shown in the table totals to 2011-12.

## 2.4 Communications

Overall strategies to ensure effective external communication:

- **Website** [www.acecrc.org.au](http://www.acecrc.org.au), relaunched July 2011, regularly updated
- **ACE News** E-newsletter produced quarterly and distributed to a comprehensive list of subscribers. Contains a message from the CEO, updates on research, newsworthy developments within the organisation and notice of significant events coming up. All stories are featured on the website
- **The media** Used strategically for ACE CRC events or research announcements
- **Position Analyses** Plain English synopses for end-users of the current knowledge in each of ACE CRC research fields, published in accordance with the milestones required under the CRC program. Available in hardcopy/PDF download
- **Report Cards** A shorter version of a Position Analysis for end-users, produced as a fold-out card, designed to answer crucial questions about specific areas in plain English. Also available as PDF download
- **Annual Report** As per CRC program guidelines. Hardcopy and on website.
- **Year in Review** User-friendly companion to the annual report for end-users. Summarises scientific achievements in plain English, showcases highlights of the year and uses photographs for maximum visual appeal. Available in hardcopy/PDF download
- **Technical Reports** ACE CRC publishes comprehensive technical reports on specific topics for end-users. These are available in hardcopy/PDF download
- **Banners and single-page flyer** Relevant, eye-catching and communicating the key message (Climate Science for Australia's Future). Used at conferences, launches and symposia
- **Face-to-face meetings/briefings** Particularly with end-users including politicians, policy advisors, existing and potential partners, as well as selected media and other science communicators
- **Attendance at other symposia and conferences**
- **Social networking** Twitter account (@acecrcscience)

### Overall strategies to ensure effective internal communication

- The ACE CRC Symposium is held bi-annually to showcase ACE CRC work and to encourage discussion of research and collaboration
- Staff forums/meetings
- Intranet on [acecrc.org.au](http://acecrc.org.au)

- Internal email list is maintained and used to disseminate information on a day-to-day basis

### External communication activities during the reporting period

- **ACE News** was published in September 2011, December 2011, March 2012
- **Media releases:** New research projects an increase in Tasmania's extreme weather events (October 2011); Research shows that Southern Ocean is warming and freshening (November 2011); Potential regime shift in decreased sea-ice production after the Mertz Glacier calving (May 2012)
- **Social networking:** 19 "tweets"
- **Position Analysis:** Position Analysis: Climate Change and the Southern Ocean published and launched (November 2011)
- **Report Card** Sea Level Rise 2012 prepared for publication
- **Year in Review** marketing publication: prepared and published
- **Technical Reports:** Government Coastal Planning Responses to Rising Sea Levels (July 2011); Extreme Tide and Sea Level Events (June 2012)
- **Face-to-face meetings/briefings:** briefing for Federal MPs including Minister Tony Burke at National Science Week event in Canberra (17/8/2011); briefing for Climate Commission (21/2/2012); Tasmanian MP's briefing (April 2012 at the ACE CRC)
- **Community Briefings:** 'Climate Conversations' program South Arm Progress Association, South Arm; St Mary's College, Hobart; Scottsdale High School; Scottsdale Public; AAD – United Nations Permanent Delegates; Ignite Your Imagination – Sea-level Rise Presentations
- **Conference attendance to promote ACE CRC research:** display at Science Meets Parliament (August 17-18, 2011)

### Internal communication activities during the reporting period

- ACE CRC Symposium: March 8 -9, 2012
- ACE staff forum: June 13, 2012

### Metrics

- **Website:** Google analytics records total number of visits (19,021), unique visits (10,744), pages per visit (2.96), average duration of visits (3min, 38sec), percentage of new visits (54.83%), returning visitors (45.17%)
- **ACE News:** approximately 800 subscribers
- **Twitter:** 70 followers
- **Media hits:** ACE CRC began a Meltwater media subscription to count mentions of the ACE CRC in digital media on 29 February 2012. Hits for period: Australia media 261; International media 57; Total 318. Please note that these

figures are indicative and do not include media stories that were not published online

- **Position analyses:** Mailing list number and downloads are counted
- **Report cards:** Mailing list number and downloads are counted
- **Year in Review publication:** Mailing list number and downloads are counted
- **Technical reports:** Mailing list number and downloads are counted
- **Symposia:** 75<sup>th</sup> Anniversary of the Declaration of the Australian Antarctic Territory, total attendance 70; ACE CRC Symposium 8 and 9 March 2012, total attendance over 110

## 2.5 Intellectual Property Management

The Intellectual Property (IP) management arrangements are outlined in the ACE CRC IP Assignment Deed and the Participants Agreement. The IP clauses within the Agreement were established in accordance with the National Principles of IP Management.

As a 'public good' CRC, the ACE CRC aims to make its research outputs widely and freely available. It does this by publishing its results in formal journals, public-ready documents, via its website and by providing data via means such as the sea-level rise webtool ([www.sealevelrise.info](http://www.sealevelrise.info)). Much of the scientific data collected is available through the Australian Antarctic Data Centre at the AAD, the Integrated Marine Observing System (IMOS) and the TPAC.

If the ACE CRC licences use of its Centre IP to a third party that party can only use the IP on the basis that it does not prejudice the ACE CRC's ability to maximise the commercial return from the Centre IP. This ensures that benefits are maximised for Australia.

The ACE CRC does not hold any patents in Australia or overseas.

## 3 Performance against Activities

### 3.1 Progress against the Key Challenge/Outcomes

#### 1. Oceans: The Southern Ocean and Sea-Level Rise (SLR)

**How is the Southern Ocean changing, and the implications that this will have for Australian and global climate now and in the future?**

The ACE CRC is exploiting the revolution in ocean observation technology to increase its capacity to study the role of Antarctica and the Southern Ocean in global and regional climate. The ACE CRC is using profiling floats that drift with the ocean currents and periodically rise to the surface to transmit temperature and salinity measurements. Miniaturised oceanographic sensors attached to seals are providing information on seal biology and the oceanic environment in which they

live. Seals travel far through the ocean and even beneath the winter sea-ice. Fixed moorings, ships and satellites are also being used to measure the physical and chemical properties of the Southern Ocean.

ACE CRC researchers are repeating tests previously carried out to calibrate changes in ocean characteristics; using satellite altimetry to determine how the Antarctic Circumpolar Current (ACC) distributes surface chlorophyll and sea-ice; and monitoring regional variations in sea surface height in the Southern Ocean. This research allows IPCC-class models to be tested against observations in order to improve the models and deliver more reliable climate projections.

The ACE CRC collaborates with United States of America, French, German, Chinese, New Zealand and Japanese partners in the Antarctic to increase our understanding of current and future changes in the Southern Ocean and further improve global climate models.

One of the most significant impacts of climate change will be caused by a rise in sea level. Recent research has shown that sea levels are rising at rates near the higher end of previous projections, and that the rate of sea-level rise is accelerating. The ACE CRC's Sea-Level Rise Impacts project focuses on providing decision-makers with targeted assessments of the risks of sea-level rise. This work is incorporating the effects of storm surges and recession of the coastline with rising sea levels.

The ACE CRC is helping Australia plan and prepare for future sea-level changes by providing specialised technical consulting, specialised vocational training for governments and industry, and a sea-level rise calculator tool called Canute ([www.sealevelrise.info](http://www.sealevelrise.info)). Canute provides key stakeholders with an understanding of how to assess risks to existing assets, plan adaptation, and set appropriate design codes and planning strategies for future development.

## **2. Cryosphere: Impacts of Changing Snow and Ice Cover**

### **How will sea-ice and the Antarctic ice sheet respond to changes in climate and what impact will changes in the cryosphere have on climate and sea level?**

The ACE CRC's Cryosphere Program is split into three main research projects: the dynamic role of polar ice sheets in future sea level; the role of Antarctic sea-ice in the climate system; and past and present climate - records and dynamics.

The great ice sheets of Antarctica and Greenland hold the largest potential for substantial and prolonged contributions to sea-level rise in a warming climate, but our present ability to predict these changes is limited. Recent observations suggest that the contribution to sea-level rise from both great ice sheets is increasing, and that this is due to increasing discharge of ice by glaciers, rather than simply by increased melt. Current computer models which simulate ice sheet dynamics and their links within the climate system are inadequate for quantifying the nature,

rapidity and extent of the response of the ice sheets to climate change, and this gives rise to the major uncertainty in sea-level predictions over century and longer time scales.

The ACE CRC's 'dynamic role of polar ice sheets in future sea level' project aims to improve computer models of ice flow dynamics, basal processes and interactions with atmosphere and ocean. The ACE CRC is collaborating with international efforts in model development, particularly building on our expertise in ice flow properties and ice-shelf-ocean interactions. The developing models will include stresses to the ice, presently neglected in ice sheet models, treatment of basal conditions, including sliding ice and sediments, basal hydrology and sub-glacial lakes. The transition of glaciers from grounded ice flow to floating ice shelves is being refined, so that changes at the ocean margins are correctly propagated to the flow in the ice sheet interior.

The ACE CRC is involved in a major collaboration with international partners in the aerogeophysical survey of unexplored sectors of East Antarctica. This project is called 'Investigating the Cryospheric Evolution of the Central Antarctic Plate' (ICECAP). The suite of instruments used in these surveys is producing vital knowledge of bedrock topography, basal rock, sediment and water conditions. These data will ensure that ice sheet models have real-world boundary data as inputs. The ICECAP survey targets deep sub-glacial basins and major outlet glaciers, which hold the greatest potential for dynamic ice sheet changes, and consequently to potential sea-level rise.

The ACE CRC's second Cryosphere project, 'The role of Antarctic sea-ice in the climate system', revolves around the fact that sea-ice is a key component of Earth's climate system – the annual change from the Antarctic winter maximum sea-ice extent to the summer minimum is one of the largest natural physical changes on the planet. Through a variety of feedback mechanisms, sea-ice acts as an agent and indicator of climate change. Sea-ice also plays a structuring role in marine ecosystem function. Over the last decades, the extent of sea-ice and its thickness have decreased in the Arctic, and a reduction in extent has also occurred in the Antarctic Peninsula region. However, it is not known how the thickness of Antarctic sea-ice is changing.

The ACE CRC is conducting field research including the future deployment of an Autonomous Underwater Vehicle, instrumented with upward-looking sonar to measure sea-ice drift. In situ observations to validate/calibrate satellite remote sensing including airborne laser altimetry will also be conducted, as well as remote sensing and deployment of sea-ice mass balance stations, equipped with biological sensors, and sea-ice drifting buoy arrays.

The last project in the Cryosphere Program is 'Past and present climate: records and dynamics'. Climate records from the Antarctic region, Southern Hemisphere and even Australia are relatively sparse and of short duration. The previous IPCC reports

have underscored the need for more palaeoclimate records from the Southern Hemisphere. These records are needed to support climate reconstructions, process studies and to test models. The project is producing additional high-resolution climate records for the Antarctic. The project is developing existing records and using these to investigate regional and hemispheric climate processes, with emphasis on connections to Australian climate.

In order to do this, the ACE CRC is expanding the spatial extent, and extending the temporal length of the network of high-resolution ice core records from East Antarctica. ACE CRC researchers are calibrating high-resolution ice core records against modern meteorological data, and using these to probe climate dynamics over timescales beyond the instrumental period. Finally, the ACE CRC is investigating longer-term fundamental climate processes related to forcing changes due to isolation and greenhouse gas variations over the last glacial cycle, and exploring hemispheric climate coupling and abrupt climate change events.

### **3. Carbon: Southern Ocean Uptake**

#### **Will the Southern Ocean continue to remove CO<sub>2</sub> from the atmosphere and how rapidly will this increase the acidity of the ocean?**

Currently one third of humankind's annual emissions of the fossil-fuel derived greenhouse gas, CO<sub>2</sub>, are absorbed by the oceans. The Southern Ocean presently absorbs about 40% of that total. The oceans act as a reservoir for carbon, called a carbon sink, which accumulates and stores carbon via the ocean's physiochemical and biological processes.

The absorption of CO<sub>2</sub>, however, comes with a cost – a decrease in the alkalinity of the ocean (often called ocean acidification). This change will have potentially serious impacts, within the 21<sup>st</sup> century, for the sustainability and management of many marine and coastal ecosystems and fisheries. Acidification is occurring first in polar seas, and for this reason, examining ecosystem responses in the Southern Ocean offers a bellwether for probable impacts around Australia.

The ACE CRC collaborates with many organisations and countries around the world to understand the ability of the Southern Ocean to draw down atmospheric carbon, and whether or not the ocean carbon sink has a saturation point. Understanding the Southern Ocean's ability to sequester carbon is vital for understanding our environmental future and, as emphasised by the IPCC, is of crucial importance for the setting of efficient emissions reductions to limit climate warming.

The ACE CRC Carbon Program has the overall goal of quantifying the role of the Southern Ocean in the global carbon cycle. It focuses on three key projects.

The first of these projects involves measuring the magnitude of uptake of atmospheric CO<sub>2</sub>; the processes that control this uptake; and their propensity for

change. The Southern Ocean's ability to take up CO<sub>2</sub> will not continue at current rates if global climate change reduces the rate of the overturning oceanic circulation and therefore hampers the effectiveness of the ocean's physical pump. Changes in sea-ice cover, ocean warming and stratification, and lack of supply of the limiting trace nutrient iron all potentially have negative effects on the effectiveness of the biological pump to lock CO<sub>2</sub> in the Southern Ocean carbon sink.

Determining the extent of ocean acidification caused by the uptake of CO<sub>2</sub>, and its biogeochemical ramifications, is the second project in the Carbon Program. The overall goal is to determine how the progress of acidification depends on both the uptake of anthropogenic CO<sub>2</sub> and its interaction with naturally varying processes that control the distributions of alkalinity, dissolved inorganic carbon, and nutrients. Using samples from Antarctic voyages, the Carbon Program is mapping the progress of acidification and measuring the abundance of carbonate forming organisms that may be impacted by ocean acidification.

The final Carbon project examines the potential and ecological risks of increasing Southern Ocean uptake of CO<sub>2</sub> via ocean iron fertilisation. The ACE CRC aims to study natural iron fertilisation to investigate the associated extent of carbon uptake and ecosystem health and compare these results to deliberate fertilisations. The ACE CRC then will assess the efficacy and risks of ocean fertilisation using field observations, synthesis, and numerical simulations.

The ACE CRC Carbon Program collaborates with DCCEE, SEWPaC, the Australian Computational Earth Systems Simulator (ACCESS), the Australian Climate Change Science program, CSIRO, AAD and other international agencies (International Ocean Carbon Coordination Project (IOCCP), CO<sub>2</sub>/Climate Variability and Predictability Program (CLIVAR), GEOTRACES, and IPCC). Impacts of ACE CRC's research include cost savings by governments and industry derived from more accurate carbon cycle models and more informed carbon management strategies.

#### **4. Ecosystems: Impacts of Climate Change on Antarctic Marine Life**

##### **What will be the impact of Southern Ocean and sea-ice changes on Antarctic ecosystems and fisheries?**

The Ecosystems Program addresses the challenge of what will be the impact of Southern Ocean and sea-ice changes on Antarctic ecosystems and fisheries. The current expectation is that the 'keystone' nature of krill will remain the same but that the productivity of the ecosystem will generally decline with the loss of sea-ice. However, emerging science is showing that the productivity of the system is uncertain and that the development of a pelagic system without sea-ice may result in the structure of the food web shifting from a krill-based food web to a fish-based food web, such as that seen on the Kerguelen Plateau of the Southern Ocean. Such a change could seriously affect fisheries in the region, and the conservation of whales and other higher predators. The ACE CRC is using a combination of field

studies along with qualitative and quantitative modelling to evaluate different scenarios for the Antarctic marine ecosystem based on prognoses of change from the IPCC AR5 analyses.

The Ecosystems Program is researching the impact of Southern Ocean and sea-ice changes on Antarctic ecosystems and fisheries by focussing on four key projects. The first of these is assessing the risks to key species of Southern Ocean marine ecosystems from climate change impacts, such as temperature and ocean acidification.

Literature and expert opinion is being used in a risk assessment framework to assess species' responses to climate change scenarios, including the development of conceptual models of the impacts of change in the physical environment and food webs. Spatial modelling will ascertain key environment drivers for species. IPCC AR5 results will be used to ascertain change in those drivers and the likely consequences to species distributions and dynamics.

The second project in the Ecosystems Program aims to contribute to determining the ecosystem impacts of predicted changes in Antarctic sea-ice by evaluating the linkages between ocean productivity and the spatial and temporal dynamics of the sea-ice zone, including sea-ice physical and biological parameters.

A realistic model of sea-ice algal productivity is being developed which requires a model of algae attached to the underside of the sea-ice as well as algae entrapped in the brine channels throughout the entire ice thickness. Further, the Ecosystems Program is collating historical datasets from the Southern Ocean. An international dataset is being developed of sea-ice biological and biogeochemical parameters from ice cores. The number of ice cores to be included in this database is likely to increase as more scientists become involved and release their unpublished data.

The third aspect of this project is to conduct in situ studies, including field programs. In situ measurements of ice algal biomass and production and an understanding of how they relate to the physical attributes of sea-ice and the water column are essential for developing the spatial models and the dynamic simulation models.

Identification of key food web processes that could be impacted by changes in the physical and biogeochemical environments in eastern Antarctica is the third project involved in the Ecosystems Program. This project has been split into two parts.

Part 1 includes regular sampling on the SR3 oceanographic transect, combined with spatial statistical analyses of available data to evaluate the types of changes in phytoplankton and zooplankton assemblages that could arise as a result of a changing climate, and the mechanisms that could cause those changes.

Part 2 is the development of a ship- and land-based integrated ecosystem study to evaluate the primary food web linkages from phytoplankton to top predators in eastern Antarctica. This project is a multidisciplinary food web study, which includes the integration of land-based and sea-based activities in collaboration with other relevant projects in the Australian Marine Mammal Centre at the AAD.

The last project in this program focuses on drawing on the results of the other ACE CRC Ecosystems projects to create a second generation marine ecosystem model which will be used to assess historical and future climate change impacts on Antarctic marine ecosystems, as well as to evaluate the types of objectives that could be appropriate for the conservation of Southern Ocean species.

Models currently under development include the Ecosystem Productivity Ocean Climate (EPOC) modelling framework, a ROMS model of eastern Antarctica and the Kerguelen Plateau and the Australian Earth-system model through ACCESS. Development of a further ecosystem model using 'Atlantis' is also being undertaken to model effects on biodiversity and to support other modelling efforts in the program. This project aims to synthesise and integrate knowledge on food webs and ecosystems to build a second-generation model that couples food web models (EPOC and Atlantis) with the ROMS model. This work is using reviews of different components of the ecosystem and is developing an appropriate representation of those components in the modelling environment. Comprehensive testing will be undertaken with EPOC and Atlantis to develop the most efficient representations possible of each module while still preserving their sensitivity to climate change impacts.

These enhanced ecosystem models will be coupled to an ocean-ice-atmosphere model through the ROMS, in partnership with the modelling group at Old Dominion University, USA. Once developed, experiments can be undertaken based on plausible scenarios for climate change impacts, as developed in the other three projects in the ACE CRC Ecosystems Program.

An important component of this early work is the development of user-friendly interfaces for building and managing these models in order to enable greater participation of ecologists and modellers alike from partner laboratories in Australia and overseas.

## 3.2 Research

The ACE CRC is on target to achieve its research outputs. A detailed summary of ACE research activities at the program level (Oceans; Cryosphere; Carbon; and Ecosystems) can be found below.

The level of end-user involvement, and evidence that the research is meeting end-user needs, is outlined in section 3.3.

In total, ACE CRC researchers have published 1 book, 19 book chapters, 84 articles in scholarly refereed journals, and 4 full written conference papers in refereed proceedings. In addition, 43 articles in scholarly refereed journals are 'in press'. These publications show that the ACE CRC is well on track to deliver its research outputs.

## 1. Oceans

The Oceans Program made good progress in 2011-2012 and continues to be on track to deliver the promised research and outreach activities.

The major fieldwork for the Oceans Program in 2011-2012 was the completion of the I9S hydrographic transect between Antarctica and Western Australia. Observations of temperature, salinity, oxygen, nutrients, carbon and ocean currents were collected every 10-30 nautical miles, from the sea surface to the ocean floor. Such measurements are the only way to track changes in ocean properties throughout the full ocean depth. Preliminary analysis suggests that the Antarctic Bottom Water continues to become less salty, less dense and to contract in area: the volume of the dense water layer in 2012 was less than half that measured in 1970. We also recovered five moorings deployed in 2010 as part of a joint Australia – USA experiment. The moorings will provide the first direct measurements of the flow along the Antarctic margin in this part of the Southern Ocean.

The 2011-2012 voyage of the *RSV Aurora Australis* also provided an opportunity for sampling of the Mertz Polynya region. These measurements suggest that the dramatic changes observed in this region following the calving of the Mertz Glacier Tongue in February 2010 continue to unfold. The dense water formed in the polynya was even less dense in 2012 than measured in 2011, immediately post-calving. The Oceans Program repeated an oceanographic station previously used by Douglas Mawson almost exactly 100 years earlier, obtaining a rare century-long perspective on Southern Ocean change.

Scientists from the Oceans Program have continued to make a significant contribution to the IPCC AR5. Prof Nathan Bindoff and Dr Steve Rintoul, respectively, are co-ordinating lead authors of the "Detection and Attribution" and "Observations of Ocean Change" chapters of the report. Primary tasks completed in 2011-2012 include co-chairing the second (France) and third (Morocco) meetings of the lead author teams, responding to comments raised by external reviewers, and preparation of the Second Order Draft of the chapters. Dr Catia Domingues has made valuable contributions to several chapters, and is recognised as a contributing author in the "Detection and Attribution" and "Oceans and Sea Level" chapters.

Researchers in the team published a number of influential papers in 2011-2012. Highlights include the first global analysis of oxygen changes in the ocean, showing that oxygen levels are declining over much of the world ocean as a result of warming and changes in stratification and ventilation (Helm et al., 2011); a revised assessment of the Earth's sea level and energy budget over the last 50 years

(Church et al., 2011); a novel method to determine the cause of changes observed in the Southern Ocean (Meijers et al., 2011); and new insights into ocean mixing (Sallée et al., 2011a,b). Several papers showed how chemical and biological distributions in the Southern Ocean are linked to ocean currents. For example, Cossa et al. (2011) showed how the overturning circulation influences the exposure of Southern Ocean organisms to methyl mercury, a bio-accumulating toxin.

The ACE CRC continues to be active in the development of the Southern Ocean Observing System (SOOS). SOOS aims to establish a sustained observing system in the Southern Ocean capable of delivering the information needed to respond to challenges like climate change, sea-level rise, and the impact of climate change on Southern Ocean ecosystems. An International Project Office (IPO) for SOOS was established at the UTAS in late 2011.

The Position Analysis "Climate Change and the Southern Ocean" was published in late 2011. This "plain-language" update on the latest Southern Ocean climate science report was well received by a variety of stakeholders and attracted substantial media interest in Australia and overseas. Other outreach activities included briefings to politicians at all three levels of government, public lectures, school visits and contributions to blogs like [www.skepticalscience.org](http://www.skepticalscience.org). ACE CRC staff continue to support the development of research infrastructure on behalf of the Australian marine community. New projects include the storage of research data collections (funded by Research Data Storage Infrastructure (RDSI)) and the development of the MARine Virtual Laboratory (funded by the National eResearch Collaboration Tools and Resources (NeCTAR)).

The Sea-level Rise Impacts team made significant inroads towards achieving its major milestones in 2011 to 2012. A completely revamped version of the web-based sea-level rise decision support tool was released, now renamed as 'Canute', and positioned with the strapline 'the sea-level calculator'. The fruits of last year's efforts were fully realised, with the national stormtide modelling work integrated into the calculator, enabling first order sea-level rise inundation assessments to be completed right around the whole Australian coastline for the first time. In addition, Canute now provides estimates of the present statistics of stormtides and tropical cyclones for the whole coastline – a first for Australia, and possibly a first for a whole continent globally.

Good progress was made towards the integration of inundation impacts of sea-level rise with geomorphology into Canute. A major sea-level rise beach erosion modelling project using X-Beach and S-Beach (undertaken with expertise from the University of New South Wales, Water Research Laboratories) for the ACE CRC has almost been completed. This will enable a first order assessment of the impact of sea-level rise on the erosion of soft shorelines to be assessed via Canute for the first time. Data will be loaded onto Canute in early 2012-2013.

Initial work commenced on the development of probabilistic inundation maps due to future sea-level rise for Tasmania. These have been developed in conjunction with the UTAS on behalf of the Tasmanian Government. These are yet to be loaded onto Canute. The ACE CRC also entered into discussions with the CRC for Spatial Information to gain access to GIS layers for the Australian Coastline (including mapping of coastal infrastructure) with the objective to prepare probabilistic maps for key locations around Australia. The ACE CRC will continue these discussions in early 2012-2013.

The ACE CRC published an important paper in Climatic Change in 2011, 'A simple technique for estimating an allowance for sea-level rise'. This paper formed the basis of assisting government planners in determining appropriate risk-based allowances.

Dr John Hunter was also a Contributing Author to Chapter 13 of the IPCC AR5 Working Group 1 report, and was also a reviewer of Chapter 13 of the Working Group 1 First Order Draft.

The ACE CRC's Oceans Program team published 14 articles in scholarly refereed journals and 1 is in press. They also published 1 book section and 1 encyclopaedia entry is in press.

## **2. Cryosphere**

The ACE CRC Cryosphere Program continued progressing its workplan and advancing milestones throughout this reporting period. This was a highly productive year with a modest amount of field activity. The year brought to fruition a number of important publications, discussed below, and included a significant component of work aimed at inclusion in IPCC AR5, despite the fact that the IPCC assessment cycle is clearly not aligned with final ACE CRC outputs. ACE CRC Cryosphere staff are involved in IPCC AR5 in both author and reviewer roles.

This was the first full year for which the full complement of new staff were in place. After evaluating the mix of staff skills and opportunities afforded by the international landscape, the Cryosphere Program is making subtle changes to its delivery mechanism. In particular, the Cryosphere Program has strengths that give it the ability to improve ice-sheet/ice-ocean modelling by better specification of boundary conditions and of processes. This increasingly drives a shift toward adopting and adapting ice sheet models from the wider international community, and strengthening, informing and testing these, rather than devoting resources to extensive ice-sheet model development at the ACE CRC. This is seen as a more productive niche and more effective way to deliver international impact.

From within the three projects a number of significant advances can be reported.

On the observational side of the ice-sheet work, the ICECAP airborne survey has continued to deliver key data and publications. Although it is now extending beyond the envisaged survey work planned within the ACE CRC, the enhancement of outputs makes this a continued priority. ICECAP flew 23 flights over 40,000 line

kilometres in the 2011/12 season, with 5 flights and 9,000 km based out of Casey. The ACE CRC engagement in ICECAP has developed to involve collaborative study of the wider East Antarctic region accessed by other hubs besides Casey. This is providing improved data on ice sheet boundary conditions and on ice sheet changes in areas including Eastern Wilkes Land and Victoria Land. Results from ICECAP have been contributed to 'BEDMAP2': the major new Antarctic bedrock reconstruction. Other related highlights include a locally led bedrock reconstruction that incorporates ice sheet dynamical constraints to better map across data gaps and a study of the sub-ice hydrology in the Aurora Basin.

The Amery Ice Shelf Ocean Research (AMISOR) project deployed new loggers for year-round, high-resolution observation of temperatures in the ocean cavity beneath the ice shelf. Work also progressed on analysis of multiple years of data from ocean moorings deployed beneath the ice shelf at 6 sites. Several papers are in preparation using these data, including studies of the formation of frazil ice and of the seasonal variability of sub-ice-shelf ocean circulation.

Ice-ocean models developed at the ACE CRC now provide realistic simulations of Antarctic continental shelf ocean processes. The modelling is an invaluable contribution across disciplines and has resulted in several publications related to studies of ice-shelf mass balance, ocean circulation processes and ecosystems. The Cryosphere Program is pleased to be hosting a Marie Curie fellow starting late 2012 on further development of coupled ice-shelf ocean models.

The sea-ice team has been heavily involved in planning work for the SIPEX-II cruise, which runs in September-November 2012. This has included substantial collaboration with WHOI, and getting experience with their AUV, which will be used on SIPEX-II. A significant output from the group has been the publication of the first complete time series of East Antarctic landfast sea-ice extent covering the period 2000-2008. Also published are collaborative results with Japanese colleagues highlighting the impact of the Mertz Glacier calving in 2010 on regional sea-ice production rates within the Mertz Glacier Polynya, a globally important source of Antarctic Bottom Water. This study indicates a potential regime shift. Other developments include much-improved techniques for deriving high-resolution maps of sea-ice motion and fast ice distribution from time series of satellite synthetic aperture radar imagery, and resolution of key sub-synoptic scale sea-ice deformation processes in drifting buoy data. The group is also taking a lead role in the publication of important new information on sea-ice formation rates and water mass formation characteristics derived from instrumented marine mammals. This is particularly exciting work, in that it addresses critical spatial and temporal gaps in our knowledge of key Southern Ocean properties and processes.

The group has also published collaborative work with USA colleagues providing the first inter-hemispheric seasonal comparison of regions of rapid sea-ice change since 1979.

The ice core group have produced a number of important results. A connection has been identified between the ENSO and summertime wind speeds in the Southern Ocean. This connection is seen in the form of links between wind-induced sea salt levels in the Law Dome ice core and ENSO, which in turn provides a proxy for ENSO-related rainfall in Eastern Australia. Other work published this year provides a marked refinement of the link between CO<sub>2</sub> and temperature changes through the end of the last ice age, 18,000 to 12,000 years ago. Careful synchronisation of data from several Antarctic cores reveals that the ocean CO<sub>2</sub> response to warming took between 0 and 400 years to occur - considerably shorter than previous estimates of around 800 years.

Other work has been concentrated around international efforts to derive the first 2,000 year-long reconstruction of Antarctic temperature using high-resolution ice cores from across the ice sheet. ACE CRC scientists have leading roles in this work, which includes a comparison of major continental regions at a global scale.

An international workshop was hosted by the ACE CRC to build partnerships and plans for the major ACE CRC ice coring project planned for Aurora Basin in December 2013.

The ACE CRC's Cryosphere Program team published 21 articles in scholarly refereed journals and 21 are in press/submitted.

### **3. Carbon**

The ACE CRC's Carbon Program is on target to achieve its research outputs, with all planned professional staff in place. In addition, two new PhD students joined the program – Nick Roden to investigate the progress of ocean acidification in Antarctic coastal waters and Emmanuel Laurenceau to study carbon export from natural Fe fertilised waters. One UTAS PhD student graduated – Julia Mayo-Ramsay *Ocean Fertilisation: Science and Regulation*, as well as University of Bremen PhD student Friederike Ebersbach *Particle aggregation and carbon export: three Southern Ocean studies*.

Several major observational campaigns were carried out in the 2011-2012 year, including:

**KEOPS-2** - a study of natural iron fertilisation of deep waters offshore from the Kerguelen Plateau (extending the KEOPS-1 study carried out over the plateau in 2005). Led by European collaborators, including ACE CRC partner LEGOS from Toulouse and VUB from Brussels, this ambitious 56-day voyage deployed a grand array of 50 drogued drifters to map mesoscale flows while the ship carried out biogeochemical process studies. The ACE CRC Carbon team deployed a trace-metal clean rosette, in-situ pumps, and drifting sediment traps to measure carbon and iron concentrations and export fluxes. The Carbon Program also released an autonomous profiling float with temperature, salinity, phytoplankton fluorescence, backscatter, and oxygen sensors, which completed more than 280 profiles from the

surface to 300m depth as it continued observations for several months after the voyage.

**WOCE 19** – a repeat voyage led by the Oceans Program, mapping hydrographic characteristics between Australia and Antarctica, including distributions of dissolved oxygen and CO<sub>2</sub> to examine the processes influencing the progress of ocean uptake of atmospheric CO<sub>2</sub>, with concomitant mapping of carbonate minerals formed by pelagic organisms potentially at risk from ocean acidification. Early results suggest significantly lower levels of particulate inorganic carbonate minerals than would be inferred from satellite observations. In addition, work in the Adelie Land Mertz Polynya was carried out during this voyage, following on from work done the previous year, and revealed continued intense biological activity and increased CO<sub>2</sub> uptake following the collapse of the Mertz glacier tongue.

**SOTS** – a service voyage to the IMOS Southern Ocean Time Series (SOTS) automated moorings for climate and carbon cycle studies in the Subantarctic Zone southwest of Tasmania. New results from SOTS include the first annual heat budget for subantarctic waters from meteorological measurements from the Southern Ocean Flux Station tower buoy, and the first annual estimate of net community production derived oxygen and total dissolved gas budgets obtained by the pulse subsurface instrument pack.

**Astrolabe** - observations of ocean carbon contents during multiple transits of the French Antarctic resupply vessel were continued to build up inter-annual perspectives on the air-sea CO<sub>2</sub> fluxes. These contribute to global syntheses such as the Surface Ocean Carbon Atlas (SOCAT), as published online for use by climate and carbon cycle scientists ([www.socat.info](http://www.socat.info)) (see page 45).

Syntheses and publications from previous field campaigns also advanced. The Deep-Sea Research Part II: Topical Studies in Oceanography ' *Biogeochemistry of the Australian Sector of the Southern Ocean* ' special volume of 21 papers was published. Among the myriad detailed results, one fascinating one was the documentation of enriched levels of iron east versus west of Tasmania. This suggests iron stimulation of production might be responsible for the higher phytoplankton biomass in the Tasman Sea, although elevated primary production (or export production) was not observed in the east during the voyage. Additional papers based on sediment trap samples collected by the SOTS program were published, and a comparison of the state of ocean acidification from new measurements in 2010-2011 versus earlier work in 1994-1995 revealed the modulating influence of variability in water masses present over the Antarctic shelf and the extent of biological production within them.

The ACE CRC's Carbon Program team published 28 articles in scholarly refereed journals and 8 in press/submitted, co-authored 1 book section with 2 book sections in press and published 1 full written conference paper in refereed proceedings.

## Turning seven million data points into one big picture

Understanding and measuring the ocean's uptake of CO<sub>2</sub> is crucial in a warming world – the oceans, after all, absorb about one quarter of humankind's current annual CO<sub>2</sub> emissions.

Dr Bronte Tilbrook, a carbon scientist with the ACE CRC and the CSIRO, is one of 100 experts from around the world who are helping to put together the Surface Ocean CO<sub>2</sub> Atlas (SOCAT) - a 40-year record of CO<sub>2</sub> accumulation in the surface ocean.

Dr Tilbrook and Dr Nicolas Metzl (from the French institution L'Océan) lead SOCAT's Southern Ocean effort, covering the region south of 30°S. This region absorbs about 40 per cent of the total global ocean uptake of anthropogenic CO<sub>2</sub>, but whether it will continue to sequester carbon at the same rate into the future is uncertain.

The international team of SOCAT researchers gathered millions of raw data points that had been collected throughout the oceans from research vessels, commercial ships and moorings since 1968. Previously, many of these were not easy to access or were poorly described. All data was recalculated and scrutinised by many scientists to ensure that strict reporting and measurement standards were followed. Almost 7 million data points made the grade.

The SOCAT project released the first version of the database in September 2011, after two years of effort. For the first time this data has been made accessible to scientists and the general public in a common, usable and well documented format ([www.socat.info](http://www.socat.info)).

The data is already being used to better determine ocean and global carbon budgets, and for research into the variability of oceanic CO<sub>2</sub> uptake, and the biological and physical processes that drive the ocean uptake. A key use of SOCAT will be to evaluate models that simulate ocean carbon uptake. The work has also helped in establishing where data coverage is particularly poor, including vast tracts of the Southern Ocean. An updated version of SOCAT is planned for 2013.

#### 4. Ecosystems

The ACE CRC's Ecosystems Program is on target to achieve its research outputs.

The modelling group has made good progress in developing a coupled ocean-ecosystem model. An ocean model for the Indian Sector of the Southern Ocean has been developed using ROMS. A sea-ice emulator has been developed as an approximation for sea-ice dynamics in the interim of a full sea-ice physics model being completed. The emulator has been included in the ecosystem model for the region based on CSIRO's Atlantis model, which is being developed in conjunction with Dr Beth Fulton from CSIRO. A method for coupling the two modelling systems (ROMS and Atlantis) has also been developed. Testing of the coupled model is expected to begin later in 2012 and the first experiments to begin early in 2013 (see page 47).

The circum-Antarctic database of biomass associated with sea-ice has been completed and results are in the process of being published. This database includes data sets on sea-ice biological properties from 32 German, USA and Australian voyages (1983 – 2008) and has been included in the ASPeCt database held at the AAD.

The SIPEX-II voyage is scheduled for September-October 2012. Planning and preparations are well underway.

Methods for qualitatively assessing climate change impacts on Southern Ocean ecosystems have been developed and published this year.

A second international workshop of the Southern Ocean Sentinel Program (Sentinel-2) was held in May 2012 as part of the international program, ICED of the Southern Ocean, including further discussions on developing the Sentinel. It summarised the state of knowledge on observed and potential climate change impacts on Southern Ocean marine biodiversity. A series of papers is being prepared for submission on ecosystem changes and risk assessments in the next reporting period.

During the reporting period, the Ecosystems Program contributed to the Working Group 2 of the IPCC AR5. The Ecosystems Program research on impacts of climate change in Polar Regions will contribute to chapter 28 of the report.

The ACE CRC's Ecosystems Program team published 17 articles in scholarly refereed journals and 6 in press/submitted. They also published 1 book and 17 book sections.

## Yes, we can glimpse the future

Imagine looking through a window to the future and seeing not just the marine life that has adapted or thrived in a warmer climate, but all the relationships and influences at play in that new environment.

An interdisciplinary team from the ACE CRC Ecosystems Program is creating this virtual world with the building of a coupled, or whole-of-system, ecosystem model that brings together existing ocean, ice, atmosphere and food web models.

This coupled modelling has not previously been attempted at a regional scale for the Southern Ocean. Spatial and seasonal variations in Antarctic marine habitats (such as the advance and retreat of sea-ice, or the change in daylight hours) make the development of models of these dynamic processes challenging, but the end result of this project will be to see the possible impacts of rising CO<sub>2</sub> emissions on the ecosystems in Southern Ocean's East Antarctic region on a computer before it happens.

The project hit top gear in 2011 when scientists from the climate modelling and ecology disciplines were brought on board. Foundation work in 2011 included risk assessments of important linkages between Southern Ocean organisms and the physical environment, as well as the development of general procedures for exchanging information between different models. In the case of the coupled ecosystem model being developed at the ACE CRC, this means that the ROMS physical oceanography model, which projects ocean changes based on IPCC emissions scenarios, will be able to communicate with the Atlantis model of the Indian Sector of the Southern Ocean, which simulates ecological processes.

The Southern Ocean can be seen as an early warning system for climate-driven change in marine systems, due to the fact that fisheries, pollution and coastal development are less pronounced there than in other regions. The nature of the environment means that Southern Polar Regions may respond dramatically to climate change, which means the ability to project the likely changes in ecosystems over time and space is crucial.

Building the model has brought together multiple disciplines – ecology, biogeochemistry, fisheries, ocean and sea-ice modelling and climate science – and institutions. ACE CRC scientists are working directly with scientists at the CSIRO and the Center for Coastal Physical Oceanography at Old Dominion University in Virginia in the USA. In 2011, ACE CRC climate modeller Stuart Corney spent 12 weeks visiting colleagues at Old Dominion, where researchers have been integral in the development of the ROMS model. Those researchers were able to offer expert guidance and advice in configuring and running ROMS for Southern Ocean applications.

ACE CRC researchers are aiming to run the coupled model for the first time in 2012.

### 3.3 Utilisation and Commercialisation

The ACE CRC continues to seek innovative ways of communicating research outcomes to maximise uptake of ACE CRC science. The section below provides a summary of the major utilisation/commercialisation activities on a program level.

#### Oceans

During the reporting period, the following utilisation milestones were achieved:

- Completion and launch of new Position Analysis: 'Climate Change and the Southern Ocean'
- Briefings to politicians across all three levels of government, public lectures, school visits and contributions to blogs like [www.skepticalscience.org](http://www.skepticalscience.org)
- The Annual General meeting was held on 5 December 2011 with key government departments (DCCEE, SEWPaC), research partners (NIWA, AAD) and commercial participants (pitt&sherry, SGS and Myriax)

The Oceans Program also maintained important links with the international scientific community via collaborations, such as the SOOS and the Global Ocean Observing System (GOOS). Through these collaborations, the Oceans Program research outputs are utilised by the global scientific community. In addition, the Oceans Program researchers, Dr Stephen Rintoul and Prof Nathan Bindoff continued in their roles as coordinating lead authors for the IPCC AR5 process. Oceans Program research outputs form important inputs into IPCC science chapters and provide significant parameters for the global climate models, which provide projections of future climate.

#### Sea-level Rise

The ACE CRC sea-level calculator 'Canute' ([www.sealevelrise.info](http://www.sealevelrise.info)) was completely revamped and released with an online training facility.

- There are currently 217 active users and 44 users who have registered for access but have not yet completed the online training to gain access to the calculator
- Regular reviews were held with key commercial participants
- Currently Canute has not been formally launched. Launch is planned for 2012-2013 and it is anticipated this will drive additional traffic to the site
- The sea-level rise team also offered consultancy services to a number of external users including Tasmanian State Government.

Uptake is measured by new registrations and active users of the website.

#### Cryosphere

During the reporting period, the following utilisation milestones were achieved:

- The Annual General meeting was held on 5 December 2011 with key government departments (DCCEE, SEWPaC), research partners (NIWA, AAD) and commercial participants (pitt&sherry, SGS and Myriax)
- Many presentations were held over 2011-2012, including to politicians, SEWPaC, DCCEE, Department of Agriculture, Fisheries and Forestry (DAFF), Department of Foreign Affairs and Trade (DFAT) and The Climate Institute
- Dr Ian Allison continued as lead author of Working Group 1 of the IPCC AR5. Cryosphere Program outputs form important inputs to the IPCC AR5 science chapters

The year focussed on publication of key results in time for incorporation into the IPCC AR5. IPCC reports remain the single most important source of climate change information for policymakers across the globe. This is a major measurement of 'uptake' for the Cryosphere Program. In addition, the Cryosphere Program is focussing on improving ice-sheet/ice-ocean modelling by better specification of boundary conditions and of processes. This forms important inputs to improve existing ice sheet models used by the wider international community. This is seen as a productive and effective way to deliver international impact with limited resources.

## **Carbon**

During the reporting period, the following utilisation milestones were achieved:

- Regular review with key government departments, research partners and commercial participants such as DCCEE, SEWPaC and the Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE), and ACE CRC core research partners
- The Annual General meeting was held on 5 December 2011 with key government departments (DCCEE, SEWPaC), research partners (NIWA, AAD) and commercial participants (pitt&sherry, SGS and Myriax)
- Many presentations were held over 2011-2012, including to politicians, SEWPaC, DCCEE, DAFF, DFAT and The Climate Institute

The Carbon Program interfaces directly with SEWPaC on policy matters such as providing a scientific basis for the evaluation of potential risks of proposed activities such as ocean fertilisation, oceanic direct CO<sub>2</sub> disposal and the addition of alkaline substances to the ocean to enhance CO<sub>2</sub> uptake and buffer acidification. Uptake is also measured by incorporation of outputs into IPCC reports.

## **Ecosystems**

During the reporting period, the following utilisation milestones were achieved:

- Annual review with key government departments, research partners and commercial participants such as DCCEE, SEWPaC and DIISRTE, and ACE CRC core research partners

- During the reporting period, the Ecosystems Program contributed to the Working Group 2 of the IPCC AR5. The Program's research on impacts of climate change in Polar Regions will contribute to chapter 28 of the report
- The second Southern Ocean Sentinel workshop (Sentinel-2) was held in May 2012. Briefings with key research users were held with Southern Ocean Sentinel Program (Sentinel-2) delegates as part of the international program, ICED

Uptake is measured by incorporation of research outputs into IPCC AR5 and the utilisation of ecosystems modelling outputs by international bodies such as CCAMLR to set sustainable catch limits for commercial fisheries.

Strategies for ensuring uptake by end-users include:

- Regular reviews with end-users to understand needs and transfer knowledge
- Production of Position Analyses, Report Cards and Technical Reports including mailout to an established database of users
- E-newsletters and Twitter to keep users updated on latest science
- Attendance and presentations at conferences and symposia
- Direct involvement in IPCC reporting process (as a major conduit to policymakers nationally and internationally)
- Media releases and briefings to journalists
- Implementing strategies to measure uptake (for example downloads of reports)

### 3.4 Education and Training

#### Education

The IMAS at the UTAS continues to support the education program.

ACE CRC and IMAS staff teach into undergraduate science degrees, and graduate diploma, honours, coursework masters, research masters and PhD programs. Students study a range of topics relevant to Antarctica and the Southern Ocean.

In the reporting period 10 PhD students commenced, 9 completed and 44 PhD students continued their studies on ACE CRC related research. Of the 9 completions, 1 is now employed at the ACE CRC, 1 found employment with CMAR, 1 is employed by IMAS, 1 is employed by Myriax, 1 is employed by the Western Australia State Government, 2 were successful in securing post-doctoral positions overseas, and 2 found employment in other areas.

During the reporting period, 2 part-time Masters students continued their studies and there were no completions. One Masters student from the European Institute for Marine Studies in Brest, France, spent 5 months at the ACE CRC on an internship project in Antarctic ecosystem modelling with the Ecosystems Program.

Five new Honours students commenced during the reporting period. A total of 6 Honours students graduated in the reporting period.

These higher degree by research students were supervised by 20 UTAS staff and 16 non-university staff members.

Six non-university staff members and 6 UTAS staff were involved in formal postgraduate educational activities, that is, 6 different postgraduate courses.

A total of 205 students (including 5 Honours students) were enrolled in undergraduate education courses during the reporting period, of whom 37 students were enrolled in a Bachelor of Antarctic Science and 42 students were enrolled in a Bachelor of Marine Science. Since 2006, the glaciologists from the Cryosphere Program have hosted 10-15 students each year from the first year unit KSA102 Introduction to Marine and Antarctic Studies on a tour of ACE CRC facilities. This tour involves an introduction to glaciology, the ice drill display and the storage lab for the ice cores. This tour occurred on 29 August 2011.

Twenty-six students were enrolled in the Masters of Antarctic Science by coursework at the end of reporting period, including 3 part-time students. The course is designed to produce expertly trained scientists with international experience and research skills in the area of Antarctic marine science.

New enrolments in Honours and Masters degrees are not strong, despite multiple projects available. The issue is the lack of students applying. The ACE CRC is working with IMAS and the CSIRO-UTAS Quantitative Marine Science (QMS) program to improve visibility of projects and enhance recruitment. However, Honours and Masters students are not as valuable to research outputs as PhD students are, and the ACE CRC will continue its focus on PhD students.

### **Training courses for end-users/professional development**

During the reporting period, the ACE CRC hosted 2 symposia and 2 workshops, attended by a total of 127 end-users. The ACE CRC also sponsored three early career scientists to attend 'Science at the Shine Dome', the annual meeting of the Australian Academy of Science. The events are outlined below.

#### *Climate Change Communications Workshop: The psychology of climate change communication*

This workshop, presented by Prof Stephan Lewandowsky, was hosted by the ACE CRC and the Tasmanian Climate Change Office on 19<sup>th</sup> of March 2012. The workshop was attended by 12 ACE CRC staff and 12 Tasmanian Climate Change Office staff.

### *ACE CRC Symposium 2012*

The ACE CRC held another highly successful ACE Symposium on the 8<sup>th</sup> and 9<sup>th</sup> of March 2012. The Symposium, From Discovery to Cutting Edge Science, focused on the achievements of ACE CRC early career researchers. Once again, registrations for the Symposium exceeded expectations, with more than 110 attending. 67 people attended the Symposium from the following organisations: AAD, Antarctic Tasmania, Bureau of Meteorology (BoM), CCAMLR, CSIRO, DCCEE, IMAS, IMOS, Myriax, NOAA, pitt&sherry, and SGS.

### *Symposium 75th anniversary of the declaration of the Australian Antarctic Territory*

The 75th anniversary of the declaration of the Australian Antarctic Territory Symposium was held in Hobart on 24 August 2011. While the 75th anniversary of the proclamation of the AAT provided a focus, presenters were encouraged to address different aspects of Australia's engagement with Antarctica. The Symposium hosted 15 different presenters and was attended by more than 70 people. Proceedings of the Symposium were published in February 2012: *Jabour, J., Haward, M. and Press, T. (2012). Australia's Antarctica. Proceedings of the symposium to mark 75 years of the Australian Antarctic Territory held in Hobart on 24 August 2011. IMAS Occasional Paper #2. Hobart, Tasmania, IMAS: 125.*

### *Aurora Basin North ice coring workshop*

The Aurora Basin North ice coring workshop was held on 12-13 April 2012 in Hobart to build partnerships and plans for the major ACE CRC ice coring project planned for Aurora Basin in December 2013. This workshop was attended by 20 people.

### *Sentinel-2*

A second international workshop of the Southern Ocean Sentinel Program (Sentinel-2) was held 7-11 May 2012 as part of the international program, ICED of the Southern Ocean, including further discussions on developing the Sentinel. It summarised the state of knowledge on observed and potential climate change impacts on Southern Ocean marine biodiversity. A series of papers is being prepared for submission on ecosystem changes and risk assessments in the next reporting period. A total of 64 people attended Sentinel-2 from the following organisations: AAD, AWI, British Antarctic Survey (BAS), CCAMLR, CSIRO, UTAS, IMOS, SOOS, NIPR, Old Dominion University, and several others. In addition, 12 ACE CRC Master of Antarctic Science students attended Sentinel-2 on day 2.

### *Climate Conversations Forums*

Another 5 Climate Conversation Forums were held during the reporting period at the following locations: South Arm Progress Association; St Mary's College; Scottsdale

High School; Scottsdale Public; Australian Antarctic Division – United Nations Permanent Delegates.

### *Science at the Shine Dome*

The ACE CRC also sponsored three early career scientists to attend 'Science at the Shine Dome', the annual meeting of the Australian Academy of Science, 2-4 May 2012. The topic was *Antarctic Science: From Mawson's expedition to today*. Attendance at this meeting is of great value to early career researchers, giving them the opportunity to gain essential career skills and to interact with a variety of peers. ACE CRC researchers Dr Jessica Melbourne-Thomas, Dr Laura Herraiz-Borreguero and Dr Elizabeth Shadwick attended 'Science at the Shine Dome'.

## 3.5 SME Engagement

There was active engagement with the three SME participants in the ACE CRC program. pitt&sherry Managing Director, Mr John Pitt continues to hold an ACE CRC Board position as the representative of the commercial and SME participants.

The Sea-level Rise Impacts project is initiating an accreditation program for its SME participants to become skilled in training end-users to use the ACE CRC sea level calculator, Canute ([www.sealevelrise.info](http://www.sealevelrise.info)).

In conjunction with SMEs, pitt&sherry and SGS Economics and Planning, the ACE CRC completed a number of collaborative consulting projects for governments. These collaborations have assisted in knowledge sharing between the ACE CRC and the SMEs, and with governments.

Myriax, a SME Software Company, and ACE CRC participant provided training in their 4D-visualisation software to selected ACE CRC scientists. There is an opportunity to actively collaborate on the visualisation of the Ecosystems Program model outputs as they become available.

### **New products and services**

The ACE CRC sea-level rise impacts team re-released an upgraded version of its sea level calculator, Canute, to assist in coastal planning and infrastructure maintenance. During the reporting period, the ACE CRC provided vocational training and gave presentations at conferences and meetings to promote its use.

ACE did not execute any licences or transfers nor did it create any spin-off companies.

## 3.6 Collaboration

Currently, the ACE CRC collaborates with 82 domestic and international organisations. Of these, 28 are Australian, 2 New Zealanders, 9 Asian, 20 North

American, 2 South American, and the remaining 21 are scattered throughout Europe.

Of the 28 domestic collaborations, 4 are industry/private sector, 8 Australian Government Institutions, 1 State Government Institution, 14 Universities, and 1 other.

Of the 54 international collaborations, 27 are Universities, 1 industry/private sector, and 26 others.

During the reporting period, the ACE CRC had several overseas visitors, including visitors from Participants (NIPR, FIO and CAMS). The ACE CRC had a special visit during February-March 2012 from Prof Olav Orheim, a distinguished Norwegian polar scientist.

For further discussions on end-user collaborations, see section 3.3 of this report.

## 4 Other activities

ACE CRC continued to undertake a number of externally funded research and consultancy activities, primarily in the areas of fine-scale climate modelling and analysis (NDRP and NERP) and sea-level rise impact assessments.

**Natural Disaster Resilience Program (NDRP):** The work already undertaken in the Climate Futures for Tasmania project is being extended to examine changes to severe weather events likely to cause significant damage (and cost) to Tasmania. This program aims to identify and address disaster risk priorities throughout the State. The ACE CRC has secured 2.5 years of funding from the Program, administered by Tasmanian State Emergency Services, to investigate these weather events using a combination of established and new techniques and indices. These events include increased bushfire risk (encompassing both bushfire meteorology and hazard), and severe storms.

**National Environmental Research Program (NERP):** Project 3 – Climate Futures – is a project within the Landscapes and Policy (LAP) hub funded through the NERP. This project extends and builds upon the successful Climate Futures for Tasmania project. This project coordinates with seven national projects within the LAP hub to provide climate change information and datasets for research into ecosystems and landscapes in a changing climate.

During the reporting period, the Climate Futures for Tasmania Program encompassing both NDRP and NERP projects have published 3 full written conference papers in refereed proceedings, 3 articles in scholarly refereed journals with 2 in press which are listed in Appendix 1.

**Coastal Inundation Mapping for Tasmanian Government:** In conjunction with the UTAS, production of inundation mapping for parts of Tasmania based on future projections of sea-level rise combined with present storm surge activity.

**Sea-level rise Planning Allowance for Tasmanian Government:** Technical paper providing guidance on a suitable sea-level rise planning allowance for Tasmania.

**Tasmanian Coastal Adaptation Pathways Project:** The provision of personnel from the ACE CRC to participate on a technical reference group for this project. The project aims to provide flexible coastal adaptation pathways for local communities in four vulnerable Tasmanian coastal areas.

**ClimateAsyst®:** The ACE CRC has a commercial agreement with SME consulting firm pitt&sherry in relation to the development and commercialisation of ClimateAsyst®. The project received funding from the Tasmanian and Local governments. ClimateAsyst® is a software tool that assists infrastructure asset owners to understand the potential impacts of climate change on their infrastructure. ClimateAsyst® outputs help end-users to determine whether current design codes for planned infrastructure will be adequate. The major activity during the reporting period was the development of a new publicly available, web-enabled version of ClimateAsyst® (which is scheduled for launch in November 2012).

## 5 Additional requirements

### 5.1 Performance review

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
<p>As the CRC moves into transition, the CRC should increase the frequency of executive committee meetings to review its research programs and utilisation activities, and to communicate the outcomes to staff.</p>	<p>Yes</p>	<p>NA</p>	<ul style="list-style-type: none"> <li>• Regular bi-monthly Executive Committee meetings are scheduled from August 2012. Additional Executive Committee meetings will also be required for the production of Position Analyses and Report Cards, education activities, data archiving, and the development of the ACE CRC wind-up plan. The wind-up plan requires Board approval at least 18 months prior to the end of the grant period (hence by end December 2012).</li> <li>• Program Leaders are meeting separately with the utilisation team to plan the production of Position Analyses and Report Cards to ensure research outcomes are communicated to end-users consistent with ACE CRC's utilisation milestones. The production schedule for publications of ACE CRC material is overseen by the CEO and Deputy CEO.</li> <li>• Decisions of the Executive Committee and the Board will be formally communicated to staff in staff meetings to keep them up-to-date with developments and future directions. An all-staff meeting was held in June and September 2012. Regular staff meetings will be held until the wind-up of the ACE CRC in June 2014.</li> <li>• The ACE CRC has also initiated an internal research-related meeting series, which run fortnightly. These meetings, inter alia, keep staff abreast of research developments and opportunities.</li> </ul>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			<p>Combined, these initiatives will be used to provide a continuous communication stream to ensure staff are updated on any new development as soon as Executive or Board decisions have been made.</p> <p>With respect to the comments relating to end-users, the ACE CRC will establish formal (minimum 6-monthly) review processes with each of the private sector end-user partners. These reviews will focus on maximising value to them and on potential end-users. Specific provisions will be made to keep overseas end-users abreast of ACE CRC wind-up developments, and Government end-users will be involved in the wind-up and transition arrangements. All participants have been encouraged to attend the Annual General Meeting held in September 2012.</p>
<p>As the CRC moves into transition the CRC should ensure its business processes are well documented.</p>	<p>Yes</p>	<p>NA</p>	<ul style="list-style-type: none"> <li>• In the lead up to the production of the ACE CRC Annual report (31 October 2012) business processes will be reviewed to ensure that documentation is up to date. Particular attention will be given to: <ul style="list-style-type: none"> <li>o Finances</li> <li>o Purchasing and asset management</li> <li>o Recruitment and retention of staff</li> <li>o Education, scholarships and bursaries</li> <li>o Management of staff leave</li> <li>o External grants, grant applications and consultancies</li> <li>o Insurance</li> <li>o Resource management (including data management and storage; and scientific sample management including quarantine)</li> </ul> </li> <li>• The ACE CRC reports to the Board quarterly on its outlook. These reports will also highlight any emerging</li> </ul>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			<p>issues with business processes in planning and executing the wind-up.</p> <p>The ACE CRC is actively engaged with the core Hobart-based partners (AAD, CSIRO and UTAS) in developing options for transition. The outcome of these discussions is reported to the ACE CRC Board and will inform the development of wind-up plan and the further refinement of the ACE CRC transition plan.</p> <p>The internal communication process is highlighted in Appendix 2.</p>
<p>The CRC should articulate with greater clarity and focus the intended outcomes of the ecosystems program and how they contribute to the strategic value and direction of the CRC and for end-users.</p>	<p>Yes</p>	<p>NA</p>	<ul style="list-style-type: none"> <li>• The ACE CRC is in the process of developing and producing a Position Analysis on Southern Ocean ecosystems. This will provide an up-to-date account of the status of knowledge of Antarctic ecosystems; a framework for future research; and a clear articulation of the context of ecosystem research in the Southern Ocean. Development of the Position Analysis will involve end-users directly through briefings and a workshop. Past practice has shown that this process leads to sharper policy focus and better strategic engagement between scientists and policy makers.</li> <li>• The ACE CRC Ecosystems Program will be working closely with international initiatives (including the IGBP/IMBER program, ICED and the Southern Ocean Observing System) in the following key areas of research focus: <ul style="list-style-type: none"> <li>i. developing whole-of-ecosystem models to assist with identifying and assessing plausible scenarios of long-term change;</li> </ul> </li> </ul>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			<ul style="list-style-type: none"> <li>ii. developing minimal-realistic models of components of the ecosystem to assist with evaluating management and conservation strategies that cannot be fully evaluated in the whole-of-ecosystem models;</li> <li>iii. undertaking assessments, based on current knowledge, of possible climate change impacts for primary taxa and habitats;</li> <li>iv. developing better assessments of the primary drivers of Southern Ocean ecosystems, including the relative importance of different habitats to key taxa (e.g. sea-ice habitats and krill), seasonal productivity and food web linkages; and</li> <li>v. designing and implementing field programs to complement these key areas.</li> </ul> <ul style="list-style-type: none"> <li>• Particular emphasis within the ACE CRC Ecosystems Program will be on leadership and strengthening national and international links as well as end-user engagement - especially in building long-term multi-disciplinary efforts to study Southern Ocean ecosystem changes. This process will also engage end-users in the IPCC, CCAMLR, the Antarctic Treaty, and the International Whaling Commission (IWC). The Program Leader of the Ecosystems Program has been recently invited to become a lead author for Working Group 2 of the IPCC AR5.</li> </ul> <p>Southern Ocean ecosystems are of significant interest because (i) they play an important role in global sequestration of carbon, (ii) they underpin the recovery and conservation of the great whales decimated by</p>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			whaling in the 20th century, (iii) they maintain populations of Antarctic krill which have the potential to sustain one of the world's largest fisheries, and (iv) they are more sensitive to climate change than most other marine ecosystems on the planet, a characteristic that could be used to refine assessments of future changes in marine ecosystems.
The CRC should continue to examine quantitative metrics of research impact and methods for capturing end-user use and uptake of research outputs.	Yes	NA	<ul style="list-style-type: none"> <li>• The ACE CRC will continue to track and report on journal ERA impacts, measuring both the quantity and quality of research publications and citation indices.</li> <li>• The ACE CRC will encourage readers of the ACE CRC e-Newsletter to sign up to receive future publications electronically if they wish. This way we can more easily track interest in our publications (such as Position Analysis reports) by measuring downloads from the ACE website.</li> <li>• The ACE CRC is participating in a case study led by ValueMetrics Australia to measure partnership value. The purpose of the case study is to develop an understanding of the value that each shareholder <u>brings to</u> and <u>gains from</u> the ACE CRC partnership.</li> <li>• Engagement of stakeholders with the ACE CRC will be measured by attendance at ACE CRC briefings, short courses, meetings, symposia, conferences and launches; and by counting media hits, number of website visits (Google Analytics), and followers on Twitter.</li> <li>• The ACE CRC Board will receive regular reporting that will include Google Analytics (for website visits); metrics from Meltwater News, Media Monitors and Google Alerts for media hits; and tracking of followers on Twitter.</li> <li>• The ACE CRC will make strategic use of the online</li> </ul>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			survey tool, Survey Monkey, for publications and newsletters, and conduct surveys of those attending conferences and symposia organised by the ACE CRC.
The CRC should promote opportunities for post-graduate student supervision by, and placements with, end-users where appropriate.	Yes	NA	<ul style="list-style-type: none"> <li>• The ACE CRC will survey its end-users for opportunities for placements for students and recent graduates.</li> <li>• The ACE CRC is creating a post-graduate student profile page on the ACE CRC website where each post-graduate student has the opportunity to explain their current research and their future employment preference in order to build their professionalism and exposure.</li> <li>• The ACE CRC quarterly newsletter will include more articles about post-graduate students. It is planned to produce a special "post-graduate student issue" after the December 2012 graduations.</li> </ul>
The CRC should improve their ability to identify users and usage of web-based tools, social media, and other outputs, as a measure of research impacts; while also providing for future business opportunities and building community knowledge and support.	Yes	NA	<ul style="list-style-type: none"> <li>• The Sea-Level Rise Tool: the ACE CRC will work with our web developer on the sea-level rise website, <i>Canute</i>, to enhance the tracking and measurement of users, including numbers of users and frequency of use.</li> <li>• In conjunction with the initiatives outlined under Recommendation 4, the ACE CRC is now tracking numbers of followers on Twitter as a means of measuring its engagement with the broader community.</li> <li>• The ACE CRC will establish formal (minimum 6-monthly) review processes with each of the private sector end-user partners. These reviews will focus on maximising value to them, and on potential end-users.</li> <li>• The ACE CRC will maintain its close connections with public sector end-users, to monitor end-user impact and uptake.</li> <li>• The series of community forums, the Climate</li> </ul>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			<p>Conversations will continue. They are an important way to encourage conversations between researchers and the public about climate change.</p> <ul style="list-style-type: none"> <li>• Researchers will continue presenting seminars at public and private schools around Hobart. In addition, the ACE CRC will continue to host public lectures when interstate/overseas researchers are visiting the ACE CRC in Hobart.</li> <li>• A relationship with the Calvin Christian School (kindergarten to Year 12) has been established as an Antarctic Studies class has been developed by one of the teachers. In July 2012, the ACE CRC provided a Calvin Christian School Year 10 student a work experience placement for 1 week. Show-and-tell tours at the ACE CRC, talks by researchers, and potential future placements will continue to inspire students from the Antarctic Studies class at the Calvin Christian School and potentially other schools in the Hobart catchment.</li> </ul>
<p>The CRC participants should pursue a unified approach to planning for the future.</p>	<p>Yes</p>	<p>NA</p>	<ul style="list-style-type: none"> <li>• The core Hobart-based partners (AAD, CSIRO and UTAS) are actively engaged in developing options for transition from the ACE CRC, and other key partners are kept abreast of these discussions.</li> <li>• The outcome of these discussions is reported regularly to the ACE CRC Board and will inform the development of the wind-up plan and the further refinement of the ACE CRC transition plan.</li> </ul> <p>The Board notes the importance of ensuring that focus is kept on the value of the partnerships in the ACE CRC. Of particular importance is keeping each of the core partners apprised of developments, which may impinge</p>

Recommendation	Implemented (yes/no)	Reasons why not implemented	Strategies to implement
			<p>on options for transition, or on future funding for the collaborations currently encompassed by the ACE CRC.</p>
<p>The CRC transition strategy should be urgently developed as a whole-of government approach in the context of the Australian Antarctic Science Strategic Plan and the National Framework for Climate Change Science.</p>	<p>Yes</p>	<p>NA</p>	<p>The work of the ACE CRC is an integral component of both the AASSP and the NFCCS. Loss of the ACE CRC will diminish the overall contributions that the partners are currently able to contribute to these important national research frameworks.</p> <p>The Australian Antarctic Science Strategic Plan has four themes. The work of the ACE CRC is principally focussed on Themes 1 and 3: “Climate Processes and Change” and “Southern Ocean Ecosystems: Environmental Change and Conservation”.</p> <p><i>A Plan for Implementing Climate Change Science in Australia</i> has been developed under the National Framework for Climate Change Science Framework.</p> <p>The CEO of the ACE CRC, the Director of the AAD, DCCEE and CSIRO have been involved in the High Level Group which drafted the <i>Implementation Plan</i> and are aware of its thrust and contents.</p> <ul style="list-style-type: none"> <li>• The core Hobart-based partners (AAD, CSIRO and UTAS) are actively engaged in developing options for transition from the ACE CRC, and other key partners are kept abreast of these discussions.</li> <li>• The Board of the ACE CRC will ensure that transition initiatives are developed which contribute to and are consistent with the AASSP and the NFCCS.</li> </ul>

## 6 Glossary of Terms

Abbreviation	Organisation Name
<b>A</b>	
AASSP	Australian Antarctic Science Strategic Plan
AAD	Australian Antarctic Division
ACC	Antarctic Circumpolar Current
ACCESS	Australian Computational Earth Systems Simulator
ACE CRC	Antarctic Climate & Ecosystems Cooperative Research Centre
AMISOR	Amery Ice Shelf Ocean Research
ASPeCt	Antarctic Sea-ice Processes & Climate
AUV	Autonomous Underwater Vehicle
AVCAL	Australian Private Equity & Venture Capital Association Ltd
AWI	Alfred Wegener Institute for Polar Research (Germany)
<b>B</b>	
BAS	British Antarctic Survey
BoM	Bureau of Meteorology
<b>C</b>	
CAMS	Chinese Academy of Meteorological Science (China)
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEO	Chief Executive Officer
CLIVAR	Climate Variability and Predictability Program
CMAR	CSIRO Division of Marine & Atmospheric Research
CO <sub>2</sub>	Carbon Dioxide
COAG	Council of Australian Governments
CPOM	Centre for Polar Oceanography and Modelling (United Kingdom)
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
<b>D</b>	
DAFF	Department of Agriculture, Fisheries and Forestry
DCCEE	Department of Climate Change and Energy Efficiency
DFAT	Department of Foreign Affairs and Trade
DIISRTE	Department of Industry, Innovation, Science, Research and Tertiary Education
<b>E</b>	
ENSO	El-Niño Southern Oscillation
EPOC	Ecosystem Productivity Ocean Climate
<b>F</b>	
FIO	First Institute of Oceanography (China)
<b>G</b>	
GDP	Gross Domestic Product
GEOTRACES	An international study of the biogeochemical cycles of Trace Elements and Isotopes in the Arctic and Southern Oceans
GOOS	Global Ocean Observing System

Abbreviation	Organisation Name
<b>I</b>	
ICECAP	Investigating the Cryospheric Evolution of the Central Antarctic Plate
ICED	Integrating Climate and Ecosystem Dynamics
ICSU	International Council for Science (formerly the International Council of Scientific Unions)
ILTS	Institute of Low Temperature Science, Hokkaido University (Japan)
IMAS	Institute for Marine and Antarctic Studies, University of Tasmania
IMOS	Integrated Marine Observing System
IOCCP	International Ocean Carbon Coordination Project
IP	Intellectual Property
IPCC AR5	Intergovernmental Panel on Climate Change Fifth Assessment Report
IPO	International Project Office
IT	Impact Tool
ITR	Information Technology Resources
IWC	International Whaling Commission
<b>K</b>	
KEOPS	Kerguelen compared study of Ocean and Plateau in Surface waters (KEOPS-1 and KEOPS-2)
<b>L</b>	
LAP	Landscapes and Policy
LEGOS	Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (France)
LOICZ	Land-Ocean Interactions in the Coastal Zone
<b>M</b>	
MUN	Memorial University of Newfoundland(Canada)
<b>N</b>	
NDRP	Natural Disaster Resilience Program
NeCTAR	National eResearch Collaboration Tools and Resources
NERP	National Environmental Research Program
NFCCS	National Framework for Climate Change Science
NIPR	National Institute of Polar Research (Japan)
NIWA	National Institute for Water and Atmospheric Research (New Zealand)
NOAA	National Oceanic and Atmospheric Administration
<b>Q</b>	
QMS	Quantitative Marine Science Program
<b>R</b>	
RDSI	Research Data Storage Infrastructure
ROMS	Regional Ocean Modeling System
ROV	Remotely Operated Vehicle
<b>S</b>	
SAZ	Sub-Antarctic Zone
SAZ-SENSE	Sensitivity of Sub-Antarctic Zone waters project

<b>Abbreviation</b>	<b>Organisation Name</b>
<b>SCAR</b>	Scientific Committee on Antarctic Research
<b>SEWPaC</b>	Department of Sustainability, Environment, Water, Population and Communities
<b>SIPEX-II</b>	Sea-ice Physics & Ecosystem Experiment
<b>SLR</b>	Sea-Level Rise
<b>SME</b>	Small and Medium Enterprises
<b>SOCAT</b>	Surface Ocean Carbon Atlas
<b>SOOS</b>	Southern Ocean Observing System
<b>SOTS</b>	Southern Ocean Time Series
<b>T</b>	
<b>TPAC</b>	Tasmanian Partnership for Advanced Computing
<b>U</b>	
<b>USA</b>	United States of America
<b>UTAS</b>	University of Tasmania
<b>W</b>	
<b>WHOI</b>	Woods Hole Oceanographic Institute (USA)
<b>WMO</b>	World Meteorological Organisation
<b>WOCE I9</b>	World Ocean Circulation Experiment Indian Ocean 9 transect

## Appendix 1– list of publications

### Books – Authorised Research (unweighted)

Haward, M. and Griffiths, T., eds. (2011). Australia and the Antarctic Treaty System: 50 years of influence. Sydney, Australia, University of New South Wales Press.

### Book Chapters

Boyce, P. and Press, T. (2011). Diplomacy. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 274-299.

Constable, A. and Welsford, D. (2011). Developing a precautionary, ecosystem approach to managing fisheries and other marine activities at Heard Island and McDonald Islands in the Indian Sector of the Southern Ocean. The Kerguelen Plateau: Marine Ecosystem and Fisheries. Duhamel, G. and Welsford, D. (eds). France, Societe Francaise d'Ichtyologie: 233-255.

Griffiths, T. and Green, G. (2011). Culture. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 346-372.

Haward, M. and Jackson, A. (2011). Australia's Antarctic future. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 334-345.

Haward, M. and Mason, D. (2011). Australia, the United Nations and the Question of Antarctica. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 202-221.

Hemmings, A.D. and Jabour, J. (2011). Already a Special Case? Australian Antarctic Policy in the First Decade of the Antarctic Treaty. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 118-137.

Higgins, H.W., Wright, S.W. and Schluter, L. (2011). Quantitative interpretation of chemotaxonomic pigment data. Phytoplankton pigments: characterization, chemotaxonomy and applications in oceanography. Roy, S., Llewellyn, C.A., Egeland, E.S. and Johnsen, G. (eds). Cambridge, UK, Cambridge University Press: 874.

Jabour, J. (2012). Maritime security: Investing in safe shipping operations to help prevent marine pollution. Antarctic Security in the Twenty-First Century: Legal and policy perspectives. Hemmings, A.D., Rothwell, D.R. and Scott, K.N. (eds). UK, Routledge: 238-256.

Jabour, J. and Haward, M. (2011). Resources. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 222-242.

Jackson, A. and Boyce, P. (2011). Mining and 'World Park Antarctica', 1982-1991. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 243-273.

Jackson, A. and Kriwoken, L. (2011). The Protocol in action, 1991-2010. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 300-319.

Jeffrey, S.W., Wright, S.W. and Zapata, M. (2011). Algal classes and their signature

- pigments. Phytoplankton pigments: characterization, chemotaxonomy and applications in oceanography. Roy, S., Llewellyn, C.A., Egeland, E.S. and Johnsen, G. (eds). Cambridge, UK, Cambridge University Press: 874.
- Kaye, S., Haward, M. and Hall, R. (2011). Managing marine living resources, the 1970s-1990s. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 164-180.
- Nicol, S. and Raymond, B. (2012). Chapter 8: Pelagic ecosystems in the waters off East Antarctica (30°E–150°E). Antarctic Ecosystems: An Extreme Environment in a Changing World. Rogers, A.D., Johnston, N.M., Murphy, E.J., and Clarke, A. (eds). London, John Wiley & Sons.
- Post, A.L., O'Brien, P.E., Beaman, R.J., Riddle, M.J., De Santis, L. and Rintoul, S.R. (2012). 52 - Distribution of Hydrocorals Along the George V Slope, East Antarctica. Seafloor Geomorphology as Benthic Habitat. Peter, T.H. and Elaine, K.B. (eds). London, Elsevier: 717-726.
- Queguiner, B., Blain, S. and Trull, T. (2011). High primary production and vertical export of carbon over the Kerguelen Plateau as a consequence of natural iron fertilization in a high nutrient, low chlorophyll environment. The Kerguelen Plateau: Marine Ecosystem and Fisheries. Duhamel, G. and Welsford, D. (eds). France, Societe Francaise d'Ichtyologie: 169-174.
- Rothwell, D.R. and Jackson, A. (2011). Sovereignty. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 48-67.
- Stoddart, M. and Haward, M. (2011). Science. Australia and the Antarctic Treaty System: 50 years of influence. Haward, M. and Griffiths, T. (eds). Sydney, Australia, University of New South Wales Press: 138-163.
- Welsford, D., Constable, A. and Nowara, G. (2011). The Heard Island and McDonald Islands Marine Reserve and Conservation Zone – a model for Southern Ocean Marine Reserves. The Kerguelen Plateau: Marine Ecosystem and Fisheries. Duhamel, G. and Welsford, D. (eds). France, Societe Francaise d'Ichtyologie: 297-304.

### Articles in Scholarly Refereed Journals

- Baeyens, W., Bowie, A.R., Buesseler, K., Elskens, M., Gao, Y., Lamborg, C., Leermakers, M., Remenyi, T.A. and Zhang, H. (2011). "Size-fractionated labile trace elements in the Northwest Pacific and Southern Oceans." Marine Chemistry **126** (1-4): 108-113.
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## Appendix 2- internal communication process

