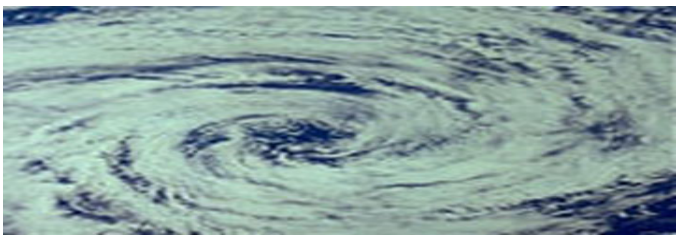


Climate Change Research Centre

Annual Report 2008



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This is the first Annual Report from The Climate Change Research Centre – the CCRC - covering its first year of existence in 2008.

The CCRC was established via University Council on 7th August, 2008, following an agreement between Professor Les Field, the Deputy Vice Chancellor (Research) and Professor Mike Archer, the Dean of the Faculty of Science.

The CCRC is a nationally significant research initiative at the University of New South Wales, combining the expertise of Co-Directors Professor Matthew England and Professor Andy Pitman leading a team of some of Australia's top climate scientists. The CCRC is a multi-disciplinary research group comprising one of the largest Australian University laboratories in climate science, oceanography, terrestrial processes, atmospheric sciences and meteorology. The Centre specializes in physics and biophysics of climate variability and climate change. The Centre also explores the underlying dynamics and physical processes of the oceans, atmosphere and terrestrial systems and their combined impacts on climate change, carbon cycle, climate extremes and climate vulnerabilities. We are a founding member of the Universities Climate Consortium.

The CCRC is growing strongly with new appointments, new research fellows and new PhD students joining us each month. We will reach 12 full time academic staff in 2009 – the scale defined by our establishment agreement with the University. This annual report documents the Centre in 2008 when we were about 60% of the current size. While this report documents a newly emerging centre in 2008 it also documents an intensively research active centre with strong successes in external research funding, publications in elite journals and an active PhD program. This report will document our 2008 successes – prioritizing the successes of the younger academic staff and some outstanding PhD students who represent both the future of the centre and key elements in the future of climate science in Australia.

Professor Matthew England

Professor Andy Pitman

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The University of New South Wales
NSW 2052, Australia
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Summary of Performance in 2008

Highlights

- Formal establishment of the CCRC and appointment of Co-Directors
- Opening of new premises by Dr Rajendra Pachauri, Chair Intergovernmental Panel on Climate Change and Hon. Carmel Tebbutt MP, NSW Deputy Premier and Minister for Climate Change and the Environment
- Nobel Peace Prize awarded to Prof Andy Pitman as a lead author on the IPCC AR4 report
- QEII Fellowship awarded to Dr Ben McNeil
- Australian Agricultural Industries Young Innovators and Scientists Award (Department of Agriculture, Fisheries and Forestry) including 20k research grant awarded to Jason Evans
- Land and water Australia Prize Eureka prize awarded to Matthew England, Agus Santoso, Alex Sen Gupta and Caroline Ummenhofer
- Banksia Environmental Scientist of the Year Award, awarded to Matthew England
- Approximately $1.2 million in external (mainly Category 1) funding
- 2008 Seminar Series which included notable international speakers

The Climate Change Research Centre was officially opened on 23 October 2008 by Dr Rajendra Pachari and NSW Deputy Premier Carmel Tebbutt MP. At the same time the CCRC physically moved out of the School of Mathematics and Statistics and into a purpose-renovated space in the former Biomedical Library section of the Mathews Building and became an independent financial and administrative entity.

The key goal of the CCRC is *to be the lead Australian University research centre in the science and selected impacts of climate change.*

Such a goal is not achieved in one year – our goal is not to merely "become" the lead, it is to *sustain* leadership. We have demonstrably established leadership in many areas of climate research in 2008. These include ocean and terrestrial physics, ocean-atmosphere-land coupling, climate modeling and the parameterization of key components of the land-atmosphere-ocean system.

Other functions and goals of the CCRC are to:

- Establish a world-class interdisciplinary research team, with balanced strengths in ocean, atmosphere and terrestrial processes.

  This was partially achieved in 2008 via the appointment of a key group of academic staff. By the end of 2008 the centre had successfully secured excellent candidates for a level E position in Atmospheric Science (Prof Steven Sherwood)), a Level B/C position specializing in climate impacts (Dr Lisa Alexander), and a level B/C position specializing in physical oceanography (Dr Katrin Meissner). All three are scheduled to commence in 2009. Final appointments were in progress in 2009 and we expect to reach our full contingent of staff in 2010.

- Provide UNSW scientists and academics from various disciplines access to outstanding information on climate science and climate impacts to underpin their research strategies.

  Staff from the CCRC are already providing core climate research expertise to support other groups around campus. This has led to several successful ARC Linkage applications hosted by the Faculty of the Built Environment and the Faculty of Engineering.

- Develop strong collaborative research programs with some of these groups; leading research innovation in some areas and facilitating external leadership in others;

  Links with several groups are developing well. We have links within the Faculty with BEES and MATHS and outside the Faculty with the Faculty of Social Sciences, Faculty of Medicine, Faculty of the Built Environment and the Faculty of Engineering. In 2008, our approach was simply to support research needs as they developed. Demand has grown such that in 2009 we have been careful to be more selective such that we can deliver on commitments in a timely manner.

- Form a platform for the submission of highly-competitive national peer-assessed research grant funding applications, specifically through the Australian Research Council's Discovery and Linkage Project schemes and for the development of proposals for research funding from industry.

  We have clearly developed this platform – demonstrated by successful ARC applications including Fellowships in 2009. We continue to grow this platform with new appointments and internal mentoring of new staff to maximize their likely ARC successes.

- Contribute to the education and training of high-quality postgraduate students in a wide range of relevant disciplines in the science and impacts of climate change, and to provide an outstanding research and learning environment.

  In late 2008 a specialized PhD program in climate science was established (code 1476), in time for new and renewing enrolments from 2009. One new international research student commenced in S2 2008 (Avila). 2009 will see at least six new PhD enrolments.

  We are growing our PhD program in an extremely competitive environment. We have been particularly successful in attracting overseas students and McNeil, England and Pitman have all taken on new students in 2008. We have initiated plans for a revised Advanced Science Undergraduate Program at UNSW to try to grow the cohort of potential and suitably trained graduate students for the long term.

- Attract external research income of $1m in 2008, increasing by at least 10% per annum thereafter;

  The centre attracted approximately $1.2 million in external funding in 2008. Over $1 million of this was category 1 research funding. (See section 5 for details of research income).

- Firmly establish UNSW as the primary research provider on climate change to state government.

  We were working towards this objective through 2008. Early progress was made – Pitman provided the NSW government's climate projections and has received follow-up support to refine these projections. UNSW has been identified as the lead climate science institution for the NSW government in recent planning documents and we will maintain this relationship into the future.

We do not report in detail on our objectives, stated in the Centre proposal, for 2008-2010. This will be provisionally reported in 12 months time. However, our core objectives are being met. We have recruited a suite of outstanding academic staff and postdoctoral researchers who will build strengths that complement existing strengths. We have positioned the CCRC for key funding opportunities including a forthcoming Centre of Excellence round. We did achieve the external research income of $1m in 2008 and will increase this by 10% in 2009. Our 2008 publication performance was extremely strong in terms of the quality of papers (more than 50% in A* journals) and we expect this to be maintained in 2009 with a significantly larger number since we are now near-fully staffed.

The CCRC has also worked hard to increase its national profile. We clearly seek to be the institution of choice for ARC Research Fellow applications, PhD applicants etc. We are now routinely invited to key meetings by CSIRO, the Bureau of Meteorology, the Department of Climate Change and the NSW Department of Environment and Climate Change. We have also attracted several Future Fellow applications and we are working to increase this number.

The Centre had a successful 2008: we were formally established, made a series of significant appointments grew external research income and built a strong and sustainable foundation for research grown.

Staff members of The Climate Change Research Centre 2008

There were no resignations or retirements among full time, permanent academic staff in 2008. Two permanent positions at level B/C were advertised and one at level E. Suitable candidates were found for all three positions and are due to start in 2009. (Sherwood, Alexander & Meissner).

Directors
Prof Matthew England
Prof Andy Pitman

Research Fellows/Academic Staff
Dr Gab Abramowitz (appointed in 2009)
Dr Jason Evans (ARC Australian Research Fellow)
Dr Donna Green
Dr Ben McNeil (ARC QEII Research Fellow)
Dr Alex Sen Gupta

Post Doctoral Research Fellows (research funded)
Dr Olivier Arzel
Dr Laura Ciasto
Dr Frank Drost
Dr Jiafu Mao
Dr Agus Santoso
Dr Willem Sijp (ARC Post Doctoral Fellow)
Dr Andrea Taschetto
Dr Caroline Ummenhofer

PhD Students
Francia Avila
Michael Bates
Faye Cruz
Khalia Hill
Sarah Perkins
Maxwell Serpa Gonzalez
Jessica Trevena
Jan Zika

Support Staff
Penny Ajani (Executive Officer – To October '08)
Stephen Gray (Executive Officer – from December '08)
Sophie Kober (Executive Assistant)

Visiting Fellows
Dr Michael Molitor
Dr Michael Rezny
Dr Frank Drost

Affiliated Staff
CCRC staff have developed collaborations across UNSW and beyond.

Dr Mark Baird
Prof Mike Banner
Dr Gail Box
Dr Phillipe Estrade
A/Prof Dale Dominey-Howes
Dr Peter Blennerhassett
Dr Gary Froyland
Prof Jason Middleton
Mr Russel Morrison
Mr Greg Nippard
Dr Moninya Roughan
Dr Scott Sisson
Dr Milton Speer
Dr Jane McAdam
Prof Frank Muller
Dr Robin Robertson
A/Prof Ashish Sharma
Dr Scott Mooney
A/Prof Michael Box

2008 Selected Staff Profiles: Dr Donna Green

Integrating indigenous and non-indigenous knowledge to understand climate impacts on remote communities

Dr Donna Green was recruited from the CSIRO to be a founding member of the Climate Change Research Centre, where she works on energy policy and climate change impacts. In this position she also leads a programme that uses indigenous and non-indigenous knowledge to understand climate impacts on remote communities in northern Australia. Her research focuses on human-environment interactions, specifically on social and economic vulnerability, adaptation and risk. Donna's current work builds on ten years' experience working in the areas of energy, environment and sustainable development in the Asia-Pacific region. This work involved translating scientific findings into policy, project management and local capacity building. Donna was a contributing author in the *UN World Energy Assessment* and was a contributing author to the 2007 Intergovernmental Panel on Climate Change report, and has won numerous awards for her writing and research. She has taught at the University of California, Berkeley, consulted for the United Nations Development Programme, and advised the Greater London Climate Change initiative.

Major achievements in 2008:

- Led multi-institutional research team to write a scoping study on the climate impacts on remote communities in the tropical north of Australia
- Developed and taught interdisciplinary course on energy policy and climate change
- Presented keynote speech at the American Museum of Natural History, New York City

Major objectives in 2009:

- Publish *Screw Light Bulbs: smarter solutions to tackle climate change*
- Participate in the public debate about Australia's greenhouse gas targets in the run up to the Copenhagen climate meeting
- Further develop research agenda around climate impacts in tropical northern Australia

2008 Selected Staff Profiles: Dr Jason Evans

Regional climate-water interactions

Dr Evans' research is centred around issues in regional climate and water resources. He has a strong background in mathematics and hence much of his research involves development and application of modelling tools. His current research involves questions about the regional impacts of changes in climate - both past and future - and the strength of the interaction between the land surface and atmosphere. His main interests include modelling regional climate, interdisciplinary studies of water resource issues, changing climate impacts on water quantity and changing land use impacts on water.

Dr Evans' main project currently focuses on land-atmosphere interactions in the Murray-Darling Basin. He is attempting to answer questions concerning the effects of land-atmosphere feedbacks on precipitation in the watershed. What is the extent of precipitation recycling in the MDB? Where is the land-atmosphere interaction strongest? Dr. Evans is currently the Chair of the Murray-Darling Basin Hydroclimate Project which is an international project sponsored by the World Climate Research Programme.

Major achievements in 2008:

- Awarded the Australian Agricultural Industries Young Innovators and Scientists Award by the Department of Agriculture, Fisheries and Forestry, Australian Government.
- Became the chair of the Murray-Darling Basin Regional Hydroclimate Project (MDB-RHP). An international project that is an element of the Coordinated Energy and Water Cycle Observations Project (CEOP) which is a project of the Global Energy and Water cycle Experiment (GEWEX). GEWEX is run by the World Climate Research Programme (WCRP);
- Published major papers focused on the water cycle of the Middle East including the regional climate change and the impact of irrigation systems (Evans and Zaitchik, 2008; Evans, 2008).

Major objectives in 2009:

- Investigate the impact of irrigation techniques on the coupled land-atmosphere system in the Murray-Darling Basin;
- Run a workshop to further the activities of the MDB-RHP; Publish further studies that characterize the current understanding of climate change in the Middle East over the coming century.

2008 Selected Staff Profiles: Dr Steven J Phipps

Understanding the links between El Niño and global climate change

El Niño has changed dramatically in the past, with El Niño events becoming stronger and more frequent over the past 8,000 years. By exploring these changes, Steven seeks to understand the links between El Niño and global climate change. The knowledge that we gain will enable us to better anticipate how El Niño might change in future.

Past changes in El Niño are reconstructed using data gathered from sources such as lake sediments and coral reefs. Computer models are then used to simulate the evolution of the climate system. By combining the computer simulations and the historical reconstructions, the physical links between El Niño and the global climate can be studied.

This research has identified natural variations in the Earth's orbit as one of the drivers of changes in El Niño. Changes in the orientation of the Earth's axis over the past 8,000 years have reduced summer insolation over Asia, resulting in a weakening of the Asian monsoon. This has reduced the strength of the easterly trade winds over the Pacific Ocean, making it easier for El Niño events to develop. Future work will seek to identify other links between El Niño and the global climate.

Major achievements in 2008:

- Released a new version of the CSIRO Mk3L climate system model, with an upgraded ocean component.
- Completed a set of "snapshot" simulations of the climate of the past 8,000 years.
- Shown that natural variations in the Earth's orbit can affect the frequency and strength of El Nino events.

Major objectives in 2009:

- Continue to develop the CSIRO Mk3L climate system model as a research tool, and to build a user community.
- Complete a set of transient simulations of the climate of the past 8,000 years
- In collaboration with leading Australian and international researchers, explore the links between El Nino and the global climate system.

2008 Selected Staff Profiles: Dr Alex Sen Gupta

Understanding the links between El Niño and global climate change

Alex uses observations of the climate system together with climate models to help understand natural variability and how things might change in the future. A particular focus is on how the Southern Ocean is likely to change. This is one of the primary regions where CO_2 is sucked out of the atmosphere and stored for long periods in the ocean – mitigating Global Warming. Future changes expected in the Southern Ocean could significantly alter this ability.

One of his recent projects, which brings together a large team of physical, chemical and biological scientists from around the world, is looking at the expected changes to the tropical Pacific over the coming century. This project is investigating how physical changes in temperature, circulation, sea-level rise and ocean acidity, are likely to impact on the regional fisheries and aquaculture. These industries are crucial to the livelihood and food security of Pacific populations. Results indicate significant threats to regional biology without prompt, strong action to limit changes in greenhouse gasses.

Major achievements in 2008:

- Providing a comprehensive description of how the Southern Ocean will respond to Global Warming;
- Identifying new Indian Ocean drivers of long term droughts over south eastern Australia;
- Completing a major assessment of how well our state-of-the-art climate models capture the Southern Hemisphere extratropical climate system.

Major objectives in 2009:

- Understanding the key future changes to the Tropical Pacific Ocean that will affect the region' fisheries;
- Quantifying the effect of different variations of El Nino on the Australian Monsoon System;
- Assesses what factors affect long-term changes in the strength of El Nino events.

2008 Selected Staff Profiles: Dr Caroline Ummenhofer

Climate variability and the Indian Ocean – Australasian region

Caroline Ummenhofer's research focuses on climate variability and change across the Indian Ocean and Australasian region and the links to large-scale ocean and atmospheric modes of variability.

In recent work led by Caroline, the dominant causes of the iconic droughts of the 20th Century in Southeast Australia were identified, including the Federation Drought (1895-1902) and World War II drought (1937-1945), as well as the recent "Big Dry". The cause lies in Indian Ocean variability, rather than Pacific Ocean conditions as traditionally assumed. This work has attracted significant media attention and been profiled widely on TV and on radio nationally, in the US, and Germany. The results also received extensive coverage in print and electronic media, both in Australia and internationally.

Caroline's work on links between rainfall extremes in Southwest Western Australia and Indian Ocean variability has significantly advanced our understanding of the mechanisms driving rainfall in one of Australia's major wheat cropping areas. In 2008, this project was awarded the prestigious Australian Museum *Eureka Land and Water Prize for Water Research and Innovation*. Her work exploits connections between ocean temperatures and rainfall variability in western and southern Australia to advance seasonal rainfall forecasting.

Caroline has applied seasonal rainfall forecasting to real-world problems in the context of improving agricultural management in collaborative work with colleagues at CSIRO Marine and Atmospheric Research. Recent work assessed how well coupled and atmosphere general circulation models represent synoptic weather systems and hence rainfall patterns. This is a cutting-edge area of research, as it largely determines the capability of climate models to adequately project future changes in rainfall, making it a top priority for numerical modelling.

Major achievements in 2008:

- 2008 Land & Water Australia Eureka Prize for Water Research and Innovation;
- Incorporation of characteristic Indian Ocean temperature pattern into the seasonal rainfall outlook issued by the Department of Agriculture and Food in Western Australia;

Major objectives in 2009:

- Identify mechanisms linking Indian Ocean sea surface temperatures and rainfall/drought variability on different time scales;
- Assess the relative importance of key drivers for SE. Australian droughts
- Understand biases in how climate models represent Australian rainfall

Operational Details

Climate change is one of the biggest threats facing humanity, with potentially devastating impacts on world food and water supply, human health, ecosystems, economies, infrastructure and global security. Climate change has become one of the highest priority areas for international research and is among the most significant policy challenges facing global decision makers in the 21st century.

The threats posed by climate change are extensive. These may include more intense cyclones, severe storms, sea-level rise, heat waves, ice sheet collapse, drought, floods, bushfires, dust storms, ice avalanches, run-off in glacial basins, hydrology and water resource stresses, ocean acidification, food supply, shoreline erosion, coastal flooding, marine and terrestrial ecosystems, loss of habitat, extinctions, human health; and threats to sustainable agriculture, forestry, infrastructure, and industry. While public opinion tends to view these as "future" threats, recent work has begun to detect changes in climate and to demonstrate a human-role in these changes. Climate change, in the sense of human-induced climate change, is not merely a "future" problem – it is happening now and it is a "clear and present danger".

In order to develop a strategic approach to UNSW's contribution to climate science and climate change the CCRC was established following an agreement between Professor Les Field, the Deputy Vice Chancellor (Research) and Professor Mike Archer, the Dean of the Faculty of Science. UNSW had a significant capacity in climate science and its associated disciplines – capacity developed over decades principally in Mathematics. However, the evolution of climate science from a Mathematics-based discipline to one requiring Mathematics, Physics, Biology, Chemistry and many other disciplines led to the need for a more coordinated research effort. Thus, the core objective of the CCRC is to bring together existing expertise in climate research at UNSW and to supplement this via strategic appointments.

UNSW, through the CCRC, is a founding member of the University Climate Consortium (UNSW, ANU, Melbourne and Monash). Our role in the UCC is to lead in the area of physical and biophysical climate science. With our partners, our objective is to lead the University effort toward an ARC CoE round. This builds on existing leadership links through the ARC Research Network for Earth System Science that is convened by Professor Andy Pitman. The aim of UNSW, through the CCRC, is to lead a Centre of Excellence proposal in tight collaboration with our partners in the UCC. We are in on-going discussion with other partners to ensure that this is tightly coupled with research institutions that form the research providers for the Australian Climate Change Science Program led from the Department of Climate Change. We also liaise closely with state government to ensure our research is targeting state-based issues where we have capacity.

The CCRC is therefore strongly focussed on providing University leadership in the science of climate change, focussed on Australian problems and working closely with other University and government agency partners. The establishment of the UNSW Climate Change Research Centre ensures UNSW's national and international profile in climate science is growing strongly, and research is undertaken to attach Australian-specific problems. We fully anticipate growing this profile and contribution through 2009 and on-going into the future.

Relationship with the University's areas of teaching/research strength/emerging areas of teaching/research strength

Despite UNSW's existing strengths spread over a number of Schools and Faculties, there is no overall program or structure within UNSW to integrate and coordinate this dispersed capacity in climate change research. The centre and new appointments will see the introduction of the first national undergraduate degree program in the Science, Impacts, and Mitigation of Climate Change. Further, to establish unchallenged national leadership in this area, several key new positions will be filled to round out our existing strengths and to cover important gaps in key strategic areas.

The UNSW Climate Change Research Centre (CCRC) recently compiled summary information about all climate-relevant research activities at UNSW. This information will be used to develop a University-wide profile of expertise in climate change research, from the science and impacts through to vulnerability, adaptation and mitigation. This relates to all aspects of climate change research, from the physical sciences, to biodiversity, the built environment, water, economics, law, etc.

The information was collated to inform the CCRC how it can best engage with the UNSW research community, and how it can best position UNSW research teams for upcoming funding opportunities in climate change research.

At the end of 2008, The UNSW Climate Change Research Centre was comprised of seven full-time core academic staff, seven fixed-term research staff, two support staff and other visitors and associate members. The Centre operates with all core staff, research fellows, and research students co-located in recently renovated space in the former Biomedical Library to enhance cross-disciplinary engagement. Other adjunct and fractional staff have associations with the Centre while maintaining their normal appointments whereas others, in some cases, take on fractional appointments with the CCRC, subject to agreement between the Centre and each participating School/Faculty.

While the core activities of the Centre are research and research student training, staff members also run undergraduate courses in their fields of expertise. A new Bachelor of Advanced Science Climate Science major will be launched in 2009. It will be reviewed and refined throughout 2009 and upgraded to become more rigorous in 2010 with the aim of attracting top students to feed into postgraduate research programs.

Relationship with the University's strategic priorities and goals

Climate change science is an area of UNSW research strength and planned strategic growth. This is underpinned by support from UNSW central via the 2007 Vice Chancellor's Strategic Priorities Funding for the period 2007-2011 (inclusive). Significant additional funding has come from the UNSW Faculty of Science over the same five-year period

The Centre will build UNSW climate change research capacity and research training outcomes at unprecedented levels. The Centre will provide UNSW with national and international prominence in the rapidly expanding area of climate change research. In supporting the growth of an area of recognized research excellence, the establishment of the Centre will address

UNSW's top strategic research priority; namely, to "Attract and retain excellent researchers and promote collaboration through the provision of high quality research facilities".

By targeting growth in postgraduate numbers to an area that has capacity to graduate internationally competitive research students; the Centre will contribute to the improvement of postgraduate research training, including the quality of the postgraduate research experience. The need for advanced graduate training in the climate sciences is rapidly growing – the UNSW CCRC will become one of Australia's largest providers of high-quality postgraduate research degrees in these areas.

Other linkages within and external to UNSW

Government agencies. The UNSW Climate Change Research Centre will serve to integrate the end-users of climate change research into the science of climate change via secondments and linkage projects. For example, policy-makers in areas as diverse as the insurance sector, community health, national parks, agriculture, the energy sector, and tourism are becoming keenly focused on the vital importance of understanding and anticipating climate change. The UNSW Climate Change Research Centre will form partnerships into these sectors to enable analysts in these important "impacts" areas to be seconded and trained in the science of climate change at UNSW. Linkages will be developed and maintained at State and Federal levels.

ARC Network for Earth System Sciences. Pitman convenes and England plays a lead role in the ARC Network for Earth System Sciences as the Oceans Node coordinator. The UNSW Climate Change Research Centre will become the lead institution of this Network and the planned follow-up Centre of Excellence. We are superbly positioned to use the Network strategically to maximize the impact of this centre.

Sydney Institute for Marine Sciences (SIMS). SIMS is a new research/teaching institute focused on changes to the biological and physical attributes of Sydney Harbour and the oceans in general, with an implicit interest in the impacts of climate change although no direct expertise in climate change prediction. SIMS is a joint university initiative (UNSW, Sydney, UTS, and Macquarie) focused in the Sydney region. The UNSW Climate Change Research Centre looks to foster and develop climate change research activities in collaboration with relevant members of SIMS, including providing targeted climate change information and predictions for the marine environment.

Risk management and climate change. The School of Safety Science is dedicated to researching, understanding and teaching risk management, and this should eventually include a major focus on natural disasters including climate change. The UNSW Climate Change Research Centre anticipates building strategic expertise in the analysis of risks and opportunities of climate change. The recent appointment of Dr Dale Dominey-Howes to UNSW, and as an Adjunct to CCRC provides the opportunity to aggressively establish these links.

Evidence of having met the defining characteristic of the centre as listed in Section 3 of the Policy

The Centre has the following characteristics, in the context of Section 3 of the Centres policy.

- Climate science, climate impacts and adaptation research are already an area of research strength but the establishment of the centre enhances this research area significantly. Our research is actively focused across several faculties, but most significantly for UNSW as a whole we would provide the integrated expertise to service demands for climate across all faculties;

- Core Centre staff are primarily science and climate science focussed, however there will be significant interaction/engagement across multiple Schools and/or Faculties. Most notably these include School of BEES, Maths, and Safety Science and the Faculty of Arts and Social Science.

- The centre has critical mass (currently 12 EFT), and the strategic investment by the University has consolidated this core expertise;

- We have a variety of income sources, being already well resourced via ARC Discovery, ARC Linkage and ARC Federation Fellowship schemes. We have facilitated proposals to other funding agencies and intend to maintain this in the future. We plan Centres of Excellence bids, bids through other national centre initiatives and applications to agencies including the Australian Greenhouse Office;

- The Centre has moved into refurbished premises on Level 4 in the old Biomed Library Building, which became ready for occupancy in October 2008. A building and facilities grant of $1.5M was secured in 2007 to fund this refurbishment. We have modest equipment needs; namely, the on-going provision of mid-performance computing at UNSW and on-going access to high performance computing via APAC, AC3 or equivalent. The mid-range computing resources will require investment either through the Faculty Computer Centre or via a bid for equipment funds for the centre.

- The centre operates with its own cost centre and accounts.

Reporting Lines and selection of the director

The Centre reports to the University through the Dean of Science. Representation from the DVC Research will be on the Centre's management committee. This provides an efficient means for routine communication while providing a simple and efficient reporting through the Faculty to the University.

Pitman and England jointly direct the Centre, reporting to the Dean of Science. Joint directorship allows for strategic efficiencies. The two Directors have synergistic skills in research terms, and have worked collaboratively for several years on a number of national climate science initiatives. Co-directorship from this team offers the Centre the greatest opportunity to flourish. England and Pitman also have regular travel commitments domestically and internationally. Thus, in terms of day-to-day operations, co-directorship enables them to cover this role with a regular presence at UNSW, while not curtailing their research capacity.

Role and contribution of the centre director to the centre

The Directors are responsible for the strategic leadership of the centre and its integration with key research providers within the University. They are responsible for direction, engagement of the staff in this direction and the encouragement of staff to work towards our vision, as well as for oversight of Centre operations and finances.

A key role is leadership in establishing, growing and maintaining the centre. The directors will position the centre for bids for major external funding. They will also jointly performance manage junior staff and mentor them in research excellence. Identifying opportunities for staff, encouraging them to seize opportunities for collaboration, travel, and funding will be key roles for both directors.

Operation of the Centre

After significant discussions over the 12 months leading up to the Centre's launch, a suite of positives and negatives were raised in respect of how the Climate Change Research Centre would link into the Faculty. All stakeholders concluded that we should be a stand-alone unit with on-going links with many schools but most strategically with BEES and Maths. The Centre does not want to be a separate School.

Through 2008 the CCRC reported directly to the Dean, on all matters relating to research, Centre strategy, staffing and funding.

All income and research quantum from ARC grants, Centres funding, consultancies, publications and other research income was expected to flow directly to the CCRC from the Faculty. This has not yet occurred and represents a significant threat to the performance of the centre. We are in on-going negotiations to implement the agreements foreshadowed in the Centre proposal.

Other than the financial returns from research quantum, the CCRC is being implemented and operated according to the Centre Proposal. We are maintaining on-going discussions with many Schools – but in particular BEES and Mathematics – to build stronger and more sustainable interactions. We are teaching in both Schools to support their programs, to give our staff experience and interaction with undergraduate students and to build the potential future graduate student base.

We have not yet held a CCRC board meeting with external membership – this was planned for mid 2009 but the changes in Dean, the uncertainty around the Faculty Review and the enormous commitment of Heads of School to the Faculty Review led this to be postponed. We aim to hold two management board meetings in 2009.

Financial Report 2008

Finances

$6 million has been earmarked to fund the centre during its first five years of operation. At the end of the initial five year period, it aims to be as close as possible to self-sufficient through research, HDR and teaching income streams. The initial $6mil allocation is comprised of $4mil from the VC's Strategic Priorities Fund and a further $2mil contribution from the Faculty of Science.

Strategic priorities funding and Faculty contributions towards the centre commenced in 2007 at which point in time most of the core staff of the centre were either still situated in the School of Mathematics and Statistics or yet to be recruited. The CCRC became its own cost centre in October 2008. Due to time taken in recruiting and appointing a full suite of staff, spending of the UNSW allocation in the first two years has been relatively modest meaning that there have been significant sums carried forward from one year to the next. This trend isn't likely to continue from 2009.

	2008
Income	
External Funds*	$1,275,653
UNSW Contribution#	$1,009,131
Total Income	**$2,284,784**
Expenses	
Payroll	$1,671,571
Equipment	$135,805
Materials	$194,880
Travel	$254,011
Total Expenses	$2,256,266
Operating Result	$28,518
Surplus brought forward from previous year^	$1,537,950
Accumulated Funds Surplus	**$1,566,468**

Notes to the Statement of Financial Performance

** 2008 External funds comprised of $1.11mil in category 1 research income*
 # 2008 UNSW income comprised of Strategic priorities funding ($290K), Faculty contribution ($400K) and UNSW contribution to England's Federation Fellowship Support Project ($300K)
^ Surplus is comprised of funds that were previously administered by the School of Mathematics and Statistics. This is made up of rolled over research funds belonging to staff now formally associated with the CCRC as well as strategic and faculty funding that was allocated from 2007 onwards.

Contributions to the centre

The Climate Change Research Centre was established on the promise of $6 million of funding from UNSW over the first five years of its operation. $4 million is to come from the Vice Chancellor's Strategic Priorities fund and $2 million from the Faculty of Science. In addition to this, from 2009 UG teaching income will start to flow to the Centre with Research Quantum earnings being passed on to the Centre from 2010.

Apart from receiving over $1.2 million in competitive research funding (see details appendix 1), the centre has received:

- $90,000 for climate change research from the Bluesand Foundation, via the UNSW Foundation. This sum is being put to use to contribute to the costs associated with Dr Steven Phipps' work in Palaeo-Climate simulations.

- Dr Ben McNeil secured a grant of $145,000 from the Live Earth organisation to be paid in 2009 to enable the compilation and production of "The Copenhagen Diagnosis", a landmark report to be presented during the next major round of UNFCCC talks in Copenhagen, December 2009. The report gathers together input and contributions from over 20 of the world's preeminent climate scientists and will present to world political and business leader the latest advances in climate science research since IPCC AR4 in clear and concise terms.

- A new prize for honours or 3rd year undergraduate students was established thanks to a $5000 donation from Silicon Graphics Inc – a company which specialises in high performance computing.

Community Engagement, Talks and Lectures

Launch of Climate Talk – Public Lecture Series

In April, 2008, the CCRC had its inaugural Climate Talk, public lecture. Michael Molitor, founder of CarbonShift Ltd and senior carbon advisor to PricewaterhouseCoopers, gave a presentation titled: *Climate Change - Show me the money*? to an audience of over 500 people at the Science Theatre, UNSW.

The talk highlighted the fact that to stabilise concentrations of greenhouse gases in the atmosphere at safe levels by 2050, we would need to avoid more than 600 billion tonnes in expected carbon emissions. This represents not only a massive cost but also an unprecedented opportunity for forward thinking industries. Michael showed that many of the leading companies are already investing in low carbon solutions. And presented an analysis of how much money would be needed and where that money would come from to achieve these ambitious goals.

The CCRC aims to present at least one major Climate Talk seminar each year, to supplement the numerous technical talks hosted by the CCRC.

Hosting of Minister Peter Garrett - local 2020 summit at UNSW

UNSW academics co-chaired a local 2020 summit on campus on Saturday April 5, 2008 with Minister for the Environment, Heritage and the Arts, Peter Garrett. The local summit was a prelude to the Australia 2020 Summit established by Prime Minister Kevin Rudd MP to ready Australia for the challenges of the 21st century.

Local summits were held around the country to inform the national summit to be held at Parliament House, Canberra, on 19 and 20 April. The local summit at UNSW was organised by Minister Garrett's office. It included 50 constituents, organizations and community groups from the federal seat of Kingsford Smith.

The morning session – Towards a Creative Society – was co-chaired by Minister Garrett and UNSW Professor Ian Howard, Dean, College of Fine Arts. The afternoon session – A National Approach to Environmental Sustainability – was co-chaired by The Minister and Professor Matthew England, co-director, Climate Change Research Centre.

CCRC in the news

Media monitoring shows that the CCRC had a significant presence in the media with over 45 media stories in 2008. Work was covered in local and international media, online, print and radio. Media outlet's include *The Age, Sydney drive time, Triple J, Channel 7's Today Tonight, Channel 10, The Australian, Torres News, Fiji Times, The Brisbane Times, The Sydney Morning Herald, Cosmos, News.Com, The West Australian, The Tech Herald (USA), The Telegraph (UK), Reuters India, Blast (Boston, USA), MSBNC (USA) and Environment Research Web (UK).* See Appendix 3 for details.

2008 External CCRC Talks

Abramowitz, G., 'Model independence and the representation of model space as a source of uncertainty', CSIRO Marine and Atmospheric Research model evaluation group in Melbourne, March 2008.

Abramowitz, G., 'Using Fluxnet data to evaluate land surface models', Ray Leuning and Gab Abramowitz, at the Fluxnet - Land surface modelling workshop in Edinburgh, 4-6 June 2008.

Abramowitz, G., 'A sub-gridcell heterogeneity parametrisation for the Community Atmosphere Biosphere Land Exchange model (CABLE)', CSIRO Marine and Atmospheric Research, April 2008.

Arzel, O.; England, M. H.; Sijp, W. P., 2008: Wind-stress feedback stabilization of thermohaline circulation modes without North Atlantic Deep Water formation during glacial times, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Drost, F. and M.H. England, 2008: Twentieth century trends in moisture advection over Australia. 15th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Geelong, Australia.

Drost, F and England, M. H., 2008: On the spatial pattern of the Southern Annular Mode, 8th Annual Meeting of the European Meteorological Society / 7th European Conference on Applied Climatology (ECAC), Amsterdam, The Netherlands.

England, M. H., 2008: The ocean's role in climate variability and climate change, Australia and New Zealand Industrial and Applied Mathematics (ANZIAM) Annual Congress, Katoomba, Australia.

England, M. H., 2008: Impacts of global climate change on emergency management in Australia, APCO Australasia Conference, Gold Coast, Australia.

England, M.H., C.C. Ummenhofer and A. Sen Gupta, 2008: Contribution of Indian Ocean SST to regional rainfall variability – mechanisms and implications for forecasting, Asia-Pacific Climate System, AOGS2008 Busan, South Korea. (Invited)

England, M.H., C.C. Ummenhofer and A. Sen Gupta, 2008: Indian Ocean SST forcing of regional rainfall variability: mechanisms and predictability, Western Pacific AGU meeting, Cairns, Australia. (Invited)

England, M.H., 2008: The Oceans and Climate Change, Western Pacific AGU meeting, Cairns, Australia. Invited Plenary Keynote

England, M.H., and W.P. Sijp: Southern Hemisphere westerly wind control over the ocean's thermohaline circulation, Western Pacific AGU meeting, Cairns, Australia. (Invited)

England, M.H., and W.P. Sijp, 2008: Southern Hemisphere westerly wind control over the ocean's thermohaline circulation. Effects of Climate Change on the World's Oceans Symposium, Gijon, Spain.

England, M.H., 2008: Improving predictions of Australian rainfall extremes using Indian Ocean surface temperatures, Australian Research Council Graeme Clark Research Forum, Parliament House, Canberra, Australia. (Invited)

England, M.H., 2008: The Oceans and Climate Change, Australian Institute of Physics (AIP) Annual Congress, Adelaide, Australia. Invited

England, M.H., and W.P. Sijp, 2008: Southern Hemisphere westerly wind control over the ocean's thermohaline circulation, American Geophysical Union (AGU) Fall meeting, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS11E-02. Invited

England, M.H., C.C. Ummenhofer and A. Sen Gupta, 2008: Indian Ocean SST forcing of regional rainfall variability: mechanisms and predictability", American Geophysical Union (AGU) Fall meeting, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract OS23B-1267.

Evans, J. P., 'Modeling the large-scale water balance impact of different irrigation systems'. Goddard Space Flight Center, Greenbelt, Maryland, USA. 12th November, 2008.

Evans, J. P., 'Science of Climate' in Peak Carbon: climate change and energy policy (HPSC 2750 / ENVP 2002), 31 July 2008.

Evans, J. P., 'Climate Change in Sustainable energy (SOLA 1070), 26 August 2008.

Gonzales, M.S., and M.H. England, 2008: Antarctic Bottom Water variability in the IPCC AR4 climate models. 15th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Geelong, Australia

Green, D., 'Climate impacts in remote communities in Northern Australia' Centre for Aboriginal Economic Policy and Research 15th Oct 2008.

Green, D., Traditional Knowledge recording in the Torres Strait. Torres Strait Regional Authority Board meeting 25-26th Sept 2008.

Green, D., 'Arnhem Land and climate change, what do you need to know?'. Garma main forum presentation, Arnhem Land, NT, August, 2008.

Green, D., Commentary on 'China and the World: How Global Warming Changes the Equation.' Panel discussion with O. Schell, First UNSW Global Leaders Lecture Series, UNSW, 8th May 2008.

Green, D., 'Climate impacts on workshop presentation on Mer Island, Warraber Island, Masig Island, Saibai Island, Boigu Island' in the Torres Strait, April 2008

McNeil, B. I., Investec, 9th Annual Emissions Trading Forum, Sydney, June 7th, 2008. (Investec)

McNeil, B. I., Inner-West Climate Change Forum with Penny Wong, Public Town Hall. Sydney, 6th August, 2008.

McNeil, B. I., University of Queensland and Brisbane City Council, BriScience Keynote. Brisbane,1 December, 2008.

McNeil, B. I., Nature Conservation Council, Keynote speaker at 'Saving a Sunburnt Country'.Sydney,12 November, 2008.

McNeil, B. I., Nature Conservation Council, Walk Against Warming Speech. Sydney, 15 November, 2008.

Pitman, A. J., Keynote Address to the Sydney Region Youth Environment Network conference; Youth environment network, Sydney Annual Conference, climate change, the power shift. September, 2008

Pitman, A. J., Key note address to the Sydney Law Society Public Forums on Climate Change. May, 2008.

Pitman, A. J., Plenary address to the Sydney University conference: *Facing climate change: Research on adaptation of agro-ecosystems*, June 2008.

Pitman, A. J., Talk on Climate Change to the Office of Strategic Operations, Department of Premier and Cabinet, April, 2008.

Pitman, A. J., Talk to State Emergency Management Committee, March, 2008.

Pitman, A. J., 'Climate Change Science – just how complicated is it?' NSW Public Health Director's Forum. May, 2008.

Pitman, A. J., Talk to the Local government climate change mitigation program - Climate Change – action for everyone. *A strategic look at how climate change affects council operations,* May, 2008.

Pitman, A. J., 'Climate change projections for Australia - changes in extremes more likely to matter to flora and fauna'. Talk to the Nature Conservation Council. November, 2008.

Pitman, A. J., Talk to the International Geosphere Biosphere Congress, Cape Town. Experience from PILPS - evaluating land surface models at points, regions, global and coupled. May, 2008.

Pitman, A. J., Talk to Hornsby Shire Council as part of its Eco Month "The basics of climate change science and the forecasted impacts for our region". May, 2008.

Pitman, A. J., CAHMDA talk, University of Melbourne. January, 2008.

Pitman, A. J., Recent progress on estimating the impact of global warming on regional Australia: from means to probabilities. Ballina Council Climate Change Forum, March, 2008

Pitman, A. J., Talk on Climate Change to Asquith Girls High School, June, 2008

Santoso, A. and England, M. H., 2008: Natural variability of Antarctic Bottom Water in a coupled climate model, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Santoso, A. and M.H. England,, 2008: Heat budget of the Indian Ocean mixed layer. 15th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Geelong, Australia.

Sen Gupta, A., A. Santoso, A. S. Taschetto, C. C. Ummenhofer, J. Trevena and M. H. England, 2008: Present-day simulation of, and future changes to, the Southern Hemisphere extratropical ocean and sea-ice in the CMIP3 coupled climate models. Western Pacific AGU Meeting. Cairns, Australia.

Sen Gupta, A., A. Santoso, A. S. Taschetto, C. C. Ummenhofer and M. H. England, 2008: Fidelity in the present-day simulation and projected changes to the Southern Hemisphere extratropical ocean and sea-ice system in the AR4 coupled climate models. Effects of Climate Change on the World's Oceans Symposium, Gijon, Spain.

Sijp, W.P., England, M.H., 2008: The effect of a northward shift in the Southern Hemisphere westerlies on the global ocean, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Sijp, W.P., and M.H. England, 2008: Isopycnal mixing controls NADW stability in ocean models, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Sijp, W.P., and England, M.H., 2008: Eocene warmth, Drake Passage and the hydrological cycle, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Sijp, W.P., and M.H. England, 2008: Effect of ocean gateway changes under past equable warm climates, American Geophysical Union (AGU) Fall meeting, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract PP33C-1586.

Taschetto, A.S. and M.H. England, 2008: Investigating the late 20th century trends in Australian rainfall. 15th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Geelong, Australia.

Taschetto, A., 'Tropical Australian rainfall trend and its modulation by Pacific sea surface temperature anomalies'. Western Pacific Geophysics Meeting. Cairns, Australia, July, 2008.

Taschetto, A., 'Investigating rainfall trends in Australia'. 15th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Geelong, Australia, January, 2008.

Taschetto, A. S.; England, M. H., 2008: Precipitation variability due to Indian Ocean SST anomalies, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Treguier, A-M., **M. H. England**, S.R. Rintoul, G. Madec, J. Le Sommer and J-M. Molines, 2008: Variability of the meridional circulation of the Southern Ocean: the role of eddy fluxes, AGU Ocean Sciences meeting, Orlando, US.

Trevena, J, Sijp, W. P. and England, M. H., 2008: Stability of Antarctic Bottom Water formation to freshwater fluxes and implications for global climate, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Trevena, J, Sijp, W. P. and England, M. H., 2008: North Atlantic deep water collapse triggered by a Southern Ocean meltwater pulse in a glacial climate state, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Ummenhofer, C. C., 'How local Indian Ocean sea surface temperatures modulate enhanced East African rainfall'. Poster presentation at 7th International NCCR Climate Summer School, Ticino, Switzerland. 3 September, 2008.

Ummenhofer, C. C., 'Australian rainfall patterns linked to Indian Ocean variability - Mechanisms and implications for seasonal forecasting'. Seminar at the NSW Department of Primary Industry, Sydney, Australia, 31 July, 2008.

Ummenhofer, C. C., 'Contribution of Indian Ocean SST to regional rainfall variability - Mechanisms and implications for forecasting', Oral presentation at AOGS2008, Busan, Korea, 20 June, 2008.

Ummenhofer, C. C., 'SST gradients and other 'dipoles' - improving understanding of physical mechanisms through numerical models', oral presentation at workshop on Australian Climate Drivers, Geelong, Australia Feb. 01, 2008.

Ummenhofer, C. C., 'Anomalous rainfall over southwest Western Australia forced by Indian Ocean SST - Mechanisms and forecasting skill', oral presentation at the 15th National Australian Meteorological and Oceanographic Society Conference, Geelong, Australia, 29 January, 2008.

Ummenhofer, C. C.; Sen Gupta, A.; England, M.H., 2008: Contributions of local and large-scale Indian Ocean sea surface temperatures to enhanced East African rainfall, European Geosciences Union (EGU) General Assembly, Vienna, Austria.

Ummenhofer, C. C, Sen Gupta, A , England, M H, 2008: The Role of Indian Ocean SST Anomalies in Modulating Regional Rainfall Variability and Long-term Change, American Geophysical Union (AGU) Fall meeting, Eos Trans. AGU, 89(53), Fall Meet. Suppl., Abstract GC43A-0714.

Appendix 1
Selection of Grants Funded in 2008

Obtaining external research funding will be a high priority for the centre to grow the group and further the reputation of UNSW climate change research. Typical avenues of funding are through the Australian Research Council (ARC), but other funding streams may become available through the Australian Greenhouse Office and the NSW Greenhouse Office. Academics at the CCRC will seek external funding to recruit postdoctoral research talent that can build teams within core areas of expertise. The current group has been particularly successful in obtaining ARC funding via the Discovery, Linkage, Network, and Federation Fellowship schemes. By the fifth year of the centre, it is projected that external research funds will be between $2million and $5million.

Snapshots of some of the CCRC's active research projects in 2008:

2005 ARC Federation Fellowship Prof MH England
Genesis of Australian Climate Extremes in the Southern Hemisphere Extra-tropical Ocean-Atmosphere
Investigating Australia's vulnerability to climate extremes in order to better understand extra-tropical variability and its unique role in extremes and predictability of climate and climate change. In the context of limited knowledge of extra-tropical variability and climate change, the project will use innovative applications of climate system models in conjunction with available observations to quantify extra-tropical ocean atmosphere variability and change, discover how this impacts on Australian climate and weather and calculate the associated predictability of extreme climate. Harsh droughts, severe bushfire seasons, climate change, soil loss and salinity all pose enormous socio-economic challenges for Australia over the next 50 years. Research into climate variability, extremes and predictability will underpin efforts to protect our biodiversity and ensure environmental sustainability. This project will have significant benefits for many sectors of society reliant on inter-seasonal and inter-annual climate prediction

DP0881798 Prof MH England; Dr WP Sijp
Coupled ocean-carbon-atmosphere feedbacks in the global climate system
2008 : $ 145,000
2009 : $ 135,000
2010 : $ 135,000
Primary RFCD 2604 OCEANOGRAPHY
The capacity of the oceans to absorb and store carbon fundamentally regulates atmospheric CO_2 concentrations. Climate change is altering the flux of carbon between the ocean and atmosphere, and may reduce the capacity of the oceans to store carbon. Research into climate change and the global ocean carbon cycle is of high national significance, and will underpin efforts to protect our biodiversity and ensure Australia's environmental sustainability. We propose a major new study of the nature of coupled ocean-carbon-atmosphere feedbacks operating in the global climate system. This work will quantify how the ocean's carbon storage capacity might shift in the future, guiding policy-makers in setting future CO_2 emissions targets.

DP0880815 Dr BI McNeil
An Investigation into Oceanic CO_2 Variability and its Influence on Atmospheric CO_2 Concentrations
2008 : $ 129,806
2009 : $ 123,806
2010 : $ 123,806
2011 : $ 120,000
2012 : $ 120,000
Primary RFCD 2604 OCEANOGRAPHY
QEII Dr BI McNeil
Carbon dioxide is a powerful greenhouse gas whose observed atmospheric increase is the central cause of climate change. The associated environmental, social and economic impacts to Australia could be staggering via coral reef degradation, loss of agricultural production, coastal erosion and extreme climate events. This work aims to better our understanding of how the oceans may mediate the effects of climate change for Australia and therefore has a strong national benefit. Quantifying the importance Australia's oceanic CO_2 sink will be important for Australian policy makers within international climate negotiations and also for better management practices to ensure the future prosperity of Australia's coral reef ecosystem.

DP0772665 (ARF) Dr JP Evans
Approved Vulnerability of the Murray-Darling basin hydrometeorology to human modification
2007 : $143,000
2008 : $140,000
2009 : $125,000
2010 : $125,000
2011 : $125,000
Primary RFCD 2605 HYDROLOGY
ARF Dr JP Evans (Initially awarded at Macquarie University)
The Murray-Darling Basin (MDB) provides 40 per cent of Australia's agricultural production. Some 1,500,00 hectares use irrigation for agriculture and year-to-year variations in productivity highlights a basin that is vulnerable to changes resulting from human activity. This proposal builds an integrated modelling system of the MDB to understand its hydrology and meteorology in the context of human modification to climate and to land use in the basin. The improved understanding of the MDB will allow science-aware policy developments that reduce the vulnerability of agriculture and water resources within the basin to future changes caused through human activity.

DP0772938 (APD) Dr WP Sijp
What controls the shift from a hot house climate to a cold house climate: the Eocene/ Oligocene climate transition and greenhouse warming
2007 : $81,030
2008 : $81,030
2009 : $81,030
Primary RFCD 2606 ATMOSPHERIC SCIENCES
This study contributes to putting Australia on the map as a centre of excellence in the study of past climates as well as in global warming research. It aims at a greater understanding of the dynamics of past warm climate states. This could ultimately lead to a better knowledge of the

formation of the ancient deposits that we mine in Australia today. Furthermore, the study of these past warm climates tells us something about current global warming as both involve increased levels of carbon in the atmosphere. The impact of climate change on Australia is likely to be large. Our study of past warm climates helps to gain an understanding of the mechanisms behind climate change and help quantify the risks of climate change posed to Australia.

DP0667075 A/Prof MH England; Dr A Müller
Abrupt Southern Hemisphere Climate Change: The Role Of The Southern Ocean Thermohaline Circulation
2006 : $85,000
2007 : $90,000
2008 : $95,000
Primary RFCD 2606 ATMOSPHERIC SCIENCES
Australia's climate is extreme, with harsh droughts, severe bushfire seasons, climate change, soil loss, and salinity all posing potentially enormous socio-economic challenges over the next ten-fifty years. Research into climate change and climate variability is thus highly significant for Australia, and will underpin efforts to protect our biodiversity and ensure the nation's environmental sustainability. We propose to launch a major new study of the stability of the Southern Ocean's thermohaline circulation and its role in global climate. This work could have significant long-term benefits for those sectors of society sensitive to shifts in climate; including agriculture, energy, freshwater supply, health, and tourism.

DP0881798 Prof MH England; Dr WP Sijp
Approved Coupled ocean-carbon-atmosphere feedbacks in the global climate system Project Title
2008 : $ 145,000
2009 : $ 135,000
2010 : $ 135,000
Primary RFCD 2604 OCEANOGRAPHY
The capacity of the oceans to absorb and store carbon fundamentally regulates atmospheric CO_2 concentrations. Climate change is altering the flux of carbon between the ocean and atmosphere, and may reduce the capacity of the oceans to store carbon. Research into climate change and the global ocean carbon cycle is of high national significance, and will underpin efforts to protect our biodiversity and ensure Australia's environmental sustainability. We propose a major new study of the nature of coupled ocean-carbon-atmosphere feedbacks operating in the global climate system. This work will quantify how the ocean's carbon storage capacity might shift in the future, guiding policy-makers in setting future CO_2 emissions targets.

LP0774996 Prof AJ Pitman; Dr J Beringer; Prof W Steffen; Dr G Richards; Dr Y Wang
Reengineering a dynamic vegetation model to explore the stability of Australian terrestrial carbon
2007 : $ 57,883
2008 : $ 63,856
2009 : $ 70,182
Primary RFCD 2606 ATMOSPHERIC SCIENCES
Australian Greenhouse Office

Collaborating/Partner Organisation(s)
Macquarie University
Overseas models do not represent Australian biophysical processes well: our flora and fauna are unique and our soils are old and nutrient poor. In contrast, the National Carbon Accounting System (NCAS) is a world-class framework for estimating current carbon processes. By building NCAS expertise into an overseas model of soil and vegetation processes we can develop the capacity to increase our confidence in future projections of carbon and vegetation change. Our proposal, linking Universities, CSIRO and the Australian Greenhouse Office establishes a team that is internationally competitive. It will enhance local expertise and local model development to ensure national policy development is underpinned by world-class science.

(Total 2008 research income: $1,275,653)

Appendix 2
2008 publications

Abramowitz, G. and H. Gupta (2008). *Toward a model space and model independence metric*. Geophysical Research Letters, 35, L05705, doi:10.1029/2007GL032834.

Abramowitz, G., R. Leuning, M. Clark and **A. Pitman** (2008). *Evaluating the performance of land surface models*. Journal of Climate. 21, 5468-5481, doi:10.1175/2008JCLI2378.1

Aiken, C.M., and **M.H. England,** (2008). *Sensitivity of the present-day climate to freshwater forcing associated with Antarctic sea-ice loss. J. Climate*, **21**, 3936-3946.

Arzel, O., T. Fichefet, H. Goosse and J. L. Dufresne (2008). *Causes and impacts of changes in the Arctic freshwater budget during the 20th and 21st centuries in an AOGCM*. Climate Dynamics, doi:10.1007/s00382-007-0258-5.

Arzel, O., M. H. England and W. P. Sijp (2008). *Reduced stability of the Atlantic Meridional Overturning Circulation due to wind-stress feedback during glacial times*, Journal of Climate, **21**, 6260-6282

Drost, F. and **M. H. England**, (2008). *Twentieth century trends in moisture advection over Australia*. Met. Atmos. Physics, **100**, 243-256.

England, M.H., (2008). *Water mass variability and change in the Southern Ocean*, Trans. Roy. Soc. Vic., **120 (2)**, i-iv.

Evans, J. P., and B. F. Zaitchik (2008). *Modelling the large-scale water balance impact of different irrigation systems*, Water Resour. Res., 44, W08448, doi:10.1029/2007WR006671.

Green, D., (2008). *Climate Change and Health: Impacts on Remote Indigenous Communities in Northern Australia'* in Climate Change and Human Health: Global Perspectives (Icfai University Press**:** India).

Green, D., (2008). **'***Opal waters, rising seas: climate impacts on Indigenous Australians'* in Anthropology and Global Climate Change: From Encounters to Actions, edited by Susan A. Crate and Mark Nuttall (Left Coast Press :US)

McNeil, B. I., R. J. Matear (2008). *Southern ocean Acidification: A tipping point at 450ppm Atmospheric CO_2*. Proceedings of the National Academy of Sciences in the USA, doi:10.1073/pnas.0806318105.

McNeil, B. I (2008). *Global ecology and importance of oceans and coasts.* In Ecological Economics of the Oceans and Coasts. Edited by M. Patterson and E. Elgar, NZ.

Beaumont, L.J., L. Hughes, **A.J. Pitman**, (2008). *Why is the choice of future climate scenarios for species distribution modelling important?*. Ecology Letters, 11 1135-1146, 10.1111/j.1461-0248.2008.01231.x.

Moles A. T., Wright I.J., **Pitman A.J**., Murray, B. R. and Westoby, M., 2008, *Is there a latitudinal gradient in seed productio*n?, Ecography, 32, 78-82 10.1111/j.2008.0906-7590.05613.x.

Pitman, A.J. and **Perkins, S.E.** (2008) *Regional projections of future seasonal and annual changes in rainfall and temperature over Australia based on skill-selected AR4 models.* Earth Interactions, 12, Pape No. 12, 1-50, doi: 10.1175/2008EI260.1

Taschetto, A. S. and **M. H England** (2008). *An analysis of late 20th Century trends in Australian rainfall*. International Journal of Climatology, doi:10.1002/joc.1736.

Taschetto, A. S. and **M. H England** (2008). *Estimating ensemble size requirements of AGCM simulations*. Meteorology and Atmospheric Physics, 100 (1-4) : 23-36, doi : 10.1007/s00703-008-0293-8.

Taschetto, A. S. and I. Wainer (2008). *Reproducibility of South America precipitation due to Subtropical South Atlantic SSTs*. Journal of Climate, 21 (12): 2835-2851

Taschetto, A.S and I. Wainer (2008). *The impact of subtropical South Atlantic SST on South American precipitation.* Annales Geophysicae, 26(11) : 3457-3476.

Wainer, I. and **A.S Taschetto** (2008). *Climatologia dos parametros de superficie marinha da regiao sudeste da costa brasileira: enfase na regiao de Sao Sebastiao*. In: Oceanografia de um Ecossistema Subtropical: Platforma de Sao Sebastiao, SP, p.41-58. Ed.: A. M. S. P. Vanin. EDUSP.

Tong, S. J. Mackenzie, **A. J. Pitman**, G. Fitzgerald, N. Nicholls and L Selvey. (2008) *Global climate change: time to mainstream health risks and their prevention on the medical research and policy agenda*. Internal Medicine Journal, 38 (6a), 445-447 doi:10.1111/j.1445-5994.2008.01688.x

Trevena, J., W. P. Sijp, and M. H. England (2008). *North Atlantic Deep Water Collapse triggered by a Southern Ocean meltwater pulse in a glacial climate state*, Geophys. Res. Lett., **35**, L09704, doi:10.1029/2008GL033236.

Trevena, J., W.P. Sijp, and M. H. England (2008). *Stability of Antarctic Bottom Water formation to freshwater fluxes and implications for global climate*, J. Climate, **21**, 3310-3326.

Santoso, A. and M. H. England (2008). *Antarctic bottom water variability in a coupled climate model*. Journal of Physical Oceanography, 38, 1870-1893.

Sijp, W. P. and M. H. England (2008). *The effect of a northward shift in the Southern Hemisphere westerlies on the global ocean*, Progr. Oceanogr., **79**, 1-19.

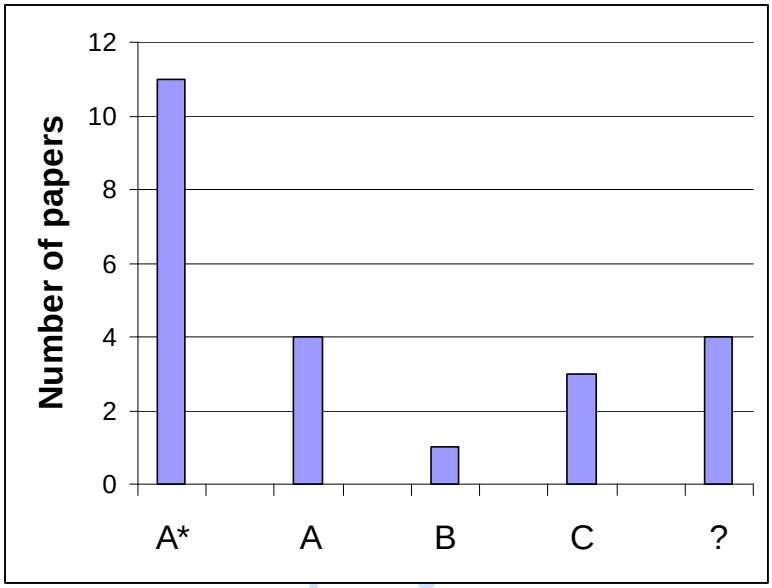
Speer, M.S (2008). *On the Late Twentieth Century Decrease in east coast* Australian Rainfall Extreme. Atmospheric Science Letters, **9**, 160-170.

Zika, J. D. and T. J. McDougall (2008*). Vertical and lateral mixing processes deduced from the Mediterranean water signature in the North Atlantic.* Journal of Physical Oceanography, **38**, 164-176.

Ummenhofer, C. C., A. Sen Gupta, M. J. Pook and **M. H. England** (2008). *Anomalous rainfall over southwest Western Australia forced by Indian Ocean sea surface temperatures.* Journal of Climate, **21**, 5113-5134.

Analysis of Publications (2008)

The CCRC was in a transition year in 2008. A suite of publications included bi-lines to other units or to other Universities for newly appointed Staff. Through 2008, the CCRC had 5.67 academic staff. The Centre produced 23 publications in 2008, primarily in elite international journals. The Australian Research Council now provides a ranking of journals and based on this ranking 50% of all papers were in A* journals.



An important part of this analysis is the final bar. There were 4 papers not classified by the Australian Research Council – these were Water Resources Research, Ecology Letters, Ecography and Internal Medicine Journal. The first three of these are likely A* journals in hydrology and ecology once those communities agree a ranking. At present, there is a penalty for multidisciplinary research – a limitation of the assessment process which will be resolved in time.

Overall therefore, in terms of journal papers, the CCRC produced over 4 journal papers per staff member. Given most staff were new appointments, or had re-located from other institutions; this is a strong early performance. However, the *quality* of the journals the CCRC's work was published in is clearly of the highest ranking.

Appendix 3 Media Coverage

22 February, 2008. Sydney Drivetime 2GB (Sydney). Dr Donna Green.

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