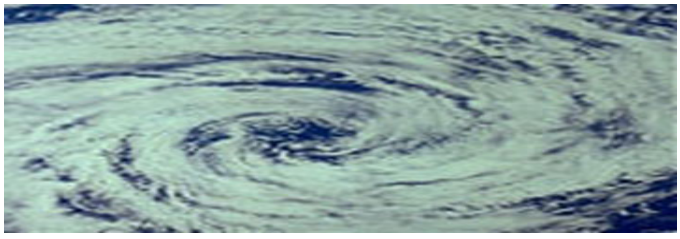


Climate Change Research Centre

Annual Report 2010



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The Climate Change Research Centre (CCRC) achieved one of its most high level strategic goals in 2009; the leading and winning of an Australian Research Council Centre of Excellence. This new Centre of Excellence, funded from 2011 firmly establishes UNSW as the national leader in Climate System Science and provides an outstanding outcome for the University. The Director and three CCRC Chief Investigators form the core of UNSW's research leadership in this centre, alongside many Associate Investigators from across UNSW, the largest contribution from any University. The efforts by staff in the CCRC (particularly Stephen Gray, Simone Purdon and Joanne York), the University's research strategy office, the office of the Deputy Vice Chancellor Research and the office of the Dean within the Faculty of Science were fundamental to this success.

However, the winning of the Centre of Excellence is one of many achievements in 2010. The winning of an ARC Laureate by Professor Matthew England was one achievement we celebrated. The winning of the International Justice Prize for the *Copenhagen Diagnosis* helped internationalize the CCRC as has the subsequent decision by Elsevier to publish this as a book. This was not the only book for the CCRC; Donna Green's *Screw light bulbs: Smarter ways save Australian's time and money"* was co-authored by Liz Minchin and has been very well reviewed nationally. Dr Katrin Meissner's successful ARC Future Fellowship highlighted the CCRC's breadth and expertise in palaeoclimate research, reinforced with the recent award of an ARC Laureate to Chris Turney. An increasing percentage of CCRC publications in elite (A* and A-rated journals) provide the foundation for the CCRC's national and international reputation as an elite research centre.

The CCRC continues to grow from strength to strength in terms of quality of publications, quantity of ARC funding successes, awards and international profile. Examples of these are provided through this report. While the Centre of Excellence will naturally provide a major focus for the climate system science research within the CCRC for the next seven years, the continuing successes in other areas of climate research including palaeoclimate, climate impacts, climate policy and decision-support provide us with an explosion of opportunities. We will report on those opportunities we strategically pursued through this year in the next annual report.

Finally, with the awarding of the ARC Centre of Excellence, the CCRC joint Directorship team of Pitman-England has formally ended. The Centre looks forward to continuing success under the new joint Directors Steve Sherwood and Matthew England, who will work closely with the Centre of Excellence Director Andy Pitman to ensure UNSW stays at the forefront of climate science research.

Professor Matthew England

Professor Andy Pitman

Climate Change Research Centre
Faculty of Science
The University of New South Wales
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Summary of Performance in 2010

Highlights

- Australian Research Council award of a Centre of Excellence for Climate System Science
- Future Justice Prize for The Copenhagen Diagnosis
- Professor Andy Pitman receives Office of Science and Medical Research NSW Scientist of the Year award
- Professor Matthew England awarded Australian Laureate Fellowship
- ARC Future Fellowship awarded to Dr Katrin Meissner
- The CCRC's second book: *Screw Light Bulbs: Smarter ways to save Australians Time and Money,* co-authored by Donna Green
- Members of CCRC appointed to the IPCC: Sherwood and Alexander as Lead Authors, Pitman as a Review Editor, and Alexander, Abramowitz and McNeil were named to the IPCC Experts Taskforce
- A series of world-class seminars including notable international speakers from UK, US, Canada and France
- Hosting of two major public lecture events: Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming, presented by Naomi Oreskes; and Climate Change and the ETS (panel discussion)
- Over 100 public lecturers, community talks and briefings
- A increase of our annual output of A and A* journal publications
- Publication of a 2nd edition by Elsevier of The Copenhagen Diagnosis as a formal book

The CCRC seminar series continued in 2010, drawing in national and international speakers and providing a platform for staff and students to share their latest research work. A selection of our distinguished guest speakers this past year include: Matthew Wells, University of Toronto; Carolina Roman, Monash University; Suraje Dessai, University of Exeter; Dave Thompson, Colorado State University and Jun-Ichi Yano, Meteo France. In addition, the late Stephen H. Schneider from Stanford University presented "Global Warming: Motivating Game Changing Actions in an Era of Spin and Confusion."

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

The achievement of this goal was further strengthened in 2010 as is evidenced by this Annual Report. Our continued goal is to *sustain* this status nationally, develop our reputation internationally and to provide significant and sustained national leadership in key areas of climate science. These include ocean and terrestrial physics, ocean-atmosphere-land coupling, climate modeling and the parameterization of key components of the land-atmosphere-ocean system. In 2010 the CCRC initiative for the ARC CoE for Climate System Science was awarded, and is set to launch in 2011. ARC Centres of Excellence are prestigious hubs of expertise through which high-quality researchers develop Australia's international standing in research areas of national priority. The establishment of the CoE at CCRC will cement the CCRC as the lead Australian University research centre into the next decade.

Other functions and goals of the CCRC have been to:

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

  This was achieved in 2010 by our final appointment of core academic staff, with the arrival of Dr Joseph Kidston. Dr Kidston was appointed in 2009 but was offered a research fellowship at Princeton University in the United States. We supported his desire to spend 18 months overseas before joining the CCRC.

  The Centre's advisory board is comprised of members from a range of disciplines and backgrounds, each able to provide input and perspective. In 2010 the advisory board was made up of the Centre Co-directors and the following members:

  - *Professor Mark Hoffman* — *(Chair) Associate Dean Research and Head of School of Materials Science and Engineering*
  - *Professor Michael Ashley* — *School of Physics*
  - *Professor Rob Brooks* — *Director Evolution and Ecology Research Centre*
  - *Dr Mark Holzer* — *School of Mathematics and Statistics*
  - *Professor Richard Stuetz* — *Director UNSW Water Research Centre*

- 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 have maintained their contribution to climate related research across campus. Our early successes in supporting groups in the Faculty of the Built Environment, Faculty of Engineering and the Faculty of Medicine win ARC Linkage grants, has been maintained. We have initiated some highly innovative research including links with the School of Psychology to explore the denial of (the science) of climate change. We have contributed to on-campus workshops, the co-supervision of PhD students in other Centres/Schools and Faculties; and on occasion, have forwarded applications from PhD students who have discovered UNSW via the CCRC but who are more suitable to research in other areas of specialty.

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

  We have sustained associations with several groups across campus. We have links within the Faculty with BEES, MATHS and Psychology and outside the Faculty with the Faculty of Social Sciences, Faculty of Medicine, Faculty of the Built Environment, School of Photovoltaic and Renewable Energy Engineering and the Faculty of Engineering. In 2010 our approach has been to support research needs as they develop. Demand has grown such that we now have to be more strategic in our selection of research opportunities, to focus on those that deliver high impact outcomes to the CCRC and to the Faculty.

- 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.

In 2010, we have been particularly successful in obtaining ARC funding via the Discovery, Linkage, Network, and Australian Laureate Fellowship schemes. Dr Katrin Meissner was awarded the ARC Future Fellowship and Professor Matthew England was awarded an Australian Laureate Fellowship. In late 2010, highly competitive submissions were either pending or in preparation for all of these schemes. The Discovery Grant announcements for funding commencing in 2011 saw the CCRC continue its success with successful outcomes for grants led by Sen Gupta, McNeil and Abramowitz & Pitman. The major research funding success of 2010 was the announcement of funding for the new Centre of Excellence for Climate system Science that will commence in 2011.

- 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.

  We now have a specialized PhD program in climate science (code 1476). We are growing this program gradually, limited by the availability of domestic PhD applicants in a highly competitive market. We enrolled six new Australian PhD students in 2010, the same number as in 2009. While we are limited by scholarships for overseas students we commenced three new international PhD students in 2010 and attracted three undergraduate practicum students from Europe wanting to research their thesis projects here, a number that is projected to grow in 2011.

  To increase the number of national PhD applications we have initiated a program of staff giving national conference talks and advertising opportunities at major Australian conferences. In 2010 we began developing a revised Advanced Science Undergraduate Climate Science major at UNSW to try to grow the cohort of potential and suitably trained graduate students for the long term. (This revised plan was approved in 2011).

- Core CCRC staff members will run undergraduate courses in their fields of expertise.

  In 2010 the Climate Change Research Centre continued its involvement in undergraduate teaching across a suite of courses. The centre's contribution to undergraduate teaching included both full course coordination and delivery, and shared teaching and coordination duties with schools. The CCRC's funding share of these teaching responsibilities in 2010 was equivalent to just over 30 EFTSL.

  This figure is expected to grow in coming years with the ongoing revision and improvement of the Bachelor of Advanced Science: Climate Science Plan. This will see additional upper level course offerings proposed. In 2011 the CCRC will also launch a General Education Course "Introduction to Climate Change".

  Courses that CCRC staff were either solely or jointly responsible for running in 2010 are listed below. (The figure in parentheses represents the CCRC's percentage share of income)

  MSCI0501 – The Marine Environment (50%)

*ARTS2241 – Peak Carbon: Climate Change and Energy Policy (0%)**
CLIM2001 – Atmospheric Physics (also PHYS2801) (80%)
MSCI2001 – Introduction to Marine Science (50%)
MSCI2051 – Coral Reef: Environment and Ecology (50%)
MSCI3001 – Physical Oceanography (100%)
MSCI3501 – Fundamentals of Climate Change (100%)
MSCI5004 – Oceanographic processes (100%)

**ARTS2241 is coordinated and taught by Dr Donna Green who has a fractional (.33 FTE) appointment in the Faculty of Arts and Social Science*

Courses in which guest lectures were given included:

GENS1004 – Science and the Cinema
SOLA1070 – Sustainable Energy
CVEN9612 – Catchment and Water Resources Modeling

- Attract external research income of $1.1m in 2009, increasing by at least 10% per annum thereafter;

  2010 External income was $1,250,603. Category 1 grant funding was $790,878 which was down on 2009 figures. This was due to a number of factors, but mostly as a result of time taken to spin up projects announced by the ARC in the second half of 2010, meaning less than a full year's funding was allocated on a number of new grants such as the Super Science Fellowships, Meissner's Future Fellowship and England's Laureate Fellowship (start date postponed until 2011).

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

  This goal was achieved in 2009, and continued in 2010. Work led by Pitman provided the NSW government's climate projections. UNSW was named in the NSW government's strategy documents as the provider of climate projections science in 2009. Evans and Alexander have led new initiatives that resulted from this work; diversifying the climate scientists providing tailored solutions to the state government. The NSW government has reinforced this relationship by placing a researcher into the Centre as a part time PhD student, helping to resource an ARC Linkage grant, committing cash to the ARC Centre of Excellence proposal and routinely accessing the Centre for advice on climate, climate science and future climate change. This includes Pitman's membership of the Ministerial Council and the provision of direct briefings to the Minister.

We have recruited a suite of outstanding academic staff and postdoctoral researchers who will build strengths that complement existing strengths. In 2010, the CCRC was awarded the ARC Super Science Fellowship that included enough funding for three research positions and the ARC Centre of Excellence. Our 2010 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, if not increase in 2011.

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 and PhD applicants. CSIRO, the Bureau of Meteorology, the Department of Climate Change and the NSW Department of Environment and Climate Change routinely invite us to key meetings.

The Copenhagen Diagnosis was an Australian-led examination, assessment and synthesis of the most significant climate science to have emerged since the last Intergovernmental Panel on Climate Change (IPCC) Assessment Report of 2007. *The Copenhagen Diagnosis* was released in a worldwide coordinated press event on 25th November 2009. The report summarised the most up-to-date climate science available in time for the UN Conference of Parties (COP15) meeting in Copenhagen in December 2009. In the ensuing 48 hours the report was downloaded or read online in excess of 100,000 times. In 2010, due to the immense success of this publication, it was decided that a 2nd edition would be released in 2011.

The ARC Centre of Excellence for Climate System Science application, led by Professor Andy Pitman, began in 2009 and was awarded in late 2010, with a promise of $24.1 million in funding. The CoE will be an international research consortium of five Australian universities and a suite of outstanding national and international Partner Organizations. Through fostering elite postdoctoral research fellows and graduate training, the CoE will build on and improve existing understandings of the modeling of regional climates to enable enhanced adaptation to and management of climate change, particularly in the Australian region, and provide a significantly enhanced capacity to understand and project the scale of future regional climate change.

The scale of research enabled by the Centre will provide for the enhancement of climate modeling and future climate projections particularly at regional scales, minimizing Australia's economic, social and environmental vulnerability to climate change. Establishing the CoE out of the Centre has cemented the UNSW as Australian leaders in climate science research.

The Centre has had a successful 2010 in terms of standard research activity metrics (income, PhD numbers and publications). We also had a successful year in terms of our institutional, State, National and International impact, particularly with the award of a Centre of Excellence for Climate System Science. The CCRC continues as a leader for UNSW in this area of high national significance.

Staff members of The Climate Change Research Centre 2010

There were no resignations or retirements among full time, permanent academic staff in 2010.

Directors
Prof Matthew England (Australian Laureate Fellow)
Prof Andy Pitman

Professors
Prof Steven Sherwood

Research Fellows/Academic Staff
Dr Gab Abramowitz
Dr Lisa Alexander
Dr Jason Evans (ARC Australian Research Fellow)
Dr Donna Green
Dr Joseph Kidston
Dr Ben McNeil (ARC QEII Research Fellow)
Dr Katrin Meissner (ARC Future Fellow)
Dr Alex Sen Gupta

Post Doctoral Research Fellows and Research Associates
Dr Laura Ciasto
Dr James Gilmour
Dr Xianhong Meng
Dr Agus Santoso
Dr Paul Spence
Dr Caroline Ummenhofer
Dr Marc d'Orgeville
Dr Shayne McGregor
Dr Steven Phipps
Dr Willem Sijp
Dr Andrea Taschetto

Postgraduate Research Students (and their primary supervisor)
Francia Avila (Pitman)
Michael Bates (England)
Kathryn Bormann (Evans)
Hamish Clarke (Pitman)
Timothy Cowan (England)
David Fuchs (CSE, co-sup Sherwood)
Khalia Hill (England)
Agata Imielska (Alexander)
Karin Kvale (Meissner)
Timothy Leslie (England)
Ian Macadam (Pitman)
Penny Maher (Sherwood)
Clinton Rakich (England)
Nina Ridder (England)
Tristan Sasse (McNeil)
Sarah Schroeder (Abramowitz)
Seyed Shahrokhi (Evans)
Emily Shaw (McNeil)
Alejandro Silva Brito (England)
Graham Simpkins (England)
Jessica Trevena (England)
Bevan Warren (Green)

Support Staff
Stephen Gray (Executive Officer)
Simone Purdon (Executive Assistant)

Visiting Fellows
Dr Olivier Arzel
Dr Faye Cruz
Dr Frank Drost
Prof Lance Leslie
Dr Michael Molitor
Dr Oleg Saenko
Dr Milton Speer
A. Prof David Thompson

Affiliated UNSW staff
Prof Mike Banner
A/Prof Michael Box
Dr Gail Box
A/Prof Dale Dominey-Howes
Dr Gary Froyland
Dr Ben Newell
Dr Scott Mooney
Dr Angela Moles
Dr Jane McAdam
Prof Frank Muller
Dr Robin Robertson
A/Prof Ashish Sharma
Dr Scott Sisson

ARC Centre of Excellence for Climate System Science

The Centre of Excellence for Climate System Science is a major initiative funded by the Australian Research Council. The Centre is an international research consortium of five Australian universities and a suite of outstanding national and international Partner Organizations. It will build on and improve existing understanding of the modeling of regional climates to enable enhanced adaptation to and management of climate change, particularly in the Australian region. The application for the Centre was awarded in late 2010 with funding of $24.1 million dollars. Professor Andy Pitman led the application and presentation process and was named Director of the Centre, ending his tenure as Co-director of the CCRC at the end of 2010.

The Centre will be launched in 2011 with extensive investment from the Australian Research Council, the University of New South Wales, the Department of Climate Change and Energy Efficiency, New South Wales Government, Monash University, the Australian National University, the University of Melbourne, and the University of Tasmania. It has strong links with the Australian Community Climate and Earth System Simulator (ACCESS) initiative and works in partnership with the National Computational Infrastructure (NCI) Facility.

The Centre's focus, Climate System Science, is the quantitative study of the climate system designed to enable modeling of the future of the climate system. It is built on a core of the sciences of the atmosphere, ocean, cryosphere and land surface. It includes the physics, dynamics and biology of these systems, and the flow of energy, water and chemicals between them. Climate System Science builds mathematical models of these systems based on observations. It describes these observations, and the underlying physics of the system, in computer codes. These computer codes are known as a "climate model" and utilize very large super computers. The Centre was conceived with a single overarching vision: A nation empowered with the science-based knowledge that enables the management of threats and opportunities associated with changes in climate. The Centre's vision is supported by the overarching goal: To resolve key uncertainties undermining the reliable projection of Australia's climate.

The scale of research enabled by the Centre will provide for the enhancement of climate modeling and future climate projections particularly at regional scales, minimizing Australia's economic, social and environmental vulnerability to climate change.

Key performance measures for The Centre's success include the number of international visitors, the number of CoE members participating in overseas working groups or boards and science steering committees, the number of PhD students supervised cross-institutionally and their completion rates, the number of visits to overseas laboratories, media coverage will measure community impact and engagement, along with website hits and report/paper downloads. The use of Centre research in strategic State and Federal documents will measure of the scale of national impact.

IPCC – Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. The IPCC is a scientific body, it reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research in its own right, nor does it take or monitor climate related data.

The main activity of the IPCC is to provide at regular intervals Assessment Reports of the state of knowledge on climate change. The latest one is "Climate Change 2007", the IPCC Fourth Assessment Report. The IPCC also produces Special Reports; Methodology Reports; Technical Papers; and Supporting Material, often in response to requests from the Conference of the Parties to the UNFCCC, or from other environmental Conventions.

The IPCC consists of 3 Working Groups and a Task Force on National Greenhouse Gas Inventories (TFI). Working Group II assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. Working Group III assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere.

Several staff from the CCRC are members of Working Group I, which assesses the physical scientific aspects of the climate system and climate change. The main topics of assessed by WG I include: changes in greenhouse gases and aerosols in the atmosphere; observed changes in air, land and ocean temperatures, rainfall, glaciers and ice sheets, oceans and sea level; historical and paleoclimatic perspective on climate change; biogeochemistry, carbon cycle, gases and aerosols; satellite data and other data; climate models; climate projections, causes and attribution of climate change.

The CCRC is proud to have several of its staff as contributors to the IPPC. Lisa Alexander is a Lead Author (LA) of Working Group I (WGI) of the Fifth Assessment report (AR5). The first WG1 AR5 LA meeting was held in Kunming, China from 8th-11th November 2010. As LA of Chapter 2, Alexander was involved in discussions on Observations: Atmosphere and Surface and in relevant cross-chapter discussions. Following this meeting, she helped to write the zero-order draft of Chapter 2, which has been sent out for expert review. In 2007, Steve Sherwood served as a contributing author to the WG I report Chapter 2 (Observations) and was an invited reviewer. For the upcoming 2013 report, he is a Lead Author on WG I - Chapter 7 (Clouds and Aerosols). Gab Abramowitz was chosen as one of around fifty experts in multi-model ensemble prediction to attend the IPCC Expert Meeting on Assessing and Combining Multi Model Climate Projections at the National Centre for Atmospheric Research (NCAR), in Boulder Colorado in January 2010. He was also part of the core writing team that collated the key meeting outcome - a guidance paper for IPCC 5th Assessment Report Lead Authors. Ben McNeil is an expert reviewer for Working Groups I and II, while Andy Pitman is a Review Editor on Chapter 9 of the Working Group I report, ensuring that review comments submitted on Chapter 9 are thoroughly addressed in the revisions to the chapter.

2010 Selected Staff Profiles: Dr Laura Ciasto

Large-Scale Modes of Atmospheric Variability and their Relationship to the Southern Hemisphere Oceans

The El Niño Southern Oscillation (ENSO) is the most prominent pattern of climate variability in the tropics but it also has a significant impact on the extratropical atmospheric circulation, which, in turn, influences the ocean conditions around the globe. The Southern Annular Mode (SAM) is the most important pattern of climate variability in the extratropical Southern Hemisphere, having large impacts on the surface temperatures, precipitation, SSTs and sea ice distribution in the middle and high latitudes. However, due to the fact that the Southern Ocean remains one of the poorly sampled regions on the globe, there is a large in gap our understanding of how these large-scale modes of atmospheric variability impact the Southern Hemisphere mixed layer ocean.

Laura's research aims to close this gap by using new high-resolution satellite and in situ observations to answer key scientific questions regarding the variability and driving mechanisms of large-scale ocean-atmosphere interactions in the extratropical Southern Hemisphere.

Major achievements in 2010:

- Collaborated with scientists from NCAR and NOAA to conduct an interhemispheric comparison of large-scale air-sea interaction, focusing on the mechanisms that control the temporal behaviour SST anomalies driven by the annular modes of atmospheric variability.
- Examined the ENSO teleconnections to the high latitude Southern Ocean surface mixed layer heat budget, demonstrating that turbulent heat fluxes and heat advection by Ekman currents contribute equally to ENSO-related SST variability throughout the SH basin, while shortwave radiation is important for resolving the structure and amplitude of SST anomalies in the subtropics.

Major objectives in 2011:

- Continue to examine the interhemispheric comparison of air-sea interaction associated with the annular modes by using an atmospheric general circulation model to determine the sensitivity of the direct and indirect response of the atmospheric circulation to varying degrees of persistence in the underlying SST field.
- Investigate how different manifestations of ENSO (i.e., traditional eastern Pacific warming vs Modoki central Pacific warming) affect climate variability in the South Hemisphere oceans, including the role of ENSO in the unprecedented warming of the central South Pacific during 2009.
- Examine the extent to which trends in the SAM and ENSO contribute to trends in Antarctic sea ice concentration.

2010 Selected Staff Profiles: Dr Joseph Kidston

Joe works on large-scale atmospheric dynamics. He aims for a theoretical understanding of important features of Earth's climate.

One of the most fundamental features of the Earth's climate system is that in the mid-latitudes the climatological surface winds blow from the west. An integral part of the westerlies is the storm tracks, which are embedded in the westerly wind belts. The transient eddies within the storm tracks act to drive the westerly winds. These eddies transport vast amounts of heat towards the poles, and are of fundamental importance for determining the state of the global climate. The same transient eddies are responsible for day-to-day variations in mid-latitude weather, and their location and character dictate the regional climate in the mid-latitudes, such as precipitation and mean-temperature. The surface westerlies are also important for global climate because they drive the major ocean current systems such as the Antarctic Circumpolar Current, the Atlantic Gulf Stream, and the Pacific Kuroshio Current, which transport huge amounts of heat around the planet. The westerlies contribute significantly to the vertical mixing in the ocean, which is of critical importance to determining nutrient supply, and thus the regional distribution of ocean fauna.

Kidston aims to understand the controls on the latitude of the westerlies, both in the context of the poleward shift that has been observed over the last few decades, and the shift that is projected to occur in future climates in all IPCC class models. He uses idealized models to address specific questions, and to isolate the dynamics that control simpler systems. The aim is to determine the relevance of the dynamics in the simplified models to the real atmosphere.

Major achievements in 2010:

- In collaboration with a colleague at BoM, showed that global climate models were generally able to simulate the trends and variability in observed temperature extremes across Australia and that warm extremes were likely to increase significantly by the end of the century irrespective of greenhouse gas emission pathways.
- Showed that natural variations in sea surface temperature patterns were related to significant changes in temperature and rainfall extremes globally.
- Showed that storminess has decreased significantly across southeast Australia since the middle of the 19th century consistent with a predicted shift in Southern Hemisphere storm tracks due to climate change.

Major objectives in 2011:

- Undertake a major study examining the cause of the poleward shift of the westerlies in a hierarchy of GCMs, testing established ideas.
- Undertake a study into the relative importance of the robust changes in mid-latitude variability that are projected to occur under a poleward shifting jet (i.e. the decrease in the persistence of the eddy-driven jet).
- Build a group of graduate students and postdocs with similar research interests to work alongside.

2010 Selected Staff Profiles: Dr Ben McNeil

Understanding the oceans role in modulating atmospheric carbon dioxide and the oceanic acidification impacts that flow in a high-CO_2 world

The ocean has absorbed 50% of the anthropogenic carbon dioxide we have emitted since the industrial revolution, which is a very good thing for mitigating the effects of climate change. Models however suggest the ocean CO2 sink to be vulnerable to climate change in the future from changes to solubility and oceanic circulation. There is still considerable uncertainty over the feedback mechanisms and stability of this future oceanic CO2 sink.

Anthropogenic carbon dioxide uptake by the ocean also decreases the pH of seawater, leading to an 'acidification' which may have potential detrimental consequences on marine organisms and flow-on effects throughout the marine ecosystem and among corals.

Ben's ocean biogeochemical cycles group focuses on improving our understanding of oceanic CO2 uptake, ocean acidification and future feedbacks of these processes in a high-CO2 world. Ben also collects new observations in a variety of marine environments to investigate the variability and magnitude of oceanic CO2 uptake and biogeochemical cycling. By improving our understanding of the ocean role on atmospheric CO2, it will help policy-makers make better judgments about mitigation options for fossil-fuel CO2 emissions.

Major Achievements in 2010:

- Derived a first estimate of the importance of the coastal ocean in influencing atmospheric CO2 inter-annual variability with a subsequent major publication
- With collaboration from international colleagues, conducted the first estimate for the exact timing of corrosive ocean conditions within Antarctic coastal waters, with subsequent publication.
- Helped lead the Copenhagen Diagnosis Report, which was a finalist for the Eureka Awards

Major Objectives for 2011:

- In collaboration with international colleagues, help redefine the definition of 'anthropogenic CO2' in the ocean
- Provide new insights and a review of coastal ocean acidification
- First papers produced from new PhD students and the hiring of a Post-doctoral research associate during the year
- Contribute to the Ocean Acidification Working Group for the 5th assessment report of the IPCC

2010 Selected Staff Profiles: Dr Katrin Meissner

Understanding abrupt climate change as well as thresholds and feedbacks in the climate system

Records of past climates reveal periods of extreme climate change and variability. Abrupt climate change, such as for example a local temperature increase of over 5 degrees within a few years, has occurred more than once in the past. We need to understand the feedbacks that govern the climate system in its natural state to be able to predict how the climate system will respond to anthropogenic carbon emissions in the future. These feedbacks are complex; they vary over a wide span of time scales and involve a number of different subsystems in the climate system.

Katrin tries to understand the mechanisms underlying abrupt climate change with the help of Earth System Climate Models. These models include many different components of the climate system (e.g. ocean, land, sea ice, land ice, atmosphere, ocean sediments, dynamics, thermodynamics, carbon cycle, nutrient cycles, etc.). Katrin also aims to quantify the feedbacks that act within the climate system. She is looking at critical thresholds and tipping points in current, future and past climate states. These thresholds indicate a level of perturbation, which, if trespassed, put the climate in a new, not always reversible, state.

Katrin joined the CCRC in December 2009 and is also an Adjunct Professor at the University of Victoria, Canada and a Courtesy Faculty Member at the Oregon State University, USA.

Major achievements in 2010:

- Was granted an ARC Future Fellowship, an ARC Discovery Grant (in collaboration with Drs. McNeil and Matear) and an ARC Linkage Infrastructure Grant (in collaboration with Dr. Baker and seven others).
- Quantified the extent of future summer melt over ice sheets and shelves under two future emission scenarios in collaboration with colleagues in Canada and New Zealand.
- Investigated the effect of changes in the Southern Hemisphere westerly winds on the ocean carbon budget in collaboration with colleagues from the CCRC.

Major objectives in 2011:

- Continue to build up my research group of students and postdocs.
- Advance our understanding of the "wriggles" in past $\Delta^{14}C$ and $\delta^{18}O$ records.
- Test and implement weathering schemes in models to assess the uncertainty in ocean carbon uptake during future climate scenarios
- Postgraduate Research Coordinator for the CCRC

2010 Selected Staff Profiles: Dr Paul Spence

High resolution global ocean modeling: understanding the role of small-scale ocean features in global climate

Observed ocean kinetic energy is dominated by mesoscale features (length scales of 10-100km), with eddy kinetic energy often found to be 100 times larger than the mean. In contrast, the vast majority of global General Circulation Model (GCM) simulations used in paleoclimate studies and in long-term climate projections are limited to coarse horizontal resolutions (i.e. > 1o). These GCMs are obliged to parametrize the effects of unresolved flows, placing the burden of proof on modellers to demonstrate that their simulations accurately represent the flow characteristics under consideration. The Intergovernmental Panel on Climate Change Fourth Assessment Report identifies the lack of a comprehensive suite of high resolution global climate simulations as restricting the ability to draw firm conclusions from GCMs. My research employs a suite of global coupled GCM simulations to explore the gap between coarse and mesoscale resolving ocean models within the framework of three foci: 1) the North Atlantic thermohaline circulation response to anthropogenic buoyancy forcing; 2) the Southern Ocean overturning response to anthropogenic buoyancy forcing; and 3) the late Eocene climate response to the opening of the Tasman Seaway.

Major Achievements in 2010:

- Found that much of the observed Southern Ocean warming can be attributed to shifting ocean fronts in response to the winds. Conclude that the response of the Antarctic Circumpolar Current to the forcing is highly dependent on the effects of mesoscale eddies, with high resolution models capable of existing in an eddy saturated ACC transport state.
- Revealed that as ocean model viscosity is reduced and the resolution increased much of the North Atlantic Deep Water (NADW) separates from the western boundary and enters the low-latitude Atlantic via interior pathways distinct from the Deep Western Boundary Current (DWBC). It is shown that bottom pressure torques play a key role in maintaining these interior NADW outflows.
- Analyzed components of Southern Ocean (SO) meridional heat transport (MHT) response to projected 21st century changes in SO wind stress. South of about 45◦S, the sign of the MHT anomaly is set by roughly equal contributions from the time mean and transient components associated with the horizontal circulation. North of 45◦S, the net southward MHT anomaly largely results from changes in the time-mean MHT associated with the meridional overturning circulation.

Major Objectives in 2011:

- The transition from DWBC to interior NADW pathways into the subtropics discussed is likely to have important implications for simulations addressing past and projected future climate change. I plan to investigating these implications by evaluating the model response to increasing greenhouse gases in conjunction with expected Green Land ice sheet melt rates.
- Conduct the first fully coupled, ocean eddy-permitting GCM simulations with realistic late Eocene bathymetry and winds to examine the climatic effects of the opening of the Tasman Seaway.

National Context and Background

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 was to lead the University effort toward an ARC CoE round, building on existing leadership links through the ARC Research Network for Earth System Science that is convened by Professor Andy Pitman. In 2010, UNSW, through the CCRC, led a Centre of Excellence proposal in tight collaboration with our partners in the UCC. This proposal was successful and the ARC CoE for Climate System Science will be launched in 2011.

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, and now the CoE for Climate System Science, 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 2011 and on-going into the future.

Relationship with the University's 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 have been filled to round out our existing strengths and to cover important gaps in key strategic areas. Professor Steven Sherwood is an atmospheric scientist who came to the CCRC from Yale University in 2009. Professor Sherwood will replace Andy Pitman as Co-Director of the CCRC in 2011 after Professor Andy Pitman's successful bid for the CoE for Climate System Science. Further academic additions include Dr Katrin Meissner who has come to the CCRC from the University of Victoria in Canada. Dr Meissner specializes in Climate Events and Earth System Climate Models. Finally, after being recruited in 2009, Dr Joseph Kidston joined the CCRC in 2010 after an 18-month research fellowship at Princeton University. Dr Kidston specializes in large-scale atmospheric dynamics.

The UNSW Climate Change Research Centre (CCRC) compiled summary information about all climate-relevant research activities at UNSW. This information was 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. Several academic staff of the CCRC work closely with other departments such as the School of Civil and Environmental Engineering and oceanography and fluid dynamics in the School of Mathematics and Statistics.

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 2009, The UNSW Climate Change Research Centre was comprised of eleven full-time core academic staff, with 14 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 was launched in 2009. It was reviewed and refined throughout 2009 and upgraded to become more rigorous degree in 2010 and will be going through its final iteration in 2011, with the aim of attracting top students to feed into postgraduate research programs.

Relationship with the University's strategic priorities and goals

Climate 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 has clearly built 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 was in alignment with the UNSW Strategic Intent of the B2B Blueprint to Beyond, and has addressed 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 has become one of Australia's largest providers of high-quality postgraduate research degrees in these areas, with 2010 seeing a steady increase in new PhD students.

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 have been developed and maintained at State and Federal levels with the appointment of Professor Matthew England to the Federal Department of Climate Change's High Level Steering Committee and the appointment of Professor Andrew Pitman to the Department of Innovation, Industry, Science and Research's Australian e-research innovation council.

Operational Details

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. The creation of the Centre of Excellence proposal where almost all the UNSW research contribution is hosted in the CCRC illustrates this characteristic.

- 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 the Faculty of Arts and Social Science.

- The centre has critical mass (currently 11 permanent academic staff, 2 professional staff and around a dozen research fellows and associates funded by grants), 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 Future Fellowship schemes to date. We have facilitated proposals to other funding agencies and intend to maintain this in the future. Successful proposals to Super Science, Future Fellowships, the ARC Centres of Excellence scheme and the NSW Environmental Trust schemes illustrate our commitment and ability to win competitive research funding. In the future we intend to continue applying for Linkage proposals, Future Fellowships and Discovery projects;

- The Centre is located in refurbished premises on Level 4 of the Mathews Building. 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. Through growth, we have filled our office space near to capacity. This has also seen an increase in our computing needs with 27TB being purchased in 2010 to meet our researchers needs.

- 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. 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 directed the Centre in 2010, 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. Professor Pitman stepped down as Co-director of the CCRC at the end of 2010, due to his successful bid for the ARC CoE for Climate System Science. Professor Steven Sherwood will be working alongside England in 2011 as CCRC Co-director.

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 continue to 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.

The Directors have also worked hard to minimize the impact of the political and media attention relating to climate change science and the denial of that science in some groups. While all in the centre give public talks, talks to high schools and volunteer groups, England and Pitman have shouldered most of this load to protect staff from the resulting e-mail and letter abuse.

Operation of the Centre

As in previous years, the centre reported to the Dean (either directly or though the Faculty management team) on all maters relating to strategy, staffing & funding. The CCRC's co-directors also meet regularly with the Associate Dean-Research in 2010 to discuss research and research strategy. The CCRC actively engages with the Science Faculty by having our own regular representation to the Higher Degree Committee, the Research Management Committee and the Faculty Executive Committee.

We continue to foster strong working relationships with other schools across the Faculty, particularly through our Undergraduate teaching program, which has natural synergies with BEES, Physics and Mathematics. A number of CCRC staff were involved in UG teaching or gave guest lectures in classes taught by other schools. Research collaboration is also taking place between the CCRC and schools within the Faculty of Science and beyond.

On a day to day management and administrative level, our professional staff have developed strong working relationships with a range of UNSW units such as the Grants Management Office (GMO), Human Resources, The Graduate Research School and departments within

central and faculty finance. This good standing has contributed to the efficient running of the centre.

Financial Report 2010

Finances

	2010	2009
INCOME		
External Funds	$1,190,170	$1,331,960
Core Strategic Funds (SPF01)	$845,486	$435,838
Other Strategic Funds	$745,078	$186,490
Consolidated Operating Funds	$913,238	$220,201
Total Income	**$3,680,659**	**$2,174,489**
SURPLUS BFWD FROM PREV YEAR		
External Funds	$717,958	$714,325
Internal Funds	$20,980	$941,817
EXPENDITURE		
Payroll	$2,808,732	$2,554,546
Equipment	$140,769	$94,292
Materials	$193,054	$176,298
Scholarships	$224,634	$186,160
Travel & Staff relocation costs	$310,336	$378,422
Total Expenditure	**$3,570,215**	**$3,379,928**
OPERATING RESULT	**$10,444**	-$1,205,439
SURPLUS BFWD FROM PREV YEAR	$738,938	$1,656,141
ACCUMULATED FUNDS SURPLUS	**$749,382**	**$450,703**

Notes to the statement of financial performance

External Funds

2010 external income was comprised of $790,878 in Category 1 grants, which was down on 2009 figures. This was due to a number of factors, but mostly as a result of time taken to spin up projects announced by the ARC in the second half of 2010, meaning less than a full year's funding was allocated on a number of new grants such as the Super Science Fellowships, Meissner's Future Fellowship and England's Laureate Fellowship (start date postponed until 2011). CCRC staff continue to maintain a successful track record with grant and fellowship applications across a range of grant schemes and funding bodies.

UNSW Contribution

Sources of UNSW funding for 2010 included $845k from the core SPF01 five year commitment and $745k in other strategic funds (SIR30, SIR50). Of the $900k in consolidated operating funds $185k was identified as UG teaching revenue and $51K as combined RIBG/IGS/RTS and the remainder being Faculty's CCRC strategic contribution of $670K (NB the centre was able to forego the Faculty $400k contribution in 2009 due to funds carried forward from 2008).

The original CCRC proposal document estimated significant earnings flowing to the centre from its UG teaching activities and "Research Quantum". These figures were based on modeling and formulae under a budget model jointly devised with the former Faculty General Manager whereby there was direct correlation between income earning activities and distribution of income. Budget models that inform the attribution of income have since changed, arguably disadvantaging the CCRC.

The CCRC's income from "Research Quantum" (RTS/IGS/RIBG, etc) has been hamstrung by the in-built lags of up to three years in the funding models and the fact that the centre's growing body of PhD students are required to enrol through BEES due to University policy which prevents centres from enrolling their own students. The fact that PhD enrolment and completion funds do not get tagged to the CCRC's revenue budget is particularly disadvantageous to the centre and significantly impacts on the amount of "gap funding" required to enable the CCRC to meet costs.

Surplus brought forward from previous year

The majority of funds carried over from 2009 to 2010 were held in external research projects. There was also a small carry over of suspense funds.

Expenditure

78.7% of the Centre's total 2010 expenditure was on people costs – compared to 76% in 2009 and 72% in 2008. In 2010 55.7% of people costs came from base operating and core strategic (SPF01) funds meaning that almost half of the centre's salaries and on-costs are supported by fellowships or grants.

As in previous years, travel accounted for the second largest proportion of expenditure. Of this over 80% was funded by external grants. Most of the remaining 20% was either for staff relocation or expenditure on staff star-up grants (SPF01).

The CCRC paid over $220,000 in stipends and top ups in 2010 to support its growing cohort of postgraduate research students.

Community Engagement, Talks and Lectures

Seminar Series

The CCRC seminar series was launched in 2009 by Dr Lisa Alexander and has become a major success of the Centre, drawing in national and international speakers and providing a platform for staff and students to share their latest research work. A selection of our distinguished guest speakers this past year include: Matthew Wells, University of Toronto; Carolina Roman, Monash University; Suraje Dessai, University of Exeter; Dave Thompson, Colorado State University and Jun-Ichi Yano, Meteo France. In addition, the late Stephen H. Schneider from Stanford University presented "Global Warming: Motivating Game Changing Actions in an Era of Spin and Confusion."
A full list of speakers and titles appears in Appendix 5.

Public Lectures

Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming
Monday 15th November 2010
Presented by the School of History and Philosophy and the Climate Change Research Centre.
Presenter: Naomi Oreskes, University of California
In this talk Oreskes outlined the ideas developed in the book 'Merchants of Doubt' written with Erik Conway. Building upon her earlier research highlighting the disconnect between the state of scientific debate and the way it was being presented in the mass media, and perceived by the American people, she suggests that confusion regarding climate science has been purposely sown by people trying to confuse us.

Climate Change and the ETS
Monday 16th August 2010
Panelists: Malcolm Turnbull MP, Dr Nikki Williams, NSW Minerals Council, Dr Donna Green, Climate Change Research Centre, Professor Matthew England, Co-Director Climate Change Research Centre & Dr Iain McGill, Centre for Energy & Environmental Markets. Representatives from CCRC along with other researchers and 'thinkers' gathered to deliver presentations and to discuss in a public forum, some of the many opportunities, problems and dilemmas scientific advances pose concerning climate change and the ETS.

CCRC in the news

The CCRC continued to have a significant presence in the media in 2010. Notable mentions include: ARC Centre of Excellence awarded in Climate System Science, Donna Green's published book *Screw Light Bulbs: Smarter Solutions to Tackling Climate Change* and the inaugural Future Justice Prize was awarded for *The Copenhagen Diagnosis*. Our Co-directors individual achievements also stood out as Professor Matthew England was awarded the Australian Laureate Fellowship, while Professor Andy Pitman was received the Office of Science and Medical Research NSW Scientist of the Year Award.

Work was covered in local and international media, online, print and radio. Media outlets include *The Australian, ABC online, New Scientist, NBC's Today Show, The Sydney Morning Herald, Science Alert, Manila Bulletin, Christian Science Monitor, Voxy.co.nz, The Geelong Advertiser, Lateline on ABC, National Geographic News and Reuters India.* See Appendix 3 for details.

2010 Selected External CCRC Talks

Abramowitz, G.: "Understanding models and modeling experiments," OzFlux workshop, Creswick.

Abramowitz, G.: "Climate change uncertainty, replicate Earths and model independence," Centre for Australian Climate and Weather Research (CAWCR) modeling workshop, Melbourne.

Abramowitz, G.: "Protocol for the Analysis of Land Surface models," Centre for Australian Climate and Weather Research (CAWCR) modeling workshop, Melbourne.

Abramowitz, G.: "Replicate Earths, hidden climate and ensembles of climate forecasts," presented by Craig Bishop, Oxford.

Abramowitz, G.: "Protocol for the Analysis of Land Surface models, CABLE community land surface modeling meeting," Canberra.

Abramowitz, G.: "Combining multiple climate model projections, Statistical Society of Australia," Sydney.

Abramowitz, G.: "Using data to assess model dependence in ensemble prediction," invited, AGU Fall meeting, San Francisco.

Abramowitz, G.: "Defining and weighting for model dependence in ensemble prediction," AGU Fall meeting, San Francisco.

Alexander, L.: "Climate and Weather Extremes: a university perspective," CAWCR Extremes meeting, Melbourne

Alexander, L.: "The representation of cyclones in the 20th century reanalysis," QCCCE ACRE meeting, Brisbane.

Alexander, L: "Assessing climate models simulations of extremes over Australia," CSIRO Extremes meeting, Perth.

Alexander, L: "Past and future changes in temperature extremes in Australia: a global context," WCRP Extremes meeting, Paris.

Ciasto, L. M., M. A. Alexander, C. Deser and M. H. England: "On the Persistence of Cold Season SST anomalies associated with the Annular Modes," Ocean Sciences Meeting, Oregon.

Ciasto, L. M.: "Observations of Large-Scale Ocean-Atmosphere Interaction in the Southern Hemisphere," MPOWIR workshop, South Carolina.

Ciasto, L. M., M. A. Alexander, C. Deser and M. H. England: "On the Persistence of Cold Season SST anomalies associated with the Annular Modes," Australia New Zealand Climate Forum, Hobart.

Ciasto, L. M and M. H. England: "Southern Ocean Mixed Layer Heat Budget Associated with ENSO," Australia New Zealand Climate Forum, Hobart.

England, M.H.: "Frontiers of Marine Science Meeting," Australian Academy of Sciences / UK Royal Society, Perth.

England, M.H.: "Pressure System: Climate Change, the media and the message," Woollahra Festival Q&A session: Climate change and the media (with ABC's Sarah Ferguson and Margot O'Neill), Woollahra.

England, M.H.: "The Science behind Climate Change," Distinguished Scholars Speakers Series, UNSW.

England, M.H.: UNSW Climate Change & The ETS Q&A Panel, Panellists include Malcolm Turnbull, Matthew England, Nikki Williams, UNSW.

England, M.H.: "Wildlife and climate change: toward robust conservation strategies for Australian fauna," The Royal Zoological Society of New South Wales 2010 forum, Mosman.

England, M.H.: Launch of the Sydney Opera House Environmental Sustainability Plan, Sydney.

England, M.H.: A Public Forum: Ask an expert about Climate, Climate Change, and Climate Policy, ANU, Canberra.

England, M.H., Agus Santoso, Steven J. Phipps and Caroline C. Ummenhofer: "Role of the Indonesian Throughflow in controlling regional mean climate and rainfall variability," AMOS.

Evans, J.P.: "Land surface model evaluation and suggestions for ADMIP," Keynote talk at ADMIP workshop.

Evans, J.P.: "High Resolution Climate Projections to Address Local Issues," Climate Change Issues for Local Councils in NSW – "Scientific and practical applications" forum, Sydney.

Evans, J.P., G. Abramowitz & A. Pitman: Land surface model evaluation and suggestions for ADMIP, Beijing, China.

Evans, J.P.: Provided expert witness to the Sydney Region Public Schools Sustainability Forum.

Green, D.: "Sea-level Rise," First Earth System Conference, ANU.

Green, D.: "Greenhouse Myths – do we need a carbon tax?" Woodford.

Green, D.: "What next? How to price carbon emissions," Perth.

Green, D.: "Climate impacts in the Torres Strait," Day of Ideas, the idea of Refuge, Perth.

Green, D.: Panel member, UNSW's Climate Change and the ETS.

Green, D.: "The forgotten Islands: climate change in the Torres Strait," Australia, Climate Adaptation Futures, Gold Coast.

Green, D.: Post-Copenhagen ecological debate, Sydney Writers' Festival, Sydney.

Green, D.: "What the DCC Indigenous report means," NCCARF Workshop on Adaptation to Climate Change in Indigenous Populations, Darwin.

Green, D.: "Indigenous Issues and Climate," at the Environmental Defender's Office 'Public Interest Law in Australia 25 years on'.

Kidston, J.: "Can the increase in the eddy length scale cause a poleward shift of the jet streams?" Princeton University, NJ.

Kidston, J.: "Can the increase in the eddy length scale cause a poleward shift of the jet streams?" EGU, Vienna.

Kidston, J.: "Can the increase in the eddy length scale cause a poleward shift of the jet streams?" University of Washington.

Kidston, J.: "Poleward Shifting Westerlies; Causes and Consequences," ANU, Canberra.

Kidston, J.: "Poleward Shifting Westerlies; Causes and Consequences, " CSIRO.

Kidston, J.: "Poleward Shifting Westerlies; Causes and Consequences, " Melbourne University.

Kidston, J.: "Poleward Shifting Westerlies; Causes and Consequences," Bureau of Meteorology.

Kidston, J.: "Barotropic Instability and the latitude of the eddy-driven jet," AGU, San Francisco.

Phipps, Steven. J: "8,000 years of El Niño: Towards data-model integration," EGU General Assembly, Vienna.

Phipps, Steven. J: "Modeling of the last 2ka," 1st Australasian 2k (Aus2k) PAGES Regional Workshop: Towards Data Synthesis, University of Melbourne.

Phipps, Steven. J: "8,000 years of El Niño: Towards data-model integration," AQUA Biennial Meeting, North Stradbroke Island.

Phipps, Steven. J: "Proxies and processors: Integrating palaeoclimate archives with climate system models," University of Queensland.

Phipps, Steven. J: "The tropical time machine: Past changes, future challenges," UK-Australia Frontiers of Science Meeting, Perth.

Pitman, A.: Key note at the AUSTRALASIAN CONFERENCE OF PLANNING AND ENVIRONMENT COURTS AND TRIBUNALS Conference.

Pitman, A.: Keynote at the Climate Assumptions workshop for the ACT government, Canberra.

Pitman, A.: Keynote at the National Operations Conference [13 to 15 September, 2010] of the Australian Water Association.

Pitman, A.: Keynote at the 6th Australia-New Zealand Climate Change & Business Conference [10-12 August 2010] "Understanding the science: Communicating the challenge"

Pitman, A.: Keynote at the Ballina Citizen's forum, 27th August, 2010.

Pitman, A.: Presentation at the Climate of the 20th Century workshop, Beijing [virtual presentation]

Pitman, A.: Presentation to the Chase Alive program, August 2010

Pitman, A.: Keynote at the AUSTRALIAN INSTITUTE of COMPANY DIRECTORS, May 2010

Pitman, A.: Talk at Cranbrook School Assembly, 24th February, 2010

Pitman, A.: Keynote to the Climate Champion program workshop 28 June.

Pitman, A.: Talk at Killara High School, 26th May, 2010

Pitman, A.: Briefing on Climate Change to KPMG, 28th July, 2010

Pitman, A.: Climate change seminar for Ku-ring-gai residents, 28th July, 2010

Pitman, A.: Talk to the "Learning to Adapt" for the National Climate Change Adaptation Research Facility, April 30th 2010

Pitman, A.: Talk to the National Climate Change Adaptation Research Facility in Brisbane, 27th October, 2010

Pitman, A.: Talk to Newington College, 21st September, 2010

Pitman, A.: Keynote to the Environmental Education Centres Principals' conference, Sydney, 11th October 2010

Pitman, A.: Talk to the SUTHERLAND CLIMATE ACTION NETWORK , 2nd June, 2010

Pitman, A.: Talk to the University of the 3rd Age, Sydney, 10th November, 2010

Pitman, A.: Talk to UBS, Sydney, 1st February, 2010

Pitman, A.: Talk to the Future Farm Industries CRC Postgraduate Professional Development Conference 18th August, 2010

Sherwood, S.: Are GCM's correct? Keynote talk, AMOS, Canberra.

Sherwood, S.: "What can water vapour isotopes tell us about deep convection?; discussion leader on Isotopes and Climate." WAVAS workshop on water vapour isotopes, Paris.

Sherwood, S., R. Allen: "The impact of natural versus anthropogenic aerosol on atmospheric circulation and cloud cover in CAM3;" EGU, Vienna.

Sherwood, S., with F. Robinson, C. Liu, D. Gerstle: "Testing the systematic response of a cloud-resolving model to forcing variations using TRMM observations over islands;" EGU, Vienna.

Sherwood, S.: "Slippery thermals and the cumulus entrainment paradox;" University of Melbourne.

Sherwood, S., with M. Colin and F. Robinson: "A revised conceptual model of cumulus clouds as thermal vortices;" AGU fall meeting.

Sherwood. S.: "Emphasizing history in communicating scientific controversies;" AGU fall meeting.

Taschetto, A. S., R. J. Haarsma, A. Sen Gupta, C. C. Ummenhofer and M. H. England: "Australian monsoon variability modulated by central-western Pacific SST warming," 17th National Australian Meteorological and Oceanographic Society (AMOS) Conference. Canberra, Australia, January, 2010.

Ummenhofer, C.: "Impacts of Indo-Pacific variability on rainfall and drought across the Australasian region", invited presentation at SATREPS Symposium on Climate Prediction and Information for the Society, Aizu, Japan.

Ummenhofer, C.: "Southeast Australian droughts linked to tropical Indian Ocean variability" oral presentation at Water@UNSW Symposium, Sydney.

Ummenhofer, C.: "Does timescale matter? Australian rainfall and Indo-Pacific variability from synoptic to decadal timescales", seminar at Lamont-Doherty Earth Observatory, Columbia University, New York, USA.

Ummenhofer, C.: "Eastern Indian Ocean variability – local versus remote influences", seminar at CCRC, UNSW, Sydney.

Ummenhofer, C.: "Ups and down(under)s in a postdoc's life: Is mobility a "must" for a successful scientific career?", ISOS Career Evening, Leibniz-Institute for Marine Science (IFM-GEOMAR), Kiel, Germany.

Ummenhofer, C.: "The role of the Indian Ocean for regional rainfall and drought: Mechanisms and implications for forecasting", invited seminar at Max Planck Institute (MPI) for Meteorology, Hamburg, Germany.

Ummenhofer, C.: "Australian droughts and the Indo-Pacific climate system – Does timescale matter?" seminar at IFM-GEOMAR, Kiel, Germany.

Ummenhofer, C.: "The role of the Indian Ocean for regional rainfall and drought: Mechanisms and implications for forecasting", invited seminar at Woods Hole Oceanographic Institution, Woods Hole, USA.

Ummenhofer, C.: "The Indian Ocean and Australian rainfall: Mechanisms, forecasting & applications", oral presentation at DISCCRS V Symposium, Phoenix, USA.

Ummenhofer, C.: "Indian and Pacific Ocean influences on Southeast Australian hydrology and drought", oral presentation at the 17th National Australian Meteorological and Oceanographic Society Conference, Canberra, Australia.

Appendix 1:
External Research Grants Funded in 2010

Obtaining external research funding continues to 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 opportunities are also actively pursued. External funding is used 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.

The major research finding success of 2010 was the announcement of funding for the new Centre of Excellence for Climate System Science to commence in 2011. However the CoE was just one among a suite of successes across various ARC schemes. External grants for which funding was scheduled to commence in 2010 included:

ARC Super Science Fellowships – Funding for 3 positions 2010 – 2013
Future Fellowship – Dr Katrin Meissner 2010 – 2014
ARC Laureate Fellowship –Matthew England 2010 – 2015
ARC Linkage Project – Lisa Alexander 2010 – 2013
ARC Discovery Project/ARF – Willem Sijp 2010 – 2014
ARC Discovery Project/APD – Andrea Taschetto & Matthew England 2010 – 2012
ARC Discovery Project – Dr Steven Phipps (UNSW sub-allocation) 2010 – 2012
AAS Australia-Germany Researcher Mobility – Caroline Ummenhofer - 2010

CCRC Staff continue to focus their energy on identifying suitable funding opportunities across various ARC schemes such as Future Fellowships, Linkage projects and Discovery projects. In late 2010, highly competitive submissions were either pending or in preparation for all of these schemes. The Discovery Grant announcements for funding commencing in 2011 saw the CCRC continue its success with successful outcomes for grants led by Sen Gupta, McNeil and Abramowitz & Pitman.

Snapshost of major active research projects in 2010:

Dr Lisa V Alexander, Prof David J Karoly, Dr Russell Vose, Dr Francis Zwiers
Transforming our research capacity in the analysis of climate extremes
2010;$47,500
2011:$97,500
2012:$100,000
2013 $50,000
Primary FoR 0401 ATMOSPHERIC SCIENCES
Partner/Collaborating Organisations: Canadian Climate Centre, Department of Climate Change, National Oceanographic and Atmospheric Agency

Given their devastating impacts, there is now a critical urgency to understand what drives extreme climate events and make timely predictions of their future risk. The analysis of comprehensive extremes datasets, comprising global observations and output of multi-model simulations, will greatly improve our ability to answer fundamental questions about the nature

and variability of extreme climatic events. This project also ensures the government's continued commitment to managing the risks associated with extreme events as an urgent priority. It represents a landmark opportunity for Australian leadership of an international collaboration between some of the world's leading climate scientists and climate data and modeling centres.

Prof Matthew H England
Future risks associated with ocean surface warming: impacts on climate, rainfall, carbon, and circulation
2010: $300,898
2011: $592,980
2012: $595,464
2013: $591,464
2014: $562,830
2015: $274,748
Primary FoR 0405 OCEANOGRAPHY
Climate change is already affecting Australia, with harsh drought, more intense bushfire seasons, increased monsoon rains, heatwaves, and warmer temperatures all a feature of the past few decades. Climate change is expected to accelerate in the future, warming the oceans at an increased rate. This will affect ocean circulation, carbon uptake and ocean-atmosphere modes, such as El Nino, with unknown intensity. This project will improve our preparedness for climate change by better quantifying the risks that ocean warming will transform Australia's climate, rainfall, and sea level; as well as the ocean's uptake of carbon and the global ocean circulation. This will benefit sectors including agriculture, water management, fisheries, and tourism.

Dr Katrin J Meissner
What caused abrupt climate change events in the past and what can they tell us about the future?
2010: $89,744.50
2011: $172,553.50
2012: $167,927.50
2013: $167,717.50
2014: $82,599.00
Primary FoR 0401 ATMOSPHERIC SCIENCES
This project will improve our understanding of abrupt climate change in the past, present and future. It will dramatically enhance Australia's capacity to use climate models to assess the probability and associated consequences of abrupt climate change in the future.

Prof Matthew H England, Prof Andrew J Pitman, Prof Steven C Sherwood, Dr Jason P Evans, Prof Andy Baker
Precipitation-groundwater interactions over eastern Australia: climate change impacts at multiple scales (Super Science Fellowships)
2010: $139,200
2011: $278,400
2012: $278,400
2013: $139,200
Primary FoR 0401 ATMOSPHERIC SCIENCES, Marine And Climate Science

Most surface water in the Murray-Darling Basin is used for agricultural activity, and groundwater extraction is accelerating. We cannot yet predict how these water resources will be affected by climate change, partly because Australian climate models do not represent key interactions between small and large scale rainfall changes, and interactions between ground water, the land surface and the atmosphere. This project will produce the first climate simulations that explicitly include these interactions. This will allow a better understanding of future changes to groundwater resources. This understanding will help us plan ahead, and enable new research to help Australia maintain food security in an uncertain future.

Prof MH England; Dr AS Taschetto; Dr GA Meehl
Modes of Pacific Ocean variability and their relationship to regional Southern Hemisphere climate
2010: $68,000
2011: $64,000
2012: $66,000
2013: $66,237
Primary RFCD 2606 ATMOSPHERIC SCIENCES
This project will provide a thorough examination of the role of the major Pacific Ocean modes in forcing variability in Australian climate. Enhancing our knowledge of the mechanisms driving natural modes of variability and how they affect Australian rainfall is fundamental for improving seasonal forecasting and long-term climate prediction. Results from this research can contribute to the underpinning sciences that inform on the risks associated with climate extremes and climate change. This is extremely beneficial to Australia, as it can have implications for adaptation strategies, assisting the socio-economic sectors dependant on climate forecasting, including agriculture, natural resources, bushfire control and water management.

Dr WP Sijp
The equable climate conundrum: the role of the global ocean in multiple climate regimes
2010: $ 104,566
2011: $ 105,566
2012: $ 104,566
2013: $ 105,566
2014: $ 104,566
Primary RFCD 2606 ATMOSPHERIC SCIENCES
This study will enhance Australia's global engagement in the research of past climates and global warming, and lead to a better understanding of the dynamics and modeling of warm climate states. This will contribute significantly to climate research in Australia and could lead to a better knowledge of the formation of the ancient deposits that we mine today. Furthermore, the study of 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. This study of past warm climates will improve our understanding of climate change physics and help quantify the risks of climate change posed to Australia.

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.

(QEII) 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.

(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 modeling 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.

Other Grants Funded in 2010

Investigator/s	Funding Scheme	2010 Income
Dr D. Green	Reef and Rainforest Research Centre	$40,000
Dr C. Ummenhofer	Australian Academy of Science: Scientific Visits to North America	$9,998
Dr C Ummenhofer	Australian Academy of Science: Austrlia-Germany mobility Scheme	$10,013
Prof A. Pitman, Prof S. Sherwood, Dr L. Alexander	Intergovernmental Panel on Climate Change Travel Support (DCCEE)	$145,000
Ms E. Shaw	CSIRO Flagship PhD topup	$7,000
Ms J. Trevena	CSIRO OCE PG Scholarship	$45,455
Mr I. Macadam	CSIRO Top Up Scholarship	$6,364
Dr S. Phipps	ARC Discovery Project – sub grant from University of Wollongong. "Untangling the links between El Nino and the changing global climate."	$15,300

Appendix 2:
2010 Publications

Books published in 2010

Green, D. and L. Minchin (2010). Screw Light Bulbs: Smarter Solutions to Tackling Climate Change. Melbourne, Scribe.

Peer reviewed Journal articles published in 2010

Abramowitz, G. (2010). "Model independence in multi-model ensemble prediction." Australian Meteorological and Oceanographic Journal 59: 3-6.

Allen, R. J. and **S. C. Sherwood** (2010). "Aerosol-cloud semi-direct effect and land-sea temperature contrast in a GCM." Geophysical Research Letters 37: L07702.

Arzel, O., A. C. de Verdière, **M. H. England**. (2010). "The role of oceanic heat transport and wind stress forcing in abrupt millennial-scale climate transitions." Journal of Climate 23: 2233-2256.

Chae, J. H., D. L. Wu, W.G. Read, **S.C. Sherwood**. (2010). "The role of tropical deep convective clouds on temperature, water vapor, and dehydration in the tropical tropopause layer (TTL)." Atmospheric Chemistry and Physics Discussions 10: 8963-8994.

Cruz, F. T., A. J. Pitman, et al. (2010). "Probabilistic simulations of the impact of increasing leaf-level atmospheric carbon dioxide on the global land surface." Climate Dynamics 34: 361-379.

Cruz, F. T., A. J. Pitman, J. McGregor and **J. P. Evans**. (2010). "Contrasting regional responses to increasing leaf-level atmospheric carbon dioxide over Australia." Journal of Hyrometeorology 11(2): 296-314.

Cruz, F. T., A. J. Pitman, et al. (2010). "Can the stomatal response to higher atmospheric carbon dioxide explain the unusual temperatures during the 2002 Murray-Darling Basin drought?" Journal of Geophysical Research 115: D02101.

d'Orgeville, M., W. P. Sijp, M. H. England and K. J. Meissner. (2010). "On the control of glacial-interglacial atmospheric CO2 variations by the Southern Hemisphere westerlies." Geophysical Research Letters 37: L21703.

Evans, J. P. (2010). "Global warming impact on the dominant precipitation process in the Middle East." Theoretical and Applied Climatology 99(3): 389-402.

Evans, J. P. and M. F. McCabe (2010). "Regional climate simulation over Australia's Murray-Darling basin: A multitemporal assessment." Journal of Geophysical Research 115: D14114.

Green, D. L., L. V. Alexander, et al. (2010). "An assessment of climate change impacts and adaptation for the Torres Strait Islands, Australia." Climatic Change 102(3-4): 405-433.

Green, D. L., J. Billy, et al. (2010). "Indigenous Australians' knowledge of weather and climate." Climatic Change 100(2): 337-354.

Green, D. L. and G. Raygorodetsky (2010). "Indigenous knowledge of a changing climate." Climatic Change 100(2): 239-242.

Liu, Y. Y., **J. P. Evans**, et al. (2010). "Influence of cracking clays on satellite estimated and model simulated soil moisture." Hydrology and Earth System Sciences 14: 979-990.

Luffman, J. J., A. S. Taschetto, M. H. England. (2010). "Global and regional climate response to late twentieth-century warming over the Indian Ocean." Journal of Climate 23(7): 1660-1674.

Macadam, I., A. J. Pitman, P.H. Whetton and **G. Abramowitz**. (2010). "Ranking climate models by performance using actual values and anomalies: Implications for climate change impact assessments." Geophysical Research Letters 37: L16704.

McNeil, B. I. (2010). "Diagnosing coastal ocean CO2 interannual variability from a 40 year hydrographic time series station off the east coast of Australia." Global Biogeochemical Cycles 24: GB4034.

McNeil, B. I. (2010). "A multi-decadal delay in the onset of corrosive 'acidified' waters in the Ross Sea of Antarctica due to strong air-sea CO2 disequilibrium." Geophysical Research Letters 37: L19607.

Newell, B. R. and **A. J. Pitman** (2010). "The psychology of global warming: improving the fit between the science and the message." Bulletin of the American Meteorological Society 91: 1003-1014.

Roubicek, A. J., J. VanDerWal, L. J. Beaumont, **A. J. Pitman**, et al. (2010). "Does the choice of climate baseline matter in ecological niche modeling?" Ecological Modeling 221(19): 2280-2286.

Santoso, A., A. R. Sen Gupta, M. H. England. (2010). "Genesis of Indian Ocean mixed layer temperature anomalies: a heat budget analysis." Journal of Climate 23(20): 5375-5403.

Shaw, E. C., A. J. Gabric, et al. (2010). "Response to comment on 'Impacts of aeolian dust deposition on phytoplankton dynamics in Queensland coastal waters'." Marine and Freshwater Research 61(504-506).

Sherwood, S. C. (2010). "Direct versus indirect effects of tropospheric humidity changes on the hydrologic cycle." Environmental Research Letters 5: 025206.

Sherwood, S. C. and M. Huber (2010). "An adaptability limit to climate change due to heat stress." Proceedings of the National Academy of Sciences 107: 9552-9555.

Sherwood, S. C., W. Ingram, et al. (2010). "Relative humidity changes in a warmer climate." Journal of Geophysical Research 115: D09104.

Sherwood, S. C., R. Roca, et al. (2010). "Tropospheric water vapor, convection, and climate." Reviews of Geophysics 48: RG2001.

Spence, P. J., J. Fyfe, et al. (2010). "Southern ocean response to strengthening winds in an eddy-permitting global climate model." Journal of Climate 23: 5332 - 5343.

Taschetto, A. S., R. J. Haarsma, **A. Sen Gupta, C.C. Ummenhofer, K. J. Hill and M. H. England.** (2010). "Australian monsoon variability driven by a Gill-Matsuno type response to central-west Pacific warming." Journal of Climate 23(18): 4717-4736.

Ummenhofer, C. C. (2010). "Southern Hemisphere regional precipitation and climate variability: Extremes, trends, and prediction." Bulletin of the American Meteorological Society 23: 48-50.

Willett, K. M., **L. V. Alexander,** et al. (2010). "State of the Climate in 2009." Bulletin of the American Meteorological Society 91(7): S19-S51.

Zika, J., T. J. McDougall, et al(2010). "Weak mixing in the eastern North Atlantic: An application of the tracer-contour inverse method." Journal of Physical Oceanography 40(8): 1881-1893.

Zika, J., T. J. McDougall, et al. (2010). "A tracer-contour inverse method for estimating ocean circulation and mixing." Journal of Physical Oceanography 40: 26-47.

Peer reviewed conference papers published in 2010

Evans, J. P. and M. F. McCabe (2010). Evaluating a regional climate model's ability to simulate the climate of the South-east coast of Australia. 17th National Conference of the Australian Meteorological and Oceanographic Society. B. A. Burns, C. Davis, A. E. Kiss and J. R. Taylor. Canberra, Australia, IOP Conf. Ser: Earth Environ. Sci.: 012004.

Evans, J. P., M. F. McCabe, et al. (2010). Impact of dynamic albedo and vegetation fraction on the simulation of drought in south-east Australia using a regional climate model. Remote Sensing and Hydrology 2010. Jackson Hole, Wyoming, USA

Liu, Y., **J. P. Evans**, et al. (2010). Comparing Passive Microwave Satellite Estimated and Regional Climate Model Simulated Soil Moisture over Murray Darling Basin in Australia (1988-2008). The Fourth International Workshop on Catchment-scale Hydrological Modeling and Data Assimilation Lhasa, Tibet

Liu, Y. Y., R. Parinussa, et al. (2010). Improving Satellite Soil Moisture Estimates by Combining Passive and Active Microwave Observations (1992-2008). Remote Sensing and Hydrology 2010 Symposium Jackson Hole,Wyoming, USA

Meng, X., J. P. Evans, et al. (2010). Impact of satellite-derived albedo on water cycle simulations over Australia's Murray-Darling Basin with the Weather Research and Forecasting (WRF) model. The Fourth International Workshop on Catchment-scale Hydrological Modeling and Data Assimilation Lhasa, Tibet

Phipps, S. J. and J. N. Brown (2010). Understanding ENSO dynamics through the exploration of past climates. PAGES 1st Young Scientists Meeting "Retrospective views on our planet's future".

Taschetto, A. S., R. J. Haarsma, et al. (2010). "Teleconnections associated with the intensification of the Australian monsoon during El Niño Modoki events." IOP Conf. Ser.: Earth Environ. Sci 11.

Other items published in 2010

Knutti, R., **G. Abramowitz**, et al. (2010). Good Practice Guidance Paper on Assessing and Combining Multi Model Climate Projections. Meeting Report of the IPCC Working Group I Technical Support Unit. T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor and P. M. Midgley, University of Bern, Bern, Switzerland: 13.

Phipps, S. J. (2010). Technical Report: The CSIRO Mk3L climate system model v1.2, Antarctic Climate and Ecosystems Cooperative Research Centre: 121.

Raupach, M., P. Briggs, V. Haverd, K. Whan and **C. C. Ummenhofer**. (2010). Chapter 4: Impact of climate variability and change on the water balance in Program Annual Report 2009/10. South Eastern Australian Climate Initiative (SEACI), CSIRO: 39-49.

"The Science of Climate Change: Questions and Answers", Australian Academy of Science, Canberra; www.science.org.au/policy/climatechange2010.html
(co-authors include: **Professor Steven Sherwood** and **Professor Matthew England**)

Sherwood, S. C., T. Kjellstrom, **Green, D. L.** (2010). "Heat Stress in a Warming World." Australian Science 31.

Items published in 2010 under authors' previous affiliations

Alexander, L. V., P. Uotila, et al. (2010#). "A new daily pressure dataset for Australia and its application to the assessment of changes in synoptic patterns during the last century." Journal of Climate 23(5): 1111-1126.

Chae, J. H. and **S. C. Sherwood** (2010#). "Insights into cloud-top height and dynamics from seasonal cycle of cloud-top heights observed by MISR in the west Pacific region." Journal of the Atmospheric Science 67: 248.

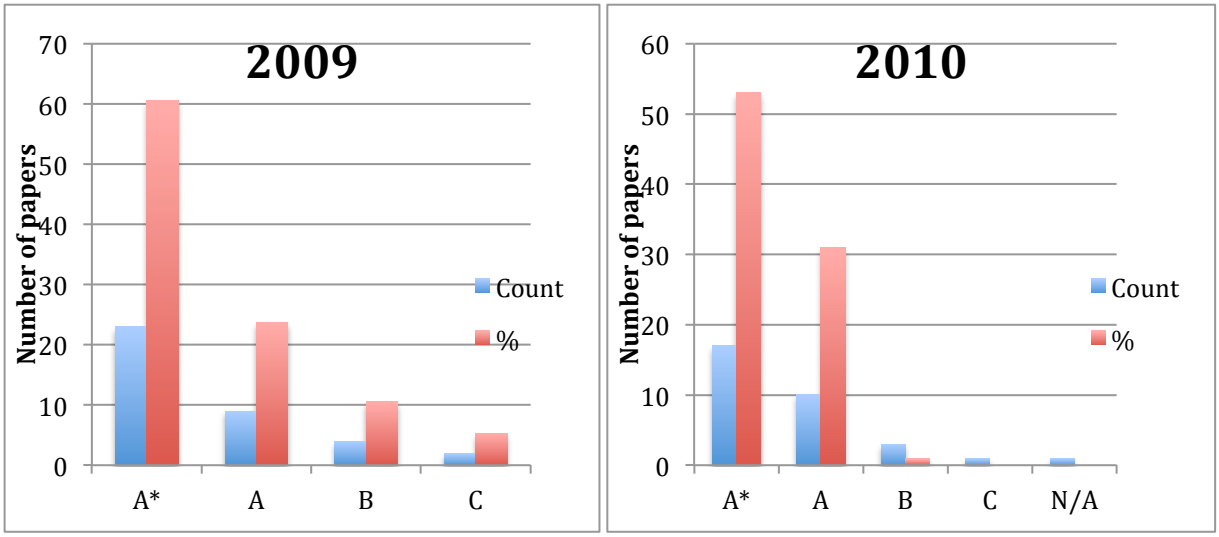
Fyke, J. G., L. Carter, A. Macintosh, A. Weaver and **K. J. Meissner**. (2010#). "Surface Melting over Ice Shelves and Ice Sheets as Assessed from Modeled Surface Air Temperatures." Journal of Climate 23: 1929-1936.

Nicholls, N., P. Uotila and **L.V. Alexander**. (2010#). "Synoptic influences on seasonal, interannual and decadal temperature variations in Melbourne, Australia." International Journal of Climatology 30: 1372-1381.

Rangan, H., C. Kull and **L. V. Alexander**. (2010#). "Forest plantations, water availability and regional climate change: controversies surrounding Acacia mearnsii plantations in the upper Palnis Hills, southern India." Regional Environmental Change 10(2): 103-117.

Analysis of Publications (2010)

The CCRC's journal publications fell overall when compared with 2009 numbers, from 38 total publications to 32, because of our focus to target A* and A journals. This focus was rewarded with an increase of the total journal publications in A and A* journals from 82% in 2009 to 84% in 2010. The figure below highlights the increase in this publication quality.



While the overall number of publications dropped in 2010 from 38 to 32, the great number of publications listed as In Press, holds promise for an increase in 2011 publications, as does the increase in staff numbers in 2010 being reflected by publications next year.

In addition to journal publications, Donna Green published a Category A book with Liz Minchin which garnered considerable positive press and became the CCRC's second book publication. *Screw Light Bulbs: Solutions to Tackling Climate Change* gives the reader a real understanding of the fundamental issues of climate change and empowerment to become more involved in the solution.

2010 saw an increase in peer-reviewed conference papers from the 3 in 2009, to 7 in 2010. Additionally, a book chapter and a number of reports were published, as were 5 journal publications listed to authors' previous affiliations.

We are pleased that the percentage increase in top-ranked journals continues to rise. Publishing in the best journals remains a focus of CCRC and we continue to strive towards publishing in *Nature* and *Science*, respectively.

Appendix 3:
Selected Media Coverage

January 25, 2010. The World Today. ABCOnline. **Climate Scientist says sceptics' are winning**. Andy Pitman.
http://www.abc.net.au/worldtoday/content/2010/s2800538.htm

January 28, 2010. ABC Science. **Scientists confirm positive CO2 feedback.** Andy Pitman.
http://www.abc.net.au/science/articles/2010/01/28/2802646.htm

February 3, 2010. The 7:30 Report. ABC Online. **Climate wars- Lord Monckton visits Australia**. Ben McNeil.
http://www.abc.net.au/7.30/content/2010/s2809518.htm

Feb 4, 2010. The World Today. ABC online. **Research links water vapour and climate change.** Steven Sherwood. http://www.abc.net.au/worldtoday/content/2010/s2810120.htm

February 8, 2010. Farm Weekly. **WA drought 'could be worst for 750 years'.** Andy Pitman.
http://fw.farmonline.com.au/news/state/agribusiness-and-general/general/wa-drought-could-be-worst-for-750-years/1745076.aspx

February 11, 2010. The Australian. **Scientists say IPCC should be overhauled or scrapped**. Andy Pitman. http://www.theaustralian.com.au/news/nation/scientists-say-ipcc-should-be-overhauled-or-scrapped/story-e6frg6nf-1225828951315

March 1, 2010. NewScientist - Environment. **Massive Antarctic iceberg threatens ocean circulation**. Matthew England.
http://www.newscientist.com/article/dn18595-massive-antarctic-iceberg-threatens-ocean-circulation.html

March 1, 2010. ABC Environment. **Changing climate is a slow burn**. Andy Pitman.
http://www.abc.net.au/environment/articles/2010/03/01//2833097.htm

Apr 16, 2010. eTurbonews.com. **Iceland volcano will have no affect on the global climate**. Steven Sherwood.
http://www.eturbonews.com/15570/iceland-volcano-will-have-no-affect-global-climate

April 27, 2010. Manila Bulletin. **Climate debate gets ugly as world moves to curb CO2**. Andy Pitman. http://www.mb.com.ph/node/254782/climate-debate-get

May 5, 2010. G online.com.au. **Climate science: fact from fiction**. Steven Sherwood.
http://www.gmagazine.com.au/features/1947/climate-science-fact-fiction

May 5, 2010. ScienceAlert.com.au. **Humans Fail in Rising Heat**. Steven Sherwood.
http://www.sciencealert.com.au/news/20100505-20918.html

May 12, 2010. The Christian Science Monitor. **Global warming: Earth could become unbearably hot, researchers say**. Steven Sherwood. http://www.csmonitor.com/Science/2010/0512/Global-warming-Earth-could-become-unbearably-hot-researchers-say

May 15, 2010.Today Show. NBC.com. **Sydney feature**. Interview with Matthew England. http://www.sydney.com/NBC_Today_Show_p3383.aspx

July 23, 2010. Voxy.co.nz. **Major Whale And Wildlife Research Project Begins In Auckland Islands**. http://www.voxy.co.nz/national/major-whale-and-wildlife-research-project-begins-auckland-islands/5/56112

July 30, 2010. ScienceAlert.com.au. **Last decade breaks heat record**. Lisa Alexander. http://www.sciencealert.com.au/news/20103007-21189.html

August 9, 2010. Geelong Advertiser. **EDITORIAL: Erosion eats at coastal values**. Matthew England. http://www.geelongadvertiser.com.au/article/2010/08/09/199091_opinion.html

August 25, 2010. Sydney Morning Herald. **Declining trees spell gloom for planet**. Andy Pitman. http://www.smh.com.au/environment/climate-change/declining-trees-spell-gloom-for-planet-20100824-13qfn.html?skin=text-only

August 31, 2010. Lateline. ABC Online. **Praise for proposal to reform climate panel**. Andy Pitman. http://www.abc.net.au/lateline/content/2010/s2998964.htm

August 31, 2010. ABC.net.au. **Change of Heart from climate skeptics**. Ben McNeil. http://www.abc.net.au/pm/content/2010/s2998746.htm

September 1, 2010. The Australian. **Local support for report on UN climate panel**. Matthew England. http://www.theaustralian.com.au/news/world/local-support-for-report-on-un-climate-panel/story-e6frg6so-1225912528257

September 20, 2010. Sydney Morning Herald. **Psychology provides insight into why people doubt climate change**. Andy Pitman. http://www.smh.com.au/environment/climate-change/psychology-provides-insight-into-why-people-doubt-climate-change-20100919-15hy4.html?skin=text-only

October 07, 2010. The Australian. **Cutting through misleading emissions**. Andy Pitman. http://www.theaustralian.com.au/special-reports/climate-change/climate-change/story-fn5oikwf-1225935589037

October 28, 2010. National Geographic News. **Worst Drought in a Century Hurting Australian Farmers.** Andy Pitman. http://news.nationalgeographic.com/news/2007/11/071108-australia-drought_2.html

Dec 31, 2010. Reuters India. **Scientists demand climate action from Australia PM**. Matthew England. http://in.reuters.com/article/2008/09/29/idINIndia-35703520080929

Appendix 4:
Committee memberships

Abramowtiz, Gabriel

- WCRP GEWEX Global Land Atmosphere System Study (GLASS) panel
- International Land Model Benchmarking (ILAMB) development group

Alexander, Lisa

- Chair WMO Commission for Climatology Expert Team on Climate Risk and Sector-specific Climate Indices
- Member WMO CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and
  Indices
- Member Surface Temperatures Benchmarking and Assessment Working Group
- Co-convenor AMOS meeting special session: Extreme weather in the Australasian region – from floods to droughts (meeting Feb 2011)
- Co-convenor IUGG: High-impact weather and extreme climate events (meeting July 2011)
- Co-convenor WCRP Open Science conference: Integrating regional data sets into global products (meeting Oct 2011)
- Lead author IPCC AR5

England, Matthew

- Member, Prime Minister's Science, Engineering and Innovation Coun-cil (PMSEIC) Working Group "Energy-Water-Carbon", 2009-2010
- Australian Academy of Sciences National Committee for Antarctic Research, since 2010
- Co-chair, CLIVAR/CliC/SCAR Southern Ocean Region Implementation Panel, since 2008
- CLIVAR Expert Group on Drought research, since 2010
- Federal Department of Climate Change High Level Steering Committee on Climate Change Science Implementation, since 2009
- CSIRO Wealth from Oceans Flagship Advisory Board, since 2008

Evans, Jason

- Member of ESCCI-ECL Technical working group.
- Member of organising committee of MODSIM 2011
- Convener of AMOS 2012

Meissner, Katrin

- Postgraduate committee, CCRC, UNSW

- Member of the “Conseil Scientifique Groupement d'Intérêt Scientifique du Grand Observatoire de l'environnement et de la biodiversté terrestre et marine du Pacifique Sud (GIS GOPS)
- Advisory board member for Earth and Planetary Science Letters

Phipps, Steven

- Chair, New South Wales centre, Australian Meteorological and Oceanographic Society.
- Member, National Council, Australian Meteorological and Oceanographic Society.
- Member, National Committee for Quaternary Research, Australian Academy of Science.
- Treasurer, Australasian Quaternary Association.
- Co-leader, PAGES Aus2k network.
- Corresponding member, INQUA Palaeoclimate Commission.

Pitman, Andy

- Member of the Australian e-Research Infrastructure Council
- Australia-India Strategic Research Fund (AISRF) Advisory Panel.
- Member, science steering committee of the Global Land Atmosphere System Study of the World Climate Research Program
- Review Editor of the 5th Assessment report of the Intergovernmental Panel on Climate Change
- Member of the Integrated Land Ecosystem - Atmosphere Process Study (iLPEAS) of the International Geosphere Biosphere Program
- Member of the reference group for the Marine and Climate Data Discovery and Access Project (MACDDAP)
- Member of the Academy of Science’s National Committee for Earth System Science
- Member of the NSW Ministerial Council on Climate Change
- Member of the NSW Research Network on Climate Change

Sherwood, Steven

- National Academy of Science author panel, "Climate Change: Questions and Answers"
- IPCC lead author, WG I
- Victorian government accreditation review committee for the Bureau of Meteorology Training Program
- University member, ACCESS steering group
- AGU fall meeting session convenor, 12/2010 "Undiscovered Climates of Earth" (with M. Huber)
- UNSW Faculty of Science Research Management Committee
- UNSW Faculty of Science Higher Degree Committee
- UNSW Centre review committee for the iCinema Centre.

Ummenhofer, Caroline

- Secretary for NSW branch of the Australian Meteorological and Oceanographic Society (AMOS)

- Member of the 10ICSHMO Conference Program Organising Committee
- Member of the American Meteorological Society (AMS) Committee for Meteorology and Oceanography of the Southern Hemisphere

Appendix 5:
CCRC Seminar Series

Katrin Meissner CCRC *What is the radiocarbon record trying to tell us?* Wednesday 3rd February

Andy Baker *Stalagmites and palaeoclimates.* Wednesday 17th February

Robert Woodham *Selecting Forecast Strategies for the East Australian Current.* Wednesday 3rd March

Mathew Wells University of Toronto *Influence of the Coriolis force on the dynamics of gravity currents.* Monday 8th March

Larry Dwyer and Ray Spurr *Australia's Carbon Pollution Reduction Scheme (CPRS): Impacts on the Tourism Industry.* Wednesday 17th March

Paul Spence CCRC *Coarse versus eddy-permitting global climate simulations of the Southern Ocean.* Wednesday 24th March

Donna Green CCRC *Screw Light Bulbs: smarter solutions to tackle climate change.* Wednesday 31st March

Seth Westra CVEN/UNSW *Seasonal forecasting of precipitation - is there an upper limit to predictability?* Wednesday 21st April

Agus Santoso CCRC *The role of the Indonesian Throughflow on ENSO dynamics.* Wednesday 28th April

Vanessa Haverd CSIRO Wednesday 16th May

Alex Sen Gupta CCRC *Global Warming and the Tropical Pacific Ocean.* Wednesday 19th May

Laura Ciasto CCRC *Observations of Ocean-Atmosphere Interaction in the Extratropical Southern Hemisphere.* Wednesday 2nd June

Carolina Roman Monash University *Climate Change adaptation - a reflection on scientists and their role(s).* Wednesday 16th June

Stephen H. Schneider Stanford University *Global Warming: Motivating Game Changing Actions in an Era of Spin and Confusion* Wednesday 23rd June

Suraje Dessai University of Exeter *Robust adaptation to climate change*. Monday 28th June

Dave Bi CAWCR/CSIRO *Performance of the Australian Climate Ocean Model (AusCOM) and the Australian Community Climate and Earth System Simulator (ACCESS) Coupled Model in Simulating the World Ocean Climate.* Wednesday 28th July

Michael Reeder Monash University *Partitioning the Tropical Overturning*

Circulation. Monday 9th August

Peter Rayner *CO_2 observations from space, status and plans* Wednesday 1st September. **Sarah Perkins** *Evaluation and 21st century projections of the CMIP3 models over Australia* Thursday 26th August.

Trevor McDougall *Seawater Thermodynamics, Neutral Surfaces and Ocean mixing processes* Monday 13th September.

Caroline Ummenhofer CCRC *Eastern Indian Ocean Variability – Local versus Remote Factors* Wednesday 15th September.

Mick Ashcroft Australian Museum and UNSW Australian Wetlands and Rivers Centre *Predicting Species' Responses to Climate Change at the Regional Scale* Wednesday 22nd September.

Joe Kidston CCRC *Global warming; what's the big deal?* Wednesday 20th October.

Vincent Rossi Coastal Oceanography Group *Influence of mesoscale physical processes on planktonic ecosystems in the regional ocean: application to the Eastern Boundary Upwelling Systems* Wednesday 27th October.

Dave Thompson Colorado State University *Understanding variability in global mean surface temperature* Wednesday 3rd November.

Steve Pekar City University of New York *The Development of the Antarctic Cryosphere During the Cenozoic: When did the Ice Sheet Cometh?* Monday 8th November.

Charles Eriksen University of Washington *Resolving Eddies to Detect Seasonal & Interannual Flows in the Ocean with High Endurance Gliders* Friday 12th November.

Naomi Oreskes University of California *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* Monday 15th November.

James Screen University of Melbourne *Exploring the causes of recent Arctic temperature amplification* Tuesday 16th November.

Jun-Ichi Yano Meteo France *An introduction to mass-flux convection parameterization* Wednesday 17th November.

Joe Kidston CCRC *Poleward shifting westerlies: causes and consequences* Wednesday 24th November.

Gab Abramowitz CCRC *Model dependence and chaos in climate prediction* Wednesday 8th December.

Jan Zika Laboratoire des écoulements géophysiques et industriels *Modelling the Southern Ocean: Four surprising results* Monday 13th December.