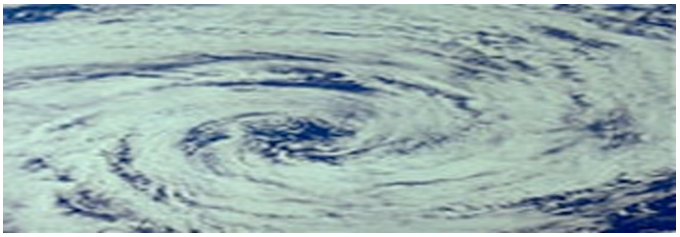


Climate Change Research Centre

Annual Report 2009



CONTENTS

Climate Change Research Centre

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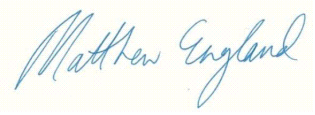
This is the second Annual Report from The Climate Change Research Centre – the CCRC – covering its second year of existence in 2009.

The CCRC continues to grow as a nationally significant research initiative at the University of New South Wales, combining the expertise of Co-Directors Professor Matthew England and Professor Andy Pitman with Professor Steven Sherwood and a team of some of Australia's top climate scientists. We are rapidly establishing the CCRC to be a research centre of international significance. The CCRC is now the largest Australian University laboratory combining climate science, oceanography, terrestrial processes, atmospheric sciences and meteorology. The Centre specializes in the physics and biophysics of climate variability and climate change. The Centre also explores the underlying dynamics and physical processes of the oceans, atmosphere and terrestrial systems and their combined impacts on climate change, the carbon cycle, climate extremes and climate vulnerabilities. We are a founding member of the Universities Climate Consortium.

Through 2009, the CCRC grew strongly with new appointments, new research fellows and new PhD students joining us each month. We reached our full complement of 12 full time academic staff in 2009 although one (Dr J. Kidson) will take up his position in 2010. The scale of the CCRC is now one of national leadership. We lead for example the science citation metrics in both oceanography and atmospheric sciences. This report documents the scale of performance during 2009.

While this report documents a strongly performing research centre, most of our metrics are still on the rise, particularly our PhD student intake. This report documents an intensively active research centre with strong successes in external research funding, publications in elite journals and an active PhD program. It highlights the foundations we built through 2009, with the underlying strategy of developing the capacity, profile and scale to lead a Centre of Excellence bid to the ARC in late 2009. Thus this report will document our 2009 successes, profiling some of the successes of our younger academic staff and some outstanding PhD students who represent both the future of the centre and key elements in the future of climate science in Australia. In this report we place these successes in the context of our overarching strategy of maintaining the excellence required of an outstanding research centre.



Professor Matthew England

Professor Andy Pitman

Climate Change Research Centre
Faculty of Science
The University of New South Wales
www.ccrc.unsw.edu.au

Summary of Performance in 2009

Highlights

- The Copenhagen Diagnosis – a CCRC-led science assessment that has been quoted by Prime Minister Kevin Rudd, has been downloaded over 1 million times and has resulted in over 5000 media stories worldwide
- The CCRC's first book: *The Clean Industrial Revolution* by Dr Ben McNeil
- A Young Tall Poppy Award – won by Dr Donna Green
- On-going growth in ARC income
- Appointment of Professor Matthew England to the Federal Department of Climate Change's High Level Steering Committee
- Appointment of Professor Andrew Pitman to the Department of Innovation, Industry, Science and Research's Australian e-research innovation council.
- A series of world-class seminars including notable international speakers from Germany, US, and Canada
- Hosting of two major national workshops: one on Southeast Australian rainfall and one on Earth System Modelling: Methods and Applications
- Almost 100 public lecturers, community talks and briefings
- A doubling of our annual output of A and A* journal publications since 2008
- An increase in our total journal publications from 23 (2008) to 38 (2009).

The CCRC seminar series was launched in 2009 by Dr Lisa Alexander and we were lucky to have several international visitors including: Dietmar Dommenget (University of Kiel), Adam Monahan (UVic Canada), Klaus Keller (Penn State University), Christa Peters-Lidard and Joe Santanello (NASA GSFC) and Phil Arkin (University of Maryland). In addition Penny Whetton from CSIRO presented "National climate change projections: history and possible future directions". We are grateful to the many staff and students from CCRC and across UNSW who made this a very successful seminar series in 2009.

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

We believe we achieved this goal in 2009 and provide evidence in this Annual Report of a scale of performance to defend this claim. Our goal now is more challenging; it 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.

Other functions and goals of the CCRC are to:

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

  This was partially achieved in 2009 via the appointment of the remaining academic staff. By the end of 2009 Professor Sherwood, Dr Lisa Alexander, Dr Katrin Meissner had all joined the CCRC. Our final appointment, Dr J. Kidson was appointed in 2009 but was

offered a research fellowship in the United States. We supported his desire to spend 18 months overseas before joining the CCRC.

- 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 and the 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 Department of Psychology to explore the denial of (the science) of climate change. We have contributed to on-campus workshops, co-supervision of PhD students in other Centres/Schools and Faculties and 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 links 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 and the Faculty of Engineering. In 2008 and 2009 our approach has been to support research needs as they develop. Demand has grown such that in we now have to be more careful and more strategic to select those opportunities 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.

  We have clearly developed this platform beyond what we reported in 2008. We have maintained a high level of success as demonstrated by successful ARC applications including Fellowships in 2009. We continue to grow this platform with new appointments and internal mentoring of new staff to maximize their likely ARC successes.

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

  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 2009. While we are limited by scholarships for overseas students we commenced one new international PhD student in 2009 and an International MSc student.

  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. We are developing a revised Advanced Science Undergraduate Program at

UNSW to try to grow the cohort of potential and suitably trained graduate students for the long term.

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

  The centre attracted approximately $1.39 million in external funding in 2009. $920,000 of this was category 1 research funding. (See section 5 for details of research income).

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

  This was achieved in 2009. 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. New initiatives that resulted from this work have been led by Evans and Alexander in the Centre, 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 2009 we positioned the CCRC for key funding opportunities including Super Science and the Centre of Excellence round. We did achieve the external research income of $1.1m in 2009 and will increase this by 10% in 2010. Our 2009 publication performance was extremely strong in terms of the quality of papers (more than 50% in A* journals) and we expect this to be maintained in 2010 with a significantly larger number since we are now near-fully staffed.

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

The 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. The report resulted in over 5000 media stories worldwide, with significant national coverage in Australia. *The Copenhagen Diagnosis* website has been visited more than one million times since the release of the report. A team of Australian climate scientists conceived the report, led its authorship, and coordinated a worldwide media release. These activities had a major global impact on awareness of the rate of climate change by the general public, policymakers, the media, and educators. The major message of the report, that climate change was occurring at a rate equal to, or above, the

projections of the Intergovernmental Panel on Climate Change (IPCC), was widely profiled by policymakers and the media in late 2009.

The Centre has had a successful 2009 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. We submitted an expression of interest for a Centre of Excellence as lead institution that was successful (the full proposal was submitted in April 2010 with outcomes known later this year). The CCRC has established clear leadership status for UNSW in this area of high national significance.

Staff members of The Climate Change Research Centre 2009

There were no resignations or retirements among full time, permanent academic staff in 2009.

Directors
Prof Matthew England
Prof Andy Pitman

Professors
Prof. Steven Sherwood

Research Fellows/Academic Staff
Dr Gab Abramowitz
Dr Jason Evans (ARC Australian Research Fellow)
Dr Donna Green
Dr Joe Kidson (starts August 2010)
Dr Ben McNeil (ARC QEII Research Fellow)
Dr Katrin Meissner
Dr Alex Sen Gupta
Dr Stephen Phipps

Post Doctoral Research Fellows (research funded)
Dr Olivier Arzel
Dr Laura Ciasto
Dr Jiafu Mao
Dr Agus Santoso
Dr Willem Sijp (ARC Post Doctoral Fellow)
Dr Andrea Taschetto
Dr Caroline Ummenhofer
Dr Marc d'Orgeville
Dr Paul Spence
Dr Xianhong Meng

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

Support Staff
Stephen Gray (Executive Officer)
Sophie Kober (Executive Assistant)

Visiting Fellows
Dr Michael Molitor
Dr Michael Rezny
Dr Frank Drost
Dr Milton Speer

Affiliated UNSW staff
Dr Mark Baird
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

CCRC International Profile: The Copenhagen Diagnosis

On 25th November 2009 the Climate Change Research Centre led Copenhagen Diagnosis was released. In the ensuing 48 hours the report was downloaded or read online more than 100,000 times. The report resulted in over 5000 media stories worldwide, with significant national coverage in Australia. It was quoted by Prime Minister Kevin Rudd, by the Minister for Climate Change and Water, Penny Wong; by the Minister for the Environment, Peter Garrett; as well as by the Greens leader in the Senate, Bob Brown and Greens Senator Christine Milne. PM Rudd, Senator Wong and Senator Brown each detailed the major findings of the Copenhagen Diagnosis in their speeches. The Copenhagen Diagnosis website has been visited more than one million times since the release of the report.

The Copenhagen Diagnosis summarised the most up-to-date climate science for the UN Conference of Parties (COP15) meeting in Copenhagen in December 2009. It included analysis on greenhouse gas emissions and atmospheric concentrations; the global carbon cycle; an update of changes to the atmosphere, the land-surface, the oceans, land-ice, glaciers, ice shelves, sea-ice and permafrost; paleoclimate, extreme events, sea level, future projections, abrupt change and tipping points; and a section devoted to answering some of the common misconceptions surrounding climate change science. It was an 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 report was aimed at a broad readership including the public, policy-makers and the media globally. It was based on the most significant peer-reviewed literature available at the time of publication, requiring the authors to carefully bring detailed and sometimes complex science into a format that could be easily digested by the interested layperson. The goal was a balanced, defensible and timely assessment of the latest science. The report, coupled with the resulting global media coverage, provided a high impact, widely accessible, clear and succinct appraisal of the latest observations and climate science available as at November 25th, 2009.

The Copenhagen Diagnosis found that changes to many of the world's major climate systems are tracking at or above IPCC projected 'worst-case' scenarios. Major findings of the report include:

- Surging greenhouse gas emissions: CO2 emissions from fossil fuels in 2008 were 40% higher than in 1990. Even if global emission rates are stabilized at present–day levels, just 20 more years of emissions would yield a 25% chance that warming will exceed 2oC, even with zero emissions after 2030.

- Recent global temperatures strongly support earlier evidence of human-induced warming: Over the past 25 years temperatures have increased by 0.5°Celsius, in good agreement with predictions based on greenhouse gas increases. Even over the past ten years, despite a decrease in solar forcing, the trend continues to be one of warming.

- Accelerated melting of ice-sheets, glaciers and Arctic sea-ice: Both the Greenland and Antarctic ice sheets are losing mass and contributing to sea-level rise at an increasing rate. The area of summer sea ice remaining in the Arctic during 2007-2009 was about 40% less than the average projection from the 2007 IPCC Fourth Assessment Report.

- Sea level rise projections updated: Global sea-level rise may exceed 1 metre by 2100 and several metres over the next few centuries without significant mitigation.

- Mitigation options are closing: To have a reasonable chance of ensuring that long-term global warming is less than 2°Celsius above preindustrial, average per-capita emissions in industrialized nations will have to be reduced by ~ 80-95% below 1990 levels by 2050.

The Copenhagen Diagnosis was conceived and led by Ben McNeil and Matthew England from the Climate Change Research Centre. Andy Pitman and Steve Sherwood each co-authored sections. Stephen Gray was the lead technical editor, compiling references and graphics, and proofreading. The website was developed by Matthew England and Stephen Gray.

The Copenhagen Diagnosis is available at www.copenhagendiagnosis.org

The Copenhagen Diagnosis Executive Summary was translated into Arabic, Bengali, Chinese, Czech, French, German, Hindi, Indonesian, Portuguese, Russian, Spanish and Polish. The report was distributed globally to all national greenhouse and climate change departments represented at the COP15 meeting and was also sent to all current Australian Members of Parliament.

The report was released in both print and online formats. The UNSW Climate Change Research Centre is the copyright holder (Hardcopy ISBN: [978-0-9807316-0-6], Online ISBN: [978-0-9807316-1-3]). The National Library of Australia recently asked that The Copenhagen Diagnosis be archived in its collection of Australian publications that aims to ensure access to the nation's documentary heritage both now and in the future.

Further education and outreach has also been pursued by the Diagnosis author team in response to the high volume of requests that have followed since the report's 2009 release. This includes provision of the report as a syllabus component for several University courses in the US, Europe, and Australia, provision of further background material and reading to educators at high school and tertiary education levels, and the provision of graphics, powerpoint slides, and other materials to teachers and other community leaders. Requests for use of figures from the report still come in regularly from monograph authors from all over the world.

2009 Selected Staff Profiles: Dr Gab Abramowitz

Understanding climate model independence and its implications for climate projections and impacts applications

There are many sources of uncertainty in climate model projections. These include future greenhouse gas levels, solar cycles and, for example, uncertainty in prescribing the precise temperature of the entire Earth's ocean and atmosphere at the beginning of a climate model simulation. There is also uncertainty that stems from the simplicity of the representation of the Earth that a climate model provides. Models necessarily make simplifications. This type of uncertainty is usually dealt with by using the average prediction from an ensemble of climate models. The more independent predictions we have, the closer we should come to getting the answers right.

Gab is interested in quantifying how independent the predictions of an ensemble of models actually are. As research organisations read the same literature, share data sets and even some sections of model code, there is reason to suspect the effective number of climate models in an ensemble may be smaller than we think. Formally defining independence is not easy though. Should an ensemble of perfectly independent models converge to the observational record, or is the observational record partly the result of unpredictable chaotic processes? In the latter case we might expect independent climate models to behave like the observational record statistically, but not necessarily match it.

Major achievements in 2009:

- Formalised definitions of model dependence in both of the above cases: (a) where we expect models to converge to observations and (b) where we expect models and observations to have similar statistical characteristics.
- Applied these definitions to the IPCC fourth assessment climate models to estimate the effective number of climate models in this ensemble.
- Derived and applied a model dependence weighting strategy that dramatically improved ensemble performance

Major objectives in 2010:

- Investigate how the application of this weighting strategy narrows the range of climate change predictions in the IPCC assessment report models
- Investigate how this narrowing affects projected climate change impacts in Australia

2009 Selected Staff Profiles: Dr Lisa V Alexander

Understanding variations in climate extremes and how these events are likely to change in the future

Weather and climate extremes have significant societal, ecological and economic impacts across most regions of the world. Future changes in the intensity and frequency of extreme weather are expected to have the most adverse effect on natural and human systems. However, to date we have little ability to monitor these events consistently, to understand what drives them or have certainty in how they might vary in the future under climate change. Primarily this is due to observed data limitations and the inability of current state of the art climate models to adequately reproduce the observed variability and trends in extremes, particularly for rainfall.

By addressing these gaps through improvement in the quality and availability of observations and model output Lisa's research aims to answer key scientific questions about the nature, variability and driving mechanisms of climate extremes. This greatly enhances the underpinning systems in place to provide policymakers with advice on how to manage the risks associated with extreme climatic events.

Major achievements in 2009:

- 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 south-east 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 2010:

- In collaboration with leading Australian and international researchers, begin development the most comprehensive global dataset of temperature and precipitation extremes for climate variability studies and model validation.
- Expand work on storms to include assessment of 100 year reanalysis products to understand the driving mechanisms for shifting storm tracks.
- Determine whether improvements to the latest version of the CCSM3 model has improved the representation of the El Niño-Southern Oscillation (ENSO) and by extension has improved the representation of maximum temperature extremes across Australia.

2009 Selected Staff Profiles: Prof. Steven Sherwood

Understanding clouds, water vapour and their links to climate change

Though cloud formation is a straightforward condensation process when you zoom into the centimetre scale, many questions remain when it comes to understanding why they develop differently under different conditions, or predicting what their aggregate effect on local or global climate will be.

Steven Sherwood came to the CCRC in 2009 to pursue such questions from a variety of angles. His research shows that relative humidity patterns in the atmosphere are changing as predicted by climate models---except several times faster. He also found that small humidity changes could strongly affect rainfall patterns by indirect mechanisms. His most recent study reveals that peak heat stress on Earth appears to be regulated by storm dynamics, and unfortunately, would increase so rapidly in a warmer climate as to become a dominant impact.

Steven and former colleagues in the US are using numerical simulations of individual storms to reveal why almost all hail and lightning is generated by continental storms, even though they account for only half of rainfall. If you experience astraphobia (fear of lightning), move to an island that is less than 50 km wide! Small islands cannot generate the strong air motions that create conditions for cloud electrification.

Major achievements in 2009:

- Wrote the most comprehensive review paper to date on interactions between atmospheric storms, water vapour and climate; and led other studies on humidity, aerosol impacts on clouds, storm dynamics, and future heat stress.
- Contributed to *The Copenhagen Diagnosis*, a CCRC-led, post-IPCC update on climate science, and other outreach and media efforts.
- Served as Postgraduate Research Coordinator for the CCRC.

Major objectives in 2010:

- Continue to build a larger group of students and postdocs, and make further improvements to the research and training of students.
- Pursue the reasons for the rapid shifts of climate zones now evident in the atmosphere.
- Embark on new projects relevant to past and future rainfall trends in Australia, and cloud feedbacks on regional and global climate.

2009 Selected Staff Profiles: Dr Willem Sijp

The equable climate conundrum: the role of the global ocean in multiple climate regimes

Global climate has been substantially warmer than today for long periods throughout earth's history, with polar warmth allowing crocodiles to thrive on Arctic islands as recently as the Eocene. These extreme conditions provide us with the only observable analogue of future warmth under human-induced climate change. Yet when hindcasting these ancient eras sophisticated IPCC models fail to reproduce polar warmth without yielding tropical temperatures that are too warm. Missing climate feedbacks must be involved. To understand past warmer climates and validate existing models,

Willem examines the interplay of ocean gateways, CO_2, atmospheric convection and ice that gives rise to this conundrum of warm global climates. I develop and run models of the hothouse climates of the Cretaceous and Eocene and collaborate with Henk Brinkhuis and Matthew Huber.

Major achievements in 2009:

- Created a working Eocene and Cretaceous model at 1.8x1.8 resolution, 40 z-levels.
- Implemented the turbulent kinetic energy scheme of Gaspar et al. 1990.
- Shown that the effect of the opening of Drake Passage at the end of the Eocene is highly dependent on the ambient warmth of the climate (published).
- Formulated a criticism (under internal review) of AMOC bistability criteria related to those of Rahmstorf 1996 (e.g. also that of Dijkstra 2007).

Major objectives in 2010:

- Publish a paper with the Eocene model wherein I open the Tasman seaway and examine the climatic effects
- Complete a set of 5000-year Cretaceous simulations under different hydrological cycle scenarios and produce a paper with Sascha Floegel at IFM Geomar, Kiel, Ger.
- Publish a paper with Henk Brinkhuis on the effects of high latitude Northern Hemisphere gateways. Emphasis on a combination of modelling work and field data. New data concerning the Turgai Strait and fresh Arctic conditions (allowing the so-called “Azolla events”) are of particular interest.
- In collaboration with leading international researchers Sascha Floegel, Henk Brinkhuis, Peter Bijl, Matthew Huber, explore the reasons behind high latitude warmth during hot house climates.

2009 Selected Staff Profiles: Dr Andrea S. Taschetto

Modes of Pacific Ocean variability and their relationship to regional Southern Hemisphere climate

The leading modes of Pacific variability regulate the earth's climate in profound ways. Foremost among these modes is the El Niño/Southern Oscillation, which itself exhibits strong inter-event variability. Over recent decades, the warm waters associated with El Niño events have been observed in the central, rather than the eastern, part of the Pacific basin. The mechanisms behind these recently-termed El Niño Modoki events are still elusive, however it is clear that their impacts on regional climate are distinct from those related to a canonical El Niño. This research explores how the Pacific Ocean sea surface temperature anomalies, particularly those associated with El Niño Modoki, drive climate variability over Australia and other Southern Hemisphere regions. The driving of regional climate variability and change is explored using available observations and a suite of ensemble climate model experiments.

Major achievements in 2009:

- A comprehensive documentation of Australian rainfall trends and extreme events over the late 20th century demonstrated that trends in total rainfall over Western Australia are driven by changes in the frequency of extreme events, while total rainfall changes over northeastern Australia are dominated by trends in the mean.
- Revealed that the El Niño Modoki SST pattern impacts Australian rainfall differently than a traditional El Niño event. While ENSO is associated with below-average rainfall conditions from September through November, Modoki produces dry conditions from March to May.
- Discovered that the Australian monsoon season shortens and intensifies in response to an El Niño Modoki signature in the tropical Pacific. Outcomes from this new research can potentially improve seasonal forecasting in Australia.

Major objectives in 2010:

- Continue to examine the physical links between the Pacific modes of variability and the Southern Hemisphere climate.
- Investigate the mechanisms associated with the El Nino Modoki triggering and its evolution.
- Install, compile and perform simulations with the new version of the National Centre for Atmospheric Research (NCAR) Community Climate System Model (CCSM4) on the Advanced Computing National Facility (APAC)

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

The CCRC is therefore strongly focussed on providing University leadership in the science of climate change, focussed on Australian problems and working closely with other University and government agency partners. The establishment of the UNSW Climate Change Research Centre ensures UNSW's national and international profile in climate science is growing strongly, and research is undertaken to attach Australian-specific problems. We fully anticipate growing this profile and contribution through 2010 and on-going into the future.

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

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

The UNSW Climate Change Research Centre (CCRC) 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.

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

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

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

Relationship with the University's strategic priorities and goals

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

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

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

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

Other linkages within and external to UNSW

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

ARC Network for Earth System Sciences. Pitman convenes and England plays a lead role in the ARC Network for Earth System Sciences as the Oceans Node coordinator. The ARC Research Networks scheme has now ended and all networks are formally being discontinued. However, Pitman's leadership of the UNSW Centre of Excellence bid has enabled UNSW Climate Change Research Centre to coordinate and lead this centre of Excellence. A successful Expression of Interest was submitted in 2009 leading to the invitation to be one of six groups at UNSW to submit full proposals. The ARC Research Network has been written into this Centre proposal in two ways. First, the research-intensive climate research Universities (UNSW, Monash, Melbourne, University of Tasmania and ANU) are formal partners in the Centre proposal. Secondly, a budget has been identified to maintain the role of the ARC Research Network in engaging students and early career researchers into the research of the centre irrespective of their host institution.

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 12 EFT), and the strategic investment by the University has consolidated this core expertise;

- We have a variety of income sources, being already well resourced via ARC Discovery, ARC Linkage and ARC Federation Fellowship schemes. We have facilitated proposals to other funding agencies and intend to maintain this in the future. Proposals to Super Science, Future Fellowships, the ARC Centres of Excellence scheme, the Australian Greenhouse Office and the NSW Environmental Trust schemes illustrate our commitment to win competitive research funding;

- The Centre is co-located in refurbished premises on Level 4 in the old Biomed Library 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.

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

Reporting Lines and selection of the director

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

Pitman and England jointly direct the Centre, reporting to the Dean of Science. Joint directorship allows for strategic efficiencies. The two Directors have synergistic skills in research terms, and have worked collaboratively for several years on a number of national climate science initiatives. Co-directorship from this team offers the Centre the greatest

opportunity to flourish. England and Pitman also have regular travel commitments domestically and internationally. Thus, in terms of day-to-day operations, co-directorship enables them to cover this role with a regular presence at UNSW, while not curtailing their research capacity.

Role and contribution of the centre director to the centre

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

A key role is leadership in establishing, growing and maintaining the centre. The directors will 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 frenzy 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

Through 2009 the CCRC reported directly to the Dean, on all matters relating to research, Centre strategy, staffing and funding.

All income and research quantum from ARC grants, Centres funding, consultancies, publications and other research income was expected to flow directly to the CCRC from the Faculty. This has not yet occurred and represents a significant threat to the performance of the centre. We remain in on-going negotiations to implement the agreements foreshadowed in the Centre proposal. Since these negotiations remain unresolved, realistically we do not anticipate the agreements foreshadowed in the Centre proposal to be honoured under the current budget model, which operates on an “as needs” basis.

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

During 2009 we met quarterly with the A/Dean Research (Faculty of Science) to discuss CCRC operational matters and strategic planning. We also met with the Dean of the Faculty of Science on a semi-regular basis, and attended the monthly Faculty Executive meetings. If successful, a formal management board would be established under the Centre of Excellence comprising external membership. During 2010, as instructed by the Dean of Science, we will continue to meet quarterly with the A/Dean Research and on an “as needs” basis with the Dean.

Financial Report 2009

Finances

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

	2009
Income	
External Funds	$1,390,028
UNSW Contribution	$796,436
Total Income	**$2,186,464**
Expenses	
Payroll	$2,554,546
Equipment	$60,353
Materials	$363,779
Travel	$373,431
Total Expenses	$3,352,109
Operating Result	-$1,165,645
Surplus brought forward from previous year	$1,566,468
Accumulated Funds Surplus	**$400,823**

Notes to the Statement of Financial Performance

External Funds

External funds were comprised of $918,075 in Category 1 competitive grants (primarily ARC), $245,810 via other research grant schemes including $107,390 received in the 2009 calendar year from Live Earth for the Copenhagen Diagnosis, $100,762 from ARCNESS and numerous smaller grants and contributions from external organisations to fund or reimburse staff and student travel to conferences, workshops and meetings.

UNSW Contribution

The 2009 contribution from UNSW funding sources included just under $100,000 in Strategic funds to support Prof Matt England's Federation Fellowship, two Goldstar Projects valued at $40,000 each (Dr Alex Sen Gupta and Dr Gab Abramowitz), two Early Career Research grants valued at $4,500 each (Dr Donna Green and Dr Alex Sen Gupta) and $5,000 in expense funds attached to Dr Caroline Ummenhofer's Vice Chancellor's Fellowship. The Faculty of Science

allocated approximately $130,000 to the centre in teaching revenue. Due to running a surplus in 2008, the Centre was able to forego its $400k strategic allocation from Faculty in 2009. The centre was also allocated $435k in strategic priorities funding in 2009 in addition to spending approximately the same amount of unspent 2008 SPF funds in 2009. Up to the end of 2009 (year 3), CCRC had drawn on $1.466m of the total $4m Strategic Priorities commitment from Central and $1.2m of the Faculty's $2mil commitment over 5 years.

Surplus brought forward from previous year

The surplus brought forward from 2008 was comprised of $714,325 in research/external funds, and approximately $470k each in Central and Faculty-derived strategic funding. In line with UNSW accounting procedures, no operating funds were carried over from 2008.

Expenditure

Predictably, the centre's largest expense is by far its people costs. In 2009 salaries and oncosts comprised 77% of total expenditure, up from 74% in 2008. Travel accounted for the next largest portion of expenditure. This figure includes relocation costs for Prof Steven Sherwood and his family from USA and for Katrin Meissner and her family from Canada and for Lisa Alexander and partner to move from Melbourne. $60,353 was spent on major IT equipment in 2009. The materials and maintenance component of $363,779 includes $153,000 paid to postgraduate students in stipends and topup scholarships and $32,000 paid to cover International PhD student fees.

Community Engagement, Talks and Lectures

Launch Seminar Series

The CCRC seminar series was launched in 2009 by Dr Lisa Alexander and we were lucky to have several international visitors including: Dietmar Dommenget (University of Kiel), Adam Monahan (UVic Canada), Klaus Keller (Penn State University), Christa Peters-Lidard and Joe Santanello (NASA GSFC) and Phil Arkin (University of Maryland). In addition Penny Whetton from CSIRO presented "National climate change projections: history and possible future directions". We are grateful to the many staff and students from CCRC and across UNSW who made this a very successful seminar series in 2009.

Workshops

A workshop on **Southeast Australian (SEA) rainfall** was held at the UNSW Climate Change Research Centre on 8-9 September 2009, bringing together about 30 scientists. The workshop was motivated by the ongoing SEA drought and associated scientific debate as to its causes and likelihood for continuance in the future in the face of global warming. The goals of the workshop were to identify areas of broad consensus, important open questions, and promising research strategies. The format was organised to maximise discussion while allowing participants to present their most recent work. Key problems include the relative roles of specific natural and anthropogenic causes in causing past rainfall variations – which bears critically on longer-term prediction – and the extent to which decadal variations are predictable. Click here to view the workshop program and power point presentations.

Earth System Modelling: Methods and Applications

7-11 September 2009. The Climate Change Research Centre, UNSW.

The winter school event took place at the Climate Change Research Centre and was run by ARCNESS. Mornings were devoted to presentations from leading Australian earth system modellers, while the afternoons were devoted to hands-on training in the use of the NCI National Facility and the CSIRO Mk3L climate system model.

CCRC in the news

Media monitoring shows that the CCRC had a significant presence in the media with over 400 media stories in 2009. Notable mentions include: The Copenhagen Diagnosis, Dr Caroline Ummenhofer's Indian Ocean Dipole (IOD) research breakthrough and Ben McNeil's published book 'The Clean Industrial Revolution'.

Work was covered in local and international media, online, print and radio. Media outlets include *The Age, Sydney drive time, Triple J, Channel 7's Today Tonight, Channel 10, The Australian, Torres News, Fiji Times, The Brisbane Times, The Sydney Morning Herald, Cosmos, News.Com, The West Australian, The Tech Herald (USA), The Telegraph (UK), Reuters India, Blast (Boston, USA), MSBNC (USA) and Environment Research Web (UK).* See Appendix 3 for details.

2009 External CCRC Talks

Abramowitz, G., 2009: Empirical benchmarking in land surface models, FLUXNET Modeling Workshop, Asilomar, California.

Abramowitz, G., 2009: Conceptions of model independence in ensemble simulations CAWCR Workshop on Ensemble Prediction and Data Assimilation, Bureau of Meteorology, Melbourne.

Abramowitz, G., 2009: An international land surface model evaluation protocol ACCESS Model Evaluation Workshop, Bureau of Meteorology, Melbourne.

Abramowitz, G., 2009: Model independence in climate and environmental prediction, UNSW Research Showcase Climate Change and Environmental Sustainability Program

Abramowitz, G., 2009: Techniques for identifying model structure weaknesses, Novel data mining strategies for exploring biogeochemical cycles and biosphere-atmosphere interactions Max Planck Institute for Biogeochemistry, Jena, German

Abramowitz, G., 2009: Model independence and the effective number of models in an ensemble, London School of Economics, 20th June, 2009 London, UK

Abramowitz, G., 2009: Towards a land surface model evaluation protocol, QUEST/GLASS Benchmarking meeting, Exeter, UK.

Abramowitz, G., 2009: Statistical benchmarking of land surface models, QUEST/GLASS Benchmarking meeting, Exeter, UK.

Abramowitz, G., 2009: Model space, model independence and techniques for identifying model structure weakness. UNSW Dept Maths and Statistics, 2009.

Abramowitz, G., 2009: Benchmarking of land surface models GLASS panel meeting.

Alexander, L.V., 2009: Diagnosing the synoptic influences driving changes in climate extremes over southern Australia during the last century, AMS 21st conference on climate variability and change, Phoenix, Arizona, USA.

Alexander, L.V., 2009: Changes in severe storms along Australia's 'Shipwreck Coast' since the mid-19th century.

Alexander, L.V., 2009: ACRE project meeting, Queensland, Australia.

Alexander, L.V., 2009: Extremes project collaboration, Met Office, Hadley Centre, Exeter, UK.

Alexander, L.V., 2009: Mechanisms driving climate extremes in Australia, University of Edinburgh, UK.

Alexander, L.V., 2009: Extreme events: observations, modelling and projections – progress since AR4, IPCC Scoping meeting, Venice, Italy.

Alexander, L.V., 2009: Trends and variability in storminess in south-east Australia since the late 19th century, CAWCR modelling workshop, Melbourne, Australia.

Cruz, F.T. A. J. Pitman, J. L. McGregor and **J. P. Evans,** Characterizing the impacts of increasing leaf-level carbon dioxide on the land surface, 9th International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne.

England, M.H., 2009: Climate change – the challenges and opportunities Environment Institute of Australia and New Zealand, March 28th 2009

England, M.H., 2009: Climate change – fact vs. fiction Bronte Beach Precinct Meeting.

England, M.H., 2009: *Re-evaluating the Scientific Imperative of Climate Change* Legalwise Seminar Wednesday 3 June 2009

England, M.H., 2009: The latest science on climate change, Sydney Yacht Club Climate Change Convention, 6 September, 2009.

England, M.H., 2009: Global climate modelling and climate change, Powerhouse Museum / Ultimo Science Festival lecture.

England, M.H., 2009: Climate change – the basic physics" AGSM Executive Programs Australian School of Business.

England, M.H., 2009: The latest science on climate change. Sydney University.

England, M.H., 2009: Climate change, Young Presidents Organisation ("YPO") Thurs 22 October, 2009.

England, M.H., 2009: UNSW Brain Food Lecture – Discussion Panel, UNSW.

Huda, S. and **J.P Evans,** 2009: Australian national Drought Policy. Meeting of the CagM (WMO Commission for Agricultural Meteorology) expert team on drought and extreme temperatures: preparedness and management for sustainable agriculture, forestry and fishery (ETDRET), Chinese Meteorological Administration, Beijing, China.

Green, D., 2009: Understanding models and modelling experiments, ARCNESS Winter School, UNSW.

Green, D., 2009: Invited speaker at Powershift, the Australian Youth Climate Coalition national conference, University of Western Sydney.

Green, D., 2009: Invited speaker at the 7th National Aboriginal and Torres Strait Islander Environmental Health, Kalgoorlie WA.

Green, D., 2009: Invited speaker at the Center for Biodiversity and Conservation Milstein Science Symposium 'Exploring the Dynamic Relationship Between Health and the Environment' New York.

Green, D., 2009: Keynote speaker at 'The impact of climate change on the social and emotional wellbeing of Indigenous Communities in rural and remote communities of Queensland' Centre for Rural and Remote Mental Health, Queensland.

McNeil, B.I., 2009: 8th International Carbon Dioxide Meeting, Jena, Germany, Death of Antarctic marine calcifying plankton linked to high CO waters.

McNeil, B.I., 2009: CLIVAR/CliC/SCAR Southern Ocean Region Implementation Panel 5th Meeting, Sydney, AUSTRALIA, Direct effects of CO2 uptake on SO ecosystems.

McNeil, B.I., 2009: Ocean Carbon Dynamics Workshop, UNSW, Coordination and Lecture.

McNeil, B.I., 2009: Climate Change Congress: Global Risks, Challenges and Decisions, Copenhagen. Presentation: Southern Ocean Acidification: A Tipping Point at 450ppm Presentation and Coordination: Copenhagen Diagnosis Workshop.

McNeil, B.I., 2009: SIMS Presentation: Ocean Acidification. Eastern Seaboard Climate Change Initiative (ESCII) Workshop.

McNeil, B.I., 2009: Climate Change Forum with Maxine McKew and Penny Wong, April 6, 2009, Shepherds Bay Community Facility, Bay Drive Meadowbank, Sydney. Update on latest climate science.

McNeil, B.I., 2009: Update on latest climate science. Climate Change Forum at Pittwater with Rob Stokes MP, Coastal Environment Centre, Narrabeen, Sydney.

McNeil, B.I., 2009: Update on latest climate science. SA Unions Climate Change Conference, Adelaide, Keynote Address, Presentation:

McNeil, B.I., 2009: Chairperson of the Think Climate Think Change Schools Competition: Parliament House Canberra, with Prime Minister Kevin Rudd, Deputy Prime Minister Julia Gillard and Climate Change Minister, Penny Wong.

McNeil, B.I., 2009: Update on latest climate science. United Nations Principles of Responsible Investment 'The Road to Copenhagen Meeting' The Westin Hotel,

McNeil, B.I., 2009: Presentation Invitation: The Post-Carbon World University of Queensland Sustainability Seminar, Hawken Building University of Queensland, Brisbane QLD.

McNeil, B.I., 2009: 'Rich and green' session, Brisbane Writers Festival, Queensland Library, Brisbane.

McNeil, B.I., 2009: Climate Change Forum, Willoughby Council with Robyn Williams, Dougherty Community Centre, Chatswood, Sydney.

Perkins, S.E. and **Pitman, A.J.,** Changes in the prediction of temperature extremes over Australia for the 21st Century based on different measures of model skill, 9th International Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne.

Pitman, A. J., 2009: Climate model evaluation using probability density functions, ACCESS/CAWRD May workshop, Second ACCESS Model Evaluation Workshop, Bureau of Meteorology, Melbourne.

Pitman, A. J., 2009: 'Climate model evaluation using probability density functions'. UNSW, 2009.

Pitman, A. J., 2009: 'The basics of global warming' for Julie Owens MP, Granville Town Hall, Granville.

Pitman, A. J., 2009: Presentation to the Forum on Climate Change for ALP Wentworth.

Pitman, A. J., 2009: Invited key note presentation to the Nuclear and Complementary Techniques of Analysis Conference (NCTA) at ANSTO.

Pitman, A. J., 2009: Key note - Catchment-scale Hydrological Modelling & Data Assimilation (CAHMDA) - III International Workshop, held in Melbourne Australia.

Pitman, A. J., 2009: Presentation to the Emergency Management Sector at the State Government's SEMC Climate Change Working Group. Portside Centre, Sydney.

Pitman, A. J., 2009: Keynote - The NSW Department of Environment, Climate Change and Water (DECCW) and the Australian Government Bureau of Meteorology are exploring the potential for an Eastern Seaboard Climate Change Initiative (ESCCI).

Pitman, A. J., 2009: Keynote CSIRO/CAWCR workship on the Selection of Global Climate Models (GCMs) for Regional Studies to be held in Melbourne.

Pitman, A. J., 2009: Free and Open Source Software for Geospatial Conference, Climate models and open source software. Sydney, Keynote with Steve Phipps.

Pitman, A. J., 2009: Climate Change Science, impacts and actions. Keynote - Independent Education Union Climate Change Conference.

Pitman, A. J., 2009: Macquarie Group Limited- Global warming science.

Pitman, A. J., 2009: Climate Change - knowns, unknowns and potential surprises - New South Wales Transport Infrastructure Development Corporation (TIDC).

Pitman, A. J., 2009: Keynote - NSW Sustainable Development Conference – observed and projected climate change in NSW.

Pitman, A. J., 2009:Talk to the Annual NSW Young Water Professionals Water Seminar Series Regional projections of rainfall changes over NSW.

Pitman, A. J., 2009: Talk for the Total Environment Centre: Global warming science.

Pitman, A. J., 2009: Woollahra Council presentation: How do scientists know that humans are causing global warming.

Pitman, A. J., 2009: Young Labour talk, The Science of Climate Change.

Sijp, W. P., 2009: The role of diffusion, SH westerlies and continental geometry in determining AMOC stability. UKTHCMIP Workshop Reading UK. Invited oral presentation.

Sijp, W. P., 2009: "Effect of ocean gateway changes under greenhouse warmth". Climate and Biotic Events of the Paleogene. Wellington New Zealand. Poster. Extended Abstracts.

Taschetto, A. S., C. C. Ummenhofer, A. Sen Gupta, and M. H. England 2009: Australian monsoon variability linked to tropical Pacific SST anomalies. EGU - European Geosciences Union. Vienna, Austria, April, 2009.

Taschetto, A. S., C. C. Ummenhofer, A. Sen Gupta, and M. H. England, 2009: Relative contributions of Pacific and Indian SST anomalies to regional climate variability. EGU - European Geosciences Union. Vienna, Austria.

Ummenhofer, C. C., M. H. England, P. C. McIntosh, G. A. Meyers, **A. Sen Gupta and A. S. Taschetto,** 2009**:** Tropical Indian Ocean variability forcing Southeast Australian droughts. EGU - European Geosciences Union, Vienna, Austria.

Hill, K., A. S. Taschetto and M. H. England, 2009: Analysis of the 1997 and 2002 El Niño impacts on Southern Hemisphere climate, 2009: 9th Conference on Southern Hemisphere Meteorology and Oceanography. Melbourne, Australia.

Taschetto, A. S., A. Sen Gupta, C. C. Ummenhofer & M. H. England, 2009: El Niño Modoki impacts on Australian rainfall. 9th Conference on Southern Hemisphere Meteorology and Oceanography, Melbourne, Australia.

Taschetto, A. S., 2009: Royal Netherlands Meteorological Institute - KNMI. Australian monsoon variability linked to tropical Pacific SST anomalies / Relative contributions of Pacific and Indian SST anomalies to regional climate variability. 29 Apr, 2009.

Taschetto, A. S., 2009: 7th Annual NCAR Early Career Scientist Assembly (ECSA) Junior Faculty Forum (JFF): "Connecting Weather and Climate in Observations, Models and Theory". 14-16 Jul, 2009.

Taschetto, A. S., 2009: Southeast Australian rainfall Workshop. UNSW, CCRC. El Niño Modoki and southeast Australian rainfall. 8-9 Sep, 2009.

Taschetto, A. S., 2009: "Climate Variability and Climate Change: Estimating and Reducing Uncertainties" , Hungarian Meteorological Service. Visegrad, Hungary, 8-17 June, 2009.

Sen Gupta, A., 2009: UNSW Open Day - Public Lecture on Climate Change

Sen Gupta, A., 2009: Galstaun College Climate Change Talk

Sen Gupta, A., 2009: Talented Students Day, Macquarie University: Climate Change Talk

Sen Gupta, A., 2009: UNSW Research Forum

Sen Gupta, A., 2009: Summit for a Post 2012 Kyoto Protocol - student model UN (Copenhagen) summit, participation of 5 international universities

Sherwood, S.C., 2009: Climate change - what we know and don't know, UNSW Pioneers.

Sherwood, S.C., 2009: What do we really know about climate change? Joint Engineering Institution

Ummenhofer, C. C., 2009: The role of the Indian Ocean for regional rainfall variability and droughts, seminar at the School of Ocean Sciences, Univ. of Wales, Bangor, UK.

Ummenhofer, C. C., 2009: The role of the Indian Ocean for regional rainfall patterns: Mechanisms and implications for forecasting", seminar at Lamont-Doherty Earth Observatory, Columbia Univ., New York, USA

Ummenhofer, C. C., 2009: Southeast Australian droughts and the Indian Ocean, Australian Meteorological and Oceanographic Society scientific seminar, Sydney.

Ummenhofer, C. C., 2009: Australian rainfall patterns and the Indian Ocean: synoptic to decadal timescales", seminar at CSIRO Marine & Atmospheric Research, Canberra, Australia.

Ummenhofer, C. C., 2009: "The role of the Indian Ocean for SEA droughts", presentation at "Southeast Australian Rainfall" workshop, Sydney

Ummenhofer, C. C., 2009: The role of the Indian Ocean for regional rainfall patterns - Mechanisms and implications for forecasting" seminar at Leibniz-Institute for Marine Science (IFM-GEOMAR), Kiel, Germany

Ummenhofer, C. C., 2009: Modulation of Australian precipitation by Indian Ocean Dipoles" poster presentation at EGU 2009, Vienna, Austria

Ummenhofer, C. C., 2009: Tropical Indian Ocean variability forcing Southeast Australian droughts" poster presentation at EGU 2009, Vienna, Austria

Ummenhofer, C. C., 2009: The role of the Indian Ocean for Southeast Australian droughts" presentation at the "Water and Energy Cycle of the Murray-Darling Basin Workshop", Sydney

Ummenhofer, C. C., 2009: The role of the Indian Ocean for Australian rainfall patterns – Mechanisms and implications for forecasting" invited seminar at Combined Rural Traders AGM NSW, Sydney & Victoria, Melbourne

Ummenhofer, C. C., 2009: Effect of tropical and subtropical Indian Ocean dipoles in driving precipitation around the Indian Ocean rim countries" at 9ICSHMO, Melbourne.

Appendix 1
Selection of Grants Funded in 2009

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

It will be noted that there were no new ARC grants won in 2009. In part this is due to most established staff having several on-going Discovery/Linkage grants. In part it is due to the new staff being appointed too late in 2008 to submit applications for funding in 2009. A significant number of newly submitted ARC Discovery and ARC Linkage grants are pending at the time of writing (May, 2010) submitted by both more established and newly arrived staff.

Despite these issues of timing, the CCRC exceeded its projected external income projections in 2009. Our target was $1.1m and we achieved $1.39m in total external funding. We also note that we have been increasingly active in searching for non-ARC Discovery and non-ARC Linkage funding including Future Fellowships, Super Science, Environmental Trust etc, outcomes of which will be reported in 2010.

Snapshots of some of the CCRC's active research projects in 2009:

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

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 modelling system of the MDB to understand its hydrology and meteorology in the context of human modification to climate and to land use in the basin. The improved understanding of the MDB will allow science-aware policy developments that reduce the vulnerability of agriculture and water resources within the basin to future changes caused through human activity.

(APD) Dr WP Sijp
What controls the shift from a hot house climate to a cold house climate: the Eocene/ Oligocene climate transition and greenhouse warming
2007 : $81,030
2008 : $81,030
2009 : $81,030
Primary RFCD 2606 ATMOSPHERIC SCIENCES
This study contributes to putting Australia on the map as a centre of excellence in the study of past climates as well as in global warming research. It aims at a greater understanding of the dynamics of past warm climate states. This could ultimately lead to a better knowledge of the formation of the ancient deposits that we mine in Australia today. Furthermore, the study of these past warm climates tells us something about current global warming as both involve increased levels of carbon in the atmosphere. The impact of climate change on Australia is likely to be large. Our study of past warm climates helps to gain an understanding of the mechanisms behind climate change and help quantify the risks of climate change posed to Australia.

Prof AJ Pitman; Dr J Beringer; Prof W Steffen; Dr G Richards; Dr Y Wang
Reengineering a dynamic vegetation model to explore the stability of Australian terrestrial carbon
2007 : $ 57,883
2008 : $ 63,856
2009 : $ 70,182
Primary RFCD 2606 ATMOSPHERIC SCIENCES
Australian Greenhouse Office
Collaborating/Partner Organisation(s)
Macquarie University
Overseas models do not represent Australian biophysical processes well: our flora and fauna are unique and our soils are old and nutrient poor. In contrast, the National Carbon Accounting System (NCAS) is a world-class framework for estimating current carbon processes. By building NCAS expertise into an overseas model of soil and vegetation processes we can develop the capacity to increase our confidence in future projections of carbon and vegetation change. Our proposal, linking Universities, CSIRO and the Australian Greenhouse Office establishes a team that is internationally competitive. It will enhance local expertise and local model development to ensure national policy development is underpinned by world-class science.

Other Select Funding

Dr Ben McNeil
Live Earth Australia Grant Funding
2009: $145,000
It is over three years since the drafting text was completed for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). In the meantime many hundreds of papers have been published on a suite of topics related to human-induced climate change. Twenty six of the world's leading climate scientists were involved in preparing *The Copenhagen Diagnosis* - a sixty page report which synthesizes the most policy-relevant climate science published since the close-off of material for the last IPCC report.

PhD Student Scholarships
CSIRO
2009: $36 727
One PhD student was awarded a full CSIRO-funded stipend, whilst two others secured top up scholarships valued at $7,000 pa.

Prof Andy Pitman
NSW Department of Environment and Climate Change
Regionalisation of extreme rainfall and temperature
2009: $50,000

This was a targeted research grant to provide projections of rainfall and temperature extremes over NSW that were consistent with projections of changes in averages provided earlier.

Appendix 2
2009 publications

Books published in 2009

McNeil, B.I., 2009: *The Clean Industrial Revolution: Growing Australian Prosperity in a Greenhouse Age*. Allen and Unwin.

Book chapters published in 2009

Green, D.L., 2009: Opal waters, rising seas: how sociocultural inequality reduces resilience to climate change among indigenous Australians. *Anthropology and Climate Change*, S Crate and M Nuttal, Eds., Left Coast Press.

Peer reviewed Journal articles published in 2009

Alexander, L.V. and S. Power, 2009: Severe storms inferred from 150 years of sub-daily pressure observations along Victoria's "Shipwreck Coast". *Australian Meteorological and Oceanographic Journal*, **58,** 129-133.

Ashe, B., K. McAneney, and **A.J. Pitman**, 2009: Total cost of fire in Australia. *Journal of Risk Research*, **12,** 121-136.

Dellnitz, M., G. Froyland, C. Horenkamp, K. Padberg-Gehle, and **A.R. Sen Gupta**, 2009: Seasonal variability of the subpolar gyres in the Southern Ocean: a numerical investigation based on transfer operators. *Nonlinear Processes in Geophysics*, **16,** 655-663.

Dessler, A. and **S.C. Sherwood**, 2009: Atmospheric Science: a matter of humidity. *Science*, **323,** 1020-1021.

England, M.H., **A.R. Sen Gupta**, and **A.J. Pitman**, 2009: Constraining future greenhouse gas emissions by a cumulative target. *Proceedings of the National Academy of Sciences*, **106,** 16539-16540.

Evans, J.P., 2009: 21st Century climate change in the Middle East. *Climatic Change*, **92,** 417-432.

Findell, K., **A.J. Pitman**, **M.H. England**, and P. Pegion, 2009: Regional and global impacts of land over change and sea surface temperature anomalies. *Journal of Climate*, **22,** 3248-3269.

Gitler, A., A. Chesi, M. Geddies, K. Strathearn, S. Hamamichi, **K.J. Hill**, K. Caldwell, G. Caldwell, A. Cooper, J. Rochet*, et al.*, 2009: α-Synuclein is part of a diverse and highly conserved interaction network that includes PARK9 and manganese toxicity. *Nature Genetics*, **41,** 308-315.

Griffies, S., A. Biastoch, C. Boening, F. Bryan, E. Chassignet, **M.H. England**, R. Gerdes, H. Haak, R. Hallberg, W. Hazeleger*, et al.*, 2009: Coordinated Ocean-ice Reference Experiments (COREs). *Ocean Modelling*, **26,** 1-46.

Hill, K.J., **A. Santoso**, and **M.H. England**, 2009: Interannual Tasmanian rainfall variability associated with large-scale climate modes. *Journal of Climate*, **22,** 4383-4397.

Hill, K.J., **A.S. Taschetto**, and **M.H. England**, 2009: South American rainfall impacts associated with inter-El Nino variations. *Geophysical Research Letters*, **36**.

Kiktev, D., J. Caesar, and **L.V. Alexander**, 2009: Temperature and precipitation extremes in the second half of the twentieth century from numerical modeling results and observational data. *Izvestiya, Atmospheric and Oceanic Physics*, **45,** 284-293.

Lamb, P.J., L.M. Leslie, R.P. Timmer, and **M.S. Speer**, 2009: Multidecadal Variability of Eastern Australian Dust and Northern New Zealand Sunshine: Associations with Pacific Climate System. *Journal of Geophysical Research - Atmospheres*, **114**.

Marchesiello, P. and **P. Estrade**, 2009: Eddy activity and mixing in the upwelling systems: a comparative study of northwest Africa and California regions. *International Journal of Earth Sciences*, **98,** 299-308.

McAneney, J., K. Chen, and **A.J. Pitman**, 2009: 100-years of Australian bushfire property losses: Is the risk significant and is it increasing? *Journal of Environmental Management*, **90,** 2819-2833.

McGregor, S., **A.R. Sen Gupta**, J. Neil, and S. Power, 2009: The modulation of ENSO variability in CCSM3 by extratropical Rossby waves. *Journal of Climate*, **22,** 5839-5853.

McNeil, B.I. and B. Tilbrook, 2009: A seasonal carbon budget for the sub-Antarctic Ocean, south of Australia. *Marine Chemistry*, **115,** 196-215.

Moles, A., D. Warton, L. Warman, N. Swenson, S.W. Laffan, A. Zanne, **A.J. Pitman**, F.A. Hemmings, and M. Leishman, 2009: Global patterns in plant height. *Journal of Ecology*, **97,** 923-932.

Perkins, S.E. and **A.J. Pitman**, 2009: Do weak AR4 models bias projections of future climate changes over Australia? *Climatic Change*, **93,** 527-558.

Perkins, S.E., **A.J. Pitman**, and S.A. Sisson, 2009: Smaller projected increases in 20-year temperature returns over Australia in skill-selected climate models. *Geophysical Research Letters*, **36**.

Pitman, A.J., N. De Noblet-Ducourdre, **F. Cruz**, E.L. Davin, G.B. Bonan, V. Brovkin, M. Claussen, C. Delire, L. Ganzeveld, V. Gayler*, et al.*, 2009: Uncertainties in climate responses to past land cover change: First results from the LUCID intercomparison study. *Geophysical Research Letters*, **36**.

Pitman, A.J. and **S.E. Perkins**, 2009: Global and regional comparison of daily 2-m and 1000-hPa maximum and minimum temperatures in three global reanalyses. *Journal of Climate*, **22,** 4667-4681.

Pook, M., S. Lisson, J. Risbey, **C.C. Ummenhofer**, P. McIntosh, and M. Rebbeck, 2009: The Autumn break for cropping in Southeast Australia: trends, synoptic influences and impacts on wheat yields. *International Journal of Climatology*, **29,** 2012-2026.

Risbey, J., M.J. Pook, P.C. McIntosh, **C.C. Ummenhofer**, and G. Meyers, 2009: Characteristics and variability of synoptic features associated with cool season rainfall in southeastern Australia. *International Journal of Climatology*, **29,** 1595-1613.

Sen Gupta, A.R., **A. Santoso**, **A.S. Taschetto**, **C.C. Ummenhofer**, **J. Trevena**, and **M.H. England**, 2009: Projected changes to the Southern Hemisphere ocean and sea-ice in the IPCC AR4 climate models. *Journal of Climate*, **22,** 3047-3078.

Sijp, W.P. and **M.H. England**, 2009: The control of polar haloclines by along-isopycnal diffusion in climate models. *Journal of Climate*, **22,** 486-498.

Sijp, W.P. and **M.H. England**, 2009: Atmospheric moisture transport determines climatic response to the opening of the Drake Passage. *Journal of Climate*, **22,** 2483-2493.

Sijp, W.P. and **M.H. England**, 2009: Southern Hemisphere westerly wind control over the ocean's thermohaline circulation. *Journal of Climate*, **22,** 6639-6652.

Sijp, W.P., **M.H. England**, and J.R. Toggweiler, 2009: Effect of ocean gateway changes under greenhouse warmth. *Journal of Climate*, **22**.

Speer, M.S., P. Wiles, and A. Pepler, 2009: Low pressure systems off the New South Wales coast and associated hazardous weather: establishment of a database. *Australian Meteorological and Oceanographic Journal*, **50,** 29-39.

Taschetto, A.S. and **M.H. England**, 2009: El Niño Modoki impacts on Australian rainfall. *Journal of Climate*, **22,** 3167-3174.

Taschetto, A.S. and **M.H. England**, 2009: An analysis of late 20th Century trends in Australian rainfall. *International Journal of Climatology*, **29,** 791-807.

Taschetto, A.S., **C.C. Ummenhofer**, **A.R. Sen Gupta**, and **M.H. England**, 2009: Effect of anomalous warming in the central Pacific on the Australian monsoon. *Geophysical Research Letters*, **36**.

Ummenhofer, C.C., **M.H. England**, **A.R. Sen Gupta**, **A.S. Taschetto**, M. Pook, J. Risbey, P.C. McIntosh, and G. Meyers, 2009: What causes southeast Australia's worst droughts? *Geophysical Research Letters*, **36,** 1-5.

Ummenhofer, C.C., **A. Sen Gupta**, **M.H. England**, and C.J.C. Reason, 2009: Contributions of Indian Ocean sea surface temperatures to enhanced East African rainfall. *Journal of Climate*, **22,** 993-1013.

Ummenhofer, C.C., **A.R. Sen Gupta**, and **M.H. England**, 2009: Causes of late-twentieth century trends in New Zealand precipitation. *Journal of Climate*, **22,** 3-19.

Ummenhofer, C.C., **A.R. Sen Gupta**, **A.S. Taschetto**, and **M.H. England**, 2009: Modulation

of Australian precipitation by meridional gradients in east Indian Ocean sea surface temperature. *Journal of Climate*, **22,** 5597-5610.

Zika, J., B. Sloyan, and T. McDougall, 2009: Diagnosing the Southern Ocean overturning from tracer fields. *Journal of Physical Oceanography*, **39,** 2926-2940.

Peer reviewed conference papers published in 2009

Evans, J.P., (2009) Water Balance in the Murray-Darling Basin and the recent drought as modelled with WRF. 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, July 2009 Cairns, Modelling and Simulation Society of Australia and New Zealand and International Association for Mathematics and Computers in Simulation, 2790-2797.

Liu, Y.Y., M.F. McCabe, **J.P. Evans**, A.I.J.M.V. Dijk, R.A.M.D. Jeu, and H. Su, (2009) Comparison of soil moisture in GLDAS model simulations and satellite observations over the Murray Darling Basin. 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, July 2009 Cairns, Modelling and Simulation Society of Australia and New Zealand and International Association for Mathematics and Computers in Simulation, 2798-2804.

McCabe, M.F., Y.Y. Liu, R. Vinukollu, H. Su, **J.P. Evans**, and E.F. Wood, (2009) Comparison of latent heat flux estimates over Australia. 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, July 2009 Cairns, Modelling and Simulation Society of Australia and New Zealand and International Association for Mathematics and Computers in Simulation, 2805-2811.

Other items published in 2009

Alexander L.V., Wang XL, Wan H, Trewin B. 2009. Trends and variability in storminess over south-east Australia since the end of the 19th century. In: 'Modelling and Understanding High Impact Weather': extended abstracts of the third CAWCR Modelling Workshop, 30 November – 2 December 2009, Melbourne, Australia. CAWCR Technical Report No. 17. AJ Hollis (Ed).

Green, D.L., U. King, and J. Morrison, 2009: Disproportionate burdens: the multidimensional impacts of climate change on the health of indigenous Australians. *Medical Journal of Australia*, **190,** 4-5.

Green, D.L. and K. Ruddock, 2009: Is climate litigation the answer to the problems faced by Torres Strait Islanders? *Sustainable Development Law and Policy*, **IX,** 23-31.

Green, D.L. and K. Ruddock, 2009: Climate change impacts in the Torres Strait, Australia. *Indigenous Law Bulletin*, **7,** 8.

Phipps, S.J., 2009: Conference Report: Science meets Parliament, Canberra, Australia, 17-18 March 2009. *Bull. of the Australian Meteorological and Oceanographic Soc.*, **22,** 68-69.

Phipps, S.J., J. Gergis, and L. Petherick, 2009: Report: PAGES 1st Young Scientists Meeting and 3rd Open Science Meeting, Corvallis, Oregon, USA, 6-11 July 2009. *Quaternary Australasia*, **26,** 8-9.

Sherwood, S.C., N. Andronova, E. Fetzer, and E. Kursinski, 2009: What can water vapor reveal about past and future climate change? *EOS Transactions American Geophysical Union*, **90,** 122.

Taschetto, A.S., **A.R. Sen Gupta**, **C.C. Ummenhofer**, and **M.H. England**, 2009: How does El Niño Modoki affect the Australian monsoon? *Clivar Exchanges*, **14,** 35-47. HERDC Category: C2

Items published in 2009 under authors' previous affiliations

Alexander, L.V., N. Tapper, X. Zhang, A. Lynch, H. Fowler, C. Taebaldi, and A. Lynch, 2009: Climate Extremes: Progress and Future Directions. Editorial for Special Issue of International Journal of Climatology. *International Journal of Climatology*, **29,** 317-319.

Alexander, L.V. and J. Arblaster, 2009: Assessing trends in observed and modelled climate extremes over Australia in relation to future projections. *International Journal of Climatology*, **29,** 417-435.

Alexander, L.V., P. Uotila, and N. Nicholls, 2009: Influence of sea surface temperature variability on global temperature and precipitation extremes. *Journal of Geophysical Research - Atmospheres*, **114**.

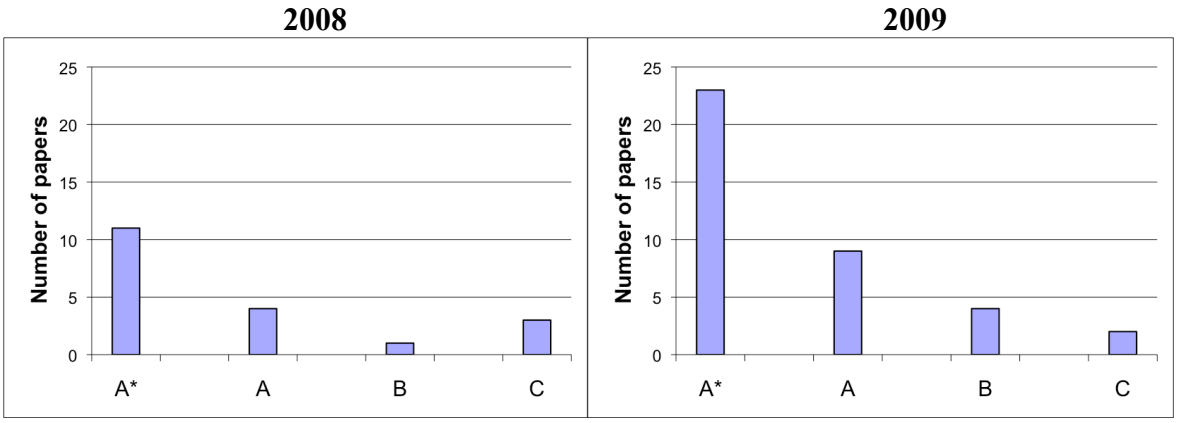
Allan, R., S. Tett, and **L.V. Alexander**, 2009: Fluctuations in autumn-winter severe storms over the British Isles: 1920 to present. *International Journal of Climatology*, **29,** 357-371.

d'Orgeville, M. and W. Peltier, 2009: Implications of Both Statistical Equilibrium and Global Warming Simulations with CCSM3. Part I: On the Decadal Variability in the North Pacific Basin. *Journal of Climate*, **22,** 5277-5297.

d'Orgeville, M. and W. Peltier, 2009: Implications of Both Statistical Equilibrium and Global Warming Simulations with CCSM3. Part II: On the Multidecadal Variability in the North Atlantic Basin. *Journal of Climate*, **22,** 5298-5318.

Analysis of Publications (2009)

The CCRC's publications grew significantly in 2009. Our strategies focussed on elite journals, in particular A* and A rated journals according to the ARC. Our A* publications grew from 11 in 2008 to 23 in 2009 and our total publications in journals increased from 23 in 2008 to 38 in 2009. Overall, we increased the percentage of our total journal publications in A and A* journals from 65% (2008) to 82% (2009). The figure below shows this change in our level of performance between 2008 (left) and 2009 (right), and the quality of performance.



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

In addition to journal publications, Dr Ben McNeil published a Category A book, a first for the Centre and a book that received considerable media attention. *The Clean Industrial Revolution: Growing Australian Prosperity in a Greenhouse Age* provides a timely vision on how Australia can transition from its dependence on fossil fuels with direct benefits to the economy.

Various refereed conference papers (Category E1) and a book chapter (Category B1) were also published.

The strength of our 2009 performance was clearly outstanding journal publications in elite journals. We published one paper in the Proceedings of the National Academy of Science that was welcome. We did not manage to publish papers in *Nature* or *Science*. We did submit several papers to these journals but all were considered too discipline specific and were subsequently published in *Geophysical Research Letters* or similar journals. We are striving to achieve publications in *Nature* or *Science* and we are encouraging staff to target these journals strategically.

Appendix 3 Selected Media Coverage

5 February, 2009. **Indian Ocean driving Australia's big dry: study**
ABC Science Online. Australia http://www.abc.net.au/news/stories/2009/02/05/2482667.htm

5 February, 2009. **Indian Ocean 'driving Australia's big dry'**
SBS News Online. Australia. http://www.sbs.com.au/news/article/1007786/Indian-Ocean-'driving-Australia's-big-dry'

5 February, 2009. **Indian Ocean is drought culprit,**
Sydney Morning Herald. http://www.smh.com.au/news/environment/indian-ocean-is-drought-culprit/2009/02/04/1233423310800.html

5 February, 2009. **Climate scientists look to Indian Ocean for reasons behind drought**
ABC Radio, A.M. http://www.abc.net.au/am/content/2008/s2482749.htm

5 February, 2009. **Scorching drought causes found, scientists claim**
Daily Telegraph, Sydney. http://www.dailytelegraph.com.au/news/indepth/causes-of-long-droughts-found/story-e6frewn9-1111118759931

15 April 2009. **Arctic Melt Back**
ABC Radio (JJJ) "The Hack"

30 April, 2009. **Climate scientists call for coal power stations' closure**
Lateline, ABC T.V. Australia. http://www.abc.net.au/lateline/content/2008/s2557593.htm

May 2009: **100 emerging leaders**
The Australian, Features

May 28th, 2009: ABC Local Radio WA (Albany) - Morning show 11am WST John Cecil

12 June, 2009. Voice of America – Phil Mercer. **Severe weather pattern threatens Asia-Pacific region**. Professor Matthew England.

17 June, 2009 **Rudd endorses emerging leaders awards for encouraging young Australians**
The Australian

23 June, 2009. **SA poised for clean energy boom**. Op-ed by Dr Ben McNeil.
Adelaide Advertiser - Adelaide, SA, Australia.

24 June 2009. 8:49 AM. ABC Southeast SA. Dr Ben McNeil.

8 July, 2009. 5:30 PM, Triple J Program: *Hack*. Dr Ben McNeil.

27 July, 2009. **Greenhouse gas laws disputed in court**
Lateline, ABC TV. Professor Andy Pitman.
http://www.abc.net.au/lateline/content/2008/s2638090.htm

28 July, 2009. **Nature's fury over stormy waters.**

The Warrnambool Standard - Victoria, Australia

29 July, 2009. 1:15 PM. Afternoons 2GB (Sydney). Professor Matthew England.

10 August, 2009. **Human-induced land cover changes can influence regional climate**. LittleAbout.com

24 September, 2009. **Climate study links Australian dust and New Zealand sunshine to pacific climate system.** Voxy.co.nz, - New Zealand http://www.voxy.co.nz/national/climate-study-links-australian-dust-and-new-zealand-sunshine-pacific-climate-sys/5/25044

24 September, 2009. **Droughts and flooding rains to intensify**. ABC News.com - Australia.

25 September, 2009. **El Nino comes in new flavours, thanks to global warming.** Sydney Morning Herald - Australia. http://www.smh.com.au/environment/el-nino-comes-in-new-flavours-thanks-to-global-warming-20090924-g4s4.html

30 October, 2009. **Tall Poppies are the pick of the crop** UNSW

2 November, 2009. **Slanders won't leave despite sea-level threat.** Sydney Morning Herald - Sydney, NSW, Australia.

12 November, 2009. **Oceans face acid test.** ABC Science online - Australia.

17 November, 2009. **Rudd upbeat on chances of emissions trading scheme deal with Coalition.** The Australian

18 November, 2009. **Australia leads world in carbon emissions.** ABC Online. - Australia.

24 November, 2009. **Too late for safe levels of carbon emissions.** Sydney Morning Herald - Sydney, NSW, Australia. http://www.smh.com.au/environment/too-late-for-safe-levels-of-carbon-emissions-20091123-iz8q.html

24 November, 2009: **Global Warming Report Finds Time Running Out** ABC News (USA) http://abcnews.go.com/Technology/GlobalWarming/global-warming-report-finds-time-running/story?id=9159815

24 November, 2009. **New report to confirm climate change trends.** Lateline, ABC TV, Australia. http://www.abc.net.au/lateline/content/2008/s2752509.htm

25 November, 2009. **Faster sea-ice melt disputes email.** The Australian - Sydney, NSW, Australia.

25 November, 2009. **Planet approaching point of no return, experts warn.**

Sydney Morning Herald - Sydney, NSW, Australia.
http://www.smh.com.au/environment/planet-approaching-point-of-no-return-experts-warn-20091124-jhes.html

25 November 2009. **Arctic Melt accelerating says new report.**
ABC Radio, A.M. – Australia. http://www.abc.net.au/am/content/2009/s2752636.htm

25 November, 2009. **Copenhagen Diagnosis: bleak update of global climate science.**
ABC Radio National - Australia. http://www.abc.net.au/rn/breakfast/stories/2009/2752561.htm

25 November, 2009. **Climate changing faster than expected: scientists.**
ABC Online - Australia.

25 November 2009: **Bleak Future for North Pole**
ABC TV News (NSW) – Australia
http://www.abc.net.au/news/video/2009/11/25/2753628.htm

26 November, 2009. **Warming diagnosis: beyond worst case.**
Sydney Morning Herald - Sydney, NSW, Australia.
http://www.smh.com.au/environment/warming-diagnosis-beyond-worst-case-20091124-jhco.html

27 November, 2009. **RP to push binding global warming accord**.
Manila Bulletin - Manila, Philippines.

27 November, 2009. **Who do you trust?**
Crikey.com

28 November, 2009. **Everything's dried up and Communities Begin to Crack.**
Sydney Morning Herald - Sydney, NSW, Australia.

30 November, 2009. **The Copenhagen Diagnosis: Sobering Update on Science**.
The Asia-Pacific Journal: Japan Focus.

4 December 2009. **Give them incentive and they will follow** (Op Ed, Dr Ben McNeil)
The Age & SMH, Australia. http://www.smh.com.au/environment/give-them-incentive-and-they-will-follow-20091203-k8te.html

Links to other selected coverage of the Copenhagen Diagnosis

http://www.abcnews.go.com/Technology/GlobalWarming/global-warming-report-finds-time-running/story?id=9159815
http://abcnews.go.com/Technology/GlobalWarming/global-warming-common-misconceptions/story?id=9159877
http://www.google.com/hostednews/afp/article/ALeqM5guyYFeHn4H0Pk5unhLBJrpVBBsug
http://www.reuters.com/article/latestCrisis/idUSGEE5AN1H2
http://www.canada.com/technology/Scientists+urge+drastic+action+Copenhagen+meet/2260366/story.html
http://www.grist.org/article/2009-11-24-copenhagen-diagnosis-offers-a-grim-update-to-the-ipccs-climate-s/
http://www.e360.yale.edu/content/feature.msp?id=2214
http://www.signonsandiego.com/news/2009/nov/24/warmings-impact-worse-expected-analysis-shows/
http://www.kpbs.org/news/2009/nov/24/uc-san-diego-researcher-says-climate-change-accele/
http://www.reuters.com/article/latestCrisis/idUSGEE5AN1QZ

Appendix 4 Committee memberships

Abramowtiz, Gabriel

- Member of the GEWEX Global Land Atmosphere System Study (GLASS) panel (foci of coordinated research in land surface).

England, Matthew

- CLIVAR/CliC/SCAR Southern Ocean Regional Implementation Panel, Co-Chair
- CLIVAR Working Group on Ocean Model Development
- Prime Minister's Science, Engineering and Innovation Council (PMSEIC) Working Group "*Carbon/Energy/Water Intersection*"
- Federal Department of Climate Change High Level Steering Committee on Climate Change Science Implementation
- Climate Scientists Australia
- CSIRO Wealth from Oceans Flagship Advisory Board
- Convenor, Copenhagen Climate Congress, Tipping Elements in the Climate System, Copenhagen, 2009
- AMOS / American Meteorological Society (AMS) 9th Southern Hemisphere Meteorology and Oceanography Conference Organising Committee

Evans, Jason

- Submission to House of Representatives Standing Committee on Primary Industries and Resources Inquiry into Australian farmers and climate change1 July, 2009.

Pitman, Andy

- Academy of Science National Committee for Earth System Science
- Global Energy Water Experiment (GEWEX) Global Land Atmosphere System Study (GLASS) Science Steering Committee
- International Geopshere Biosphere Programme iLEAPS science steering committee
- AMOS / American Meteorological Society (AMS) 9th Southern Hemisphere Meteorology and Oceanography Conference Organising Committee
- NSW government's Climate Research Networks panel
- NSW Ministerial Advisory Council (climate change)
- Risk Frontiers advisory board
- Climate Scientists Australia briefing to Federal Parliamentarians

Sherwood, Steven.

- Higher Degree Committee
- Faculty Research Management Committee
- ACCESS university steering group