



**Earth Systems and  
Climate Change  
Hub**

National Environmental Science Programme



# Research Plan

VERSION 3 EXECUTIVE SUMMARY

November 2016



**Australian Government**



National  
**Environmental  
Science  
Programme**

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# Introduction

## The National Environmental Science Programme

The National Environmental Science Programme (NESP) is a long-term commitment to support environmental and climate research. The key objective of the NESP is to improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision making. The focus of NESP is on practical and applied research that informs on-ground action and that will yield measurable improvements to the environment.

The Programme will build on its predecessors—the National Environmental Research Program (NERP) and the Australian Climate Change Science Programme (ACCSP)—in securing for decision makers the best available information to support understanding, managing and conserving Australia's environment.

The NESP is delivered through multi-disciplinary research hubs or consortia, hosted by Australian research institutions.

The NESP seeks to achieve its objective by supporting research that:

- is practical and applied and informs on-ground action
- addresses the needs of the Australian Government and other stakeholders by supporting and informing evidence-based policy and improving management of the Australian environment
- is innovative and internationally recognised
- enhances Australia's environmental research capacity
- is collaborative and builds critical mass by drawing on multiple disciplines, research institutions and organisations to address challenging research questions
- produces meaningful results accessible to government, industry and the community
- includes synthesis and analysis of existing knowledge
- builds relationships between scientists and policy-makers to encourage collaborative problem solving on environmental issues.

NESP end-users will be a broad range of stakeholders whose decisions may impact on the environment, and include the Australian Government, state governments, industry, business, community groups and Indigenous land managers (or Indigenous communities).

The intended outcomes of the NESP are:

- Enhanced understanding of and capacity to manage and conserve Australia's environment.
- Improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate.
- Timely research that is used by policy and decision-makers to answer questions and provide solutions to problems.

- Research outcomes that are communicated clearly to end-users and the general public, and stored in a manner that is discoverable and accessible.

## Role of the Earth Systems and Climate Change Hub

In the context of the intended NESP outcomes, the goal of the Earth Systems and Climate Change (ESCC) Hub is to ensure that Australia's policies and management decisions are effectively informed by Earth systems and climate change science now and into the future (Figure 1).

It will achieve this by building a national partnership, with world-leading capability in multi-disciplinary Earth system science and modelling that provides Earth system and climate information in support of a productive and resilient Australia.

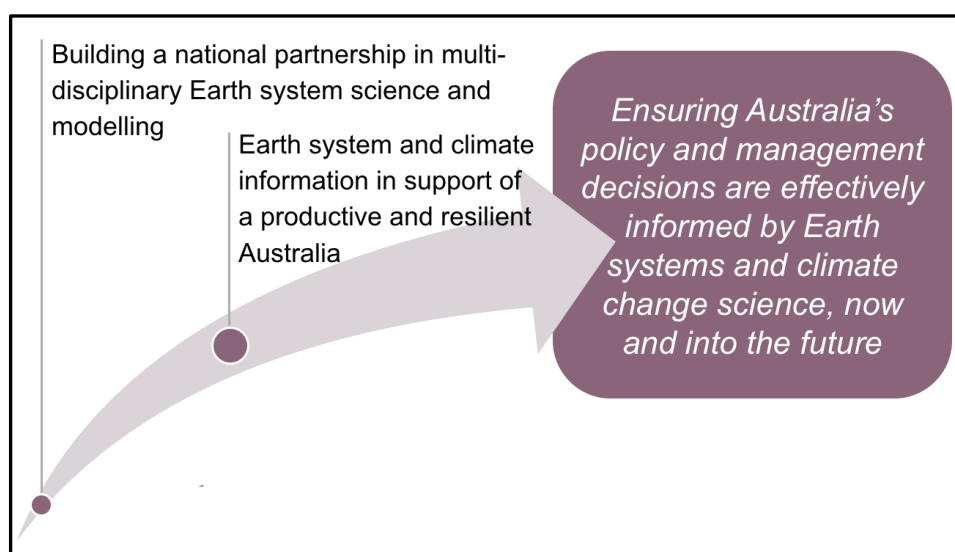


Figure 1: Earth Systems and Climate Change Hub goal

The Hub will deliver knowledge, information, and data products and services to ensure that environmental decision making is informed by an understanding of Australia's past, current and future climate.

It will build a national climate Earth system and climate simulation capability in ACCESS (the Australian Climate Community Earth System Simulator); ensure the provision of nationally coordinated climate information for use across NESP and the broader stakeholder community; support the University of Melbourne to establish a National Centre for Coasts and Climate (NCCC); and undertake research that informs low-cost abatement options.

Consistent with the Hub's stated goal and intended outcomes, the objectives of the Hub are, through world class research, to:

- lead the further development of a world-competitive, national Earth system and climate modelling capability (ACCESS) to deliver for weather and climate predictions and projections for the Australian community
- advance understanding of Australia's climate variability, extremes and associated drivers
- develop and strengthen stakeholder relationships, and support informed management and evidence-based decision-making

- facilitate outreach and communication of science products and services to end-users and the general public.

A schematic ‘programme logic’ summarising the strategic ‘path to impact’ for the Hub is provided in Appendix 1 (for more detail see also section entitled ‘Hub Programme Logic’). A glossary of terms and acronyms referred in this Research Plan is provided in Appendix 2.

## History of Australian Earth System and Climate Research

The NESP is an amalgamation of the NERP and the ACCSP.

The ACCSP was a three-decade research programme funded by the Australian Government with matching co-investment by CSIRO and the Bureau of Meteorology. It built much of Australia’s Earth system and climate science capability. This capability has been significantly augmented in recent years by the universities—especially as a result of the ARC Centre of Excellence for Climate System Science (ARCCSS). It is this capability and history of collaboration that led to a consortia partnership, led by CSIRO, being successful in a competitive tender process to form the current ESCC Hub.

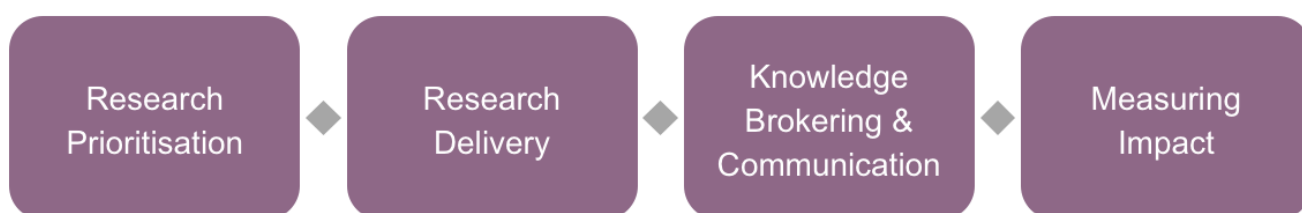
The ACCSP also provided the foundation for several complementary initiatives over the last decade or so, including: i) CSIRO and Bureau strategic investment in developing ACCESS (from 2005 to the present); ii) regional climate programs such as SEACI, IOCI and PACCSAP; iii) the NRM Regional Projections project that culminated in delivering of the Climate Change in Australia (CCiA) information and website ([www.climatechangeinaustralia.gov.au](http://www.climatechangeinaustralia.gov.au)) in 2015; and iv) investment in state-based regional climate projections research programs (e.g. TasFutures, Goyder, Queensland, VicCI and NARCLiM).

## Purpose of Research Plan

This Research Plan has been developed by the ESCC Hub, in consultation with the Department of the Environment and Energy (the Department hereafter) and other key stakeholders.

The purpose of the Research Plan is to outline:

- the research priorities the Hub is funded to investigate
- the research projects that will address these priorities
- how the output of the research will be communicated and brokered to key stakeholders
- how the impact of the research will be measured
- how Hubs will work collaboratively within and across Hubs.



This Research Plan also provides appropriate detail on the overall governance of the Hub, including outlining the broader funding profile, key staff and research organisations, and the key risks needing to be monitored and managed to ensure success.

## Hub administration and governance

### Overview

The Hub Leadership Team (HLT) and Hub Programme Management Team (HPMT) collectively have responsibility for the Hub's research delivery and operational management and administrative activities.

Research activities are structured via an agreed research portfolio endorsed by the Hub Steering Committee (HSC) and approved by the Department.

Figure 2 illustrates the Hub's governance structure, along with our key members and partnerships.

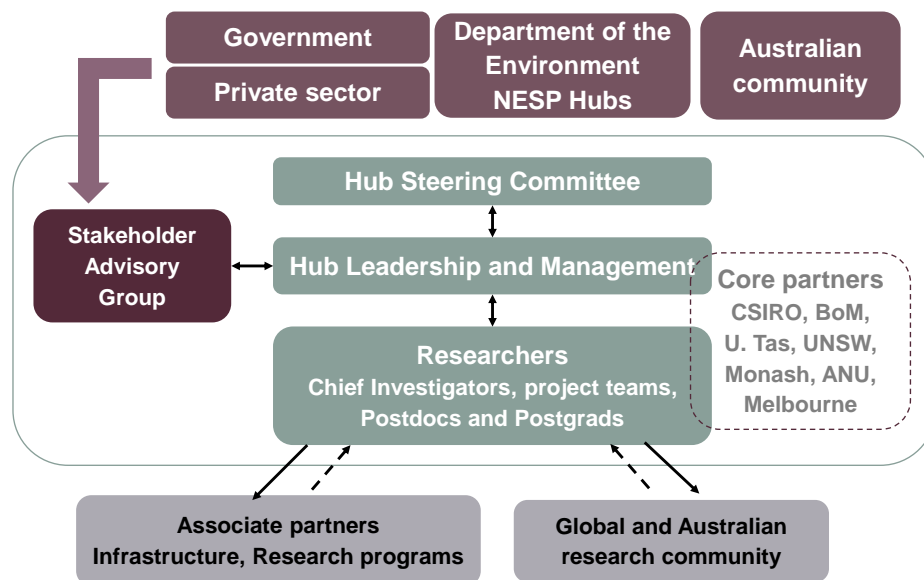


Figure 2: Earth Systems and Climate Change Hub Governance

### Hub Leadership and Programme Management Teams

The Hub Leader, working together with the other members of the HLT, and the HPMT, has accountability for overall Hub performance, including research delivery and associated milestone compliance, and day-to-day management and administration of all Hub activities across all Partners. The Hub Leader is Dr Helen Cleugh, from CSIRO.

The HLT is comprised of the Hub Leader and three Deputy Leaders, each representing the Hub Partners: Dr Aurel Moise (Bureau of Meteorology), Mr Kevin Hennessy (CSIRO) and Professor Nathan Bindoff (University of Tasmania, representing the university partners).

The HPMT comprises Dr Geoff Gooley (Programme Manager and primary contact for Monitoring & Evaluation activities) and Ms Mandy Hopkins (Programme Coordinator and primary contact for Indigenous Engagement activities). Mandy and Geoff are also the Hub's primary contacts for coordinating Hub-level data and information management, and communication and knowledge



brokering activities. The HPMT meets weekly and for convenience within the Hub it is referred to as Hub Central.

## Hub Steering Committee

The HSC provides strategic supervision over the Hub's performance against its objectives. This group comprises up to 12 individuals who have been identified and appointed because of their acknowledged expertise and professional interest in those research domains of relevance to the Hub, and/or to represent the interests of the Department of Environment and Energy and the Hub's partner agencies. Meeting approximately four times per year, the timing of the HSC meetings will be aligned to oversee key governance milestones for the Hub, including the annual Research Planning cycle, in a timely manner.

The roles, responsibilities and membership of the Hub Steering Committee include:

- ensuring the alignment of research activity to the policy needs and interest of the Department and other key stakeholders
- connecting the Hub's research questions, activities and outputs to relevant research activity and policy initiatives outside the Department
- overseeing the development and implementation of the Research Plan, including the review and amendment of the Research Plan, as required
- directing, and endorsing, the development, and delivery of any reporting, monitoring and evaluation requirements under this agreement
- reviewing, monitoring and guiding project performance.

## Hub Stakeholder Reference Network and Advisory Group

Dealing with the Hub on behalf of, and in the best interests of the Hub's broad external stakeholder network (presently > 200 institutions, agencies and individuals; see also Stakeholder Engagement p.18) is the Hub Stakeholder Advisory Group (HSAG). The primary role of the HSAG is to have governance oversight of the external stakeholder engagement arrangements of the Hub to ensure that such arrangements are effective, efficient, fair and equitable. This group comprises up to 10 individuals who have been identified and appointed because of their acknowledged expertise and/or professional interest in those research domains of relevance to the Hub – especially the Hub's outcome areas. Meeting approximately four times per year, the timing of the HSAG meetings will be aligned to precede and thereby inform the HSC meetings in a timely manner.

The Terms of Reference for the HSAG, and its composition, are provided in Appendix 4. Note that the HSAG has an independent Chair, who also serves on the Hub's Steering Committee.

## The Department of the Environment and Energy

The Department has responsibility for managing the NESP, including the approval of this Research Plan, assessment of progress of projects under this Research Plan, and payment of any NESP funding associated with the Hub agreement.

Importantly, the Department is the key end user of research under the NESP, and works closely with the Hub and other key stakeholders in determining and negotiating the delivery of research under the Research Plan.

## The Minister

The Minister for the Department of the Environment and Energy is the sole delegate with authority to approve major changes to the scope and funding allocation to the Hub, including all (current and future) versions of this Research Plan.

## Research priorities

The ESCC Hub is committed to a body of activity that includes short and long-term research projects. Each activity year, the Department will work with the Minister, the Hubs and other key stakeholders to identify and refine research priorities, and develop aligned projects.

This research prioritisation is a rolling process, and delivery of key milestones in each activity year, along with the Hub's Annual Progress Report and submission of the annual Research Plan to the Department, will inform the process. The NESP and Hub level monitoring and evaluation activities, including the Biennial NESP Programme Evaluation, which will review the impact and success of the programme across all Hubs, also play an important role in informing strategic directions and associated research priorities.

This constant consideration and evaluation of research output and impact will give confidence in the performance and effectiveness of the Hub in addressing its objectives, and thence the programme. It will also provide the basis for the flexibility needed for the Hub to adapt and respond to new and emerging stakeholder needs and research priorities in an adaptive manner, and ensures that the Hub's focus is fixed on the delivery of relevant and practical research which is outcome focused and targeted at addressing the needs of end-users.



The Earth Systems and Climate Change Hub research priorities, summarised in Figure 1, are:

a) ***Building the utility of Earth systems and climate change information***

- Work with our Partners and NESP to establish a National Centre for Coasts and Climate.
- Research to inform the lowest cost abatement opportunities, by both cost and weighted potential for mitigation.



- Engage with stakeholders to ensure that the information is being provided in a manner which supports decision-making and is meeting the needs of end users.
- Collaborate across National Environmental Science Programme Hubs to ensure that Earth systems and climate change research informs the broader Programme. This would include provision of nationally consistent and targeted regional climate projections and information relevant to specific issues, such as threats to marine and terrestrial ecosystems and ocean acidification.
- Develop and enhance Australia's national capability in Earth system and climate simulation through ongoing improvement of the Australian Climate Community Earth System Simulator (ACCESS) in the areas of accessibility and simulation performance.

**b) *Improving our understanding of how the climate system may change in the future.***

- Investigate how human activities will continue to influence the carbon cycle and change the chemistry and physical state of our oceans, atmosphere and terrestrial systems.
- Improve understanding and simulation of Southern Hemisphere climate drivers<sup>1</sup> in our climate models (especially ACCESS) to increase our confidence in projections of likely future climate change at multi-annual to multi-decadal time scales. Improve our understanding of how climate variability (e.g. the El Niño-Southern Oscillation) and the frequency, intensity and extent of extreme events (e.g. tropical cyclones and droughts) may change in the future.
- Further develop our ability to simulate and provide regional information on future climate, from years to decades.
- Consider low likelihood but high impact consequences of climate change for Australia to improve risk management decisions.
- Use improved climate projections and understanding of the drivers of climate to inform understanding of climate and coastal interactions.

**c) *Improving our observations<sup>2</sup> and understanding of past and current climate***

- Use observations of greenhouse gases and the Australian regional carbon budget to track changes and improve our understanding of how the different components of the natural and human elements of the carbon cycle interact and influence each other.
- Identify how the different scale drivers<sup>2</sup> of the climate system interact in the Southern Hemisphere to generate our past and current climate.
- Improve observational records<sup>3</sup> used for Australian climate change research, and examine the current and past patterns and trends in climate variability and extremes in the Southern Hemisphere, with an emphasis on the Australian region.  
Analyse robust observational records of our atmosphere, oceans, cryosphere and terrestrial systems to undertake 'detection and attribution' studies in order to identify and explain significant changes in our current climate.

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<sup>1</sup> The term "climate drivers" refers to the main modes of variability and change, such as the El Niño Southern Oscillation (ENSO) and changes in radiative forcing due to factors such as increases in greenhouse gases.

<sup>2</sup> The Hub has confirmed that this priority does not imply that the Hub undertakes primary observations – especially those that are the responsibility of operational agencies such as the Bureau of Meteorology.

## List of research projects

Below is a list of all completed and new/ongoing (approved) research projects and associated case studies funded under the ESCC Hub. For more detail on each specific project, please refer to Attachment A–Research Projects.

List of all Research Projects – a) Research Plan V1 and V2 (Approved and Completed); b) Ongoing; and c) Proposed for Research Plan V3

### Research Plan - Version 1 & 2 (Approved projects) - Completed

Project number	Project name	Project leader	Lead organisation	Timeframe
1.2	Stakeholder engagement	Helen Cleugh	CSIRO	2015 only (as approved in RPV1)
1.4 & 2.12	Sea level projections for NCCARF	Kathy McInnes	CSIRO	Sep 2015 – Jul 2016 Complete
1.5	Supporting the Establishment of the NCCC: Phase I (Engagement)	Helen Cleugh	CSIRO	Jan 2015 – Dec 2015 Complete

### Research Plan - Version 1 & 2 (Approved projects) - Ongoing

Project number	Project name	Project leader	Lead organisation	Timeframe	Status (on track/ delayed)
1.1	Current capability and future directions assessment	Helen Cleugh	CSIRO	July 2015 – Jul 2017	Delayed
1.3	Low cost abatement options: scoping workshop and report	Helen Cleugh	CSIRO	2016 only (as approved in RPV1)	Delayed and now ceased
2.1	Preparing ACCESS for CMIP6	Simon Marsland	CSIRO	Jul 2016 – Jun 2019	On track
2.2	Enhancing Australia's capacity to manage climate variability and climate extremes in a changing climate	Pandora Hope	Bureau of Meteorology	Jul 2016 – Jun 2019	On track
2.3	Towards an ACCESS decadal prediction system	Terry O'Kane	CSIRO	Jul 2016 – Jun 2019	On track, but changes likely given new investment by CSIRO
2.4	Changing oceans and Australia's future climate	Susan Wijffels	CSIRO	Feb 2016 – Jun 2019	On track
2.5	Improving Australia's climate model (ACCESS)	Tony Hirst	CSIRO	Jul 2016 – Jun 2019	Two milestones delayed
2.6	Regional climate projections science, information and services	Kevin Hennessy	CSIRO	Jul 2016 – Jun 2019	On track

Project number	Project name	Project leader	Lead organisation	Timeframe	Status (on track/delayed)
2.7	Refining Australia's water futures	Dewi Kirono	CSIRO	Jul 2016 – Jun 2019	On track
2.8	Extreme weather projections	Andrew Dowdy	Bureau of Meteorology	Jul 2016 – Jun 2019	On track
2.9	Risk assessment of future carbon sources and sinks	Pep Canadell	CSIRO	Jul 2016 – Jun 2019	On track
2.10	Coastal hazards in a variable and changing climate	Kathy McInnes	CSIRO	Jul 2016 – Jun 2019	On track
2.11	Establishing the NCCC	Stephen Swearer	Univ. Melbourne	May 2016 – May 2019	On track

## Research Plan - Version 3 (Approved activities and case studies)

Identifier	Activity Description	Leader	Lead organisation	Timeframe
ESCC Indigenous Engagement Activities 3.1 and 3.2	Indigenous engagement activities. See pg. 22	Mandy Hopkins Helen Cleugh	CSIRO	Jan 2017 – Apr 2018 i.e. RPV3 and RPV4 funding
ESCC Case Studies (RPV3) - 3.3 to 3.9	Case Study activities. See Attachment A	Helen Cleugh	CSIRO	Oct 2016 – Dec 2017

## Expected outcomes

The expected outcomes of the NESP are:

1. Enhanced understanding of, and capacity to manage and conserve Australia's environment.
2. Improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate.
3. Timely research that is used by policy and decision-makers to answer questions and provide solutions to problems.
4. Research outcomes that are communicated clearly to end-users and the general public, and stored in a manner that is discoverable and accessible.

Research under the NESP is expected to inform the policy and programme delivery of the Department. More broadly, it will engage and inform all key stakeholders with an interest in the outputs of environmental and climate science research, including state and local governments, business and industry, community groups, Indigenous land managers (or Indigenous communities) and education institutions.

## Outcomes for the ESCC Hub

In the context of these NESP outcomes, the Hub's goal (see Figure 1) is:

*To ensure that Australia's policies and management decisions are effectively informed by Earth systems and climate change science, now and into the future.*

Achieving this goal requires a portfolio of integrated research across the land, oceans and atmosphere domains; using modelling, simulations, projections and analyses of observations; and ensuring the provision of information to next- and end-users, and other stakeholders.

Within the scope of the Hub's research priorities, Hub-level outcomes were determined to better focus the Hub's research portfolio. These were based on information contained in relevant national strategies and plans, including: the National Marine Science Plan [October 2015]; Australia's national science and research priorities [May, 2015]; the National Climate and Resilience and Adaptation Strategy; the former National Climate Change Science Framework; and relevant end-user needs assessments (some of these were done by the Hub Partners).

Through this process, the Hub identified the top five climate challenges facing Australia as the Hub's outcomes (Figure 3). The Hub's portfolio of proposed research projects is designed to address these outcomes at a sectoral level and thereby deliver impact and benefit for Australia. Additional and important climate challenges, in the health, heritage, infrastructure, and national security/defence sectors, are also acknowledged and will be indirectly addressed by the Hub's research to varying degrees.

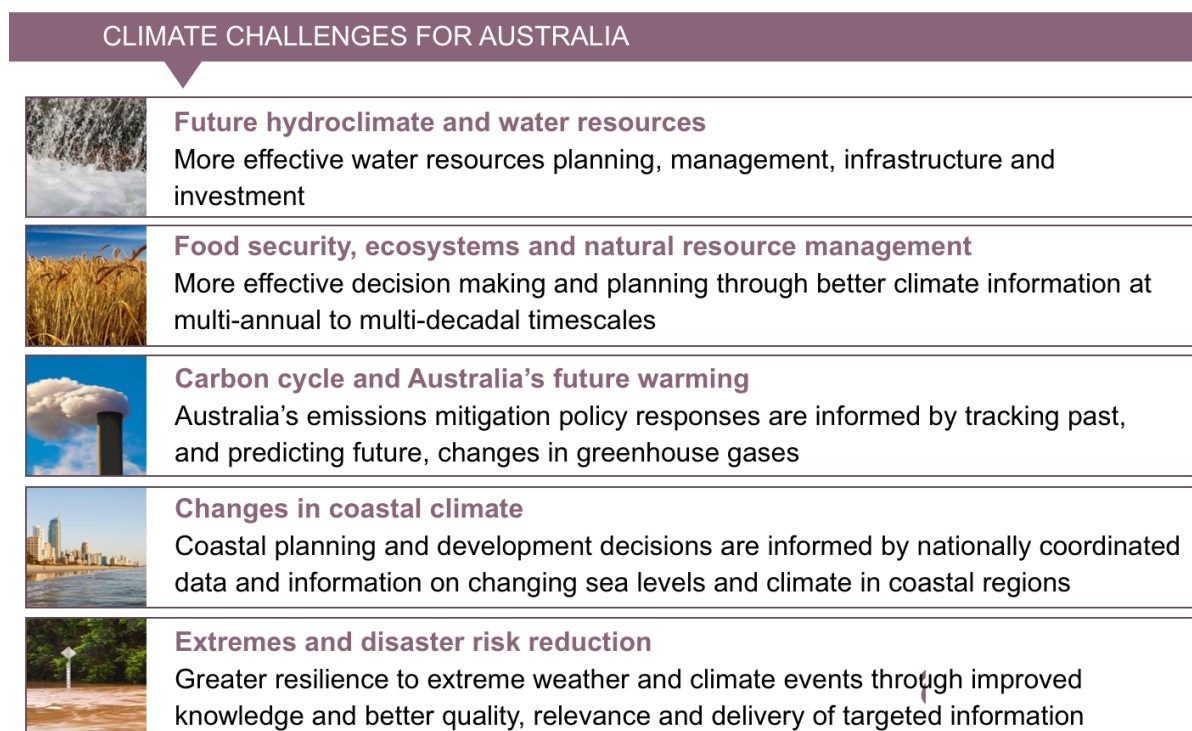


Figure 3: Earth Systems and Climate Change Hub Outcomes

These five ESCC Hub outcomes are being continually validated through our stakeholder engagement, including end-users at federal, state and local government level, natural resource

management (NRM) groups, Indigenous communities and the private sector. To date, the outcome areas for the Hub have resonated strongly with our stakeholders. For example, the jurisdictions welcomed the sectoral focus on water resources; ecosystems, resource management and food security; coasts; and extremes (especially fire weather). The ACT, SA, Victoria and WA jurisdictions have all identified these as key areas for their adaptation strategies. In addition to these five sectoral-focussed outcomes are a further four, largely Hub-centric cross-cutting and capability-oriented outcomes:

- a) A national climate and Earth system simulation capability providing Australia with the ability to prepare and plan for, and manage, the societal, economic and environmental risks associated with climate variability and change.
- b) Nationally consistent and targeted climate information (data, knowledge and products) for the Australian region that informs and provides the evidence base for:
  - Adaptation, planning, and mitigation responses and decision-making.
  - Decision-making to enhance resilience, productivity and better manage climate risk.
- c) Enhanced end-user capacity in the effective use of Hub research outputs.
- d) A vibrant and critical mass Australian capability in Earth system and climate science; deeply engaged with global climate research activities that deliver benefit to Australia.

All outcomes align strongly with the following adaptation principles that underpin the Australian Government's National Climate Resilience and Adaptation Strategy:

- *Good adaptation avoids passing risks onto future Australians* – this requires future projections of climate that allow the consequences of future greenhouse gas emissions scenarios to be quantified, and to inform society about its adaptation and mitigation choices.
- *The changing climate is considered when making decisions now and into the future.*
- *Decisions are informed by the best available information.*

## ESCC Hub Programme Logic

The detailed Programme Logic for the Hub (Appendix 1) and the summary schematic in Figure 4 show how the Hub's research links to its goal, research priorities and outcomes.



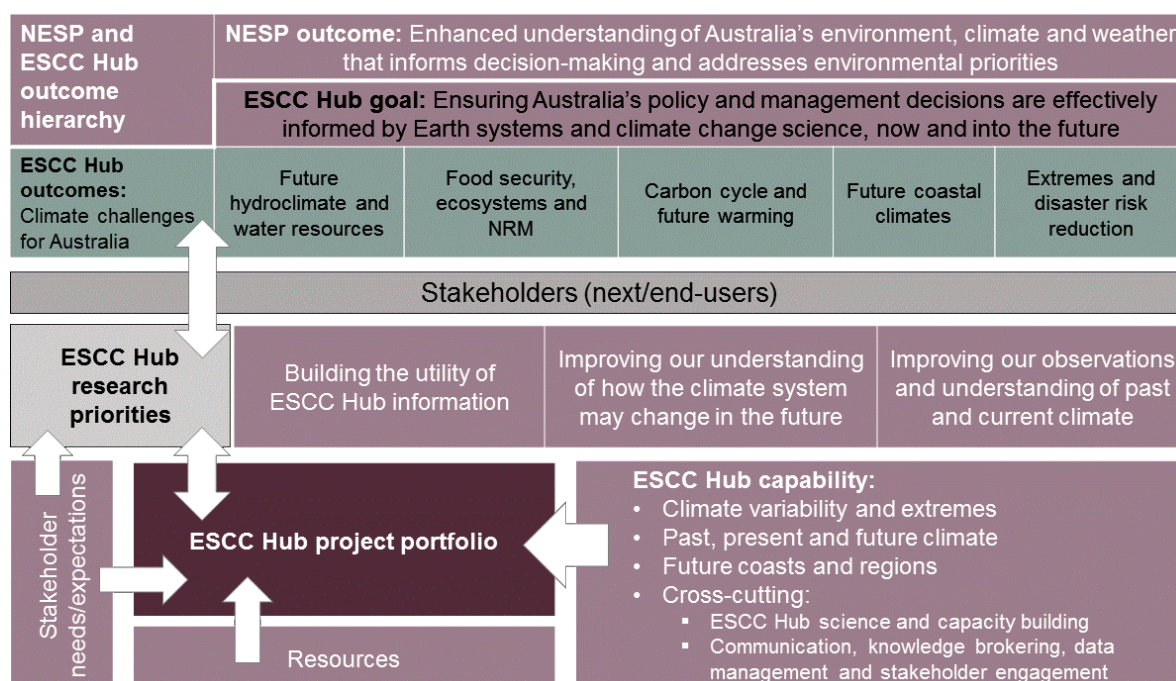


Figure 4: Summary schematic of NESP Earth Systems and Climate Change Hub programme logic

The Programme Logic also describes the core capability within the Hub, which is critical to delivering the outcomes and providing flexibility. The project research areas are all strategically important priorities for the partner agencies, meaning that the Hub is able to leverage significant research capability from the Partners. This critical mass of core capability is also one of the Hub's approaches to managing the risks associated with key skills and expertise. Each of the Partners is committed to maintaining a critical mass capability in those priority research areas that underpin the Hub's Research Plan and associated projects.

The Hub's research project portfolio has been developed as an integrated body of work to ensure that, collectively, all projects deliver to the Hub outcomes described in Figure 4. There are several projects whose path-to-impact is through other projects, so their delivery is primarily via next-users rather than directly to end-users. Furthermore, the outputs from some projects primarily address just one or two outcomes, while the outputs from other projects addresses multiple outcomes (Figure 5).

Figure 5 also illustrates the integrated nature of the research activities, while the matrix in Figure 6 explicitly identifies the inter-dependencies and linkages between the approved Research Plan projects. Given the highly integrative, inter-dependent and cross-agency collaborative nature of the research portfolio, the Hub is able to leverage on the complementary capability that resides across the Hub's Partners.

As already explained, the proposed research projects represent what can be achieved with the funding available. While some projects may seem ambitious in terms of their goals, in fact the research proposed is often modest given the magnitude of the challenge and the potential for on-ground impact. The project Chief Investigators, HLT and Hub partners have carefully reviewed the project proposals to ensure that the research can be delivered within the time and resource constraints of the Hub, however it is important to note that several Projects (e.g. Projects 2.4 *Changing oceans and Australia's future climate*, 2.5 *Improving Australia's climate model (ACCESS)*, 2.9 *Risk assessment of future carbon sources and sinks*, and 2.3 *Towards an ACCESS decadal prediction system*), while coherent and self-contained, are actually part of a larger effort within the partner agencies.



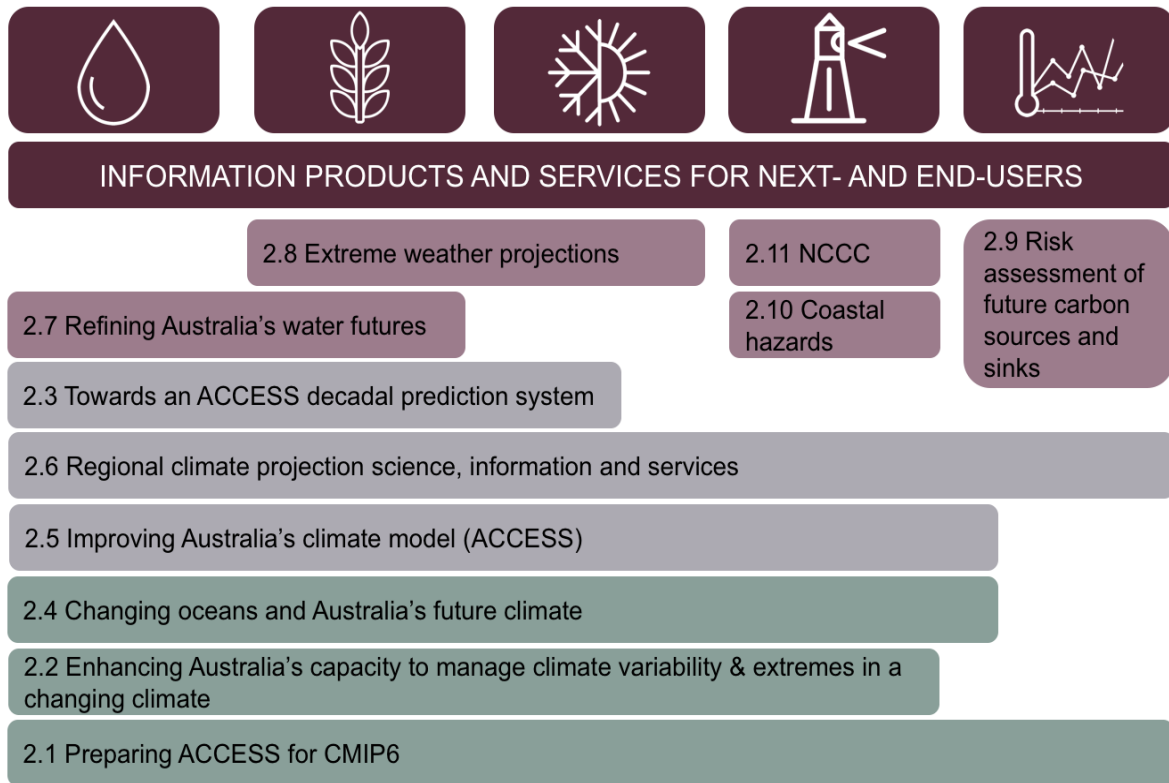


Figure 5: Alignment of Research Plan V2 and V3 research projects to Hub outcomes. Cross cutting projects, with a primarily next-user focus, are positioned towards the lower part of the figure, while more targeted projects with an end-user focus are positioned in the upper part of the figure.

	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11
2.1											
2.2											
2.3											
2.4											
2.5											
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2.9											
2.10											
2.11											

Figure 6: Primary linkages and inter-dependencies between Hub projects. (Project numbers are the same as in Figure 5.)

## Expected outputs

Outputs from the Hub are targeted towards meeting the needs of key stakeholders (both next and end-users) and support our goals and outcomes. They broadly fall into two categories:

- **Outputs that provide scientific and technical information and credibility:** Enhanced models; data and information; analyses, simulations and projections; data access and analysis tools; journal publications, technical reports and high-value information products.
- **Outputs that support the Hub's communication, knowledge brokering, outreach and capacity development:** Websites and content; non-technical summaries, brochures and reports; multi-media content and training; postgraduate and professional development and training; professional and public fora (training workshops, seminars, conferences, etc).

The table below describes the generic types of research outputs that will be delivered, either through the research projects (described more fully in Attachment A) and/or via the Hub communication and knowledge brokering activities (described in the Hub's respective Communication and Knowledge Brokering and Indigenous Engagement strategies). Output types #1 – 4 primarily address the specific scientific and technical needs of next/end-users, while types #4 – 6 primarily address the more general communication, knowledge brokering and outreach needs of next/end-users. They reflect the key activities, methods and deliverables described in the Hub's Communication and Knowledge Brokering Strategy (action plan) and the projects listed under Attachment A.

Importantly all projects are required to deliver an annual Work Plan that identifies their specific research outputs for that year. This is where a detailed description of project-specific outputs is provided.

Earth System and Climate Change Hub outputs

Type of output	Purpose	Comments
1. Research publications a) Journal papers b) Conference papers c) Technical and/or summary reports	<ul style="list-style-type: none"> <li>• Peer review – establish quality and credibility of Hub research</li> <li>• Communication and exchange of knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• Publically available, via links available on ESCC website</li> </ul>
2. Data a) Model data – hindcasts, current assessments and future projections as digital data sets, maps and similar visualisation products b) Observed data – past and current c) Application-ready datasets d) Information products	<ul style="list-style-type: none"> <li>• Peer review – establish quality and credibility of data and information products</li> <li>• Deliver credible, peer-reviewed information for scientific assessments, impact assessment, adaptation planning and mitigation responses</li> <li>• Data available for other users</li> </ul>	<ul style="list-style-type: none"> <li>• Publically available, via links available on ESCC website</li> <li>• Information products may be a combination of modelled and measured data, along with additional analyses, to transform these data into information</li> </ul>
3. Model system, components and tools a) Enhanced or new model versions and/or systems b) Enhanced or new sub-models, modules and/or parameterisations c) Diagnostic tools and/or frameworks	<ul style="list-style-type: none"> <li>• Benchmarking to evaluate model performance and establish credibility</li> <li>• Credible future climate simulations for research; assessment of Australia's future climates under different economic and emissions scenarios; and input into regional climate projections for impact</li> </ul>	<ul style="list-style-type: none"> <li>• Australia's national weather and climate model system (ACCESS) is the only global model developed in the Southern Hemisphere.</li> <li>• Where possible, participate in national or international benchmarking activities.</li> </ul>

Type of output	Purpose	Comments
	assessment, adaptation planning and mitigation responses <ul style="list-style-type: none"> <li>Improve model competitiveness, availability and accessibility for researchers and/or end users</li> </ul>	
4. Communication and knowledge products <ul style="list-style-type: none"> <li>a) Targeted information products</li> <li>b) Brochures</li> <li>c) Case studies</li> <li>d) Newsletters (including The Chirp)</li> <li>e) Tailored products to support Indigenous engagement, capacity building and research, as appropriate and consistent with the Hub's Indigenous Engagement Strategy</li> </ul>	<ul style="list-style-type: none"> <li>Communication and knowledge-brokering</li> <li>Building knowledge and understanding</li> <li>Deliver credible, peer-reviewed information for impact assessment, adaptation planning and mitigation responses</li> </ul>	<ul style="list-style-type: none"> <li>Products will be made available via the ESCC (and other appropriate) website and stakeholder networks.</li> <li>Some use of social media is envisaged, but only where it is effective.</li> <li>Products will be derived from Research Project materials as appropriate.</li> </ul>
5. Communication and engagement activities <ul style="list-style-type: none"> <li>a) Workshops and conferences</li> <li>b) Seminars and forums</li> <li>c) Regular 'science informing policy' event</li> <li>d) Briefings</li> <li>e) Regular engagement with stakeholder networks.</li> <li>f) Tailored activities to support Indigenous engagement, capacity building and research, as appropriate and consistent with the Hub's Indigenous Engagement Strategy</li> </ul>	<ul style="list-style-type: none"> <li>A more active way to share knowledge, information – either to a general or specific audience – that facilitates feedback, problem-solving and value-add.</li> </ul>	The Hub is proposing: <ul style="list-style-type: none"> <li>Annual, targeted workshops</li> <li>Briefings to the government, states, business sector and other key stakeholders. This includes a regular (six-monthly) briefing to the Minister.</li> </ul>
6. Training	<ul style="list-style-type: none"> <li>Building the capacity of our next-users, end-users, general public and Indigenous communities to:               <ul style="list-style-type: none"> <li>understand the current state of climate change science</li> <li>effectively utilise the information provided by our Hub and other knowledge providers</li> <li>effectively use Hub models, data and other products</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>For postgraduates: training activities will "piggy-back" on the world-class training activities that the ARCCSS already provide.</li> <li>For stakeholders: training activities will be provided through our stakeholder networks as appropriate and affordable.</li> </ul>

## Stakeholder engagement

Effective stakeholder engagement is essential to realising the Hub's goals, outcomes and delivery of tangible, on-ground impact. The primary purpose of the Hub's stakeholder engagement is to inform the Hub's research project portfolio development and implementation in a way that addresses the prioritised needs of target next- and end-users of the Hub's research, information products and services.

The Hub's approach to engaging with external stakeholders includes the full cycle from engagement to inform research prioritisation; to the delivery of research outputs; and evaluation and review. This is the framework that formally captures the commitment to ensuring the Hub's research projects are informed by next- and end-user needs. At a Hub-level, and for all projects within the Hub, this cycle is managed formally within the Hub's Evaluation Planning Framework. Its implementation occurs via the associated Monitoring & Evaluation Action Plan, systematic progress reporting, and delivery of the Hub's Communication and Knowledge Brokering and Indigenous Engagement strategies.

To avoid any confusion, the Hub's primary focus is those internal and external stakeholders who are one or some combination of the following points along the 'knowledge value chain':

- a) Next-users of the knowledge and information delivered by the Hub's research – these are often allied researchers, research projects, programs or agencies (including both internal and external to the Hub and the NESP more generally).
- b) End-users (typically external to the Hub and the NESP more generally) of the Hub's information products and services, which may have been modified and value-added by next-users.
- c) Providers (typically external to the Hub and the NESP more generally) of research infrastructure and other inputs to the research undertaken by the Hub.

The task of identifying the Hub's key internal and external stakeholders and their respective needs has been an initial focus of the Hub's Research Plans, and our ongoing implementation of the Communication and Knowledge Brokering Strategy, Indigenous Engagement Strategy, and by association, the Hub's Evaluation Planning Framework.

## External stakeholders

The External Stakeholder Engagement Plan identifies over 200 external institutions, agencies and individuals who *have an interest in, or use for, the best available Earth system and climate change science*. These stakeholders effectively make up the Hub's Stakeholder Reference Network (HSRN) and encompass all levels of government, NGOs, Indigenous communities, peak bodies and private companies; many relevant sectors (including emergency services, environment, agriculture, fisheries, forestry, water, health, energy, defence, transport, infrastructure, finance, insurance, foreign affairs and trade, tourism, resources); research agencies and broader research communities, including other NESP Hubs. The latter include agencies and programs that invest in infrastructure upon which the Hub's research depends (for example, the National Computational Infrastructure [NCI] led by ANU and the Integrated Marine Observing System [IMOS]); and research providers/programs outside the Hub but with strong allied interests (for example, NCCARF, Antarctic Climate and Ecosystems Cooperative Research Centre [ACE CRC]).

HSRN details are managed within a dedicated database that summarises relevant engagement activities and outcomes, actions arising and associated contact details etc. The HSRN database is categorised in a manner to facilitate prioritised and customised engagement activities along the following lines:

- Minister for the Environment and Energy/Department of the Environment and Energy (as the relevant NESP Programme Manager and sponsor).

- Those stakeholders for which the Hub has an agreed and tangible direct link to one or more designated (approved Research Plan) projects.
- All other HSRN registered stakeholders (typically who have a general interest in the Hub's projects but not necessarily a direct link to any one project)

The Hub recognises that the broader Australian community are also stakeholders, given the national and global importance of climate change and its high profile in the community. The general public will have access to all Hub project-level outputs as they are open source. The Hub will invest in further developing general (Hub level) communication products for dissemination via traditional and social media (including for example, *The Conversation*, radio and print interviews, targeted magazine articles, etc). However, given the Hub's primary research delivery role, such activities and products will typically be done in liaison with the partner agencies to ensure cost-effective delivery.

The very nature of Earth system and climate change research means that there is often no one-to-one relationship between a specific research project and end-user needs. For example, end-users may want credible, tailored estimates of future temperatures for an Australian region; producing this requires development of an internationally-benchmarked model that performs well for Australia and has been tested and parameterised using Earth system observations and data. These simulations then need to be combined with other global climate model simulations to produce an ensemble of simulations. The model outputs are then evaluated and refined to a finer spatial resolution; and the results need to be packaged and delivered in a way that is useful for end-users (which may require an iterative process of engagement and co-design).

## Internal stakeholders

The Hub's key internal stakeholders include (see also Figure 2):

- The Hub Steering Committee and Stakeholder Advisory Group
- The Hub Leadership and Programme Management Team
- The Hub's CIs and associated project teams
- The Hub's partner agencies, including those parts of CSIRO and the Bureau of Meteorology who are not within the Hub (e.g. CSIRO Land and Water, CSIRO Agriculture; Bureau Climate Monitoring and Services) and in the universities (e.g. the Monash Sustainability Institute).

## Indigenous engagement

The Hub is committed to meaningful, beneficial and respectful Indigenous engagement and collaboration during all phases of the delivery of the NESP. Where relevant, due consideration will be given to actively involving key Indigenous stakeholders in research prioritisation, research delivery and, especially, the communication of research output. The Hub's approach to Indigenous engagement is detailed in its Indigenous Engagement Strategy.

This means that the Hub has a strong, centrally coordinated approach to Indigenous engagement at the Hub level, with individual research projects undertaking specific activities and developing tailored communication and information products within this overarching framework. The following description therefore applies both at the Hub level, and for individual research projects.

The initial goal of the Hub's Indigenous Engagement Strategy is to build relationships with Aboriginal and Torres Strait Islander people and communities as a first step towards our long-term goal of providing targeted climate information to Indigenous Australian communities. To this end, the Hub has established very good contacts with researchers working with Indigenous communities.

All Lead CIs, and the Hub's leadership and programme management staff, attended a CSIRO program called '*Seeing through both eyes*' in November 2015. This will be repeated periodically as needed to ensure all Hub personnel have the awareness and understanding needed to enable them to work with Indigenous staff, groups and communities in an effective and meaningful way; and increases the capacity of individuals and teams to communicate with Indigenous stakeholder groups and contribute to more effective engagement generally with Indigenous people and communities.

The Hub leadership also participated in the CAUL Hub Indigenous Research Protocol workshop and NESP Hub Community of Practice event in 2016, to ensure that the Hub remains coordinated with the broader NESP Indigenous engagement and remains up-to-date with best practice.

The Hub will implement three, linked Hub-level activities that will draw on the research expertise of Research Plan V2 and activities undertaken throughout 2016. These are described in more detail in Attachment A2.

The matrix below captures the level of Indigenous engagement by Research Plan V3 projects:

- High – the project will work closely with Hub Central in all Indigenous engagement activities proposed for Research Plan V3.
- Medium – the project will have some engagement, either in an activity specifically being developed for that project and/or with some of the Indigenous engagement activities planned for Research Plan V3.
- Low – Hub Central will draw on project's science and capability to develop information products for the activities proposed in Research Plan V3 but the project itself is less likely to be directly involved.

Short Project Name	High	Medium	Low
2.1: ACCESS and CMIP5			
2.2: Climate variability			
2.3: Decadal prediction system and marine extremes			
2.4: Changing oceans			
2.5: Improving ACCESS			
2.6: Regional climate projections science, information and services			
2.7: Water futures			
2.8: Weather extremes			
2.9: Carbon risks			
2.10: Coastal hazards			
2.11: NCCC			



## Collaboration and partnerships

The NESP encourages a collaborative, multi-disciplinary approach to environmental and climate science research. The success of the Hub in achieving its impact depends on a capacity to foster partnerships across Hubs, and with a wide range of relevant stakeholders—as explained above. The table below identifies those partners and stakeholders with whom the Hub has already engaged in 2015 and 2016. This list has grown and matured throughout Research Plan V2 (2016) and this will continue throughout Research Plan V3 (2017) and the lifetime of the Hub, as further explained in our Communication and Knowledge Brokering Strategy.

Hub Collaborations and Partnerships (all acronyms are defined in the glossary at Appendix 2). The Hub has had face-to-face contact with all partners and stakeholders listed below in 2016.

Partner	Relationship to ESCC Hub	Role (institution, program, individual)	Expertise	Alignment to Hub goals
<b>Programs or agencies who are non-funded partners providing research capability and/or represent key next and end users</b>				
IMOS	Director is a member of HSAG	Program: Provides critical research infrastructure to NESP ESCC research	Ocean observing infrastructure	Critical to ocean observations; which underpin several outcomes and research priorities
NCI	Member of ACCESS Advisory Group (Bureau, CSIRO, Universities are part of this)	Program: Provides critical research infrastructure to NESP ESCC research	High Performance Computing for ACCESS modelling; CMIP model and observed data storage	Critical to ACCESS development and use; CMIP6 participation; and delivery of climate information
ARCCSS	Director is member of HSC. CIs are involved in Hub research projects	ARC-funded centre providing underpinning climate system science to Hub research	Climate systems science	Aligned to some research priorities
ACE CRC	CEO is a member of the HSC	Program: CRC potentially both users, and providers, of research	Antarctic and Southern Ocean – cryosphere processes	Aligned to some research priorities; complementary research goals
NCCARF	Director is a member of HSAG	Program: Both a next and end user of Hub research. NCCARF also connects the Hub's research to broader end-user communities	Adaptation to climate change, with a focus on the coastal zone, especially sea-level rise impacts	Aligned to some research priorities; complementary research goals
Reef Traditional Owners and Reef Catchments NRM	Stakeholders and collaborator on Indigenous Engagement	Program: Stakeholder group with whom we are developing several Indigenous engagement activities	Traditional owners and Indigenous knowledge; natural resource management	Aligned to Hub's Indigenous engagement goals and objectives.
Goyder Institute	Potential partners for a case study on water	Program: Provides research needed to inform decisions, resource management and policies in South Australia	Water resources, hydrology, coastal; mitigation and adaptation	Strong interest in Hub's research into water, fire, and NRM and extremes outcome areas

Partner	Relationship to ESCC Hub	Role (institution, program, individual)	Expertise	Alignment to Hub goals
Kimberley Land Council and Seed	Potential co-leaders of a proposed workshop with Indigenous leaders on climate change	Agency: Seed is an Indigenous group within the Australian Youth Climate Coalition	Traditional owners and Indigenous knowledge; climate change; natural resource management	Aligned to Hub's Indigenous engagement goals and objectives.
Government collaborators, with whom the Hub has established links in 2015–16 (Qld, NT, NSW pending)				
State & Local Government Departments and Agencies	States and territories: <ul style="list-style-type: none"><li>SA Dept of Environment, Water &amp; Natural Resources</li><li>Tas Dept of Primary Industries, Parks, Water &amp; Environment</li><li>Vic Dept of Environment, Land, Water &amp; Planning; and Dept of Economic Development, Jobs, Transport &amp; Resources</li><li>ACT Climate Change Policy Group</li><li>WA</li></ul> Other: <ul style="list-style-type: none"><li>Greater City of Geelong</li><li>Torres Strait Regional Authority</li><li>World Heritage Areas: Gondwana Rainforests World Heritage Areas (and Australian World Heritage Areas)</li></ul> Commonwealth: <ul style="list-style-type: none"><li>Department of Agriculture and Water Resources (DAWR)</li><li>Murray Darling Basin Authority (MDBA)</li></ul>			
NESP Hubs				
<ul style="list-style-type: none"><li>Clean Air &amp; Urban Landscapes (CAUL)</li><li>Marine Biodiversity</li><li>Threatened Species Recovery</li><li>Northern Australia Environmental Resources (NAER)</li><li>Tropical Water Quality</li></ul>	Collaborators on specific areas of research; Indigenous engagement; and users of climate knowledge and information.  At the Cross-Hub Workshop run by the Hub, we identified a several research areas of mutual interests, and a set of actions to build the collaboration and path-to-impact for our Hub.		Primarily urban greenhouse gas emissions and climate change (CAUL); climate impacts (all); and Indigenous engagement (NA)	Aligned to some research priorities

## Communication and knowledge brokering

Successful delivery outputs that influence decision-making (and thereby realising outcomes and on-ground impact) requires clear and effective communication and brokerage of research outputs to key stakeholders. To this end, the ESCC Hub has developed and implemented a Communication and Knowledge Brokering Strategy that:

- strongly aligns with this Research Plan
- describes how the Hub will facilitate knowledge sharing between researchers and target next/end-users
- specifically identifies and includes activities that bring researchers, policy makers and environmental managers together to facilitate evidence-based decision-making
- details the research products and services and associated promotional material to be developed by the Hub
- describes how data and information produced by the Hub will be managed (including curation) and made accessible to the general public
- demonstrates how the Hub meets or exceeds the funding agreement requirements for Communication and Knowledge Brokering by identifying the specific communication and knowledge brokering roles and allocated resources associated with these activities.

The Hub has updated its Communication and Knowledge Brokering Strategy, including feedback from the Department and reflecting the progress made by the Hub through 2016.

The key developments undertaken for Research Plan V2 were:

- a) Launch of the Hub's website ([www.nespcclimate.com.au](http://www.nespcclimate.com.au)), and weekly contributions to the Department's newsletter (The Chirp).
- b) Development, use and dissemination (at conferences, workshops and meetings) of Hub collateral (single page project descriptions, Hub postcards, Hub outcome cards, pull-up banner); and development of a standardised Hub PowerPoint presentation.
- c) Population of the stakeholder section, noting this will continue to be updated throughout the implementation of the Hub's external stakeholder engagement plan.
- d) Clarity around the relative roles of the Hub leadership and project personnel in delivering communication and knowledge brokering functions is explained in the Hub's Communications and Knowledge Brokering Strategy thus *"Delivery of general communication and knowledge brokering activities relevant to stakeholders across the Hub's project portfolio will primarily be undertaken at the Hub level. More project specific research communication and knowledge brokering activities will primarily be undertaken at the project level. For practical reasons to do with enhancing the effectiveness and efficiency of communication and knowledge brokering activities more generally within the Hub, opportunities for Hub level coordination of multiple/simultaneous project level engagements with stakeholders will also be realised where appropriate."*

This is managed in part in a practical way via provision of an annual Work Plan for each project which includes activities relating to Comms & KB, Stakeholder identification and

engagement; Indigenous Engagement (where appropriate); and the nature and timing of data outputs” (see also discussion under monitoring and evaluation (M&E), below).

The relevant Communication and Knowledge Brokering activities are captured in the accompanying action plans, which are updated annually to align with implementation of each research plan (i.e. Research Plan Vx) and identify those specific activities that involve individual research projects and teams.

Hub-level activities proposed for periodic inclusion in annual Research Plans include:

- a) The Hub’s **case studies** (p. 27 below), which provide additional communication activities and products.
- b) Training Hub researchers in the important areas of: communication, pitching your science, and stakeholder engagement. These modules are custom designed for the Hub, although external guidance and facilitation will be sought, along with engagement with some of our key stakeholders (next- and/or end-users).
- c) Activities described as part of the Hub’s Indigenous Engagement Strategy and p. 20, above.
- d) Briefings with government (science-meets-policy); key next-users (CSIRO, Bureau of Meteorology, others as appropriate); and end-users (senior managers in private and public sector, as advised by the HSAG).

## Data accessibility

The NESP guidelines require that all information (including research data) produced under the programme is made publically and freely available on the internet. In this context, the ESCC Hub recognises the need to promote open access to public sector and publically funded information.

The Hub’s approach to data and information management is covered in the Communication and Knowledge Brokering Strategy. The Hub is committed to ensuring that all data and information data are discoverable by and available to, stakeholders. Accordingly, appropriate protocols have been developed to ensure that metadata statements for each project are completed, collated and catalogued as per NESP guidelines.

The Hub aims to make the metadata catalogue available on its external website in accordance with Departmental arrangements for NESP. The Hub leadership will also work with Partner Agencies to ensure consistency with relevant agency-specific data and information management arrangements.

Where appropriate, the Hub will use existing research infrastructure, developed under NCRIS, ACCSP and ANDS to curate and, where appropriate, distribute ESCC datasets. This specifically includes: the Earth Systems Grid at the NCI for CMIP data; IMOS and TERN data portals for oceans and terrestrial data; the Carbon Observatory for carbon cycle information (see Project 2.9); and CSIRO’s Cape Grim greenhouse gas data website.

The Hub anticipates playing a role in coordinating data curation and distribution across these complementary agencies and initiatives, but this vision has not yet been articulated via any formalised plan. The Hub committed to ensuring that an inventory of ACCSP data sets is made accessible to next- and end-users via an appropriate ESCC Hub website link to the ACCSP website, where the new ACCSP metadata catalogue has now been posted so that these data are

also curated and potentially available for further use. This is being achieved via an activity being done under the auspices of the ACCSP in coordination with the Hub to develop a curated record of all data collections and models from at least the last 3-years of the ACCSP. This IP resource is considered a critical and highly valuable input to the Hub's knowledge value chain.

The Hub will also be enhancing model systems—specifically ACCESS—with the goal of ensuring ACCESS can be used by the research community; and model simulations are accessible. It is not envisaged that the ACCESS model will be publically available although those components developed within Australia are already open source (e.g. the Land Surface Model, CABLE [Community Atmosphere Biosphere Land Exchange]).

## ESCC case studies

A new feature of Research Plan V3 is investment from the Hub's non-research (Communication and Knowledge Brokering) budget into several case studies that draw from the research being undertaken across the Hub's Research Plan project portfolio and Indigenous engagement activities. By fostering direct engagement with next-users and end-users, they help the Hub to demonstrate impact and the associated value of the Hub's research. As they are essentially extensions of the approved Research Plan projects, these case studies are by default aligned to the Hub's outcomes and research priorities.

The case studies are not research activities, rather their focus is on how the research is being used to achieve next or end-user impact with emphasis on the role of communication and knowledge brokering and stakeholder engagement (especially including Indigenous stakeholder engagement).

They all address one or more of the Hub's five outcome areas (Figure 5) in order to ensure there is a whole-of-Hub benefit. The outputs would be one (or a combination) of the following:

- brochure(s)
- video(s) or animations
- workshops with report and recommendations
- a tool or product that is being used by one or more stakeholders
- training module(s).

Approved case studies are detailed in the below table. These were selected based on those key areas identified by the Hub leadership, and solicited via a call for Expressions of Interest.



Recommended Case Study Activities for Research Plan V3. These are described in Attachment A

Case Study number	Title and summary	Leaders (supporting team)	Outcome area	RPV2 projects that contribute to case study
3.3	Climate change impacts on inshore aquatic ecosystems and coastal communities in the Torres Strait Islands: A Workshop (Torres Strait Regional Authority; AFMA and potentially other NESP Hubs).	Geoff Gooley (interim) Kathy McInnes Neil Holbrook Kevin Hennessy	Food Security and NRM Coasts	2.10 (Coastal hazards) 2.3 (Marine extremes component) 2.6 (Regional climate projections science)
3.4	Coastal climate adaptation with City of Greater Geelong (Ralph Roob) and CSIRO Data61	Kathy McInnes	Coasts	2.10 (Coastal hazards) 2.11 (Establishing the NCCC)
3.5	Climate variability and change in WA (video with WA Museum)	Geoff Gooley (interim) Kevin Hennessy Pandora Hope	Water Food Security	2.2 (Managing climate variability and extremes) and 2.6 (Regional Climate Projections Science).
3.6	Climate Change in Australia mobile website (with Bureau of Meteorology)	Aurel Moise Tim Erwin, John Clarke	All outcome areas	2.6 (Regional climate projection science)
3.7	Climate Change for Councils (pilot): Working with one or two regional councils to develop useful knowledge brokering and communication resources that are accessible for their needs and audiences.	Mandy Hopkins	All outcome areas	All projects
3.8	Web delivery portal for coastal hazards information	Kathy McInnes Nathan Bindoff Mandy Hopkins	Coasts	2.10 (Coastal hazards)
3.9	Practical and empowering responses to coastal erosion	David Kennedy and Jon Barnett	Coasts	2.11 (Establishing the NCCC)

## Evaluation Planning Framework

The Hub's Evaluation Planning Framework (EPF) sits within and complements the NESP Monitoring and Evaluation (M&E) Plan relevant to all Hubs. Specifically, the ESCC Hub's EPF outlines the process by which both Hub and project level planning is developed and implemented in a way that is outcome focussed, targeted at next-users and end-users, and delivers measureable impact.

The EPF, through design and implementation of a Hub-level M&E Plan, also provides for real-time performance monitoring and management, progress reporting and review, along with how the Hub will assess and report on its strategic path-to-impact. The Hub's EPF therefore underpins the Hub's flexibility and responsiveness to accommodate changing priorities, commitment to excellent and relevant research, while at the same time facilitating innovation and continuous improvement in service delivery.

## NESP Monitoring and Evaluation Plan

The overarching NESP M&E Plan provides the framework through which the progress and success of all NESP Hubs will be measured. It will enable clear performance assessment via a common set of high level indicators used across the programme, along with qualitative, narrative based reporting of project progress and impact.

Key performance indicators for each NESP Hub will be aligned to a number of key themes:



Two important elements of the M&E Plan are annual project reporting and the biennial programme evaluation.

## Project and financial reporting

Under the terms of the NESP Funding Agreement, the following reports are required to be submitted to demonstrate Hub performance and project progress:

- **Annual Progress Report:** to be submitted in April of each year and describes, in quantitative and qualitative terms, the progress of work against the Research Plan.

- **Audited financial information:** submitted alongside the Annual Progress Report and demonstrates the income and expenditure of the Hub.
- **A Final Report:** submitted at the conclusion of all Hub activity.

## Biennial evaluation

Under the Portfolio Budget Statements for the Environment and Energy Portfolio, the single key performance indicator for the NESP is biennial qualitative assessments that show Departmental staff, state governments, business, community groups and others are using research output from the NESP to inform policy development. The NESP Biennial Evaluation is a key performance metric and output of the NESP's M&E Plan.

The outcomes and findings of the Biennial Evaluation will inform and direct the future delivery of the programme, including the research priorities. The biennial review will be used to inform the review and evaluation of the NESP after two and four years as requested by the Minister in making his funding decision for the NESP.

Under the terms of the funding agreement, the ESCC Hub is required to participate in any programme evaluations or reviews planned during the life of the NESP.

## Hub Monitoring and Evaluation Plan

The Hub M&E Plan features both a schematic 'programme logic' (also referred to as a 'theory of action'), which is provided in Appendix 1, and key evaluation questions (KEQs), which define the critical success factors relevant to all aspects of Hub operations (day-to-day through to whole-of-life), including:

- Hub administration, including general management and coordination
- implementation of the Hub's research project portfolio
- communication and knowledge brokering
- stakeholder engagement
- risk management
- realisation of sustainable, longer-term strategic outcomes and path-to-impact.

The Hub-level M&E Plan therefore also provides the relevant input to facilitate implementation of the NESP M&E Plan, specifically including the delivery of the Biennial Evaluation Report, and (as previously stated) it also ensures that the Hub's research is continually informed by stakeholder needs (see following summary schematic).



As a part of this, all approved Research Plan projects are required to submit detailed annual Work Plans describing their objectives, tasks and outputs. Operationally, these Work Plans will feed into the Hub's internal quarterly Progress Reports and annual reporting to the Department. They also enable the Hub to monitor resourcing, and track progress in a measureable way.

These Project Work Plans and Progress Reports are the primary means by which the Hub will monitor project performance in terms of milestone compliance as well as the ongoing process of stakeholder gaps and needs review and analysis. Consistent with the EPF requirements, this information feeds back into the Hub's Communication, Knowledge Brokering and Indigenous Engagement Strategies throughout the life of the Hub: at both a Hub and project level (where it is also the means by which the research responds to changing and emerging stakeholder needs).

## Funding

The ESCC Hub is supported through funding from the Australian Government's National Environmental Science Programme. Under the Department of the Environment and Energy Portfolio Budget Statements, the NESP provides for around \$142 million over the life of the Programme.

The table below describes the funding from the NESP available to the ESCC Hub over the life of the agreement, which ceases on 30 June 2021.

	2015 Actual <sup>1</sup>	2016 Budget	2017 Budget	2018 Budget	2019 Budget	2020 Budget	2021 Budget	Total
	\$	\$	\$	\$	\$	\$	\$	\$
<b>NESP Funding</b>	466,000	3,050,000	5,100,000	5,100,000	5,100,000	4,550,000	550,000	23,916,000

Expenditure of NESP funding under the Hub is expected to be distributed amongst three main items of expenditure (research, general communication and administration). The funding must be expressed, in the table below, as a percentage of the total for any given calendar year noting that funding for research must total at least 80% of the funding. The balance (20%) of the funding can be allocated between general communication and administration with no more than 10% of the funding being allocated to administration.

Research	83%
General communication	8%
Administration	9%

Under the terms of the NESP, the minimum total for recipient and other contributions per year is 100% of the funds paid by the Department under this agreement.

## Hub approach to risk mitigation and management

The Hub's Risk Register, which is divided into a) Hub level risks, and b) risks that have been identified and categorised from the individual research project proposals that will be managed and

treated at a whole-of-Hub level – primarily via implementation of the Hub’s governance arrangements and Hub-level Monitoring and Evaluation Plan.

A consistent risk management approach implemented across the Hub delivers significant benefits in terms of effectiveness and efficiency; especially as the risks identified by all projects fell mostly into the following five categories:

1. Dependency on project(s), infrastructure and data sources that are funded external to the Project and/or Hub and are not always under the control of the project leadership, specifically:
  - IT skills and infrastructure (including the NCI facility at ANU, which provides processing capacity for climate model simulations along with significant data storage capacity).
  - Observational infrastructure.
  - Observed and modelled data (including CMIP6).
  - Performance of climate models generally, and especially Australia’s climate model—ACCESS.
2. Staffing: Loss of staff with key skills and/or insufficient critical mass of staff.
3. Inadequate Hub-level communication and knowledge brokering, stakeholder and Indigenous engagement, which could limit the effectiveness of these activities at a research project level and/or Hub level (see also Risk Category #5).
4. Resource constraints and stakeholder expectation management.
5. Path-to-impact limited because it will be realised via other projects, Hubs and/or stakeholders (i.e. the project primarily delivers to next rather than end-users), and/or because of misinterpretation and/or miscommunication of results.

## Flexibility

The Hub is aware that flexibility is important for the Department. The following is a summary of the Hub’s approach to ensuring there is adequate flexibility in the Hub’s research portfolio:

1. **Leveraging off past commitments:** The Hub is able to leverage existing IP from previous investments (e.g. ACCSP), whereby a small amount of discretionary Hub investment can deliver more immediate stakeholder benefits (‘low hanging fruit’). Such IP is broad-based and has flexibility to meet fit-for-purpose needs while funded NESP projects gain traction and begin delivery.
2. **ESCC Hub capability and IP:** This extends beyond existing (Research Plan V2) project teams and across all core Partners. The Hub is confident it has the capability needed to re-orient its research activities to meet emerging Departmental needs and priorities.
3. **Research Plan - implementation:** The project commitments vary in duration from 12 months to 3 years, with provision for periodic stop/go reviews where appropriate. This provides the option for re-scoping/re-direction throughout the lifetime of the approved Research Plan projects. There are also uncommitted NESP research funds available from 2018-2021 for reinvestment. The annual research planning cycle provides the governance and oversight (via the Department and HSC) needed to reinforce this flexibility in terms of re-scoping investment each year.
4. **Communication and knowledge brokering:** The Hub has some discretionary resources held-back that are available to be committed to activities (including products and services) that emerge from yet-to-be determined next/end-user needs.

5. **Business development and stakeholder engagement:** We are also undertaking a strategic and systematic approach to business development as an integral part of our stakeholder engagement strategy. The purpose is to facilitate new coinvestment opportunities to leverage core Hub funding (detailed in our Communication and Knowledge Brokering Strategy). Examples to date include recent developments in the 'water' project area and outcome domain, which has seen direct additional coinvestment from CSIRO of \$200K and indirect coinvestment via SA Govt/Goyder for proposed case studies.



# Appendix 1. Earth Systems and Climate Change Hub: programme logic (V1.12)

Attachment A: NESP Earth Systems & Climate Change Hub - Programme Logic (V1.12)					
NESP Goal & ESCC Specific Outcome	To improve our understanding of Australia's environment through collaborative research that delivers accessible results and informs decision-making				
	Improved climate and weather information for Australia through a greater understanding of the drivers of Australia's climate.				
ESCC Hub National Challenges	Water Futures	Global Warming & the Carbon Cycle	Climate Extremes & DRM	Coasts & Communities	Food Security & NRM
ESCC Hub Goal	Policy development, planning, management and associated decision-making in Australia effectively and efficiently informed by <i>Earth Systems &amp; Climate Change Science</i> now and into the future				
ESCC Hub Objective(s)	Through world class research and development, to: • lead further development of the nation's modeling capability and capacity for weather and climate prediction and projections • achieve greater understanding of Australia's climate variability, extremes and associated drivers • develop and strengthen stakeholder relationships and support informed management and evidence-based decisions-making, and • facilitate outreach and communication of science products and services to end-users and the general public				
Practice change	ES science more targeted at end-users through clearer path-to-impact and outcomes focus	ES science more effectively & efficiently integrated within Australian environmental research	End-users routinely access best available ES science capability and knowledge to inform policy and management decisions	Stakeholders actively engage with the Hub; seek to understand ES science; and provide positive feedback and support to Hub	
Stakeholders and Next/end-users	Australian Government Minister/Department of the Environment	Other NESP Hubs	Federal, State & Local Government Sectors	Australian industry - business, finance and insurance groups	Indigenous communities and general community Australian and international Earth system science and climate research community
ESCC Hub Governance	Programme Management: Administration; Progress Reporting; Performance, Financial and Risk Management; Monitoring & Evaluation Communication, Knowledge Brokering and Outreach: Steering Committee and Stakeholder Engagement; Data & Information Management; Coordination and Management				
ESCC Hub Research Outputs	<u>Science &amp; Technical</u> : Enhanced models (multi-year and higher spatial resolution); data/information management systems; analyses, forecasts & projections; data access and analysis tools; journal papers, technical reports and other information products <u>Communications, knowledge brokering, outreach and capacity development</u> : knowledge management systems, websites and content, non-technical summaries, multi-media content and training, postgraduate and professional development, professional and public forums (training workshops, seminars, conferences etc)				
ESCC Hub Research Priorities	Building the utility of ESCC information		Improving our understanding of how the climate system may change in the future		Improving our observations and understanding of past and current climate
ESCC Hub Thematic Research Areas	Communications, knowledge brokering, data/Information management & outreach/end-user engagement				
ESCC Hub Partners, IP, resources & capacity	Climate variability & extremes		Past, present & future climate		Future coasts & regions
	Earth Systems & Climate Change Science integration & capacity building				
	Hub consortium – CSIRO, Bureau and Universities Cash/in kind – existing capability and IP, infrastructure, collaborative and stakeholder networks Leveraged off existing capacity, momentum and track record in ACCSP, NRM, PACCSAP, TERN, IMOS, NCI, SEACI, IOCI etc				

## Appendix 2. Glossary for Research Plan V3 and projects/case studies in Attachment A

Acronym	Definition
AAS	Australian Academy of Science
ACCESS	Australian Community Climate and Earth System Simulator
ACCSP	Australian Climate Change Science Programme
ACE CRC	Antarctic Climate and Ecosystems Cooperative Research Centre
ARC	Australian Research Council
ARCCSS	Australian Research Council's Centre of Excellence for Climate System Science - Australian Research Council Centre for Climate System Science: collaboration of key universities and PRFAs on climate modelling and extremes
ARCCE	Australian Research Council's Centre of Excellence for Climate Extremes (to start in 2018)
Argo	A global array of profiling floats operated by over 25 nations under the auspices of the United Nations' World Meteorological Organisation and the International Oceans Commission. Argo Australia is major contributor funded partially by the Integrated Marine Observing System and partner programs such as the Australia Climate Change Science Program, the ACE CRC, Bureau of Meteorology and CSIRO. <a href="http://www.argo.net">www.argo.net</a> ;
AWRA	Australian Water Resources Assessment (model)
BIOS	Fine-spatial-resolution (0.05 degree) offline modelling environment for Australia, in which predictions of CABLE are constrained by multiple observation types
BoM	Bureau of Meteorology
CABLE	Community Atmosphere Biosphere Land Exchange model
CAPRICORN	Clouds, Aerosols, Precipitation Radiation & Atmospheric Composition over the Southern Ocean
CAUL	Clean Air and Urban Landscapes Hub
CCiA	Climate Change in Australia website ( <a href="http://climatechangeinAustralia.gov.au">climatechangeinAustralia.gov.au</a> )
CCAM	Cubic Conformal Atmospheric Model (a CSIRO global model that can “zoom” to high resolution over regions of interest – used to generate downscaled climate projections)
CCHDO	CLIVAR and Carbon Hydrographic Data Office, funded by the US National Science Foundation and operated by the Scripps Institution of Oceanography. CCHDO is the data curator, repository and distribution point for the global GO-SHIP program and also helps compile high-quality calibration data sets used to quality control Argo profiles for climate applications.
CFT	Climate Futures for Tasmania
CORDEX	COordinated Regional Downscaling Experiment
CMIP5 and CMIP6	Coupled Model Intercomparison Project 5 and 6
CMOR	Climate Model Output Rewriter
CSIRO DAP	CSIRO's Data Access Portal – access to publically available, catalogued and DOI'd data resources. Collections in the DAP are curated for long-term storage and distribution.
DECK	Diagnosis Evaluation & Characterisation of KLIMA
ECL	East coast low

Acronym	Definition
ENSO	El Niño–Southern Oscillation
ESCC	Earth Systems and Climate Change
ESGF	Earth System Grid Federation
ESM	Earth System Model
ET-CCDI	Expert Team on Climate Change Detection & Indices
GCP	Global Carbon Project
GHG	Greenhouse Gases
GO-SHIP	An internationally coordinated global decadal-repeated survey of ship-based sections of top-to-bottom ocean physical and chemical properties. Australia has contributed to key regional lines via the ACCSP and the ACE CRC. GO-SHIP uniquely monitors the ocean carbon inventory and full depth heat and freshwater budgets, extending below Argo's current operating depth. <a href="http://www.go-ship.org">www.go-ship.org</a> .
HLT	Hub Leadership Team
HPMT	Hub Programme Management Team
HSAG	Hub Stakeholder Advisory Group
HSC	Hub Steering Committee
HSRN	Hub Stakeholder Reference Network
IMOS	Integrated Marine Observing System - Integrated Marine Observing System, funded by Australia's National Collaborative Research Infrastructure Strategy. IMOS provides partial support for key climate ocean observing systems such as Argo, moored series, some carbon measurements.
IPCC	Intergovernmental Panel on Climate Change
LSAVs	Large-scale Atmospheric Variables
M&E	Monitoring and Evaluation
MCV	Managing Climate Variability research and development program
MHW	Marine Heat Waves
MOM	Modular Ocean Model (MOM), developed by NOAA GFDL (see below) and is part of the ACCESS system.
NARCLIM	NSW/ACT Regional Climate Modelling
NCCARF	National Climate Change Adaptation Research Facility
NCCC	National Centre for Coasts and Climate
NCI	National Computational Infrastructure
NCRAS	National Climate Resilience and Adaptation Strategy
NCRIS	National Collaborative Research Infrastructure Strategy
NERP	National Environmental Research Program
NESP	National Environmental Science Program
NOAA	US National Oceans and Atmosphere Administration. NOAA spans operational forecasting and research services across fisheries, weather, oceans and climate. NOAA's many laboratories and arms operate substantial parts of the global climate and ocean observing system and modelling centres.
NOAA GFDL	NOAA Geophysical Fluid Dynamics Laboratory – a key partner in ACCESS as the developer of the ocean model used, the Modular Ocean Model (MOM).
NRM	Natural Resources Management
OTE	Ocean Temperature Extremes

Acronym	Definition
PACCSAP	Pacific-Australia Climate Change Science & Adaptation Planning Program
PEGS	Process Evaluation Groups
POP	Population Orders Physiology (a stand-alone tree demography and landscape structure module for Earth System Models)
PCCSP	Pacific Climate Change Science Program
RCP	Representative Concentration Pathways
RPV1, RPV2, RPV3	Research Plan Versions 1, 2 and 3
SAM	Southern Annular Mode
SCU	Southern Cross University
SEACI	South Eastern Australia Climate Initiative
SOCRATES	Southern Ocean Clouds Radiation Aerosol Transport Experimental Study
TC	Tropical Cyclones
TERN	Terrestrial Ecosystem Research Network
TRMM	Tropical Rainfall Measurement Mission
UM	Unified Model
UoM	University of Melbourne
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Program

## Appendix 3. ESCC Hub Steering Committee Terms of Reference and Membership



### TERMS OF REFERENCE AND MEMBERSHIP

## Hub Steering Committee

### Purpose

The Hub Steering Committee (HSC) provides strategic direction and oversight of Hub governance, including processes for managing partnerships, setting research priorities, approval and acquittal of finances, allocation of funding and resources, and performance monitoring and assessment of hub impacts.

The HSC is not a decision-making body, rather is a high-level review and advisory forum designed to facilitate outcomes as an independent source of reference and oversight on behalf of the Hub and the Department relating to:

- Strategic decisions made by the Hub Leader/Leadership team and partners (both Supporting and Associate); and
- Strategic advice and directions provided to the Hub by Department of the Environment and Energy.

### Membership

The HSC will comprise the following members and representation:

Role	Nominee	Status
1. Independent Chair	Dr Wendy Craik	Accepted
Partner representatives:		
2. CSIRO	Dr Andreas Schiller, Oceans & Atmosphere A/Director Dr Steve Rintoul, CSIRO Climate Science Centre A/Director	Accepted Accepted
3. Bureau of Meteorology	Dr Peter May, Assistant Director, R&D Branch	Accepted
4. Universities	Dr Neville Nicholls, Monash University	Accepted
5. Department of the Environment and Energy	First Assistant Secretary, DotEE  Katrina Maguire, Assistant Secretary, Adaptation & International Climate Change Policy, DotEE	TBC  Accepted
6. Hub Stakeholder Advisory Group (HSAG)	Dr Nick Wood, Director, Climate Policy Research	Accepted
7. Director of ARC Centre of Excellence in Climate System Science ( <i>ex officio</i> )	Dr Andy Pitman, UNSW	Accepted
8. Up to two independent members with expertise in Earth systems science and its application to government policy, industry and broader end-user needs	Ms Jo Mummery, University of Canberra  Professor Tony Worby, ACE CRC/UTas	Accepted  Accepted
9. Hub Leader ( <i>ex officio</i> )	Dr Helen Cleugh, CSIRO	Accepted

Other invitees from time to time as appropriate (observer status), including other key personnel representing the ESCC Hub, other NESP Hubs, Department of the Environment and Energy, other government portfolio agencies, the HSAG and other key end-users and stakeholders

### Specific HSC roles and responsibilities

Given their purpose, the specific functions and associated roles and responsibilities of the HSC will be to:

1. Provide a structured forum for engagement between the Hub Leadership with:
  - The Minister and Department of the Environment and Energy (NESP management)
  - The Hub Stakeholder Advisory Group
  - Other NESP Hubs and external stakeholders.
2. Provide strategic guidance to the Hub on research directions, priorities, delivery and outputs, communication and engagement, to ensure alignment of research activities to policy needs of Department of the Environment and other target end-users and key stakeholders.
3. Oversee, review and endorse or approve as appropriate:
  - Research Plan development, implementation and resource allocation
  - Amendments to the Hub organisational arrangements, Research Plan and associated allocation of resources that may constitute a variation to formal agreements between the Hub and Department of the Environment
  - Development and delivery of annual progress, financial, monitoring and evaluation and final reporting to:
    - i) ensure compliance with agreed performance and associated quality standards
    - ii) strategic alignment with agreed NESP priorities and expected outcomes.
4. Identify and communicate high level issues and opportunities, including new and emerging research gaps and needs of target end-users, to facilitate linkages to broader research and government initiatives across government and other stakeholders.
5. Provide a forum for members to share information relevant to core business of the Hub and the NESP more generally, including providing specific advice to the Hub in relation to communicating outcomes to external stakeholders within government, industry and the general community.

**Decisions made by the HSC will be by consensus.**

### Role of the Independent Chair

The independent chair will be appointed in agreement with the Department, and will work closely with Hub Leader to:

1. Preside over HSC meetings and ensure the HSC is well organised, functions effectively, and meets its obligations and responsibilities.



2. Act as a conduit between Hub leadership, the Steering Committee members and the Department as appropriate.
3. Ensure the Hub leadership is reporting well to the HSC and the functionality and responsibilities of the relationships between the two groups is well managed
4. Ensure all HSC members are meeting the roles and responsibilities as detailed in these Terms of Reference.

### Terms of appointment

Appointments will be made by formal invitation from the Hub Leader. Members will be appointed for a term of three years. After this time they will be eligible for re-appointment. If a member wishes to resign his or her appointment, they must provide the Hub Leader and Chair with a written resignation. The appointment of a Steering Committee member may be terminated, on the advice from the Hub Leader to the Chair, if they fail to meet the HSC Terms of Reference or failure to attend three consecutive Steering Committee meetings.

### Meeting frequency

The HSC will meet quarterly during the term of the Hub; meetings will be scheduled 12 months in advance (from 2016). HSC meetings will be scheduled to align with the delivery of key milestones that require HSC approval due in April (Annual progress reports) and October (Research Plans) of each year.

### Operational matters

The HSC secretariat support will be provided by the Hub Programme Management Team, who will be responsible for the preparation and circulation of agendas, minutes and actions arising, and of supporting documentation, papers and reports on behalf of the HSC.

A draft agenda and relevant background documentation will be circulated to all members for comment a minimum of ten working days prior to scheduled meetings.

All meetings will be minuted, with draft minutes and associated actions circulated to members for comment a maximum of ten working days after scheduled meetings, and final minutes circulated to members after a maximum of ten further days.

### Remuneration

All HSC operating costs including out-of-pocket costs for HSC members will be covered by the Hub Leadership & Management component of the Hub budget.

The Hub reserves the right to provide a modest honorarium to the HSC Chair if needed, funded from the Hub budget.

### Conflict of interest

Steering committee members must declare any conflicts of interest at the start of each meeting or before discussion of the relevant agenda item or topic. Details of any conflicts of interest should be appropriately minuted. Where members of the HSC are deemed to have a real or perceived conflict of interest, it may be appropriate that they are excused from Committee discussions and/or deliberations on the issue. The Chair will be responsible for assessing declared conflicts of interest and how these will be managed for the meeting and/or particular agenda items.

## Appendix 4. ESCC Hub Stakeholder Advisory Group Terms of Reference and Preliminary Membership



National Environmental Science Programme

### TERMS OF REFERENCE AND PRELIMINARY MEMBERSHIP

## Hub Stakeholder Advisory Group

### Purpose

The purpose of the Hub Stakeholder Advisory Group (HSAG) is to ensure that relevant external stakeholder engagement activities are undertaken in an effective and efficient manner, consistent with meeting the Hub's broader strategic objectives. These arrangements should also provide appropriate assurance to the Hub Steering Committee (HSC), which has oversight of all aspects of the Hub's operations and performance, that such activities are based on appropriate governance in terms of meeting the expectations of stakeholders and adding value where appropriate.

The HSAG consists of up to 10 individuals who would be nominated/selected because of their acknowledged expertise in those research domains of relevance to the Hub – especially the Hub's outcome areas. It is envisaged that the HSAG will act collectively as an agent/advocate dealing with the Hub on behalf of and in the best interests of the HSRN. Most importantly, they will be enthusiastic and committed to the role that climate science plays in informing decision-making in Australia. The HSAG will facilitate the Hub's engagement with the broader stakeholder community, using the HSRN as its 'eyes and ears' into stakeholder needs and views.

Specifically, the HSAG will provide:

- a structured and transparent mechanism to ensure that stakeholder engagement over the Hub's lifetime is consistent with the Hub's goals
- oversight of the implementation of the Hub's stakeholder engagement activities on behalf of the broader stakeholder network and the HSC.

### Membership

The HSAG will comprise the following members and representation:

Role	Nominee	Status
1. Independent Chair	Dr Nick Wood, Director, Climate Policy Research	Accepted
2. Member	Ms Jack Knowles, Manager, NRM Policy, National Farmers' Federation	Accepted
	Prof Jean Pelutikof, Director, National Climate Change Adaptation Research Facility	Accepted
	Mr Michael Nolan, Chair, United Nations Global Compact-Cities Program, RMIT University	Accepted
	Dr Tas van Ommen, Program Leader, Climate Research, Australian Antarctic Division	Accepted

	Dr Tim Moltmann, Director, Integrated Marine Observing System, University of Tasmania	Accepted
	Mr Neil Plummer, Assistant Director, Climate Information Services, Bureau of Meteorology	Accepted
3. Observer (ex officio)	Dr Helen Cleugh, CSIRO, Hub Leader	Accepted
	Dr Geoff Gooley, CSIRO, Hub Program Manager	Accepted
Other invitees from time to time as appropriate (member and observer status), including other key personnel representing the ESCC Hub, other NESP Hubs, Department of the Environment and Energy, other government portfolio agencies, the HSC and other key end-users and stakeholders		

### Specific HSAG roles and responsibilities

Given the stated purpose, the specific functions and associated roles and responsibilities of the HSAG will be to:

- Advise the Hub Leadership, and Steering Committee more broadly, in relation to the governance around the Hub's external stakeholder engagement arrangements to meet expectations of the HSRN, specifically in terms of balance (fairness and equity) and quality control (completeness, accuracy and timeliness), and add value to stakeholder outcomes and impacts.
- Facilitate active engagement with the Hub Leadership/Programme Management and Project Teams on all matters to do with interests of the HSRN.
- Advise the Hub Leadership about relevant (external) next and end-user information gaps and needs, including emerging issues and new opportunities.
- Advise the Hub Leadership about important external stakeholder engagement fora, activities and scope; including potential business development and communication opportunities.
- Provide input to, and feedback on, the Hub's Research Plan(s), Evaluation Planning Framework, and Communication and Knowledge Brokering Strategy – from a HSRN perspective.
- Provide feedback on the Hub's overall performance in relation to its alignment with external user needs and priorities, including relevance, effectiveness and efficiency in addressing program objectives, realising outcomes and delivering impact.

### Role of the Independent Chair

The Independent Chair will be appointed in agreement with the Hub Leader, and will work closely with Hub Leader and/or Program Manager to:

1. Preside over HSAG meetings and ensure the HSAG is well organised, functions effectively, and meets its obligations and responsibilities.
2. Act as a conduit between Hub leadership, the HSAG members and the HSC on behalf of the broader Hub stakeholder network
3. Ensure all HSAG members are meeting the roles and responsibilities as detailed in these Terms of Reference.

### Terms of appointment

Appointments will be made by formal invitation from the Hub Leader. Members will be appointed for a term of one year initially. After this time they will be eligible for re-appointment. If a member wishes to resign his or her appointment, they must provide the Hub Leader and Chair with a written resignation. The appointment of a HSAG member may be terminated, on the advice from the Hub Leader to the Chair, if members fail to meet the agreed Terms of Reference or failure to attend three consecutive HSAG meetings.

### Meeting frequency

The HSAG will meet quarterly during the term of the Hub; meetings will be scheduled 12 months in advance (from 2016) to align with scheduled HSC meetings.

### Operational matters

The HSAG secretariat support will be provided by the Hub Programme Management Team, who will be responsible for the preparation and circulation of agendas, minutes and actions arising, and of supporting documentation, papers and reports on behalf of the HSAG.

A draft agenda and relevant background documentation will be circulated to all members for comment a minimum of ten working days prior to scheduled meetings.

All meetings will be minuted, with draft minutes and associated actions circulated to members for comment a maximum of ten working days after scheduled meetings, and final minutes circulated to members after a maximum of ten further days.

### Remuneration

All HSAG operating costs including out-of-pocket costs for HSAG members will be covered by the Hub Leadership & Management component of the Hub budget.

### Conflict of interest

HSAG members must declare any conflicts of interest at the start of each meeting or before discussion of the relevant agenda item or topic. Details of any conflicts of interest should be appropriately minuted. Where members of the HSAG are deemed to have a real or perceived conflict of interest, it may be appropriate that they are excused from Group discussions and/or deliberations on the issue. The Chair will be responsible for assessing declared conflicts of interest and how these will be managed for the meeting and/or particular agenda items.

## Attachment A1. Research Projects

### Project 2.1 – Preparing ACCESS for CMIP6

#### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Simon Marsland <a href="mailto:simon.marsland@csiro.au">simon.marsland@csiro.au</a> (03 9239 4548)		

The Australian Community Climate and Earth System Simulator (ACCESS) is a weather and climate model for Australia.

Given its importance to Australia's climate preparedness and resilience, ACCESS needs to be an internationally benchmarked, world-class global climate modelling capability that is significantly more accurate than other global climate models for the Australasian and Southern Hemisphere region.

We're preparing the next generation ACCESS model for participation in for the World Climate Research Programme's Climate Model Intercomparison Project – Phase 6 (CMIP6). This will provide a global benchmark to assess ACCESS's performance and suitability for applications across the Earth Systems and Climate Change Hub.

This work also supports Australia's effective management of climate risks and opportunities, and engagement with future climate assessments, including the IPCC sixth assessment report.

#### Expected outcomes

Participation in CMIP6 allows for the quality and performance of the ACCESS model system to be internationally benchmarked and assessed. Benchmarking and comparisons with other models enable areas of weakness/improvement in ACCESS to be identified, providing a focus for model development activities.

CMIP6 participation also:

1. focuses ACCESS model development on the highest priority and most significant climate research questions, ensuring our investment in research is well targeted, and effective.
2. ensures that Australian global climate simulations are included in IPCC AR6, giving Australia profile, status and credibility among the international community, and raises the credibility and profile of ACCESS within the Australian community
3. ensures that ACCESS – and therefore Australian climate simulations – are well integrated into CMIP6 data, which will be used to develop periodic climate change assessments for the Australian region that effort.



The capability and model improvements generated in this project are directly transferable to the other modelling projects within the ESCC Hub, and the improvements in model performance are of direct benefit to the other ESCC science projects that exploit ACCESS model results.

## Project 2.2 – Enhancing Australia’s capacity to manage climate variability and climate extremes in a changing climate

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
Bureau of Meteorology		Pandora Hope <a href="mailto:p.hope@bom.gov.au">p.hope@bom.gov.au</a> (03 9669 4774)		

Heatwaves, floods and droughts in Australia have high economic, agricultural and human costs. Managing the risks and reducing the costs associated with climate variability and extremes requires a better understanding of the influence of climate change now and into the future.

We’re analysing past climate variability and extremes, and projections of the El Niño–Southern Oscillation’s impact on drought, to improve our understanding of the driving mechanisms and processes. Our focus is on longer timescale extremes (extended heatwaves and droughts) and the historical record of tropical cyclones.

This will inform the development of robust projections that will help Australia prepare for and respond to climate variability, extremes and change in the future.

### Expected outcomes

The research in this project will provide greater clarity on the role of climate variability and climate extremes (drought, heavy rainfall, extreme temperatures and severe winds) in past and future climate.

This will help decision makers (e.g. local, state and federal government representatives, water managers, NRM groups, Indigenous groups, infrastructure planning, public health and coastal planners) to more clearly understand the risks and opportunities that climate change poses, and so will contribute to:

- reducing environmental damage and loss of productive ecosystems and land-uses
- supporting sustainable reconstruction and asset maintenance
- supporting improved design and operation of infrastructure
- enhancing resilience to climate change and specifically the ability of Australians to prevent, prepare for, and respond to extreme events and multi-year and decadal changes in Australian climate.

## Project 2.3 – Towards an ACCESS decadal prediction system

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Terence O’Kane terence.o'kane@csiro.au (03 6232 5066)		

Climate projections, on the scale of many decades (such as the projections at Climate Change in Australia) provide critical information for medium to long-term planning and decision-making, while daily to seasonal forecasts (such as the Bureau of Meteorology’s Climate Watch outlooks) inform short-term operational decisions. Forecasts on a scale of one to 10 years, a timescale critical for planning for multi-year climate variability, are particularly important to the marine, agriculture, energy and water sectors. However, at present we have a limited capability at this timescale.

We’re supporting development of the forecasting capability to fill the gap between seasonal climate predictions and multi-decadal climate projections. We will build, test and apply a state-of-the-art multi-year climate forecasting system within Australia’s national climate model, ACCESS.

We’re also investigating and characterising the decadal-scale predictability of ocean temperature extremes around Australia, and analysing climate model simulations against observations to assess trends in sea surface temperature extremes that might be attributable to climate change.

Ocean temperature extremes can have devastating consequences for marine life, fisheries and aquaculture. Tracking and predicting changes in marine extremes are key to managing and reducing their impacts in these sectors. This work will ultimately inform marine and agriculture policy and adaptive management strategies for industry and the environment, including assessment of marine temperature extremes, which have large impacts on marine life and fisheries.

### Expected outcomes

A decadal prediction system will routinely inform policies and adaptive management strategies in the marine and land sectors at an economically relevant timescale. This project will begin to close the critical forecast gap between seasonal climate prediction and longer-term (multi-decadal) climate projections, and give us better insight into the feasibility of decadal predictions.

The ocean temperature extremes component of this project will improve our understanding of the time scales over which these events are predictable and will enable improved marine and coastal planning and response decisions informed by knowledge of changing ocean temperature extremes on 1–10-year time scales.

## Project 2.4 – Changing oceans and Australia’s future climate

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/03/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Susan Wijffels <a href="mailto:susan.wijffels@csiro.au">susan.wijffels@csiro.au</a> (03 6232 5450)		

Global warming is ocean warming: over 93% of the extra heat stored by the Earth over the past 50 years is found in the ocean. Ocean heat uptake is one of the rate-setters of global warming. To interpret past changes, and better predict changes in the climate we need to understand how the ocean takes up heat, and how ocean heat uptake may change as the planet warms.

We’re using observations and models to improve the representation of ocean heat uptake in climate models. This will improve projections of future warming, sea-level rise and water availability for Australia.

### Expected outcomes

This project will deliver new information on how and why the oceans are changing and on the consequences of ocean change for terrestrial climate and marine ecosystems. Decision-makers will be able to use this information to develop more robust strategies for marine conservation, biodiversity and natural resource management.

New information about the influence of the Indian Ocean on Australian climate, in particular changes in the hydrological cycle and water availability, will inform more effective water resources planning, management and infrastructure investment.

Assessments of change in ocean heat storage will guide the development of national and international climate policies, contribute to verification of their efficacy, and provide a means of tracking mitigation impacts on the rate of climate change.

This project will enhance Australia’s resilience to climate variability, climate change, and their impacts by improving the national capacity to anticipate, interpret and respond to climate events and trends. Outcomes of the project will include:

Nationally coordinated data and information on changing sea levels and climate in coastal regions will inform coastal planning and development decisions.

## Project 2.5 – Improving Australia’s climate model (ACCESS)

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Tony Hirst <a href="mailto:t.hirst@bom.gov.au">t.hirst@bom.gov.au</a>		

The Australian Community Climate and Earth System Simulator (ACCESS) equips Australia with a global climate modelling capability that is uniquely concerned with the weather and climate of the Australasian and Southern Hemisphere region. The key outcome is a national preparedness that enables Australia to better manage weather and climate impacts, including future risks and opportunities; saving lives, resources and money.

We’re improving ACCESS’s simulation of important climate processes in the Australasian region, focusing on rainfall and weather extremes.

This will allow for multi-year to multi-decadal projections, as well as enabling better forecasting on daily through to seasonal time scales. As a result, policy makers and researchers will have access to better climate information.

### Expected outcomes

All sectors of Australia’s economy that require information about climate for management and policy decisions will benefit from the enhanced capability of ACCESS resulting from this project.

Better model predictions underpin better decision making for our environment. Improvements in the skill of the predictions of key weather and climate phenomena over Australia, from heatwaves to floods, will lead to improved management of our natural and human resources, enhanced resilience and productivity, and reduced costs associated with climate-related damage.

Australian researchers broadly can access and use the ACCESS model system, diagnostic tools and experimental frameworks developed under this and related projects. The consequence is that Australian climate research is more coordinated and efficient through use of common models, tools and methodologies. Next-user researchers, particularly projects in projections development, detection/attribution and carbon-cycle change, will benefit from the development undertaken in this project.

## Project 2.6: Regional climate projection science, information and services

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Kevin Hennessy <a href="mailto:kevin.hennessy@csiro.au">kevin.hennessy@csiro.au</a> (03 9239 4536)		

Credible and salient climate projections are necessary to underpin adaptation activities. However, there are a few areas where uncertainties remain large, data are inadequate for impact assessment, and uptake has been limited. Furthermore, a new set of climate simulations is due in 2018–19, so we need to begin development of new projections that represent the state of the art.

We're developing improved climate products and services for stakeholders, so they can readily access the information they need for adaptation and other climate related activities. We're constraining uncertainty and improving confidence in projections, and we're laying the groundwork for the next generation of regional projections.

### Expected outcomes

Work undertaken in this project will ensure:

- targeted stakeholders understand and have access to relevant information, products and services to support uptake and utility of existing (and future) projections.
- stakeholders have better understanding of the sources of confidence and uncertainty in projections, so risk management will be better informed.
- preparation for the next set of projections is based on strategic planning, well in advance, including progress towards development of new methodologies and approaches and co-ordinated preparation for new data sources.

Enhanced uptake of existing and new projection products and services will allow next/end-users to more fully assess the impact of climate variability and change to inform planning and decision-making. This will improve the scientific evidence supporting important long-term investments, with benefits for society, the economy and the environment.

Easy access to credible, relevant and legitimate information and guidance about climate change will:

- reduce environmental damage and loss of productive ecosystems and land-uses
- support sustainable reconstruction and asset maintenance
- support improved design and operation of infrastructure
- enhance resilience to climate change
- facilitate better-informed use of various sources of climate projections and reduce the potential for conflicting messages in impacts and adaptation work.

## Project 2.7 – Refining Australia’s water futures

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
CSIRO		Dewi Kirono <a href="mailto:dewi.kirono@csiro.au">dewi.kirono@csiro.au</a> (03 9239 4651)		

Information about, and analyses of, future water availability are critical for water resources planning and investment decisions; however, credible and consistent projections for a range of hydroclimate variables are not currently available.

We’re improving our national ability to simulate how changes in climate and land use in the future will affect Australia’s hydroclimates and water resources.

Along with this, we’re ensuring that the projections are both relevant and useful to sectors that are significantly affected by climate and water, such as (but not limited to) agriculture.

### Expected outcomes

In the long-term, this project will contribute to more sustainable water management practice, with water managers being able to routinely access and use best available hydroclimate projections to inform water resources planning, management and investment.

Science from this project has the potential to enhance management and policy in natural resources adaptation to climate change. The availability and utility of consistently derived and interpreted hydroclimate metrics will allow integrated assessments and adaptation planning in many different and connected applications and sectors, including agriculture, industry, mining and environment.

For example, the projections developed from this project will fill the knowledge gaps around northern Australia future surface water and hence have significant potential to contribute to the Government Plan for Information Support Development described in the White Paper on Developing Northern Australia.

Outputs from this project also have significant potential to contribute to improve information for on-farm decision making as part of the government plan to support framers to prepare for drought and other risks<sup>3</sup>.

The Bureau of Meteorology is a likely key end-user for these future assessments of water resources.

<sup>3</sup> Strengthening our approach to drought and risk management, Chapter 3 of the Agricultural Competitiveness White Paper.



## Project 2.8 – Extreme weather projections

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisations		Project leader		
Bureau of Meteorology and CSIRO		Andrew Dowdy a.dowdy@bom.gov.au (03 9669 4722)		

Extreme events, such as tropical cyclones, bushfires, east coast lows and thunderstorms, incur significant economic, environmental and human costs.

Robust scientific information about the influence of climate change on these extreme events is needed for effective disaster risk reduction, emergency response, infrastructure design and operation, planning and policy making, and sustainable development.

We're improving our understanding of existing and projected characteristics of these extreme events.

This will allow us to provide information and tools that will improve resilience and adaptive capacity to the impacts of climate change on extreme weather events, throughout Australia and in other regions of the world.

### Expected outcomes

By refining estimates of the effect of climate variability and change on extreme weather events, and improving the quality and delivery of this information, this project will enable better prevention, preparedness, response and recovery to extreme weather and climate events in Australia.

Our science will be available to inform:

- Design standards for infrastructure and planning (e.g. wind speed and storm surge events).
- National and state guideline documents (e.g. bushfire risk management and bushfire-prone area maps; and mitigation of the adverse impacts of future storms on coastal communities and the environment).
- Planning and policy documents (e.g. land planning in coastal areas; and bushfire management plans that set out informed long-term management strategies for fire hazards and risks within a bushfire-prone area).

The work undertaken in this project will also address key knowledge gaps for tropical cyclones, east coast lows, thunderstorms and extreme fire weather, thereby underpinning ongoing research within and outside of the ESCC Hub. For example, extreme rainfall and winds are produced by tropical cyclones, east coast lows and thunderstorms, all of which are poorly represented by current global climate models. Improved knowledge about how these systems might change in the future will help inform other projects in relation to interpretation of climate model output for various regions of Australia.

## Project 2.9 – Risk assessment of future carbon sources and sinks

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisation		Project leader		
CSIRO		Pep Canadell <a href="mailto:pep.canadell@csiro.au">pep.canadell@csiro.au</a>		

Policy makers need information on carbon and greenhouse gases so they can develop successful national policies and international engagement to achieve climate mitigation targets.

We're assessing the potential for current carbon abatement by revegetation and conservation in Australia, with an emphasis on their potential vulnerability under future climate change, and long-term carbon-climate feedbacks.

We're also developing data products that show national and global carbon budget trajectories (carbon dioxide and methane), and how these are tracking on the pathways needed for global climate stabilisation by the end of the 21st century.

This project supports Australia's involvement in the Global Carbon Project.

### Expected outcomes

Research in this project will improve our national capability to track, understand and predict future changes in greenhouse gases, and the biogenic (produced by living organisms) carbon budget for Australia. This will support and inform Australia's policy responses, and play a key role in ensuring the effectiveness of global actions to mitigate emissions.

Our assessment of the potential of land-based carbon sequestration and its vulnerability under future climates will lead to more effective carbon sequestration activities. It will also inform decisions on how much and where to invest in carbon sequestration and protect existing carbon sinks, establishing more successful and long-term sustainable deployment of mitigation capacity.

For example, enhanced government abatement policies that take full advantage of the carbon mitigation potential from revegetation and carbon stocks conservation will directly enhance the robustness of policies to achieve Australia's 2030 emissions reduction target and inform about the potential for carbon sequestration in Northern Australia that that could lead to new development policies

Our work tracking Australian and global carbon budgets, and monitoring carbon budgets against agreed global targets, will support the Australian Government in achieving its mitigation targets.

## Project 2.10 – Coastal hazards in a variable and changing climate

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/07/2016	30/06/2019	12/2015	In progress
Lead research organisation		Project leader		
CSIRO		Kathleen McInnes <a href="mailto:kathleen.mcinnnes@csiro.au">kathleen.mcinnnes@csiro.au</a> (03 9239 4569)		

Over \$226 billion in Australian assets could be at risk from a 1.1 m increase in sea level (a high-end projection for 2100), due to coastal erosion and inundation. However, the projected changes and their coastal impacts remain uncertain and controversial.

We're improving our understanding of past coastal stressors (sea level, storm surges and waves) to develop projections for the future and the physical impact these changes might have.

Our research will ensure that Australians can plan effectively for coastal change.

### Expected outcomes

Our sea-level projections, analysis of extreme events and changes in wave conditions will be critical inputs to improved coastal planning guidelines. This improved knowledge base will inform planning and management decisions by councils, state planning and conservation authorities and coastal developers, and help deliver appropriate responses to environmental and social developments.

More robust and demonstrable knowledge of coastal impacts will result in more cooperative (win-win) strategies being adopted in the coastal zone, and reduce conflict and costly litigation between councils and developers. These strategies will be more directly linked to local needs but, at the same time, be based on nationally and globally consistent scenarios.

Our science will also inform the Australian Government on the impacts of coastal change, assisting both the government and our near neighbours to better deal with coastal change and be well informed in international negotiations related to climate change.

## Project 2.11 – Establishment of the National Centre for Coasts and Climate – Phase 1

### Project overview

Project details				
Length	Start date	End date	Approval date	Status
3 years	01/05/2016	01/05/2019	15/04/2016	In progress
Lead research organisation		Project leader		
University of Melbourne		Stephen Swearer <a href="mailto:s.swearer@unimelb.edu.au">s.swearer@unimelb.edu.au</a> (03 8344 6253)		

Despite considerable knowledge about climate change and its impacts on marine and terrestrial habitats in coastal ecosystems, there has been very little change in the way coasts are governed in Australia. The local governments responsible for coastal management do not always get the science-based information at the scales they require.

We're establishing the National Centre for Coasts and Climate (NCCC) at the University of Melbourne to work with stakeholders to identify the best ways of addressing climate change impacts in Australian coastal ecosystems.

Through the NCCC we'll investigate how coastal vegetated habitats store carbon, and how climate change is likely to impact on coastal erosion. We'll use this knowledge to develop ecological engineering solutions to enhance the capacity of coastal ecosystems to adapt to climate change.

### Expected outcomes

The creation of NCCC as part of this project will provide increased capability in delivering on ground, solutions-focused and engaged science to identify feasible solutions for addressing climate change impacts in coastal ecosystems.

Our work on blue carbon (carbon stored in marine and coastal habitats) will improve our understanding of the variability and underlying drivers of carbon accumulation rates in coastal vegetated habitats.

Our research will improve understanding of the drivers of coastal erosion and of coastal erosion processes at higher resolution time and space scales. This will allow for better predictions of how different types of coastlines are likely to respond to future climate change.

Through our examination of ecological engineering solutions and how to implement them, local government will have a greater awareness of the value and feasibility of these solutions, and be better informed on their implementation.

This research will also:

- Assist in the development of nationally coordinated policies and approaches for adapting Australia's coast to climate change.
- Assist Government in meeting Australia's post-2020 emissions reduction targets.
- Generate methods for reducing the production of greenhouse gas emissions as part of Government's Emissions Reduction strategy.

## Attachment A2. Indigenous engagement activities and ESCC case studies

### Activity 3.1: Climate change information products for Indigenous communities

In collaboration with the Reef and Rainforest Traditional Owners, this pilot will develop a package of 'Climate Change 101' information from across the Hub's research portfolio, for use in outreach activities with the Reef & Rainforest TO group. The anticipated outcome from this engagement is this information would greatly benefit this community.

This package will include:

- a PowerPoint slide pack
- more technical written information in the form of information sheets
- a video (this is likely to be developed as part of the Workshop to be held in Activity 3.2).

### Activity 3.2: Meeting Indigenous priorities for climate change information, capacity building and engagement

In partnership with CSIRO Land and Water's Collaborative and Indigenous Science team, Kimberley Land Council (KLC) and Seed (the Indigenous branch of the Australian Youth Climate Coalition, and Australia's first Indigenous youth-led climate network), the Hub will identify Indigenous priorities for climate-change focussed information, capacity building and forms of engagement. This will contribute to future plans to meet the Hub's Indigenous engagement goal.

This activity will build on previous work with Indigenous communities to reach common understanding about priority needs, including: (1) the 2012 workshop run by Monash University and the Yorta Yorta National Aboriginal Corporation (YYNAC) as part of an NCCARF-funded activity; (2) NCCARF's current initiatives in peer-learning events<sup>4</sup> with Indigenous peoples to underpin further development of their Indigenous Adaptation Research Plan; and (3) other relevant initiatives identified through the project.

The activity will co-design a workshop bringing together Hub researchers and interested respected and trusted members of the Indigenous and research community (outside the ESCC Hub). A primary objective of the workshop is to continue the dialogue about climate change with Indigenous leaders, with a focus on one of the key findings from the 2012 NCCARF Workshop: the need to ensure that climate data and information are provided in a useful and meaningful way to Indigenous communities; and that there is consideration given to what are the most important variables that are relevant to Indigenous communities.

A key goal for this workshop is to provide recommendations regarding what climate change information, capacity building, and form of engagement would be of greatest value to Indigenous communities. A product that we are very keen to propose, and explore in terms of its utility and impact, is a narrative about climate change that captures Indigenous knowledge and insights, for

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<sup>4</sup> This was the event held in Adelaide around the time of the NCCARF Conference in July 2016.

example a *Seeing through both eyes* version of the State of the Climate, which is produced biennially between CSIRO and the Bureau of Meteorology

### CS 3.3: Climate change impacts on inshore aquatic ecosystems and coastal communities in the Torres Strait Islands

The Torres Strait Regional Authority (TSRA) and Australian Fisheries Management Authority (AFMA) want information on interdependencies between climate change and impacts on inshore fisheries, marine habitat (coral reefs, seagrass beds, mangroves) and coastal communities. Such knowledge would be drawn from Project 3.2, 3.3, 3.4, 3.6 and 3.10.

A Decision Support System will collate/synthesise new scientific and existing traditional knowledge to prioritise community values around ecosystem services. A stakeholder workshop convened by the Hub, TSRA and AFMA is proposed to facilitate outreach of existing knowledge, identify key information gaps and needs, generate tailored communication products, and identify strategic 'way forward' options.

The focus is on engaging with regional and Indigenous stakeholders in the Torres Strait who are both next and end-users of the Hub's climate science. Path-to-impact at Hub level will be achieved by ensuring key next/end-users have enhanced knowledge and the Hub is better informed for future project design and delivery.

### CS 3.4: Coastal climate adaptation with the City of Greater Geelong

Data61 have previously engaged with the City of Greater Geelong to investigate future flooding hotspots under extreme events and sea level rise using the SWIFT hydrodynamic model. This model offers to provide a next generation solution to investigating and mitigating urban flooding under climate change by dynamically modelling aspects of urban flooding not presently accounted for by 'bathtub' modelling approaches. In particular, SWIFT takes account of:

- (1) The temporal variation of sea levels during a storm surge because of the astronomical tidal component
- (2) The connectivity of flood water pathways via the stormwater drainage system
- (3) Rainfall runoff inputs

The City of Greater Geelong have expressed a need for additional interpretation material around the selection of extreme sea level and sea-level rise scenarios for use by coastal managers in the running of SWIFT. The aim of this case study is to work with Data61 and City of Greater Geelong to design appropriate guidance material for the usage of SWIFT. This will leverage the research being undertaken in NESP project 3.10 to work with Data61 on developing boundary condition inputs for SWIFT and broader plans by Data61 and NCCARF to offer the SWIFT model as a next generation inundation modelling platform to aid coastal councils in adaptation to sea level rise.

### CS 3.5: Climate variability and change in WA

South-western Australia has experienced a significant reduction in rainfall since the 1970s. From 1998 to 2012, the Indian Ocean Climate Initiative developed a better understanding of the causes of climate variability and change in WA. Amongst various communication products was an animation of winter-total rainfall contours on a map of south-western Australia from 1940-2010, showing the contraction of rainfall to the south-west corner. This simple video was influential in the decision to build a desalination plant near Perth to augment water supply.

In recent years, rainfall has continued to decline in south-western Australia, so stakeholders want the animation updated to 2016.

A new rainfall animation from 1940-2016 will be developed by Projects 2.2, 2.6 and 2.7 in collaboration with WA Museum. It will focus on total rainfall for the months in which most of the decline has occurred, i.e. May-Aug. If funding permits, an equivalent animation will be produced for the period 2030-2090 for low/high emission scenarios.

Updated information about past and future rainfall variability and change for south-western Australia will provide the WA Department of Water, WA Water Corporation and WA Department of Agriculture and Food with scientific evidence to underpin risk management decisions. Targeted communications and stakeholder engagement

### CS 3.6: Climate Change in Australia mobile website (a prototype)

Climate change projections produced by the NRM project resulted in a wealth of state of the art climate change projection information, including maps, tools and educational products. It encompasses a large range of regionally important information on how our climate might evolve and associated uncertainties. This work has already been very successful at ground level (Natural Resource Management community) as well as in the impact community. It has been presented to many levels of government (Local, State and Federal) via ministerial briefings and other high level presentations.

Building on the vast resources provided in the CCiA website (<http://www.climatechangeinaustralia.gov.au/en/>), this mobile website would provide an easy to use and accessible interface to the climate change data and thereby potentially increase the dissemination of the information significantly. This mobile website would be linked to a subset of the data behind the CCiA website. There is a great wealth of information which can be explored and made accessible through this mobile website. From simple maps of projected changes to rainfall and temperature to more interactive tools such as the analogue tool.

### CS 3.7: Climate Change for Councils (pilot)

The ESCC Hub is well positioned, both as a producer and curator of the latest climate change science, to empower local councils with the confidence and understanding to use climate change science products to inform their decision making.

Case study 3.7 will involve working with one or two regional councils to develop useful knowledge brokering and communication resources that package climate information for them in a way that is useful and accessible for their needs and audiences. These knowledge products will be drawn from across all the Hub's research portfolio; and any relevant 2017 case studies.

The outputs from case study 3.7 will include:

1. A model, i.e. an example of an approach, for engaging with local government to increase their understanding of climate and Earth systems science.
2. A package of knowledge brokering and communication products that can be customised to suit different councils, and added to/refined over time. (This may be as simple as a resource page for local government on the Hub website, as detailed as template driven, customizable publications and presentations).



## CS 3.8: Web delivery portal for coastal hazards information

The CSIRO and ACE CRC web page (<http://www.cmar.csiro.au/sealevel/>) has been the primary vehicle for communicating sea level science and delivering key data sets to the broader scientific community that were developed as part of the former ACCSP project. It has an average 1925 visitor /month, viewing 4765 pages /month. The main type of downloadable data to date has been sea level reconstruction and updates to the satellite altimetry data. The sea level web page currently sits on an unsupported server in Hobart and as such runs the risk of becoming non-functional should the server fail.

A survey of dozens of consumers of coastal and extreme sea level information across Australia has indicated that a portion of that community requires and uses information on sea level extremes such as that delivered by the Canute sea level tool but also desire for it to be easier to access.

Case study 3.8 will aim to upgrade the sea-level web page to a more secure platform and at the same time enhance its utility. This will be done by providing existing extreme sea level information requested by the broader community, enhancing its user base and creating an effective platform for the delivery of new information that is planned through Project 3.10.

## CS 3.9: Practical and empowering responses to coastal erosion

Local people struggle to relate the big scales of climate impacts science to the local, social and environmental processes that are important and relevant to them. Solutions to climate change impacts in the coastal zone require solutions focused science that co-produces knowledge and practices with relevant stakeholders to inspire and enable local communities to act on their values and goals for the future.

Previous engagement with the Tiwi around climate change alarmed local residents and escalated feelings of powerlessness. This study seeks to educate local communities about climate adaptation and provide practical guidance for what actions can be implemented to help address coastal erosion in the Islands.