



A short history of the future: Australian climate projections 1987–2015



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ABSTRACT

This paper describes the history of national climate change projections for Australia since 1987, with a focus on the series of statements in 1992, 1996, 2001, 2007 and 2015. These were prepared by CSIRO up to 2001, and by CSIRO and the Bureau of Meteorology from 2007 onward. A range of scientific and communication issues were addressed in preparing each statement, including decisions concerning climate model ensembles, emission scenarios, forming ranges of change, use of probability, use of expert judgment, spatial resolution, presentation methods and representing uncertainties.

There are a number of *perennial* issues, *trends* and *tensions*, which may be of interest to future production of regional projections for Australia and other regions. For example, managing and communicating uncertainty in future climate due to differing emissions and model responses has been a *perennial* element of the projections. There has been a *trend* towards wider scope in variables analysed, time periods discussed and use of peer review, as well as greater content in the statements over time, partly reflecting available modelling results and the increasing range, needs and sophistication of users. There are several notable *tensions* in this work, reflected in some approaches being adopted and then dropped in subsequent statements. Examples include the choice of spatial resolution, the use of probability, model evaluation and expert judgement. These tensions reflect the difficulty in striking the right balance between competing scientific considerations or between scientific credibility and saliency for users.

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1. Introduction

Many aspects of our climate have changed over the last century, human activities are contributing to some of these changes, and further changes are expected in future. The scientific evidence underpinning these findings across the globe has been documented in peer-reviewed literature assessed by the Intergovernmental Panel on Climate Change (IPCC) in Assessment Reports published in 1990, 1995, 2001, 2007 and 2013 (IPCC 1990, 1995, 2001, 2007, 2013b). Many government agencies, businesses, non-government organisations, communities and individuals want to assess how climate change may impact society and the natural world and to plan adaptations, so there is a high demand for regional climate change projections.

Some regionally-relevant projection information is available from the international literature such as IPCC assessment reports. For example, the Fourth Assessment Report in 2007 featured a regional projections chapter (Christensen et al., 2007), and the Fifth Assessment Report in 2013 featured an Atlas of projections as well as a regional chapter (IPCC, 2013a). However these projections are typically at a larger scale than is desired by users (e.g. the 2013 Atlas uses regions of northern Australia and southern Australia plus New Zealand), and limited quantitative information is provided. This is adequate for awareness-raising in an international context, but it is inadequate for regional and sectoral impact assessment to inform decision-making. Therefore, there is a need for regional projections information to be independently created and published for individual countries. This has been done for a number of countries including the UK (Murphy et al., 2009), the Netherlands (KNMI, 2014), Switzerland (CH2011, 2011), Canada (CCCSN, 2009), the USA (Mearns et al., 2012; NEX, 2015), Australia (CSIRO and Bureau of Meteorology, 2015) and Vietnam (Katzfey et al., 2014). We note that regional projections are often based on high resolution regional modelling, but here we use the term to include regionally focussed analysis of global climate model output (as has usually been the approach used in the Australian work).

There is an opportunity to learn from the evolution of regional projections. This has been done for UK projections published in 1991, 1996, 1998, and 2002 by Hulme and Dessai (2008). They found that climate scenarios are a compromise between the needs of policy, science and decision-makers, and proposed three key criteria against which to evaluate their effectiveness, based on Cash et al. (2003): saliency, credibility and legitimacy. Saliency represents the relevance of the scenarios to the decision-makers, credibility is about scientific and technical robustness, and legitimacy relates to the transparency of the engagement, design, construction and distribution process.

The UK projections saw various trends through the period of 1991–2009, including a move towards more complexity. Communication products and services grew in sophistication, especially following the creation of the UK Climate Impacts Program (UKCIP) in 1997, which facilitated interactions between experts from science and policy. An analysis of the 2009 UK projections was performed by Steynor et al. (2012). The two key lessons were (i) scenarios must be accompanied by ongoing guidance and support to ensure widespread and appropriate uptake, and (ii) on-going dialogue between those providing scenarios and the communities using them is needed to deliver credible scenarios that balance user requirements and science credibility (Steynor et al., 2012).

The UK experience resonates with the Australian experience. This paper describes the development of Australian climate projections from 1987 to 2015. It documents the different products and the changes in methods and scope. This will provide a resource for those working on climate projections in Australia and in other regional contexts. The focus here is on issues from a climate projection supplier's perspective, and we present several recurring motifs, classified as *perennial issues, trends and tensions*. Further research will consider the Australian projections in their institutional, policy and user community context, the effectiveness of stakeholder engagement and support, the uptake of products and services, and an assessment of the strengths, weaknesses and lessons learned. Note that the paper does not address evolution of the quantitative content of the projections (e.g. projected warming and percentage rainfall change), because for a region as large and climatically diverse as Australia, that would require a detailed treatment that is beyond the scope of this paper.

Section 2 provides a chronology of the projections and their context. Section 3 comprises the main body of the paper and covers the methods and scientific basis of the projections, issue by issue, as well as covering some broader considerations such as international linkages and dealing with uncertainty. The key findings are synthesised in the Concluding Discussion (Section 4).

2. Chronology of projections

Australian climate change projections were published by CSIRO in 1987, 1990, 1991, 1992, 1996 and 2001, and by CSIRO and the Australian Bureau of Meteorology in 2007 and 2015 (CSIRO, 1992, 1996, 2001; CSIRO and Bureau of Meteorology, 2007, 2015). The projections from 1992 onward were closely tied to IPCC reports (Section 3.14) and may be recognised as official national climate projections, being the only national projections funded by Federal Government, and were the projections cited in documents from government and related agencies, including the national State of the Environment reports, government planning and policy documents, State of the Climate reports, Australian Academy of Science reports, and the UNFCCC National Communications. From 2001, Federal Government departments also provided a review. They were free, supported by technical reports and journal papers, and covered a range of climate variables, time horizons and emission scenarios. Although supported by journal articles and technical reports, much of our focus here is on the primary communication publications aimed at a wide audience (citations above), which we will refer to as projection 'statements'.

The first Australian projections were developed for a series of impact assessments released at the national Greenhouse 87 conference (Pearman, 1988) and were supported by a book chapter (Pittock, 1988). In the years immediately following this conference, a new Commonwealth Government-funded research programme which addressed a broad range of climate change issues was established (Australian Greenhouse Science Program, later known as the Climate Change Research Program). Additionally, a number of Australian State and Territory governments began funding CSIRO for regional climate projections and related assessments, beginning with the Victorian government (Pittock and Hennessy, 1989). With this support, updates to the 1987 national projections were published by CSIRO in 1990 and 1991 (as part of reports to

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