



Climate projections for ecologists

Climate projections are essential for studying how plants and animals will respond to climate change, but few attempts have been made to interpret climate models for ecologists. The ambiguity and confusion that frequently surround climate projections have hampered ecologists' efforts to effectively analyse and communicate the potential impacts of climate change on natural systems.

We explain climate models and the issues that ecologists need to consider when using climate projections, including the strengths and weaknesses of available climate projections, the uncertainty associated with projections at different spatial and temporal scales, the differences between available downscaling methods, and the implications of these factors for ecological models.

Research outcomes

- » We documented the climate model outputs and issues that ecologists need to consider when applying climate projections.
- » Ecologists who understand climate projections and how to apply them will be able to make informed decisions about their choice of climate model, emissions scenario, baseline period, and data resolution. They will also understand the importance of explicitly stating and justifying their choices, which affect the results and conclusions of their studies.
- » For managing biodiversity at landscape scales in the future, ecologists will be able to use climate models more effectively when determining and advising land managers on future scenarios for natural systems.

Ecology and climate science are different disciplines

Climate projections produced from global climate models are now widely used in ecological studies, where they are essential tools for assessing how species and communities of plants and animals will respond to climate change.

To model the impact of climate change on ecological systems, ecologists need to incorporate research from ecology and climate science — two disciplines that are not well integrated, and that have different approaches, languages and tools. This lack of integration has restricted ecologists' understanding of the modelled climate data and how to use it appropriately.

Few attempts have been made to interpret climate models for ecologists. Determining how plants and animals may respond to climate change is important for informing and supporting management decisions for conserving biodiversity into the future.

Main Range, Kosciuszko National Park

The IPCC has changed its reporting

In 2013–2014, the Intergovernmental Panel on Climate Change (IPCC) released its fifth assessment report of the science of climate change. Climate scientists are now using a set of more than 50 climate models and have changed the way they describe emissions scenarios. Ecologists need to understand the strengths and weaknesses of the models used, and what the new emissions scenarios are based on.

Many different climate data products are available

Global climate models are usually at resolutions of several hundred kilometres, but ecologists require data at a much finer scale. With recent developments in the field of downscaling data from global climate models, a range of accessible products that provide climate data at a fine scale is now available. However, this climate data is derived in different ways, and finer resolution does not always mean more accuracy. An update on the range of models, the data available and how to deal with uncertainty in projections is, therefore, timely.



What did we do?

We identified the climate model outputs and issues that ecologists need to consider when applying climate projections in ecological studies.

In our paper, 'Climate Projections for Ecologists', we explain what a climate model is, what a projection is (as opposed to a prediction), and how global climate models are evolving.

We explain the reasons for uncertainty, range and variability in climate projections.

We describe changes in the IPCC's use of emissions scenarios, moving from emissions scenarios based on socio-economics (the 'Special Report on Emission Scenarios', or SRES, which comprised the A1, A2, B1 and B2 scenarios) to scenarios based on different climate policies (known as 'representative concentration pathways', or RCPs).

We explain how projections from global climate models, which are usually at resolutions of several hundred kilometres, can be downscaled to the fine scales required by ecologists, and we describe the advantages and disadvantages of the different methods of downscaling (dynamical, statistical and simple scaling).

Some publicly accessible datasets that could be useful for ecological analyses are listed.

We highlight some of the challenges ecologists face in using climate projections in their studies and suggest ways to effectively address them. Challenges include:

- choosing the appropriate emissions scenario, global climate models, climate variables (e.g. rainfall, wind), resolution of climate projections and baseline period
- presenting outputs from multiple climate projections
- capturing climatic variability such as extreme events
- downscaling projections from monthly to daily and sub-daily time scales.

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How did we do it?

We brought together climate scientists and ecologists to highlight the common misunderstandings about climate projections, and we then addressed these issues through a synthesis of the climate science literature.

What did the results tell us?

Ecologists need to consider uncertainty in climate projections

To accommodate the uncertainty associated with climate projections, we recommend that ecologists studying the influence of future climate on natural systems should:

- include high and low emission scenarios to frame the range of responses to unmitigated climate change
- use more than one global circulation model, chosen to best represent the variables of interest in the study region
- consider the most appropriate way to present the output from multiple climate models
- report the range or standard deviation in the results if presenting the mean of data from multiple climate models
- choose a baseline appropriate to the study subject
- state all choices explicitly and acknowledge the impact of these choices on the results.

Fine-scale climate projections are urgently needed

There is still a pressing need for regional climate projections at biologically relevant spatial and temporal scales for more regions around the world. Many ecological applications require gridded data at fine temporal resolutions, as well as fine spatial resolutions.

The Climate Futures for Tasmania project produced fine-scale regional climate projections for Tasmania and for the Australian Alps. In consultation with land managers, ecological indices that can be used with multi-model projections of future climate in the Australian Alps have also been generated.

The fine-scale climate projections enable researchers, planners and managers to explore the likely implications of climate change over a region.

Where to from here?

An ongoing and improved dialogue between climate modellers and ecologists will help bridge the gap in understanding climate projections, enabling ecologists to make better use of the available climate data by, for example, incorporating climate variability and extremes into ecological models and analyses.

With better information available, policymakers are able to better prepare for and manage the impacts of climate change on biodiversity at landscape scales into the future.

Who are the researchers?

Dr Rebecca ('Bec') Harris



Bec has an extensive background in field ecology and thermal biology. As part of our Climate Futures Project, she works closely with researchers across the hub to extract, analyse and interpret climate projections for species under threat from climate change.

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Luciana is a geographer and remote-sensing specialist based at the ANU Fenner School in Canberra. She is part of the Bioregional Futures team applying tools and techniques to study characteristics of landscape ecosystems and the patterns of diversity under scenarios of natural and human-induced change.

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Further reading

Antarctic Climate & Ecosystems Cooperative Research Centre (2010) *Climate Futures for Tasmania climate modelling: the summary*. Antarctic Climate & Ecosystems Cooperative Research Centre, Hobart, Tasmania.

Harris RMB, Grose M, Lee G, Bindoff N, Porfirio L & Fox-Hughes P (2014) Climate Projections for Ecologists. *WIREs Climate Change*, doi: [10.1002/wcc.291](https://doi.org/10.1002/wcc.291).

About the NERP Landscapes and Policy Hub

The Landscapes and Policy Hub is one of five research hubs funded by the National Environmental Research Program (NERP) for four years (2011–2014) to study biodiversity conservation.

We integrate ecology and social science to provide guidance for policymakers on planning and managing biodiversity at a regional scale. We develop tools, techniques and policy options to integrate biodiversity into regional-scale planning.

The University of Tasmania hosts the hub.

www.nerplandscapes.edu.au



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