



## Challenges in providing and applying multi-model climate scenarios for climate change adaptation

### Key Messages

- Our current understanding of the changing climate is that there are varying levels of confidence in how different climate variables will be affected.
- Adaptation decisions must be based on climate scenario information from a set of climate models which represents the range of outcomes consistent with this current understanding.
- The climate information requirements for assessing vulnerability and planning adaptation often includes the need for spatially detailed data requiring downscaling from available global climate model projections.
- We can reduce the resources required to downscale and use projections from an ensemble of climate models by sampling from the ensemble to represent the range of outcomes with a few models.
- Using this range of outcomes allows us to assess the range of impacts in physical systems and economic sectors implied by our current understanding of how the climate will change.
- Exploring responses to this range of impacts will allow an assessment of adaptation options consistent with a range of future climate changes reflecting the latest scientific understanding.

### Overview

Climate science work provides the foundation for the Adapting to Climate Change in China (ACCC) project. Decision-makers look to climate science to assist them in developing adaptations that will perform well in future. Models of climate change indicate a range of plausible futures, and decision-makers need to be able to make use of this information in order to make robust adaptation planning decisions.

Current understanding of the future climate means that there are differing levels of confidence for different climate variables. It is therefore unwise to base decisions on the outputs of a single climate model, as it is not possible to determine which model is best at predicting our future climate. So it is important that decision-makers take account of the wider range of plausible future climates, indicated by a number of climate models – the multi-model approach.

Decision-makers often require information at a higher resolution than that offered by global climate models. Higher resolution models can produce this information but this can involve significant effort. ACCC has adopted a novel approach which produces the necessary higher resolution information, but with fewer resources.

Here we discuss the use, within ACCC, of a multi-model approach and the implications of this approach for assessing impact and vulnerability, and for planning adaptations.

### Why use multi-model projections?

Much of our current understanding about why the climate is changing and how it will change in the future comes from climate models. These give very clear messages that the climate will continue to warm and indicate that significant changes in precipitation and other climate parameters are expected in many locations.

Despite this very clear general trend, climate models produce different results, showing a variation in the magnitude and sometimes the pattern of climate changes. This means that climate

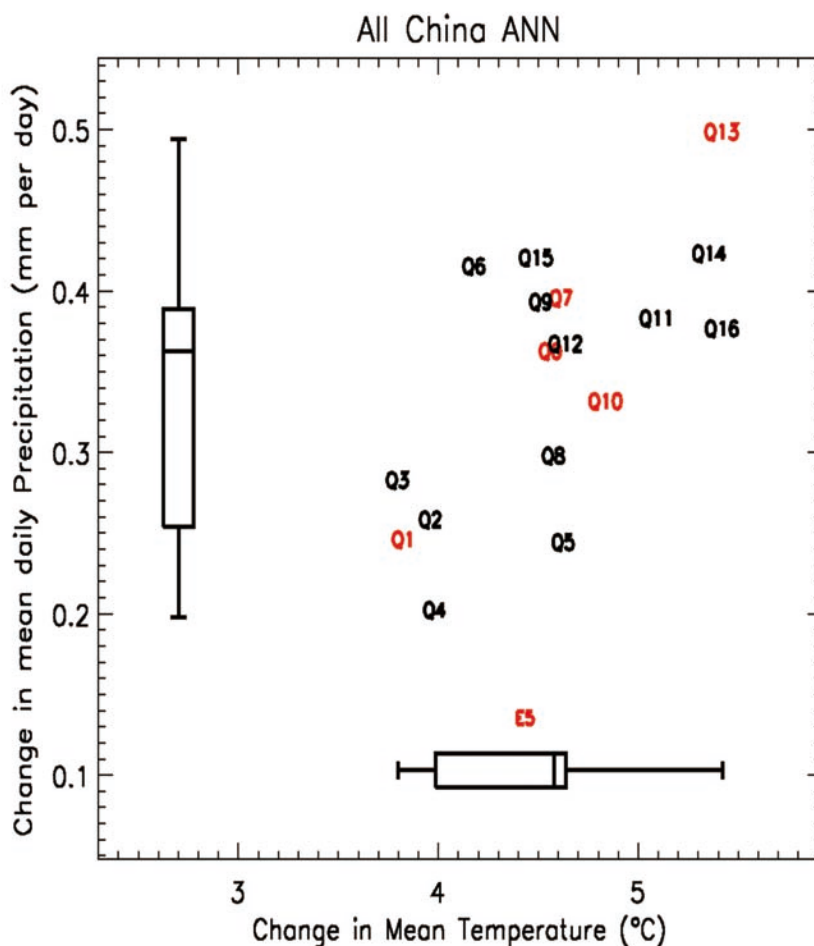
scientists have different levels of confidence in different aspects of future climate change. Currently there is no objective method of selecting which particular climate model projection of future climate is likely to be correct. To help people make the best decisions about how to adapt to future climate, decision-makers need to consider information from a range of model projections of future climate.

In addition, assessments of the impacts of climate change on sectors such as water availability, ecology and agriculture and food security often require information about specific regions, and thus at a higher resolution than is available from global climate models (GCM). Adding information to the GCM using a higher-resolution regional climate model can resolve this, but it is resource intensive, and can rarely be applied to large ensembles of different climate models.

## Providing multi-model scenarios for ACCC

The ACCC initiative has made use of a novel approach to the problem of providing climate information that meets the needs of decision-makers, but which also makes effective use of available resources.

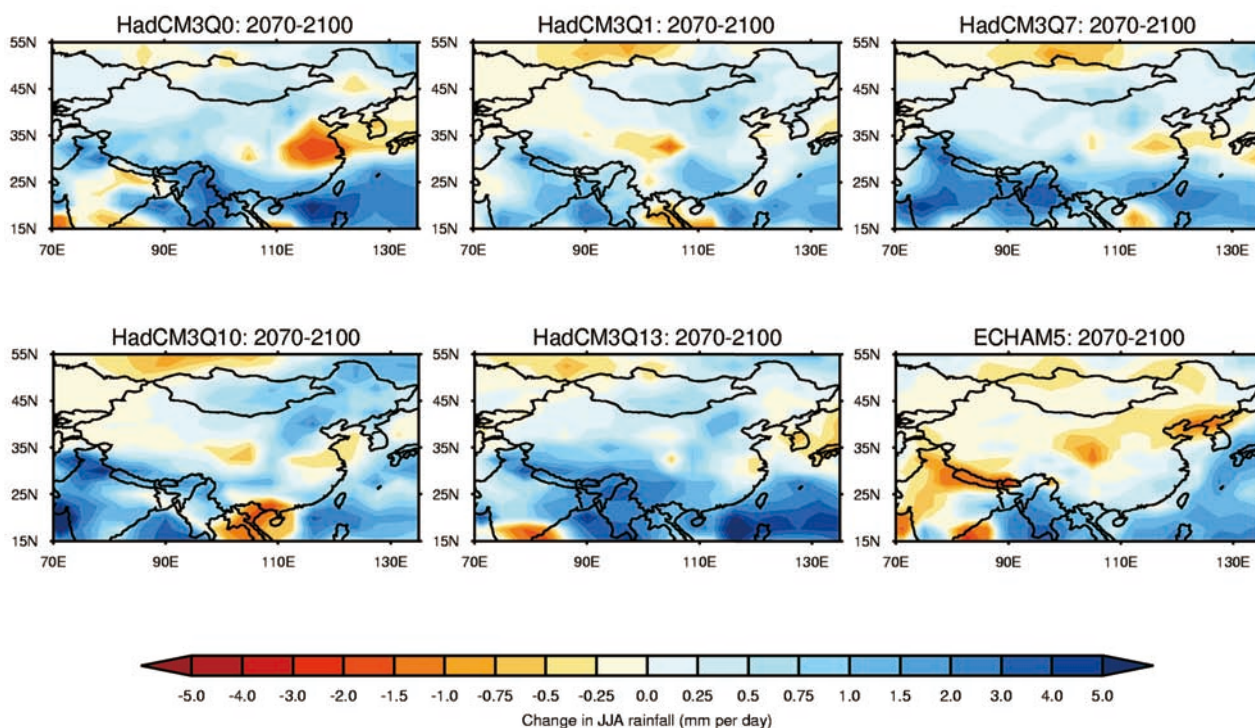
Modelers took a sample from members of GCM ensembles that were available for downscaling, and from these they are providing a range of downscaled climate scenarios. These scenarios are representative of the range of changes that are indicated by the full ensemble. A sub-set of 5 models was selected for use in the ACCC project so that they represented the key features of the climate in the different climatic regions across China realistically and spanned a similar range of changes in temperature and rainfall as the full ensemble.



*Projected future climate change by 2100 for China in a 17-member climate model ensemble (Q0-Q17) from the Met office Hadley Centre, and ECHAM5 (E5), under one emissions scenario. Models highlighted in red were selected to sample the range of outcomes. All models project that China will become hotter, and with more precipitation, but we can sample models that represent the smallest changes, and some that represent the largest.*

Changes to rainfall were a particular challenge. Differences in spatial patterns of precipitation change simulated by different GCMs can result in the direction of change (whether average rainfall increases or decreases) being different in a particular region of interest. In order to capture this uncertainty for different regions within China, the sub-set was also selected so that it simulated different spatial patterns in the precipitation change, as well as a range of average changes for the whole country.

This approach has allowed the ACCC partners to provide high-resolution projections which account for this range of potential future climates to those who are involved in impacts assessment and decision making, whilst using available resources efficiently. As the amount of available global climate model data increases in the run-up to the next IPCC report, approaches such as this will become increasingly important as a way to represent information on the range of possible future climate changes contained in large ensembles, without incurring unmanageable human, computer and data resource requirements.



*Projected future changes in wet-season rainfall by 2100 for China in the 5 selected ensemble members and ECHAM5, under one emissions scenario. These models were selected to represent a range of different spatial patterns of precipitation changes.*

## Using multi-model projections

The availability of multiple scenarios of future climate presents both challenges and opportunities to those using the information for understanding impacts, vulnerabilities and risks and when identifying appropriate adaptation measures.

Some assessment may be required to judge which scenarios should be used and effort will be required to understand the implications of these. However, having multiple climate scenarios allows users to plan for a range of outcomes, allowing for the implications of uncertainty in their analyses, which can lead to more robust conclusions being drawn. Basing impacts, vulnerability and risk assessments on a single scenario of future climate ignores the fact that a given climate scenario will, in general, not be an accurate prediction, and could result in excessive or insufficient adaptation, or even maladaptation.

Selecting the scenarios to consider in such an assessment requires an understanding of the system for which impacts, vulnerabilities or risks are being explored (i.e. agricultural crops, water resources, health system, etc.), including its sensitivity to changes in the driving climate parameters. Scenarios should be selected so they allow for a range of possible outcomes, especially if they allow for the testing of sensitivities and possible thresholds.

In the case of supporting adaptation assessments, having multiple scenarios that explore a range of plausible future climates is fundamentally important. Consideration of multiple climate scenarios that better reflects the associated uncertainties provides an opportunity to identify a more robust adaptation strategy with measures consistent with known sensitivities and thresholds and reflecting associated risk aversion.





*ACCC aims at improving the application of climate scenarios for assessing future impact of climate change in key sectors, such as agriculture and water. Building a common understanding of the main features and limitations of climate scenarios is a crucial step in this process.*

## About the Authors

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## About the ACCC Project

ACCC is an innovative policy research initiative focusing on linking climate change research with policy making and development. The Project started in June 2009 as a collaboration between UK, China and Switzerland; it is funded by the UK Department for International Development (DFID), the Swiss Agency for Development Cooperation and the UK Department for Energy and Climate Change (DECC).

For more information and updates visit the project web site: [www.ccadaptation.org.cn](http://www.ccadaptation.org.cn)

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