Regional climate projections for NSW

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Climate Change Projections

- Global Climate Models (GCMs) are the primary tools to project future climate change
  - CSIRO’s Climate Change in Australia
  - UNSW/DECCW projections

- Do you need higher spatial resolution?

- Downscaled climate projections for NSW
  - Statistical downscaling
    - Analogue technique (Timbal et al)
    - Stochastic Weather Generator (Liu et al)
  - Dynamical downscaling
    - NARcliM project
GCM Projected Changes
GCM Projected Changes
GCM Simulations
GCM Projected Changes
CSIROs Climate Change in Australia


In 2007 the Intergovernmental Panel on Climate Change (IPCC) released their fourth assessment report, concluding that:

- Warming of the climate system is unequivocal
- Humans are very likely to be causing most of the warming that has been experienced since 1956
- It is very likely that changes in the global climate system will continue well into the future, and that they will be larger than those seen in the recent past.

These changes have the potential to have a major impact on human and natural systems throughout the world, including Australia.

The IPCC reports provide limited detail on Australian climate change, particularly when it comes to regional climate change projections. For this reason the Australian Greenhouse Office, through the Australian Climate Change Science Programme, engaged CSIRO and the Bureau of Meteorology to develop climate change projections for Australia.

Climate change in Australia is based upon international climate change research leading conclusions from the IPCC’s fourth assessment report. It also builds on a large body of climate research that has been undertaken for the Australian region in recent years.

Climate change in Australia provides essential tools for government, industry and the community to understand the likely magnitude of climate change in Australia and the possible impacts.

The Climate Change in Australia report is available for download from the Technical Report page of this website.
CSIRO's Climate Change in Australia

New South Wales / Australian Capital Territory Temperature Change

Region: New South Wales / ACT
Variable: Temperature change
Year: 2070
Percentile: All
Period: Summer

Projections are given relative to the period 1989-1999 (referred to as the 1990 baseline for convenience). These projections give an estimate of the average climate around 2030, 2050 and 2070, taking into account consistency among climate models. Individual years will show variation from this average. The 50th percentile (the midpoint of the spread of model results) provides a best estimate result. The 16th and 90th percentiles (lowest 10% and highest 10% of the spread of model results) provide a range of uncertainty. Emission scenarios are from the IPCC Special Report on Emission Scenarios. Low emissions is the B1 scenario, medium is A1B and high is A1F2.
CSIROs Climate Change in Australia

Climate Change in Australia > New South Wales / Australian Capital Territory Rainfall Change

Region: New South Wales / ACT
Variable: Rainfall change
Year: 2070
Percentile: All
Period: Summer

Projections are given relative to the period 1986-1995 (referred to as the 1990 baseline for convenience). The projections give an estimate of the average climate around 2030, 2050 and 2070, taking into account consistency among climate models. Individual years will show variation from this average. The 50th percentile (the midpoint of the spread of model results) provides a best estimate result. The 10th and 90th percentiles (lowest 10% and highest 10% of the spread of model results) provide a range of uncertainty. Emissions scenarios are from the IPCC Special Report on Emission Scenarios. Low emissions is the B1 scenario, medium is A1B and high is A1F1.
UNSW/DECCW projections

- Prof. Andy Pitman et al. Combined four GCMs to produce an ensemble projection of climate change for NSW
- Some GCMs are better than others at regional scales
- GCMs not spatially detailed enough to have confidence in changes occurring in areas smaller than ~1/4 of NSW
Rainfall – to 2050 [A2]
Temperature (to 2050, A2)

Spring
+2.0°C to +2.5°C

Summer
+1.0°C to +1.5°C

Winter
+2.0°C to +3.0°C
Do you need higher spatial resolution?

- Are surface variations important?
  - Coastlines
  - Mountains
  - Abrupt land-use changes

- Are regional scale atmospheric phenomena important?
  - Frontal rain systems
  - Mountain barrier jets
  - Sea-breezes
  - Tropical cyclones......
GCM Simulations
GCM Simulations
GCM Projected Changes
GCM Projected Changes
GCM Simulations

GISS Mean Annual Temperature 2000

CSIRO Mean Annual Temperature 2000

CCSM Mean Annual Temperature 2000
GCM Simulations
GCM Projected Changes

GISS Mean Annual Temperature 2090-2000

CSIRO Mean Annual Temperature 2090-2000

CCSM Mean Annual Temperature 2090-2000

Climate Change Research Centre

UNSW The University of New South Wales Sydney, Australia
GCM Projected Changes
GCM Simulations

GISS Mean Annual Temperature 2000

CSIRO Mean Annual Temperature 2000

CCSM Mean Annual Temperature 2000
GCM Simulations
GCM Projected Changes

GISS Mean Annual Temperature 2090-2000

CSIRO Mean Annual Temperature 2090-2000

CCSM Mean Annual Temperature 2090-2000
Getting to smaller spatial scales

Downscaling

- Statistical
- Dynamical

Regional Climate Models

Weather Research and Forecasting (WRF) model

10km horizontal resolution
GCM Simulations
GCM Simulations
GCM Simulations

CCSM
Annual Precipitation
2000

WRF
Annual Precipitation
2000

mm

Climate Change
Research Centre

UNSW
Downscaled climate projections for NSW
BoM “Analogue” statistically downscaled projections

Timbal, B., E. Fernandez and Z. Li. 2009: “Generalization of a statistical downscaling model to provide local climate change projections for Australia”, Environmental Modelling and Software, 24, 341-358

Variables downscaled
• Daily precipitation, min & max temperature

To station locations & 0.05° grid

Contact: B.Timbal@bom.gov.au
BoM “Analogue” statistically downscaled projections

Methodology:
Find a historical analogue based on a small set of predictors

Predictors can include: Mean sea level pressure, temperature at 850 hPa, wind speed at 850 hPa, ....

Limitation: cannot predict an event that has not occurred in the historical record.
BoM “Analogue” statistically downscaled projections

Change in rainfall: A2 (2050) – current climate

Winter

Summer

4 GCMs

BoM- SDM of the 4 GCMs
NSW DPI “stochastic weather generator” statistically downscaled projections

Dr De Li Liu, NSW Department of Primary Industries, Senior Research Scientist

Variables downscaled
• Daily precipitation, min & max temperature

To station locations

Contact: de.li.liu@industry.nsw.gov.au
NSW DPI “stochastic weather generator” statistically downscaled projections

Methodology:

- Estimate statistical distributions of precipitation, min & max temperature from historical daily record
- Estimate changes to these distributions from GCM monthly projections
- Use stochastic weather generator to generate synthetic daily time series from these distributions

Limitation: How well do GCMs reproducing current statistical distributions? How are changes at the monthly time-scale reflected in daily distributions?
NSW/ACT Regional Climate Modelling (NARClIiM) Project

Dynamical downscaling project which is just starting. A collaboration between CCRC, UNSW & OEH. Due to complete in 3 years.

Variables downscaled
- More than 100 climate and related variables
- At least 3 hourly, daily and monthly times scales
- 10km resolution grid

Project contact: Graham.Turner@environment.nsw.gov.au
Research contact: jason.evans@unsw.edu.au
NSW/ACT Regional Climate Modelling (NARCliM) Project

Methodology:

- Create lateral (& SST) boundary conditions from GCMs
- Drive RCMs with GCM boundary conditions

Limitations: Requires large amounts of computer time & data storage. (estimated at ~6 million CPU hours & 1PB)
The NARCliM domain
Currently available climate projections for NSW

Directly GCM based
- CSIRO – Climate Change in Australia
- UNSW / DECCW

Downscaled climate projections
- BoM “analogue” statistically downscaled projections
- NSW DPI “stochastic weather generator” statistically downscaled projections

In the future there will be NARClIm dynamically downscaled projections
Regional climate projections for NSW

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