



Future climate extremes and the NARClIM modelling project

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Science

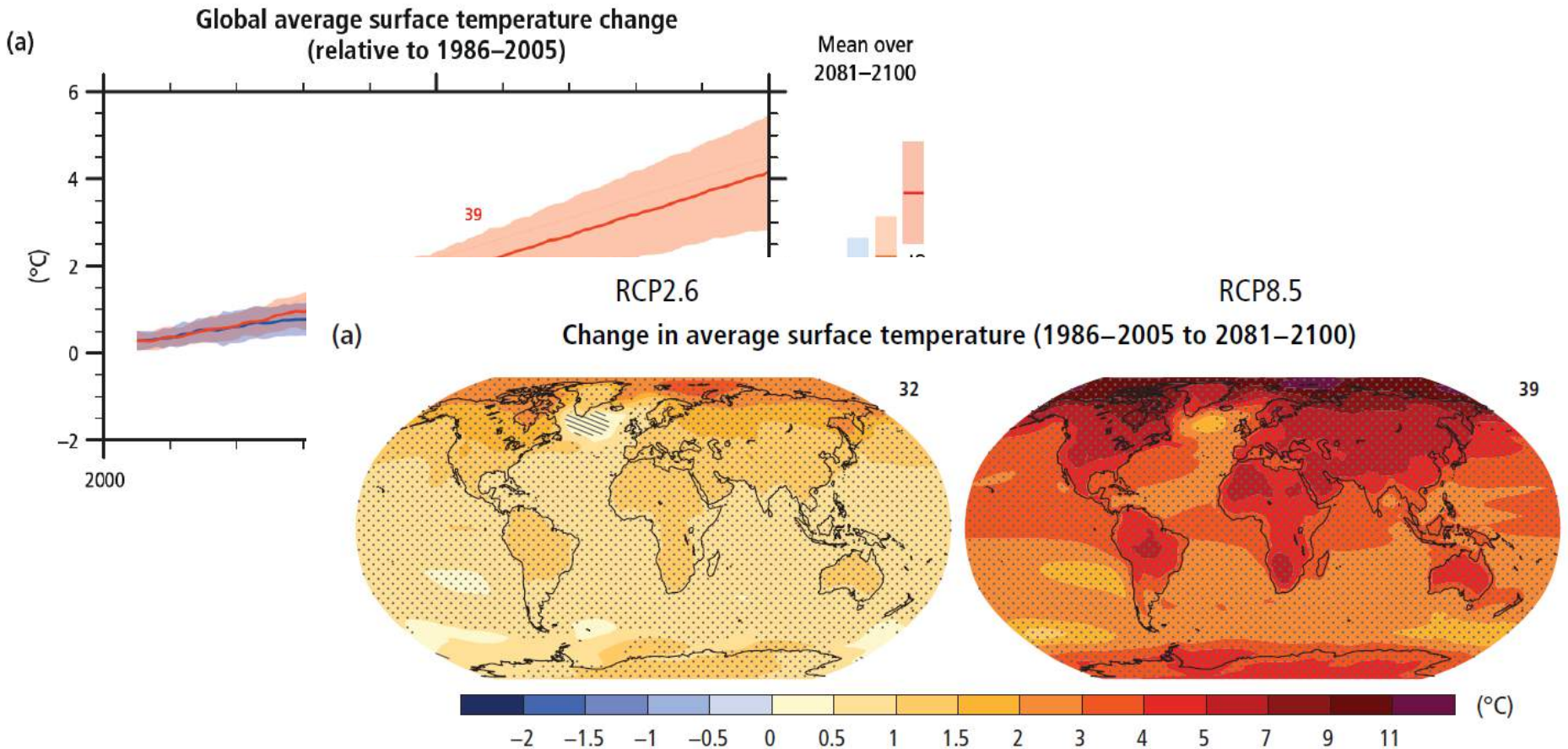
Climate Change Research Centre

Jason P. Evans
& the NARClIM team

Outline

- Global climate change
- NARClIM – regional climate projections
- Future mean climate changes
- Heatwaves
- Extreme precipitation

Global Climate Projections



NARClIM

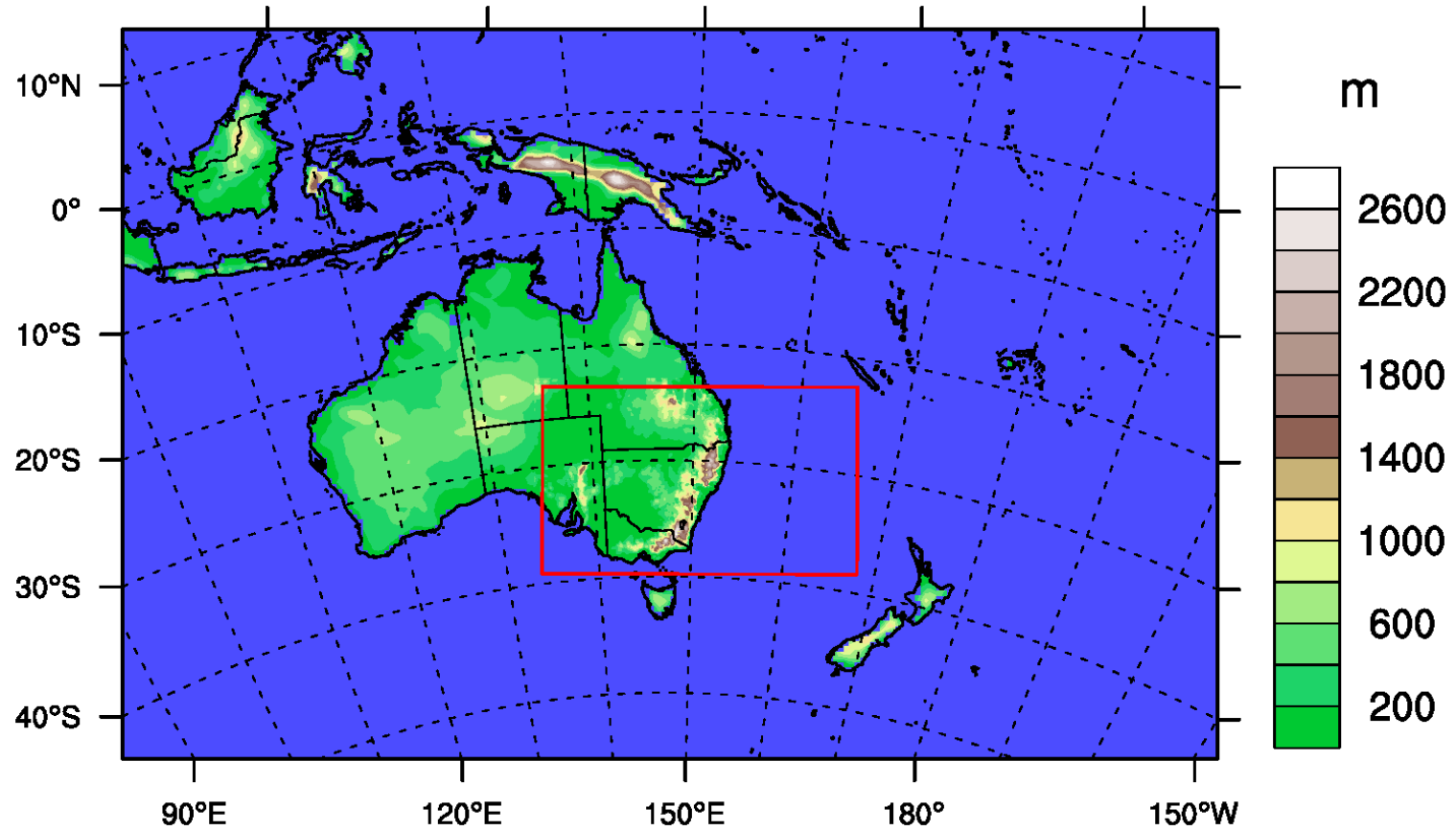
NSW / ACT Regional Climate Modelling project

NARClIM is a collaboration with state governments to produce a climate projection ensemble that can be used across government departments to include future climate change in planning processes in a systematic and consistent way.

NARCIIM Modeling

- A2 scenario
- 4 GCMs + 3 RCMs = 12 member ensemble
- 2 domains: AUS44 (CORDEX 50km), NSW/ACT (10km)
- Control period: NCEP re-analysis 1950-2010
- 3 GCM time-windows: 1990-2010, 2040-2060, 2060-2080
- Apply statistical bias correction to remove systematic bias

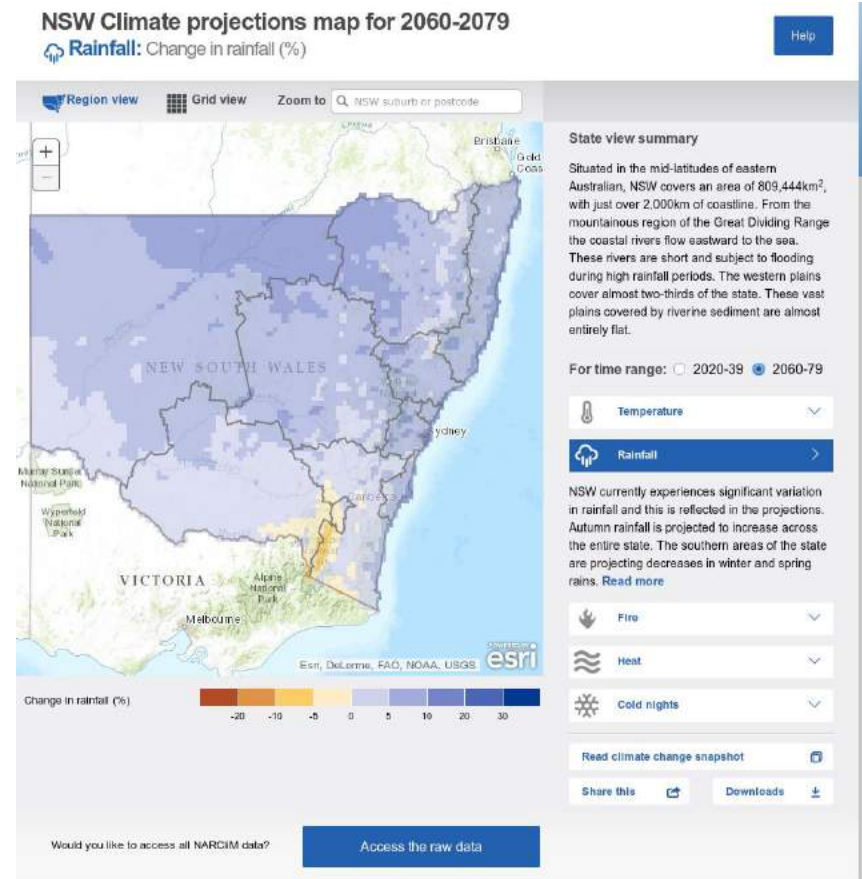
RCM domains



NARClIM data

NARClIM data underpins the AdaptNSW website

<http://www.climatechange.environment.nsw.gov.au/>





Future mean climate changes

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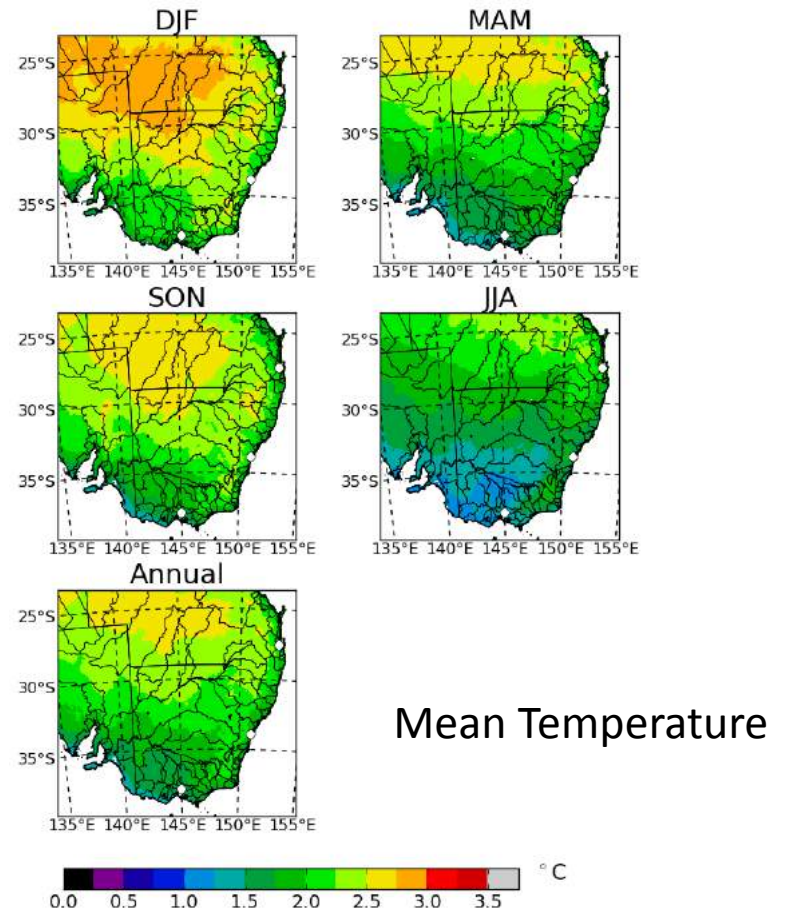
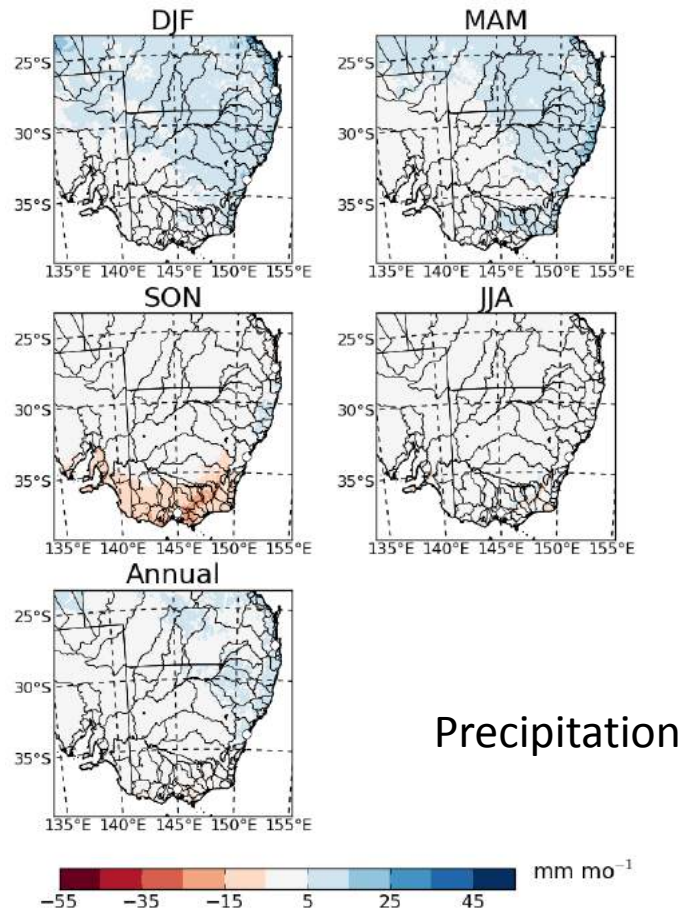
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Far Future minus Present Day

2060-2079

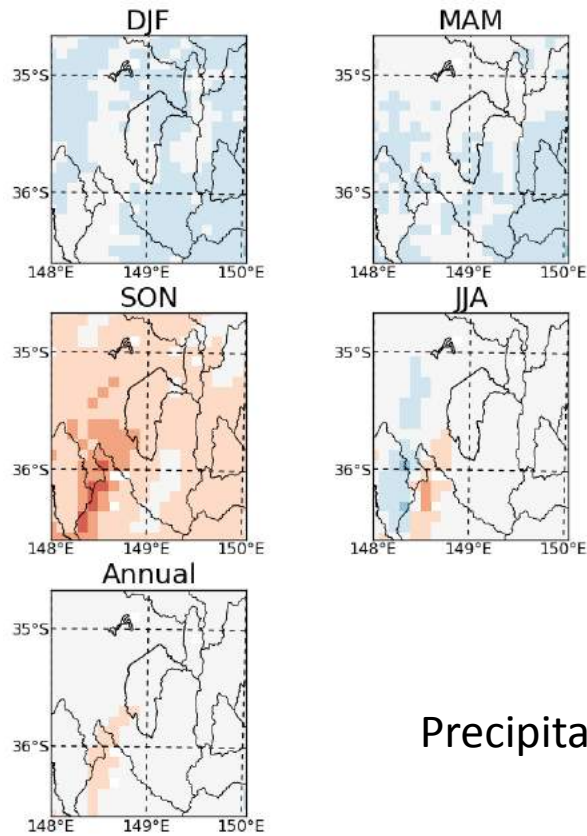
1990-2009



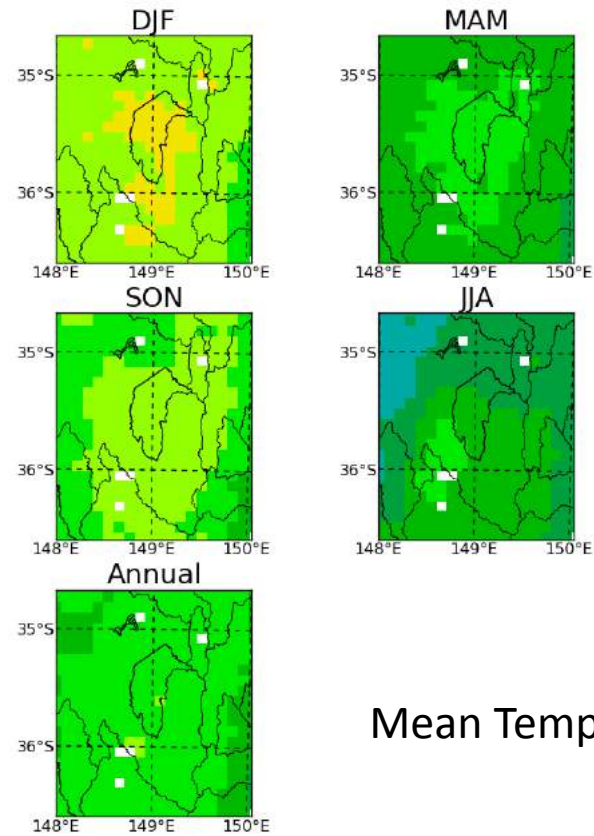
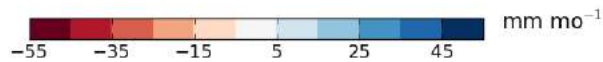
Far Future minus Present Day

2060-2079

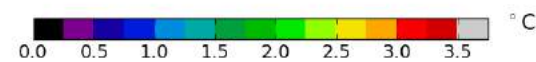
1990-2009



Precipitation



Mean Temperature





Future heatwaves

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Excess Heat Factor

Two terms :

- Acclimatisation
 - $EHI_{accl} = (T_i + T_{i-1} + T_{i-2})/3 - (T_{i-3} + \dots + T_{i-32})/30$
- Significance :
 - $EHI_{sig} = (T_i + T_{i-1} + T_{i-2})/3 - T_{95}$

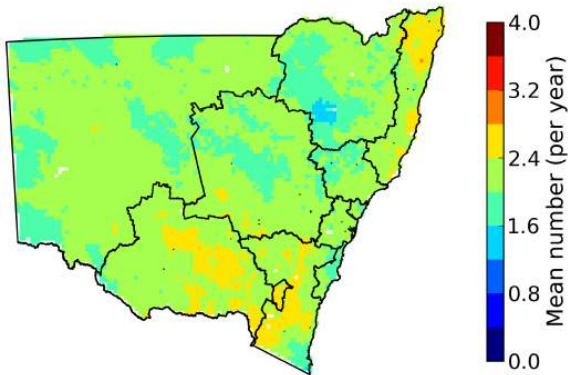
$$EHF = \max(1, EHI_{accl}) \times EHI_{sig}$$

A heat wave occurs when $EHF > 0$ during 3 or more consecutive days. Provided metrics include :

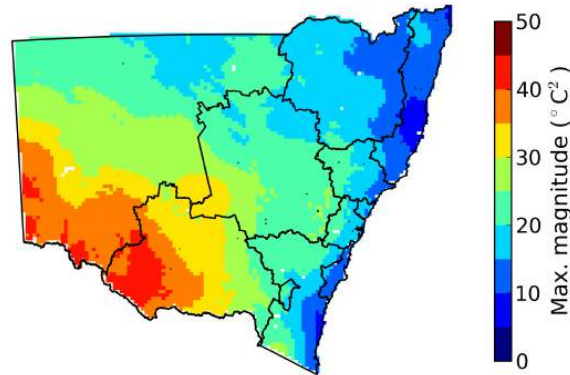
- HWA (amplitude) : amplitude of the hottest day in the hottest heatwave event in a year. Maximum EHF of the
- heatwave with the highest average EHF in a year ($^{\circ}C^2$)
- HWN (frequency) : number of heatwave events in a year
- HWD (duration) : duration of the longest heatwave in a year (days)

Observed Heatwaves (1990-2009)

Frequency



Amplitude



Duration

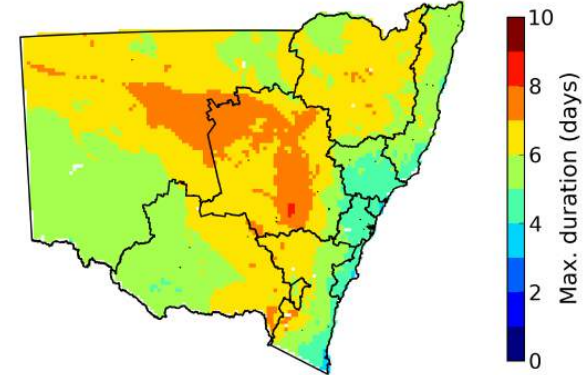


Figure: Present-climate (1990-2009) heatwave indices from AWAP observations using the 1990-2009 reference period.

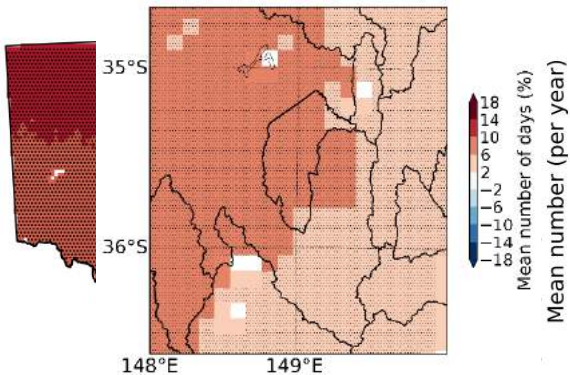
- The number of heat waves is quite homogeneous over NSW.
- The amplitude is highest over the southwest and lowest along the coast related with temperature variability.
- Longest heat waves tend to appear towards the interior of NSW.

Far Future minus Present Day

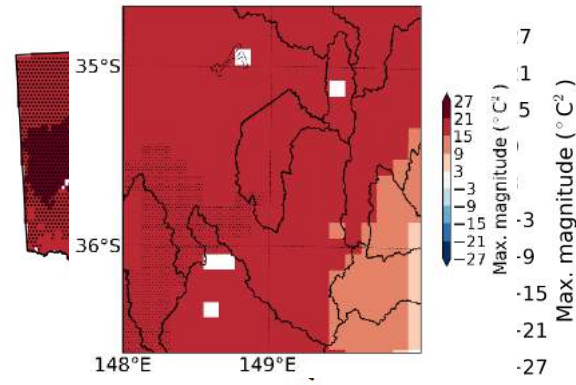
2060-2079

1990-2009

Frequency



Amplitude



Duration

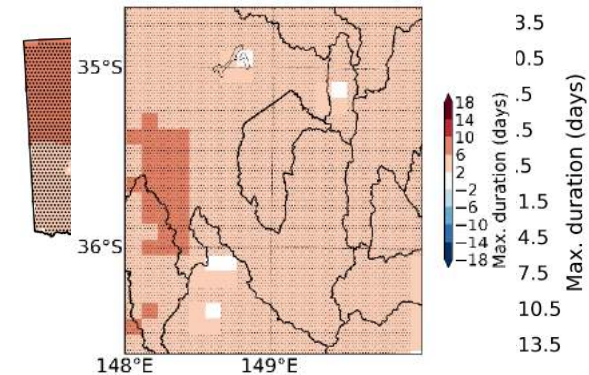


Figure: Far-future (2060-2079) projected changes for heatwave indices from the NARClM ensemble with respect to present climate (1990-2009).

- The number and duration of heat waves increase significantly everywhere in NSW for the period 2060-2079.
- The amplitude increases everywhere but only significantly over western NSW.



Extreme Precipitation

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Observed trends in rainfall extremes

Rx1day

Annual maximum 1-day rainfall

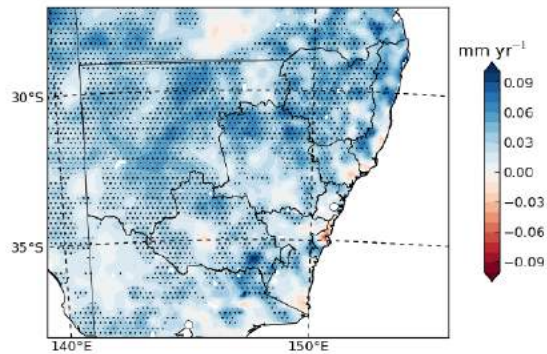


Figure 3.17: Trends from 1911 to 2014 in annual maximum 1-day precipitation (Rx1day) [mm yr^{-1}]. Stippling indicates the trend is significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

R99pTOT

Contribution of largest 1% of events

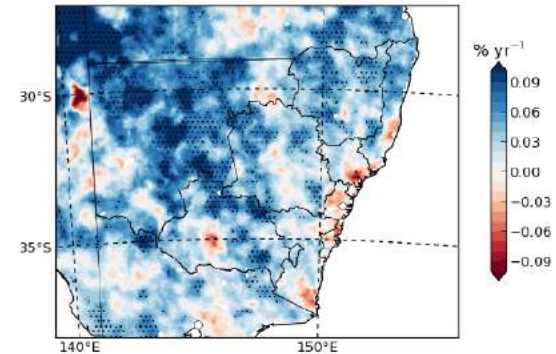


Figure 3.26: Trends from 1911 to 2014 in contribution from extremely wet days as % of PRCPTOT (R99pTOT) [$\% \text{ yr}^{-1}$]. Stippling indicates the trend is significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

NARClIM Evaluation

Rx1day

Annual maximum 1-day rainfall

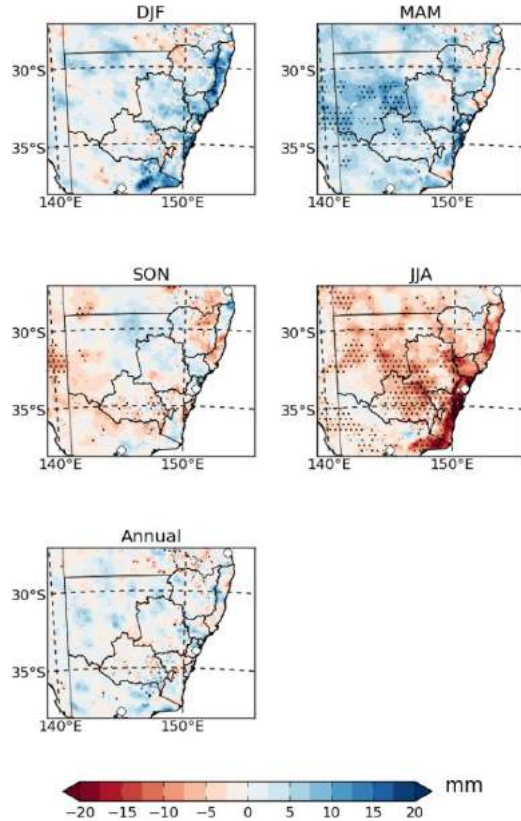


Figure 4.13: Present-day (1990-2009) multi-model average seasonal and annual maximum maximum 1-day precipitation (Rx1day) minus corresponding AWAP observations [mm]. Stippling indicates the bias is significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

R99pTOT

Contribution of largest 1% of events

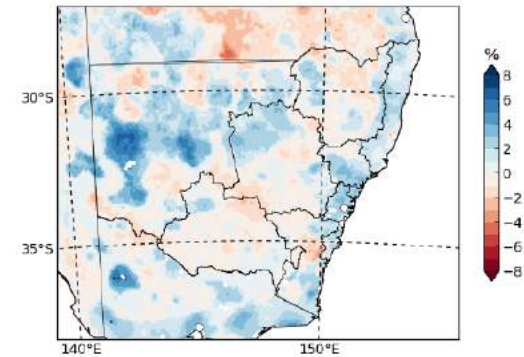


Figure 4.22: Annual multi-model means of bias-corrected WRF minus AWAP contribution from extremely wet days as % of PRCPTOT (R99pTOT) for years 1990-2009 [%]. Stippling indicates the bias is significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

Observed extremes (1990-2009)

Rx1day

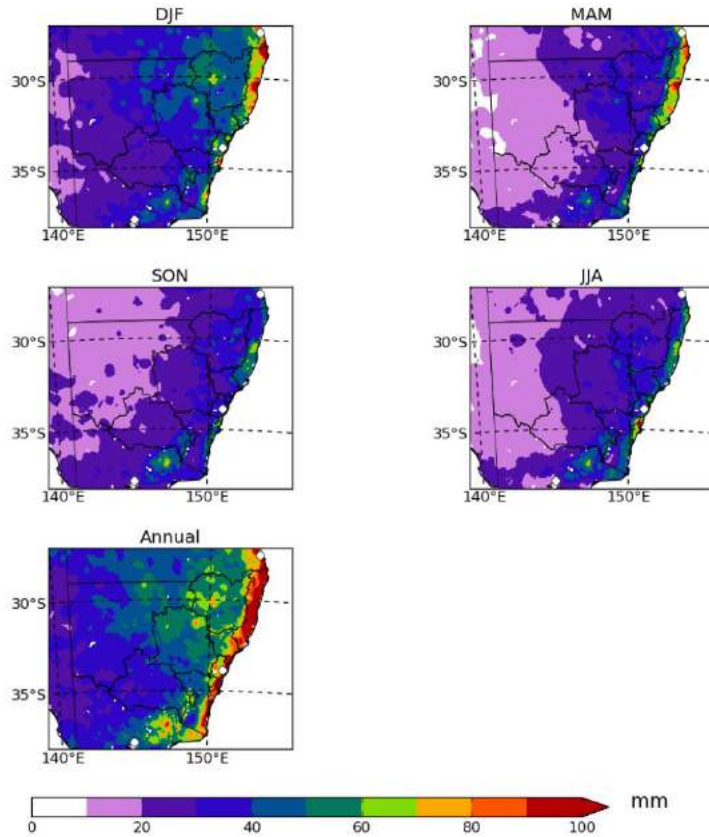


Figure 3.1: Present day (1990-2009) average seasonal and annual maximums of AWAP maximum 1-day precipitation (Rx1day) [mm]. White circles (top to bottom): Brisbane, Sydney, Melbourne.

R99pTOT

Contribution of largest 1% of events

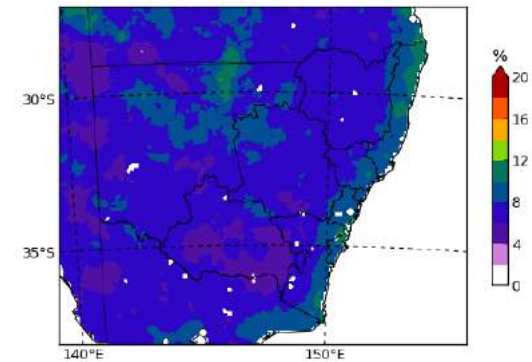


Figure 3.10: Annual means of AWAP contribution from extremely wet days as % of PRCPTOT (R99pTOT) for years 1990-2009 [%]. White circles (top to bottom): Brisbane, Sydney, Melbourne.

Far Future minus Present Day

2060-2079 1990-2009

Rx1day

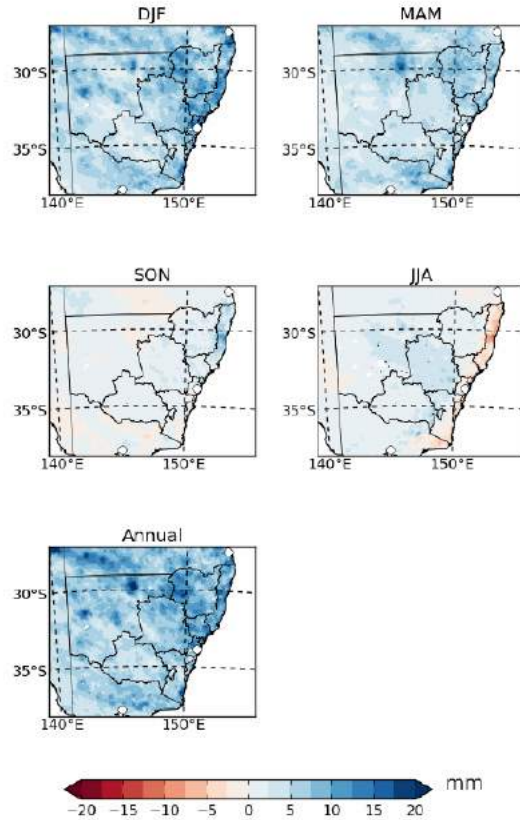


Figure 6.13: Multi-model mean changes between far future (2060-2079) and present (1990-2009) in seasonal and annual maximum maximum 1-day precipitation (Rx1day) [mm]. Stippling indicates that the changes are significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

R99pTOT

Contribution of largest 1% of events

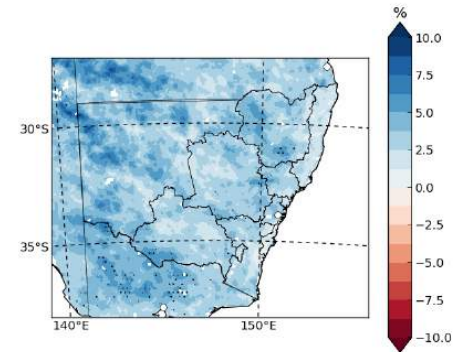


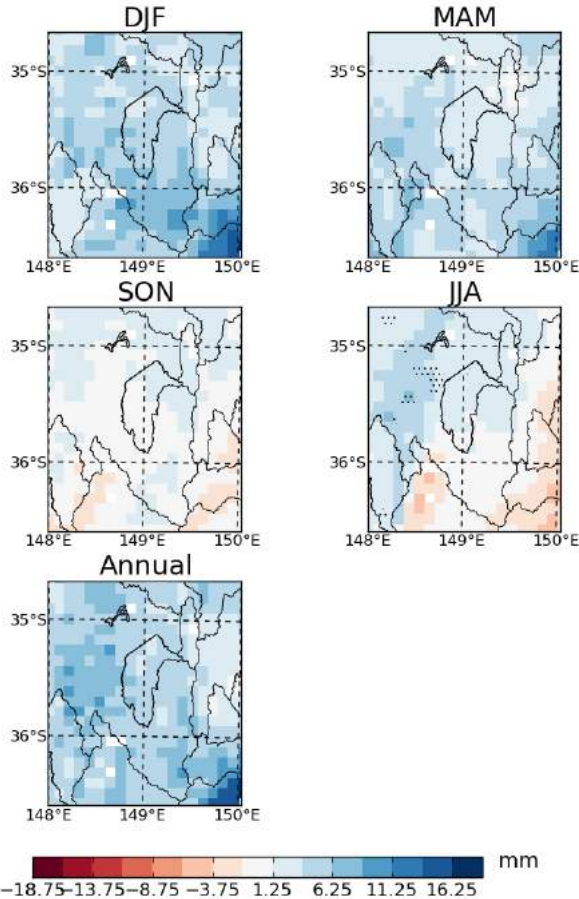
Figure 6.22: Annual multi-model means changes between years 1990-2009 and 2060-2079 for contribution from extremely wet days as % of PRCPTOT (R99pTOT) [%]. Stippling indicates that the changes are significant at the 5% level. White circles (top to bottom): Brisbane, Sydney, Melbourne.

Far Future minus Present Day

2060-2079

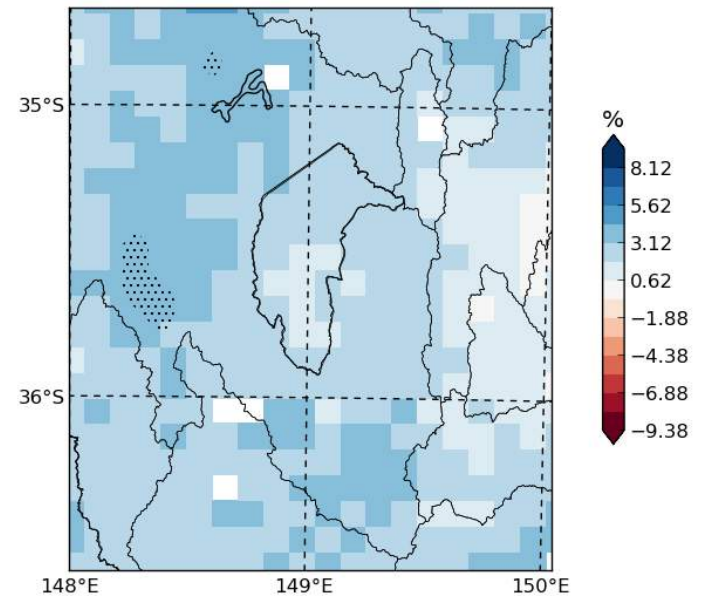
1990-2009

Rx1day



R99pTOT

Contribution of largest 1% of events

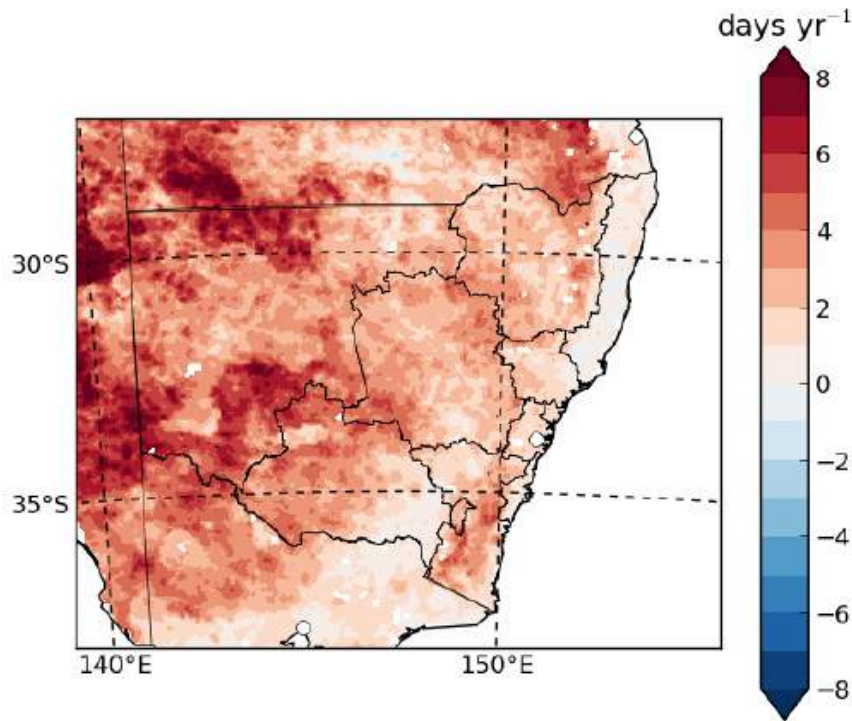


Far Future minus Present Day

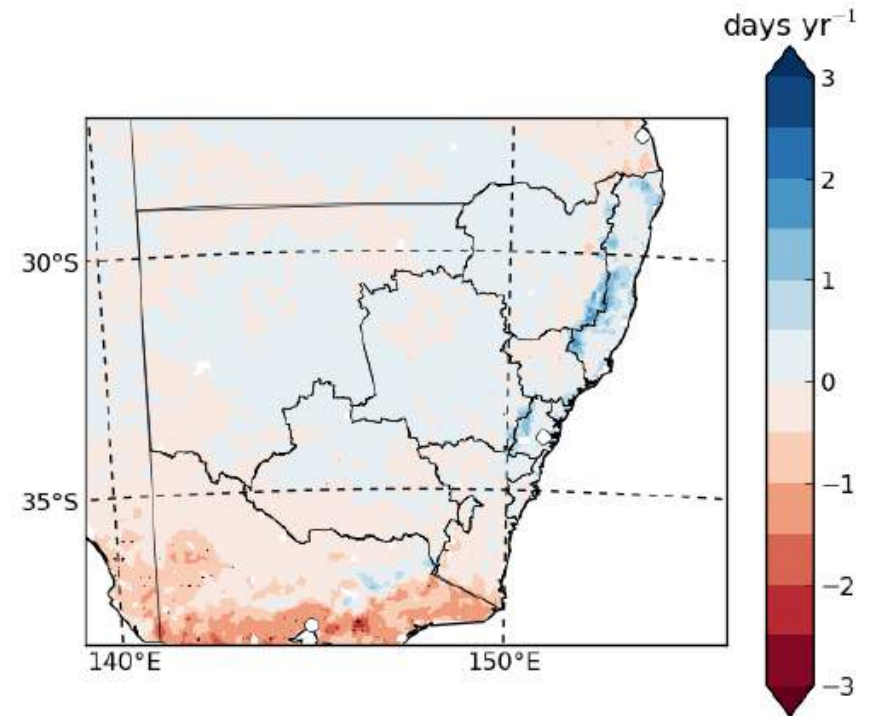
2060-2079

1990-2009

Max Consecutive Dry Days



Max Consecutive Wet Days



Summary

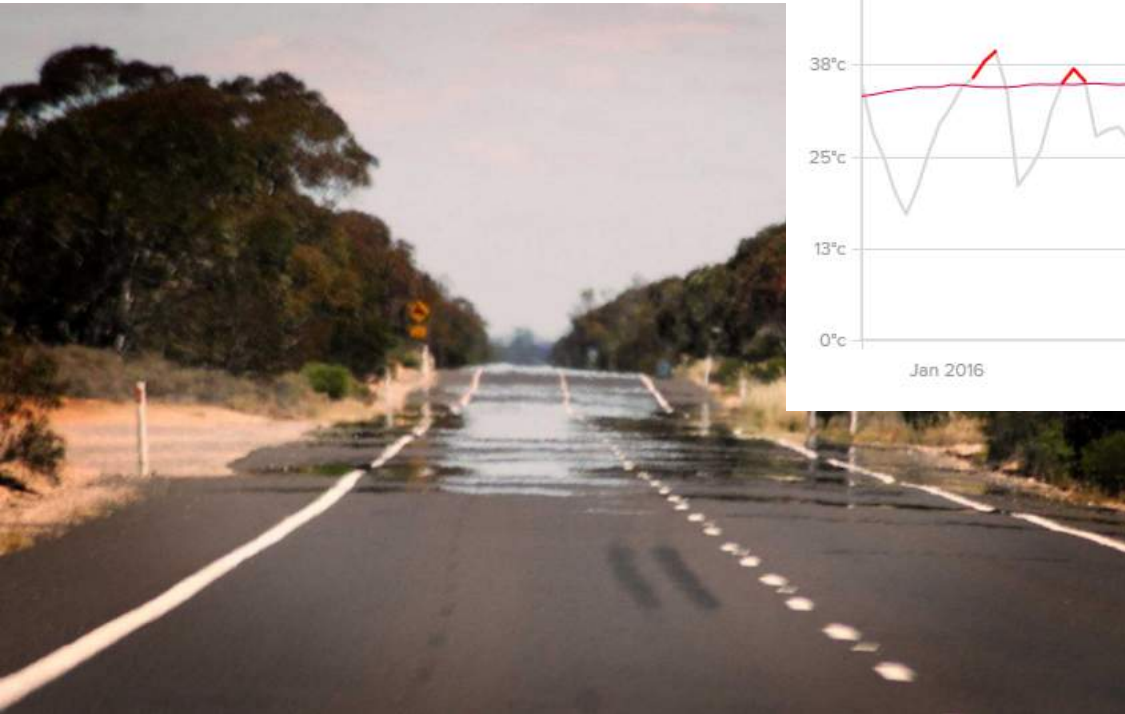
Future (~2070) climate extremes in the UMCCC

- **Heatwaves**
 - ~twice as many days will be classed as heatwaves by today's standards
 - The hottest heatwave will be hotter
 - The longest heatwave will be twice as long
- **Extreme precipitation**
 - Extreme precipitation is projected to increase but not significantly compared to inter-annual variability
 - Note that when averaged over the catchment this can produce significant increases – that is, streamflow levels can change significantly

What does it mean for you?

CANBERRA (35.31S, 149.2E)

The **solid red line** on the graph is the heatwave threshold for this particular station.
When temperature exceeds this threshold for 3 or more days, a heatwave occurs.



More time spent in
heatwave conditions

What does this mean for you?



Higher maximum flow levels



Lower minimum flow levels



Thank you for your attention

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