Evaluation of HadAM3P simulations in the Australian region

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1. Introduction

In order to quantify uncertainty in global and regional climate model forecasts, large ensembles of climate model simulations are required. While such ensembles are beyond the capability of conventional supercomputing resources, they may be achieved through the aggregated computing power of distributed computing projects.

Launched in 2010, the weather@home.net experiment runs a moderate-resolution global atmospheric model (HadAM3P) with an embedded regional model (HadRM3P) on personal computers volunteered by the general public. To date, weather@home.net has generated over 759,000 model-years of simulations, a unique modeling resource at this resolution.

How well does the weather@home.net global model represent rainfall and temperature over Australia?

2. Background to weather@home.net experiment

There are currently **36,000 active hosts** in **138 countries** participating in the weather@home.net experiment.

On each computer a global climate model is run with an embedded regional climate model driven by specified SST.

- Global model: HadAM3P (1.875˚x 1.25˚, 19 levels)
- Regional model: HadRM3P (0.44˚x 0.44˚, 19 levels)
  - *Europe regional model:* *> 414,700 model years generated*
  - *North America regional model:* *> 218,800 model years generated*
  - *Southern Africa regional model:* *> 126,000 model years generated*

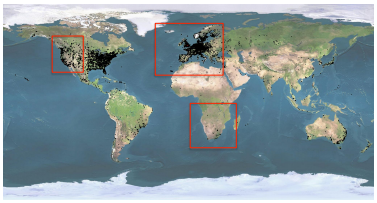

Figure 1. Location of hosts across the globe running *weather@home.net* climate model simulations (source: *climateprediction.net* group). Approximate boundaries of the three existing regional domains are shown.

3. Data and methodology

- An ensemble of HadAM3P simulations is used to examine rainfall and temperature variability over four regions of the Australian continent, for the period 1960 to 2010.
- The HadAM3P simulations are sourced from the weather@home.net Europe experiment. 50 ensemble members are used (standard physics, perturbed initial conditions).
- Rainfall and temperature averages are calculated over land points only.
- Model-derived rainfall and temperature values are compared against the Australian Water Availability Project (AWAP) high quality observational dataset.

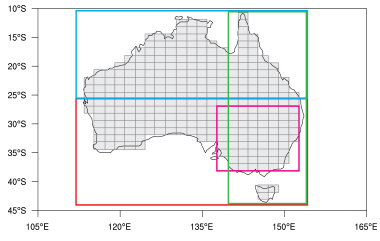

Figure 2. Boundaries of the regions used in this study: northern Australia (blue), southern Australia (red), eastern Australia (green) and southeast Australia (pink). The model grid points over land are shown in grey.

4. Relationship with ENSO conditions: southeast Australia temperature and rainfall

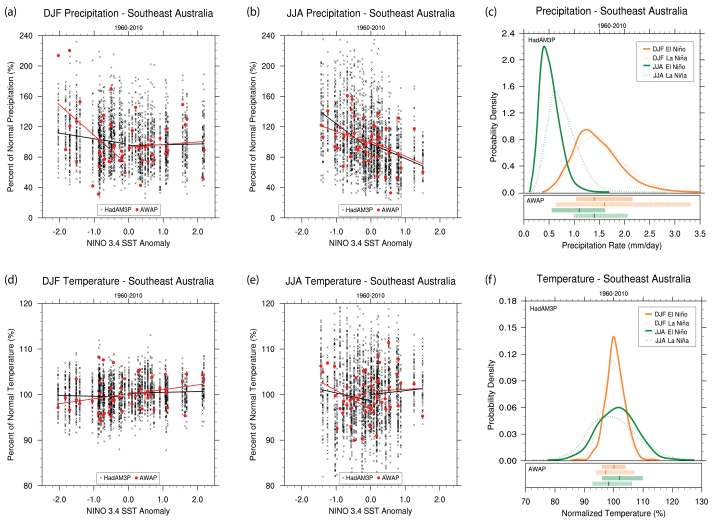

Figure 3. (a, b, d and e) Scatter plots of seasonal Niño-3.4 SST anomalies against southeast Australian precipitation/temperature (season and parameter as labelled). Seasonal averages from HadAM3P simulations are shown in black, while AWAP observations are shown in red. Lines of best fit, calculated using ordinary least squares regression, are included. PDFs of HadAM3P seasonal (c) precipitation and (f) temperature are shown for El Niño events (Niño-3.4 SSTAs > 0.5˚C) and La Niña events (SSTAs < -0.5˚C), accompanied by AWAP observations (median value with 5-95th percentiles shaded).

- HadAM3P is able to represent the asymmetric relationship between ENSO and rainfall (temperature) over southeast Australia during DJF (JJA). A symmetric relationship is represented for the opposite season, consistent with the AWAP observations.
- HadAM3P simulates warmer, drier conditions during El Niño events (PDFs significantly different at 95% significance level using Kolmogorov-Smirnov test).

5. HadAM3P model bias

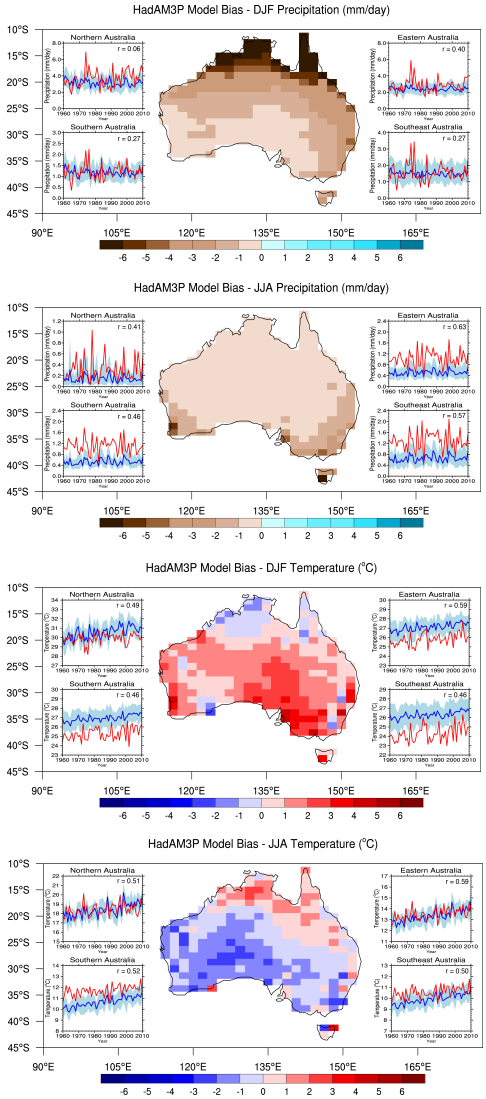

Figure 4. ***Spatial plots:*** The bias between the seasonal mean of the HadAM3P ensemble and the seasonal mean of the AWAP observational dataset, calculated for each year between 1960 and 2010. ***Timeseries:*** Seasonal average rainfall and temperature for the respective regions (as labelled). The HadAM3P ensemble mean is indicated by the solid blue line while shading denotes the 5th-95th percentiles. AWAP region-averaged seasonal values (red line) are included for reference. The correlation coefficients (r) are also shown.

- HadAM3P generally under-represents rainfall over Australia. The correlation between modelled and observed rainfall is stronger in JJA than DJF.
- HadAM3P over-represents the annual temperature cycle over southern and eastern Australia. There is good correlation between modelled and observed temperature for all four study regions.

This study is ongoing. The next step will be to examine the performance of a regional climate model embedded within the HadAM3P model.