Simulating regional hydroclimate variability and change on decadal scales

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Improved simulation of regional hydroclimate and trends

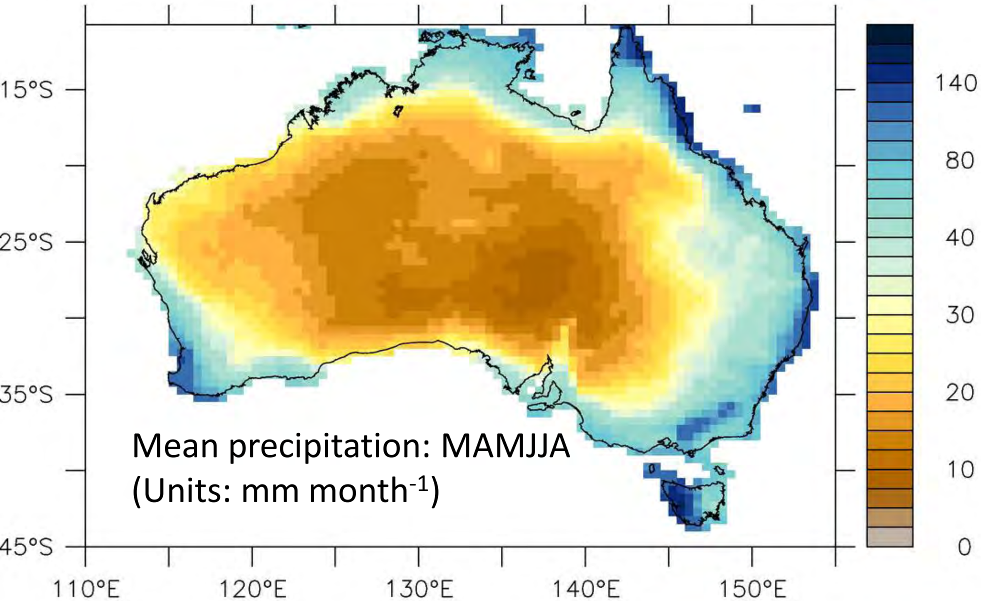
Drivers from the NOAA 2013-2017 Research and Development Plan:

"What causes climate variability and change on global to regional scales? **Understanding**

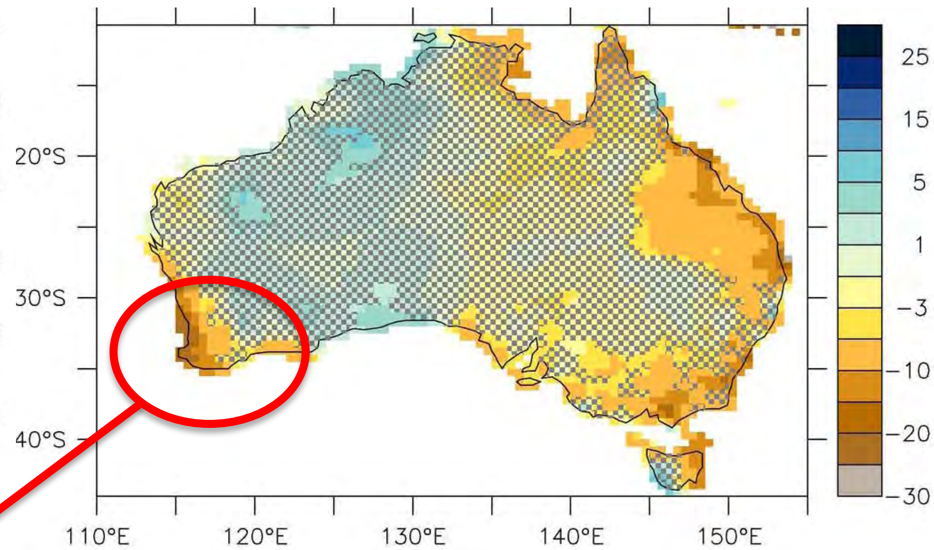
What improvements in global and regional climate predictions are possible?" **Prediction**

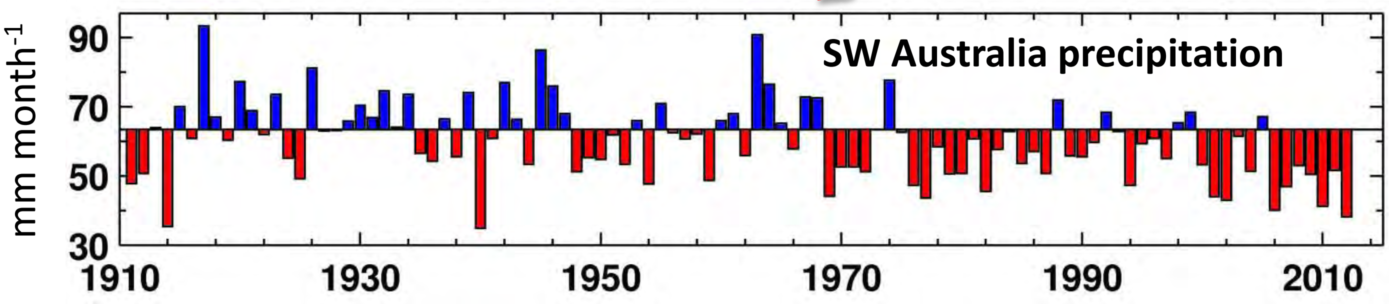
- Advances in modeling, particularly resolution, offer the potential for improved prediction and projection of regional hydroclimate
- The CM2.5 family of models offers substantial potential for regional hydroclimatic simulations across timescales
- A study of Australian precipitation trends demonstrates this potential

Characterizing the Australian hydroclimatic signal



Change in precipitation (MAMJJA)
(1991-2012) minus (1901-1990)





Using CM2.5 simulations to explore observed drying

Suite of simulations with CM2.5 high-resolution model: (Delworth et al., 2012)

- 50 Km atmosphere
- 0.25^0 ocean

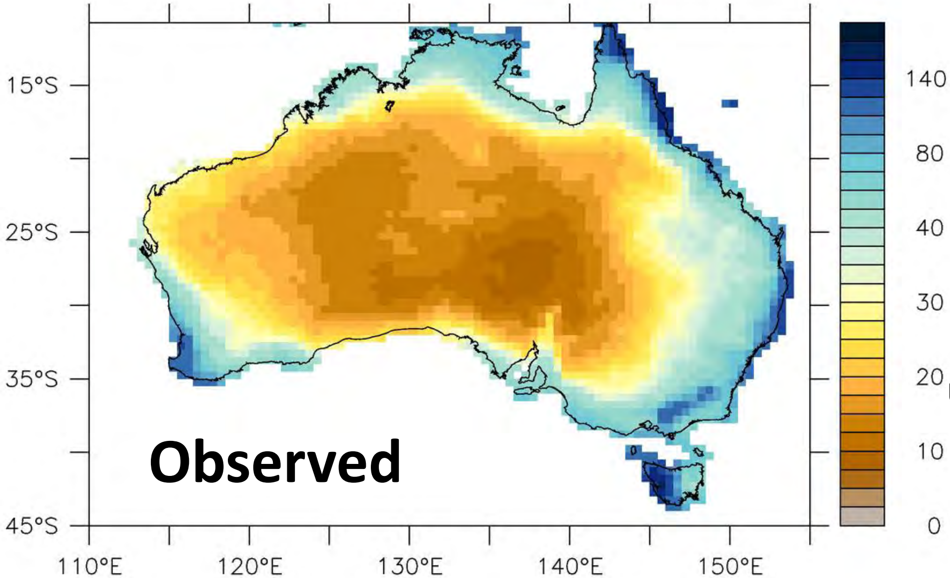
1. 1000-year Control with preindustrial forcing

2. 5-member ensemble of simulations from 1861-2100 [ALLFORC]

3. 3-member ensembles [1861-2012] using subsets of forcing
   - ANTHRO
   - NATURAL
   - AEROSOL
   - WMGHG
   - OZONE

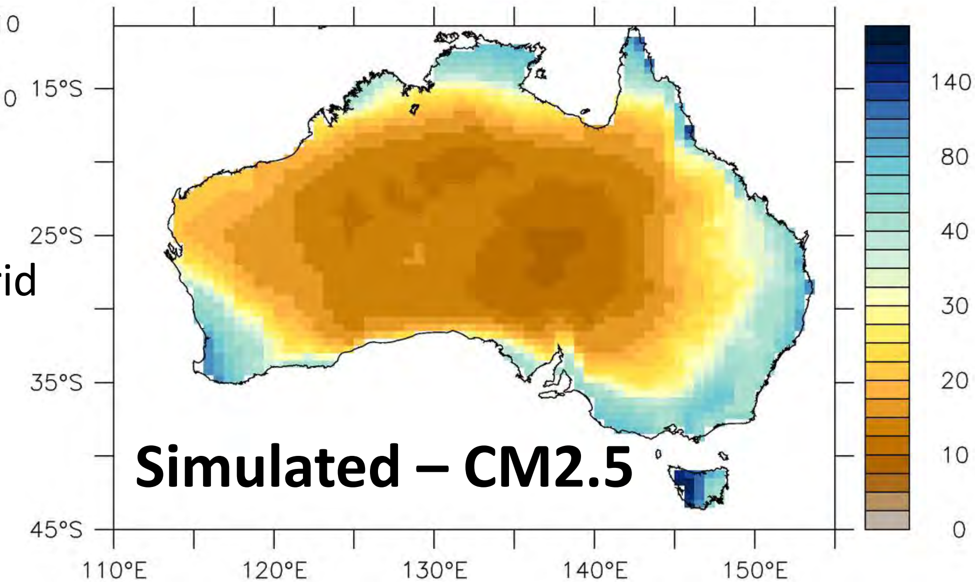
How well does the model simulate Australian precipitation?

(austral winter - MAMJJA)



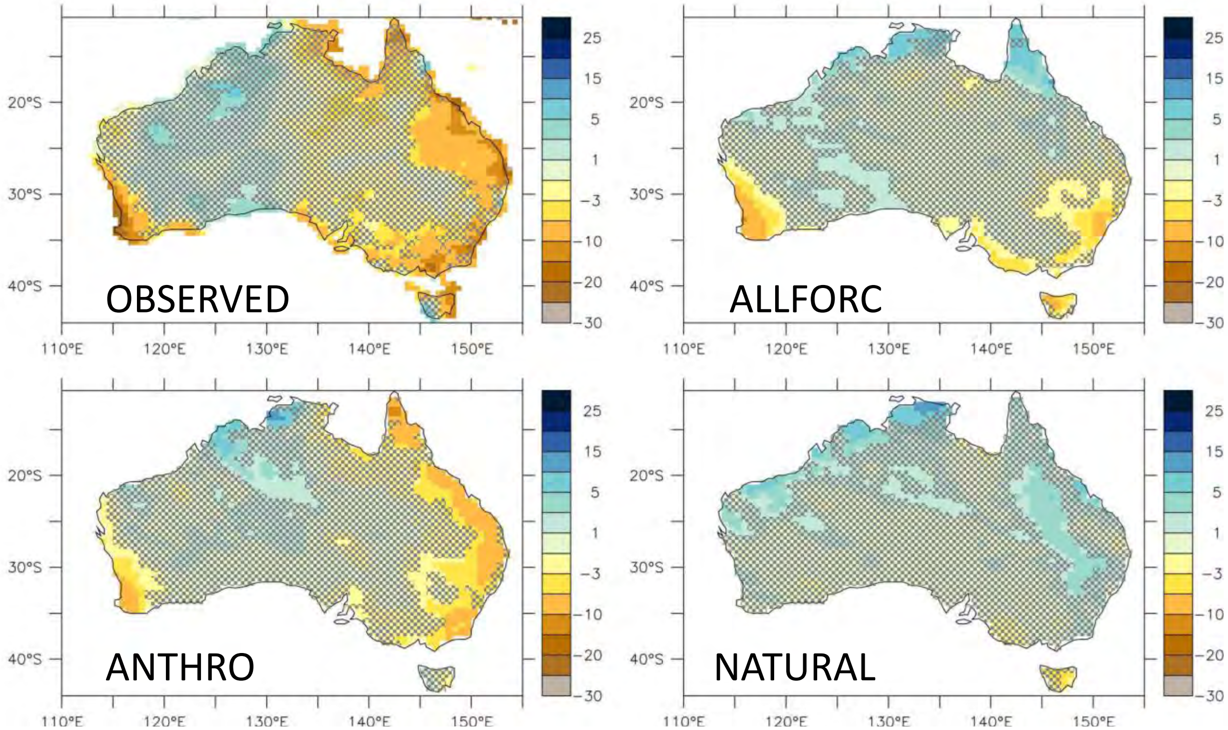
Highly credible simulation of regional-scale precipitation offers encouragement for use of this model to study variability and change

Units: mm month^{-1}



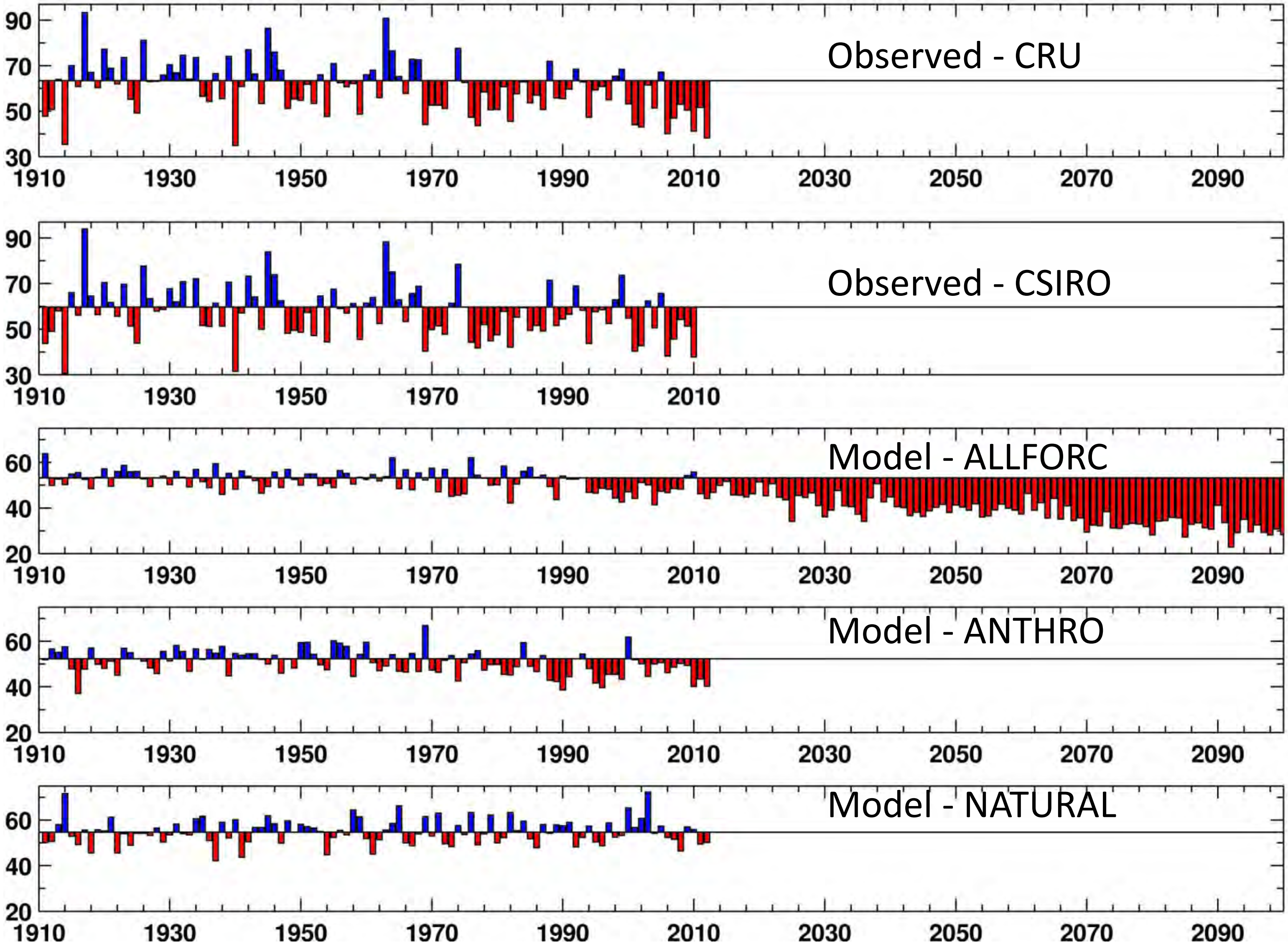
In going from 200 Km grid (CM2.1) to 50 Km grid (CM2.5), error in simulating precipitation is reduced by 49%.

Observed and simulated changes in precipitation
(Mar-Aug: 1991-2012 minus 1901-1990)



Units:
mm month^{-1}

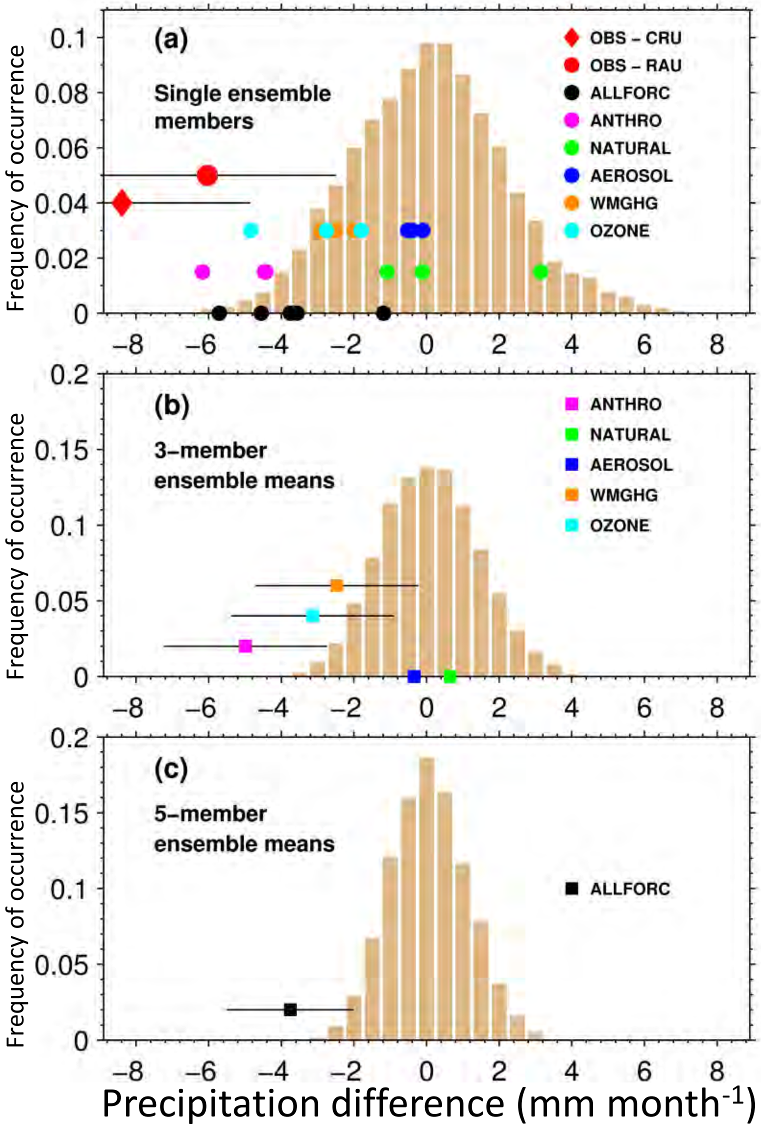
Time series of precipitation- SW Australia



UNITS: mm month^{-1}

Chance and the roles of various forcing agents

How likely is it that the simulated drying simply occurs by chance?



Factors responsible for simulated drying:

- poleward movement of storm track
- expansion of Hadley cell

Summary and Discussion

1. New generation of high-resolution climate models offers the *potential* for substantially improved prediction and projection of regional-scale climate, including precipitation

2. Observed multidecadal drying over southern Australia is largely reproduced in GFDL CM2.5 model in response to increasing greenhouse gases and ozone changes.

3. Projections suggest drying trend will amplify through the 21st century

4. Studies ongoing in other regions (South America, North America)

5. Natural climate variability plays critical role

6. We need to use:
   - **large ensembles** of simulations (better characterize natural variability)
   - **high-resolution models** (improved regional-scale climate simulation)