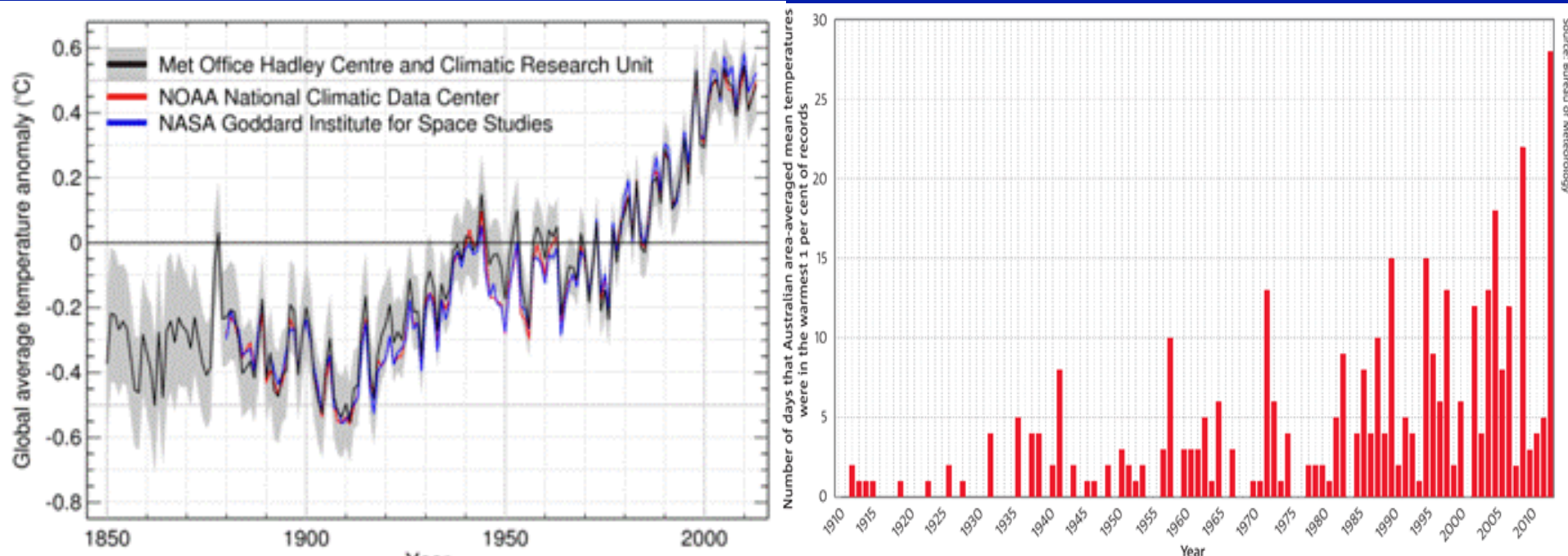


Attribution of 2013 Australian Temperature Extremes

Professor David Karoly

School of Earth Sciences and ARC Centre of Excellence for Climate System Science,
University of Melbourne



Overview

- 2012-13 summer record Australian temperature
- 2013 record annual Australian temperature
- Weather@home ANZ citizen science project and attribution of record daily extremes

Acknowledgements

Sophie Lewis, Mitch Black, Andrew King, Lisa Alexander (CoE)

Nikos Christidis and Peter Stott (Hadley Centre)

CMIP5 D&A simulations

CPDN team, Myles Allen (Oxford), Sue Rosier (NIWA), TPAC

THE ANGRY SUMMER

IN JUST
90 DAYS:
123
RECORDS
BROKEN
 THROUGHOUT
AUSTRALIA

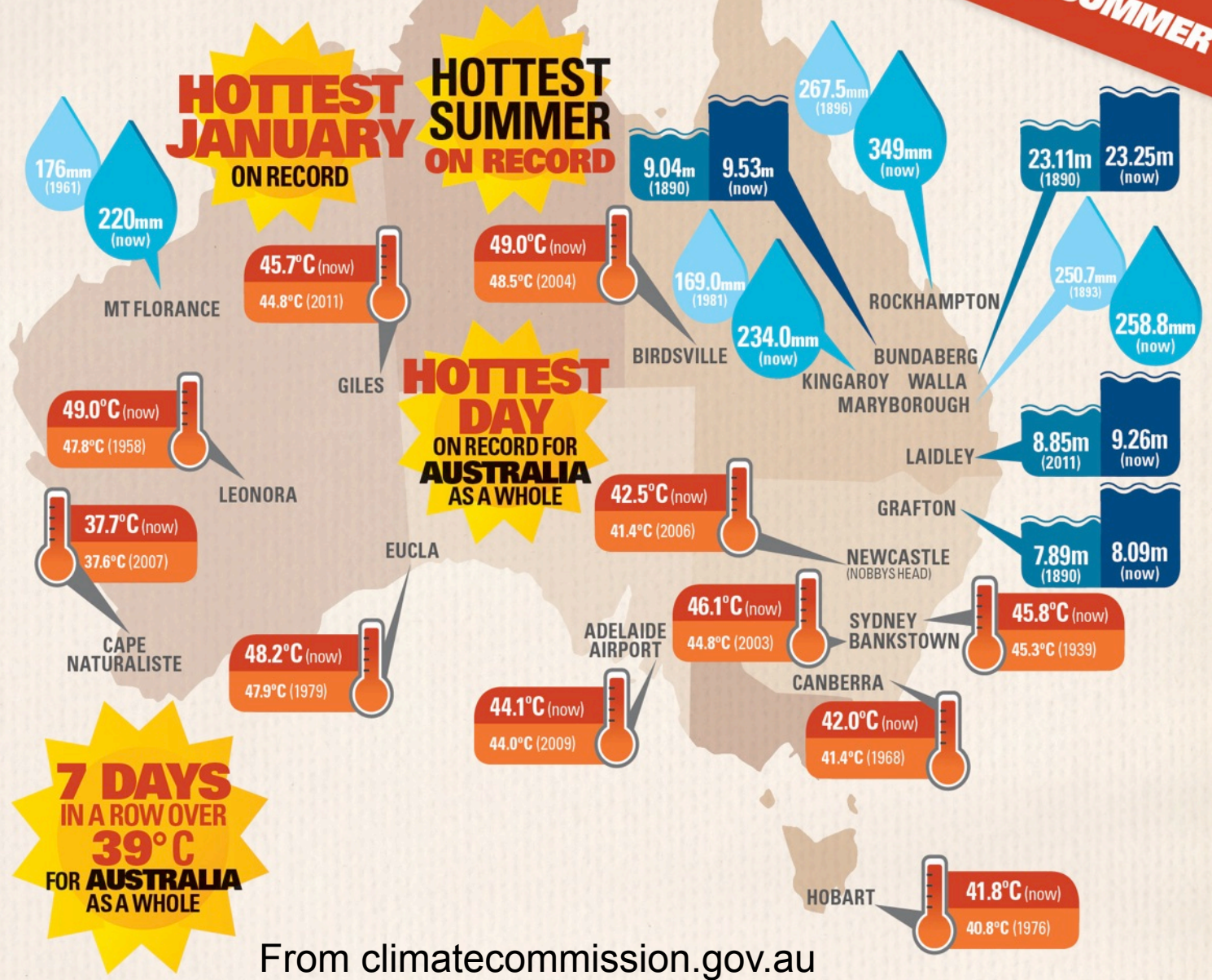
HERE ARE JUST
23 OF THE 123
 RECORDS FROM SUMMER 2012/2013

MAXIMUM TEMPERATURE RECORDS

FLOOD RECORDS

DAILY RAINFALL RECORDS

HEATWAVE RECORDS



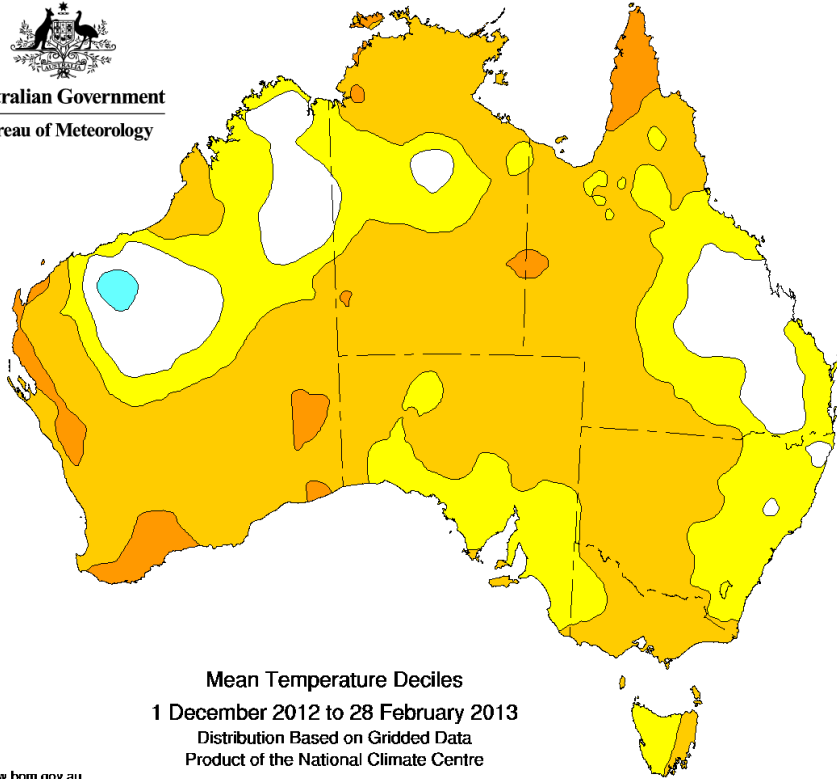
From climatecommission.gov.au

DATA SOURCES: BoM. (2013a). Special Climate Statement 43 – extreme heat in January 2013, BoM. (2013b). Special Climate Statement 44 – extreme rainfall and flooding in coastal Queensland and New South Wales.

The Angry Summer 2012-13



Australian Government
Bureau of Meteorology

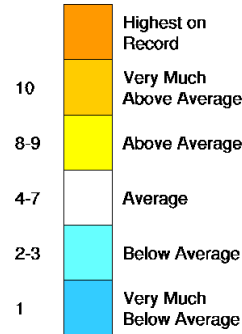


Mean Temperature Deciles
1 December 2012 to 28 February 2013
Distribution Based on Gridded Data
Product of the National Climate Centre

<http://www.bom.gov.au>

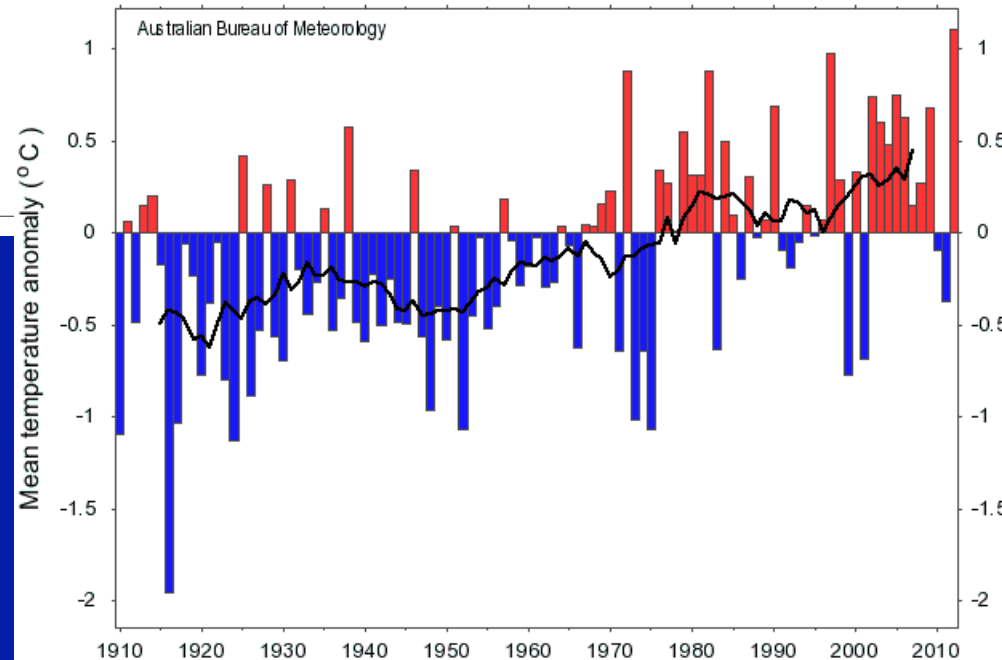
© Commonwealth of Australia 2013, Australian Bureau of Meteorology ID code: AWAP

Temp. Decile Ranges



Record temperature across Australia during summer 2012-13

Summer mean temperature anomaly - Australia (1910-2012)



The Angry Summer 2012-13

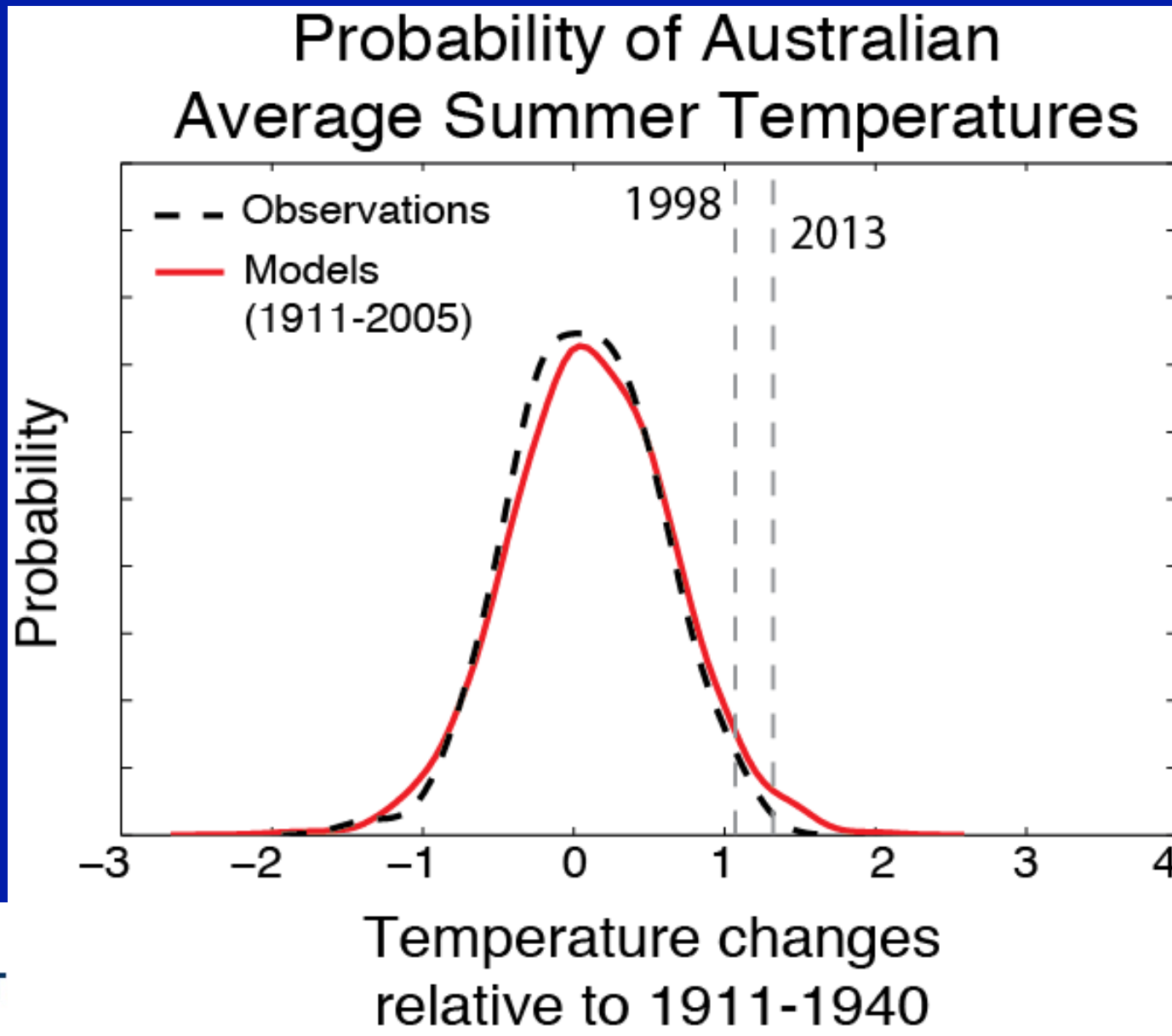
- Use global climate model simulations to assess the role of natural variability and increasing greenhouse gases on chances of extreme summer temperatures across Australia
- First, assess model skill in simulating observed variability of Australian summer temperatures
- Then assess difference in chances of extreme summer temperatures for simulations with/without increasing greenhouse gases

The Angry Summer 2012-13

Climate model simulations

Experiment	Forcing	Period	No. of runs
historical	Anthropogenic (increasing ghgs and aerosols) + Natural (solar and volcanic)	1850-2005	9 models, 32 runs
Historical Nat	Natural (solar and volcanic only)	1850-2005	9 models, 32 runs
RCP8.5	Anthropogenic (increasing ghgs and aerosols)	2006-2020	9 models, 19 runs

The Angry Summer 2012-13

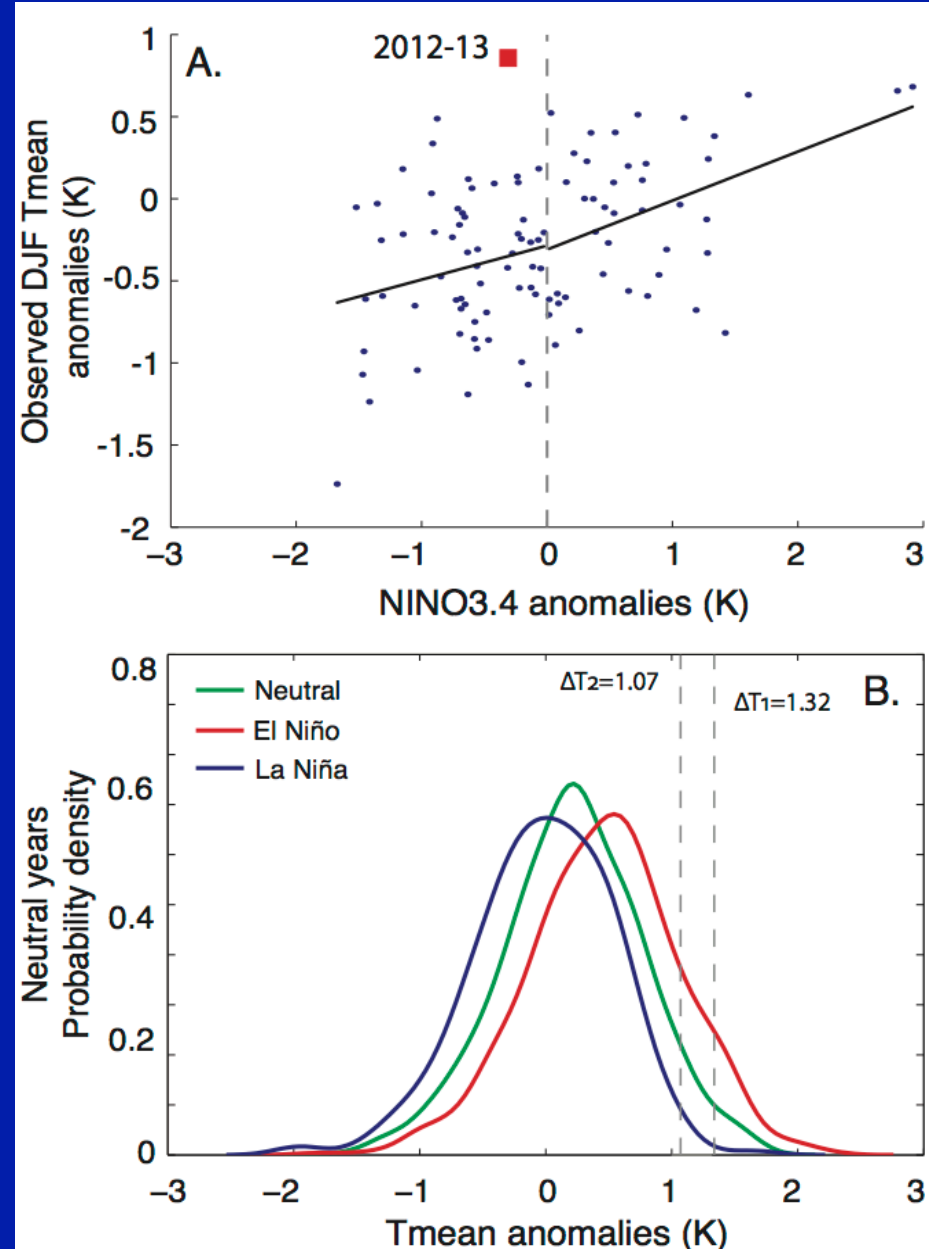


The Angry Summer 2012-13

Scatterplot of summer temperatures against Nino3.4 temperatures

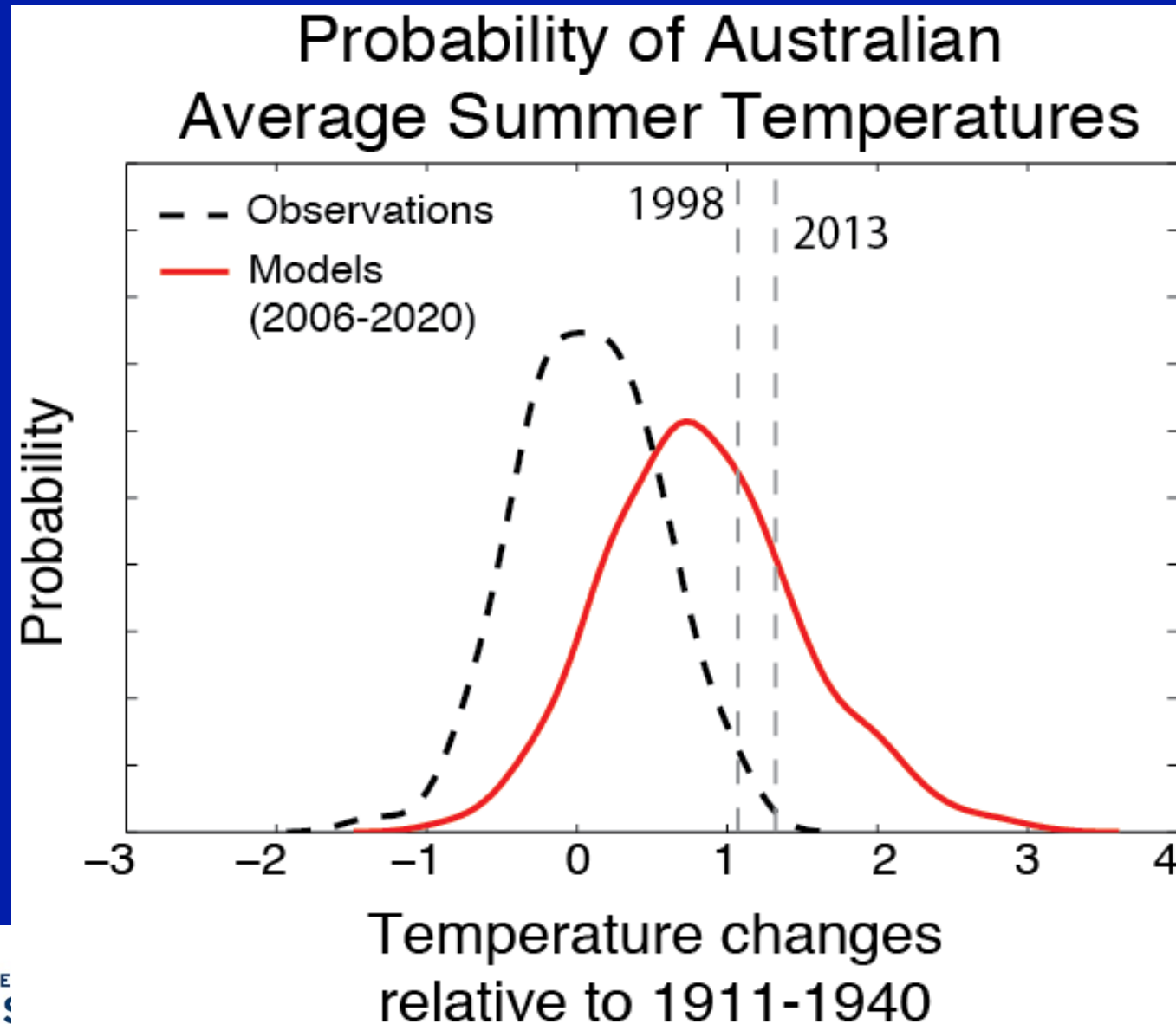
Shift in chances of summer temperatures anomalies for different phases of El Niño and La Niña

Much higher chance of very hot summers in El Niño years



The Angry Summer 2012-13

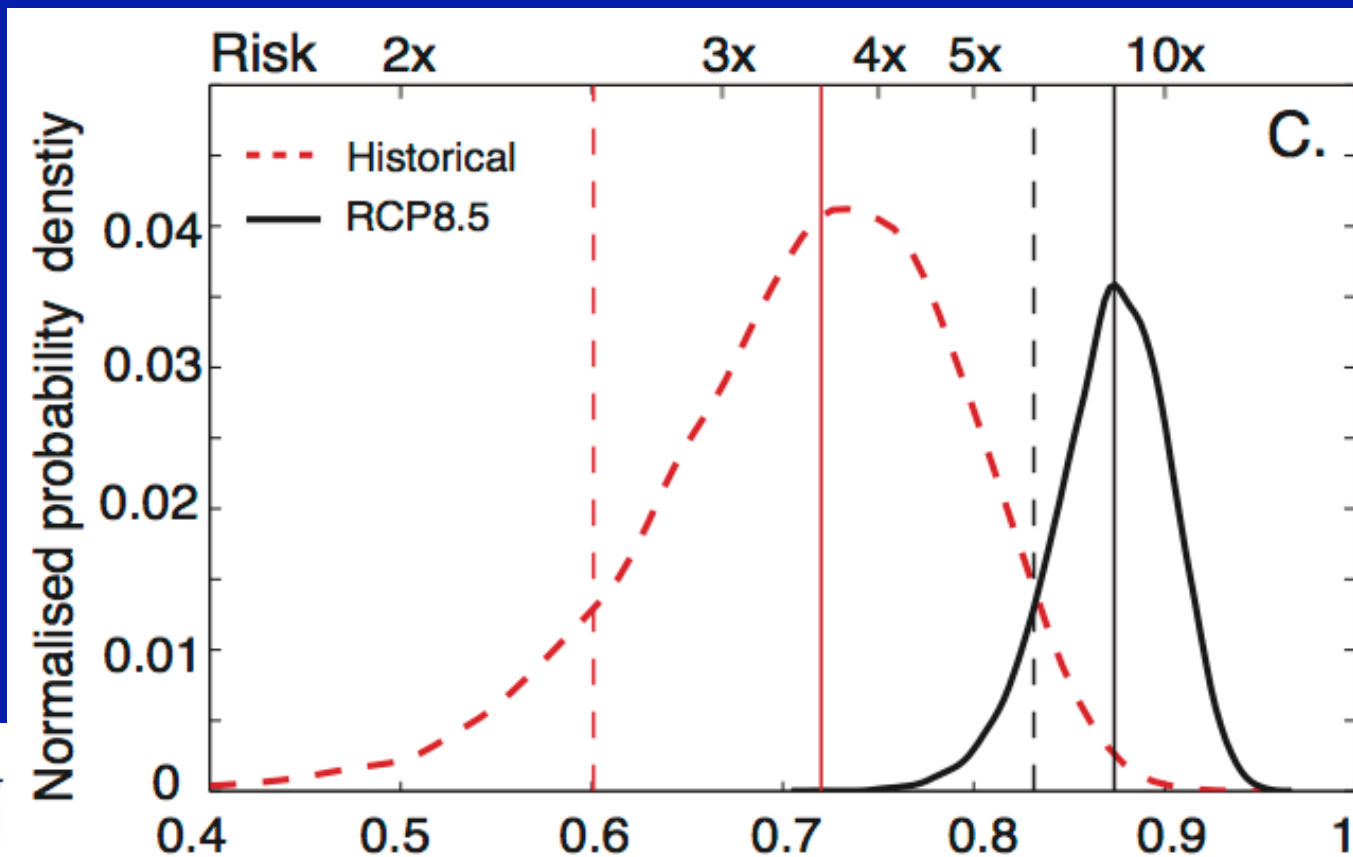
Change in probability of extreme summer temperatures for a warming climate



The Angry Summer 2012-13

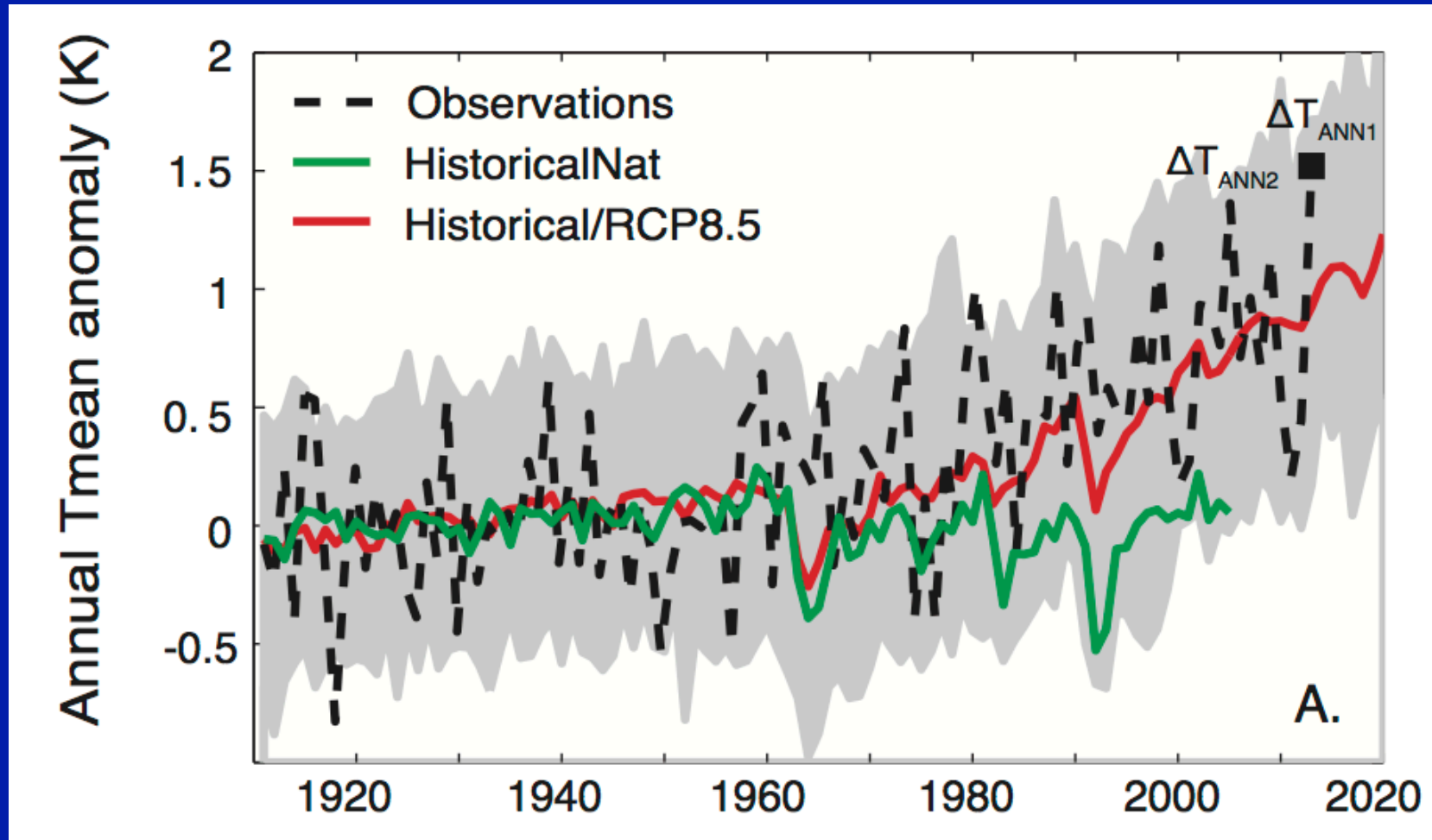
Increase in likelihood of extreme summer temperatures due to human influences during 2006-2020 (RCP8.5) and during 1981-2005 (historical).

Increasing greenhouse gases have very likely increased the chances of extreme summer temperatures by at least a factor of five already.



Record 2013 annual Australian temperature

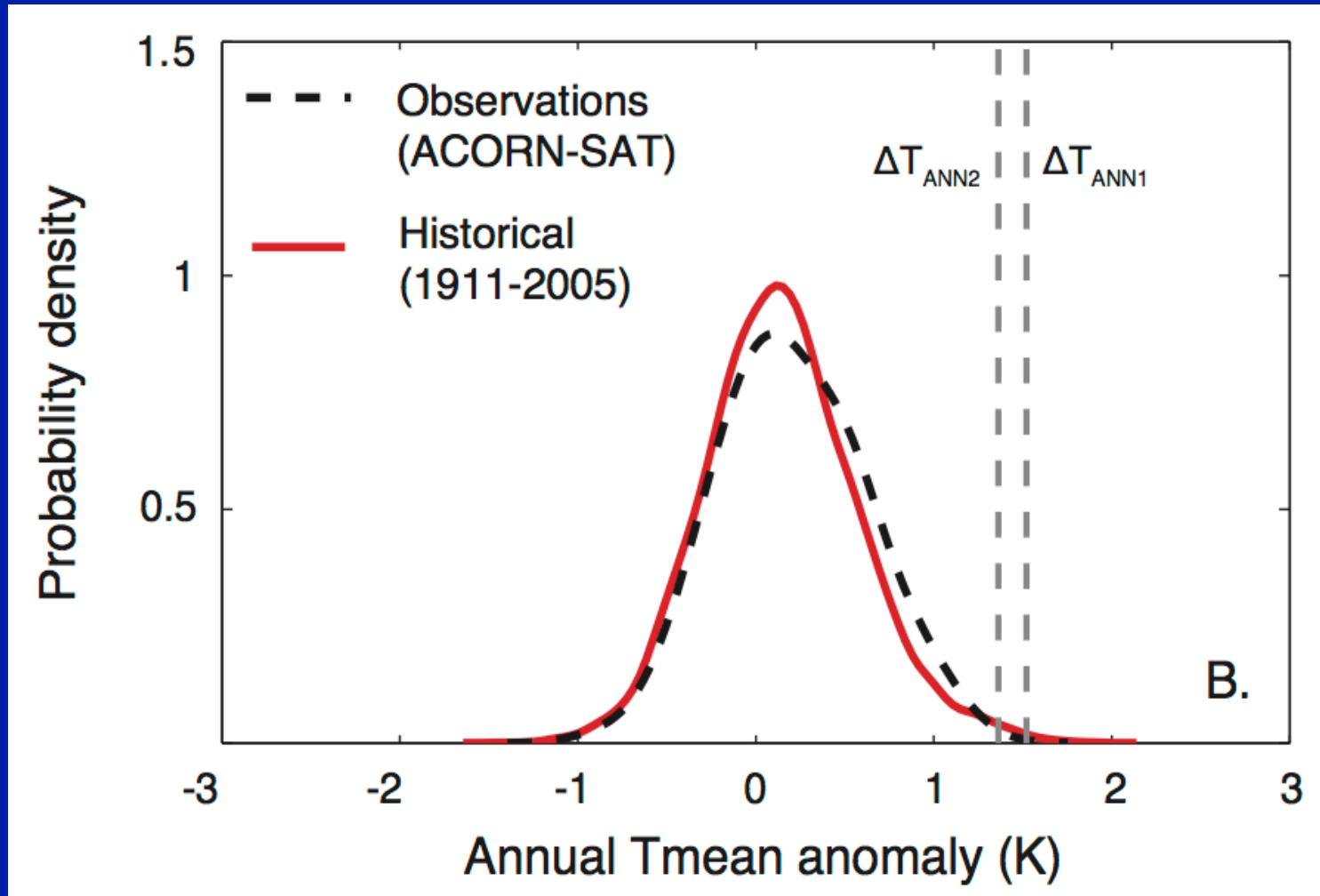
Record temperature averaged across Australia in 2013



Record annual Australian temperature

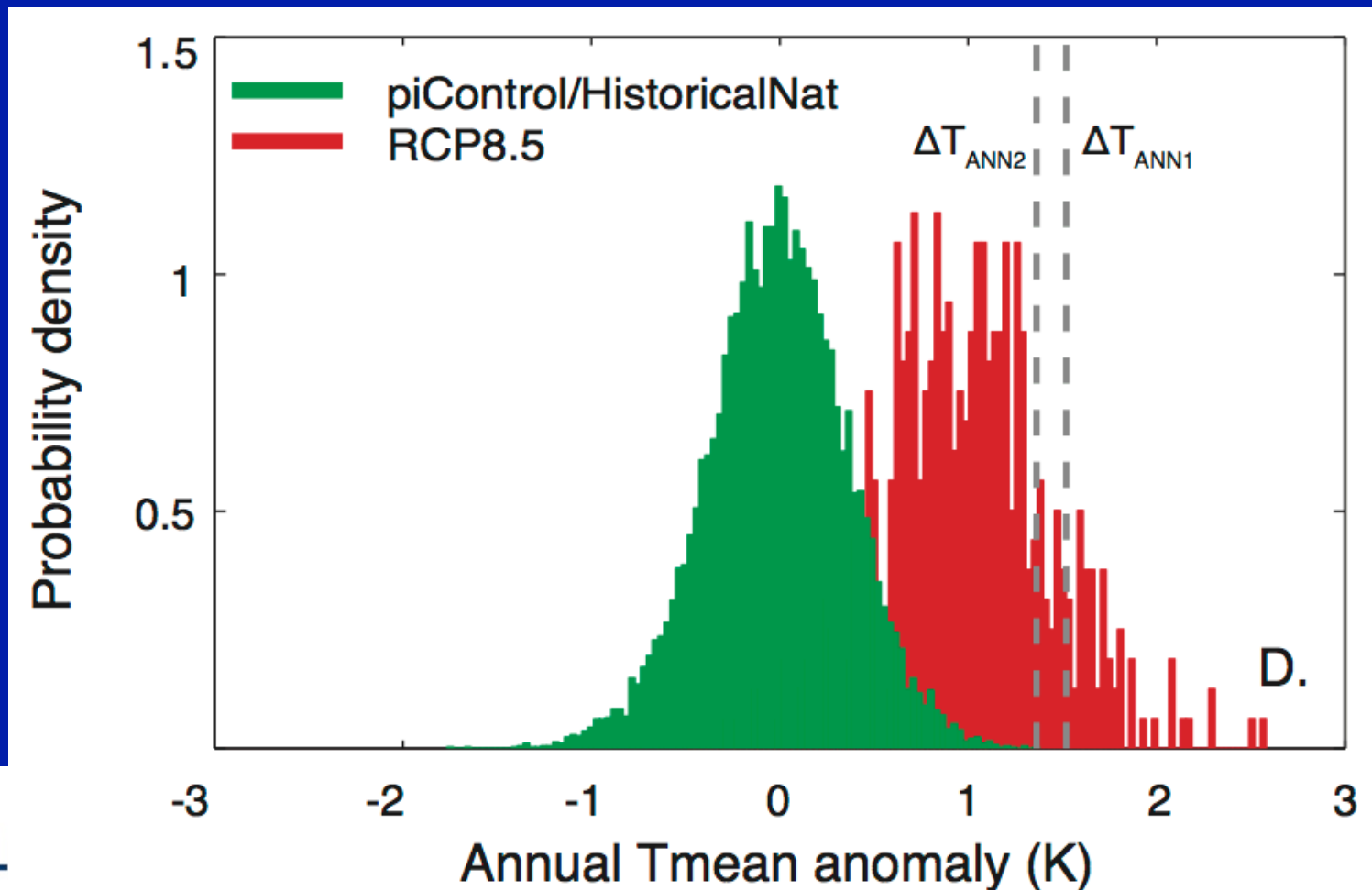
- Repeat the analysis used for the attribution of the record Australian summer temperature 2012-13
- Use global climate model simulations to assess the role of natural variability and increasing greenhouse gases on chances of exceeding the previous record annual temperature across Australia
- First, assess model skill in simulating observed variability of Australian annual temperatures
- Then assess difference in chances of a new record annual temperature for simulations with/without increasing greenhouse gases

Record 12-month Australian temperature



Record 12-month Australian temperature

HistNat simulations: No years in 5728 exceed 2005 record
PI control: 1 year in 6795 exceeds 2005, none exceed 2013
RCP8.5 2006-2020: 1 year in 6 exceeds 2005 record (540 yrs)



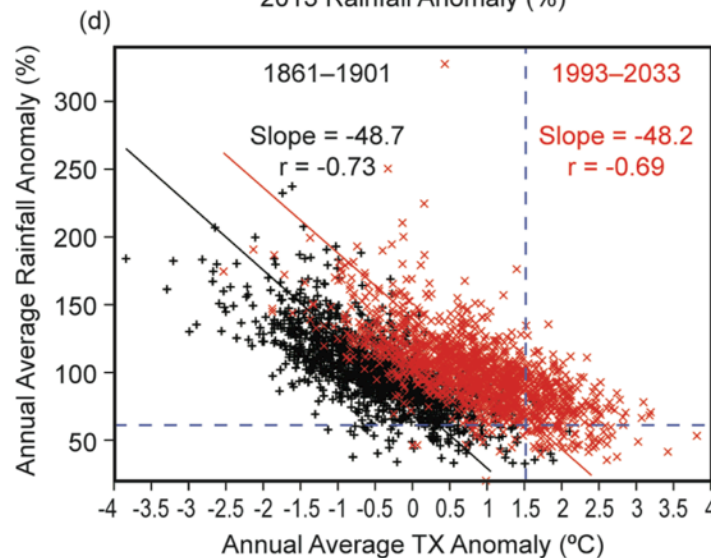
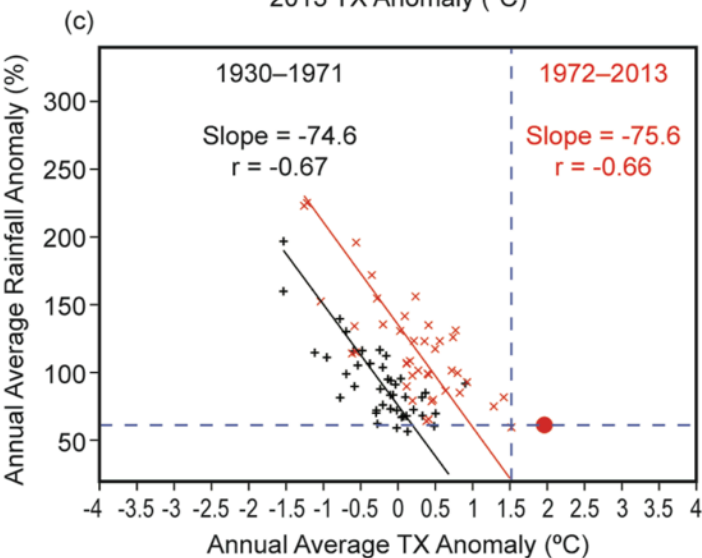
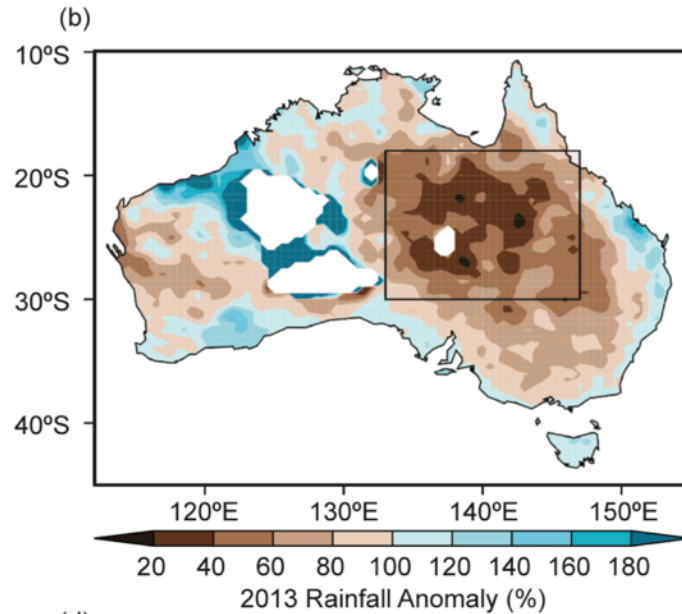
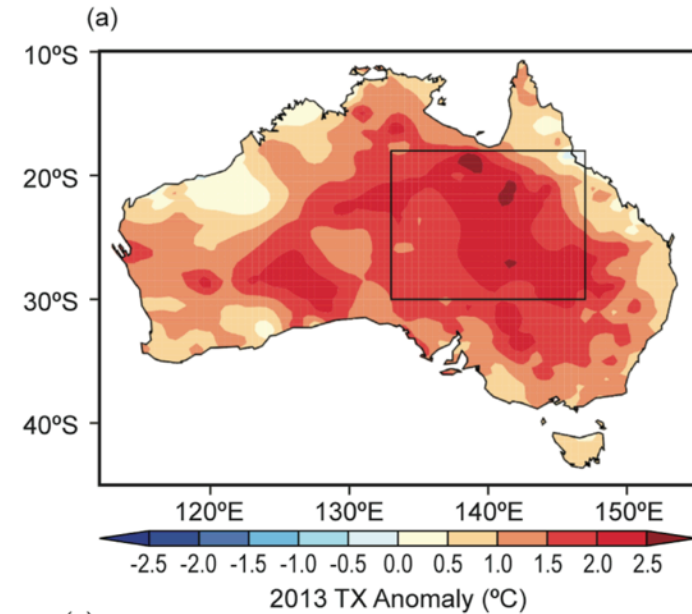
Drought and record 12-month Tmax in NE Aust

No change in drought freq due to clim change

>25x increase of hot years in dry vs wet years

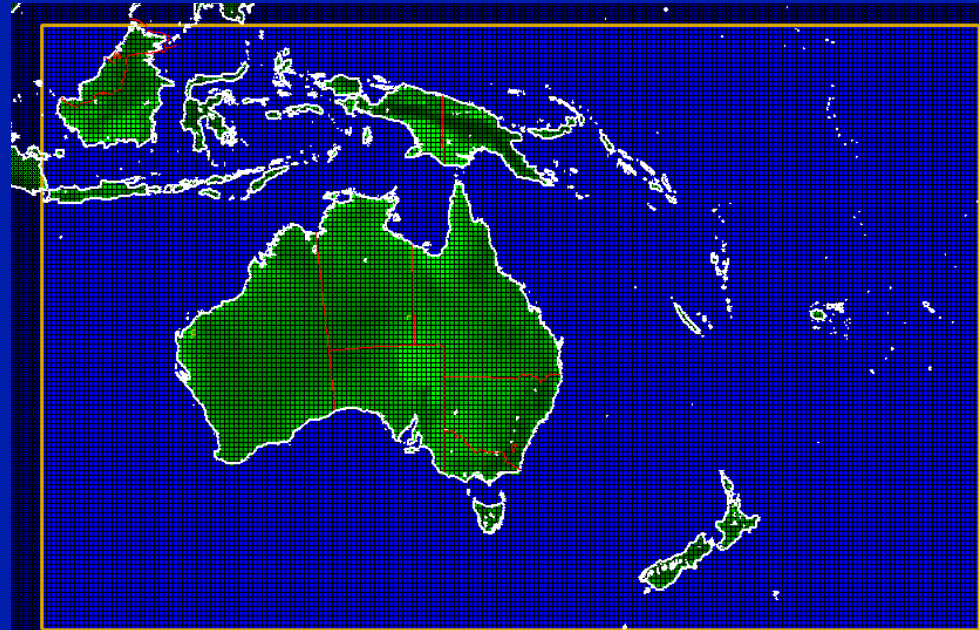
>23x increase of hot years due to climate change

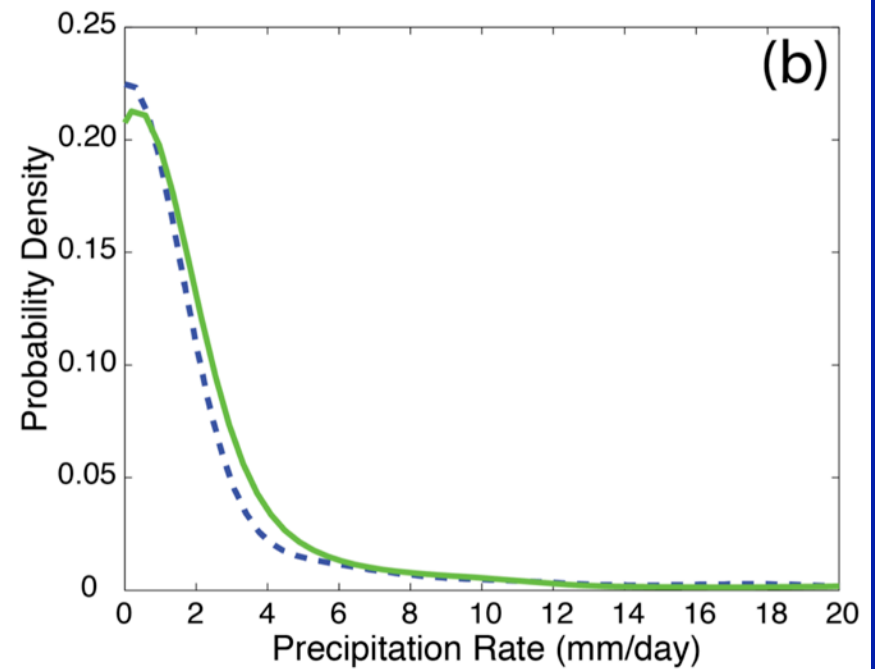
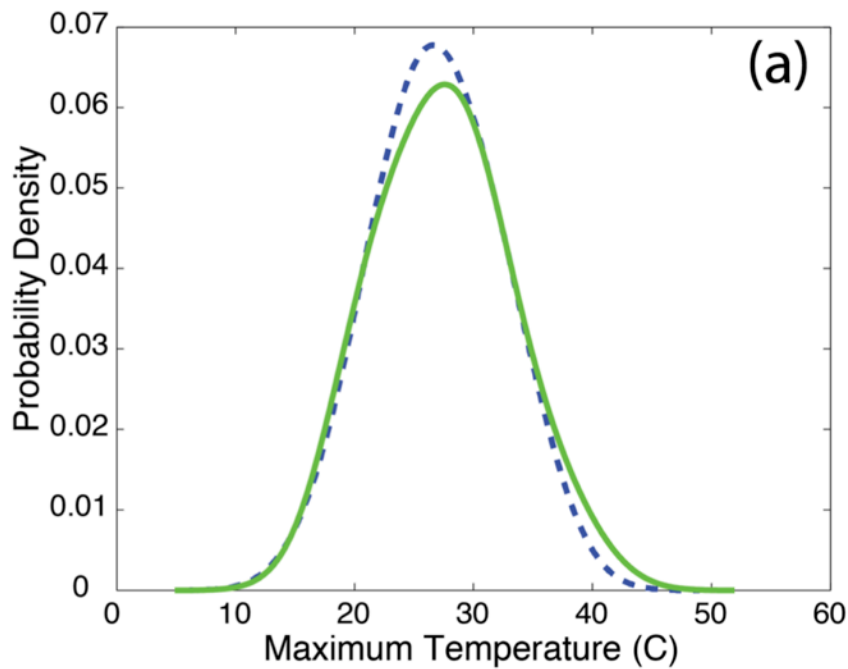
Bivariate FAR:
>7x increase in hot and dry years due to climate change



Weather@home ANZ experiment

- Partnership between ARC Centre of Excellence for Climate System Science, Oxford University and NIWA (NZ) to run Australia-New Zealand domain
- Uses CORDEX Australasia domain (0.44° resol, 216x145)
- Simulations for 2013 with specified SSTs initially
- Remove human-caused SST and ghg changes for natural runs
- Perturbed initial conditions, different forcings
- Launched 26 Mar 2014, >40,000 runs distributed, >30,000 years daily data back



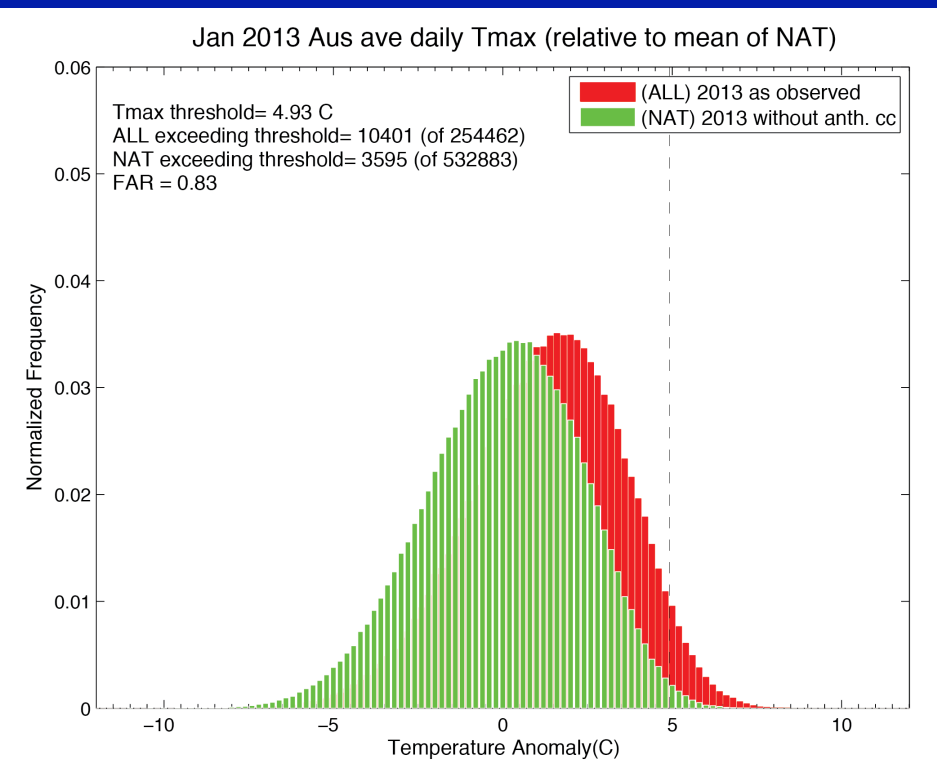


Probability distributions of daily data for Canberra in summer;
 nearest grid cell from ANZ W@H run
 Canberra airport weather station

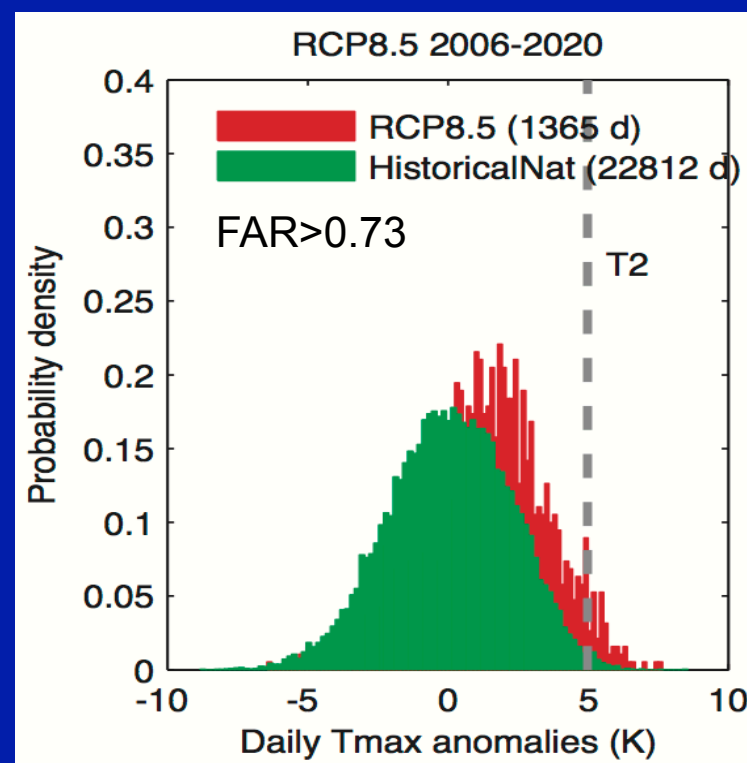
Preliminary results

Compare results for natural vs all observed forcings for daily Australian average Tmax in Jan, record 7 Jan 2013 of 40.3°C

Area-mean daily Tmax, All and Nat only forcings



W@H ANZ

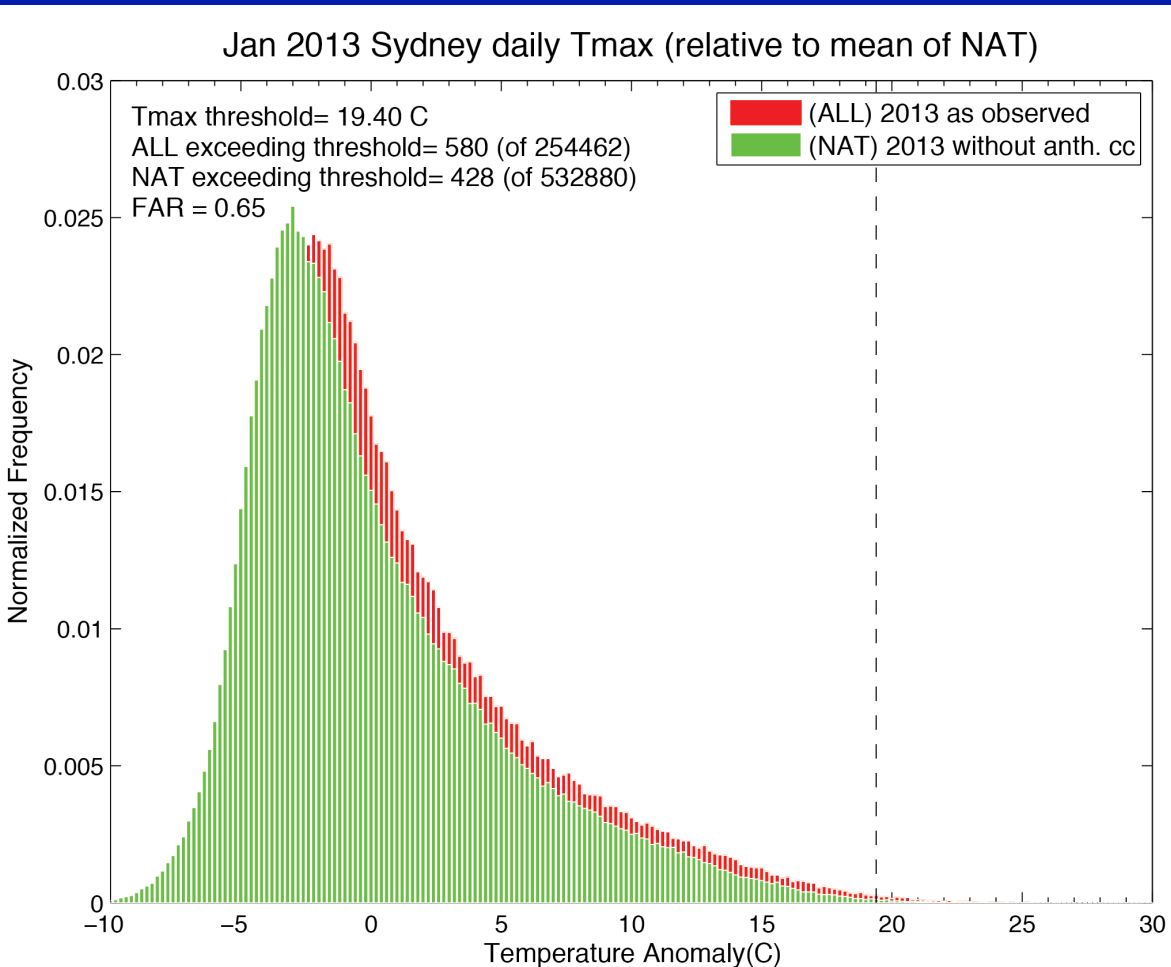


CMIP5 selected models

Preliminary results

Now compare results for natural vs all observed forcings for daily Sydney record Tmax in Jan 2013

Daily Tmax, All and Nat only forcings



Please sign up to
W@H ANZ

[http://
www.climateprediction.net/
weatherathome/australia-
new-zealand-heat-waves/](http://www.climateprediction.net/weatherathome/australia-new-zealand-heat-waves/)



THE UNIVERSITY OF
MELBOURNE

Summary

- Anthropogenic climate change has very likely increased the chances of extremes summer temperatures across Australia, such as in 2012-13, by at least a factor of five already
- Anthropogenic climate change has very likely increased the chances of the recent record Australian annual average temperature by at least a factor of 1000. It is virtually impossible to explain this record by natural variability alone.
- The weather@home ANZ project is allowing us to make preliminary attribution statements for single station record daily temperatures in Australia
- Natural variability associated with a moderate La Niña event likely was the major contributor to the extreme rainfall in southeast Australia during March 2012, with climate change a smaller and uncertain contributor

References

- Lewis, S.C. and D. J. Karoly (2013) Anthropogenic contributions to Australia's record summer temperatures of 2013. *Geophys. Res. Lett.*, **40**, 3705-3709.
- King, A.D., et al. (2013) Limited evidence of anthropogenic influence on the 2011–12 extreme rainfall over southeast Australia, *BAMS*, **94**, S55-58
- Christidis, N., et al. (2013) An attribution study of the heavy rainfall over eastern Australia in March 2012, S58-61
Both in “Explaining Extreme Events of 2012 from a Climate Perspective”, T. Peterson et al., *BAMS*, **94**, Sept 2013.
- King, A. D., et al. (2014) Climate change turns Australia's 2013 Big Dry into a year of record-breaking heat. *BAMS*
- Lewis, S.C., and D.J. Karoly (2014) The role of anthropogenic forcing in the record 2013 Australia-wide annual and spring temperatures. *BAMS*