Data requirements for detection and attribution of extremes

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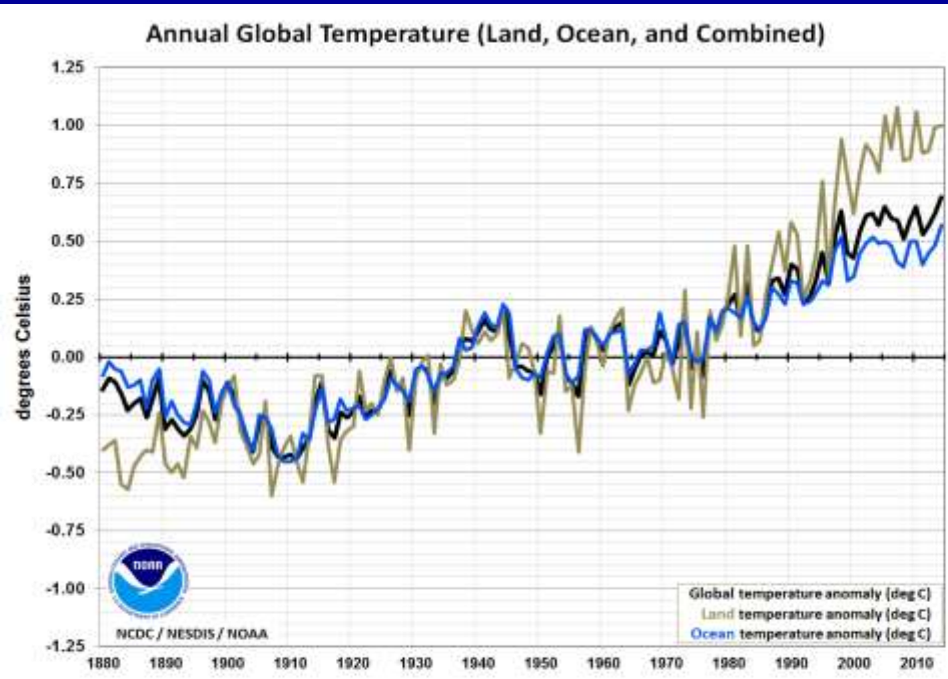

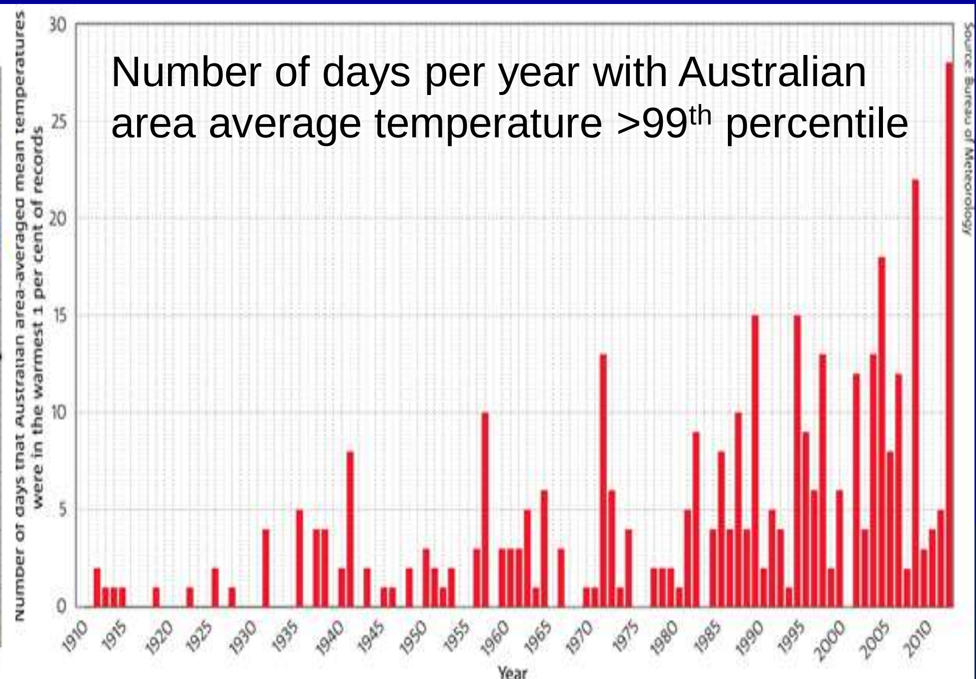

Overview

- Background: IPCC AR5 conclusions on extremes
- What is needed for detection and attribution?
- Event attribution: 2012/13 record summer Australian temperatures

Acknowledgements

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

CMIP5 D&A simulations

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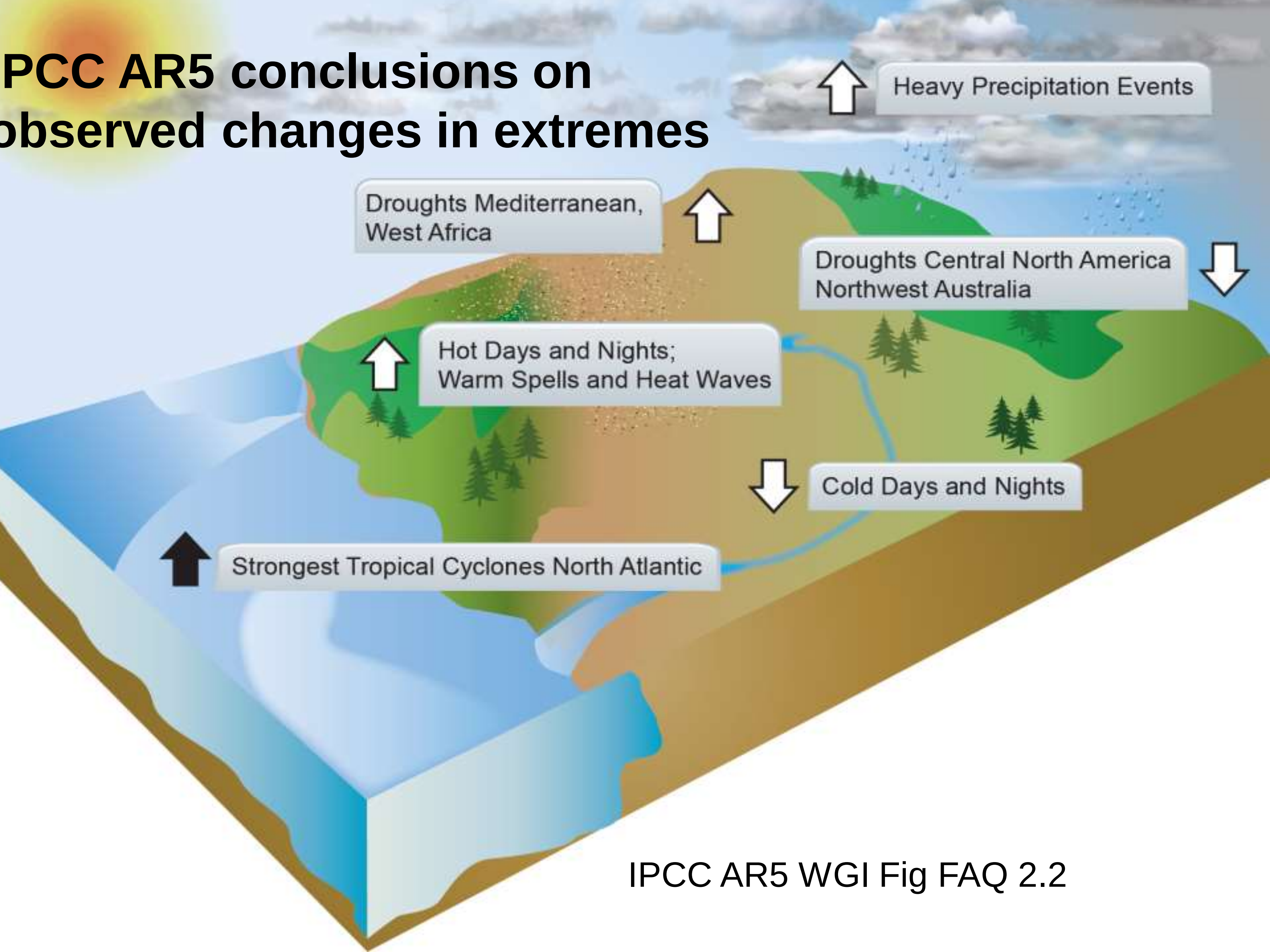
PCC AR5 conclusions on observed changes in extremes



IPCC AR5 WGI Fig FAQ 2.2

What is detection and attribution?

Attribution of climate change to specific causes involves statistical analysis and the careful assessment of multiple lines of evidence to demonstrate that the observed changes are:

- unlikely to be due entirely to internal climate variability;
- consistent with the estimated responses to a given combination of anthropogenic and natural forcing; and
- not consistent with alternative, physically plausible explanations of recent climate change

Why use detection and attribution?

- Identify the likely cause or causes of significant observed changes
- Evaluate the performance of models in simulating natural variability and the response to forcings
- Provide greater confidence in model projections of future changes

Requirements of detection and attribution?

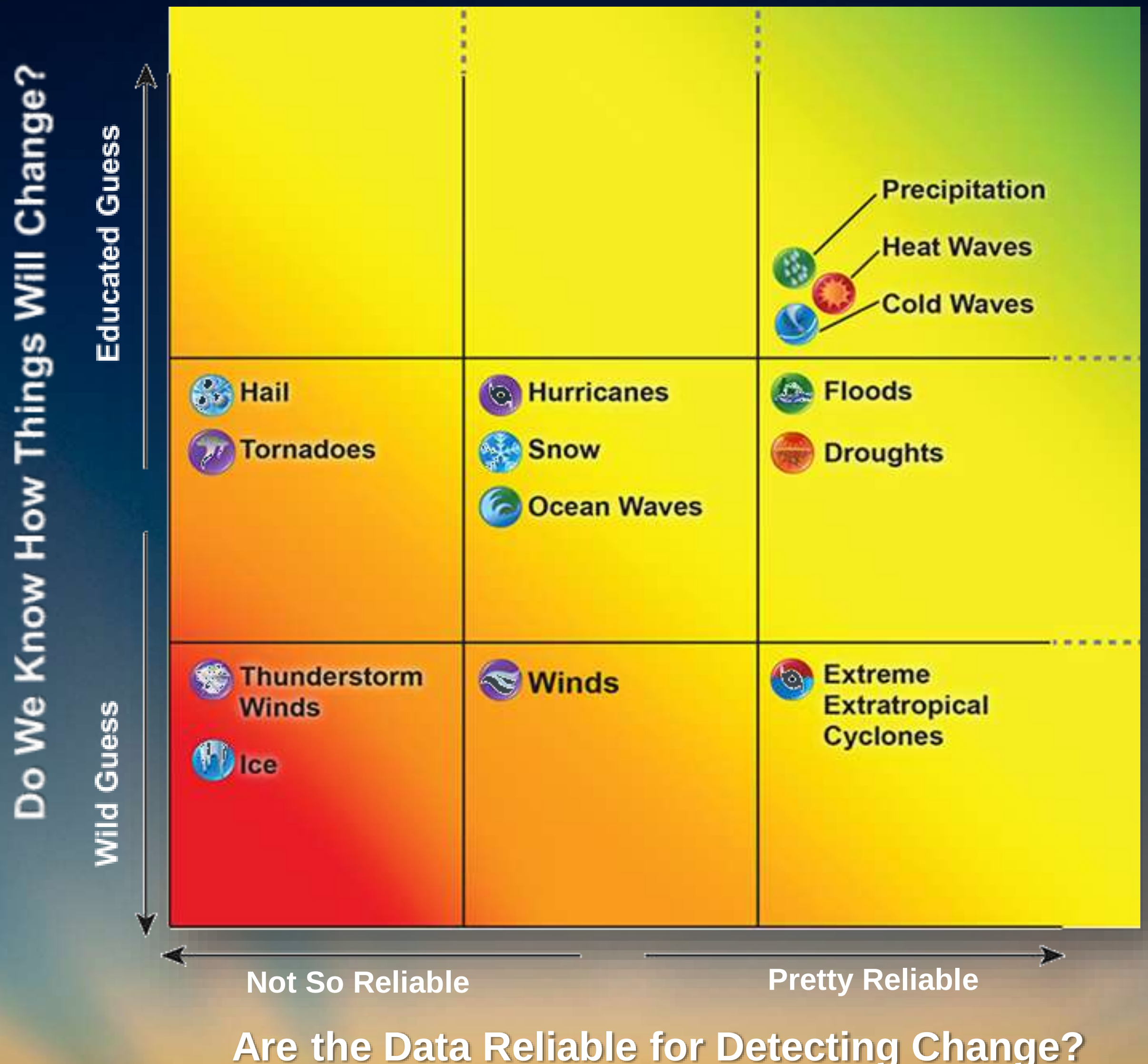
- Variable with high signal-to-noise ratio
- Long observational record
- Long control model simulations and ensembles of forced climate model simulations
- Consistent response to specified forcings between different models – consistent signals
- Separable signals between different forcings
- Statistical analysis methods that enhance signal relative to noise and for identifying signals in observed changes

Observational requirements

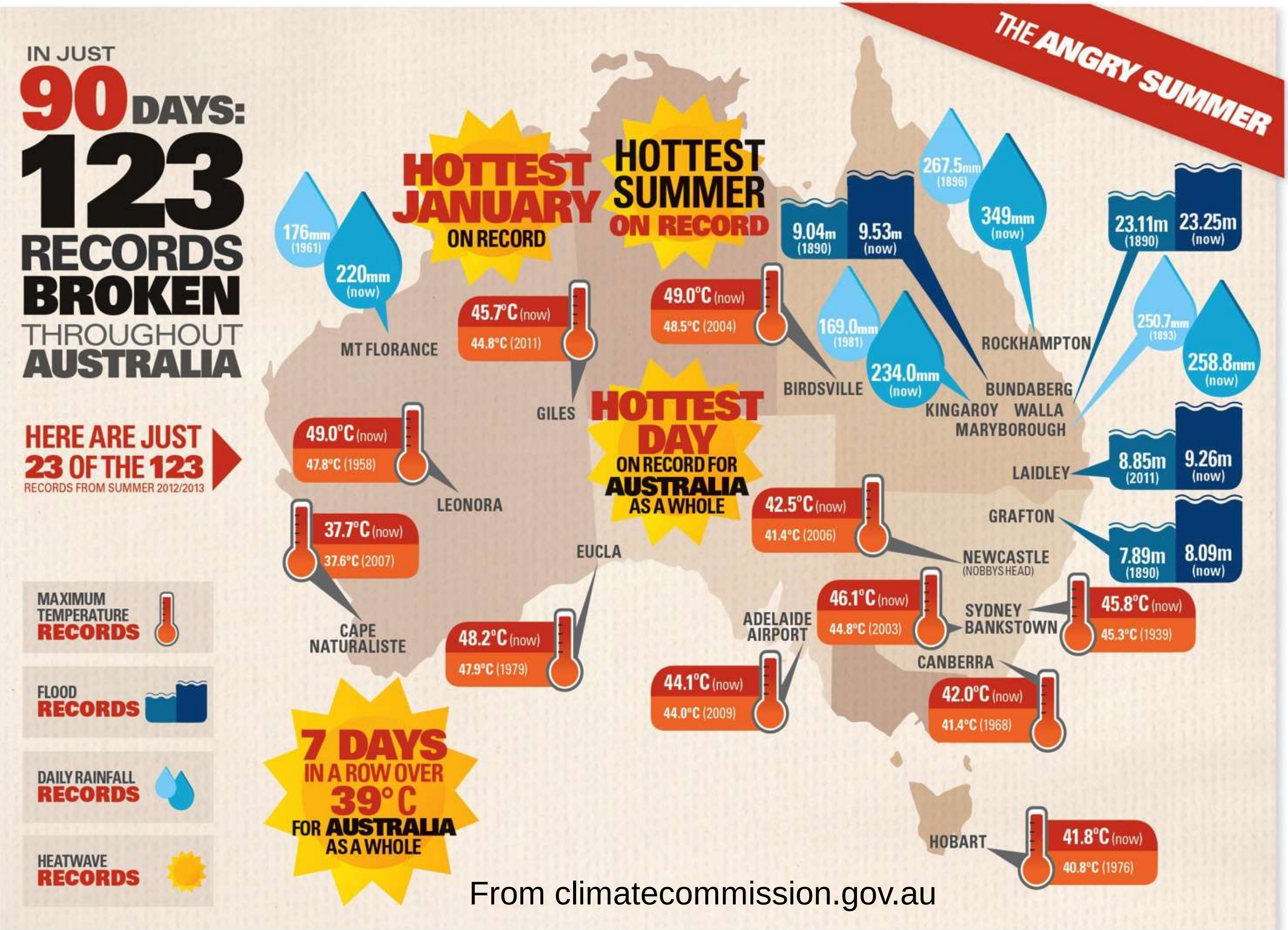
Having identified a variable with potential high signal-to-noise ratio and model simulation capability, need

- Long, high quality, homogeneous and continuous observational record
- Good spatial and temporal resolution – space and time averaging is likely to enhance signal-to-noise
- Good uncertainty estimates, preferably multiple independent datasets or analyses

Putting It All Together



From Russ Vose, Wednesday



From climatecommission.gov.au

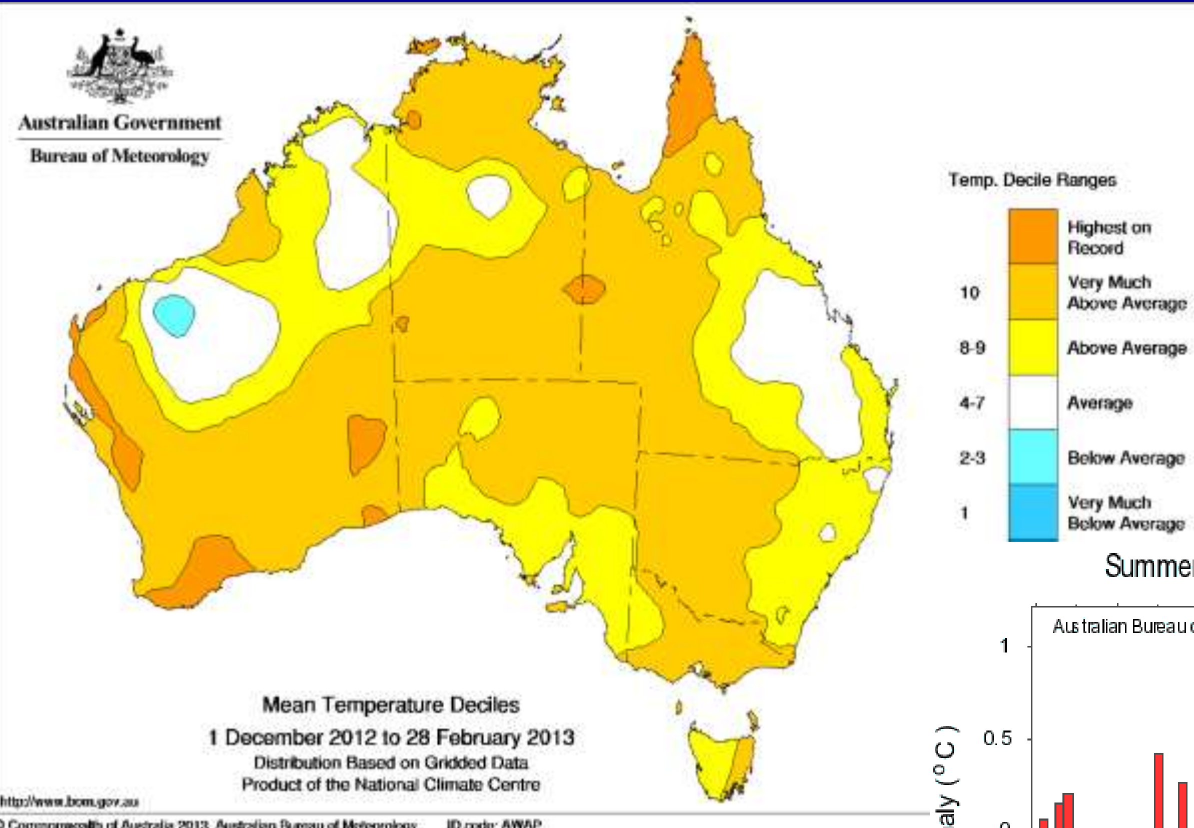
DATA SOURCES: BoM. (2013a). *Special Climate Statement 43 – extreme heat in January 2013*; BoM. (2013b). *Special Climate Statement 44 – extreme rainfall and flooding in coastal Queensland and New South Wales.*

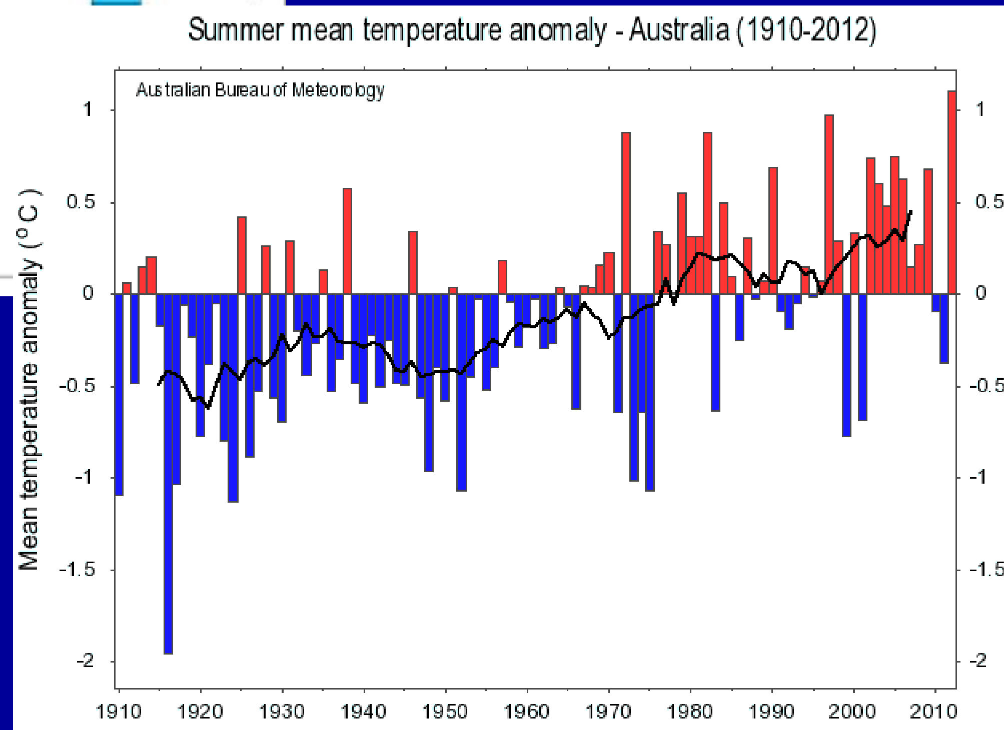
Attribution of extreme events

- Evaluate the performance of a climate model in simulating the observed variability of the type of event
- Determine the likelihood of exceeding a threshold under different forcing conditions
- Determine the Fractional Attributable Risk, $FAR = 1 – P_0/P_1$ where P_0 is the probability of exceeding the threshold in the “control” climate, and P_1 is the probability of exceeding the threshold in the perturbed climate

The Angry Summer 2012-13

Record temperature across Australia during summer 2012-13





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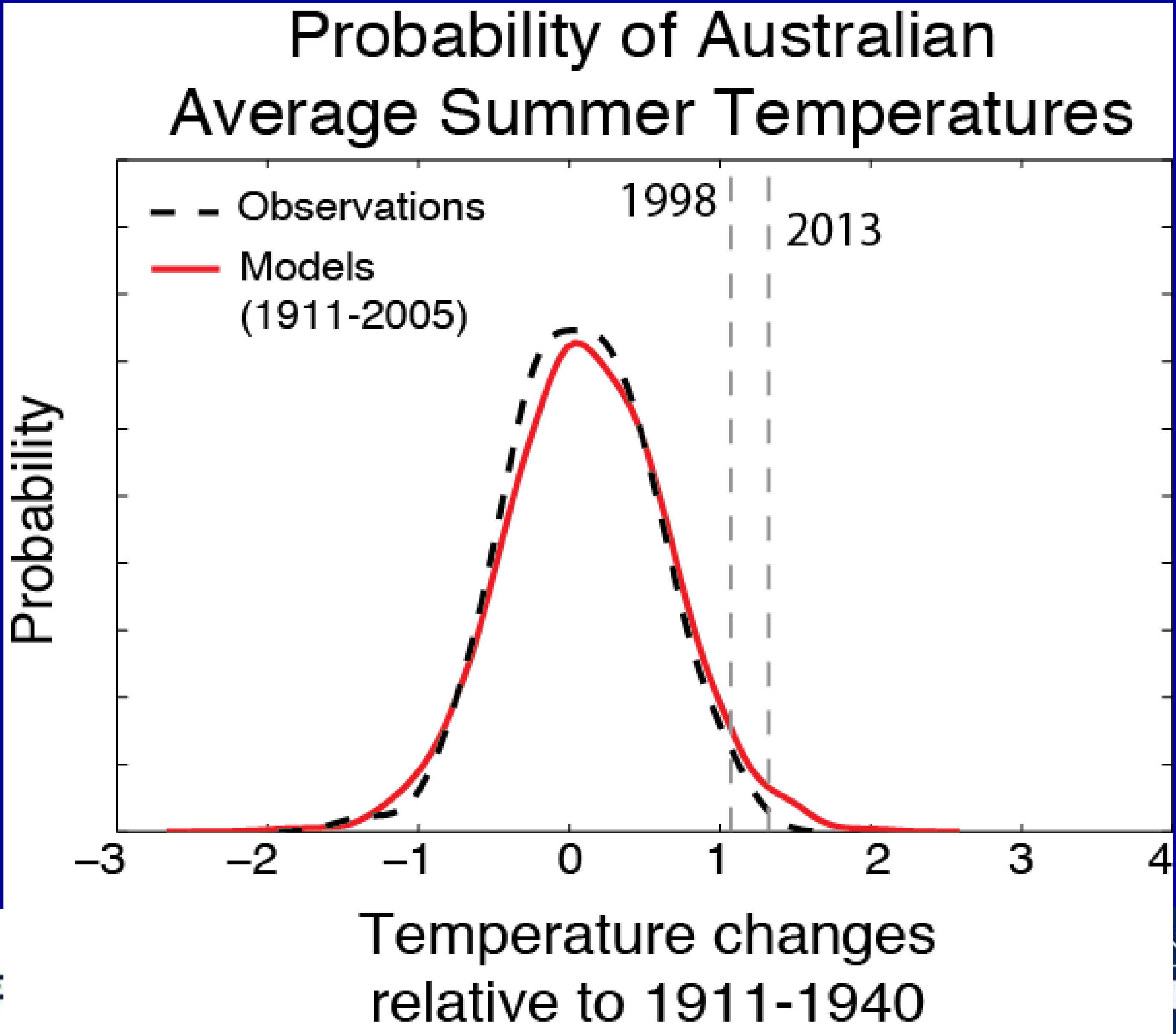
The Angry Summer 2012-13

CMIP5 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



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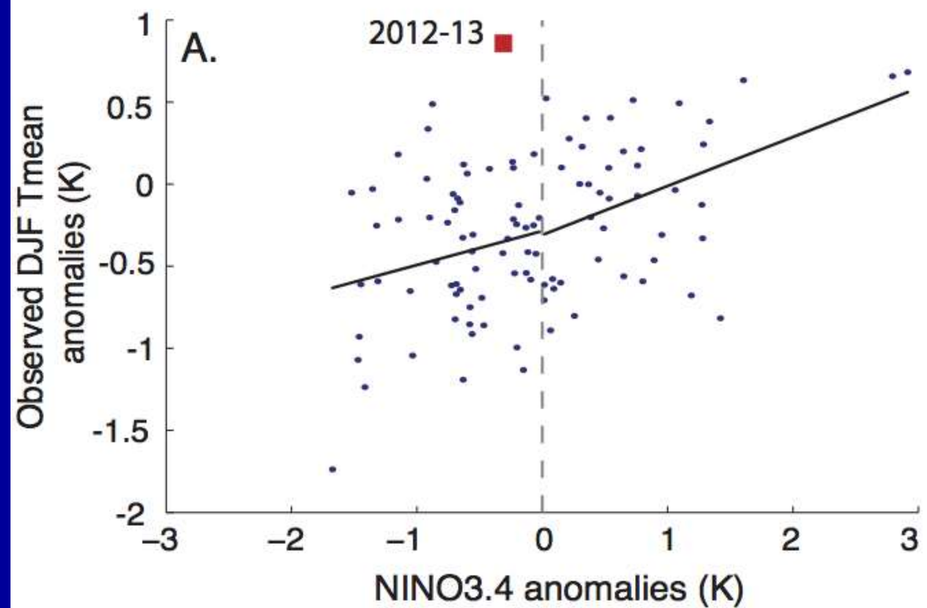
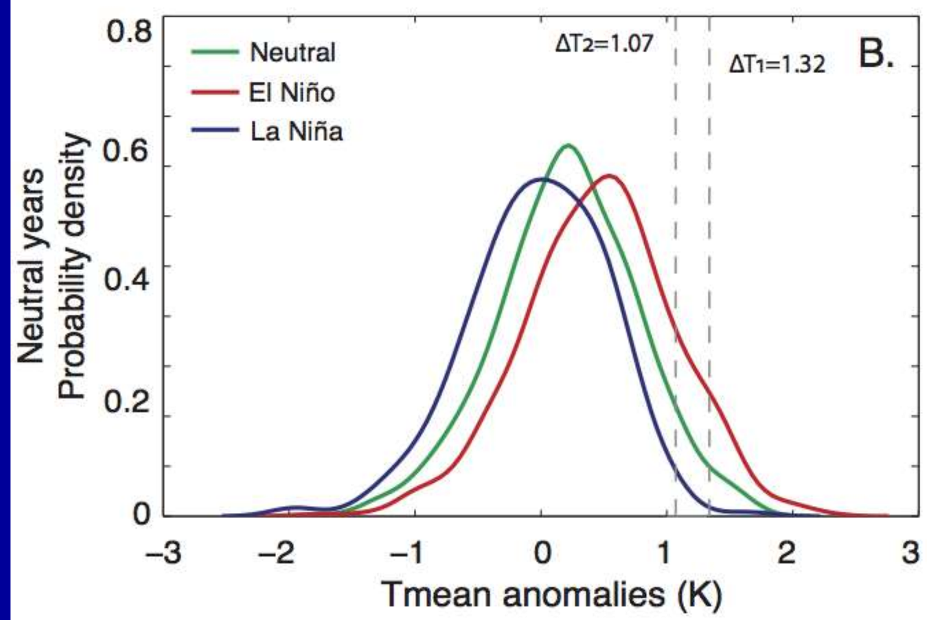
The Angry Summer 2012-13

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





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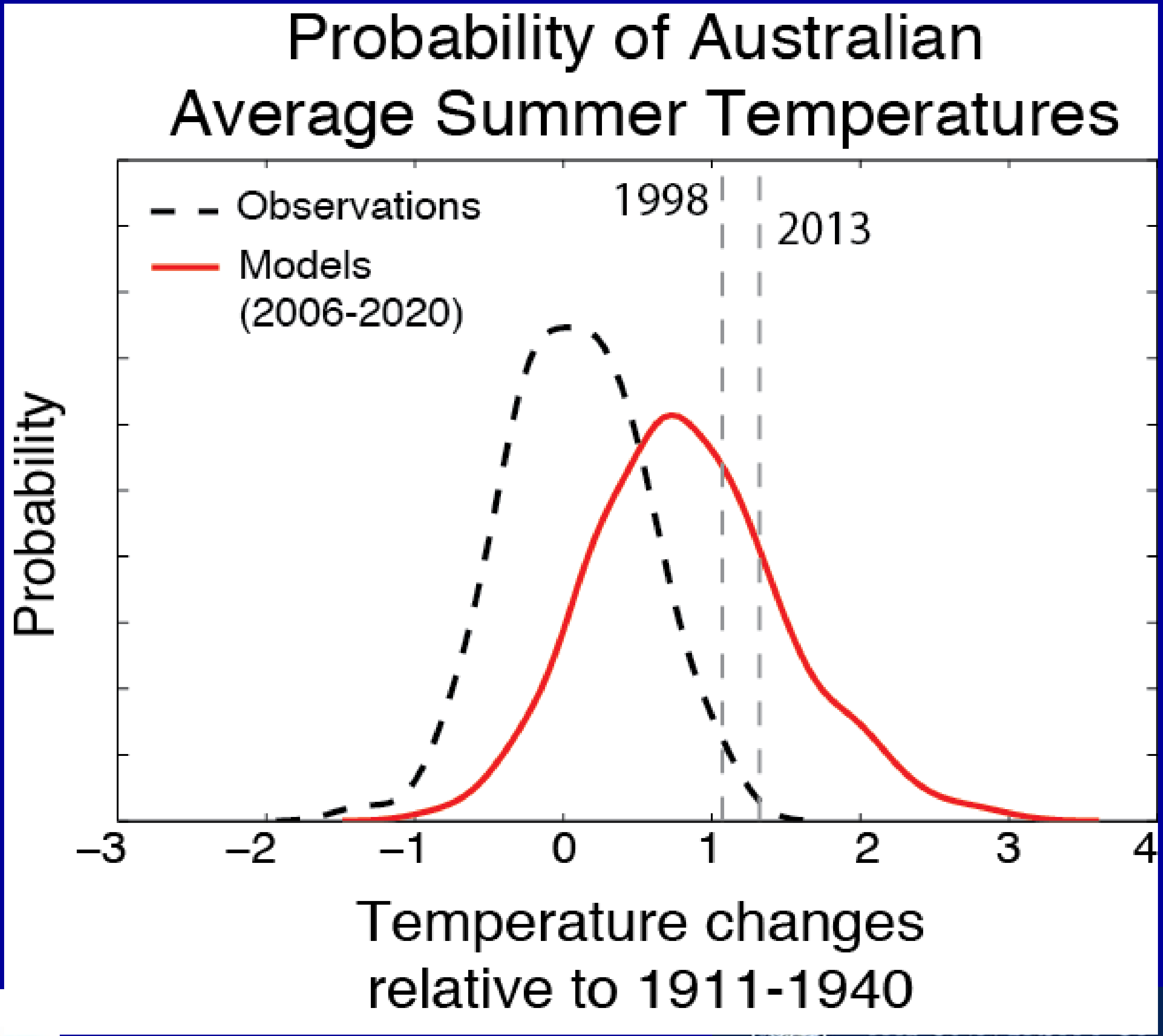
The Angry Summer 2012-13

Change in probability of extreme summer temperatures for a warming climate

At least five times increase in probability of summer temps > in 1998 due to human influence on climate

Lewis and Karoly (2013) GRL



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Summary

- Observational requirements:
  - long, continuous, homogeneous data records
  - good space and time resolution
  - uncertainty estimates, multiple independent analyses
- Detection and attribution:
  - identify a significant observed change
  - demonstrate the change is consistent with specific forcings
  - not consistent with other forcings
- Anthropogenic climate change has very likely increased the chances of extreme summer temperatures across Australia, such as in 2012-13, by at least a factor of five already

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. (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*

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