ARC CENTRE OF EXCELLENCE FOR CLIMATE SYSTEM SCIENCE

Australian Government
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Climate change, climate variability and climate extremes

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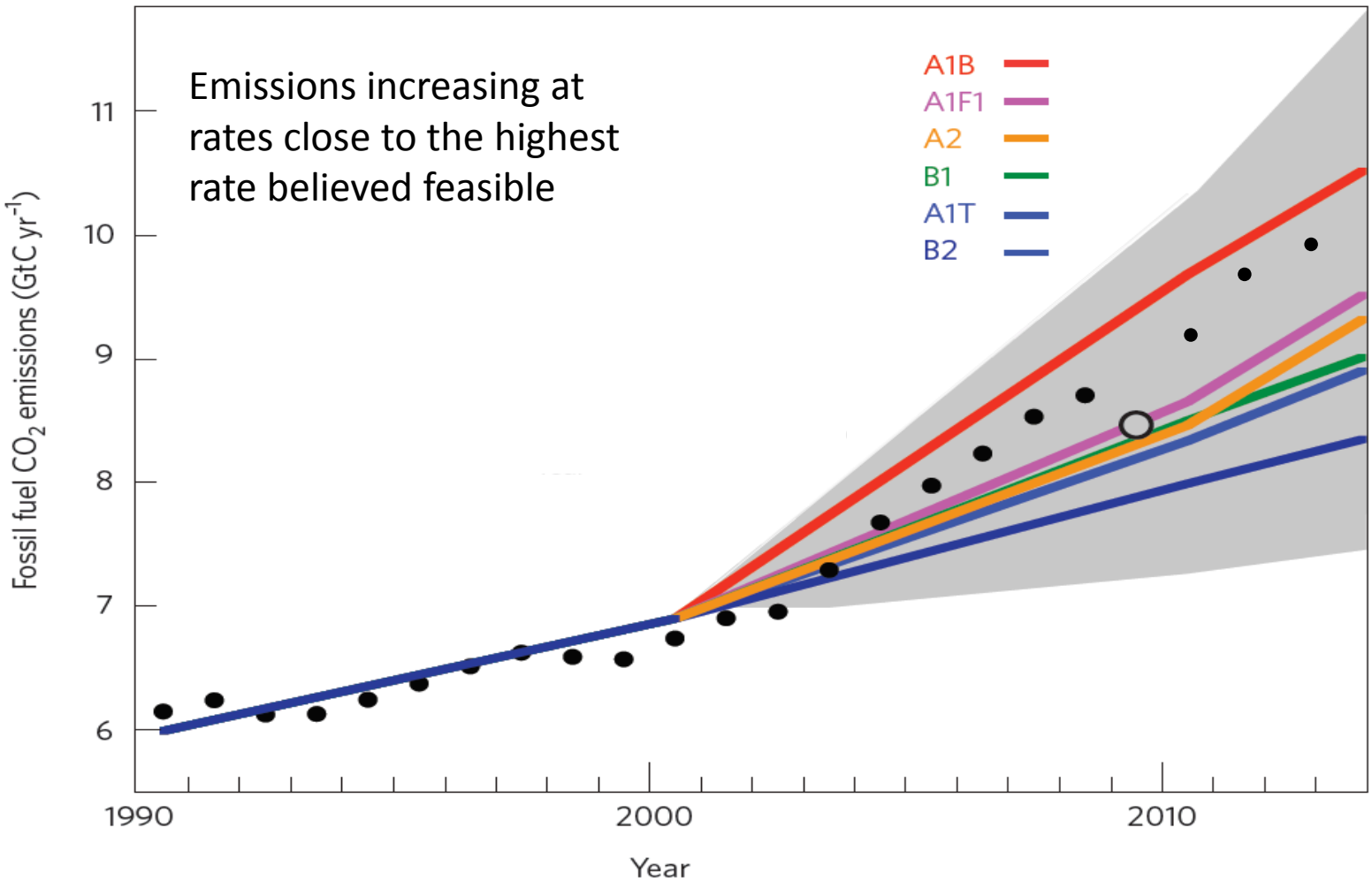
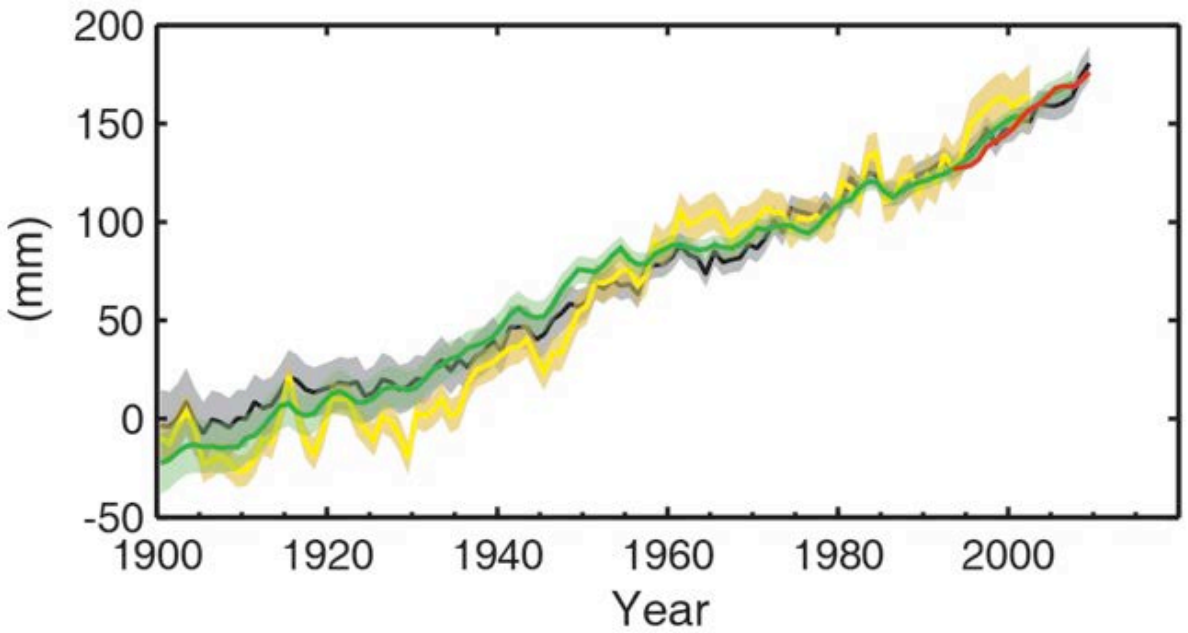
Outline

- Latest global science
- Drivers of change over Australia
  - Greenhouse gases
  - Modes of variability
- The future

We know emissions are increasing



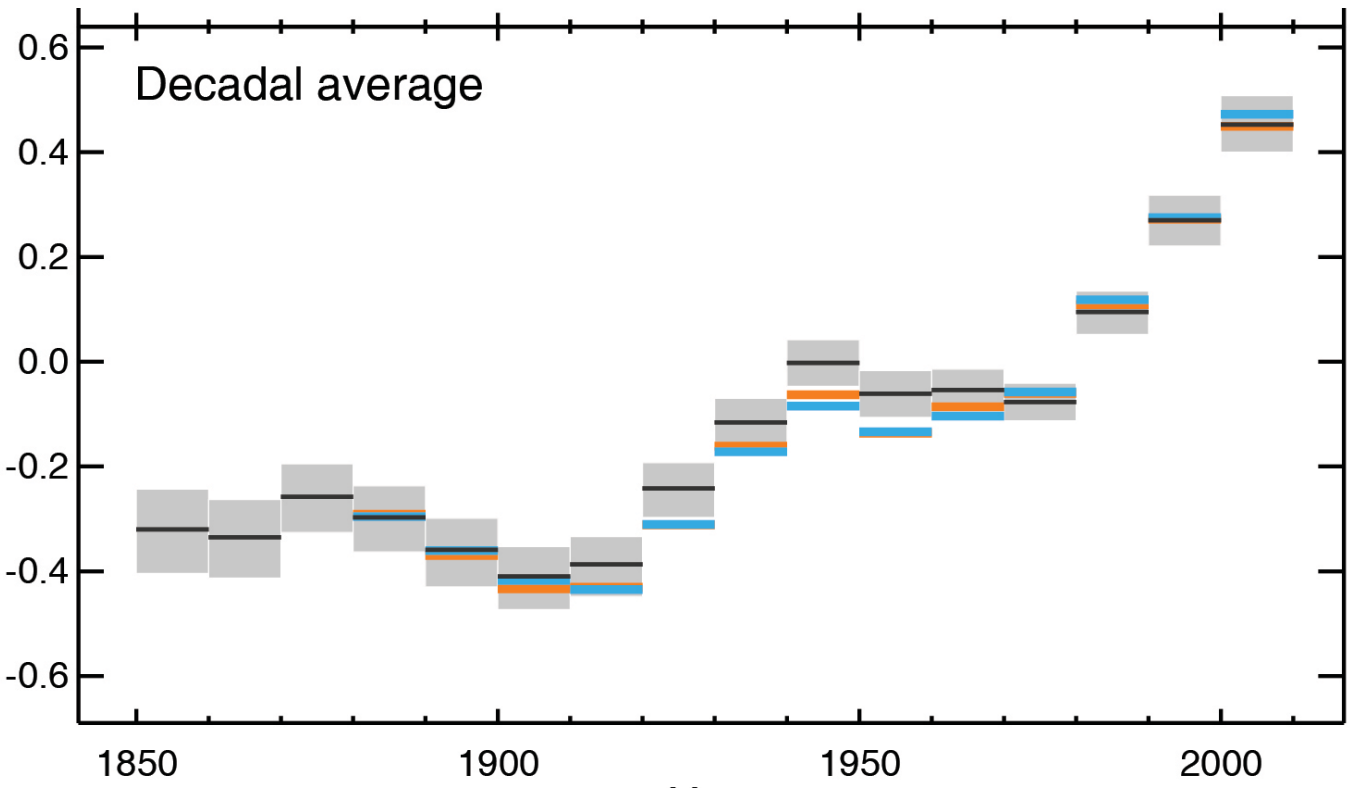
We know sea level is rising



Global average sea level has risen by 0.19 metres over the 20th century (1901 to 2010)

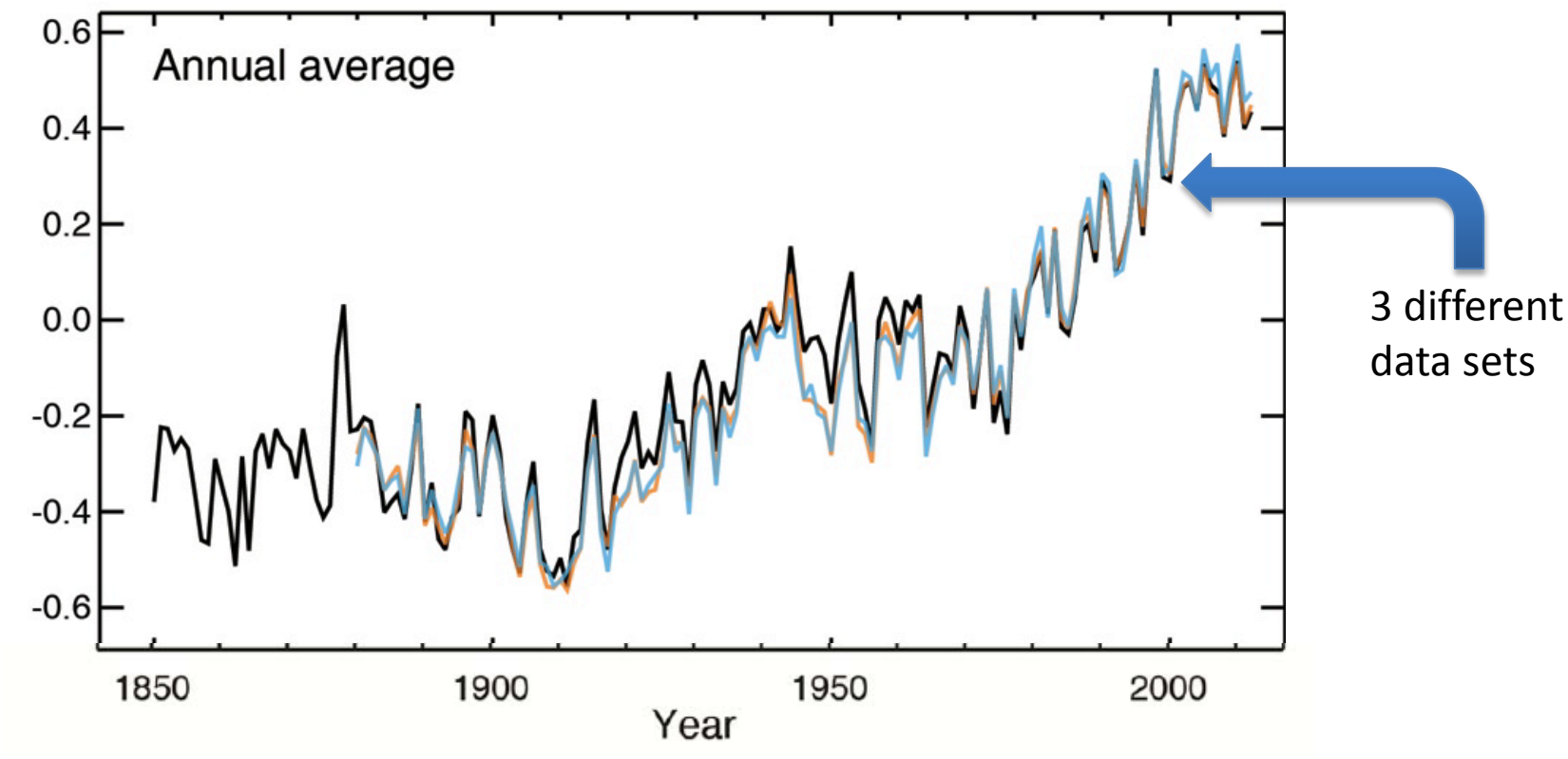
The recent rate of sea level rise is unusual in the context of the last 2000 years.

Global temperatures are rising …



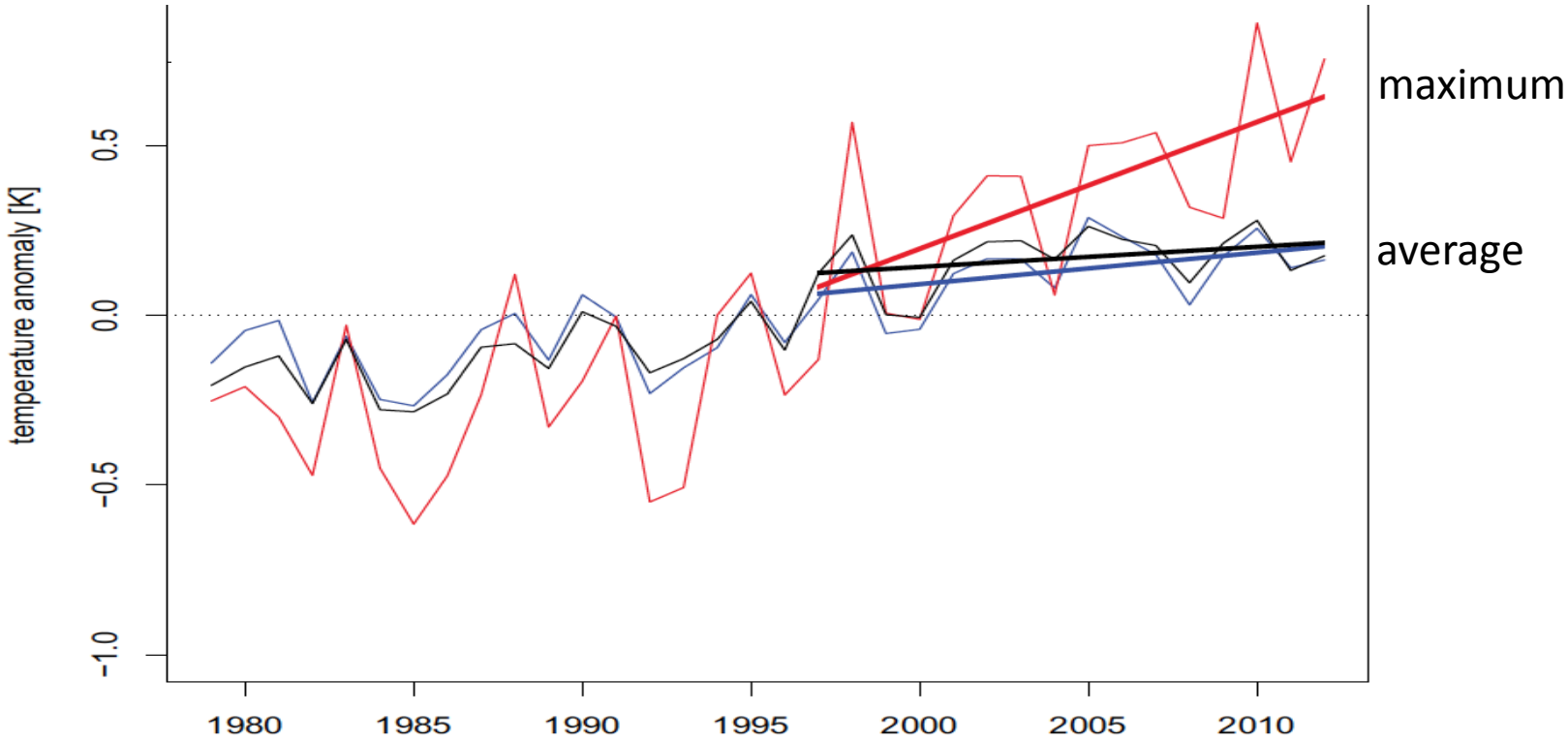
Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

Global temperatures are rising …



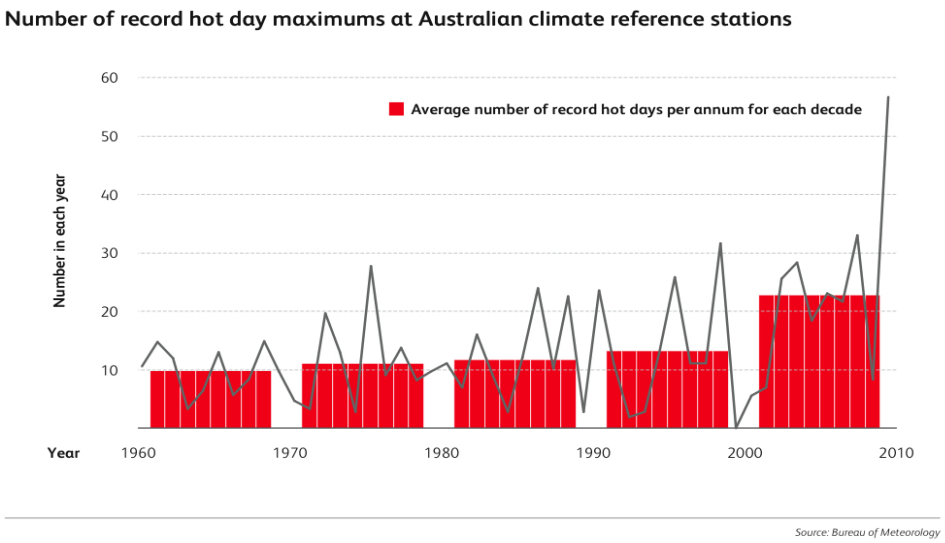
Global average air temperature has increase by around 0.89°C since the start of the 20th century (1901-2012)

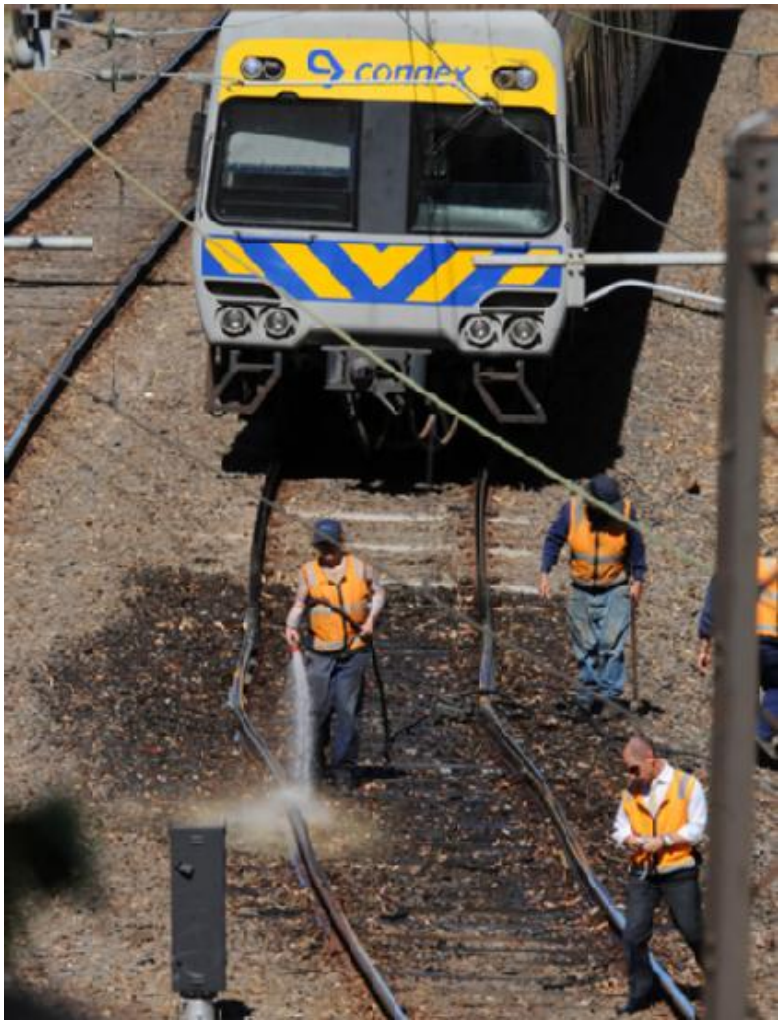
Temperature extremes are rising …



Seneviratne, Nature Climate Change, 2014

Heat waves: health & infrastructure





<u>January 2009 - Southern cities</u>

Costs: >200 premature deaths; losses ~$800 M +
Heat waves are already

- getting earlier,
- more intense
- lasting longer

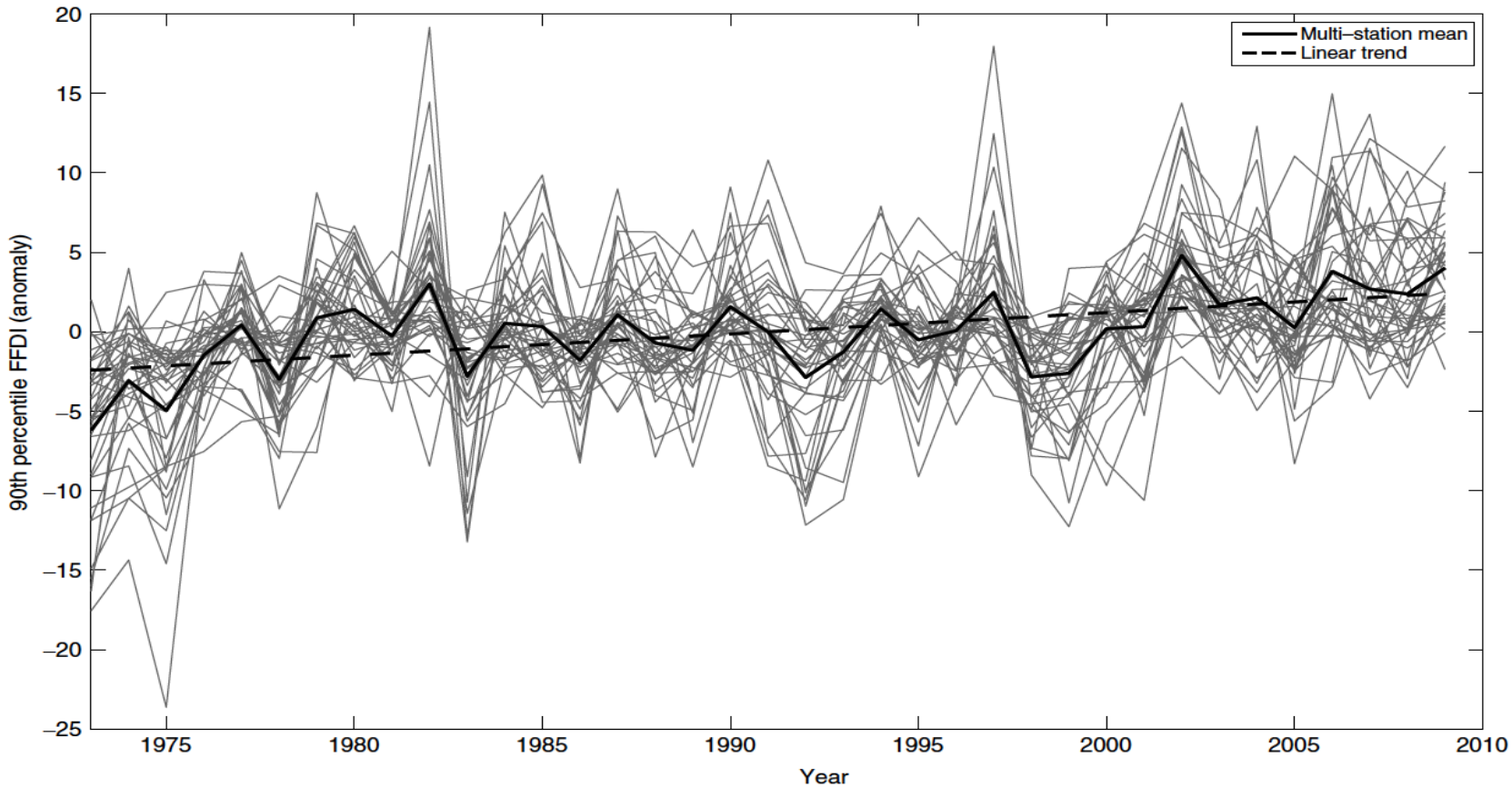
Frequency of heat waves expected to

- double by 2030;
- triple by 2070

BoM 2010; Stafford Smith 2009; Perkins & Alexander, 2013

Other extremes: bush fires

- Bush fire risk … extreme risk [FFDI > 90th percentile]



Clarke et al., 10.1002/joc.3480

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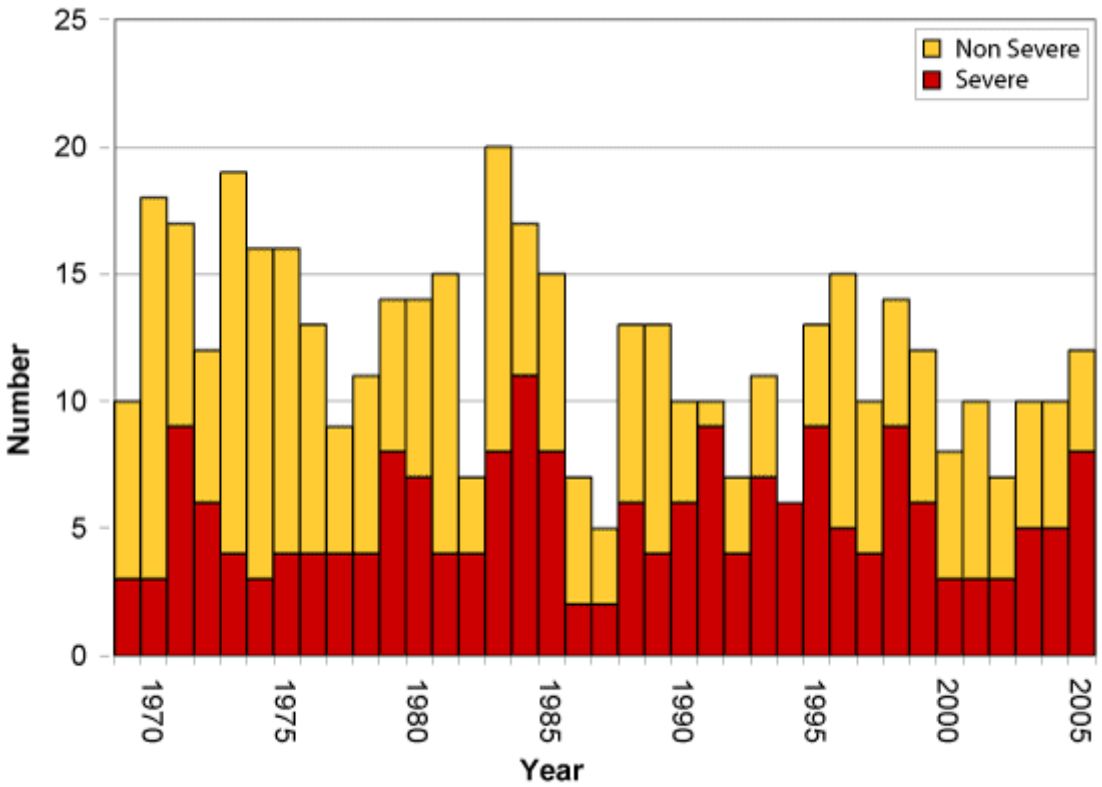
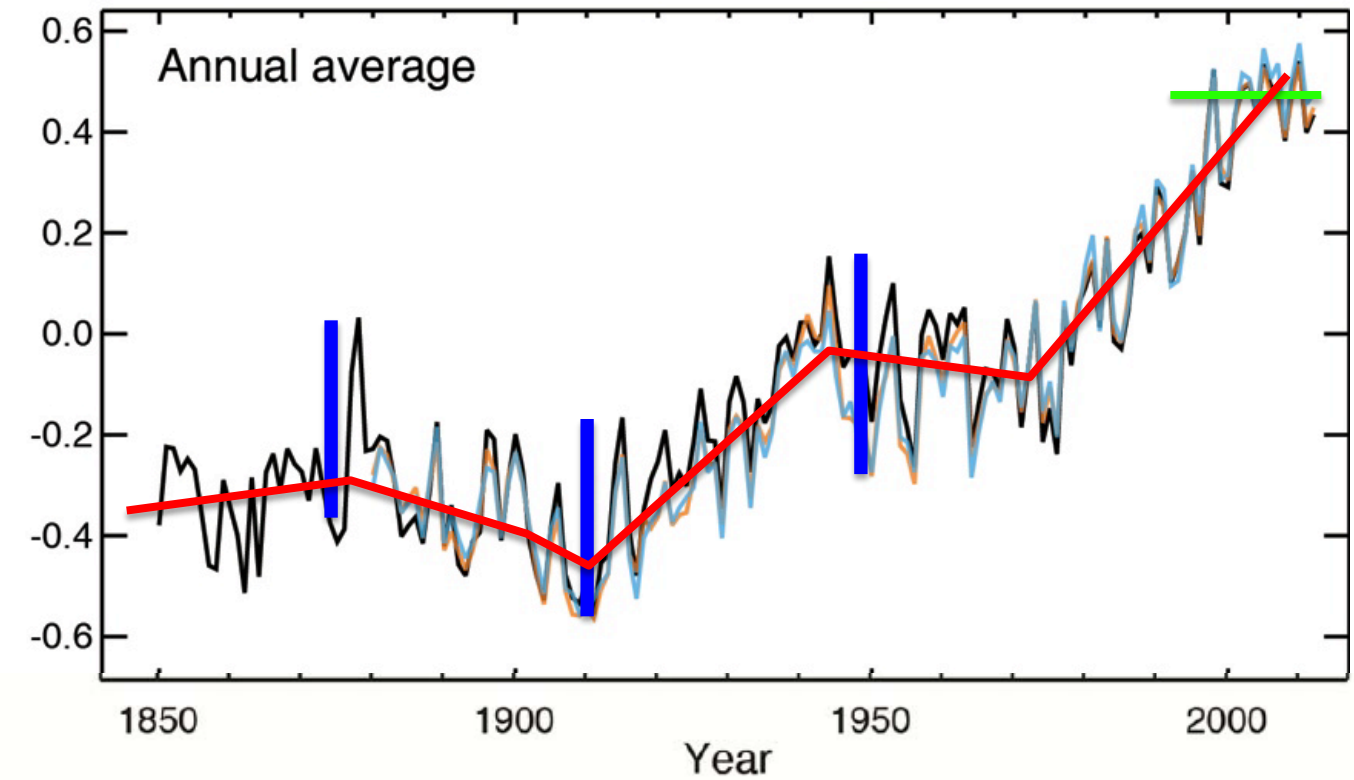
Other extremes: Cyclones ...



Number of severe and non-severe tropical cyclones from 1970 - 2005 (BoM 2010).

The “hiatus”

Only in the mean, in some regions.

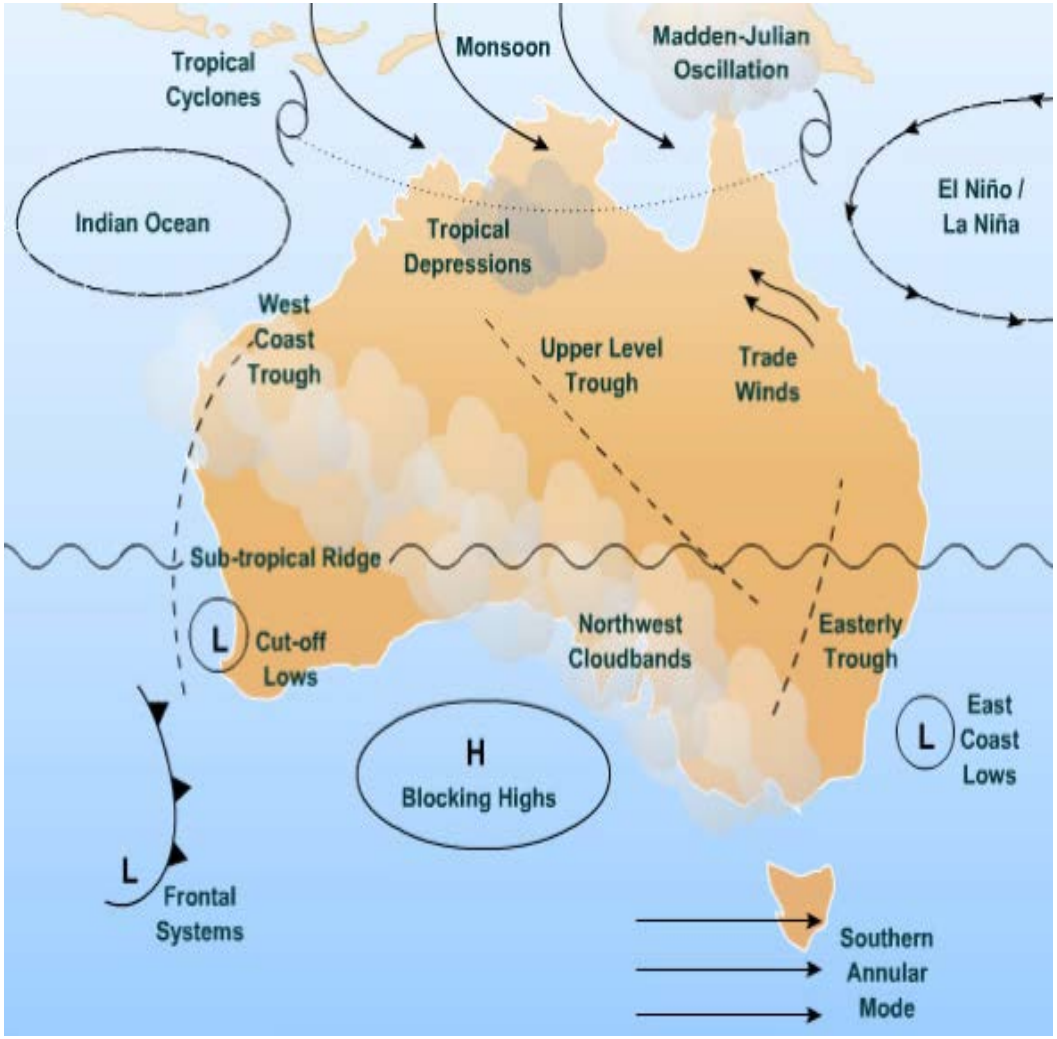


Modes of variability

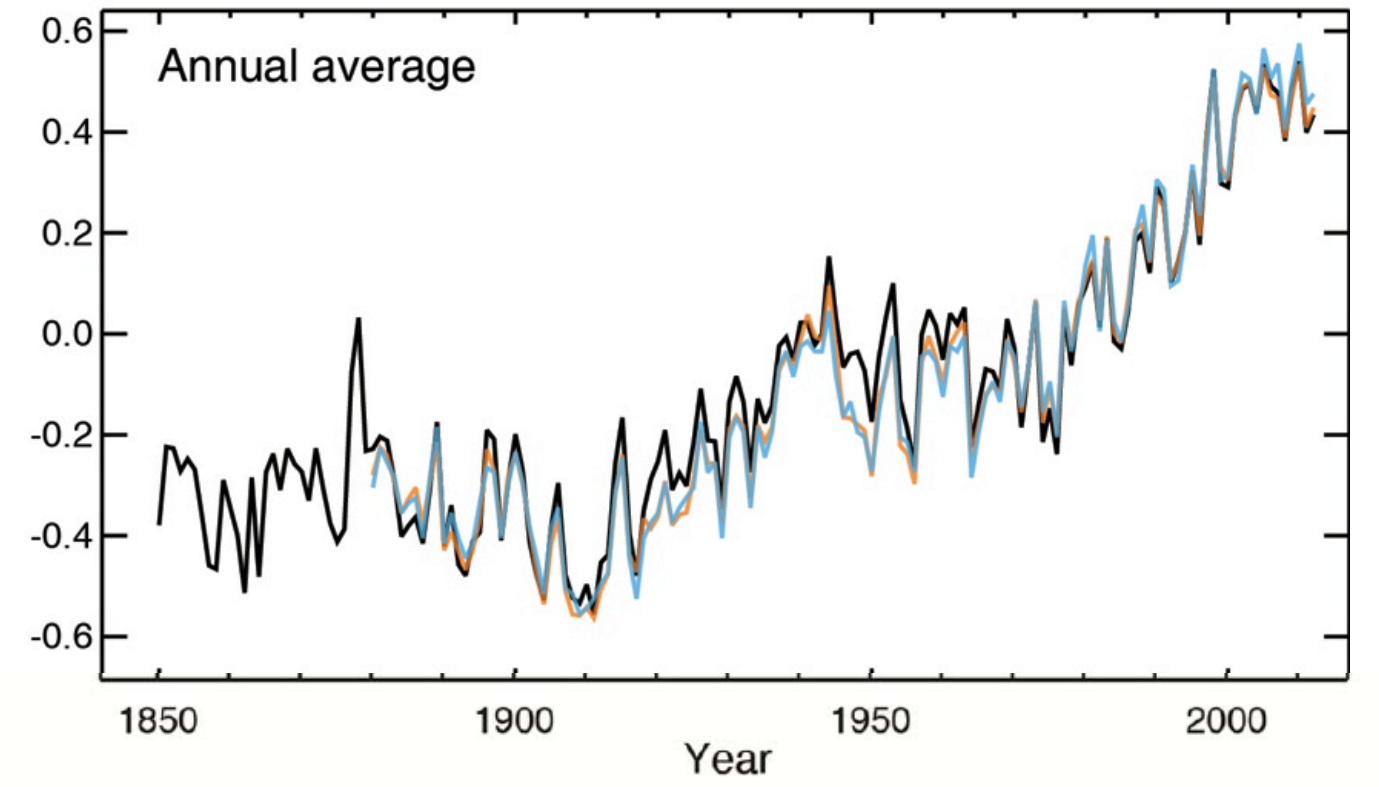
Variability – ENSO, IOD, SAM, aerosols, sun spots, NAO ….

Trend – substantially driven by greenhouse gas increases

Modes of variability



- Large scale drivers in time and space
- Explain 30-50% of variability
- Future sensitivity is poorly known
- Interactions between modes critically important

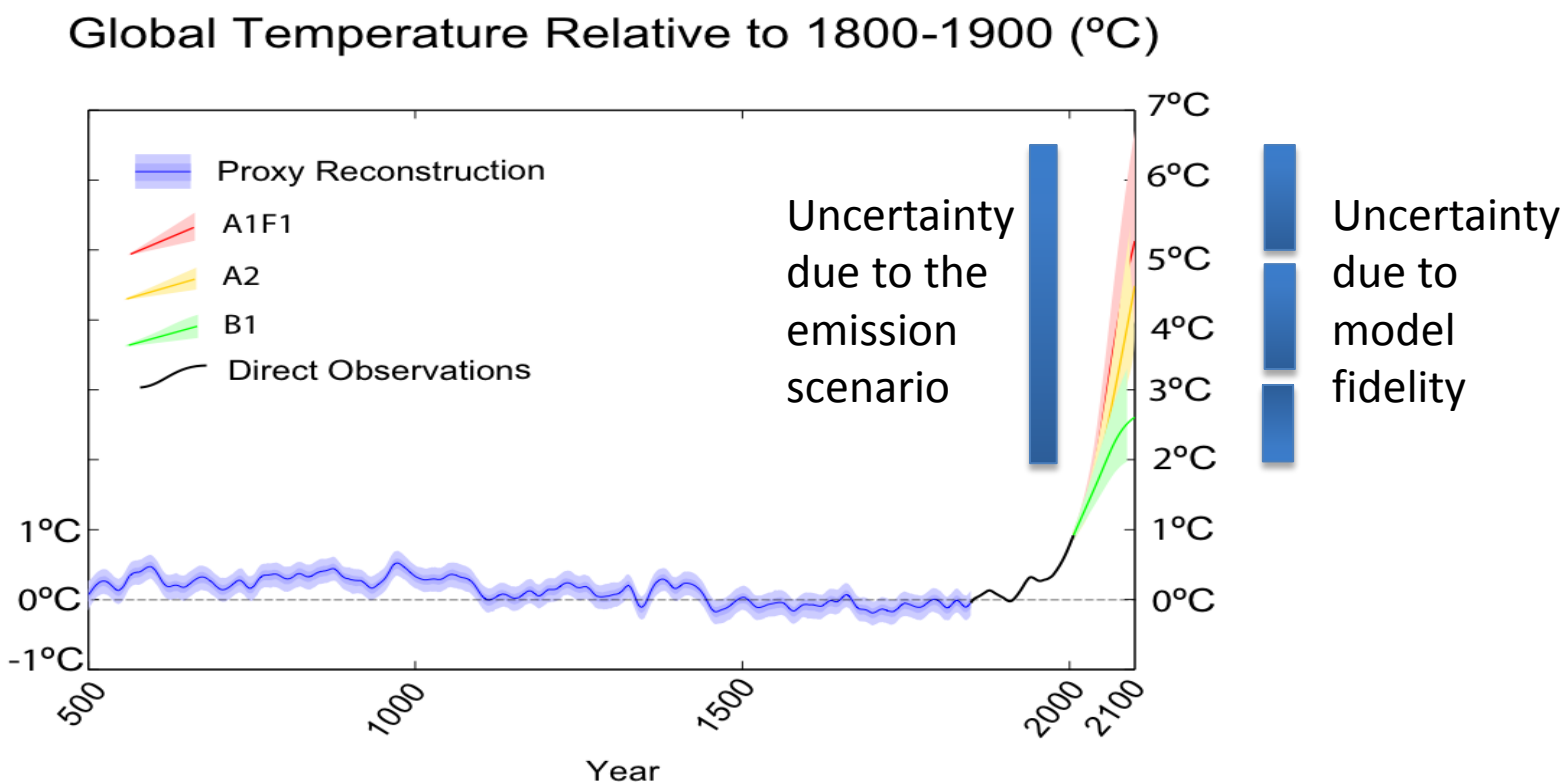


Variations on timescales of:

- 1-7 days is weather prediction. Initial value problem.
- up to many months is seasonal prediction. Caused by modes of variability
- Up to a decade is decadal prediction. Caused by modes of variability + forcing
- From decades to centuries is climate prediction. Caused by long term forcing (CO_2, CH_4 etc)

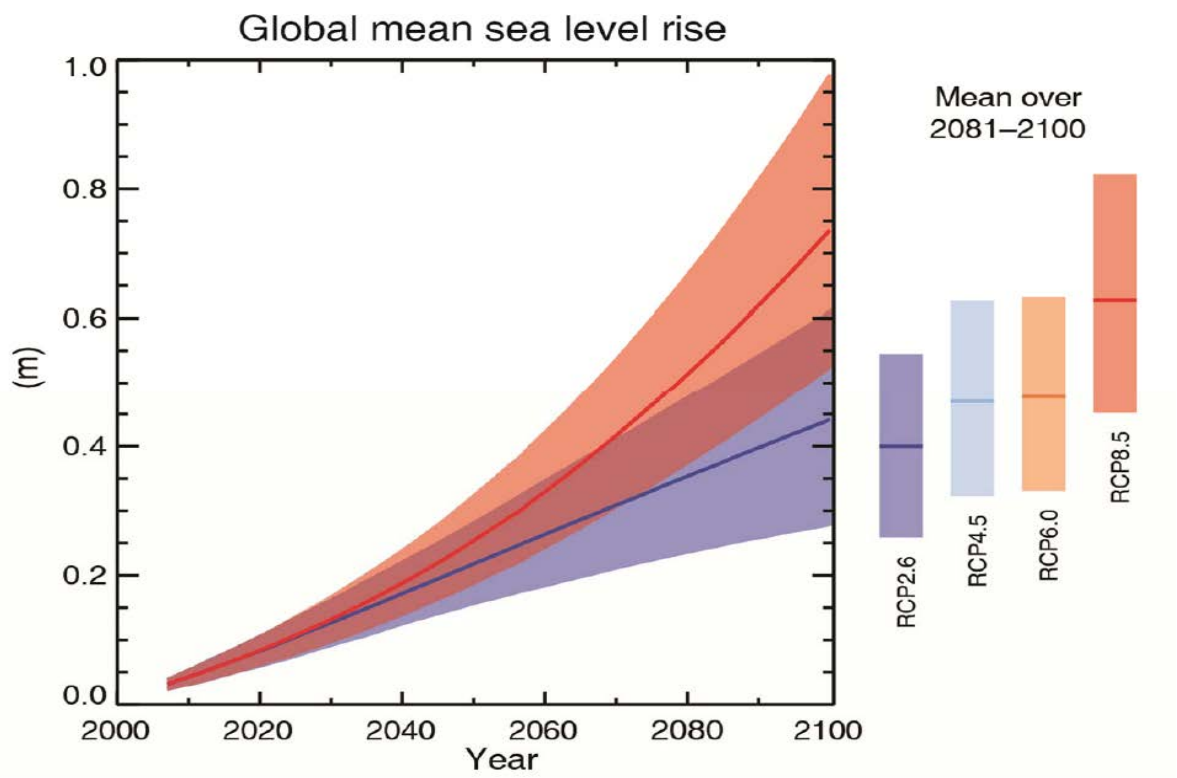
Future warming

- Simulating future trends is a matter of emissions



- Simulating the timing and interactions between modes of variability to give *timing* of regional variability exceeds capacity

Sea level rise

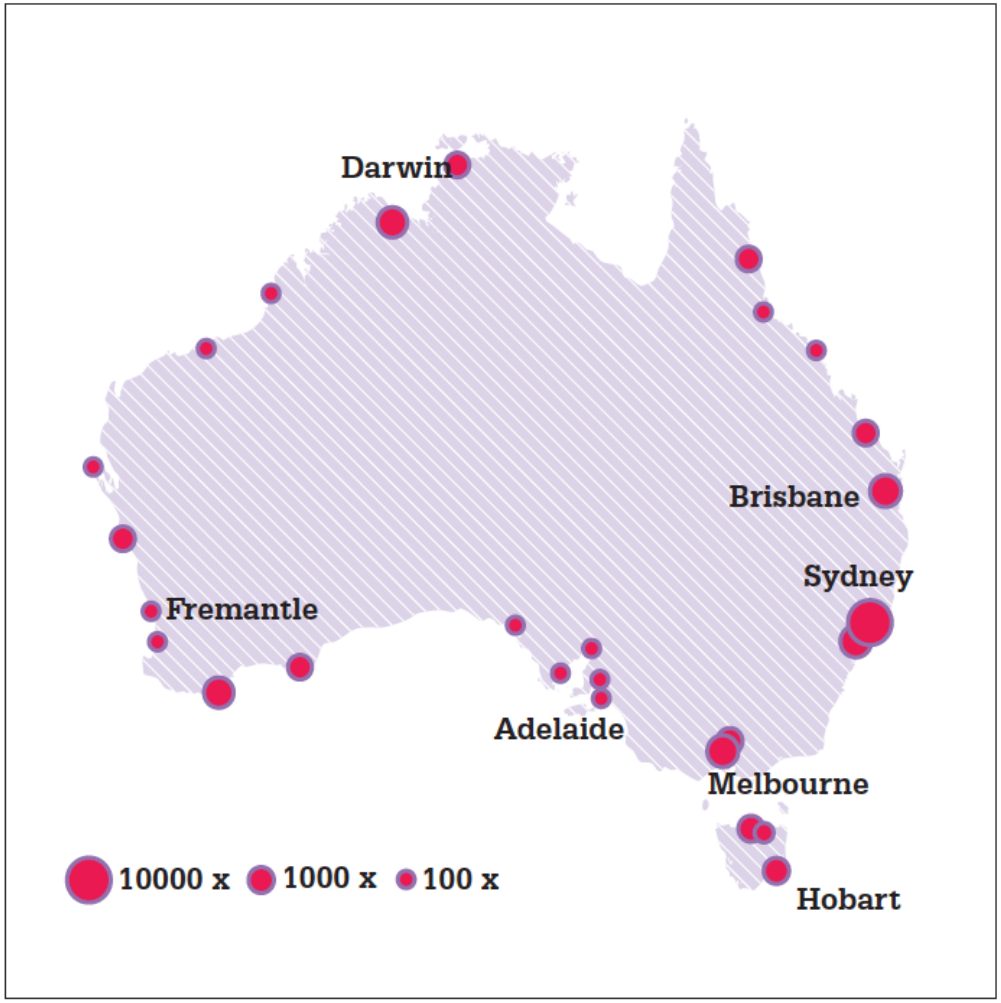


Fairly simple – basic thermodynamics

Global mean sea level will continue to rise:

Assume 1 m by 2100 excluding storm surge

Sea level rise



Source: ACE CRC 2008.

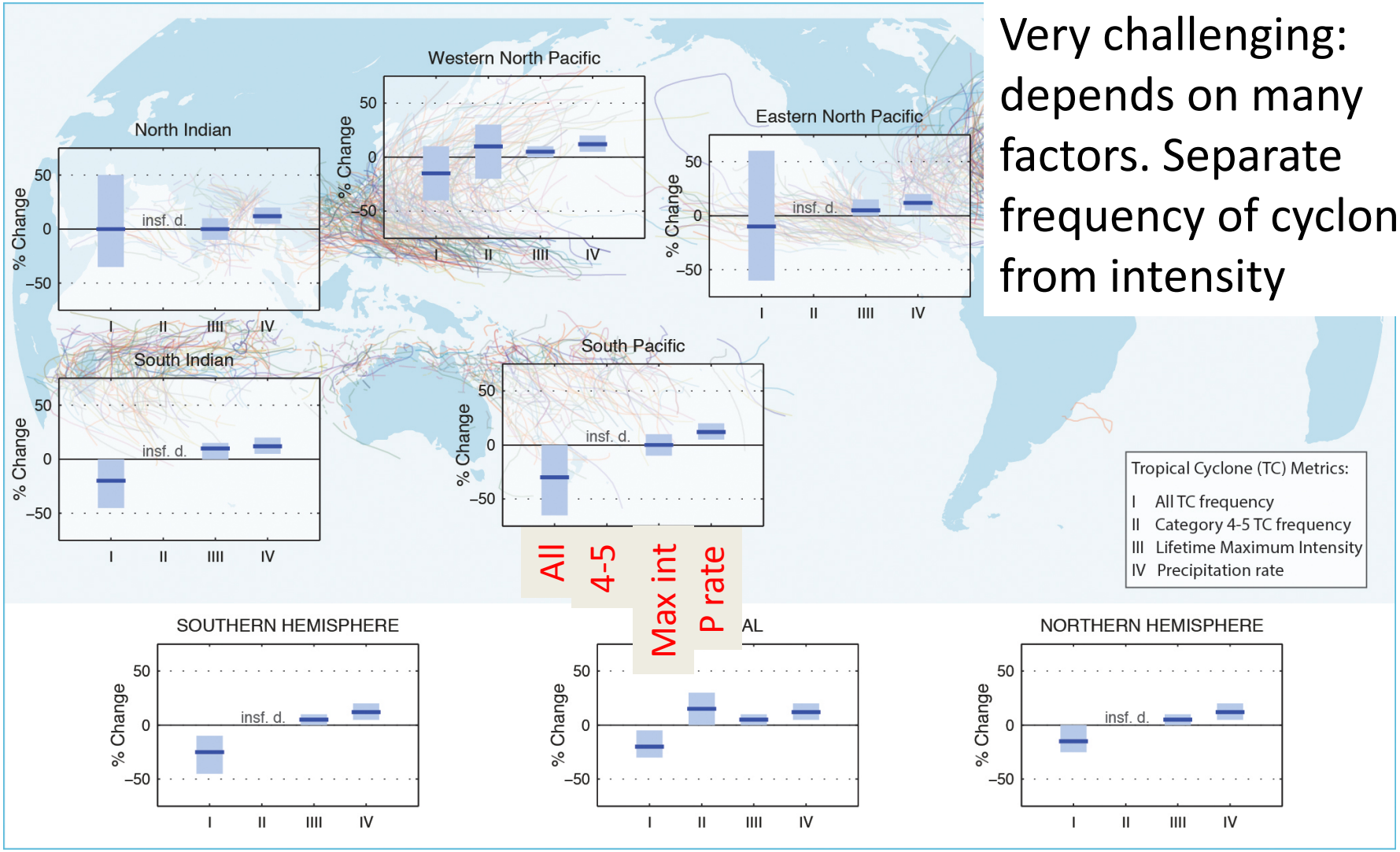
Easy to do of you know the mean change – just probabilities with a changing mean

So: with a 0.5m SLR

- Once per decade becomes 1000 times a decade or every 3 days
- Once per century becomes 1000 times a century or 10 times a year

We expect 1m by 2100

Future tropical cyclone activity



Very challenging: depends on many factors. Separate frequency of cyclones from intensity

Confidence in projections – to 2050

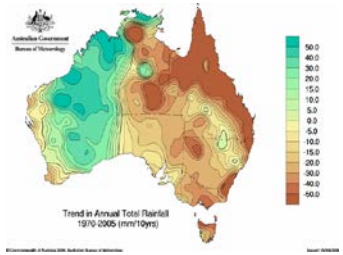
Decreasing value

Decreasing skill

✔

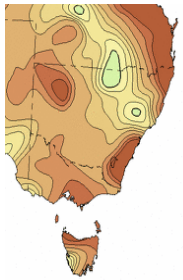
Global

✔



Continent

? - developing



State

✗

City / catchment

The Science situation

We are not on track to limit warming to 2°C

- Want a 75% chance of not exceeding 2°C ?
  - If emissions grow at 3.5% per year, carbon budget runs out in 2021
  - If emissions fall by 2% per year, carbon budget runs out in 2030
  - If emissions fall by 4% per year, carbon budget runs out in 2040

- implausible – we will exceed 2°C and and plausibly 4°C. Plan for the consequences

A significant investment in building resilience, minimizing vulnerability, developing a detailed understanding of your vulnerability to climate and planning for significant climate change is the key message from IPCC AR5.

Conclusions

- Future changes depend deeply on what variable you are talking about:
  - Increases in T, sea level, ocean acidification are certain
  - Increases in extremes occurring faster than the mean
  - Increases in rainfall intensity, bush fires very probable.
  - Changes in some variables like cyclones less certain
  - Changes in some variables unknown (hail)

- Case-by-case studies of these variables can be illuminating if examined thoroughly

- Its emissions that control the scale of change so the scale of the problem is up to us